DESIGNING A DEMAND-DRIVEN SUPPLY CHAIN DASHBOARD

by

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Declaration

I certify that the minor dissertation submitted by me for the degree Master's of Commerce (Business Management) at the University of Johannesburg is my independent work and has not been submitted by me for a degree at another university.

SETOTA KEABETSWE RAMOSHEBI

Dedication

I dedicate this dissertation to my loving wife, Koketso MmaNaledi Ramoshebi, who encouraged me to register for a Master's degree

and

To Naledi, my daughter, to whom I say, 'Your timing couldn't have been better'.

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EXECUTIVE SUMMARY

The aim of this study was to design a demand-driven supply chain dashboard geared towards improving performance measurement in a medical technology company. In this case study, Becton Dickinson (BD) was used as an example of a medical technology company. Document analysis of BD supply chain documents was performed. Underpinning the qualitative content analysis construct was the SCOR® model supply chain performance attribute and a dashboard design framework. The combined strength of all the BD respondents' documents reviewed in this study was used to map design elements for constructing a demand-driven supply chain dashboard.

CHAPTER 1. INTRODUCTION

1.1. Introduction

Over the past years, more and more firms have come to perceive supply chain management as a lever of competitive advantage, a key pillar for a winning strategy, (Hugos, 2011:263). Demand management as a function of supply chain management has been recognised as pivotal to meeting a firm's financial performance (Shapiro, 2009:518).

Shapiro (2009:518) suggested that the synergy between a firm's performance and supply chain management is often not fully appreciated by business stakeholders; this is because supply chain managers often do not effectively articulate the importance of competitive supply chain management. Supply chains are often seen as cost centres as opposed to competitive levers (Ketchen, Rebarick, Tomas, Hult and Mayer, 2008). Supply chain managers should be able to explain financial performance matrix in supply chain terms and also demonstrate how pro-active supply chain management can help enhance a firm's financial performance metrics (Ketchen, *et al*., 2008; Ellinger and Ellinger, 2014).

Lambert (2008:287) stated that supply chain management is the key to end-to-end business integration processes; it integrates the end user and the originating supplier by supporting the flow of products, service and information that create value for customers and business stakeholders. The supply chain should be perceived as a single organisation whose measure should span all the business functions (Lambert, 2008:288).

1.2. Background

This research study sought to investigate a medical technology company on the inference that using supply chain management as a competitive lever can enhance a firm's position in the market in which it operates. In this study Becton Dickinson and Company (BD) was observed as an example of a medical technology company.

BD is a leading global medical technology company that develops, manufactures and sells medical devices, instrument systems and reagents (Becton, Dickinson and Company, 2013). BD was founded in 1897; its global headquarters are situated at Franklin Lakes, New Jersey in the United States of America, and it employs nearly 30 000 associates in more than 50 countries throughout the world (Becton, Dickinson and Company, 2013).

In South Africa BD has offices located in Johannesburg (Becton, Dickinson and Company, 2013). This study makes particular reference to the operation of BD in South Africa as a microcosm of the medical technology industry. BD serves healthcare institutions, life science researchers, clinical laboratories, the pharmaceutical industry and the general public (Becton, Dickinson and Company, 2013).

In order to provide the reader with a sense of the complexity and need for collaboration within the BD supply chain, the operations and geographic span of BD South Africa are described below.

BD South Africa uses a direct distribution model, delivering direct to its end customers. BD South Africa's direct model is supported by its third party logistics (3PL) partner, UTi Pharma, which warehouse, distribute, invoice customers and collect payment from customers on behalf of BD South Africa.

BD South Africa utilises shared demand planning, supply planning and customer services resources based in Belgium (Temse and Erembodigam) and France (Pont de Claix). These resources are shared between countries where BD Global operates, namely; Eastern Europe, Middle East and Africa (EMA) regions. Through their consulting group, Supply Chain Design and Innovation (SDi), UTi Pharma's National Inventory Control (NIC) operated a materials resource planning system (MRP) that optimised replenishment of stock into BD's distribution network. This MRP requires a strong collaboration between the BD business managers, BD EMA resources, and UTi Pharma NIC.

1.3. Problem statement

Supply chain management can be seen as a competitive lever for differentiation (Cetinkaya, Cuthbertson, Ewer, Klaas-Wissing, Piotrowicz and Tyssen 2011:20). Supply chain management is an integral business function that has a significant impact on a firm that seeks to coordinate and integrate its activities into a seamless end-to-end process with full visibility of its performance (Lamb, Hair and McDaniel, 2010:1). In order to coordinate a firm's activities for seamless integration and full visibility, supply chain data and information should be contained in a single point of reference (Morton-Owens and Hanson, 2012).

During the period of this research, BD did not have a coordinated supply chain performance dashboard that seamlessly measured, monitored and managed its supply chain performance in relation to the end-to-end business activities (Lamb *et al.*, 2010). Their many uncorrelated, different and laborious supply chain reports did not make it easy for supply chain and business stakeholders to keep track of the performance of the supply chain. This observation prompted the researcher to design a dashboard to remedy the situation.

1.4. Research aims

The aim was to design a demand-driven supply chain dashboard geared towards improving performance measurement. To this end, the strategy was to:

- Identify key performance measures and metrics relevant to inform a demand-driven supply chain dashboard, and
- Establish design elements for constructing a demand-driven supply chain dashboard.

1.5. Research objectives

The research objective was twofold:

- To review supply chain key performance indicators used by a medical technology company
- To map a demand-driven supply chain dashboard design using the collected data.

1.6. Research questions

The research question was twofold:

- What are the measures and metrics used by a medical technology company to measure, monitor and manage supply chain performance?
- What is a strategically well-matched, demand-driven supply chain dashboard design that can be used by the medical technology company?

1.7. Conceptual framework

Suthers, Vatrapu, Medina and Dwyer (2007:1) suggest that a high degree of convergence is reached between participants sharing information in the form of a dashboard. Eckerson (2011:5) states that dashboards translate a firm's strategy into objectives, metrics, initiatives and tasks for each group and individual in the organisation. Eckerson (2011:5) further states that the performance dashboard:

'*... communicates strategic objectives and enables business people to measure, monitor and manage key activities and processes needed to achieve their goals*'.

The arguments by these authors formed the theoretical foundations of this research. In order to achieve a state of seamless integration of a firm's end-to-end business activities, the supply chain has a pivotal role to coordinate such integration. This may be achieved through the introduction of an inclusive demand-oriented supply chain dashboard that captures the essence of performance appraisal and management in pursuit of the strategic objectives of a firm and also fosters collaboration between supply chain stakeholders and business.

1.8. Research strategy

The methodology used in this study is a mixed research method; it combines elements of qualitative and quantitative research approaches (Driscoll, Appiah-Yeboah, Salib and Rupert, 2007; Borrego, Douglas and Amelink, 2009). The qualitative aspect of the research method includes both case study and qualitative content analysis (Namey, Guest and Mitchel, 2012).

The selection of a case study as a research methodology was motivated by the need to use BD as an example of a medical technology firm in designing a demand-driven dashboard. A case study method may be used in research where data is collected in a natural setting (Darke, Shanks and Broadbent, 1998). In this case study, document analysis was the preferred technique for reviewing data because the primary source of data was documentary evidence. A case study research method allows the use of multiple methods of data analysis (Darke, *et al.*, 1998).

The quantitative elements of the mixed research method were introduced because of the need to do some simple numerical calculations in order to help with the interpretation of the multivariate data set of findings, that is, ‘how many’, ‘what percentage’ and to ‘what extent’ did the documents reviewed contain specific elements that were pertinent to answering questions posed by the research (Muijs, 2011).

1.9. Delimitations of the study

The research is limited to BD South Africa’s operations. Empirical primary data collected during the research. BD South Africa is used as an example of a medical technology firm, the data of which may not be representative of all medical technology companies.

1.10. Limitations of the study

The study is limited to BD South Africa’s supply chain operations. The study reviewed primary data over the period July 2012 to April 2013.

1.11. Significance of the study

The study contributes towards a repository of the body of knowledge in the field of supply chain management. The study will also contribute towards the researcher obtaining of his Master’s degree in Commerce.

1.12. Structure of the dissertation

Chapter 1 – Introduction

The first chapter introduces the topic and draws the background of the study from preliminary literature. The problem statement, aims, objectives and questions of the research are stated. The conceptual framework and research strategy are presented. The delimitation, limitations and significance of the study are also discussed.

Chapter 2 – Literature review

This chapter presents the literature review. Supply chain theory including supply chain performance measurement is discussed. The definition of a dashboard is provided and a framework for developing a dashboard is outlined. An overview of research is stated and the research design is presented.

Chapter 3 – Methodology

In this chapter the research design is outlined and the data collection process is explained. The research instrument is also discussed. Validity, reliability, methodology, critique and ethics of the study are also stated.

Chapter 4 – Results and discussion

In this chapter the findings of the study are presented.

Chapter 5 – Conclusions

The final chapter presents the conclusions in the form of a recommended dashboard design, taking into account the combined strengths of the respondents' documents.

CHAPTER 2. LITERATURE REVIEW

2.1. Introduction

Hugos (2011:173) suggests that there is a need for people in an organisation to view performance data on one single page. Hugos refers to this single page as a dashboard. Eckerson (2011:10) refers to a need for 'an organisational magnifying glass' that focuses on efforts of employees towards an explicit, commonly shared set of goals and objectives set out by the corporate strategy.

This chapter presents an exploration of literature concerning the concept of supply chain dashboard design. The concept of performance dashboard and management dashboard is discussed synonymously. A theoretical framework on how to design demand-driven supply chain dashboards is also presented.

The literature provides theoretical insight, but it can only provide a summary of existing scholarship (Mouton, 2011:166); it does not provide new, or validate existing, empirical knowledge. However, in order to confidently tackle the research problem at hand, it is also necessary to conduct a literature review on research; this should help establish the most fitting research design or approach to answer the research questions posed in this discourse.

2.2 Supply chain theory

There are many definitions of 'supply chain' available in the literature. Ayers (2006:5) states that the supply chain is product life cycle processes that facilitate physical flows of information, knowledge, finances and product through a network of multiple suppliers with the ultimate objective of end-user satisfaction. However, Kash and Calhoun (2010) suggest that the supply chain as a concept should be thought of differently; it should be thought of as a 'demand chain'. The notion of 'demand chains' suggests a demand-centric approach to the supply chain, meaning organising and collaborating along the supply chain with a focus on responding to demand.

Ross (2011:146) states that being demand-driven means being customer centric; focusing on what influences a customer's purchasing patterns: their requirements for product features, price points, delivery and buying habits. According to Branch (2009:101), the concept of a demand-driven supply chain network as coined by AMR Research, is a practice of designing supply chains around the imperatives of sensing, shaping and responding to customer demand. Ayers (2010) defines demand-driven supply chain networks as pull systems that respond to market demand requirements and can be perceived as a shorthand for lean, synchronised supply chain systems. Demand-driven supply chain networks are able to reduce waste by operating with minimal stock levels, reducing the cost of expediting orders or out-of-stocks, reducing the cost of price markdowns and expired or obsolete inventory write-offs.

The Economist (2009:14) suggests that demand-driven supply chain networks should not only reduce costs; they should also help shape and manage demand to maximise profits. Demand-driven supply chains are based on accurate, granular and flexible forecasts; they sense real-time, actual demand; they embrace collaborative sales and operations planning, which all in turn allow for maximising profits (*The Economist*, 2009:14).

Kash and Calhoun (2010) describe a demand-driven company as a company that exhibits the following attributes:

Delivery networks: The delivery networks are not only based on highways and roads, but are also web-based, taking cognisance of the advent of the worldwide web, mobile technology gadgets and related platforms.

Propriety framework: The propriety framework seeks to understand and manage demand, supply, competition, innovation and profitability.

Demand profit pools: Organic growth and higher profitability is achieved through the appreciation of the effectiveness of customer and consumer demand profit pools.

Business intelligence systems: The organisational strategy is to know and understand how to serve the needs of the customer now and in the future, thereby pre-empting competition. Business intelligence systems are used to establish the next opportunity for growing profits.

Demand chain networks: The network of manufacturers, retailers and media partners shares the same objectives and vision of customer centricity.

Intellectual obsolescence: The obsolescence of intellectual property is recognised to be far worse than the obsolescence of physical inventories. There is a continuous need to shorten lead times of goods to the customer; equally there is a need for speed to market in bringing new ideas to the market.

2.3 Measuring supply chain performance

Companies that seek to manage demand-driven supply chain networks better in order to improve performance, focus on how to measure supply chain performance (Shah, 2009:119). However, Coyle, Langley, Gibson, Novack and Bardi (2009:151) state that measuring the performance of a supply chain successfully, depends on the right metrics that capture the essence of supply chain processes. Chase (2009) adds a firm's demand forecast performance must be matched to the company-wide key performance indicators in order to demonstrate the value and impact that demand planning has on a firm's overall performance. A demand-driven supply chain dashboard must include metrics that validate the influence of forecast on inventory, revenue and profitability (Chase, 2009). Coyle *et al.* (2009:151) also add that dashboard metrics should be tiered and aligned to strategic and tactical key performance indicators in order to support decision-making at different levels of the organisation.

Tyndall, Gopal and Partsch (1998:35) advocate that a dashboard is key in measuring, monitoring and managing supply chain operations. Tyndall *et al*. (1998:35) suggest four categories of metrics to be considered when measuring supply chain performance:

- Operational cost
- Time and response
- Profitability and margins
- Customer service

Shah (2009:200) draws an elaborate list of key supply chain metrics; these are illustrated in Table 2.1. She categorises these metrics into four categories namely:

- Supply chain planning metrics
- Supply relationship management metrics
- Customer relationship management metrics
- Enterprise resource planning metrics

Table 2.1 Supply chain metrics

Supply chain planning metrics	Supply relationship management metrics	Customer relationship management metrics	Enterprise resource planning metrics
▪ Forecast accuracy ▪ Total inventory ▪ Plant utilisation ▪ Warehouse utilisation ▪ Fleet utilisation ▪ Dwell time through supply chain ▪ Plan vs actual inventory ▪ Production plan variance	▪ Supplier quality ▪ Purchase cost ▪ Direct material cost ▪ Delivery performance ▪ Supplier on time performance	▪ Customer lift ▪ Customer retention ▪ Customer lifetime value ▪ Sales performance ▪ Sales off-take vs out of stock in stores ▪ Product availability ▪ Promotion goal ▪ Inquiry handling time ▪ Win ratio	▪ Perfect order ▪ Supply chain cost ▪ Accounts payable ▪ Accounts receivable ▪ Cash to cash cycle time ▪ Cost detail ▪ Order cycle time

(Source: Shah, 2009)

2.4 SCOR® model

Supply chain performance is directly linked to customer satisfaction and can increase a firm's market capitalisation (Phelps, 2006:1). According to Phelps (2006) such customer satisfaction and market capitalisation can be achieved by using the Supply Chain Operations Reference (SCOR®) model. Wisner (2012) states that the SCOR® model is distinguished as a system for integrating and measuring supply chain performance. Irfan, Xiaofei and Chun (2008) confirm that the SCOR® model provides a comprehensive and flexible framework that can be used by firms to improve their supply chain both internally and externally. Indeed, the SCOR® model provides firms with the capability to communicate in one language, measure performance and formulate clear strategies and objectives on how to optimise performance (SCC, 2014).

The first version of the SCOR® model was released by the Supply Chain Council (SCC) in 1997 (Phelps, 2006). Version 11 of the SCOR® model was released in 2012 (SCC, 2014), and it is this version that was used in this study.

