Supply Management and Procurement at a South African FMCG Company: A Practical Example of Developing a Decision Support Tool for Managing Direct Material Cost

by

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Declaration

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Abstract

One of the functions within the supply chain of manufacturing companies is the procurement of direct materials that are needed for the production of products sold to consumers. Even though the process of purchasing materials was always required within the manufacturing process, it only recently gained attention on management level. Today, organisations set up centralised procurement functions that develop global sourcing strategies in order to align procurement processes, people and technology. The goal is to reduce total cost while maintaining high quality, availability and service levels. However, procurement functions are challenged by a number of risks during its global sourcing activities that can have major impacts on direct material cost.

Johnson & Johnson is a major global player within the Fast Moving Consumer Goods (FMCG) industry and acknowledged a significant sense of uncertainty relating to the identification and measurement of direct material cost drivers within their global procurement function. Even though Johnson & Johnson is aware that the economic environment has an impact on its procurement spend, it has a limited ability to measure and quantify these effects. Based on the case of Johnson & Johnson, this study's objective was to develop a decision support tool that measures and analyses the impact of cost drivers on direct material cost. The aim was to develop a model that can be used by procurement professionals in industry in order to provide insight into the procurement cost structure and to identify opportunities that can lead to risk and cost reduction.

A case study research design was followed, which included secondary and primary research to collect qualitative and quantitative data. The research methods included observations and input discussions at the company, as well as a comprehensive model development process, which was used in order to create the decision support tool. As the decision support tool was developed on the case of Johnson & Johnson, data were collected from the company in order to test the model and generate outputs.

Following the individual process steps of the development process resulted in a highly structured and documented approach to develop the decision support tool. Two major cost drivers of procurement spend when conducting global sourcing were identified: fluctuating exchange rates and volatile commodity markets. Both of these cost drivers were analysed and included during the decision-support tool development process. As a result, a decision support

tool is presented that provides functionality to measure the exposure and the potential impact value of the first-tier currency impact, second-tier currency impact as well as the inflation impact. Furthermore, “what-if” and scenario analyses provide a predictive view based on actual forecasts. As an additional output, the decision support tool provides detailed insight and transparency of the total procurement spend, providing important information for decision makers.

Keywords: supply chain management, supply management, procurement, global sourcing, strategic sourcing, decision support system (DSS), fast moving consumer goods (FMCG), exchange rate fluctuation, volatile commodity markets, sensitivity analysis

Opsomming

Een van die funksies in die voorsieningsketting van vervaardigingsmaatskappye is die verkryging van direkte materiaal wat benodig word vir die vervaardiging van produkte wat aan verbruikers verkoop word. Hoewel die proses van materiaalaankope nog altyd binne die vervaardigingsproses nodig was, het dit eers onlangs op bestuursvlak aandag getrek. Vandag stel organisasies gesentraliseerde verkrygingsfunksies saam wat globale strategieë ontwikkel vir die verkryging van hulpbronne om sodoende verkrygingsprosesse, mense en tegnologie met mekaar in ooreenstemming te bring. Die doel is om totale koste te verminder terwyl hoë gehalte, beskikbaarheid en diensvlakke gehandhaaf word. Tydens die globale verkrygingsaktiwiteite word daardie funksies egter deur ’n aantal risiko-uitdagings in die gesig gestaar wat ’n groot impak op direkte materiaalkoste kan hê.

Johnson & Johnson is ’n vername wêreldspeler binne die industrie vir vinnig bewegende verbruikersgoedere (VBVG) en herken ’n beduidende gevoel van onsekerheid wat verband hou met die identifisering en meting van direkte materiaalkostedrywers binne hulle globale verkrygingsfunksie. Hoewel Johnson & Johnson daarvan bewus is dat die ekonomiese omgewing ’n impak op hulle verkrygingsbesteding het, beskik hulle oor beperkte vermoë om hierdie effekte te meet en te kwantifiseer. Gegrond op die geval van Johnson & Johnson, was hierdie studie se doelwit om ’n besluitsteunhulpmiddel te ontwikkel vir die identifisering en meting van direkte materiaalkostedrywers. Die oorhoofse doel was om ’n model te ontwikkel wat deur verkrygingsberoepslui in die bedryf gebruik kan word om insig in die verkrygingkostestruktuur te voorsien, en om geleenthede te identifiseer wat na risiko en kostevermindering kan lei.

’n Gevallestudienavorsingsontwerp is gevolg wat primêre en sekondêre navorsing ingesluit het vir die versameling van kwalitatiewe en kwantitatiewe data. Die navorsingsmetodes het waarnemings en besprekings by die maatskappy sowel as die omvattende modelontwikkelingsproses ingesluit om hierdie besluitsteunhulpmiddel te skep. Aangesien die besluitsteunhulpmiddel op die geval van Johnson & Johnson berus, is data van die maatskappy versamel om sodoende die model te toets, en uitset te genereer.

Die volg van die individuele stappe van die ontwikkelingsproses het gelei tot ’n hoogs gestruktureerde en gedokumenteerde benadering in die ontwikkeling van die besluitsteunhulpmiddel. Twee belangrike kostedrywers van verkrygingbesteding in die

uitvoer van globale verkryging is geïdentifiseer: wisselkoersfluktuering en onbestendige kommoditeitsmarkte. Albei hierdie kostedrywers is ontleed en ingesluit tydens die ontwikkelingsproses van die besluitsteunhulpmiddel. Gevolglik word 'n besluitsteunhulpmiddel gebied wat funksionaliteit verskaf om die blootstelling en potensiële impakwaarde van die eerstevlakvaluta-impak, tweedevlakvaluta-impak, sowel as die inflasie-impak te meet. Verder verskaf "wat as"- en scenario-ontledings voorspellende beskouings wat op werklike vooruitskattings gegrond is. As bykomende uitset verskaf die besluitsteunhulpmiddel gedetailleerde insig en deursigtigheid van die totale verkrygingbesteding, en verskaf sodoende belangrike inligting vir besluitnemers.

Sleutelwoorde: voorsieningskettingbestuur, voorsieningsbestuur, verkryging, globale verkryging, strategiese verkryging, besluitsteunhulpmiddel (BSH), vinnig bewegende verbruikersgoedere (VBVG), wisselkoersfluktuering, onbestendige kommoditeitsmarkte, sensitiwiteitsontleding

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Acronyms and Abbreviations

AEX	Euronext Amsterdam
AIP	JSE stock symbol of Adcock Ingram Holdings Limited
APAC	Johnson & Johnson business division for Asia Pacific
BI	Business Intelligence
BN	Billion
BOM	Bill of Material
BP	Business Plan
CHC	Consumer Health Care
COGS	Cost of Goods Sold
CPG	Consumer Packaged Goods
CPI	Consumer Price Index
DSS	Decision Support System
EMEA	Johnson & Johnson business division for Europe, Middle East and Africa
ENA	Reckitt Benckiser business division for Europe and North America
EUR	Euro
FMCG	Fast Moving Consumer Goods
FX	Foreign Exchange
GBP	Pound Sterling
GDP	Gross Domestic Product
GP	Gross Profit
HPCB	Tiger Brands category for home, personal care and baby
JSE	Johannesburg Stock Exchange
KMB	NYSE stock symbol of Kimberly Clark
LA	Johnson & Johnson business division for Latin America
LAPAC	Reckitt Benckiser business division for Latin America, North Asia, South East Asia, Australia and New Zealand
LSE	London Stock Exchange
MOQ	Minimum Order Quantity
MS Excel	Microsoft Excel
NA	Johnson & Johnson business division for North America
NPD	New Product Development
NTS	Net Sales
NYSE	New York Stock Exchange

OTC	Over-the-counter
PG	NYSE stock symbol of Procter & Gamble
PHC	Personal Health Care
PO	Purchase Order
PPI	Producer Price Index
RB.	LSE stock symbol of Reckitt Benckiser Group plc
RUMEA	Reckitt Benckiser business division for Russia, Middle East, North Africa, Turkey and Sub-Sahara Africa
SKU	Stock Keeping Unit
SME	Subject Matter Expert
TBS	NYSE ticker Tiger Brands Limited
TCO	Total Cost of Ownership
U.S.	United States of America
UL	NYSE stock symbol of Unilever PLC
ULVR	LSE stock symbol of Unilever PLC
UN	NYSE stock symbol of Unilever N.V.
UNA	AEX stock symbol of Unilever N.V.
UNIA	AEX stock symbol of Unilever N.V.
UOM	Unit of Measure
USD	U.S. Dollar
VBA	Visual Basic for Applications
ZAR	South African Rand

Chapter 1 - Introduction

1.1 Introduction

The importance of supply management and procurement within the supply chain has increased significantly over the past 20 years (Tassabehji & Moorhouse, 2008: 55). Especially in multinational, global companies, procurement has developed from being just a necessary function of purchasing to a core element with major strategic importance. With the increasing share of direct material cost, one of the reasons of the rising importance of procurement can be found in the financial statements of the global corporations (Boston Consulting Group, 2008). Therefore, it is not surprising, that an increasing number of companies centralise their procurement functions and develop integrated global sourcing strategies in order to align processes, people and technology, and reduce material cost and improve availability across the company.

For companies that engage in the fast moving consumer goods (FMCG) market, optimised procurement processes and efficient sourcing strategies play a vital role. The diverse FMCG industry offers a wide range of products in several categories, spanning from food and beverages to personal health care (PHC) and home care products. Therefore, manufacturers source a vast amount of materials, which are needed for the production of these so-called consumer packaged goods (CPG). This needs to be done as cost efficient and effective as possible in order to ensure a competitive advantage. In South Africa, several companies compete in the FMCG market across a number of product categories and are confronted by a variety of challenges with regards to direct material cost. Volatile commodity markets and the weak Rand are only two examples of a number of potential sourcing cost drivers for South African manufacturing companies.

There is a significant sense of uncertainty when it comes to measuring the exposure of such cost drivers on the supply chain. Johnson & Johnson, being one of the companies that engage in the consumer health care (CHC) market in South Africa, is interested in being able to improve its understanding and to quantify the effect of cost drivers on its material cost. These costs are not traceable in financial statements and are not measured actively elsewhere. The lack of transparency makes it challenging for the strategic sourcing team to consider these cost drivers when making strategic procurement decisions. Market research was conducted by an external consulting firm, which identified cost drivers related to uncertainty in the supply

chain, but did not go into detail with regards to direct material cost. Johnson & Johnson is aware that the economic environment has a significant impact on their material cost and internal efforts were made to measure individual cost drivers. However, a new approach towards ensuring transparency and visibility of the procurement side of the business is necessary, in order to identify and measure the cost elements that affect direct material cost. A decision support tool that transforms available data into decision-making information is required in order to have a clear understanding about direct material cost and to be able to have a more predictive view on cost impact that might occur in future.

The purpose of this chapter is to provide the background and the motivation for this research study. Therefore, the reader is introduced to the company on which the case study is conducted. Furthermore, the problem is formulated and research objectives are presented. The research design and scope is explained and important terms used in this paper are defined. Lastly, the reader is provided with an overview of the structure of the document.

1.2 Background

Johnson & Johnson is a leading multinational corporation in the health care and pharmaceutical industry, offering a broad range of CHC and pharmaceutical products. Being a holding company, Johnson & Johnson includes more than 265 operating companies in 60 countries (Johnson & Johnson Services, 2015a). The three business operating companies are categorised into three business segments (see Figure 1.1).

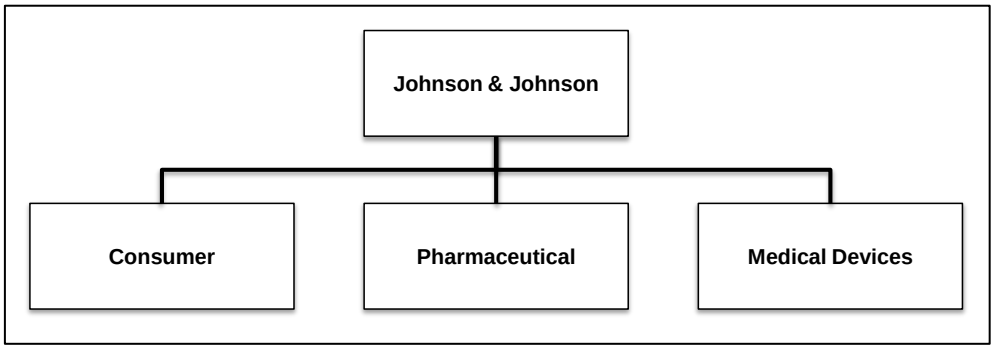

Figure 1.1: Johnson & Johnson Company Structure

(Source: Johnson & Johnson Services, 2015b)

Johnson & Johnson has developed a centralised global strategic sourcing function within the organisation. Their sourcing practices include sophisticated bidding and modelling methods with a global reach, as well as the consolidation of category spend across direct materials and external manufacturing. The global procurement function is structured into global categories in order to implement global strategies, while still maintaining a focus on regional needs.

With regards to the operations in South Africa, Johnson & Johnson believes that there are key elements that negatively impact its annual spend on direct materials. However, these areas of improvement are not clearly defined and can only be considered as educated guesses based on experience and gut feeling. For example, so called second-tier currency impacts are often not understood or quantified, making it impossible to derive actions or to make sourcing decisions that consider these impacts. According to Johnson & Johnson, second-tier currency impacts are experienced when sourcing in local currency from a supplier that imports its raw materials from a foreign country, resulting in a price that is exposed to a foreign exchange (FX) rate. Packaging suppliers, which source resins necessary for container materials, such as plastic bottles, experience this especially as their resins are mostly sourced from a foreign country. A model for second-tier currency impact currently exists on a regional level. However, this model needs further evaluation and investigation, as it is not detailed enough for the South African operations. This is also caused due to the fact that this model only takes second-tier currency impacts into consideration without considering other cost drivers. Even though Johnson & Johnson has currently focussed on the second-tier currency impact, it is not the only cost driver of direct material cost. Another cost driver of direct materials is the commodity prices of raw materials. As commodity prices are determined on international markets, volatility of these rates can have an impact on direct material cost. Similar to the second-tier currency impact, there is no complete understanding of how the material cost is affected by volatile commodity prices.

The idea for this research study began after an initial assessment of Johnson & Johnson's South African operations by an external consulting firm. The objective of this assessment was to provide an overview of current performance and challenges as well as to provide an external perspective to understand gaps against competitors. It also aimed to identify areas of improvement by using yet-to-be activated levers in order to improve the Gross Profit (GP) margin. As GP is defined as the difference of Net Sales (NTS) and Cost of Goods Sold (COGS), there is a direct dependency on direct material cost. Even though the consultancy firm did a basic analysis on materials sourced and identified areas for improvement, it did not cover influencing factors of material cost.

Even though there is a basic idea of the factors that might influence direct material cost, no research was conducted in order to identify, analyse and quantify these cost drivers. Also, the external consultants appointed did not provide sufficient information regarding material cost management.

1.3 Problem Formulation

Johnson & Johnson's global procurement function is structured in enterprise-wide categories and divided into different regions, enabling its regional sourcing team to support global sourcing strategies while remaining focused on specific regional needs. However, Johnson & Johnson identified that there is a lack of transparency of direct material cost within their supply chain and believes that its South African operations could improve its sourcing performance by managing its direct material cost more efficiently and effectively.

In order to manage and control direct material cost, the driving factors of direct material cost need to be identified and analysed. A thorough analysis of factors impacting direct materials that investigates all elements in the market, which have an influence on direct material cost, is necessary. Some cost drivers of direct material cost have been identified already and it is assumed that these external factors have a major impact on cost. However, no quantitative evidence is available at present to measure the actual exposure of these impacts on the corporation's direct material spend in South Africa.

Therefore, a gap exists between the perceived impact on material cost by external cost drivers and the available information to validate this claim. Even though significant information is available, a direct approach to steer and to proactively manage cost has not been developed to date. Without being able to understand and measure the impact of these cost drivers, cost management and strategic sourcing decision-making is challenging.

Research is necessary to close the gap due to the uncertainty of cost factors affecting direct materials spend in the supply chain. Transparency and visibility in direct material cost is required in order to identify and measure the cost elements that affect direct material cost. A new decision support tool that transforms available data into decision-making information would provide a clearer understanding about direct material cost and would be able to provide a more predictive view of future costs in order to support strategic sourcing decisions.

Resulting from the aforementioned problem formulation, the following research question is derived: ***"Can a decision support tool be developed that measures, analyses and provides insight on cost drivers of direct material cost in order to improve the decision-making process within the procurement function?"***

1.4 Research Objectives

Resulting from the before mentioned problem formulation, this study's primary objective was to **develop a decision support tool** that measures and analyses the impact of cost drivers on direct material cost. This tool should be developed on the case of Johnson & Johnson's consumer division in South Africa. The aim is to develop an interactive and usable decision support tool that provides insight into the various cost drivers of the procurement spend and to generate a more predictive view of direct material cost compared to what was available before the study. This support tool should be based on a financial model and focus on the currency impact on direct material cost in its calculation. This includes the possibility of running a sensitivity analysis of external impacts on direct material cost, as well as scenario planning considering different assumptions. The decision support tool should provide detailed insight into the individual products and materials, which can be linked to various suppliers. Resulting from that, dedicated sourcing decisions can be made in order to manage, control and improve direct material cost.

Based on the primary research objective, this thesis included two secondary objectives that needed to be achieved. Table 1.1 illustrates the different objectives and provides an overview of the different sub-objectives that were necessary to be achieved. The first secondary objective was to ensure the **usability of the decision support tool**. For this purpose, key components of decision support systems (DSSs) need to be included in the new tool and the user-interface needs to be effective. Additionally, practical advice on how the tool should be used and how its results can improve the overall decision-making process need to be provided. Furthermore, the process to implement the decision support tool into the organisation should not be complicated. Therefore, ways to implement the findings resulting from the decision support tool need to be identified and the functionality to integrate the decision support tool into business processes needs to be provided. Smooth integration from a technical side as well as convenient usability for the end user needed to be ensured.

The second secondary objective was to **verify the general validity of the decision support tool** and to identify whether it can be applied to other cases outside the scope of the research. For this purpose, a comparative competitor analysis of Johnson & Johnson's competitors within the South African FMCG market is conducted. In order to achieve this secondary objective, it was necessary to identify the key players in the industry that specialise on the CHC sector, to illustrate their operations in the South African market and to analyse what

risks they experience relating to the procurement of materials. The objective also includes exploring as far as practically possible competitors' sourcing processes and challenges as well as the measures that they undertake to leverage against these challenges. The findings of the analysis had to be considered in the decision support tool development process, by including cost drivers that were identified before by competing companies. As the primary objective is focused on Johnson & Johnson, the exploratory competitor analysis attempts to identify whether other FMCG companies in South Africa face similar challenges and risks relating to direct material cost in their supply chains. The results of this analysis could be used in order to make assumptions about the validity and reliability of this thesis and whether a decision support tool could be used in similar environments.

Table 1.1: Research Objectives of the Thesis

Objective Type	Objective	Sub-Objectives
Primary	Development of decision support tool	• Identification of cost drivers and measurement of impact on cost • Provide predictive view of potential cost impact and analysis • Define and follow specific methodology
Secondary	Usability of the decision support tool	• Identification of key components of decision support systems • Development of appealing user-interface while ensuring efficient and effective use • Provide recommendations for implementation
	Validity of the decision support tool	• Comparative competitor analysis • Identification of key players in industry • Assessment of shared risks

As this research study is conducted at Johnson & Johnson, the before mentioned research objectives are aligned with the tangible deliverables for the company. These deliverables include the decision support tool, a guideline on how to implement and use the model, as well as recommendations on how to use the model's results as part of the decision-making process.

1.5 Research Design and Conceptual Framework

As described in section 1.4, this thesis had one primary research objective and two secondary research objectives. In order to achieve the research objectives, the research process extended over three phases. These three phases included: (1) secondary research, in the form of a comprehensive literature review and secondary data collection; (2) primary research in order to collect qualitative data from the company; and (3) the decision support tool development process, which again was divided into a planning, construction and application phase.

The research process is based on the conceptual framework, which is illustrated in Figure 1.2. The figure demonstrates the flow of the research, which starts with the problem and the knowledge gap. From the problem, the research objectives were derived, which drive the research within the input, process and output part. The conceptual framework follows the input-process-output approach and explains the main concepts that are studied. The framework was used to guide the researcher during the process and is also intended to provide the reader with a background on how the research was conducted. Furthermore, the framework is used to connect all aspects of the study. The research objectives, which were derived from the problem formulation and the knowledge gap, were considered throughout the research and guided the underlying processes.

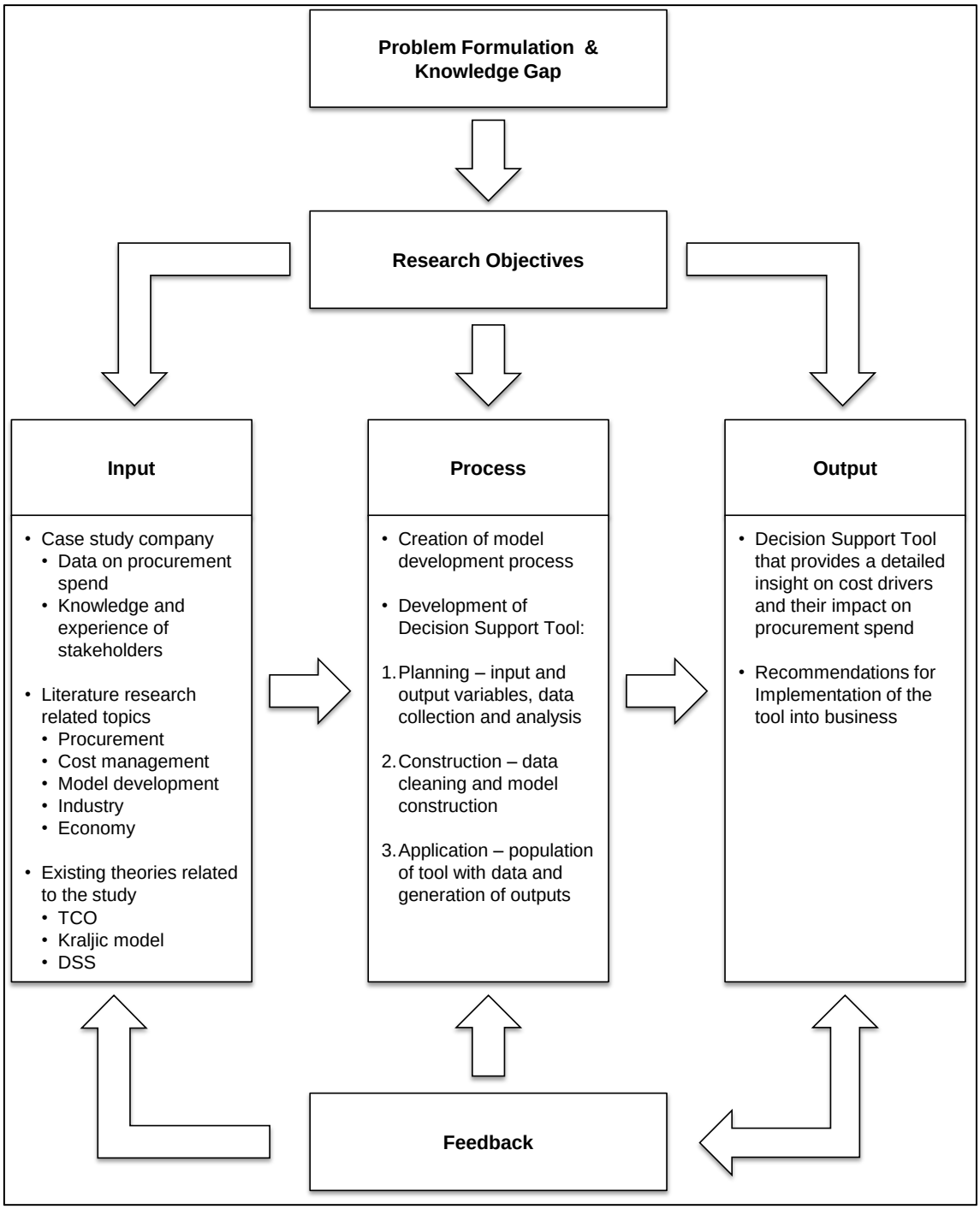

Figure 1.2: Conceptual Framework of the Study

The research design of a research study can be considered the overall framework of how data is collected and analysed (Bryman, Bell, Hirschsohn, dos Santos, du Toit & Masenge, 2014: 100). It defines the structure which provides the researcher a guideline on which research methods to use (Bryman *et al.*, 2014). For this thesis, a case study research design was chosen. Figure 1.3 depicts the research process of this study within the case study research design. It is depicted, how the three different phases of research build up on each other and what actions they include. A case study involves an in-depth analysis and exploration of a

specific case, which could be an organisation, a person, a community, an event or a location (Bryman *et al.*, 2014: 110). This study is conducted on a specific case: the FMCG company, Johnson & Johnson. Therefore, a case study research design was the most suited research design for this thesis. Furthermore, Bryman *et al.* (2014: 110) identified that case studies are widely used in business research, where cases are defined as a workplace or an organisation. The objectives of this thesis included the development of a decision support tool for Johnson & Johnson in order to provide an enhanced procurement spend understanding. As this objective is set in a business context and in an organisational environment, a case study research design was used that included an intensive and detailed analysis of the organisation.

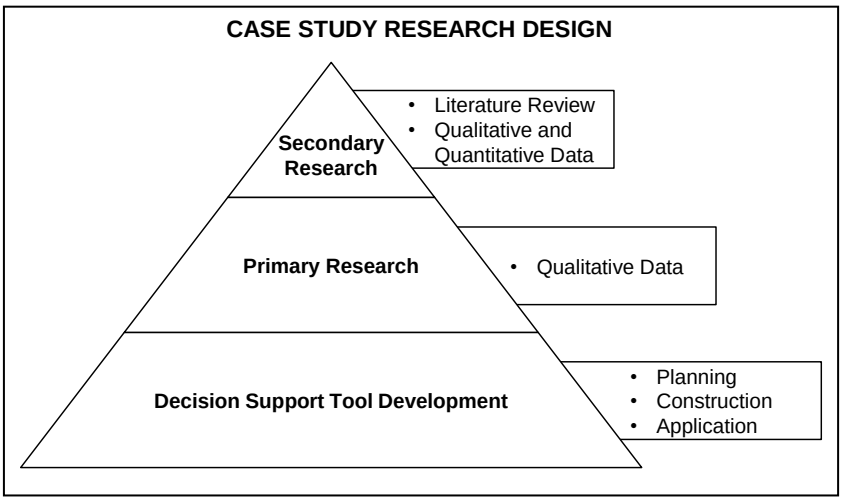

Figure 1.3: Research Process and Design

Furthermore, the case study research design was exploratory in nature. As the name suggests, exploratory research has the purpose of exploration on the research problem (Van Wyk, 2012). It is used for problems on which none or only little previous research has been done before as well as for projects addressing a subject with a high level of uncertainty (Brown, 2006; Van Wyk, 2012). Exploration provides the researcher the freedom of selecting a number of research methods in order to achieve the research objectives (Shields & Rangaraja, 2013). Exploratory research fits to the research problem and the objectives of this study, as Johnson & Johnson has a basic idea about cost drivers on direct material cost in South Africa, however, no complete understanding and no decision support tool exists. Also, there is a need for the investigation of this problem due to the lack of previous research and studies on practical decision support tools in this context.

This study followed different research approaches of a quantitative and qualitative nature in order to achieve the research objectives. According to Creswell (1994: 174), a combined

approach of quantitative and qualitative research methods has an advantage in that a study is not limited to either quantitative or qualitative research methods. In order to achieve the objectives of this study, qualitative and quantitative research methods were required. Additionally, Bryman *et al.* (2014) found that using a combination of quantitative and qualitative research methods to collect data is a widely-used method for data collection and analysis. Therefore, a mixed methods approach to research was the most appropriate to use.

This study made use of secondary research. Secondary research data is described as information or data that has already been collected (Stewart & Kamins, 1993). Also, the result of primary research conducted by someone else is considered secondary data when used in another research study. Using secondary data has the advantage of being cost and time efficient, as data is used for research which is already available (Stewart & Kamins, 1993). Johnson & Johnson provided secondary information in the form of secondary data for the purpose of this research study. This data is highly confidential as it contains extensive information about their direct materials, such as the suppliers, quantities, cost, as well as information about their products, including the materials and quantities used. Data were provided from their internal database, which offers information about inflation rates, exchange, feedstock prices, as well as forecast. This means that significant data were available and needed to be analysed and prepared in order to filter the data that is relevant for the problem. Therefore, a thorough data assessment was necessary to understand and become familiar with the data. This ensured that the prepared data is consistent and could be used for further analysis.

In addition to the secondary research, primary research was conducted. Primary research is the execution of new research in order to achieve the research objective (Zikmund, Babin, Carr & Griffin, 2012). As this study is conducted on the specific case of Johnson & Johnson, which included spending a significant amount of time at their offices, observations and insight gained at their offices form an important part of the primary research. According to Bryman *et al.* (2014), participant observation and discussions to gather inputs are methods widely used within case study research that provide detailed insight into a case. Therefore, discussions and conversations with employees were held in order to obtain detailed information and to understand the processes that Johnson & Johnson use. As primary research can involve interviews, surveys, questionnaires or observations, qualitative and quantitative data can be gathered during the process, depending on the research method used (Zikmund *et al.*, 2012).

This mixed approach helped to understand which data is relevant for achieving the research objectives.

After all data had been assessed and properly evaluated, this study used a quantitative approach in order to develop a decision-making tool that links the acquired data to support sourcing decision-making. Within this analysis, several variables were used in order to generate the individual as well as aggregate impact on the dependent variable – the material cost. The independent variables included foreign exchange rates, commodity prices, international exposure rates of materials, labour inflation and energy costs. The results of the sensitivity analysis, which also include forecast scenarios, were interpreted and recommendations were made to Johnson & Johnson.

1.6 Research Scope

In section 1.5, the research design of this thesis was presented. Being conducted in a case study research design, this study focuses on direct material cost management at a South African consumer goods manufacturing company, namely Johnson & Johnson. As the main objective of this study is the development of a decision support tool, all materials that are sourced for the South African market are within scope of the study. Even though the thesis focuses on Johnson & Johnson, the goal was to develop a decision support tool that is not limited to the use of Johnson & Johnson, but that can be adapted to other consumer goods manufacturing companies.

With regards to the quantitative research, the quantitative data analysed included confidential data from Johnson & Johnson, for the time period of 2014 and 2015. Other data that was used included forecasts, which are available in the public domain.

Possible limitations within the available data could be that the data cannot be used in order to build a sensitivity model, as Johnson & Johnson requires. This could be caused by not having the required data available, or by the data being irrelevant for the study.

In order to achieve the secondary objective of verifying the validity of the decision support tool, an exploratory competitor analysis was conducted. This competitor analysis should be used in order to give Johnson & Johnson insight about whether competitors experience similar challenges within and risks relating to direct material cost of their procurement functions. There could be limitations in conducting research, as such information involves confidential company data. The competitors themselves will most likely not reveal their

internal sourcing processes and challenges. Therefore, the analysis relies on available literature. Therefore, the extent of the competitor analysis might be limited as it is dependent on the information available in the public domain.

1.7 Ethics

As this study is a practical example of managing direct material cost at Johnson & Johnson, the confidentiality and sensitivity aspect of data needs to be considered. However, as Johnson & Johnson was interested in an improved understanding on external factors that influence its procurement spend relating to direct materials, a significant amount of data were provided.

In order to be able to conduct research on Johnson & Johnson and to obtain access to all internal information, a confidentiality agreement was signed. Therefore, confidential information and data were desensitised and all numbers disguised prior to presentation within the thesis. The numbers presented are fictitious and specific terminology and other names have been altered. This ensures that no confidential information about Johnson & Johnson's procurement spend, suppliers, materials or employees is shared. The confidentiality of the data is, however, no limiting factor to the results of this thesis, as the decision support tool was developed and tested prior to desensitising. The actual values generated by the decision support tool for the case of Johnson & Johnson are not required for achieving the objectives of this thesis. Instead, examples are used in order to demonstrate the decision support tool's functionality and outputs.

1.8 Definitions

There is a broad range of definitions with regards to supply chain management terminology available in literature. In 'Purchasing and Supply Management', the term procurement is used interchangeably with purchasing and supply management (Leenders, Johnson, Flynn & Fearon, 2006). Baily, Farmer, Crocker, Jessop and Jones (2008) make use of the terms purchasing, procurement and strategic procurement, and lacks a clear differentiation between the different terms. On the other hand, Burt, Petcavage and Pinkerton (2010) clearly differentiate between the terms of purchasing and supply management. As this study focuses on the management of direct material cost, the term also needs a clear definition. In literature as well as in practice, the meaning of the term direct material cost has divergent meanings. The amount that is recorded as direct material cost can differ between organisations, depending on the cost objects included in the calculation.

As it is always dependent on the context where the before mentioned terms are used, there is room for interpretation. This is also applicable to functions and processes within organisations, as the meanings of the terms depend on how companies define these terms. For the purpose of consistency throughout the study, the terms purchasing, procurement and direct material cost are clearly distinguished and defined.

(a) Purchasing

Purchasing is defined as the process of buying goods and services. This process includes the generation of the purchase order (PO). Often, the term "purchasing" is also used as the title of the business function (Burt *et al.*, 2010). Over time, the purchasing process gained importance and expanded to a more strategic function. Because of that, the name of the function has changed and several different terms, such as "purchasing and supply management," "procurement" and "strategic sourcing", are used. However, for the purposes of this study, the term purchasing deals with the transactional process of buying goods. Purchasing can be seen as the foundation for procurement.

(b) Procurement

For the purposes of this study, procurement is defined as the business function that strategically integrates all related functions to provide goods and services to the organisation (Leenders *et al.*, 2006). Procurement includes purchasing, consumption management, supplier selection, contract negotiation and supplier management. As purchasing is the actual buying of goods on an operational level, the scope of procurement is on a strategic and tactical level (Baily *et al.*, 2008). The term strategic sourcing also needs to be mentioned in this context. Strategic sourcing includes the development of a sourcing strategy that supports the organisation's strategy while reducing cost and minimising risk. Other activities of strategic sourcing are to analyse the organisation's spend, with regards to what is purchased from which supplier, and to analyse the whole supply market, including the available suppliers and market developments. For the purposes of this study, strategic sourcing activities are considered to be included in the procurement function.

(c) Direct Material Cost

Direct material cost is the cost of material that can be distinctively identified with a manufactured, final product. It includes the cost of the material that becomes a physical part of the product as well as the cost of the material that is used during the production process,

which can be identified specifically with the product (Sandretto, 1986). These include the cost of scrap material, waste material and the cost of defective units. It is important to mention that direct material cost does not only include the price for the material quantities, but also all cost paid to the suppliers for the delivery of the material. These costs usually include the shipping costs, tax and duty. By dividing the direct material cost by the material quantity, the so-called unit price of direct material is calculated (Sandretto, 1986).

1.9 Document Outline

This section provides an overview of the structure of this thesis. The document outline is presented in Figure 1.4. In order to give the reader a better understanding, the content of the different chapters are briefly described in the following.

In Chapter 1 (Introduction), the reader is introduced to the topic and background on the rationale for this thesis is provided. The research question and the derived research objectives are shared and the applied research design is demonstrated. Furthermore, the scope of the research is defined and ethical considerations are noted. Additionally, key terminology used throughout this thesis is defined.

Chapter 2 (Literature Review: Procurement in Global Organisations) builds the first part of the extensive literature review of this thesis. The chapter includes a discussion of the literature on the procurement function in general and focuses specifically on the aspect of cost management. Additionally, attention is placed on DSSs and data visualisation. The chapter concludes with a summary of the key deductions made from the covered literature.

The second part of the literature review of this thesis is presented in Chapter 3 (Literature Review: The South African Fast Moving Consumer Goods Industry). The chapter provides an overview of the FMCG industry and its components, and presents the different players in the South African market. Furthermore, the chapter examines the South African economy and current trends. Again, deductions made from the literature are presented at the end of the chapter.

Chapter 4 (Case Description: Johnson & Johnson) provides an overview of the company on which the case study is conducted. For this purpose, the company, i.e. Johnson & Johnson, is introduced and its operational setup is presented. Additionally, background on its procurement operations is shared and the current situation within the South African operations is examined.