The SCOR® model spans the entire supply chain, from suppliers to customers, and is depicted in Figure 2.1. Bolstorf and Rosenbaum (2012) list six pillars the SCOR® model:

a. **Plan** – balancing of supply and demand
b. **Source** – sourcing and procurement of goods, materials and services
c. **Make** – manufacturing of goods
d. **Deliver** – order to distribution process
e. **Return** – reverse logistics and after-sales services
f. **Enable** – support processes for executing operations for a to b above

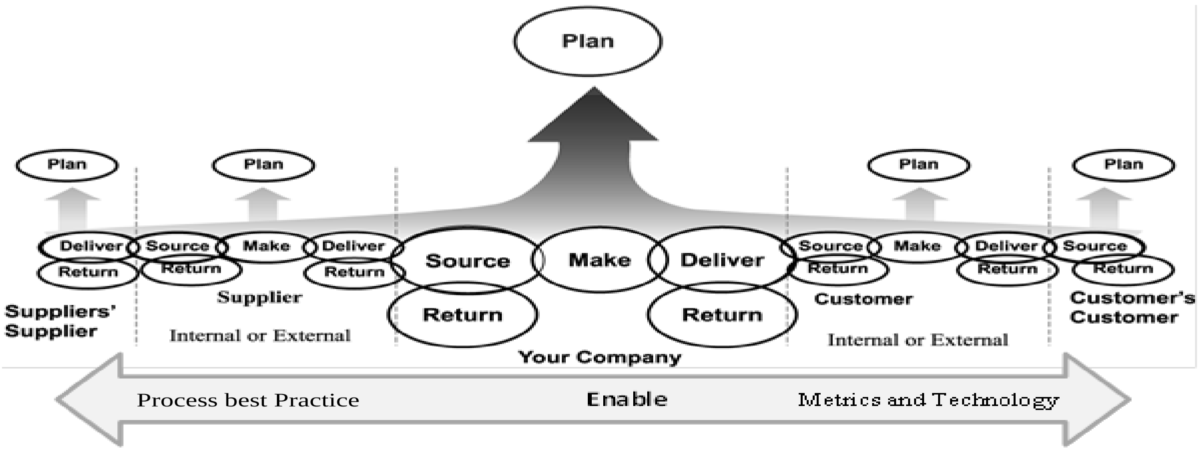


Figure 2.1 The SCOR® model

(Source: Adapted from Yilmaz and Bititci, 2006)

Table 2.2 is a representation of the SCOR® model's five core supply chain performance attributes (SCC, 2012:1), namely reliability, responsiveness, agility, cost and asset management.

Reliability – measures the ability to perform tasks in a manner that is reliable and consistent with the predicted outcomes
Responsiveness – measures the speed at which tasks are performed
Agility – measures the ability to respond to the external environment
Costs – measures the cost of operating a process
Assets management – measures the ability to efficiently use assets

Table 2.2 SCOR® model supply chain performance model

Reliability	On-Time, In-full, complete and undamaged order fulfilment
Responsiveness	Speed from customer request to delivery
Agility	Time to scale up? Cost to scale down?
Cost	Cost of process? Cost of Goods Sold?
Assets Management	Working Capital? Return on Investment?

(Source: Adapted from SCC, 2012)

The SCOR® model is hierarchical and it has three levels in scope (Kasi, 2005). Each level of metrics is a cascaded detailed diagnostic of the previous level. Table 2.3 is a depiction of SCOR® model level 1 metrics mapped against the supply chain performance attributes (SCC, 2012). In this discourse the focus is on level 1 metrics.

Table 2.3 SCOR® model level 1 metrics

Attributes	Level 1 Metrics
Reliability	Perfect Orders Fulfilment
Responsiveness	Order fulfilment Cycle Time
Agility	Upside Supply Chain Flexibility Upside Supply Chain Adaptability Downside Supply Chain Adaptability Overall Value at Risk (VAR)
Cost	Total Cost to Serve
Assets Management	Cash to Cash Cycle Time Return on Supply Chain Fixed Assets

(Source: SCC, 2012)

The advantage of the SCOR® model is that it can be used to analyse and improve performance; it has broad global scope and definition, and is adaptable to unique applications across industries (SCC, 2010:2). Phelps (2006) lists the benefits of using the SCOR® model:

- Improved speed of deployments
- Faster and greater return on investments
- Common metrics across organisation directly linked to processes
- 'Benchmarkable' metrics with other reference model users in the industry
- Reference model serves as a neutral 'common language'
- Facilitates easier gap assessment
- Documented best practices derived from thousands of users

2.5 Defining a dashboard

Eckerson (2011:10) defines a dashboard as a tool that provides information, alerts and insights that help businesses measure, monitor and manage performance optimally. Shah (2009:200) agrees with this view, and describes a dashboard as a single point of access of timely and relevant information that provides alignment, visibility and collaboration across the organisation and helps define, monitor and analyse performance. Rasmussen, Bansal and Chen (2009) have a similar view: a dashboard is a business intelligence tool that provides and enhances a user's business intelligence; it provides information at the speed of thought and it quickly lets the user know what to act upon. Burnett (2011:413) also agrees, saying a dashboard helps communicate complex information quickly and draws on the strengths of a single business intelligence platform.

Capehart and Capehart (2007:389) define a dashboard as an aggregation of various data that provides an overview of information for decision making. They equate a dashboard to a cockpit of a car; it is a summary of critical alerts, performance information and maintenance items. Shah (2009:200) agrees with the cockpit analogy, and adds that a dashboard displays visual cues such as thermometers, traffic lights, speedometers, tables and charts. Morana (2013) suggests that dashboards should be seen as both a dialog tool and diagnostics tool; they should be used to drive communication and also to give a prognosis of where issues may lie within the supply chain.

Simply, a dashboard gives a bird's eye view on information and helps monitor whatever is important to a decision maker (Saute, 2010:401). From a supply chain context, a dashboard integrates relevant information from all supply chain stakeholders enabling visualisation of performance (Flynn, Morita and Machuca, 2011:64); it should also enhance collaboration and information sharing between supply chain stakeholders. Eckerson (2011:7) is of a similar view − dashboards increase coordination; they foster cross-functional dialogue between departments and across the management hierarchy.

Eckerson (2011:10) summarises a dashboard as a tool that translates organisational strategy into objectives, metrics, initiatives and tasks; it provides timely information and insight to enable users to improve decisions, optimise processes and plan better. Dashboards add value to an organisation by communicating and refining strategy, increasing visibility, providing coordination and increasing motivation (Eckerson, 2011:7).

2.6 A framework for designing a dashboard

According to Rasmussen *et al.* (2009), having a poorly designed dashboard is more common than not. Further, Burnett (2011:412) adds that different people and different organisations define dashboards differently.

Burnett (2011:412) states that a dashboard should contain key performance indicators, metrics, and charts, trends and data visualisation. However, he (Burnett, 2011:412) adds that metrics and charts can be personalised to an individual's responsibilities and all information should be represented in one space. Shah (2009:200) echoes the same: data displayed on a dashboard may include tables, charts, maps and visual cues like thermometers, traffic lights an analog-speedometer.

Figure 2.2 is a depiction of a supply chain dashboard with visual cues using analog-speedometer, colour alerts and graphs. Also displayed in Figure 2.2 are key supply chain metrics; order to cash cycle, forecast to fulfil cycle, purchase to pay cycle, and cash conversion cycle.

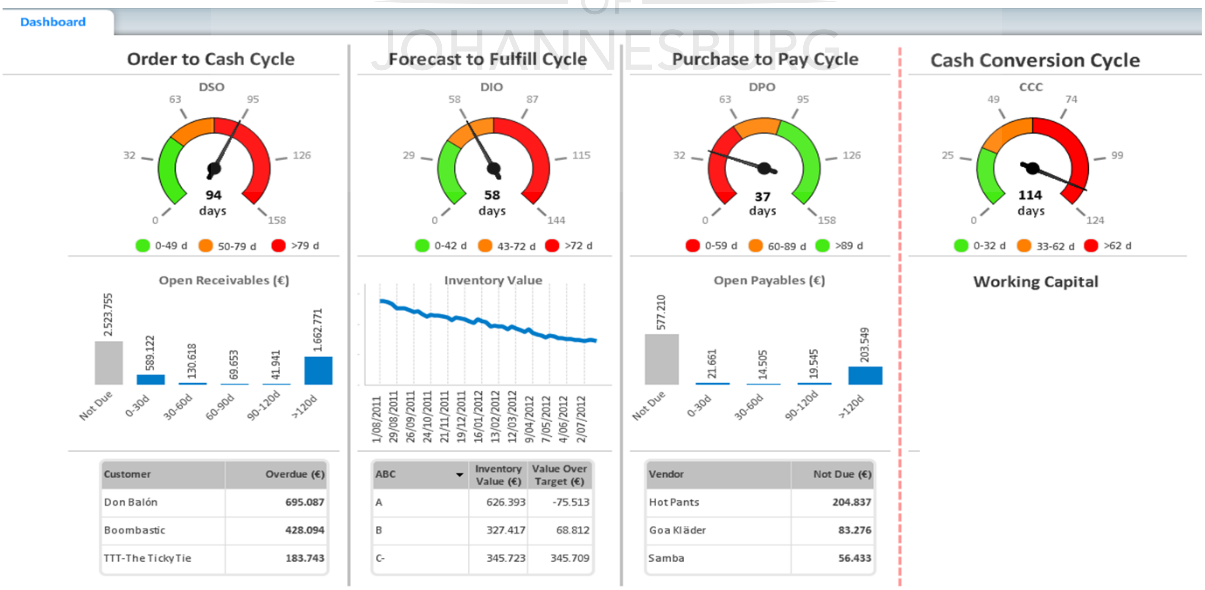


Figure 2.2 Dashboard example

(Source: Qlinkmarket, 2014)

2.7 Dashboard development

Bertels (2006:269) states that dashboard development is not an event, but a process, and should be managed as a project. Noetix (2004) suggests six steps for dashboard development and deployments, as depicted in Figure 2.3.

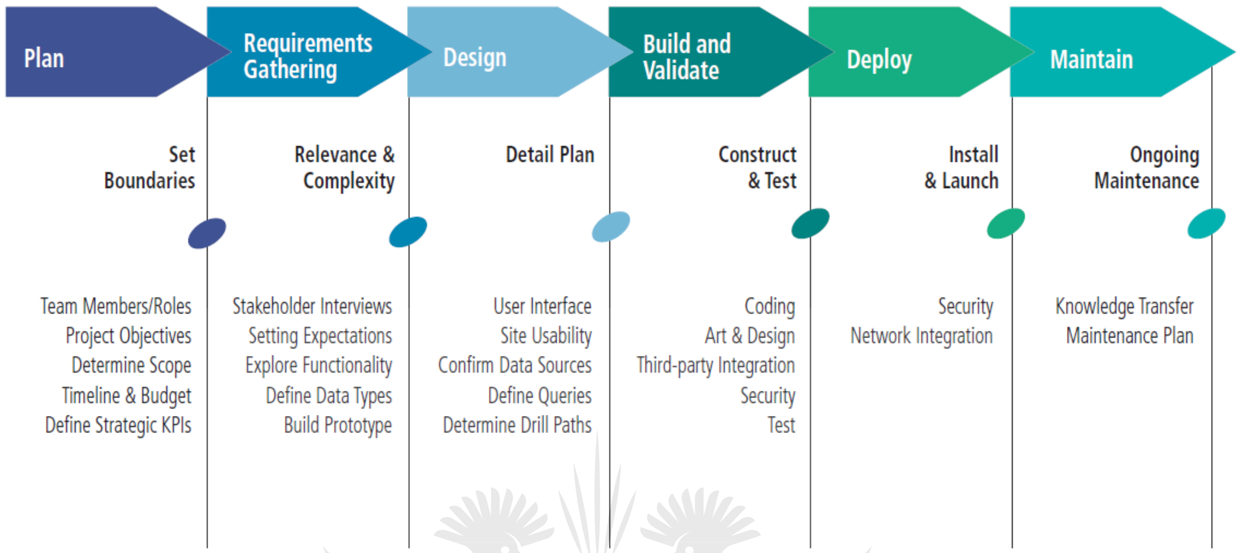


Figure 2.3 Dashboard development and deployment methodology

(Source: Noetix, 2004)

- ***Plan***
  Dashboard development and deployment should take a project approach. A project team with a project scope, plan, timelines and budget must be put in place. Key performance indicators should be established and accountabilities shared among project team members.

- ***Requirements gathering***
  Once the project scope for dashboard design has been defined, interviews with key stakeholders should be conducted. The objective of the interviews should be to determine the needs and expectations of the stakeholders and users. The needs and expectations should be mapped against clear key performance indicators as identified in the project scope to avoid any scope creep. Options for dashboard presentation and functionality should also be discussed during the interviews.

- ***Design***
  Major aspects of dashboard design include the refining of the user interface and control flow of information, the confirmation of data sources for each element of data, the definition of queries needed to retrieve each data element, and the determination of drill paths.

Dashboard design should be done only once the requirement for the content and appearance of the dashboard has been agreed upon.

- ***Build and validate***

  Dashboard design and build is a creative process; there is no ideal way of designing a dashboard. However it is important to ensure that the information displayed on a dashboard allows for statistical interpretation. It is important to evaluate what graph and chart types best represent the information to be displayed. It is also important to decide on the grouping of data that will give the greatest visibility for cross-analysis. Thresholds and their respective colour schemes and alerts should be defined. The types of selectors and level of drilling interactivity should also be decided on.

  The dashboard should be able to query and gather information from appropriate databases with the company. The more databases there are in a company the more complex the build process can be, as a multiple database query will be required. In a supply chain environment this process can be even more difficult given that enterprise resource planning (ERP) and customer relationship management (CRM) systems are generally complex database systems.

  Information displayed on the dashboard is only as reliable as its data source. Data used to build dashboard information should be accurate, timely and complete. To ensure the accuracy, datedness and completeness of the dashboard content, the queries created must run regularly to deliver information to the dashboard. Security rules should also be included to ensure that different users have different access profiles for different levels of hierarchies and dimensions of data and information.

  Once the dashboard has been designed and coded to completion, it must be tested before it is deployed for operation. The testing is important to ensure that the dashboard lives up to the assumptions and expectations of the requirements and specifications outlined in the project plan. The validation process should include both the technical team and the representative from the different users.

- ***Deploy***

  When the dashboard has been built and tested it should be deployed and made operational by introducing it into the business environment. It should be integrated within the company's information technology environment including the consideration of portals or extranets for business partner and customer access. This is important for a demand-driven supply chain network where customers and partners are key collaboration stakeholders.

- ***Maintain***
  Once the dashboard has been deployed and implemented, ongoing maintenance is required. Business requirements and expectation change as the market and needs of customers change. This means that the dashboard will also need to adapt to the changes in order to remain relevant and meaningful to its purpose. Therefore the dashboard needs to remain flexible and open to such investable change requirements.

2.7.1 Different types of dashboards

Shah (2009:200) suggests that there are five types of dashboards, namely: enterprise performance dashboards, divisional dashboards, process/activity monitoring dashboards, ad hoc query capability dashboards, and interfaced dashboards. These are discussed in Table 2.4.

Table 2.4 Types of dashboards

Enterprise Performance Dashboard	These Dashboards provide a consolidated view of the company's divisions and operations for senior management.
Divisional Dashboards	These dashboards are used to display divisional management performance metrics.
Process Activity Monitoring Dashboards	These dashboards are used to monitor specific processes or activities. They could include for example live conditions of capturing and order processing.
Ad Hoc Query Capability Dashboard	These dashboards are used to report data that is not covered by standard reports. Data input and output selection fields are used to query the enterprise data warehouse to retrieve pre-defined information.
Interfaced Dashboards	These are dashboards that are linked through business intelligence tools to a database/s in order to retrieve live data

(Source: Shah, 2009)

Eckerson (2011:13) is elaborate regarding elements of designing a dashboard; he writes about the concept of Monitor, Analyse, Drill to Detail (MAD) and 'three threes' (Figure 2.4). He suggests that when reviewing the design of a dashboard, it is necessary to consider that first, there are three types of application or uses of a dashboard secondly, there are three layers or hierarchies to a dashboard and thirdly, there are three types of dashboards.