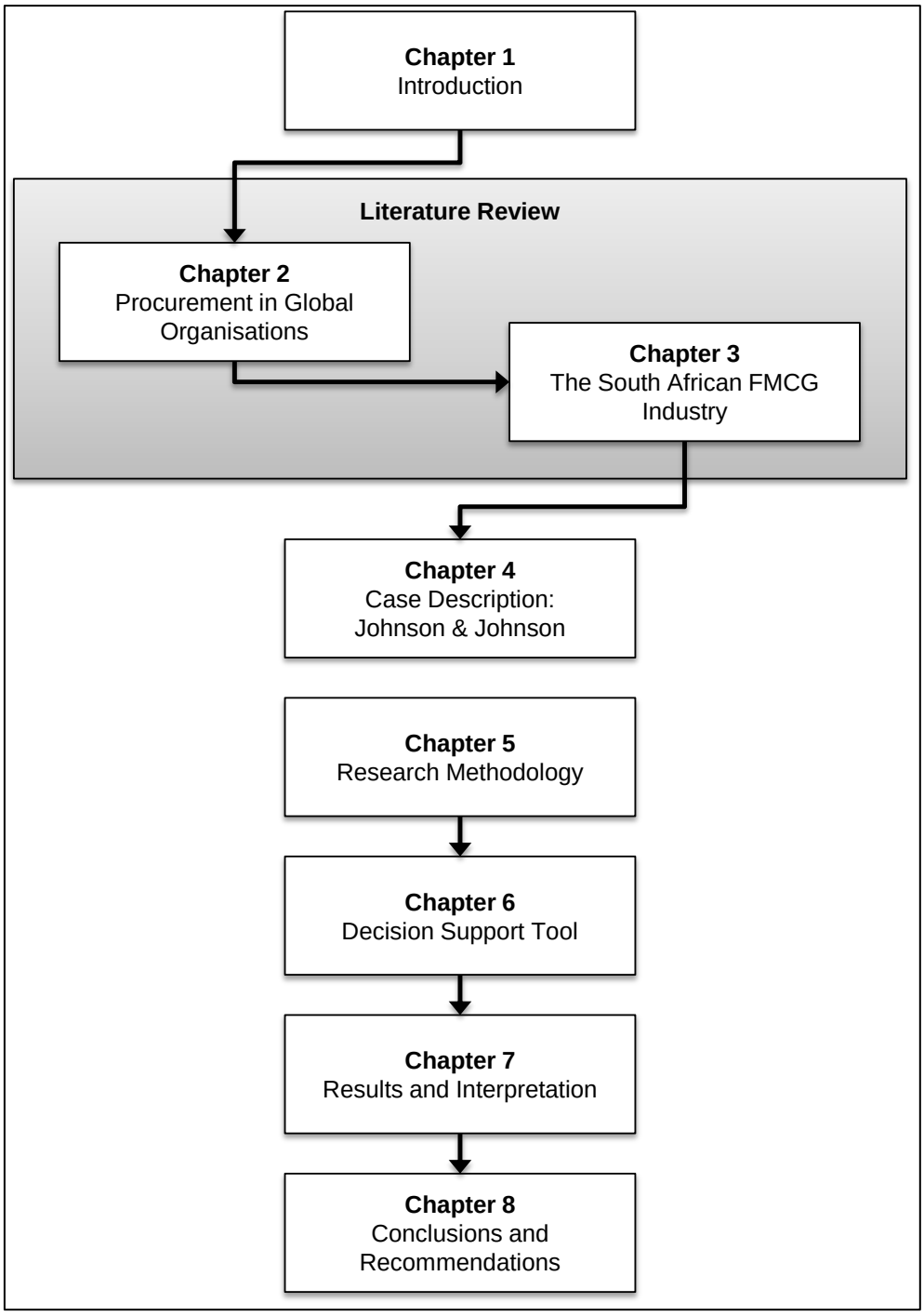

Figure 1.4: Document Outline

Chapter 5 (Research Methodology) presents the research methodology followed during the study. Based on the research design, the chosen research methods for secondary and primary research are discussed. The complete research process is shared, including a detailed overview of the decision support tool development process. Furthermore, methods that were followed to increase the validity and reliability of the research are presented.

Chapter 6 (Decision Support Tool) presents the developed decision support tool. The findings of the complete development process and the individual process steps are presented, such as data collection, data exploration and data preparation. Furthermore, the finalised decision support tool structure and the developed calculations are provided. Last but not least, the application and the user interface of the tool is presented.

Chapter 7 (Results and Interpretation) discusses the findings presented in Chapter 6 and reflects on the findings of the literature review. The results are interpreted and special attention is placed on the need for a decision support tool, its development and structure, as well as the outputs provided by the tool. Additionally, the researcher provides remarks on the study's validity and reliability. Furthermore, limitations of the study that were identified during research are described.

Chapter 8 (Conclusions and Recommendations) provides a summary of the findings of the research and addresses the research objectives that were set out prior to the study. Furthermore, the chapter includes recommendations for the implementation of the decision support tool and proposes areas for future research. The chapter concludes with final remarks from the researcher.

Chapter 2 - Literature Review: Procurement in Global Organisations

2.1 Introduction

Managing cost in an effective and efficient way is one of the major tasks of a procurement organisation within a company. Bearing in mind that the impact of cost directly affects the profitability of a company, the execution of an efficient procurement strategy is crucial. Especially in multinational corporations with production facilities in several countries, aligned and integrated procurement processes can result in advantages in profitability and improved cash flow. In order to realise efficient and effective procurement practices, an understanding of key cost drivers and their impact on direct material cost is essential. This also relates to the implementation of these drivers into a sensitivity cost model.

Firstly, this chapter provides a review of the procurement function in general in order to explain its role within supply chain management, as well as the challenges with which procurement is faced. Furthermore, special attention is placed on cost management in the procurement function, different cost drivers of direct material cost are discussed and the concept of Total Cost of Ownership (TCO) is explained.

As this study's main objective was to develop a decision support tool that measures and analyses the impact of cost drivers on direct material cost, an overview about DSSs in the business intelligence (BI) sector is provided. Current practices and similar approaches in the field of financial modelling and cost modelling are analysed, and a framework of a model development process is depicted. Also, the DSSs that are used to analyse the data, construct the model and visualise the results are reviewed in this chapter. The chapter concludes with deductions made from the literature review on procurement in global organisations.

2.2 The Role of Procurement in Supply Chain Management

As stated in section 1.1, the importance of procurement's role in supply chain management has increased significantly over the past 20 to 30 years (Tassabehji & Moorhouse, 2008: 55). Procurement is no longer just the transactional function of buying materials and finished goods from suppliers, but has evolved to be an integrated business process at top management level. Global organisations make use of strategic sourcing practices, which involve sophisticated bidding and modelling methods at a global level. As per Leenders *et al*. (2006),

procurement is defined as the business function that strategically integrates all related processes to provide goods and services to the organisation. These processes are purchasing, consumption management, supplier selection, contract negotiation as well as supplier management.

That the procurement role has only recently gained importance within organisations can also be derived by the amount of available literature on the topic. One of the first articles that focussed on the purchasing role was published in 1983, when Kraljic presented his paper with the title: *"Purchasing must become supply management"* (1983). During this time, companies were faced with an increased complexity in purchasing. Scarce resources, political conflicts, economic changes, increasing competition and rapid changes of new technologies were increasingly affecting supply chains negatively (Kraljic, 1983). Some companies started to lever against these external supply pressures by increasing or implementing global sourcing activities, establishing long-term contracts with suppliers or forming joint ventures. Within his paper, Kraljic (1983) presented a purchasing model that companies should apply in order to move from transactional purchasing to a more strategic form of supply management. The aim of the model is to reduce purchasing risk within the supply chain while also using purchasing power on important suppliers in order to increase profit. Initially, the model was only developed for the internal use at the organisation where Kraljic was working at the time, but given its success and simplicity, the tool was published just at the time of increasing pressure on the purchasing function (Glöckner, Pieters & de Rooij, 2005). The model, which is still used in organisations today, involves four phases: (1) classification, (2) market analysis, (3) strategic positioning and (4) action plan (Kraljic, 1983).

Within the classification phase, all purchased items of an organisation need to be categorised according to their impact on profit and on the involved supply risk in the purchase of the items. Figure 2.1 illustrates Kraljic's product purchasing classification matrix, which includes four different categories for purchased items, namely leverage items, strategic times, noncritical items, and bottleneck items. For each of these categories, a different purchasing approach is proposed. For strategic items, which add significant value to the organisation but are also exposed to a high supply risk, purchasing decisions need the highest attention and should be supported by extensive market and risk analysis as well as optimisation and simulation modelling (Kraljic, 1983). For leverage items, purchasing approaches can include making use of full purchasing power and substitute between suppliers. Bottleneck items require detailed market analysis and decision models, as supplies for these items are rare.

Non-critical items should be dealt with on normal basis, and standard market analysis should be sufficient for these items (Kraljic, 1983).

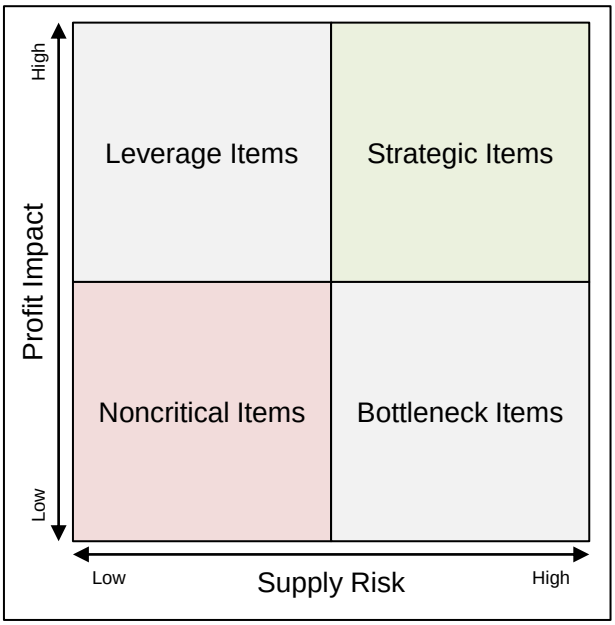

Figure 2.1: Product Purchasing Classification Matrix

(Source: Kraljic, 1983)

During the market analysis phase, the company needs to identify how much power its suppliers have and measure it against its own buying power. This process includes a detailed review of the supply market and available suppliers, as well as an internal assessment of supply needs (Glöckner *et al.*, 2005). In the strategic positioning phase, all 'strategic items' of phase 1 are classified according to the market analysis that was done in phase 2. This is done by entering all items into Kraljic's Purchasing Portfolio Matrix (1983), which is depicted in Figure 2.2. The matrix x-axis represents the supplier strength, whereas the y-axis represents the company strength. Within the matrix, nine quadrants represent the different categories, being exploit, balance and diversify.

After all items have been entered into the portfolio matrix, Kraljic (1983) proposes to develop actions plans for all items, depending on their location in the matrix. He suggests following three different purchasing strategies: exploit, balance, and diversify (Kraljic, 1983). The first strategy recommends that the company should exploit its high purchasing power in order to achieve good prices and to secure long-term contracts with key suppliers to minimise supply risk. If an item is located in a diversify field, the company should try to reduce supply risk by identifying new suppliers or using different materials. Also, rationalisation of materials is an

option. The balanced approach is a mixture between the exploit and diversify strategy (Kraljic, 1983).

Although this model was presented over 30 years ago, the model is still applied today (Glöckner *et al.*, 2005). The process of categorisation of materials in order to develop purchasing strategies is very common in organisations, which cluster their procurement functions according to material categories. The model can help to identify threats and risks regarding the supply situation of individual materials and allows developing action plans for these cases. Kraljic (1983) concludes his article by stating that companies that will continue on a *"purchasing as usual"* basis will be faced by increasing competitiveness. However, companies that transform supply management into a strategic business function can benefit by having a secure supply base and lower purchasing cost.

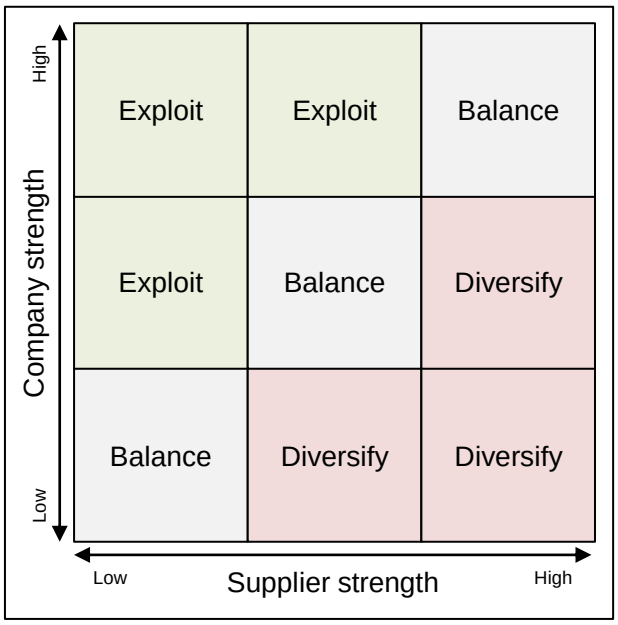

Figure 2.2: Purchasing Portfolio Matrix

(Source: Kraljic, 1983)

More recent research has shown that with the increasing trend of globalisation, more and more companies have realised that following the right procurement strategy within global markets is of utmost importance (Butter & Linse, 2008: 76). As Kraljic demanded *"purchasing must become supply management"* (1983) three decades ago, today, purchasing is no longer seen as a simple function of buying goods or services, but has become an integrated management function, which offers new opportunities. Today, the purchasing transaction and the actual order placement is only just one result of an integrated procurement strategy. Butter and Linse (2008) point out in their report that even though the procurement

function increased its level of importance in the past years, there is still room for an even higher recognition at a management level. The increasing global sourcing activities in procurement need to be directly linked to strategic decisions in future.

The typical procurement decisions, such as where to buy and from which supplier, are no longer made on a basic understanding of direct purchasing cost and other easily identifiable related costs, such as transport or import cost (Butter & Linse, 2008). Moreover, decisions are also based on other types of transaction costs, such as costs that are related to cultural, institutional and political differences in order to minimise the TCO. A profound knowledge of all costs resulting from procurement decisions builds the basis for making strategic decisions, such as sourcing offshore or producing locally (Butter & Linse, 2008).

The discussion whether a global sourcing or a local buying procurement strategy is more advantageous has been widely discussed and is highly dependent on the business of a company. As demonstrated in a study of Cho and Kang (2001: 542), the reasons for global sourcing are mainly improvement in cost reductions, quality and availability. The types and degrees of improvements in these areas depend on several aspects, such as the firm size (and the related import volume or percentage of imports) and product types, as well as on the regions from which products can be sourced. Furthermore, several challenges and risks associated with global sourcing were identified. These challenges include cultural, political and legal differences as well as the longer distance to source, which could result in risks, such as transportation delays, foreign exchange rate fluctuations, language differences and more (Cho & Kang, 2001).

According to Jiang and Tian (2009), the initial motivation for global sourcing is cost savings in order to have a price advantage, as the need for product differentiation has declined with the progress of globalisation. In their study, they have also identified quality and availability as major benefits for global sourcing, as well as the increased number of available suppliers and the access to worldwide technology (Jiang & Tian, 2009). Jiang and Tian (2009) conclude in their study that even though global sourcing introduces many opportunities, it also brings challenges. Therefore, organisations need to understand that the benefits they can achieve through global sourcing come with a certain amount of risk. For the procurement function, it is thus of utmost importance to have a good understanding of these risks, as well as to have measures in order to lever against them. In the following section (see section 2.3), the major challenges and risks of global procurement and procurement in general are reviewed.

2.3 Global Procurement – Benefits and Challenges

Monczka and Giunipero (1984) analysed the purchasing practices of twenty-six multinational organisations in one of the first studies on international purchasing. Their objectives included obtaining information on the different benefits that companies achieve through international purchasing, as well as on the challenges that are experienced during the process and its implementation. The results of the analysis revealed that major benefits of international purchasing are savings in purchasing cost, increased number of suppliers, improvements in quality, exposure to new technology, improvements in supply availability, increased competition as well as lead-time reduction (Monczka & Giunipero, 1984). Similar to the study of Monczka and Giunipero, the objective of a study conducted a few years later by Birou and Fawcett (1993) was to get insight into the challenges, requirements and benefits of international sourcing. However, their study was one of the first that aimed to determine these benefits, requirements and challenges on a longitudinal level, as most research before was only focusing on small scale samples or case studies. In their study, Birou and Fawcett (1993) discuss the results of their conducted survey, which included 149 surveys completed by purchasing and material management executives. The population spread over different industries, and respondents experience with international sourcing varied. According to the study's results, the greatest benefit of international sourcing is the opportunity for lower prices of sourced products (Birou & Fawcett, 1993). Other identified benefits included an increased competitiveness of the company, access to higher quality products and global technology, a better delivery performance and customer service and an increased number of suppliers (Birou & Fawcett, 1993: 35).

When comparing the results of the studies of Monczka and Giunipero (1984) and Birou and Fawcett (1993) with regards to international sourcing benefits, one quickly identifies similarities. According to these studies, companies with effective international sourcing processes gain competitive advantages, such as cost savings through better prices, improved quality and availability through an increased number of suppliers, as well as access to new global technologies. All of these benefits increase the companies' competitiveness in the market. In a more recent study conducted by Cho and Kang (2001), which focussed on the benefits and challenges of global sourcing in the retail industry, similar benefit factors were identified. The perceived benefits were classified into three categories: (1) competitive advantage, which included access to lower priced goods, enhanced competitive position and better value for money; (2) quality assurance, which included access to higher quality goods

and better quality control; and (3) service enhancement, which included better availability, delivery and customer service (Cho & Kang, 2001: 553). Their statistical analysis revealed, however, that the level or degree of how companies benefit from global sourcing differs depending on the firm size, product types as well as import volume (Cho & Kang, 2001: 554). Jin and Farr (2010) took the idea further and analysed the benefits and challenges of apparel companies that engage in global sourcing with regards to the sourcing items and top management commitment of the organisation. Their study revealed that there is no significant difference between the perceived benefits and challenges depending on the sourcing items (Jin & Farr, 2010). The more competitive price achieved through global sourcing was found to be the most important benefit. However, companies that have a high commitment from top management perceived more benefits of global sourcing and less challenges than companies with low commitment from top management (Jin & Farr, 2010: 41). This result shows how critical top management engagement is in global sourcing for its success. Even though several studies have shown that global sourcing does have significant benefits for organisations, which can result in a competitive advantage, companies still need to be aware that the success and level of these benefits depend highly on the organisation itself, its size and the market.

Alongside the benefits, a global approach to sourcing bears risk. Several risks have been identified in global sourcing. In a recent study by Jiang and Tian (2009), cost risk, quality risk, security risk and intellectual property risk were found to be the major risks involved. All of these risks can result from the widely discussed challenges of global sourcing. In the study conducted by Monczka and Giunipero (1984), they not only identified the before mentioned benefits of international purchasing. They have also identified that companies are facing seven major problems when implementing and executing global sourcing. These challenges are: (1) logistics, inventory and distance; (2) nationalism; (3) cultural business differences; (4) communication; (5) foreign exchange rate; (6) customs proceedings; and (7) lack of available technology (Monczka & Giunipero, 1984). Similar challenges were identified in the more cross-sectional study by Birou and Fawcett (1993). In their study, the identified challenges were categorised into strategic, tactical and environmental challenges (Birou & Fawcett, 1993: 35). Strategic challenges refer to the qualification of suppliers, the logistics of long supply chains, and the coordinated use of just-in-time (JIT) sourcing strategies. Tactical challenges include daily operations and associated challenges, such as customs proceedings, exchange rate fluctuation and the knowledge of foreign business operations. Environmental

challenges faced are cultural and language differences, nationalism as well as political differences (Birou & Fawcett, 1993: 35).