- ***Three applications of the dashboard*** – The three applications of a dashboard are the monitoring application, the analysis application and the management application. The monitoring application of a dashboard helps users monitor performance against metrics; predefined thresholds are used to create alerts to which users must respond. The analysis application helps users explore data across different dimensions and hierarchical levels in order to ascertain the root cause of alerts or exceptions. The management application of a dashboard helps foster collaboration and decision making.

- ***Three layers of the dashboard*** – The three layers of a dashboard are illustrated in Figure 2.4. MAD is an acronym for manage, analyse and drill to detail. A user should be able to monitor a key metric on a dashboard, respond to alerts or exceptions regarding that metric by way of analysis, and drill into details of the root cause before taking action. A dashboard should provide a self-access ability to manage, analyse and drill to detail in order to allow for informed actions or decisions.
- ***Three types of dashboards*** – According to Eckerson (2011), there are three types of dashboards. Note that this is contrary to Shah (2009) who suggests that there are five types of dashboards. Eckerson (2011) lists the three dashboards as operational dashboards, tactical dashboards and strategic dashboards. Operational dashboards allow frontline workers to monitor, manage and control operational processes using detailed data that is refreshed frequently, and emphasis is placed on monitoring performance. Tactical dashboards help monitor, manage and control departmental processes and projects, and the emphasis is more on analysis of performance. Strategic dashboards help monitor the execution of strategy and give emphasis to management as opposed to monitoring and analysis.

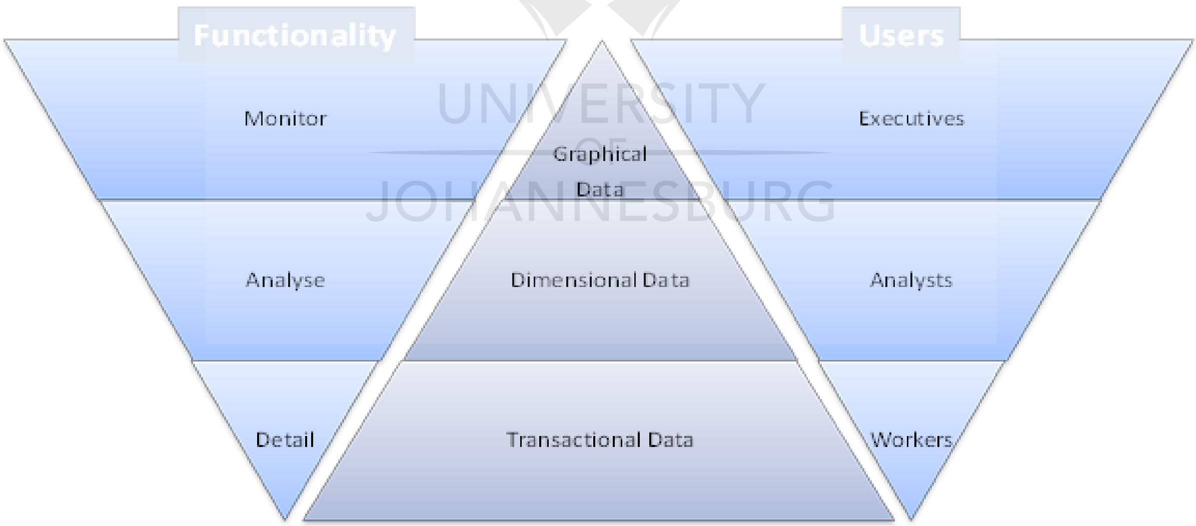


Figure 2.4 Monitor, analyse, drill to detail framework

(Source: Eckerson, 2011)

2.7.2 Elements of dashboard design

According to Microstrategy® (2011), a framework for developing a dashboard has four elements. These elements are as detailed in Figure 2.5.

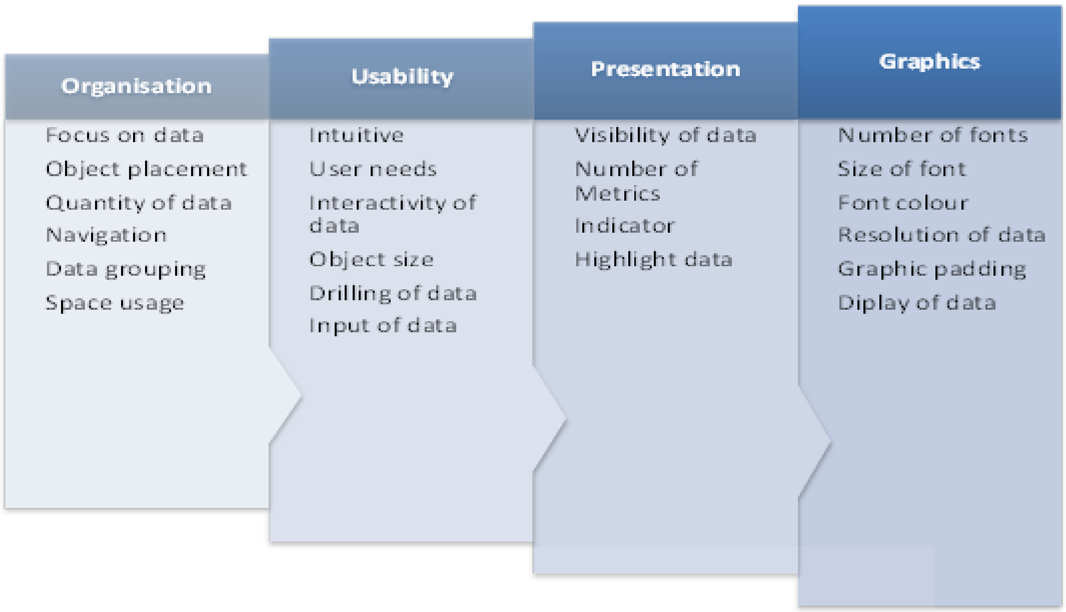


Figure 2.5 Framework for a dashboard

(Source: Microstrategy®, 2011)

2.7.2.1 Organisation

The dashboard needs to remain simple and the usage of graphics needs to be kept to the minimum. This reduces confusion and maintains focus on important data. A busy or cluttered dashboard can easily result in the user being confused and will detract from the primary message of the dashboard.

Groups of data should be delineated with sufficient space between them. Data should be placed strategically on the dashboard; data at the top and at the bottom of a dashboard tends to receive more attention from the user.

Navigation of the dashboard should be simple: navigation buttons and links should be kept on a consistent location of the dashboard, and it is best to keep them at the top of the dashboard panel. This is important when a dashboard has multiple panels and layers.

Data that is similar should be kept together; it helps with the analysis of trends and connections between the various data.

Dashboard space should not be wasted; spaces on panels and grids should be limited. All relevant and important information should be displayed. The data should also not overflow, even more so when using graphs.

2.7.2.2 Presentation

The number of metrics used on the dashboard should be kept to a minimum, ensuring only important and relevant ones are displayed. According to Eckerson (2011), three to seven metrics on a dashboard should give the required impact.

The dashboard should display the most important key performance indicators, trends, variances, comparisons and related performance statistics. When showing variances it is important to show the value of the variance and whether the variance is adverse or positive by using arrows or plus (+) or minus (−) signs.

Contextual information and labels should not be highlighted. Only the metric information should be highlighted. This will ensure that the primary message of the dashboard is carried thorough congruently to the respective audience. Too many metrics can confuse users and the primary message of the dashboard can be lost in the translation of one metric to another.

2.7.2.3 Usability

Interactive elements on the dashboard should be intuitive. Data selectors should be obvious and discoverable; ensure the icons and hints are obtrusive to the user.

It is important to develop a dashboard with the user in mind, for example, senior management prefers a more visual approach to data as opposed to junior people in an organisation.

Users should be able to do dynamic drilling of data on the dashboard in order to view multiple dimensions of the dashboard. Chase (2009) agrees that a dashboard should provide the ability and flexibility to drill down, up and around hierarchical levels of data.

For the purpose of navigating the dashboard, text entry prompts and scrolling should be limited as far as possible as these reduce user-friendliness. Rather use ‘page-by’ and prompt types like wheels, steppers, switches, date and time pickers, and geo-location. These should help with ease of usability and navigation of the dashboard.

2.7.2.4 Graphics

The least number of fonts should be used when designing a graph. The fonts should be readable. To improve legibility, the font colours must be in contrast to the background of the graph. Also the firm’s corporate colour schemes should be considered when choosing the colour scheme for the graph.

Colour should be used to organise and direct data (for example, colour can be used to show different alerts – red can be used to indicate a metric that falls below expectation).

2.8 Overview of research methods

Research is intended to discover knowledge (Khan, 2011). The acquisition of knowledge requires asking specific questions and finding answers to those questions (Bless, Higson-Smith and Kagee, 2006)

Hussain (2011 states that research can be defined as a method of arriving at a reliable solution to a problem, through a planned and systematic collection, analysis and interpretation of data. Khan (2011:2) agrees, and states that research aims to achieve an answer to a problem through the application of a research methodology. A research methodology should guarantee unbiased, reliable and credible information (Khan, 2011:2).

The advantages of scientific research in solving a problem is that it is objective and systematic, it generalises, it is purposive and it is also replicable (Khan 2011:3).

Scientific research can take a qualitative or quantitative form (Schreier, 2012:21); quantitative research is concerned with numerical data and requires little interpretation while qualitative research deals with symbolic material (verbal, visual data, artefacts, etc.) and leaves much more room for interpretation.

2.8.1 Quantitative research

When you think of quantitative research you should channel your thoughts towards numbers and statistics (Muijs, 2011); the process of quantitative research is concerned with the collection of numerical data in order to explain a particular phenomenon or answer a specific question.

Interestingly, even when data is not quantitative in nature it can be collected in a numerical way (Muijs, 2011); a research instrument can be designed in such a manner that it simplifies data that does not exist naturally in a quantitative form into quantitative data.

According to Muijs (2011) quantitative research is used to answer one of four questions that:

- Require a numeric answer
- Require numerical changes
- Seek an answer regarding factors that influence or explain a phenomenon
- Require a hypothesis

Quantitative research is good at answering descriptive and inferential questions, testing theories and hypotheses, and testing for causality. In order to capture the depth of a research problem, ethnographic methods, interviews, in-depth case studies and other qualitative methods are required (Muijs, 2011).

According to Namey *et al*. (2012), qualitative research involves collecting data of any kind that does not involve the collection of ordinal numbers; it aims to answer the 'how', 'what' and 'why' of phenomena where data is difficult to collect using more quantitatively orientated methods. It notably does not seek to answer the questions of 'how many' or 'how much', which are answered by quantitative methods (Bricki, 2007).

Mack and Woodsong (2005) state that qualitative methods are typically more flexible and allow for spontaneity; the relationship between the researcher and the participant is less formal and therefore allows for adaptability. It also allows for asking broader questions and, when coupled with a well-defined methodology, it can lead to the discovery of new insight (Christie, Row, Perry and Chamard, 2000).

The qualitative research method allows for the use of a 'smaller' sample of data and exploration of a limited extrapolation of the general population of data; it can seem deceptively easy to organise, implement, analyse and report (Boxill, Chambers and Wint, 1997:46).

Qualitative research is by nature interpretive; it deals with material that requires interpretation; nonetheless, different interpretations of the same material can be valid (Schreier, 2012:28). Further, the validity of qualitative research refers to the extent to which the research instruments capture what the research question requires to be answered and the overall quality of the research.

2.8.2 Mixed research methods

The epistemological debate on quantitative research versus qualitative research is that quantitative research is seen as 'realistic' or 'positivist' while qualitative research is seen as more 'subjective' (Muijs, 2011). However, it is possible for a quantitative research to exist in the same space as a qualitative research; in fact this is a pragmatic approach to research (Muijs, 2011).

Muijs (2011) states that mixed research methods become relevant when you want to capture both the breadth and depth of a research question. Mixed research methods allow for flexibility and unshackle research answers from the epistemological camps' assertions (Muijs, 2011).

2.9 Study design

A qualitative research does not require the use of statistical methods and techniques (Dos Santos and Conceição, 2013:94), as the interpretation of phenomena and the attribution of meaning is sufficient. While there is a myriad of research methods and methodology combinations, this discourse takes interest in the qualitative research methods, in particular the case study and research qualitative content analysis methods.

2.9.1 Case study

The Case study research method has many definitions (VanWynsberghe and Khan, 2007; Zucker, 2009). These case study definitions are summarised in Table 2.5. A case study as a research method can simply be defined as a research method that seeks to understand a specific and current management incident (Christie *et al.*, 2000).

A case study can be structured as single or multiple case study research (Darke *et al.*, 1998). A single case study research is relevant where the case is critical, unique, and critical for testing a formulated theory or an exploratory pilot study (Christie *et al.*, 2000). A multiple case study is purposive in nature and provides a potential for generalisation of findings; it also provides a rigorous and complete research approach when compared to a single case study (Christie *et al.*, 2000).

Case studies are critiqued for lacking methodological rigour and bias; however, a carefully designed research methodology can overcome this criticism by constructing validity, conformability, internal and external credibility and reliability into the research methodology (Christie *et al.*, 2000). According to Yin (2009), it is accepted that in a case study, neither independent variables are manipulated nor are confounding variables controlled.

Table 2.5 Definition of case study research method

	Hakim 1994	King 1985	McKiney 1996	Patton 1990	Saunders 1998	Smith 1988	Stake 1985	Yin 1989
Holistic	■	■		■				
Absence of control						■		
Rare phenomena						■		
Source ideas						■		
Source hypotheses						■		
Situation of theory development						■		
Furture systematic research						■		■
Boundaries between phenomena and context are not clearly defined						■		■
Contemporary focus within a real life context				■		■		■
How and why questions						■		■
Little control over events					■			
Depend on inductive reasoning					■			
Use multiplicity of data				■	■			■
Are specific					■			
Are descriptive, qualitative, exploratory and explanatory		■			■	■		■
Have heuristic value					■			
Emperical enquiry								■
Multiple sources of evidence are used								■
Embedded case studies wer sub units of analysis								■
Unit chosen was temporally and spatially bound		■						
Intensive examination of specific factors			■					
Particular historical development		■						
Unique configuration of being		■					■	
Bounded system							■	

(Source: Adapted from Christie *et al.*, 2000)

2.9.2 Qualitative Content Analysis

Qualitative Content Analysis (QCA) can be defined as a method of systematically describing the meaning of qualitative material (Schreier, 2012:1). Mouton (2011:158) describes a QCA research design as an approach that is aimed at reviewing the content of documents, where content refers to meanings, pictures, symbols, themes or any message that can be communicated.

QCA is also known as qualitative document analysis (Daymon and Holloway, 2011:321), where the objective of the method is to discover patterns of categories of meaning. GAO (1998) gives a simple definition of QCA; it is a set of procedures for collating information in a standardised format so that it can be used by analysts to make inferences about the characteristics and meaning of recorded material.

According to Schreier (2012:7), QCA requires the translation of meanings contained in the material under review into categories of a coding framework, where these meanings need to be of interest to the research.

According to Mouton (2011:166), QCA is not obtrusive; this reduces the error associated with interaction with the research subject. Since QCA is systematic, flexible and reduces data, it makes the research data manageable (Schreier, 2012:5). Further, the flexibility of this method increases the reliability and validity of the coding framework because the coding framework is tailor-made to the research question (Schreier, 2012:7).

The overall external validity of the findings of the qualitative content analysis research method is limited by the authenticity of the data source and representativeness of the sample size (Mouton, 2011:166). The challenge with QCA is that the coding framework is valid to the extent that the categories defined are representative of the concepts posed by the research question (Schreier, 2012:7).

2.10 Summary

Demand-driven supply chains as a concept purport to drive organic growth and profitability through alignment of all supply chain stakeholders on customer centricity. The SCOR® model and its performance attributes provide an industry best practice from a supply chain performance measurement and metrics perspective. In this study the SCOR® model supply chain performance attributes were used in the design of the research instrument.

Dashboards are important for measuring, monitoring and managing performance. Dashboards serve also as a tool to foster collaboration and communication among stakeholders. There are different types and levels of dashboards and there are different dimensions of information to a dashboard.

When developing a dashboard, a dashboard development process must follow a project management approach. Dashboards should be designed in such a way that they can be reconfigured to adjust to the changing landscape of information requirements. When designing dashboards it is important to take cognisance of the different elements required to ensure that the dashboard is visually appealing while maintaining the primary message it was intended for.

Although there are extremely differing epistemological stances on quantitative and qualitative research methods, the two methods can pragmatically co-exist in one ecosystem of a mixed research design. In this discourse there is an interest in the qualitative research methods with a specific focus on qualitative content analysis and the case study research method.

CHAPTER 3. METHODOLOGY

3.1 Introduction

The research objective proposed to review supply chain key performance indicators used by a medical technology company. The research also proposed to map a demand-driven supply chain dashboard design using data collected in the study. These objectives were to be achieved by gathering, studying and interpreting quantitative and qualitative data in a single study (Leech and Onwuegbuzie, 2009).

3.2 Research design

This study followed a mixed research method; it combined elements of qualitative and quantitative research approaches (Driscoll *et al*., 2007). Qualitative research was relevant because both research questions in this study sought an answer to the 'what' of a phenomenon (Namey *et al.*, 2012):

- What are the measures and metrics used by a medical technology company to measure, monitor and manage supply chain performance?

- What is a strategically well-matched demand-driven supply chain dashboard design that can be used by the medical technology company?

The qualitative method was driven by the non-numeric nature of the data collected in the study (Muijs, 2011). Supply chain documents and literature data were collected in the study. There was a need to allow for flexibility and adaptability in managing the various features of the collected documents (Mack *et al.*, 2005). The case study methodology was therefore coupled with a qualitative content analysis methodology in order to review the respondents' documents (Yin, 2009).

The quantitative elements of the mixed research method were introduced to do simple numerical calculations. These calculations were used to interpret the multivariate data set of findings; 'how many', 'what percentage' and to 'what extent' did the documents reviewed contain specific elements that were pertinent to answering questions posed by the research (Muijs, 2011).

3.2.1 Case study

A single case study research method was used, with BD used as an example of a medical technology company (Christie *et al.*, 2000). The objective was to review the supply chain key performance indicators used specifically by BD, and to map a demand-driven supply chain dashboard design that can be used by a medical technology company. Supply chain documents from BD were purposively selected for the research study (Christie *et al.*, 2000). The findings thereof were used to generalise the measures and metrics required to inform a demand-driven supply chain dashboard design.

3.2.2 Qualitative content analysis

In this case study, qualitative content analysis was the preferred technique for reviewing data because the primary source of data was documentary evidence (Mouton, 2011). Qualitative content analysis aims to discover patterns in documents (Daymon and Holloway, 2011). The contents of BD's supply chain documents were reviewed using qualitative content analysis. The study reviewed BD's supply chain documents for patterns of measures, metrics and document layout.

Figure 3.1 shows a qualitative content analysis construct designed by the researcher to discover these patterns. It shows the archival sources from which supply chain documents were sourced. The funnel depicts the processes undertaken to collect, analyse and interpret data and findings. BD supply chain measures and metrics were reviewed against the SCOR® model supply chain performance attributes' level 1 metrics (SCC, 2010a). The layout of BD's supply chain documents was reviewed against a dashboard design framework (Eckerson, 2011; Microstrategy®, 2011). The process followed to analyse the document was as follows:

- Documents were retrieved from archival sources found in BD's supply chain information depository network.
- A research instrument was used to collect, analyse and interpret the data gathered.
- The documents were reviewed against the content analysis construct.
- The findings were mapped on a document comparison matrix.
- By way of drawing from the combined strength of each report, a demand-driven dashboard design was proposed.

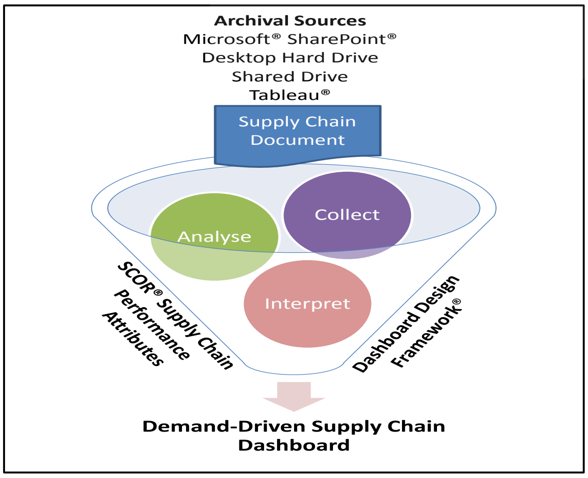


Figure 3.1 Qualitative content analysis construct

(Source: Researcher)

3.3 Research instrument

In some qualitative studies the individual identified as the researcher or observer is the research instrument or research tool (Schuh and Upcraft, 2001) − as is the case in this study.

3.3.1 Sampling

The sampling in this study was a non-probability purposive or judgmental sampling technique (Latham, 2007:9). BD was singled out as a specific medical technology company on which the research was conducted. Participants were also pre-defined by the researcher based on his inherent knowledge of the BD supply chain structure of operation as a supply chain manager at the company.

3.3.2 Participants

The total number of participants was limited to 11 supply chain planners, which was the total number of available supply chain planners. Nine of the participants were from BD and two were from UTi Pharma.

The researcher deemed it fair and appropriate to give a reasonable notice period to obtain an acceptable response rate to improve the reliability of the research. The planners were requested via email to provide supply chain documents within four weeks of receipt of the request. The documents requested were for the period spanning October 2012 to April 2013.

3.3.3 Supply chain documents

The documents requested from the planners were those frequently used by the supply chain stakeholders to measure performance and make decisions during the demand review process, and the sales and operation planning meetings. Transactional information from the documents was excluded from the analysis, as this information was not relevant to strategic and tactical decision-making in the formulation of the new demand-driven supply chain dashboard design.

The documents from the respondents were received via email. Each document was coded according to:

- source , and
- order of receipt.

Archival sources that were available are listed and discussed as follows:

- **Workstation (WS):** The supply chain planners' individual computer desktop workstations.

- **Microsoft® SharePoint®:** A web-based collaboration, data management, communication, idea-creating, problem-solving tool (www.windowsharepoint.com)
- **Futurewave (FW):** A business-to-business (B2B) web-based portal (www.futurewave.com) used by UTi Pharma clients
- **Tableau® (TB):** A web-based portal (www.tableausoftware.com) used by BD and UTi Pharma; the reports from this source were accessed by the researcher from his BD workstation and connect to the World Wide Web.

3.3.4 Data collection and evaluation tool Excel provides data analysis capability (Brotton, Weir-Barton, Wetta-Hall and Moss, 2007). A data evaluation tool was designed and developed in Microsoft® Excel® 2010 for this study. The data analysis tool was designed in the format of a spreadsheet table. The data analysis tool had a three-pronged application, and was used to:

- collect data from the respondents’ documents,
- analyse the data collected, and
- interpret the findings.

Expressed in the columns of the data analysis tool were categories of meaning, sub-categories of meaning and attributes of categories of meaning. The categories and sub-categories of meaning supported the qualitative content analysis construct discussed earlier, where the SCOR® model supply chain performance attributes were plotted first followed by the Microstrategy® dashboard design framework attributes. The SCOR® model was used because it had the advantage of common metrics that can be benchmarked across organisations and industry (SCC, 2010b).

3.3.5 Data analysis method

The documents were rated and scored by the researcher. The scale type used for data analysis was an ordinal level of measurement (Jakobsson, 2004). In this measurement, a nominal scale of 0 to 3 with ordered categories of qualitative attributes and rank was used.

The unit of analysis for this research was organisational. The objective of using the organisation as the unit of analysis was to use BD as an example of a medical technology company.

The respondents’ documents were reviewed against the attributes of the categories and sub-categories of meaning, applying the qualitative content analysis construct (Figure 3.1). A rating range of between 0 and 3 was then assigned to each attribute of meaning. Each rating was given a weighted value and colour code to develop heat maps (Few, 2006).

The data evaluation tool was an analytical scale rubric (Mertler, 2001). A rubric is a chart or list to describe the measures that a researcher can use to evaluate or rate performance against pre-set requirements (Mertler, 2001; Wolf and Stevens , 2007). It also allows the rater to rate that requirement on an ordinal scale (Wright, 2010).

In order to assess the extent to which each attribute of category is presented in each document, an ordinal scale of 0 to 3 was used to score the documents (Jakobsson, 2004), as follows:

- Zero (0) meant that the document did not present the requirements of a particular attribute of category. Colour code: Blue.
- One (1) meant that the document presented one requirement of a particular attribute of category. Colour code: Green.
- Two (2) meant the document presented two requirements of a particular attribute of category. Colour code: Orange.
- Three (3) meant the document met three or more requirements of a particular attribute of category of meaning. Colour code: Red.

A mean attribute score was calculated using the points allocated to all the documents. SCOR® model level 1 metrics, as presented in the SCOR® Quick Reference Guide (SCC, 2010b), were considered when reviewing the documents against the SCOR® supply chain performance attributes.

The data collected during research was a multivariate data set which required visual representation and comparison for ease of interpretation. For this reason heat mapping and radar charts were designed into the research instrument (Few, 2006; Atanassova, 2010).

The categories used in the radar chart followed that of the categories of meaning attributes defined in the columns of the data evaluation tool. The rating on the radar chart was extrapolated from the scoring allotted in the research instrument. The radar charts were used to identify gaps in the findings and observations from each document. The radar charts visually depicted the relative strengths and weaknesses of findings from each respondent's document (Atanassova, 2010). Radar charts were created in Microsoft® Excel® using the charts toolbar.

3.4 Validity and reliability

Validity means that findings are true and certain in that findings accurately reflect the situation and are supported by evidence (Guion, Diehl and McDonald, 2011). According to Ghauri and Gronhaug (2005), validity has to do with whether the findings of the study can be generalised to other similar settings.

Reliability is the ability to consistently produce the same results when assessing a construct (Buelow and Hinkle, 2008).

3.4.1 Validity

The research instrument and design embodied a scientific approach to collecting, analysing and interpreting the data. This created an ecosystem of data that could not be manipulated as data and results are found in a single instrument. This maintained the accuracy of the study.

All respondents' documents were received into the researcher's single email inbox. This allowed for the maintenance of the integrity and traceability of all documents.

A predefined and consistent coding system was used to track each respondent's document. This ensured the ability to uniquely reference each document when data contained in each report was analysed.

The design of the data evaluation tool was based on a well-defined data evaluation method referenced in the literature. A rubric system and ordinal scale was used to review the data collected in the study.

The data evaluation tool was based on a qualitative content analysis construct which drew on the SCOR® model. The literature review in this study showed that the SCOR® model is universal across industries, is 'benchmarkable' and provides a common language for supply chain stakeholders (SCC, 2010b).

The data evaluation tool was based on a dashboard design framework based on a literature review with a specific adoption and application of Eckerson (2011) and Microstrategy® (2011) dashboard design frameworks.

The study was conducted in a manner which accurately reflected the situation at BD and this was supported by the research instrument and design. Given that BD is a medical technology company, the findings of the study may be generalised to other firms in the medical technology industry.

3.4.2 Reliability

All the respondents' documents reviewed were subjected to the same research instrument without prejudice or favour. No data set was treated differently and no data set was manipulated. The coding framework was tailor-made to meet the requirements of the research questions which, in turn, increased the reliability and validity of the study. In order to interpret the reliability of the research study, a participant response rate was factored into the findings and observations of the research (RMIT University, 2009).

The research instrument was non-obtrusive and reduced the error associated with interaction with the research subject (Mouton, 2011). The instrument was also developed in a manner that allowed for a systematic and flexible approach of collecting data, which made the research data manageable (Mack and Woodsong, 2005).

A letter of request to conduct the research using BD as a case study (Appendix 1) was sent to BD's general manager, Mr Peter Mehlape. A confirmation letter (Appendix 2) was received from the general manager. A participation request letter (Appendix 3) was sent to the participants.

3.5 Methodology critique and limitations

Despite the authentic data collected from BD's archives, BD is simply a representation of one company in a pool of medical technology companies; therefore, the overall external validity of the findings was limited by the representativeness of sample size (Mouton, 2011).

Further, the sample size of 11 participants can be viewed as an exploration of a limited extrapolation of the general medical technology companies' population of supply chain performance management documents. Moreover, the sample size could also seem deceptively easy to organise, implement analysis and report on the study (Boxill *et al.*, 1997).

The categories defined in the study were assumed to be representative of the concepts posed by the research questions which may affect the validity of the study should those concepts not be adequately articulated by the themes of categories.

Although the research strategy, design and analysis were based on principles and concepts found in the literature, a literature review could only provide existing scholarship; it did not provide new or validate existing empirical knowledge (Mouton, 2011).

3.6 Ethics

Ethical considerations included the maintenance of confidentiality of BD classified information and intellectual property. This was achieved in the following ways:

- BD was formally requested for permission for the researcher to access its supply chain records for the purpose of conducting this study. The request was also formally granted by BD's general manager.
- Supply chain planners were formally requested to participate in the research. It was noted that the research was voluntary, thus no one was forced to participate. It was also noted that all participants would remain anonymous, thus their personal identifiable information was protected.
- The actual documents reviewed in the research are not explicitly displayed in the discourse, but instead the research data evaluation tool was used to make representation of the respondents' documents.
- There was no compensation paid to any of the participants in this study. The researcher has no conflict of interest with the findings of the research.

3.7 Summary

The research strategy in this research followed a mixed research method. The research was conducted using BD as an example of a medical technology firm. A non-probability purposive sampling technique was used to collect primary data.

The researcher developed a research data evaluation instrument that was used to collect, analyse and interpret data. Findings and observations were interpreted using the aid of heat maps and radar charts.

CHAPTER 4. RESULTS AND DISCUSSION

4.1 Introduction

In this chapter the findings of the research are presented. The observations made during the content analysis of BD's supply chain respondents' documents are unveiled. The strengths and weaknesses of each document were reviewed and discussed in consideration of a demand-driven supply chain dashboard design.

4.2 Participants' response

Respondents' documents were received via email. Each document was coded according to its archival source and numeric order of receipt.

Eleven invitations to participate in the study were administered; two to UTi Pharma and nine to BD. Table 4.1 shows that there was a hundred per cent (100%: n=2) response rate from UTi Pharma participants and a forty-four per cent (44%: n=4) response rate from BD participants. The overall response rate was a fifty-five per cent (55%: n=6).

Given that this research was a case study involving the population of 11, a 55% response rate was deemed acceptable.

4.3 Document types and features

Table 4.1 shows the types and features of the respondents' documents. All documents were received via email:

- **Document receipt:** Four documents were email attachments and two were web links.
- **Document source:** Three documents were from workstations, one from Microsoft® SharePoint®, one from Tableau® and one from Futurewave.
- **Document format:** Four documents were in Microsoft® Excel®, one in PDF and one was in web-based format.
- **Company:** Two documents were received from UTi Pharma and four from BD.

Table 4.1 Types and features of respondents' documents

	Document type and Features					
Name Code	SP1	TB2	WS3	FW4	WS5	WS6
Received as	Web link	Web link	Attachment	Attachment	Attachment	Attachment
Source	Microsoft® Sharepoint ®	Tableau®	Workstation	Futurewave	Workstation	Workstation
Format	Microsoft Excel®	Web-based	Microsoft Excel®	PDF	Microsoft Excel®	Microsoft Excel®
Company	BD	UTi Pharma	BD	UTi Pharma	BD	BD

(Source: Created by researcher specifically for this study)

For the purposes of developing a dashboard design, in this study the critical elements are the document source and the document format.

4.3.1 Document source

Table 4.1 shows that all documents obtained from BD except for one were archived on workstations, which increased the risk of a lack of accessibility to supply chain documents; this means that the concerned supply chain planner's security login credentials would be required to retrieve the report from their workstation.