In the study conducted by Cho and Kang (2001), which focussed on benefits and challenges of global sourcing in the retail industry, challenges and risks were categorised into the groups of logistics (inventory management, border-crossing procedures, transportation delays), cultural differences (language, customs proceedings, different business practices), regulations (quotas, tariffs, trade restriction bills), and country uncertainty (exchange rate fluctuations, political instability). Similar to the perceived benefits, their analysis revealed that the level or degree of how companies are affected by these challenges in global sourcing significantly depends on the product type, the percentage of imports, the experience of global sourcing, as well as the regions and countries from where the products are sourced (Cho & Kang, 2001: 556). In a recent study by Christopher, Mena, Khan and Yurt (2011: 67), a categorisation framework global sourcing risks was developed. This global sourcing risk classification was developed based on prior frameworks available in literature (Christopher & Peck, 2004; Christopher, 2005; Manuj & Mentzer, 2008). According to Christopher *et al*. (2011: 67), global sourcing risks can be divided into four categories: supply risk, process and control risk, environmental and sustainability risk, and demand risk. The four categories are depicted in Figure 2.3 and the individual risks are provided. Most of the identified risks were categorized into the environmental and sustainability risk category. This shows, that a high risk results from factors that cannot directly be controlled. Especially for these risks, risk management strategies need to be employed.

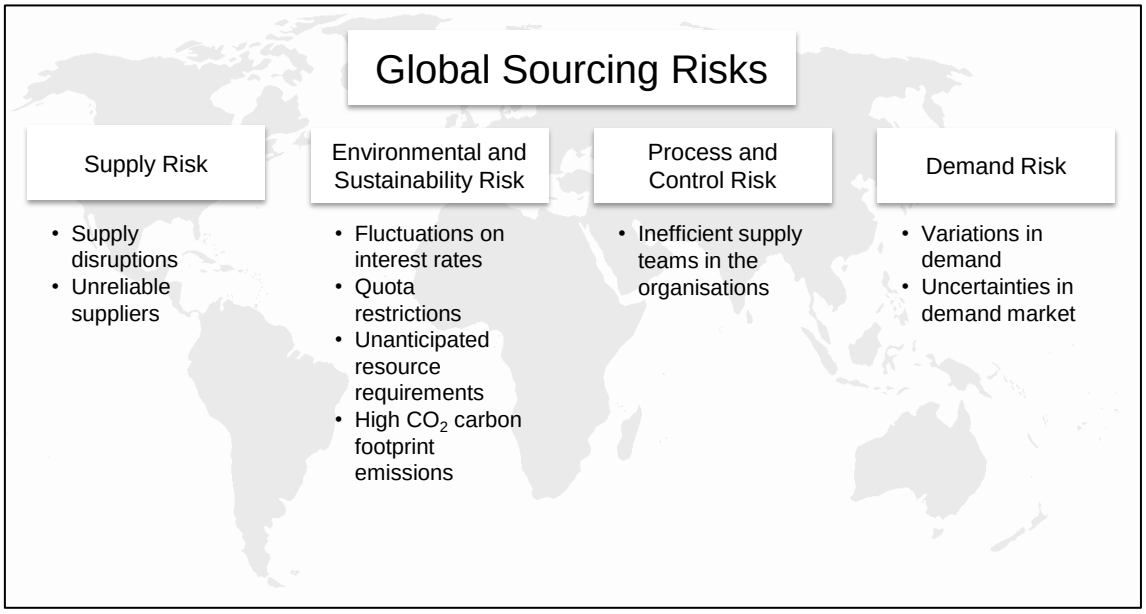

Figure 2.3: Global Sourcing Risk Categories

(Source: Christopher *et al.*, 2011)

All the before mentioned categorisation frameworks identified similar challenges faced due to global sourcing. As a number of different categorisation approaches exist (Monczka & Giunipero, 1984; Birou & Fawcett, 1993; Cho & Kang, 2001; Jin & Farr, 2010; Christopher *et al.*, 2011), one can conclude that there is no standard approach to risk classification in global sourcing. However, all of these studies have revealed similar challenges to which companies are exposed when engaging in global procurement. Furthermore, the extent to which an organisation is exposed to a certain risk differs depending on the company's characteristics. In the following section (see section 2.4), special attention is placed on the challenges that are related to cost in global procurement.

2.4 Cost Management in Procurement

With the increasing share of material cost, one of the reasons of the rising importance of procurement can be found in the financial statements of the global corporations (Boston Consulting Group, 2008). Particularly for companies that are operating on a multinational level all around the globe, the increased complexity from global sourcing activities raises cost calculation challenges. With expanding supplier bases, increases in the number of materials driven by new product development (NPD) and new stock keeping units (SKUs), organisations are challenged to calculate cost accurately while remaining efficient. A big challenge that organisations encounter is the gathering of internal information in order to ensure visibility of cost (Van Der Hoeven, 2003: 48). A profound knowledge of all cost resulting from procurement activities builds the basis for making more informed strategic

decisions (Butter & Linse, 2008: 76). As one of the major objectives of the procurement function is to increase the organisation's competitive position, effective cost management plays a vital role in order to use every opportunity to reduce and/or eliminate cost incurred (Leenders *et al.*, 2006).

2.4.1 Financial Risk in Global Procurement

Adler and Dumas (1984) clarified in their study that there is a clear distinction between risk and risk exposure. On the one hand, risk is a question of unexpected changes in the business environment. Risk exposure, on the other hand, is *"what one has at risk"* (Adler & Dumas, 1984: 41). The important question to answer is how to measure the risk exposure of companies to changes of certain variables. As the study is focusing on cost management of direct materials, this section will focus on the financial risks and challenges that organisations face that drive direct material cost in volatile markets. With regards to the before described categorisation framework, these challenges would best be described as environmental and sustainability risk within the global sourcing risk classification framework of Christopher *et al*. (2011).

In this section, environmental and external challenges that can develop into cost drivers of direct materials are analysed. Measures to deal with these challenges and mitigate the cost risk are presented.

(a) Exchange Rate Fluctuation

Referring to section 2.3, global sourcing involves a cost risk (Jiang & Tian, 2009). Companies that engage in global sourcing are exposed to a cost risk due to fluctuating exchange rates. The risk to which the companies are exposed to is highly dependent on the associated currencies in which companies are trading. Even companies that do not directly have foreign operations and are not involved in any transaction in foreign currencies are generally still exposed to foreign currency risk (Adler & Dumas, 1984). Even though these companies do not have any foreign currency within their financial statements, they can still be exposed to exchange rate risk, e.g. via suppliers that are located in foreign countries, but sell their goods in the company's domestic currency. Within the context of this study, this type of currency risk is considered second-tier currency risk or second-tier currency exposure. It is important for organisations that this exposure to currency risk is not neglected just because it is not visible in financial statements, but rather managed by measuring and analysing the exposure.

In cases where the exchange rate is relatively stable, trading between the countries is less difficult than in cases with volatile exchange rates. There is no currency risk in cases where currency changes are predictable and certain. Currency risk can be lower in weak currencies than in strong currencies, depending on the predictability of the change (Adler & Dumas, 1984). However, in cases with fluctuating currencies, it is important that companies have a good insight into the currency development and currency exposure management in order to make strategic purchasing decisions (Jiang & Tian, 2009).

As far back as 1989, Carter and Vickery (1989) identified that exchange rate impacts would become an important aspect of global sourcing. Fluctuating exchange rates do not only have an impact on the supplier selection decision, but also on the volume and timing of purchases at the supplier once selected. In their study, their findings included two strategies to manage exchange rate fluctuations. They noted that using exchange rate forecasts in order to make supplier selection decisions is essential in global sourcing. Secondly, the volume-timing of purchases should always consider the exchange rate development once a supplier has been selected (Carter & Vickery, 1989). Resulting from that, one can assume that using forecasts of exchange rates can have a major impact on financial and strategic decisions.

According to Holweg, Reichhart and Hong (2011), costs resulting from fluctuating exchange rates and their impacts are usually difficult to predict and do not necessarily occur on a regular basis. In order to minimise and limit currency risk, hedging against exchange rate fluctuations can be a successful tool (Holweg *et al.*, 2011). Other companies try to minimise the risk by asking their suppliers for a fixed price (Locke, 2003). However, this strategy generally does not work if there is a major weakening of the buyer's currency, as suppliers will almost always ask for an increase in price in order not to default. Instead of shifting the risk to the supplier, who in such cases will no longer be able to deal with the decreasing revenues and thus will not be able to supply a product, a company should rather develop a strategy on what to do if their currency weakens before selecting a supplier in a foreign country (Locke, 2003).

Snell (2010: 28) suggests five practices to effectively manage currency volatility. Firstly, a thorough analysis of the applicable currencies involved needs to be conducted in order to achieve visibility and understanding of the markets. Secondly, the total cost of the material or product that is sourced needs to be understood and determined. This total cost can involve raw materials, packaging, labour and energy and is closely related to the TCO concept, which is

analysed in section 2.4.2. Thirdly, raw material indices can be used in order to tie material prices to a certain currency. Fourthly, the supplier base can be expanded to regions with other, more stable currencies. Lastly, the exchange rate volatility risk can be shared with the suppliers in the form of price mechanisms that are defined in the contract (Snell, 2010: 28).

Fluctuating exchange rates definitely need to be considered as a risk in global sourcing. However, smart decision-making through good exchange rate information can have a major beneficial impact on an organisation. Even though fluctuating exchange rates are considered a challenge and potential risk in global sourcing and have been accepted as such widely in literature (Carter & Vickery, 1989; Birou & Fawcett, 1993; Cho & Kang, 2001; Jiang & Tian, 2009; Jin & Farr, 2010), literature on managing this risk in global sourcing is scarce. With regards to second-tier currency exposure in procurement, there is a gap in literature and previous studies.

(b) Commodity Price Risk

For manufacturers, direct material costs are directly related to commodity prices. Even though manufacturers do not necessarily buy the raw materials directly, their suppliers base their prices on the commodity's value. As commodities are traded on global markets, commodity prices are not only influenced by demand and supply, but also by financial trading and investments (Zsidisin & Hartley, 2012: 46). As a result, commodity prices are in general highly volatile and need to be considered as a major business risk (Bartram, 2005: 161).

In his study, Bartram (2005) compared the standard deviations of several exchange rates, interest rates, commodity prices and stock market indices, and showed that commodity prices have the highest volatility. As this indicates the importance of risk management for commodity price volatility, it bears mentioning that most of the available literature focuses on other financial risk, such as fluctuating foreign exchange rates (Bartram, 2005: 161). Empirical research has shown that commodity price exposure is highly dependent on the industry in which a company is operating, as well as on the commodities involved.

Companies can be exposed to commodity price risk in two ways, namely as output risk or input risk (Bartram, 2005). The output risk can be described as the risk that volatile commodity prices present to the price a company asks for its product. If a product is highly dependent on a certain commodity, or the commodity is sold directly, the market price determines the selling price for the company. Therefore, the output risk directly affects

revenue and profit. In these cases, the exposure of commodity price risk can be easily identified (Bartram, 2005). From the input side, not only companies that directly purchase raw commodities are exposed to commodity price risk. Most of the time, direct material costs for raw materials, components and packaging are affected by volatile commodity prices. In these cases, the commodity price risk exposure can be hard to identify, as most suppliers do not break down their sales price into proportions of commodities. Also, suppliers of the goods that are faced with the price volatility and dependant on the contract, might ask for price increases (Bartram, 2005; Zsidisin & Hartley, 2012).

According to Zsidisin and Hartley (2012), the first step to manage commodity price volatility is to get an overall understanding of the risk exposure. This is important, as volatile commodity prices have a direct impact on strategic business decisions, such as when to buy and at which quantity, pricing, budgeting and projecting profit, as well as on contract negotiations. Understanding of commodity price volatility and using this knowledge to effectively manage commodity price risk is essential for companies to gain a competitive advantage.

2.4.2 Total Cost of Ownership

One measurement to increase visibility of procurement cost is the establishment of a TCO model. A TCO model includes a breakdown of direct and indirect cost associated with the purchase. TCO extends beyond the purchasing or acquisition cost, and having a TCO model in place helps to identify the different cost drivers, which then enables the making of strategic decisions in order to minimise the total cost of ownership (Leenders *et al.*, 2006).

The origins of the TCO concept dates back to 1986, when the Gartner Group did research on life cycle cost of PCs and realised a lack of accountability for IT (Mieritz & Kirwin, 2005). From then on, the concept of TCO evolved to a recognised standard method for financial analysis of cost and is not only used by IT organisations, but also applied in many other industries.

Instead of simply comparing supplier prices for a cost object, TCO models are used to determine all cost elements related to the purchase in order to identify opportunities for cost reduction and cost avoidance for the individual cost elements (Leenders *et al.*, 2006). According to Leenders *et al*. (2006), TCO acknowledges the fact that the purchasing price is just one part of the cost that results from buying and owning the goods, and states that there

are several variations for calculating TCO. Depending on the need and structure of the organisation, the company has to develop an individual method for calculating TCO, since there is no general one-size-fits-all solution.

Ellram (1993: 3–10) developed a TCO model, which groups the cost elements into three categories: pre-transaction cost, transaction cost and post-transaction cost. In this method, the costs are viewed in the order in which they are incurred. Pre-transaction cost includes all cost that occurs from the identification of a need to purchase a good until the actual order placement. However, the order placement itself is not included. Other costs can be the qualification of sources or the integration of the supplier into the company's IT systems. Transaction costs include the purchase price itself, as well as the cost related to the order placement and the administrative cost regarding receiving the goods. Post-transaction costs include all cost that occurs after the purchase of the goods. These include all costs associated with the goods being owned by the buyer, such as defective parts, repairs and maintenance. Furthermore, costs may result from line fallouts and equipment downtime, which also need to be considered in the TCO calculation (Ellram, 1993: 3–10). All of these individual cost elements shall then be used in order to make an assessment for areas of cost reduction or avoidance.

In 1994, Ellram took her discussion of TCO further and proposed a taxonomy on TCO models (1994). She defined two models, namely a standard model and a unique model. In comparison to the unique model, the standard model can be used repeatedly while only little or no adjustment to the cost drivers included is necessary. The unique model, on the other hand, is always developed for a specific situation and the cost drivers included depend on the specific purchasing decision. She concluded that there is no standard approach to the usage of TCO and its implementation, due to the difference in the models. A good understanding of cost drivers of TCO is necessary in order to design the appropriate modelling tool. This can only be achieved if the procurement function does not operate in isolation from other organisational functions (Ellram, 1994: 171).

In addition to the before mentioned approaches to TCO, Ferrin and Plank (2002) have conducted an extensive literature review of other concepts of TCO in their study. All of these concepts follow the belief that costs need to be analysed from a long-term perspective, including elements other than only the purchasing price. Furthermore, the impact of the specific purchasing decision on other business units and functions needs to be considered.

Lastly, all related cost of other activities in the supply chain related to a purchase must be measured and understood in order to make a strategic decision. Ferrin and Plank (2002) noted that the TCO concept has been widely discussed in literature, but no empirical research was available regarding the question whether organisations actually use the TCO concept. Their empirical research revealed that firms use TCO models to evaluate purchasing decisions. However, not a single standard model for TCO was used by the companies, but rather similar models that include different cost drivers. An extensive number of cost drivers that companies use in order to generate their TCO were identified (see Table 2.1). Resulting from their findings, they conclude that a standardised model for TCO will not exist, but that cost drivers which are used more regularly can be found in more TCO models than others (Ferrin & Plank, 2002: 18).

Table 2.1: TCO Cost Drivers

Operations Cost	**Quality**	**Logistics**	**Technological Advantage**
• Manufacturing • Machine Efficiency • Production to Schedule • Labor Savings • Assembly Cost • Operating Supplies • Long-Term Operating Costs • Capacity Utilization • Increase in Production Output • Equipment Speed • Cost in Use • Line Speed	• Durability • Replacement • Field Failure • Customer Downtime • Inspection • Cost of Quality • Calibration Cost • Rework • Scrap • Customer Returns • Rejection Cost • Quality Improvement • Unplanned Downtime • Out-of-Service Costs	• Freight • Packaging • Customer Service • Availability • Handling • Instability in Freight Rates • Outbound Cost • Tariffs • Leadtime • On-Time Delivery • Supplier-Managed Inventory • Time to Schedule • Warehousing • Duties • Import Fees • Entry and Harbor Maintenance Fees	• Design Obsolescence • Suitability for Intended Use • Flexibility for New Use • Technology • Changing Technology • Long-Term Advantage • Supplier Ability to Change Technology
Maintenance	**Supplier Reliability and Capability**	**Inventory Cost**	**Miscellaneous**
• Supplies • Training • Downtime • Costs • Labor • Repair Costs • Parts • Spare Parts • Long-Term Maintenance Costs • Repair Frequency • Reliability • Preventive Maintenance Schedule	• Partnering Costs • Team Costs • Trust • Supplier Capabilities • Payment Terms • Supplier R&D Capability • Supplier Ability to Grow • Supplier Support • Service by Supplier • Stocking at Supplier • Familiarity with Supplier	• Safety Stock • Procurement fo Inventory Reduction • Storage • Perishability • Turnover	• Taxes • Value Chain • Warranty • Product Design • Availability • Disposal Costs • Liability and Indemnification • Obsolescence Cost • Salary, Benefits • Indirect Labor • Product Use • Depreciation • Lease or Buy • Supplier Cost Drivers • Safety • Support Costs • Utility Costs • Installation • Ease of Operation • Noise Level • Technical Support • Validation Cost • Service Costs • Overall Competition • Service Costs • Currency Exchange Rates • Direct Labor • Total Installed Price • Lease Rate Factors • Flexibility of the Supplier • Tooling and Fixtures • Environmental Issues
Transaction Cost	**Life Cycle**	**Initial Price**	
• Administration • Ease of Transaction • Supplier Conversion Cost • Small Orders • Procurement • Transactional Activity • Long-Term Savings	• Long-Term Usage • Projected Life Cycle • Life of Product • Life Cycle Stability • Cost Savings over Life of Product • Useful Life • Redesign Cost • Life Cycle Obsolescence Cost	• Unit Cost • Initial Purchase Price • Long-Term Price Stability • Initial Capital Expenditure	
Opportunity Cost	**Customer-Related**		
• Cost of Money • Overhead	• User Satisfaction • Customer Perceptions • Customer Specifications		

(Source: Ferrin & Plank, 2002)

Butter and Linse (2008) built a framework in order to further evaluate the cost factors associated with sourcing and procurement within international markets. Transaction cost was split into two different categories, i.e. *"hard costs"*, which are easy to quantify, such as

transport cost and import duties, and *"soft costs"*, which include other factors that are not clearly defined and accessible (e.g. costs from reviewing contracts, costs resulting from cultural differences, costs associated with risk, etc.). Butter and Linse (2008) created a list of identified costs in procurement, which need to be considered in making procurement decisions (see Table 2.2). This list is intended to improve judgement on the importance of various cost types and provides an extension to the TCO concept (Butter & Linse, 2008).

Table 2.2: Classification of Costs in Procurement

Objective ("hard") Factors	**Internal Factors (decisions within company control)** • Search and information cost connected with identifying suppliers • Direct cost of acquisition • Transport cost • Quality assurance • Installation and maintenance cost • Intellectual property costs • Training
	External Factors (decisions controlled by others) • Legislation in relation to trade • Currency effects • Import/export permits, levies • Labor costs and safety standards • Government rules and regulations
Subjective ("soft") Factors	**Internal Factors (decisions within company control)** • The effect of sourcing decisions on existing jobs • The effects on reputation and brand value • Corporate culture: Will staff support new suppliers? • Sustainability tradeoffs inside the company • Risk aversion: Will staff be able to deal with the risks associated with new supply options?
	External Factors (decisions controlled by others) • Sustainability considerations in relation to local and global economic environments • Cultural differences connected with doing business • Political differences concerning democratic rights, distribution of wealth, unions, and political stability • Customer views on desirable sources/suppliers • Labour circumstances • Environment

(Source: Butter & Linse, 2008)

In another study on cost in global sourcing, Holweg *et al.* (2011: 333) distinguish between three types of cost in global sourcing: static, dynamic and hidden cost. The categorisation is similar to the previously mentioned model of Butter and Linse (2008). Static costs include unit costs, transport and clearance cost, and other additional service cost that might be

incurred on a regular basis. Dynamic costs are costs incurred that result from changes, such as demand changes that require more safety stock. Dynamic costs also include costs that result from stock out situations and lost sales due to long transport lead-times. The hidden cost category includes all costs that are not directly related to the actual supply chain operation of global sourcing, but which impact the whole business environment. Next to changing energy cost and changing political situations, currency fluctuations belong to this category (Holweg *et al.*, 2011).

Burt *et al*. (2010) use a similar approach to TCO of classifying cost drivers into categories. Total cost is also comprised of three components: acquisition costs (e.g. purchase price, planning costs, taxes and duties, and financing costs), ownership costs (e.g. downtime costs, risk costs, conversion cost, supply chain cost) and post-ownership costs (e.g. warranty costs, product liability cost, customer dissatisfaction cost). These three components include all costs that are directly or indirectly related to the procurement and use of the goods. However, these components shall not be considered as a standard model, but rather as a framework for components of a model that a company develops. Further, Burt *et al.* (2010) explain, that TCO cannot only be applied to individual cost objects of a company, but also extends to a much broader view throughout the supply chain. The TCO concept can be modified and integrated into strategic cost analysis in order to evaluate outsourcing opportunities or other decisions with long-term effects on cost. A TCO analysis can therefore include other related issues, such as foreign exchange risk, foreign political and economic stability or volatility of demand (Burt *et al.*, 2010).

In a more recent study conducted by Christopher *et al*. (2011), it is found that even though methods to increase transparency of costs in global sourcing such as TCO exist, these methods are not often applied in practice due to the amount of time, data and cooperation they require to be administered. This shows that there is still a lot of room for improvement for companies with regards to their insight on cost and understanding of cost drivers.

2.5 Decision Support Systems

Due to rapid advancements in information technology, organisations have more access to data than ever before. Increased availability of data forced companies to better anticipate changes and volatility in the market, in order to ensure a competitive advantage over their competitors. However, an increasing amount of data does not necessarily result in a better understanding of the market, nor does it automatically yield improvements in operational performance (Vitt,

Luckevich & Misner, 2002). Companies need to be aware that data first needs to be transformed into valuable information in order to derive decisions, which finally result in actions that result in a value added to the organisation. Therefore, companies not only need BI in order to collect and analyse data. Methods in order to obtain insight into the raw data and to derive actions out of it are also required. For this purpose, DSSs are developed. DSSs, which are part of BI and its computer technology solutions, are used in order to transform raw data into decision-making information. A DSS is defined as *"an interactive computer-based system or subsystem intended to help decision makers use communications technologies, data, documents, knowledge and/or models to identify and solve problems, complete decision process tasks, and make decisions"* (Power, 2007). In a similar definition by Sauter (2011: 5), DSSs are described as *"computer-based systems that bring together information from a variety of sources, assist in the organisation and analysis of information, and facilitate the evaluation of assumptions underlying the use of specific models"*. Both of these definitions relate to DSSs as a computer-based system, which enables the decision makers to access relevant information whenever they need to make a decision. As stated by its name, DSSs support the decision maker by providing an interactive platform to data insight information.

The concepts and methods of DSSs have been widely discussed in literature, and several frameworks on DSS categories exist (Marakas, 1999; Li, Feng & Xia Li, 2001; Shim, Warkentin, Courtney, Power, Sharda, *et al.*, 2002; Hedgebeth, 2007; Power & Sharda, 2007; Sauter, 2011; Power, Sharda & Burstein, 2015). According to Power and Sharda (2007: 1045), classifying DSSs into different categories can support the developer of the system, as the category provides guidelines on how it should be designed and constructed. In his DSS framework, Power (2002) differentiates between five specific DSS types, including model-driven DSS, communications-driven DSS, data-driven DSS, document-driven DSS and knowledge-driven DSS. The characteristics of the different DSS types are presented in Table 2.3.

Model-driven DSS include computer-based systems, which use complex financial, simulation and optimisation models in order to support in decision-making. These models can include functionalities to use parameters in order to perform "what-if" analysis and to examine sensitivities on certain variables (Power & Sharda, 2007). As the objective of this study is to develop a decision support tool that measures and analyses the impact of cost drivers on direct material cost, such as the sensitivity of different variables on procurement spend, the decision support tool developed would be classified in the model-driven DSS category. According to

Power and Sharda (2007), a model-driven DSS is characterised by being accessible and usable in an easy manner, and intended for the purpose of a specific, repeatable decision situation. This means that a model-driven DSS needs to be accessible and usable by top management and lower level employees alike.

Table 2.3: DSS Categories and Characteristics

DSS Type	Characteristics
Model-driven	• Simple access to quantitative data • Provides access to statistical and analytical tools and sophisticated models. • Usage of complex financial, optimisation and simulation models to provide decision support. • Can include functionality for decision analysis, forecasting, linear programming and simulation • Usage of data parameters provided by decision-maker.
Communications-driven	• Based on communication and network technology. • Enables communication between people. • Enables the sharing of information. • Supports collaborative decision making.
Data-driven	• Access to and manipulation of internal as well as external data. • Query and retrieval tools for data build basic functionality. • Includes data warehousing. • Can include real-time data processing functionality.
Document-driven	• Retrieval and management of unstructured documents. • Computer storage and processing of documents. • Often accompanied by search engines to access specific documents, images, sounds and video.
Knowledge-driven	• Based on artificial intelligence and statistical inference technology. • Include specialised problem-solving expertise. • Can include data mining aspects, which enables to analyse large amounts of data to produce content relationships.

(Source: Power, 2002)

The structure of a DSS is comprised of three major components, namely the data component, the model component and the user interface (Shim *et al.*, 2002). Figure 2.4 illustrates the three different components. The data component includes access to internal and external data, as well as relevant information. This data is used in the model component of the DSS, where modelling functions and calculations are executed. The user interface must be easy to use and understand, in order to provide the decision maker with access to interactive queries, reporting and visualisations (Shim *et al.*, 2002). The setup of a DSS is very important for its functionality, as all components of the system need to work together. Furthermore, dependencies between the different components need to be identified before the system is developed in order to ensure that the desired functionality and analysis can be executed with the available database and model construct, and accessed via the user interface.

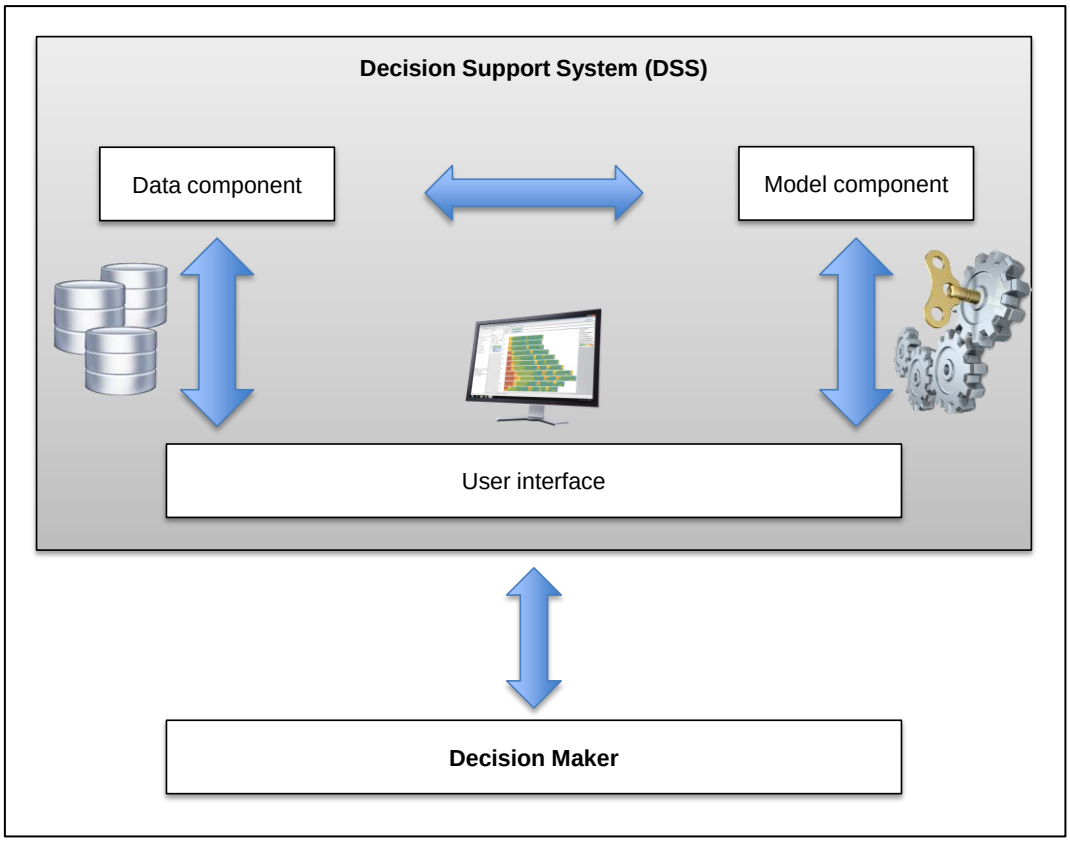

Figure 2.4: Components of a Decision Support System

(Source: Sauter, 2011: 15)

The model that needed to be developed for this thesis fits into the model-driven DSS category. This type of DSS uses algebraic, financial, simulation and optimisation models to provide decision support. Therefore, the methods and procedures of how such a DSS is developed were further investigated in literature, and current practices were analysed in the following section (see section 2.5.1). Furthermore, a review on how visualisations are used for DSSs is presented in section 2.5.2.

2.5.1 Financial Modelling

The primary objective of this study was to develop a decision support tool that measures and analyses the impact of cost drivers on direct material cost. The aim of the model is to provide decision makers with insight and information on cost within global procurement, and to enable an improved decision-making process based on the model's outputs. Within the sensitivity analysis, multiple cost driving factors, such as the currency risk exposure and commodity price exposure, needed to be considered. The goal was to develop a spreadsheet-based model in order to perform "what-if" and scenario analysis. This model should be used as a decision support tool within corporations in order to provide a more predictable view on direct material cost as well as to increase visibility on the individual cost components.

Literature offers several theoretical and economic models used for research that include cost drivers, such as the exchange rate exposure (Bodnar, Dumas & Marston, 2002; Bartram, Brown & Minton, 2010). The results of these models in research suggest that many firms have significant exchange rate exposure risk (Bodnar *et al.*, 2002: 199). Furthermore, these models mostly attempt to understand the exposure on issues, such as exchange rate or commodity, with regards to the effect on the company's financial results or stock value (Bartram *et al.*, 2010: 148). This means that most of these theoretical models consider the different risk exposures as an output risk, which affects revenues. The economic models are not intended to be applied in practice within organisations to identify different exposure levels or cost. Literature on financial models that are applied in the industry is scarce, due to the specific requirements of individual companies. Some case studies and practical examples of cost modelling, optimisation modelling and scenario planning exist (Robinson, 2006; Feller, 2008; Christensen & Rosvall, 2012; Guertin, 2014). In contrast to the theoretical and economic models, these models can be directly applied and used within organisations. All of these models are developed specifically to the needs of a specific company and generate results that these companies can use for decision-making. The identified models provide certain key characteristics of financial models, which are described in the following sections 2.5.1.1 and 2.5.1.2. As this study also develops a financial sensitivity model that can be applied, a similar approach was applied.

2.5.1.1 Financial Modelling Process

In order to build an effective model, one first needs to understand how such a model is defined. According to Rees (2008), most models built in practice are often very time-consuming to understand, audit and validate. As a result, it is difficult to share the model with others, as they would first need to be instructed on how to use the model. Also, most models need a vast amount of rework, even if only slight changes are required. In practice, this results in a developed model that is tied to its creator, who needs to answer all questions about the analysis and in case of changes. Furthermore, models lack clarity of objectives and contain errors or assumptions, which might lead to inability to answer initial questions. As a result, Rees (2008) identified a number of key requirements in order for a model to be effective:

- It requires shortest possible time to understand.
- It is driven by objectives.
- It does not contain errors.

In order to successfully build a model, key questions must be answered from the start, i.e. in the model design stage. These can include: What are the key objectives and outputs of the model? What types of variables should be included or what dependency relationships between the variables must be captured? Also, the level of detail or aggregation needs to be clarified. Even though more detail might reveal further insight, it also makes the model more complex and increases the possibility of mistakes. Therefore it is essential to assess the required level of detail (Rees, 2008).

According to Tennent and Friend (2005), financial models can be considered as the main tools used for financial analysis of major business decisions. Models can help organisations in terms of analysis, such as analysing cost on basis of given inputs, and decision-making, as it should allow users to explore different outcomes by changing variables and assumptions. Tennent and Friend (2005) developed a financial modelling process, which includes all stages that are necessary to develop a successful model (see Figure 2.5). The process starts with the definition of the business question and ends with the implementation of the project and a project review. In between, the required outputs and inputs need to be identified and revised, data needs to be collected and the model needs to be build. After the construction of the model the data will be entered and findings and results need to be documented. These steps need to be considered during development and form an important part of the methodology of this study.

2.5.1.2 Sensitivity and Scenario Analysis

The use of sensitivity analysis can be very useful in order to present changes and impacts on key outputs. The presentation of the results should be separate from the in-depth calculations and summarise main inputs and outputs. In order to conduct a sensitivity analysis, a range of input variables, such as forecast scenarios, needs to be available and displayed (Rees, 2008). Having a number of scenarios available as output results and comparison between the different scenarios can help facilitate decision-making. The different scenarios should always be relevant to the environment in which a business operates and show the key trends that are expected for future developments (Tennent & Friend, 2005).

In order to create different scenarios, the following procedure should be applied:

1. Key inputs and variables with a high degree of uncertainty for future forecasts and high impact on outputs need to be identified.
2. The possible alternative behaviours of the input variables need to be identified.

3. Three to four realistic scenarios should be selected.
4. The model's output needs to be linked to the different scenarios, and results need to be compared.
5. Business strategies are developed (Tennent & Friend, 2005).

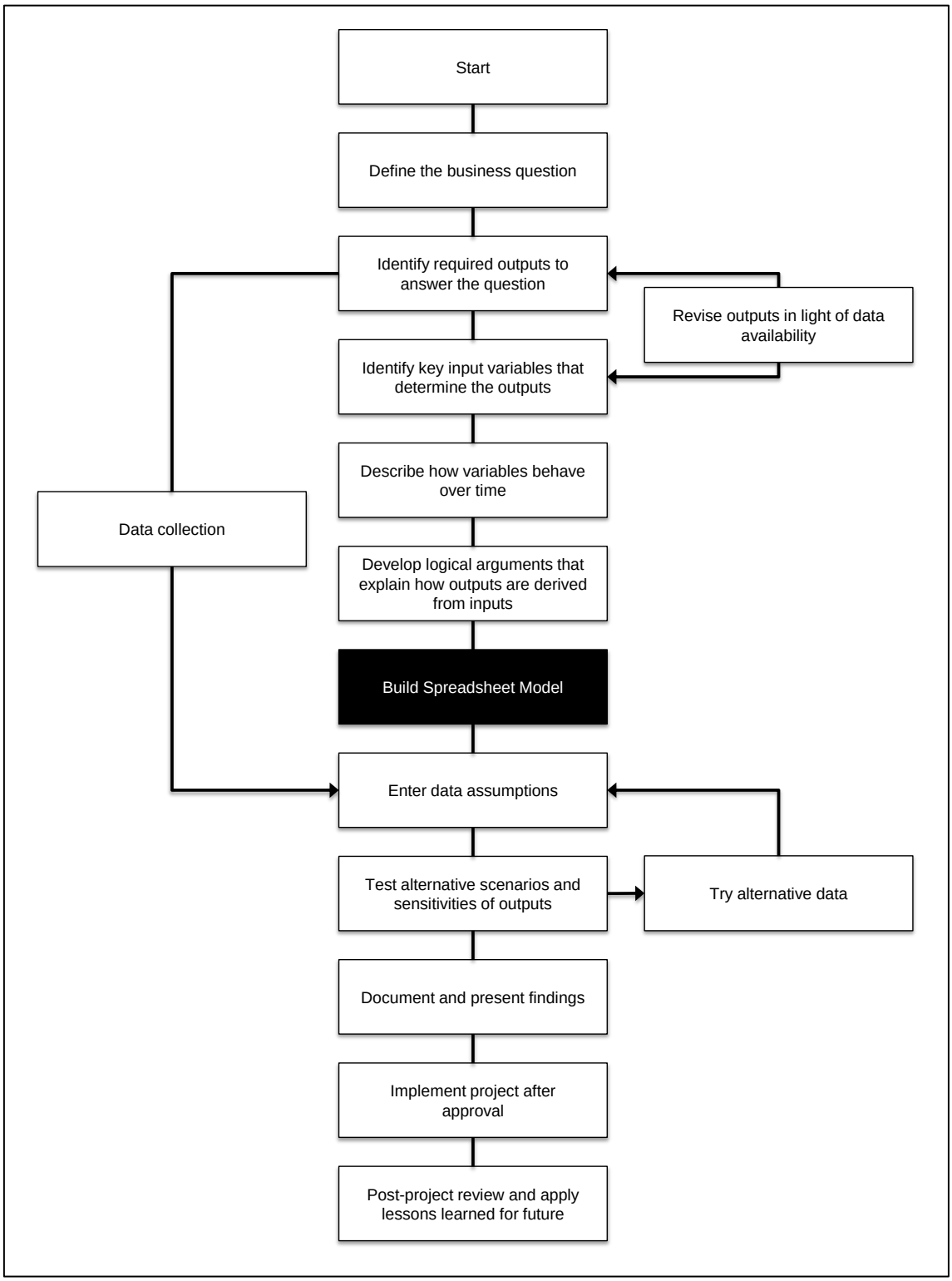

Figure 2.5: Financial Model Development Process

(Source: Tennent & Friend, 2005)

Swan (2008) defines a clear distinction between sensitivity analysis and scenario planning: In contrast to scenarios, where a range of key inputs are changed to create a specific situation, a sensitivity or "what-if" analysis is used to observe and compare results when only one or two input variables are changed.