All the documents received from UTi Pharma and one document from BD were retrieved from web-based information technology archives; where one report was web-based (TB2), the other formatted in PDF (FW4) and the other a Microsoft Excel® (SP1) document. A web-based archive preserves the integrity of the data; it reduces the risk of not working from the same data or not working from the same snapshot of time. It also increases the accessibility of documents as they would be archived in a central location. Working from information technology platforms similar to Futureview, Microsoft® SharePoint® and Tableau® reduces the error associated with human manipulation and data capturing (Ecora, 2013). These platforms also provide the option of downloading data in different document formats.

4.3.2 Document format

Table 4.1 shows that all documents received from BD were in Microsoft® Excel® format. Documents developed in Microsoft® Excel® are prone to errors associated with human manipulation, capturing and viruses (Protiviti, 2011). When reporting in Microsoft® Excel® there is a risk that stakeholders may not be working from the same set of data or even the same snapshot of time, which increases the risk of loss of context and misinterpretation of data (Ecora, 2013). Documents received from UTi Pharma were PDF or web-based. PDF documents are static and preserve the integrity of data. Web-based documents are dynamic and interactive and also provide the option to be downloaded in various formats including Microsoft® Excel® or PDF.

4.4 Overall ranking of respondents' documents

Table 4.2 shows the general ranking of the respondents' documents. The mean attribute score obtained for all the documents was 20.2 points out of a possible 54 points based on a calculation of 18 attributes and a maximum score of 3 points for each attribute. The overall attribute rating for all the respondents' documents was, therefore, 37%.

SP1 ranked the highest with a score of 33 points. WS3 and WS5 ranked the lowest overall with a score of 6 points, respectively. TB2, WS6 and FW4 scored in the range 19 to 31 points.

Area 'A' in Table 4.2 had the highest concentration of the orange colour code (score of 2 on the ordinal scale), indicating that on average the respondents' documents presented two requirements of the 'structure' sub-category.

Area 'B' of Table 4.2 had the highest concentration of the blue colour code (score of 0 on the ordinal scale), indicating that on average the respondents' documents did not present the requirements of 'agility' and 'cost' of the SCOR® performance attributes.

Table 4.2 Ranking of original documents

Category	Sub-category	Attributes of category	SP1	TB2	WS3	FW4	WS5	WS6	Mean Attribute Score
SCOR ® model Supply Chain Performance		Responsiveness	1	1	0	1	0	2	0.8
		Reliability	1	3	0	1	0	3	1.3
		Agility	0	0	0	0	0	0	0.0
		Cost	0	1	0	1	0	0	0.3
		Asset	0	0	0	2	0	1	0.5
Dashboard Design Framework	Application	Monitor	0	0	0	3	0	3	1.0
		Analyse	2	0	0	2	0	0	0.7
		Manage	3	2	1	2	1	1	1.7
	Layers	Monitor	0	0	0	2	0	2	0.7
		Analyse	2	0	0	1	0	2	0.8
		Drill to Detail	3	0	0	2	0	1	1.0
	Level	Strategic	3	1	0	2	0	2	1.3
		Tactical	3	0	0	2	0	0	0.8
		Operational	3	0	1	0	1	0	0.8
	Structure	Organisation	3	3	1	3	1	3	2.3
		Presentation	3	2	2	3	2	2	2.3
		Usability	3	3	1	1	1	1	1.7
		Graphics	3	3	0	3	0	3	2.0
		Total score	33	19	6	31	6	26	20.2
		Rating (fraction of maximum total score)	61%	35%	11%	57%	11%	48%	37%
		Ranking	1	4	5	2	5	3	

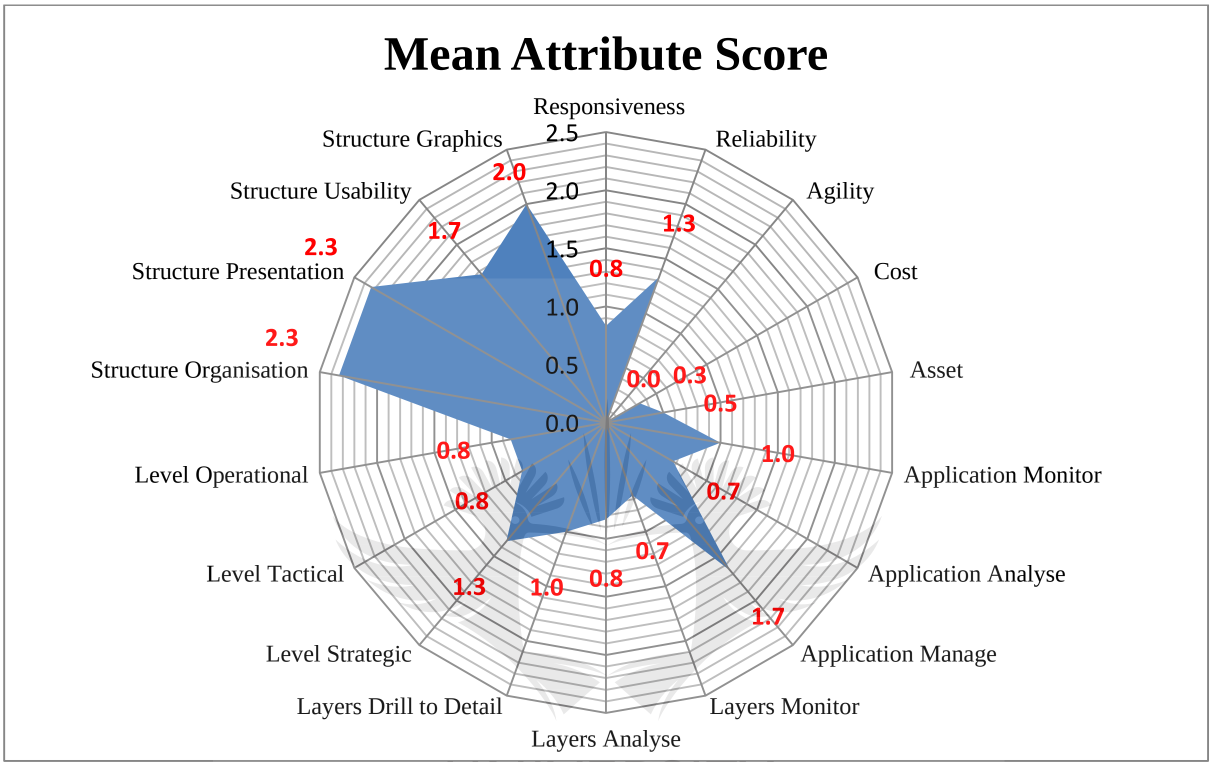
Maximum total score per report	54
Minimum total score per document	0

(Source: Researcher)

In general, Table 4.2 indicates that the 'applications', 'layer' and 'level' sub-categories scored an average rating of 33%, which is 9 points out of a possible 27. Generally the documents scored poorly on the SCOR® supply chain performance on the ordinal scale. Based on these low scores on the ordinal scale, in general the respondents' documents were considered to be one-dimensional. The respondents' documents were not designed to show strategic, tactical and operational information.

4.5 Overall strengths and weaknesses of respondents’ documents

Figure 4.1 shows that ‘structure organisation’ and ‘structure presentation’ were the strongest attributes of the documents. ‘Agility’ and ‘cost’ were the weakest attributes of the documents.



(Source: Researcher)

Figure 4.1 Average strength and weakness of the reviewed documents

4.6 Specific ranking of respondents’ documents

4.6.1 SP1

Document SP1 was received on email as a web link to a BD Microsoft® SharePoint® site (Table 4.1). SP1 took the format of a Microsoft® Excel® document. From Table 4.2, SP1 scored 33 points out of a possible 54 points and was allocated a rating of 61% overall for its attributes. SP1 was the best ranked document. SP1 scored the full 3 points on the ‘level’ and ‘structure’ sub-category respectively.

The high concentration of the red colour coding in Table 4.1 intercepting the SP1 column readings and the dashboard design framework category row demonstrated high scores across the dashboard design framework category. SP1 scored 31 points out of possible 39 points and was rated 79.5% for the dashboard design framework attributes. However the attributes of ‘layer analyse’, ‘layer monitor’ and ‘application analyse’ scored at 2, 0 and 2 respectively.

SP1 had a drill up and down function by product hierarchy to three levels and by region to four levels. This function led to SP1 scoring 3 points for the ‘lever application’ attribute. However, SP1 did not show any alerts, and it therefore scored 2 points for the ‘application analyse’ and ‘layer drill-to-detail’ attributes respectively.

SP1 had views of budget, financial forecast and volume demand forecast. These views provided financial management, demand management and commercial management applications of the document. These views resulted in a score of 3 points for the ‘application manage’ attribute.

The budget, financial forecast and volume demand were also trended by month. The respective variance in terms of volume demand forecast accuracy and budget gaps were also displayed. These trends and variances resulted in SP1 scoring 3 points for the ‘structure presentation’ attribute. When coupled with the drill-up-to function at region and product hierarchy level, SP1 presented strategic, tactical and operational dimensions. These dimensions resulted in the document scoring 3 points for the ‘level strategic’, ‘level tactical’ and ‘level operational’ attributes respectively.

From a ‘structure’ sub-category perspective, SP1 had a good use of contrast in terms of colours and fonts when considering the ‘graphic’ attributes. From a ‘usability’ perspective SP1 was intuitive and discoverable, it was visually appealing and the data was multi-dimensional from a drilling perspective. And, from the ‘organisation’ attribute perspective the like data was grouped together with good use of graphs and tables and drop-down fields for drilling data.

It is shown in Figure 4.2 that SP1 lacked the requirement of the SCOR® supply chain performance attributes. Two performance metrics were presented in SP1, namely, forecast accuracy and order-fill. These metrics resulted in SP1 scoring 1 point for the ‘responsiveness’ and ‘reliability’ attributes respectively. SP1 scored 2 points out of a possible 15 points and was allocated 13.3% for the SCOR® supply chain performance attributes.

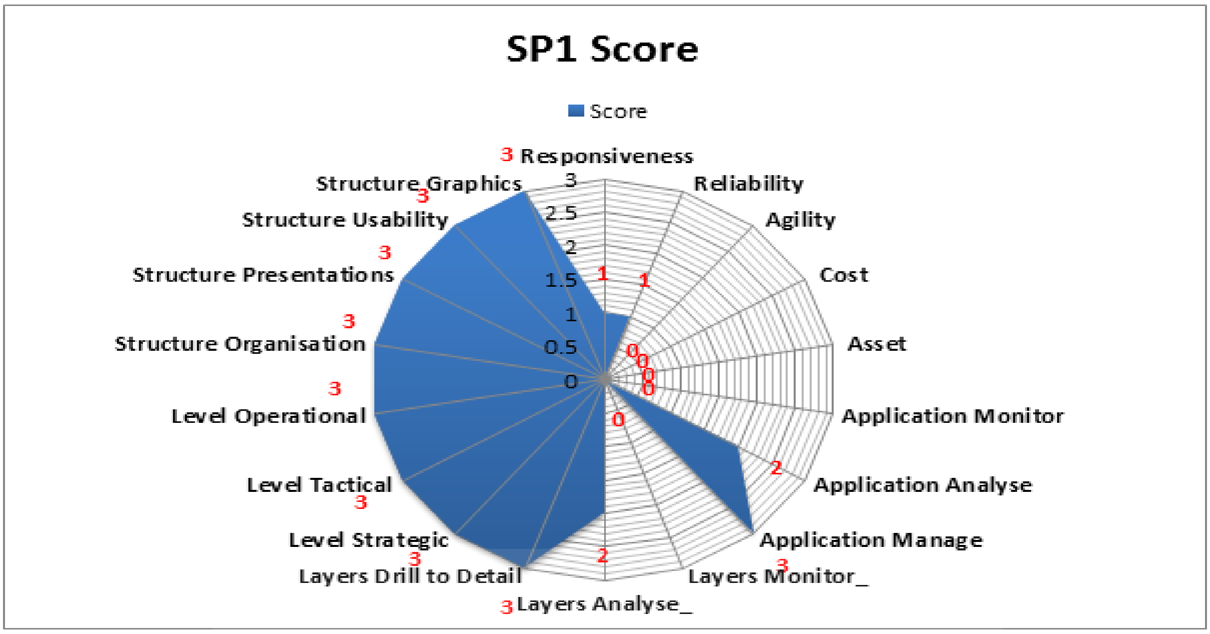


Figure 4.2 SP1 score

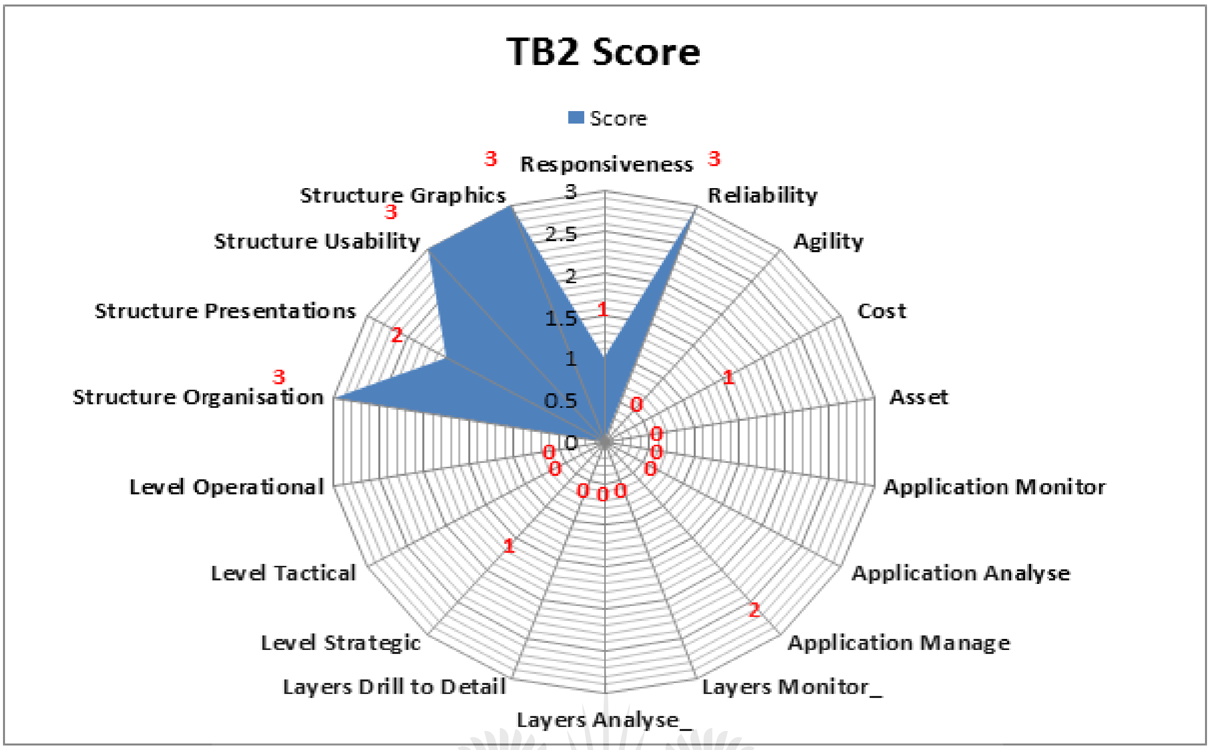
(Source: Researcher)

4.6.2 TB2

TB2 was received on email as a web link to UTi Pharma's Tableau® website (Table 4.1). TB2 took a web-based format. Being web-based, SP1 was downloadable as a portable document format (PDF), Joint Photographic Experts Group (jpeg) picture or Microsoft® Excel® document. Further, multiple users were able to access the same document simultaneously, allowing all users to work from the same set of data and at the same point in time.

Table 4.2 shows that TB2 scored 19 points out of a possible 54 points and was allocated a rating of 35% overall for its attributes. TB2 was ranked fourth.

Figure 4.3 shows the strengths and weaknesses of TB2. TB2 did not meet the requirement of eight of the 19 attributes and therefore scored 0 for 'agility', 'asset', 'application monitor', 'application analyse', 'layers monitor', 'layers analyse','layers drill-to-detail', 'level tactical' and 'level operation' respectively.