2.5.2 Data Visualisation

In section 2.5, the three different components of a DSS were presented. One of these three components is the DSS user interface, which is needed in order to make data and information accessible to decision makers. The quality of the user interface is of utmost importance for a DSS as it the main point of contact with the user. The final implementation and usage of a DSS by a decision maker is dependent on the user interface, functionality of the support tool and the simplicity of using it. If the tool is too complicated and not understandable or it is simply not possible to access the information on what the model is intended to deliver, it is likely that the tool will not be used in practice. Therefore, significant effort during the DSS development process needs to be invested into the user interface design phase. According to Li *et al*. (2001), the time dedicated to the creation of the user interface of a DSS has increased over the evolution of DSS and takes up a large percentage of the total time of DSS construction. As the importance of the DSS design has been widely recognised, Li *et al*. (2001) conclude that the structure and layout of a DSS user interface have a large impact on the quality of the complete DSS.

One part of the user interface of a DSS is the outcome and results section of the tool, which is the ultimate final product that the DSS creates in order to support the decision maker. The format of this final output and the way in which the information is communicated to the decision maker is very important and needs to be considered in the design phase of DSS construction. According to Li *et al*. (2001), most of today's DSSs still use characters and numerical formats in order to present information and communicate the data to the user. However, this is not the best way of communicating data. Not all users of the DSS are affiliated and interested in the numbers and the mathematical equations. Top management is usually not interested in the detail and also might not understand the mathematical background. As a pre-requisite of model-driven DSS, the tool needs to be accessible, usable and understandable by top management and lower level employees alike (see section 2.5). Therefore, the output should rather be presented in a simple and easy to understand manner,

which can be used by everyone to read the data and access the information, no matter in which position they are. This is where data visualisation comes into play.

Data visualisation is the process of visualising data or information into graphical representations. By its definition, data visualisation is based on quantitative or qualitative data and results in a visual representation of the data that is readable by its viewers and supports exploration, examination and communication of information (Azzam, Evergreen, Germuth & Kistler, 2013). According to Li *et al*. (2001), translating the outcome of a DSS into the *"universal language of the visual"* benefits the viewer. For the viewer, interpreting data in the form of graphical displays, such as charts, maps, graphs and dashboards, is more simple and straightforward to understand than huge data tables that need to be investigated first. A visual display lets the viewer make use of the natural ability of humans to identify and understand patterns quickly (Li *et al.*, 2001). In general, the data that is visualised can include quantitative and qualitative data, and the scope of how the information can be visually represented is broad. Data visualisation can be stationary, animated, or interactive (Fayyad, Grinstein & Wierse, 2002). While stationary visualisations, like a set of images or charts, and animated visualisation, such as a time series of charts in a presentation, limit the viewer of the visualisation to a specific view only, animated visualisations have the advantage to dig deeper into the subject by using filters, setting parameters, or changing the perspective.

Many different possibilities to visualise data exist. However, the design and chosen type of visualisation needs to be considered carefully when communicating data. Using a chart that is not suited for the data that should be displayed can lead to wrong perception by the viewer, as it might not communicate the information as intended (Azzam *et al.*, 2013). When using visualisation to present the outcomes of a DSS, this can result in wrong decisions due to the misconception of the visualisation. Another challenge of data visualisation is the quality of data and the reliability of the displayed information. According to Azzam *et al*. (2013), the *"foundation of any visualization is the data used to create it"*. In other words, only if the data is accurate and has a high standard of quality, the visuals can be reliable and truly reflect the investigated issue. However, poor data quality, which refers to missing values, an unrepresentative sample, or simply wrong data, leads to unreliable visualisations that can mislead viewers easily. Therefore, it is necessary to ensure that the data is in the right format and error-free before visualising and communicating data.

A wide range of software packages is available on the market that offers programs to visualise data and communicate information. For model-driven DSS that are constructed in a Microsoft Excel (MS Excel) framework, visualising data within MS Excel is certainly an option. Next to its spreadsheet operations, MS Excel has built-in functionalities to create a variety of different charts, such as bar charts, line charts, pie charts and others. Due to its simplicity in the creation of charts, MS Excel is often used for the quick visualisation of data in the work environment. Even though a wide range of possibilities to visualise data in MS Excel exists, the functionalities with regards to interactivity are limited. Charts are static and require data adjustments in order to generate change views. Also, MS Excel does not provide effective presentation modes, which most often results in the workaround of exporting charts to other programs, such as MS PowerPoint, in order to communicate the data. When MS Excel's capabilities run out, other software programs that offer functionalities for the user to engage with the data interactively and to explore data insight are needed. One of these programs is Tableau.

Tableau is a *"visualization querying engine and user interface that makes it easy to discover and communicate with data"* (Jones, 2014). Developed by the American computer software company Tableau Software in 2003, the mission of the Tableau software is to *"help people see and understand data"* (Tableau Software, 2015a). Tableau enables users to quickly look at data from a variety of different perspectives, perform sophisticated analyses of multiple data sources at the same time and to communicate information in an efficient way. The constructed data visualisations are interactive and the data processing happens instantly. Decision makers have the functionality to use Tableau in order to engage with the data, visualise results according to their demand and use the gathered information and knowledge as decision support.

Furthermore, visualisations are appealing in their design. The design and aesthetics of visualisation must not be neglected, as it is an important aspect when communicating the data (Li *et al.*, 2001). According to Jones (2014), visualisations that are more appealing in the eyes of the viewer are paid more attention than poorly designed and formatted visualisations. Also, aesthetic elements can increase the interest of the viewer and are remembered better (Jones, 2014). Therefore, the functionality and appealing design of its visualisations make Tableau a suitable tool to communicate information.

Another advantage of Tableau is that it allows the reader to dig deeper into data while still being able to provide an overview at the same time. This enables the viewer to identify patterns or outliers in the data effortlessly, as no restructuring of the data is required. The software allows its user to quickly filter the results, highlight certain trends, drill down into lower categories, and change timelines and other features without having to work with the raw data. Figure 2.6 is an example of an interactive Tableau dashboard. The dashboard presents the profitability of individual locations, monthly sales by segment as well as monthly sales by product category at the same time. Within the dashboard, the user can directly interact by clicking or hovering over data points in order to filter and display related information. Also, the user can use filters in order to display only the information of interest. Through the interactivity of the dashboard provided, the user can instantly focus on specific fields of interest, while still having the option of a complete overview.

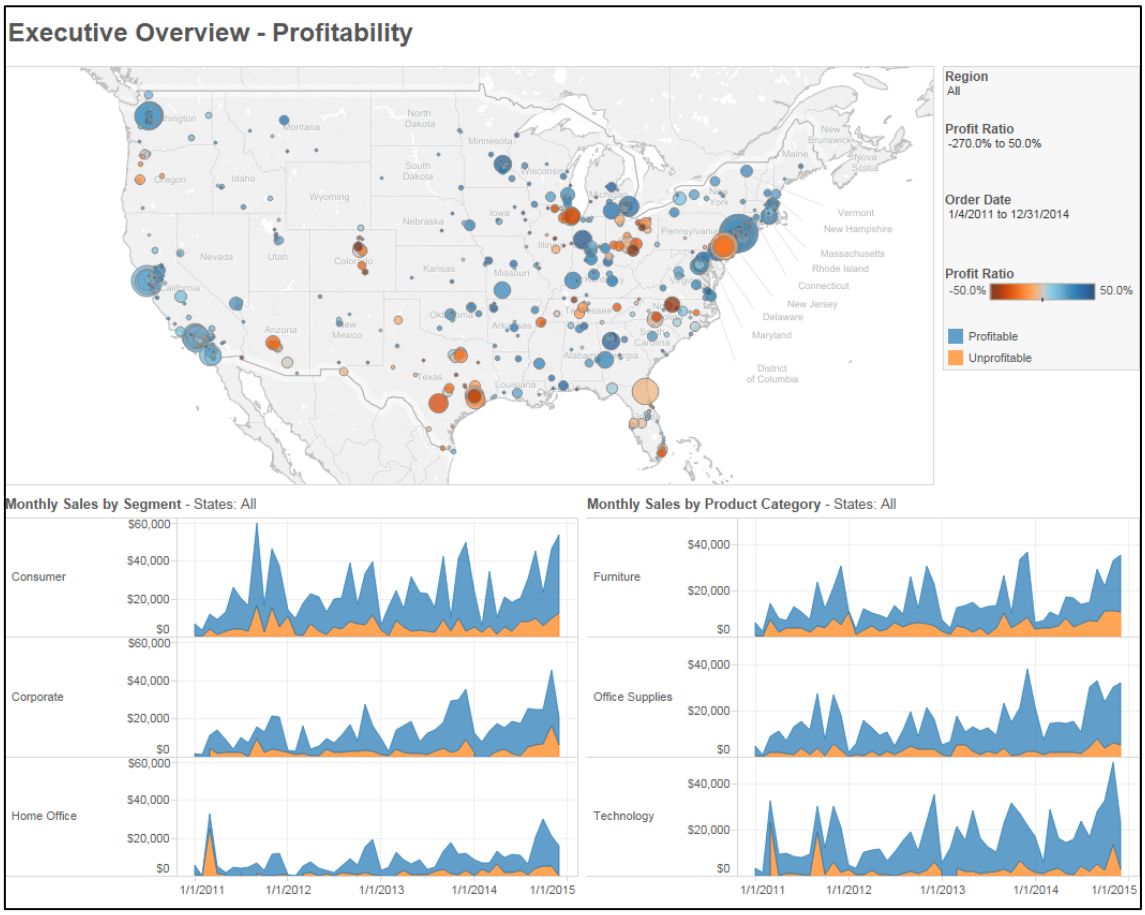

Figure 2.6: Example of a Tableau Dashboard

(Source: Tableau Software, 2015b)

Furthermore, Tableau offers the functionality to change the data source independently of the visualisation. This means that the visualisation can be used for multiple datasets at the same time, making the data source interchangeable. According to Fayyad *et al*. (2002: 225), this is a

key criteria for model visualisation. It allows taking snapshots of multiple datasets at a time, and enables the viewer to compare between the datasets in order to detect patterns or outliers in the data.

Tableau is a data visualisation tool that definitely needs to be considered when creating a DSS and designing its user interface. As outlined in this section, the user interface is an important component of DSSs, and visualisations of data play a vital role as it allows users to gain insight into the data by exploring it from different perspectives. Effective data visualisation, and visualisations that communicate information accurately and effortlessly, can help decision makers perform his or her task.

2.6 Deductions made from Literature

This chapter reviewed the literature pertaining to the procurement function in general, its benefits and challenges and, furthermore, focussed on the task of cost management with regards to financial risks of global organisations. The literature review was conducted given the background of the primary objective of this thesis, being the development of a decision support tool for direct materials and their cost drivers. By additionally reviewing the relevant literature on DSSs, one derived an understanding about how and why BI tools are used within organisational processes. Furthermore, financial modelling techniques were analysed and a framework of a model development process was reviewed. Lastly, literature on data visualisation was reviewed, as the visualisation of data forms an important aspect within DSSs. In this section, key deductions from the literature are presented.

The procurement function and its role within supply chain management have been widely discussed in literature. Not only because of its increasing importance within organisations in the last decades due to increasing global sourcing activities, but also because the function itself has changed drastically. Before procurement was seen as the business function that strategically integrates all processes related to the provision of goods and services to the organisation (Leenders *et al.*, 2006), procurement was merely seen as the transactional process of purchasing and buying materials or finished goods from suppliers. One of the first articles that outlined the importance of procurement was released by Kraljic in 1983. Kraljic claimed that *"purchasing must become supply management"* and explained that purchasing should be a part of corporate strategy and no longer a pure transactional business function (1983). In order to give organisations a better understanding of which supply strategy they should follow in order to maximise profits and minimise risk, Kraljic developed a purchasing

model. This model, which is still used today, helps procurement managers to classify purchased items and to derive strategic approaches for its procurement. Due to its simplicity and effectiveness, procurement managers can easily focus on strategic purchasing items and allows them to develop action plans for different items. Other researchers have confirmed that it is important to integrate the procurement function on top management level that includes everything from purchasing, consumption management, supplier selection, contract negotiations and supplier relationship management. Especially with regards to the supplier selection, decisions should not be made by just comparing the transaction cost and purchasing price. A complete understanding about all related costs resulting from procurement is necessary in order to make strategic decisions. Resulting from the findings in literature, one can conclude that the classification of purchased or nowadays procured items is of utmost importance. Companies need to be aware of their strategic items, i.e. the items that add significant value to the organisation, but that are also exposed to the biggest supply risk. These items should be prioritised when making procurement decisions and need the highest support with regards to market and risk analysis as well as optimisation and simulation modelling.

The literature review has also shown that global procurement can result in a number of benefits to the organisations, but also bears risks and challenges. In a number of studies of older and more recent research, the major benefits identified were similar to each other. Companies with effective global procurement strategies gain competitive advantages, such as cost savings through better prices, higher quality products and increased supply availability through an increased number of suppliers, as well as access to new global technologies. All of these benefits increase the companies' competitiveness in the market. In addition to the benefits, multiple studies have identified similar challenges of global procurement. The major challenges organisations are facing when executing global procurement activities are related to the logistics of long supply chains, cultural, language and business differences, fluctuating exchange rates as well as customs proceedings. These challenges are of a strategic, tactical and operational nature, and can result in a number of risks. As a number of different risk classification frameworks exist in the available literature and were presented in this section, one can conclude that there is a general awareness of the risk involved in global procurement. As presented in Figure 2.3, risk can be categorised into four categories, i.e. supply risk, process and control risk, environmental and sustainability risk, and demand risk. The degree or level of how organisations benefit or are exposed to risk does not only depend on an

effective procurement strategy. Studies have shown that the success and level of the perceived benefits or challenges highly depend on the organisation itself, its size and the market in which it competes. Furthermore, companies that have a high commitment from top management with regards to its procurement function experience more benefits and fewer challenges surrounding global procurement than companies with low commitment from top management. The available literature on global procurement has shown that organisations can generate significant benefits when global procurement is executed efficiently. However, with the opportunity of realising benefits come certain risks. These risks need to be considered and risk management strategies should be deployed in order to mitigate them.

With regards to cost management in procurement, the literature was reviewed while focussing on the financial risk to which companies are exposed, and the concept of TCO, which can be used in order to increase the understanding of all cost components. Financial risks to which companies are exposed when using global procurement include exchange rate fluctuations as well as commodity price risk. These fit into the environmental and sustainability risk category as per classification in Figure 2.3. Both of these risks represent significant cost drivers of direct material cost for companies that engage in global sourcing, as transactions include different currencies, and materials prices are exposed to commodity prices. In order to mitigate the risk and hedge against it, several financial instruments, such as forward exchange rate contracts, swap options or forward contracts, exist. Especially in highly volatile markets, companies need to have a good understanding of their cost in order to determine the level of exposure to these risks. With regards to so-called second-tier currency impacts, which also need to be investigated within this thesis, literature is scarce. However, there is no doubt that this risk exists, as it can be seen as a derived exchange rate fluctuation risk.

As literature has shown that the first step to manage financial risk in global procurement is for companies to obtain an overall understanding about its risk exposure, the concept of TCO was reviewed. TCO can be used in order to increase the understanding and the transparency of cost within organisations. The goal is to increase the understanding on incurred cost and to be able to have a more predictive view on cost impacts that might occur in future. This includes the measuring of all costs related to a purchase, such as pre-transaction cost, transaction cost and post-transaction cost. Over the years, a number of different TCO frameworks were developed. All of these have identified similar cost components and have the objective to increase transparency. Furthermore, the literature review revealed that if companies use the TCO concept to identify their costs, no standard model was applied. This means that TCO

needs to be adapted based on the needs of an individual company, its cost setup as well as its business operations. Nevertheless, TCO can be used within the procurement area of organisations in order to identify different cost drivers. As a result, companies can focus on big cost drivers by finding ways to manage these costs. In practice, however, applying TCO is very time and resource intensive, and requires a lot of cooperation within the company. If applied efficiently, it can generate opportunities to save costs.

Lastly, the chapter reviewed available literature on the usage and setup of DSSs. DSSs are part of the BI environment and used in order to transform raw data into decision-making information. The information gathered by the use of a DSS should support decision makers in order to make the best decision in a given situation. DSSs exist in several different forms, such as model-driven, communications-driven, data-driven, document-driven or knowledge-driven DSS. Each of the different types has specific characteristics regarding its setup and usage. For this thesis, model-driven DSSs and its concepts are the most relevant type, as they use complex financial, simulation and optimisation models in order to support in decision-making. These models can include functionalities to use parameters in order to perform a "what-if" analysis and to examine sensitivities on certain variables. As illustrated in Figure 2.4, DSSs consist of the data component, the model component and the user interface. The review of the literature has shown that for DSSs to be effective, the design and the layout of the user interface need to be appealing to the user. Therefore, effective use of data visualisation needs to be considered. Data visualisation is the process of transforming data and information into graphical representations. Visual images and illustrations, such as charts and graphs, are more simple and quicker to understand than large data tables. Another characteristic of an effective DSS is interactivity. Interactive DSSs are more usable than static DSSs, as they allow its user to analyse the data without restructuring the raw data source. As a vast amount of different software offerings to visualise data exist, this thesis made use of Tableau, due to its availability and ease of usability. Decision makers have the functionality to use Tableau in order to engage with the data, visualise results according to their demand and use the gathered information and knowledge as decision support. All of this happens in an interactive and live user environment, allowing the user to dig deeper into the data with just a few mouse clicks. While reviewing the software, it was decided to use Tableau within this study in order to visualise the decision support tool developed, as effective data visualisation and visualisations that communicate information accurately and effortlessly, can help decision makers perform their task.

Chapter 3 - Literature Review:
The South African Fast Moving Consumer Goods Industry

3.1 Introduction

This chapter provides an overview of the industry in which Johnson & Johnson operates. A brief discussion of the FMCG industry builds the foundation for a detailed review on the CHC sector. Furthermore, the key South African market players operating in the CHC sector are reviewed and South Africa's economic landscape is analysed.

3.2 The Fast Moving Consumer Goods Industry

Fast moving consumer goods (FMCG) are products that in general have a short shelf life and a high inventory turnover rate (KPMG Africa Limited, 2014). Customers purchase these products on a regular, routine basis without extensive thinking or comparison between products due to the products' relative affordability, rapid consumption and the rather low differentiation between brands. The high inventory turnover rate is caused by the high consumer demand as well as the products' shelf life, which depends on the nature of the goods and its perishability. Due to the high price pressure, the profit margins are low for the retailers and manufacturers of the products. Therefore, a high volume turnover of the products is needed in order to overcome the low profit margins and to be profitable. Retailers generally use economies of scale in order to offset the low margins. High quantities are purchased from manufacturers and large quantities are sold to the consumers in order to make a cumulative profit, rather than a profit on one individual purchase (KPMG Africa Limited, 2014). Furthermore, manufacturers use marketing techniques in order to develop brand loyalty with the customer (KPMG Africa Limited, 2014). Loyal customers are needed in this highly competitive environment with an intensive amount of substitute products. As the manufacturing companies do not usually sell their products directly to the end consumer but rather to the retailers in the market, it is still in their interest to increase brand awareness in order to trigger sales.

The FMCG industry is usually not as affected by economic downturns or depressions as other consumables related to high investments, such as luxury goods, durable goods or major appliances, that are only replaced after a certain period of time (KPMG Africa Limited, 2014). According to the Reckitt Benckiser Group (2015a), the FMCG industry has proven to perform

better in an economic recession compared to before mentioned high investment industries, as there is always a need to use goods to clean floors, launder clothes and soothe pains, but not the necessity to invest in a new car or fridge.

According to KPMG Africa Limited (2014), the FMCG industry, which is also referred to as consumer packaged goods (CPG) industry, is one of the largest industries worldwide. The FMCG industry includes a variety of products in the foods and non-foods sector. Food and beverages include short shelf life goods and perishable items, such as fruits, vegetables and meats as well as longer shelf life goods, such as bottled water, soft drinks and alcoholic drinks, chocolates and sugar (MBA Skool, 2015). Non-food items include consumer goods for personal care, such as toiletry items in the forms of creams, toothpastes and shampoos as well as household care, such as floor and dish cleaners and washing powders (MBA Skool, 2015). Another category of FMCG is over-the-counter (OTC) drugs, which are medicines that are sold directly to consumers without the need for a prescription (U.S. Food and Drug Administration, 2013).

Due to the high diversity of products in the FMCG industry, a large number of companies engage in the market. In the worldwide market, key players include companies such as Unilever, Procter & Gamble, Johnson & Johnson and Nestlé (KPMG Africa Limited, 2014; MBA Skool, 2015). The major brands in the consumables markets are products of FMCG companies. These brands are usually marketed by the companies via television advertisements and are well known in the population (Reckitt Benckiser Group plc, 2015a). An information graphic about the different industry players and their individual brands can be found in Appendix A (Baker, 2012).

According to Euromonitor International (2015a: 6), the size of the retailing industry in South Africa was ZAR874.1 billion (BN) in 2014, of which ZAR47.5BN can be attributed to the health and beauty specialist retailers. However, the total market size is bigger, as the before mentioned number does not include grocery retailers, which also offer a wide product range in this industry (Euromonitor International, 2015a). South Africa's leading retailers in terms of market share in 2014 were Shoprite Holdings Ltd (10.6% market share), Pick n Pay Retailers (7.8%), Spar Group Ltd (6.1%), Massmart Holdings Ltd (4.8%) and Woolworth Holding Ltd (3.9%) (Euromonitor International, 2015a: 10–11).With regards to the largest health and beauty specialist retailers, Clicks Group Ltd is the market leader with ZAR13.2BN NTS in 2014, which represents 26.1% market share (Euromonitor International, 2015a: 74). Dis-

Chem Pharmacies were ranked second with a mere 3% market share in 2014 (Euromonitor International, 2015a: 74). This wide gap between the leading retailers specialising in health and beauty retailing again indicates that a major share of health and beauty products are sold by non-specialist retailers.

In the next section, the PHC and OTC market, being part of the CHC industry, will be analysed further.

3.3 Consumer Health Care

Within this section, the CHC market segment, being part of the FMCG industry, is explored and market details with regards to the South African market are provided. As Johnson & Johnson engages in the CHC market, this background on the CHC market in South Africa, including the different products that are comprised in this category, builds the foundation for understanding the market environment of this study. There are a variety of different categories and subcategories used within the CHC industry. For the purposes of this study the two categories considered are PHC and OTC.

3.3.1 Personal Health Care

One part of CHC is PHC, sometimes also referred to as personal care. PHC includes a variety of products used for personal hygiene and beautification. Depending on the manufacturer, common sub-categories of PHC in which various products fall include oral care, baby care, skin care, hair care, sanitary care, wound care and beauty care (Marketline, 2014a; Johnson & Johnson Services, 2015c; Procter & Gamble, 2015; Tiger Brands, 2015a, Tiger Brands, 2015b; Unilever, 2015a). These categories include products such as bath and shower products, deodorants, soap, shampoos, conditioners, styling agents, oral rinses, toothpaste, creams, lotions and many others (Euromonitor International, 2014a; Marketline, 2014b, Marketline, 2014c).

According to Marketline (2014c: 7), the personal hygiene market in South Africa, which is defined as the market that includes bath and shower products, deodorants as well as soap, generated ZAR6.5BN in 2013, which indicated a growth rate of 9.5% to 2012. Within their classification, deodorants take the largest share of 64.3%, followed by soap and bath and shower products with 27.3% and 8.4%, respectively (Marketline, 2014c: 10).

With regards to the hair care market, which according to Marketline (2014b: 7–8) includes shampoo, conditioner, hair colorants, perms and relaxers as well as styling agents, revenues of

a total of ZAR6.5BN were generated in 2013. Shampoo and conditioners are the two biggest contributors to the market, having a market share of 27% and 24.2%, respectively (2014b: 10).

On the other hand, Euromonitor International (2014a: 5) takes a different approach in categorisation and provides a detailed look into a number of subcategories in their report. A differentiation is made between baby and child-specific products, bath and shower products, colour cosmetics, deodorants, depilatories, fragrances, hair care, men's grooming, oral care, skin care, sun care as well as sets and kits. In total, the beauty and personal care market as defined by Euromonitor International had a value of ZAR35.3BN in 2013 (2014a: 5). The market value and market share of the different categories are shown in Figure 3.1, where bars represent the market value in ZAR million. The fragrances category has the largest market value, with a share of 20.1%.

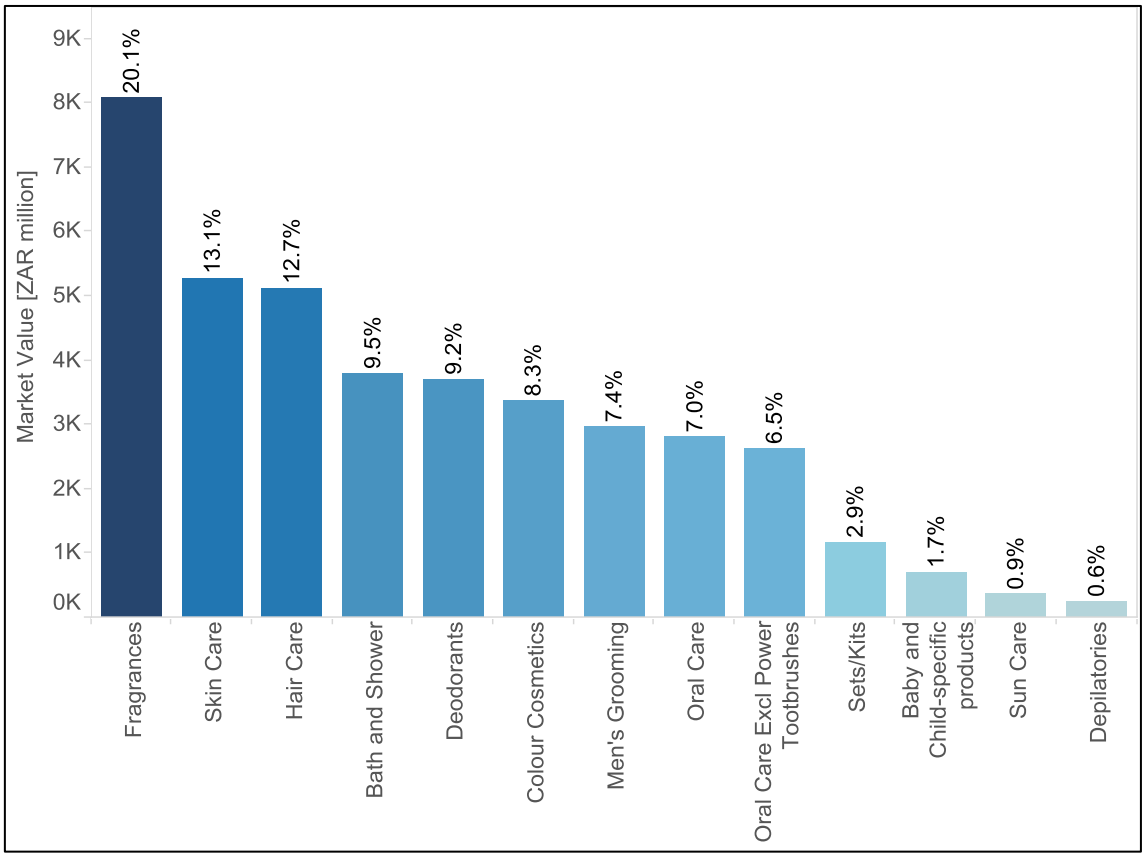

Figure 3.1: Beauty and Personal Care Market – Market Value and Share per Category

(Source: Euromonitor International, 2014a: 5)

Furthermore, a significant number of players engage in the market. The company shares of the beauty and personal care market are shown in Figure 3.2. From the figure one can directly see that Unilever has the highest market share in the beauty and personal care markets, with

14.1%. Due to the many different companies in the market, the beauty and personal care sector can be considered highly competitive. However, it needs to be considered that Euromonitor International (2014a) has defined the beauty and personal care industry relatively broadly. In order to get a detailed view with regards to the competitive landscape, it is necessary to go into subcategory level. For example, Johnson & Johnson is only listed at position nine overall, having a market share of 2.7% (Euromonitor International, 2014a: 7). However, Johnson & Johnson is the market leader with a 27.8% market share in the baby and child specific products category, followed by Tiger Consumer Brands with 16% (Euromonitor International, 2014a: 33).

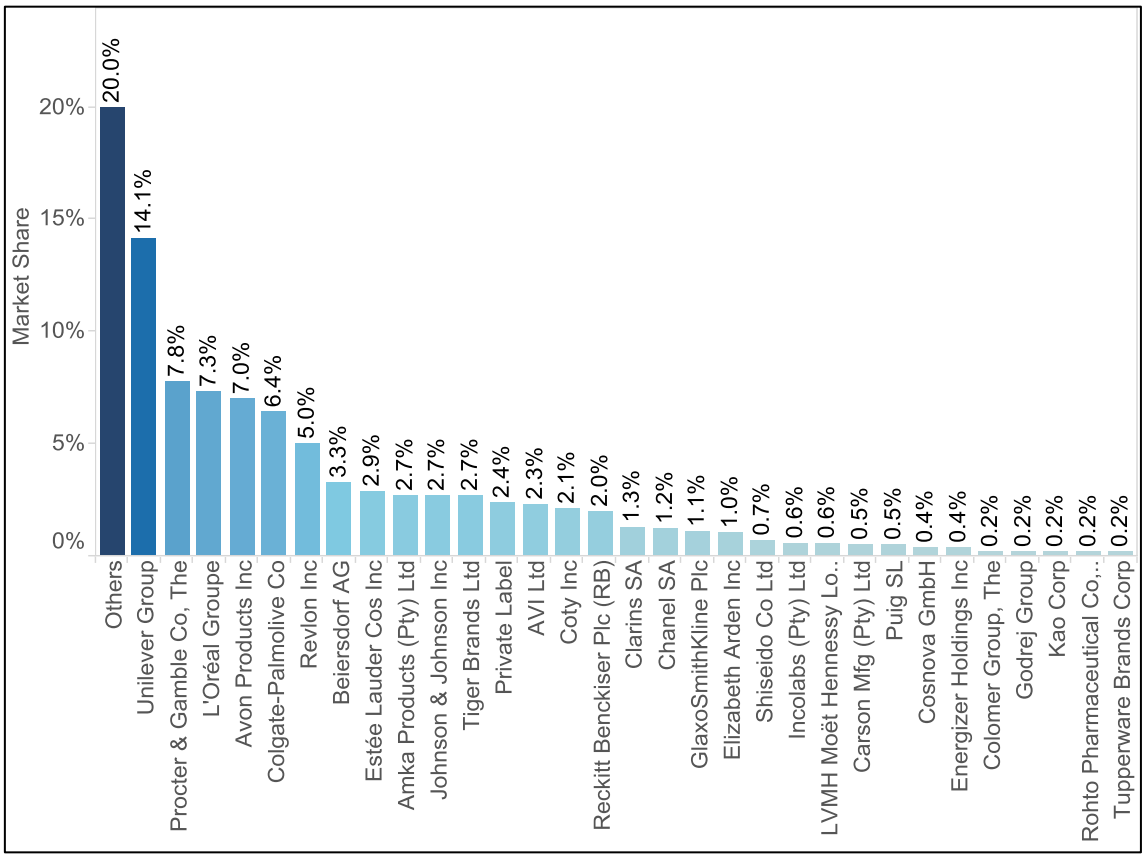

Figure 3.2: Beauty and Personal Care Market – Market Share per Company

(Source: Euromonitor International, 2014a: 7)

Overall, it can be said that the PHC market has a high diversity of products, with a large number of players engaging in the South African market. The total market size is large and a market growth of 10% was generated in 2013 despite tough trading conditions (Euromonitor International, 2014a: 1). In order to analyse competitors within the beauty and personal care market, it is essential to go into subcategory level and identify the individual players within that category.

3.3.2 Over-The-Counter

In addition to the PHC market, the OTC market is another category of CHC. The OTC industry, which is also referred to as OTC drugs or pharmaceuticals industry, includes the sale of medicines which are directly sold to consumers without the need of a prescription for the drug (U.S. National Library of Medicine, 2015). Therefore, consumers do not need to consult a physician before purchasing an OTC medicine, which enables accessible self-medication. OTC drugs are reviewed by a regulatory agency in order to ensure that the drugs are safe and effective for use by the consumers (U.S. Food and Drug Administration, 2015).

According to Marketline (2014d), the OTC pharmaceuticals market includes the sale of a variety of drugs, such as traditional medicines, cough and cold preparations, vitamins and minerals, indigestion preparations, analgesics, medicated skin products, plasters and bandages as well as first aid kids. In 2013, the OTC market value in South Africa was ZAR8.6BN, and indicated a growth rate of 4.9% to the previous year (Marketline, 2014d). Figure 3.3 illustrates the market share through the different categories, indicating the traditional medicines segment as the largest with a market share of 37.1%. The main distribution channels of OTC medicines in South Africa are pharmacies with a market share of 71.8% (Marketline, 2014d). However, general retailers are also supplying the South African consumer with OTC medicines.

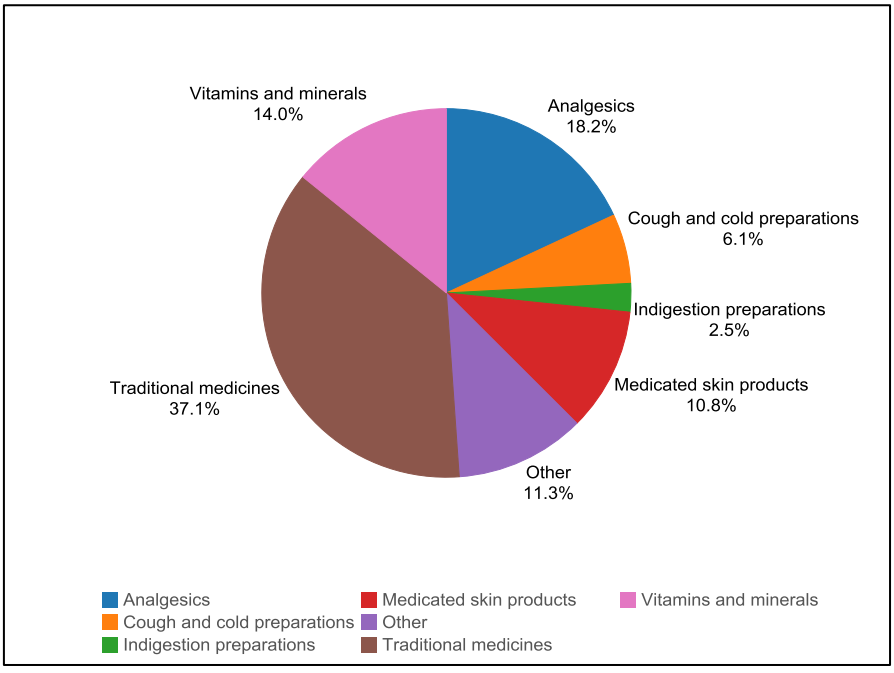

Figure 3.3: OTC Market – Categories and Market Share

(Source: Marketline, 2014d: 9)

In another market research study conducted by Euromonitor International (2014b), the reason for the growth in the OTC market, is the increasing pressure on the South African population to reduce non-essential spend. Resulting from electricity and fuel inflation in combination with constraints on incomes, the South African population has reduced their visits to physicians and moved to self-medication and OTC products (Euromonitor International, 2014b). Similar to Marketline's (2014d) figures, Euromonitor International (2014b) estimates OTC sales in South Africa at ZAR8.0BN in 2013.

According to Cohen, Paquette and Cairns (2005: 39), there is a clear increasing trend of prescription drugs switching to OTC. Reasons for the shift are the manufacturers that desire to increase viability of brand names, the health care insurance companies that want to contain costs, and the consumers that are moving into the self-care direction (Cohen *et al.*, 2005). Also, the market for OTC medicines is expanding as regulatory instances ease up their OTC statuses for certain drugs that are only available as prescription drugs. Furthermore, Cohen *et al*. (2005: 39) point out the fact that companies often try to switch to OTC before a drug loses its patent in order to have a competitive advantage over competitors which can create generics as soon as the patent is lost. The trend of an increased number of drugs switching from prescription to the OTC can therefore have a high impact on the market size, which results in profit optimisation opportunities for companies that engage within this market.

Similar to the PHC market, the OTC market and its products can be clustered into various categories and a number of OTC manufacturers can be identified. The different players in the CHC industry, their major products and strategies are discussed in section 3.4. Given the size of the CHC industry in South Africa as well as the highly competitive market environment, being cost efficient in manufacturing is of utmost importance. The low margins in the FMCG market ask for optimised COGS, in order to improve profits. Resulting from that, optimising the procurement spend is a top priority in organisations.

3.4 Players in the Market

In section 3.3, the South African CHC market was explored. The CHC market in South Africa includes a wide variety of products, which are produced by a number of different manufacturers. As one of the objectives of this thesis was to conduct a competitor analysis of Johnson & Johnson, the literature on main competitors was reviewed. Within this section, major competitors engaging in the same CHC categories as Johnson & Johnson are analysed.

The list of competitors selected is not exhaustive, but should rather be seen as a representative sample of players in the same market in order to compare operations and find similarities.