(Source: Researcher)

Figure 4.3 TB2 score

TB2 scored 14 points out of a possible 39 points for the dashboard design framework, a rating of 35.9% for this category. TB2 had good use of contrast in terms of colours and fonts, it was intuitive and discoverable, and it was visually appealing. The data was one-dimensional and like data was grouped together with good use of graphs and tables. TB2 scored 3 points for the 'graphics', 'usability' and 'organisation' attributes respectively.

TB2 scored 5 points out of a possible 15 for the SCOR® supply chain performance attributes, and a rating of 33.3% was allocated for this category. One point was scored for the availability metric which met the 'responsiveness' attribute. Three points were scored for the line fill, on-time, line order and quantity order metrics which met the 'reliability' attribute. One point was scored for the cost of goods sold (COGS) metric which met the 'cost' attribute.

4.6.3 WS3

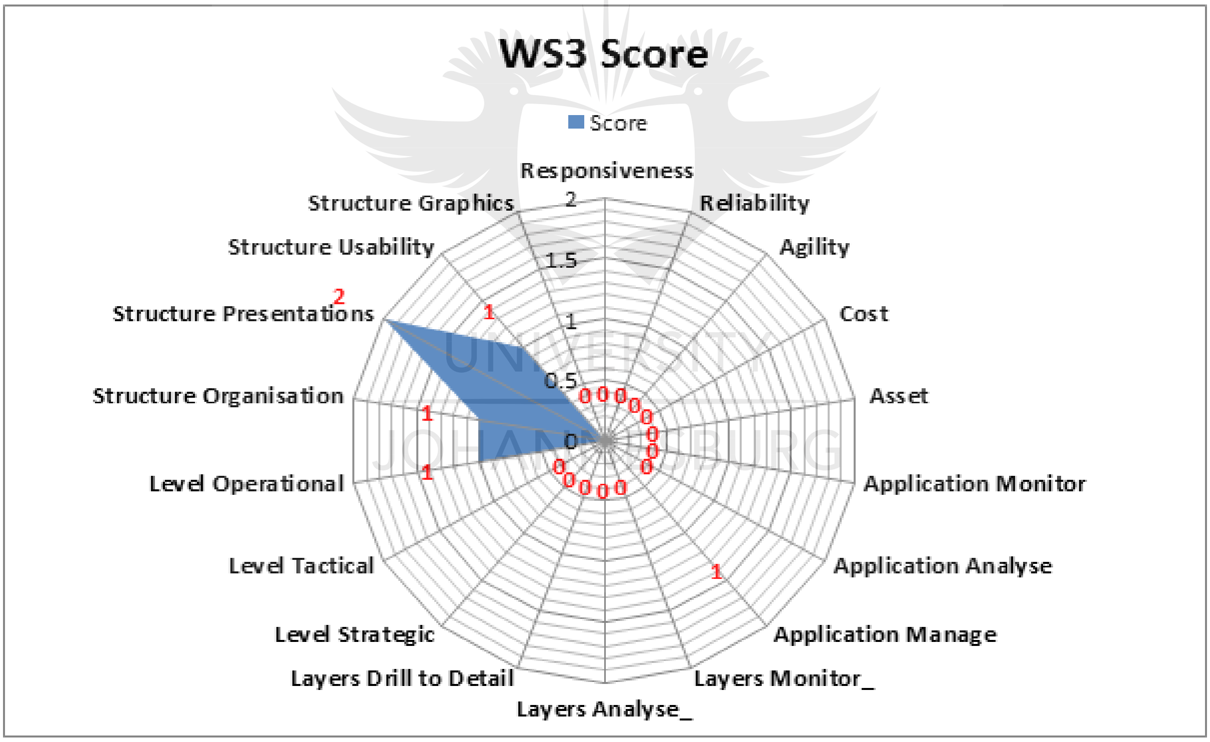
WS3 was received as an email attachment from a BD supply chain planner's workstation (Table 4.1). WS3 took a Microsoft® Excel® format.

Table 4.2 shows that WS3 scored 6 points out of a possible 54 points and was allocated a rating of 11% overall for its attributes.

Figure 4.4 shows the strengths and weaknesses of WS3. WS3 did not meet the requirement of 13 of the 19 attributes and scored 0 for 'responsiveness', 'reliability', ‘agility’, ‘cost’, ‘asset’, ‘application monitor’, ‘application analyse’, ‘layer monitor’, ‘layer analyse’, ‘layer drill to detail’, ‘level strategic’, ‘level tactical’ and ‘graphics’ respectively.

WS3 scored 6 points out of a possible 39 points for the dashboard design framework. A rating of 15.4% was allocated for this category. WS3 did not score any points for the SCOR® supply chain performance attributes; there were no performance metrics presented in the document.

WS3 scored 1 point for ‘application manage’, ‘operational’, ‘organisation’ and ‘usability’ respectively. The data in WS3 was presented at the lowest level of product hierarchy. It was presented at a stock keeping unit (sku) level. The data in WS3 was presented in one dimension using a table in a simple spreadsheet format. SP1 scored 2 points for ‘presentation’ as their data was trended by month and variances calculated between actual sales and forecasted sales units.



(Source: Researcher)

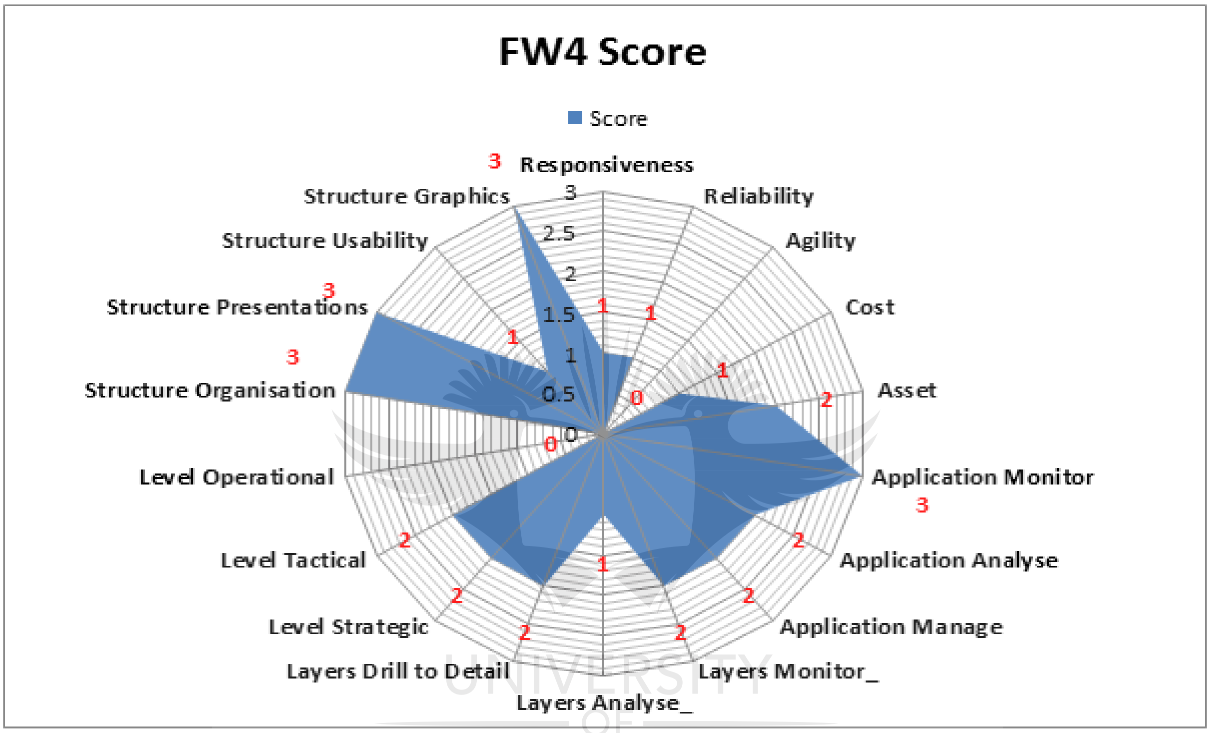
Figure 4.4 WS3 score

4.6.4 FW4

FW4 was received as an email attachment of a document downloaded from UTi Pharma’s Futurewave website (Table 4.1). FW4 took the format of a PDF document.

Table 4.2 shows that FW4 scored 31 points out of a possible 54 points overall and was allocated a rating of 57% overall for its attributes. FW4 was the second best ranked document.

Figure 4.5 shows that FW4 was the most well rounded document in terms of scores; FW4 scored at least 1 point across all the attributes with the exception of ‘agility’ and ‘operational’ where it was scored 0 for both.



(Source: Researcher)

Figure 4.5 FW4 score

FW4 scored 26 points out of a possible 39 points and was allocated a rating of 66.7% for the dashboard design framework.

FW4 scored 3 points for ‘asset’, ‘application monitor’, ‘organisation’, ‘presentation’ and ‘graphics’ respectively. From an ‘application monitor’ perspective, a pre-determined threshold was defined; three colours (green, yellow and red) were used to alert the user of the metric performance against the threshold. Green indicated that the metric was in the acceptable range, yellow indicated that the metric performance was erratic over a period of three months and the red indicated that the metric was consistently outside the acceptable range for a period of at least three months. From an ‘organisation’ perspective, graphs and tables were used to present the data and all like data was grouped together. From a ‘presentation’ perspective the metrics were trended by month and variances calculated. From a ‘graphics’ perspective there was good use of fonts, colour and contrast; BD and UTi Pharma logos were also included in the design of the document.

FW4 was scored 2 points for ‘application analyse’, ‘application manage’, ‘layers monitor’, ‘drill-to-detail’, ‘strategic’ and ‘tactical’ attributes. The data presented in the FW4 was two-dimensional. The data could be drilled-to-detail by region and channel. Alerts and threshold were used to help the user to manage and analyse by exception. Clear responsibilities for each metric were defined by organisation.

FW4 scored 1 point for ‘layer analyse’ because of alerts designed into the document and also scored 1 point for ‘usability’ because the document had two dimensions to it, namely channel view and region view.

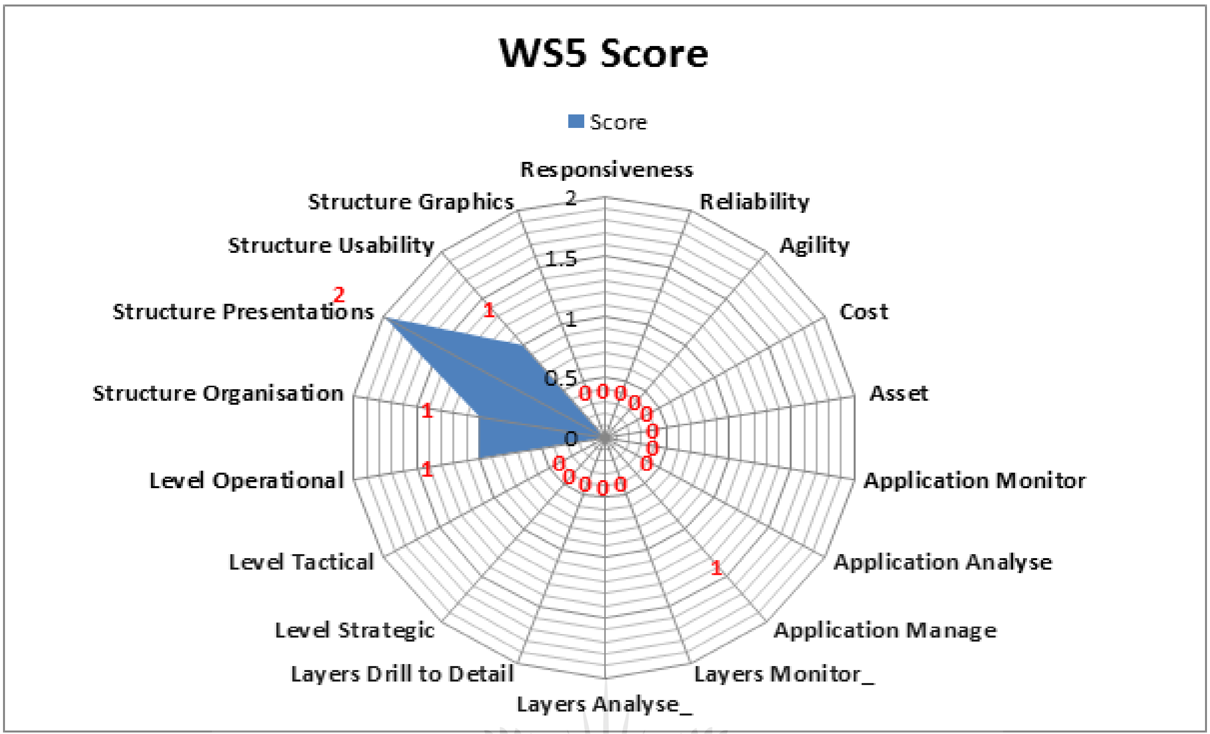
One SCOR® supply chain performance attribute requirement was not met when scoring FW4. FW4 scored 5 points out of a possible 15 points and was allocated 33.3% for the SCOR® supply chain performance attributes. This score was similar to that of TB2. Two points were scored for the ‘asset’ attribute for the metrics stock adjustments and days sales outstanding (DSO). One point was scored for the ‘responsive’, ‘reliability’ and ‘cost’ for the metrics line receipt in service-level agreement (SLA), on-time in-full and credits as a percentage of gross sales respectively.

4.6.5 WS5

WS5 was received as an email attachment from a BD supply chain planner’s workstation (Table 4.1). WS5 took a Microsoft® Excel® format.

WS5 scored exactly the same as document WS3. Table 4.2 shows that WS5 was scored 6 points out of a possible 54 points and was allocated a rating of 11% overall for its attributes.

Figure 4.6 shows the strengths and weaknesses of WS5. WS5 did not meet the requirements of 13 of the 19 attributes and was scored 0 for ‘responsiveness’, ‘reliability’, ‘agility’, ‘cost’, ‘asset’, ‘application monitor’, ‘application analyse’, ‘layer monitor’, ‘layer analyse’, ‘layer drill to detail’, ‘level strategic’, ‘level tactical’ and ‘graphics’.



(Source: Researcher)

Figure 4.6 WS5 score

WS5 scored 6 points out of a possible 39 points for the dashboard design framework and was allocated a rating of 15.4%. WS5 did not score any points for the SCOR® supply chain performance attributes because there were no performance metrics represented in the document.

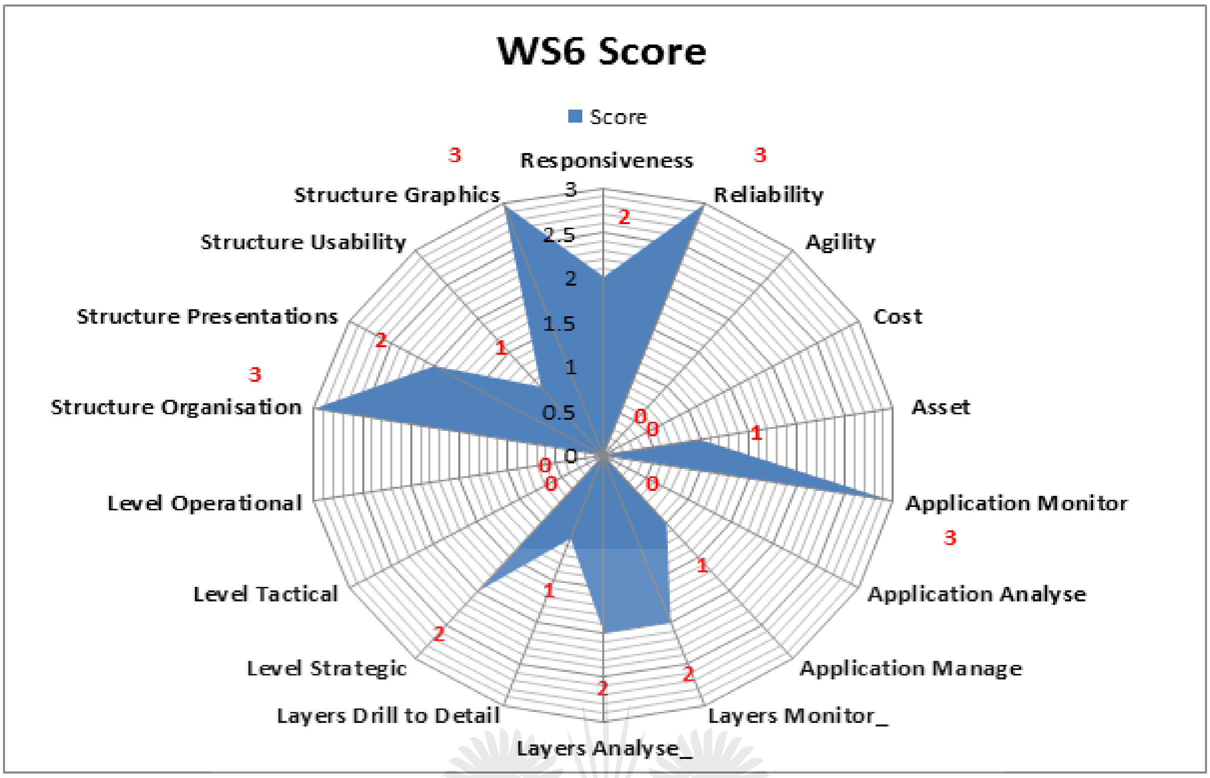
WS5 scored 1 point for ‘application manage’, ‘operational’, ‘organisation’ and ‘usability’, respectively. The data in the document was presented at the lowest level of product hierarchy at a stock keeping unit (sku) level and it was one dimensional; using a table in a simple spreadsheet format. WS5 scored 2 points for ‘presentation’ because the data presented was trended by month and variances calculated between actual sales and forecasted sales units.

4.6.6 WS6

WS6 was received as an email attachment from a BD supply chain planner’s workstation (Table 4.1). WS6 took a Microsoft® Excel® format.

Table 4.2 shows that WS6 scored 26 points out of a possible 54 points and was allocated a rating of 48% overall for its attributes. WS6 ranked third.

Figure 4.7 shows the strengths and weaknesses of WS6. WS6 did not meet the requirement of five of the 19 attributes and was scored 0 for ‘agility’, ‘cost’, ‘application analyse’, ‘level operational’ and ‘level tactical’.



(Source: Researcher)

Figure 4.7 WS6 score

WS6 scored 13 points out of a possible 39 points for the dashboard design framework and was allocated a rating of 33.3%.

WS6 scored 3 points for ‘application monitor’; the document had predefined thresholds and alerts for all the metrics it displayed. WS6 scored 3 points for ‘organisation’ and ‘graphics’; graphs and tables were used, like data was grouped together and there was a good use of fonts, colour and contrast.

WS6 scored 2 points for ‘layers monitor’, ‘layers analyse’, ‘strategic’ and ‘presentation’. WS6 was one-dimensional, data viewed was by region and stock keeping unit (sku); it had a function to filter by region. The data was trended by month and variances were calculated for all metrics. A rating of 1 point was scored for ‘application manage’, ‘drill to detail’, and ‘usability’.

WS6 scored 6 points out of a possible 15 for the SCOR® supply chain performance attributes; a rating of 40% was allocated. One point was scored for the finished goods inventory turns metric which met the ‘assets’ attribute. Three points were scored for the back order, on-time in-full and service to sales metrics which met the ‘reliability’ attribute. Two points were scored for forward days sales and forecast accuracy metrics which met the ‘responsiveness’ attribute.

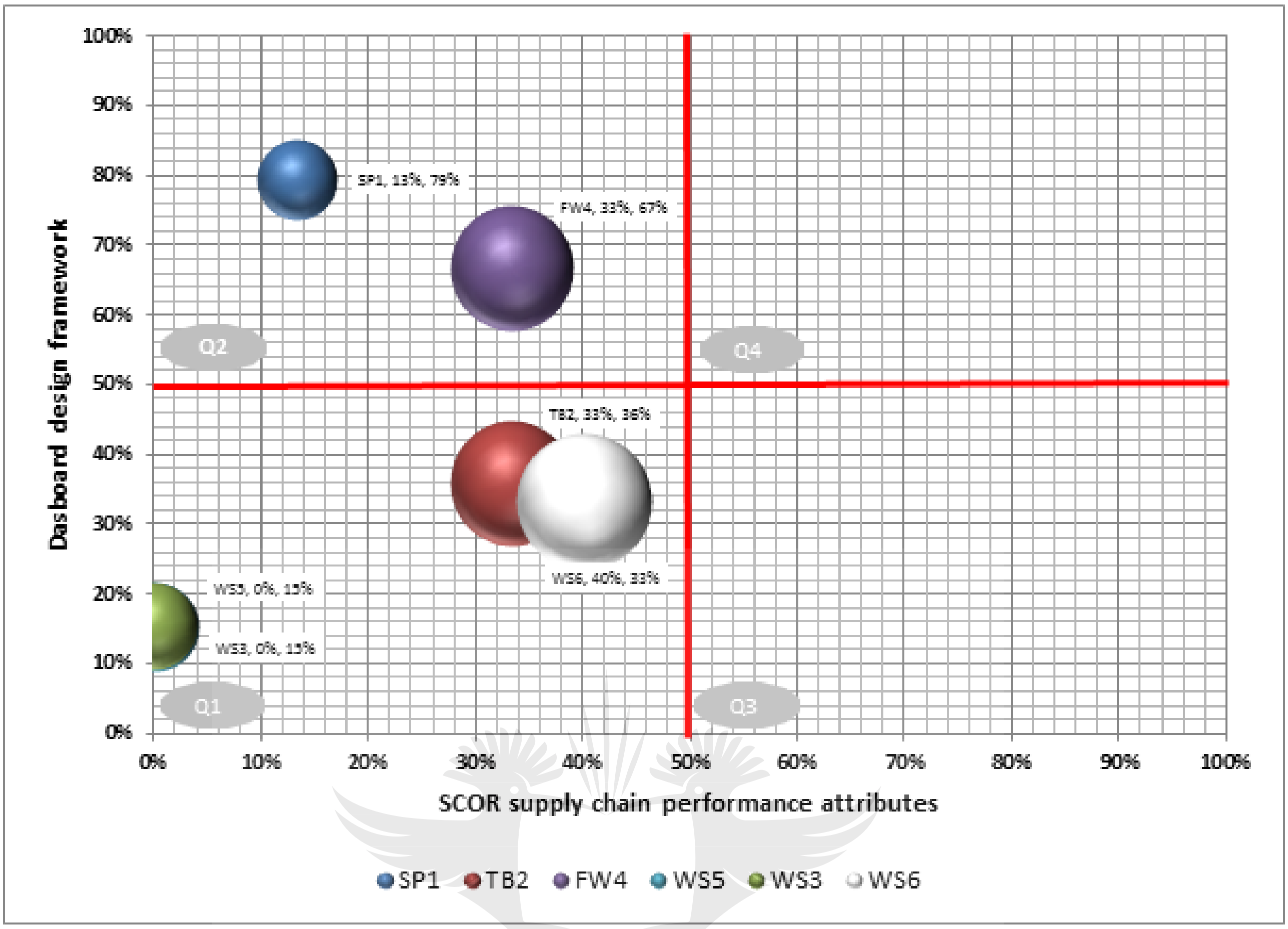
4.7 Document comparison matrix

Figure 4.8 is a four-quadrant representation of the scores of the six respondents' documents reviewed during the study. The graph is illustrative of the qualitative content analysis construct decribed in the research design. On the x-axis is the possible rating for the SCOR® supply chain performance attributes. On the y-axis is the possible rating for the dashboard design framework attributes.

- Quadrant one (Q1) represents a rating of less than 50% for both elements of the dashboard design framework and the SCOR® supply chain performance attributes.
- Quadrant two (Q2) represents a rating of more than 50% for elements of the dashboard design framework and less than 50% for elements of the SCOR® supply chain performance attributes.
- Quadrant three (Q3) represents a rating of less than 50% for elements of the dashboard design framework and a rating of more than 50% for elements of the SCOR® supply chain performance attributes.
- Quadrant four (Q4) represents a rating of more than 50% for both elements of the dashboard design framework and the SCOR® supply chain performance attributes.

Figure 4.8 illustrates that none of the documents reviewed appear in the third quadrant (Q3) or the fourth quadrant (Q4). All the respondents' documents scored low on the SCOR® supply chain performance attributes. Two documents (SP1 and FW4) appear in the second quadrant (Q2). SP1 and FW4 scored high on the dashboard design attributes. Four documents (WS5, WS3, TB2 and WS6) appear in the first quadrant (Q1). WS5, WS3, TB2 and WS6 scored low on the dashboard design attributes.

The findings show that in order to design an ideal supply chain dashboard for a medical technology company, the SCOR® supply chain performance category gap would have to be closed. Creating a comprehensive dashboard with the characteristics of quadrant four (Q4) of the document comparison matrix (Figure 4.8) may require drawing on the combined strengths of all the six respondents' documents analysed in this study.



(Source: Researcher)

Figure 4.8 Original document comparison matrix

4.8 Summary

A total of six documents from respondents were reviewed. They were presented in different document formats and were also retrieved from different archival sources. In general the respondents' documents attributes were rated as weak. The weak rating was attributable to a lack of SCOR® model supply chain performance attributes.

CHAPTER 5. CONCLUSIONS

5.1 Introduction

From the findings in Chapter 4, there was a need to draw from the combined strengths of all the respondents' documents in creating dashboard design that would bridge the SCOR® model supply chain performance attributes gap. This chapter draws a conclusion by mapping a new dashboard design using these strengths.

5.2 Dashboard scoring

In order to design a demand-driven supply chain dashboard design, the best scores for each attribute of category by report were considered. Table 5.1 is a heat map similar to Table 4.2 of Chapter 4. However, in Table 5.1 the best scores for each category attribute have been extrapolated to come up with the highest attribute score. The highest attribute score was used to develop the total score for a proposed dashboard design.

Table 5.1 indicates that the proposed dashboard design scored 44 points out of a possible 54 points which resulted in a rating of 81%. The score of the proposed dashboard design had an 11 point advantage over document SP1; SP1 was the first ranked document with a score of 33 points. The total mean attribute score of the six reviewed documents was 20.2, which translates into an advantage of 23.8 points for the proposed dashboard design.

The proposed dashboard design scored 36 points out of a possible 39 points for the dashboard design category and was allocated 92% for this category. This rating was 13 percentage points above document SP1's rating of 79%. It also scored 8 points out of a possible 15 points for the SCOR® supply chain performance category and was allocated 53% for this category. This rating was 20 percentage points above the document FW4's rating of 33%.

Table 5.1 Best attribute scores

Category	Sub-category of Meaning	Attributes of category	SP1	TB2	WS3	FW4	WS5	WS6	Highest Attribute Score
SCOR ® Supply Chain Performance		Responsiveness						2	2.0
		Reliability		3				3	3.0
		Agility	0	0	0	0	0	0	0.0
		Cost		1		1			1.0
		Asset				2			2.0
Dashboard Design Framework	Application	Monitor				3		3	3.0
		Analyse	2			2			2.0
		Manage	3						3.0
	Layers	Monitor				2		2	2.0
		Analyse	2					2	2.0
		Drill to Detail	3						3.0
	Level	Strategic	3						3.0
		Tactical	3						3.0
		Operational	3						3.0
	Structure	Organisation	3	3		3		3	3.0
		Presentation	3			3			3.0
		Usability	3	3					3.0
		Graphics	3	3		3		3	3.0
		Total Score							44.0
		Rating (fraction of maximum total score)							81%
		Maximum total score per report	54						
		Minimum total score per report	0						

(Source: Researcher)

5.3 Dashboard placement

The proposed dashboard design was placed in quadrant four (Q4) of the document comparison matrix (Figure 5.1), which is ideal. However, from a SCOR® supply chain performance category perspective, the proposed dashboard design made it into quadrant four (Q4) by a small margin of 3 percentage points. Even under the proposed supply chain dashboard design 'agility' was still scored 0 (Table 5.1).

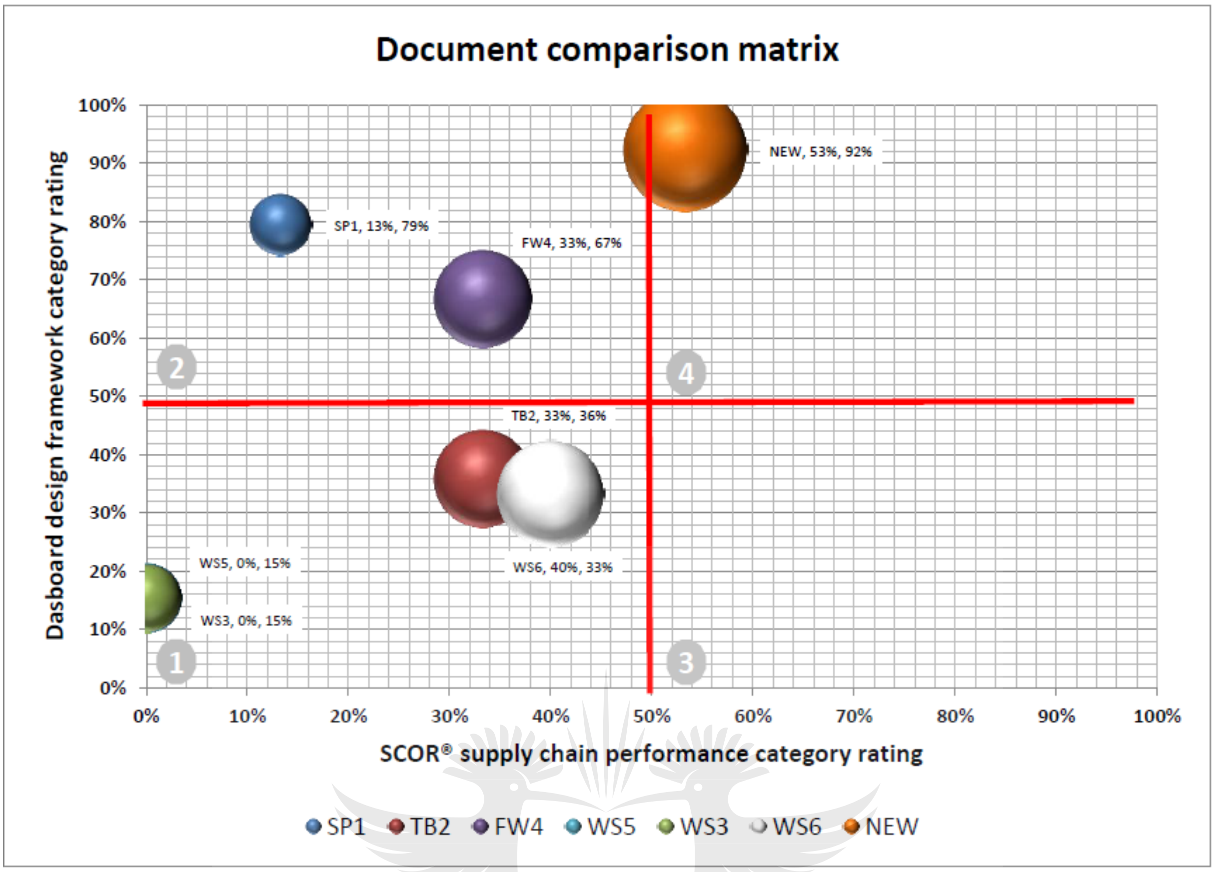


Figure 5.1 Proposed document comparison matrix

(Source: Researcher)

5.4 Supply chain segmentation

Perhaps to ensure that the design of a new dashboard falls comfortably into quadrant four (Q4), the research study should have factored a supply chain segmentation element into the research instrument. It is possible that the low SCOR® supply chain performance category scores are attributable to BD's supply chain's competitive differentiators. This means that one performance attribute may have been positioned more strategically than the others in terms of the SCOR® model segmentation matrix. The SCOR model segmentation matrix provides that performance attributes can be positioned as superior, advantage or parity (SCC, 2010a).

Table 5.1 shows that 'reliability' scored the highest at 3 points, followed by 'responsiveness' and 'asset' at 2 points, then 'cost' at 1 point. This suggests that it is possible that at BD the supply chain segmentation objective was to have 'reliability' as a superior attribute. The data suggests that 'responsiveness' and 'asset' were advantage attributes. The data also suggests that 'cost' was positioned as a parity attribute. However, this cannot be proved as the research was not designed to answer this question. None-the-less, it is accepted that an element of supply chain segmentation should have been factored into the design of the research design.

The research was specific in that the objective was to establish a demand-driven supply chain dashboard design. Taking supply chain segmentation into consideration, the superior attribute was 'reliability', the advantage attributes were 'agility' and 'responsiveness', and the parity attributes were 'asset' and 'cost'. The ordinal scale was amplified by a factor of 3, 2 and 1 for the superior, advantage and parity attributes respectively.

With this approach a new dashboard design would fall into quadrant four (Q4) as depicted in Figure 5.2. The new dashboard design fitted comfortably into quadrant four (Q4) with the SCOR® supply chain attributes rating at 60%, an increase from 53%.

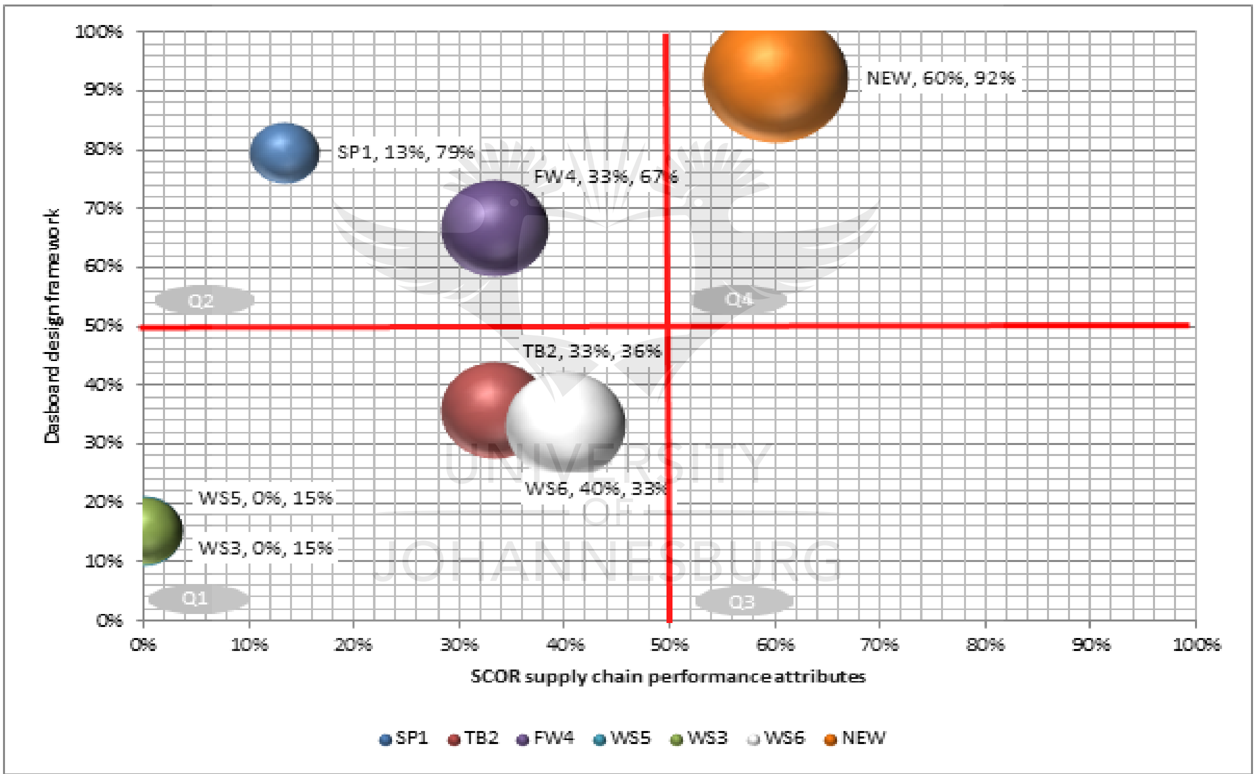


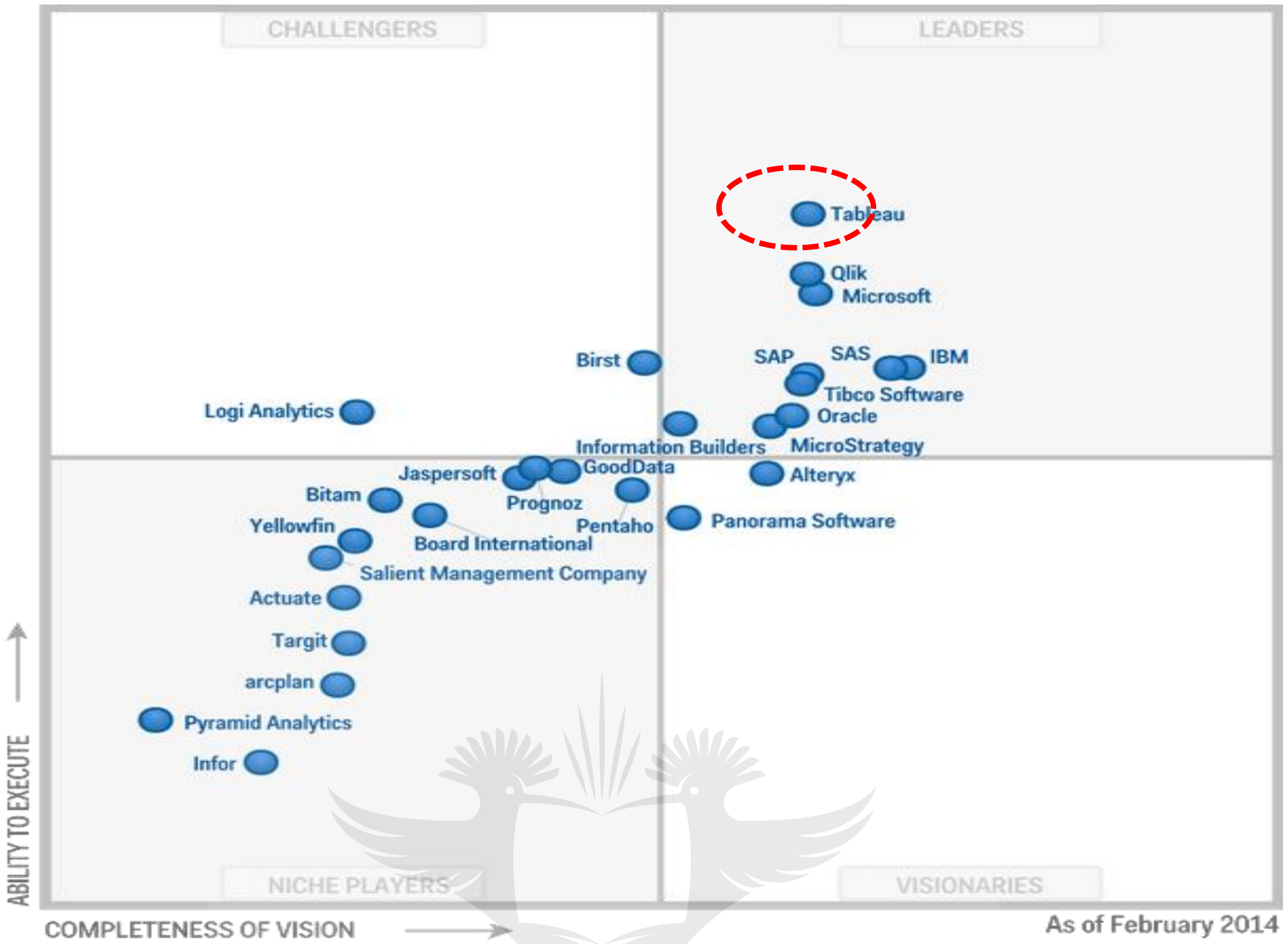
Figure 5.2 Advanced document comparison matrix

(Source: Researcher)

5.5 Single data repository

The data used to create the respondents' documents were from different data sources. Some documents were created using data from BD data systems and some from using UTi Pharma data systems. Documents were accessed from two different platforms, namely, the supply chain planners' computer workstations and web-based database applications. When designing a dashboard, it is recommended that the data is gathered in and accessed from a single source or platform. At BD, a planner's computer workstation can only be accessed by the particular planner. The BD Microsoft® SharePoint® site can only be accessed by BD employees. However both the UTi Pharma Futurewave and Tableau® sites can be accessed by both UTi Pharma and BD employees.

The practicality of bringing more than one company's set of data in single point of storage, processing and retrieval is essential. From observation both Futurewave and Tableau® appear to be suitable for the new dashboard design. However the limitation of Futurewave is that it is a UTi Pharma in-house developed application. Tableau® provides a more conducive platform because it is an open source cloud-based platform. Cloud computing is essentially the aggregation of data centres on the internet; it aggregates execution applications at various levels of computing which may include operating systems, middleware and servers (Tsuchiya, Sakamoto, Tshichimoto and Lee, 2012:168). The other advantage of Tableau® is its ability to process big data. Big data is a term used to convey the notion of huge quantities of data, real-time data and the next generation of data management (Schroeck, Shockley, Smart, Romero-Morales and Tufano, 2012). In addition, Tableau® has, globally, been ranked first as a leader in the Gartner magic quadrant for business intelligence and analytics platforms report (Figure 5.3). The Gartner magic quadrant provides a graphical competitive positioning technology provider namely Leaders, Visionaries, Niche Players and Challengers (Gartner, 2014). Tableau® also has the capability to provide downloadable options in Microsoft® Excel®, PDF, jpeg and tagged image file (TIF) format.



(Source: Gartner, 2014)

Figure 5.3 Gartner magic quadrant

5.6 Future research suggestion

This study took a conceptual approach to designing a demand driven dashboard. A case study research of a practical application of the proposed dashboard design as conceptualised in study could expand on the work done.

5.7 Summary

This study stemmed from the assumption that supply chain management can coordinate and integrate a firm's activities into a collection of seamless end-to-end processes and ultimately enable full visibility of the firm's performance (Lamb *et al.*, 2010). This coordination and integration could be achieved by using demand-driven supply chain dashboards (Suthers *et al.*, 2007).

This study sought a solution to a situation where there were many uncorrelated, different and laborious supply chain reports which did not make it easy for supply chain and business stakeholders to measure, monitor and manage the performance of the supply chain. The desire was to design a demand-driven supply chain dashboard geared towards improving performance measurement in a medical technology company.

In this study, two objectives were stated. These objectives have been met as follows:

- To review supply chain key performance indicators used by a medical technology company.

BD was used as an example of a medical technology company. Document review was used to review BD's supply chain documents. BD's supply chain key performance indicators were reviewed against the SCOR® model supply chain performance attributes.

- To map a demand-driven supply chain dashboard design using the collected data.

Literature review was used to establish a dashboard design framework. BD's supply chain documents were reviewed against the dashboard design framework. The combined strengths of all the respondents' documents were used to establish a demand-driven supply chain dashboard design (Figure 5.2).

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Table 6.1 Table of acronyms

3PL	Third Party Logistics
B2B	Business To Business
BD	Becton Dickinson
COGS	Cost Of Goods Sold
CRM	Customer Relationship Management
DSO	Days Sales Outstanding
EMA	Eastern Europe, Middle East And Africa
ERP	Enterprise Resource Planning
GAO	General Accounting Office
jpeg	Joint Photographic Experts Group
MRP	Materials Resource Planning
NIC	National Inventory Control
PDF	Portable Document Format
QCA	Qualitative Content Analysis
SCC	Supply Chain Council
SCOR	Supply Chain Operations Reference
SDi	Supply Chain Design And Innovation
sku	Stock Keeping Unit
SLA	Service-Level Agreement
TIF	Tagged Image File

APPENDICES

Appendix 1 Copy of letter requesting permission to conduct research study

UNIVERSITY OF JOHANNESBURG

Dept. of Business Management
Telephone: 011 559 3151

11 October 2012

Peter Mehlape
General Manager - East and Southern Africa
Becton Dickinson (PTY) Ltd
20 Woodlands Drive
Woodlands Office Park
Building 31, 2nd Floor
Woodmead
Johannesburg
2199

Dear Mr Mehlape,

You are kindly requested to give approval to Mr S.K. Ramoshebi (Student Number 201145162) to collect research data from your organisation. He is currently a registered MCom Business Management student in the Faculty of Management at the University of Johannesburg and busy with his Minor Dissertation. The topic for his research is "A Novel E2E SCM Dashboard: Crafting a Company-Specific Demand Management Instrument in the Supply Chain of a Medical Technology Company".

Mr Ramoshebi will be looking at certain reports and records for information.

The findings of the research will be used solely for the purpose of this academic exercise.

Yours sincerely

Dr. Adri Drotskie
Head: MCom Business Management

Auckland Park Kingsway Campus | Cnr Kingsway and University Road Auckland Park
PO Box 524 Auckland Park 2006 Johannesburg Republic of South Africa | Tel +27 11 559 2911 | www.uj.ac.za

Appendix 2 Copy of letter giving permission to conduct research study

Becton Dickinson (Pty) Ltd
20 Woodlands Drive, The Woodlands Office Park
Building 31, 2nd Floor, Woodmead, 2191
Johannesburg, South Africa
Tel: +27 11 603 2620
Fax: +27 11 603 2640
www.bd.com/za

BD
Helping all people
live healthy lives

22 October 2012

Dr. Adrie Drotskie
Head: MCom Business Management
Auckland Park Kingsway Campus
Cnr Kingsway and University Road
Auckland Park
2006

Dear Dr. Adrie Drotskie

Please refer to your request letter dated 11 October 2013; I hereby approve Mr. S. K. Ramoshebi (Student Number 201145162) to collect research data from Becton Dickenson South Africa (PTY) Ltd.

Regards

Peter Mehlape
General Manager: East and Southern Africa

Appendix 3 Copy of letter to research study participants

BD
20 Woodlands Drive
The Woodlands Office Park
Building 31
Rivonia
2138

02 May 2013

Dear Colleague,

REQUEST TO PARTICIPATE IN RESEARCH STUDY

My name is Setota Ramoshebi. I am a Master of Commerce student at the University of Johannesburg in the department of Transport and Supply Chain Management under the supervision of Prof. G. Prinsloo.

You are invited to participate in a research project entitled "Designing a Demand-Driven Supply Chain Dashboard for a Healthcare Technology Company".

The aim of the research is to design a demand-driven decision support supply chain dashboard geared to, holistically, improve performance reporting, monitoring and decision making within the supply chain of a healthcare technology company. This study has been approved by the University of Johannesburg and the General Manager of Becton Dickinson, South Africa. It is envisaged that this research will add value to how the medical technology company measures, analyses and manages performance within its supply chain.

You are requested to submit reports or links to reports that you use/used to measure the measure and manage the supply chain performance of Becton Dickinson (South Africa) over the period beginning in **October 2012 and ending in April 2013**.

Kindly note that the research is confidential and your personal information will remain anonymous. Responses to the survey will be reported in aggregated form to protect the identity of respondents.

Participation in this research is voluntary and you will not receive compensation for participating in the research study. Neither the researcher nor the University has a conflict of interest with the findings of the research.

Please send your reports or links to reports via email to me at Setota_RAMOSHEBI@europe.bd.com within four (4) weeks of receiving this correspondence.

Thank you in anticipation.

Yours sincerely,

____
Setota K. Ramoshebi