3.4.1 Adcock Ingram Holdings Limited

Adcock Ingram is a South African pharmaceutical company based in Johannesburg that engages in manufacturing, marketing and distributing a wide range of pharmaceutical and health care products (Adcock Ingram, 2014: 4). The company is listed at the Johannesburg Stock Exchange (JSE: AIP) with a market capitalisation of approximately ZAR 9BN (Adcock Ingram, 2014: 4).

The company is structured into five divisions: consumer, OTC, prescription, hospital and logistics (Adcock Ingram, 2014: 4). The consumer division offers products in several CHC categories, such as analgesics, coughs and colds, supplements, digestive, nutrition and personal care (Adcock Ingram, 2014: 16). The OTC division specialises in OTC products that are mainly sold via the pharmacy distribution channel, where the pharmacist plays a vital role for the customer's product choice (Adcock Ingram, 2014: 16). However, they also sell their products to wholesalers and retailers, as well as to the South African government (Adcock Ingram, 2014: 18). The consumer and OTC divisions contribute the largest segments of their business (Adcock Ingram, 2014: 4). Additionally, Adcock Ingram offers prescription drugs in the form of generic as well as branded medicines. Furthermore, their hospital division offers a number of critical care products used in the provision of medical care and treatment (Adcock Ingram, 2014: 16).

Adcock Ingram operates three manufacturing sites in South Africa: the high-volume liquids facility in Clayville, which produces most of the OTC products, the tablet and capsule facility in Wadeville, which predominantly produces prescription drugs, and the critical care facility in Aeroton (Adcock Ingram, 2014: 4). In addition to the South African market, Adcock Ingram operates in other parts of Africa, such as Namibia, Ghana and Sierra Leona and have manufacturing plants in Ghana and Zimbabwe, as well as a distribution hub in Kenya (Adcock Ingram, 2014: 4; Marketline, 2015: 3). Furthermore, Adcock Ingram engages in the Indian market. They operate a joint venture manufacturing facility in Bangalore, as well as a marketing operation in Mumbai (Adcock Ingram, 2014: 4). These factories do not only serve the Indian market, but are also an alternative and back-up to supply the South African market (Adcock Ingram, 2014: 4).

Within their process to manage risk, Adcock Ingram (2014: 27) identified a number of areas of risk, such as increasing competition, regulatory compliance, infrastructure challenges as well as exchange rate fluctuations. Exchange rate fluctuations remain a risk, especially with regards to current market trends and the volatility of the South African Rand. Adcock Ingram classified the foreign exchange risk into their uncontrollable risk category (Adcock Ingram, 2014: 44). According to Adcock Ingram (2014: 44), the currency volatility and the depreciation of the Rand against major currencies have a major impact on purchasing prices of materials and finished goods sourced internationally. Even though forward cover rates are used in order to hedge against the fluctuations, they still experience decreasing margins because of the currency impact (Adcock Ingram, 2014: 44).

3.4.2 Kimberly-Clark

Kimberly-Clark is a multinational corporation offering personal care products on a global scale. The United States based company specialises in the manufacturing and distribution of consumer products made of natural and synthetic fibres (Kimberly-Clark Corporation, 2015: 1). The Kimberly-Clark Corporation is listed at the New York Stock Exchange (NYSE: KMB) and has a market capitalisation of USD 43.0BN (Kimberly-Clark Worldwide, 2015). Kimberly-Clark South Africa operates as a 100% subsidiary of the US based corporation, and employs over 800 people (Kimberly-Clark Worldwide, 2008a).

Kimberly-Clark South Africa operations are aligned with the policies and procedures of the main corporation. This includes the business organisation, which is separated into three business segments based on product categories (Kimberly-Clark Corporation, 2015: 2). The personal care business offers products such as diapers, baby wipes, feminine care and related products. Within the consumer tissue segment, various paper-based products are offered, such as facial tissues, paper towels, and napkins. Whereas the personal care and consumer tissue business segments are targeting consumers, the third business segment – Kimberly-Clark Professional – targets business customers and offers enterprise solutions such as toilet and facial tissues, hand towels, soaps and sanitisers (Kimberly-Clark Corporation, 2015: 2).

In South Africa, Kimberly-Clark South Africa produces their products in two manufacturing facilities. At the Enstra Milli manufacturing facility in Springs, Gauteng Province, the company produces toilet and facial tissues as well as paper towel products (Kimberly-Clark Worldwide, 2008b). Furthermore, they use the plant for the production of diapers. In their Cape Town plant, the feminine care products are produced and several tissue products are

converted (Kimberly-Clark Worldwide, 2008b). Furthermore, six distribution centres are operated within various provinces in South Africa (Kimberly-Clark Worldwide, 2008c).

The Kimberly-Clark Corporation (2015) has identified several risk factors in its annual report for 2014. Challenges such as raw material price increases, increased competitive environment, changes in customer behaviour or foreign market risks need to be dealt with on a daily basis, as their effects can have a major impact on financial results (Kimberly-Clark Corporation, 2015: 4). With regards to foreign market risks, the international operations are exposed to foreign exchange risk. An increase in sourcing cost of operations outside the U.S. was identified, which is caused due to the strong U.S. dollar. In order to mitigate the risk, Kimberly-Clark Corporation (2015: 4) uses foreign currency forward and swap contracts for a portion of transactions denominated in currencies other than the U.S. dollar. Therefore, the company is not only aware of the currency impact they experience when converting financial results of foreign operations to U.S. dollar, but also the currency impact within the foreign operations. Furthermore, the Kimberly-Clark Corporation (2015: 5) experiences a significant increase of raw material prices, energy cost and transportation services. High volatility of certain commodity prices, such as pulp or petroleum, is directly related to this phenomenon. Even though Kimberly-Clark is aware of these challenges, they have not used any derivative instruments to hedge against these risk (Kimberly-Clark Corporation, 2015: 6). This means that the only measure they can use in order to prevent decreasing margins is to adjust the selling price for finished goods.

3.4.3 Procter & Gamble

Procter & Gamble is a major multinational FMCG corporation, with headquarters located in Cincinnati, USA (Mohiuddin, 2014). Procter & Gamble offers a wide range of consumer products across several categories and sells products in more than 180 countries around the world (Procter & Gamble, 2014: 11). Their customer base is diversified and includes mass retailers, grocery stores, drug stores, department stores, distributers as well as e-commerce. Procter & Gamble is listed at the NYSE (NYSE: PG) and has a market capitalisation of USD 204.7BN (Morningstar Inc., 2015). In South Africa, Procter & Gamble operates its subsidiary Procter & Gamble (Pty) Ltd since 1995 and is a leading player across several consumer categories (Euromonitor International, 2014c: 1).

The global corporation is structured into four industry-based sectors, each offering a variety of products and brands. These are: beauty, hair and personal care that include products such as

skin care, cosmetics and shampoo; health and grooming, including OTC medicines, oral care and shaving appliances; fabric and home care, including laundry detergents, dish care and batteries; and baby, feminine and family care, including baby wipes, diapers, feminine protection products as well as paper towels and tissues (Procter & Gamble, 2014: 73). Even though not all of their products are available in the South African market, Procter & Gamble enjoys relatively large brand recognition amongst consumers across product categories (Euromonitor International, 2014c: 1).

Procter & Gamble engages in markets all around the world. With operations across all sectors in Asia Pacific, Western Europe, Eastern Europe, Latin America, Middle East and Africa and North America (Mohiuddin, 2014), Procter & Gamble is present on all continents. Procter & Gamble has two offices in South Africa, with its head office located in Sandton, Johannesburg, and its financial office in Cape Town (Euromonitor International, 2014c: 1). Their only manufacturing site is located in Kempton Park, Johannesburg, where diaper products are produced. A new production facility is planned to go online in 2016 or early 2017. This manufacturing facility is intended for the production of products from multiple products to serve the local South African market as well as export markets.

In their 2014 annual report, Procter & Gamble (2014: 13) discusses several risk factors that they believe could adversely affect their financial results. Next to competitive pressure and changes in consumer demand, Procter & Gamble identified several drivers for cost fluctuations. Changes in commodity prices, raw materials, labour and energy costs, as well as foreign exchange and interest rate fluctuations have a direct impact on their cost (Procter & Gamble, 2014: 13). Because of their international operations, the organisation earns revenues and pays expenses in many currencies other than the U.S. dollar. Therefore, the company is exposed to a high risk as a result of currency fluctuations, which is also because their consolidated financial statements are denominated in U.S. dollars. In order to hedge against the exchange rate risk, Procter & Gamble uses forward contracts with maturities of up to 18 months and enters currency swaps with maturities up to five years (Procter & Gamble, 2014: 42). Furthermore, the company can choose to use futures, options and swap contracts to manage commodity price volatility (Procter & Gamble, 2014: 42).

3.4.4 Tiger Brands Limited

Tiger Brands is a major South African FMCG manufacturer and offers a wide range of products within their product portfolio. The company, with its headquarters in Johannesburg,

participates in several FMCG categories including food, home, personal care and baby products with significant market shares in these categories (Marketline, 2014e: 1). Tiger Brands Limited is listed at the JSE (JSE: TBS) and has a market capitalisation of about ZAR 63.4BN (Bloomberg, 2015a). Furthermore, it has several subsidiaries and operates in various countries.

In line with their product categories, the company is segmented into four business divisions: grains, consumer brands, exports and international and Nigeria (Tiger Brands Limited, 2015: 10). Tiger Brands' grains division participates in maize and wheat milling, bread baking and offers pasta, rice and oat products. The consumer brands division, which is the largest contributor to the company's turnover, includes groceries, snacks, beverages, meat products, out of home as well as home, personal care and baby (HPCB) within its product portfolio (Tiger Brands Limited, 2015: 7). Within the HPCB category, Tiger Brands offers brands in baby care, skin care, bath and shower as well as hair care (Euromonitor International, 2014a: 25). The exports and international division as well as the Nigeria division, are segmented business divisions that deal with the exporting of Tiger Brands' products into the rest of Africa, as well as with the manufacturing of products at the international manufacturing sites (Marketline, 2014e: 4).

Tiger Brands operates in more than 70 sites spread across South Africa and distributes their products to 22 African countries (Marketline, 2014e: 4; Tiger Brands, 2015c). Besides South Africa, manufacturing sites are operated in Nigeria, Kenya, Cameroon, Ethiopia, Zimbabwe and Chile (Marketline, 2014e: 4). Tiger Brands has grown through several acquisitions in recent years and strategically increased their exports into new markets (Tiger Brands Limited, 2015: 1). Their big distribution network enables them to substitute between manufacturing sites as well as to have insights into several local markets across Africa.

Even though Tiger Brands is a South African based company, it is still experiencing a variety of financial risks related to their international operations. The company is exposed to risk related to currency volatility, interest rates and commodity price fluctuations (Tiger Brands Limited, 2015: 35). In order to manage these risks, Tiger Brands has set up a risk management programme across all business operations, which includes a formal risk policy. According to Tiger Brands Limited (2015: 70), the most significant risks they identified included changes in consumer preferences, the domestic trading environment of South Africa, challenges of resources and procurement, as well as foreign currency risk. With regards to the

mentioned resources and procurement risk, Tiger Brands Limited (2015: 72) point out its exposure to commodity price risk due to purchases of raw materials. To mitigate the risk, the company closely monitors and reviews the impact of environmental factors, such as weather and the global supply situation, on its purchasing cost. In order to manage foreign currency risk, the company makes use of foreign exchange contracts as well as an internal foreign exchange policy which limits the number of transactions involving foreign currencies (Tiger Brands Limited, 2015: 73).

3.4.5 Unilever

Unilever is a multinational FMCG company that is involved in manufacturing, distributing and marketing food, beverages, and cleaning and personal care products (Unilever, 2015b: 12). The company, which was founded in 1930 as a business merger between the companies Margarine Unie from the Netherlands and Lever Brothers of the United Kingdom, is operating as a single entity, while still having two separate legal identities (Unilever, 2015c). The British entity, Unilever PLC, is based in London and listed at the London Stock Exchange (LSE: ULVR) and NYSE (NYSE: UL), while the Dutch entity, Unilever N.V., is located in Rotterdam and listed at the Euronext Amsterdam (AEX: UNA and UNIA) and the NYSE (NYSE: UN). Even though the company has two legal entities, it acts as one, single operating entity and shares all brands. The before mentioned different shares are exchangeable one-to-one, resulting in equal rights for shareholders regarding voting and cash flows (Unilever, 2015c). Unilever's combined market capitalisation in 2014 was EUR 93.9BN (Unilever, 2015b: 33).

Unilever's product portfolio spans over four categories: personal care, foods, refreshments, including beverages and ice cream, and home care (Unilever, 2015b: 10). Within these categories, Unilever concentrates on their 13 *"billion euro brands"* (Unilever, 2015b: 10). The personal care category, which is Unilever's biggest contributor to turnover with 37%, includes five of these EUR1BN brands (Unilever, 2015b: 18). In this category, Unilever offers hair care, skin care and oral care products, as well as other personal care products such as deodorants and cosmetics (Unilever, 2015b: 18). Their foods category contributes 25% of revenue, while the refreshment and the home care category both contribute 19% (Unilever, 2015b: 32). The home care category includes laundry products, such as products for fabric cleaning and fabric conditioners, as well as household care products, such as cleaning agents (Unilever, 2015b: 24).

Unilever operates on a global level, selling their products in more than 190 countries and manufacturing at more than 240 manufacturing sites around the world (Unilever, 2015b: 9–10). Their operations are organised into three geographical areas: the Americas, Europe and all other markets comprising Asia, Australasia, Africa, Middle East, Turkey, Russia, Ukraine and Belarus (Unilever, 2015b: 13). Unilever has identified opportunities in emerging markets due to increases in population and consumption and, therefore, increased their business in these markets. In 2014, 57% of their turnover was generated in emerging markets (Unilever, 2015b: 28). Unilever has a long history in South Africa as products were exported to South Africa as far back as 1890, and the first local company was registered in the Cape Colony in 1904 (Fieldhouse, 1996: 145). Today, the subsidiary Unilever South Africa offers home, personal care and food products to various wholesalers, retailers, as well as smaller grocery shops (Unilever, 2015d). Two corporate offices, five manufacturing sites and eight sales offices demonstrate the strong presence of Unilever in South Africa (Unilever SA Ltd, 2015).

Due to its global presence and operations within all geographical areas, Unilever is exposed to a variety of risks. However, Unilever tries to mitigate these risk factors with the help of a strategic risk management approach. Therefore, they identified a number of key principal risks, such as brand preference, i.e. the risk of changing consumer demand, talent, i.e. the risk of losing key personnel in a very limited talent pool, especially in emerging markets, or the supply chain risk, which includes fluctuations in supply costs due to unforeseen events, supplier disruptions or supply bottlenecks (Unilever, 2015b: 36). Furthermore, Unilever is exposed to exchange rate risk and the fluctuations involved. In order to mitigate these risk, Unilever (2015b: 34) makes us of simple derivatives, such as interest rate swaps and future contracts for foreign exchange rates. Another way Unilever aims to mitigate exchange rate risk is through operating companies borrowing financial means directly in local currency (Unilever, 2015e: 52). Changes in exchange rates also have an impact on commodity prices, which also need to be considered as a financial risk in this context.

3.4.6 Reckitt Benckiser Group plc

Reckitt Benckiser is a United Kingdom based company engaged in the production and distribution of health care, personal care as well as household and cleaning products. Reckitt Benckiser operates globally in more than 60 countries and distributes its products to nearly 200 countries (Marketline, 2014d: 25). The Reckitt Benckiser Group has its headquarters in Berkshire, England, and is listed on the LSE (LSE: RB.). Its market capitalisation is

approximately GBP 43.70BN (Bloomberg, 2015b). In South Africa, Reckitt Benckiser has its head office and manufacturing facilities located in Johannesburg (Reckitt Benckiser Group plc, 2015b).

Reckitt Benckiser is structured into three geographical divisions, as well as an additional food division that acts in the United States (US) only (Reckitt Benckiser Group plc, 2015c: 5). The South African operation is integrated into the Russia, Middle East, North Africa, Turkey and Sub-Saharan Africa (RUMEA) division (Reckitt Benckiser Group plc, 2015c: 4). Within the geographical divisions, major business focus is laid on the sales of branded products in three business lines: health, hygiene and home (Marketline, 2014d: 25). Within the health business, OTC solutions, denture care as well as foot care products are manufactured and distributed. The hygiene business is the largest contributor to Reckitt Benckiser's revenue and includes antiseptics, multi-purpose cleaners and other products to improve personal and home hygiene for better health. Their home segment offers air care and fabric treatment products (Reckitt Benckiser Group plc, 2015c: 5).

Reckitt Benckiser is a multinational corporation operating in major markets on a global level. According to Reckitt Benckiser plc (2015c: 12), combining Europe and North America (ENA) in one organisation enables them to benefit from greater speed and larger scale to their initiatives. Next to the ENA and RUMEA regions, Reckitt Benckiser also operates in Latin America, North Asia, South East Asia, Australia and New Zealand (LAPAC) in one organisation.

Reckitt Benckiser has identified strategic risks as well as uncertainties that could affect the organisation's results. The company has implemented a risk assessment process in order to assess the exposure of the company to the risks and to find ways to mitigate the risks in general (Reckitt Benckiser Group plc, 2015c: 24). The company has identified the *"top ten"* risks, which include issues like health regulatory compliance, technology failure, business interruption, loss of key management, and others (Reckitt Benckiser Group plc, 2015c: 24). Furthermore, exchange rate risk was identified as an additional risk, being part of the financial risks to which they are exposed. Being based in the United Kingdom, Reckitt Benckiser reports its financial statement in pound sterling (GBP). Due to its international operations, it is naturally exposed to exchange rate fluctuations and currency exchange effects. In order to mitigate the risk, Reckitt Benckiser borrows in foreign currency and uses hedging methods, such as forward foreign currency exchange contracts (Reckitt Benckiser Group plc, 2015c:

127–128). Even though certain mitigation strategies exist, the company needs to monitor the worldwide currency markets closely, as 92% of Reckitt Benckiser's revenue is generated outside the UK, and thus needs to be converted into local currency (Reckitt Benckiser Group plc, 2015c: 127–128). This high percentage of revenue that is generated in foreign currency results in a major exposure to exchange rate risk and underlines the importance of well-implemented risk management strategies.

3.5 Economic Landscape

South Africa is one of Africa's most competitive economies (Euromonitor International, 2015b: 2). According to Euromonitor International (2015b), the main drivers for the competitive landscape are low business tax rates, a large capacity for innovation as well as relatively low bureaucratic regulations, which make it easier for companies to enter the market. On the other hand, however, South Africa's business environment is challenged by a lack of skills in the labour market, low quality in the educational system, as well as the increasing outages of electricity caused by unstable energy infrastructure (Euromonitor International, 2015b: 2). As a result, one could assume that it is important to understand and closely monitor the economic environment in order to conduct profitable business in South Africa.

Even though South Africa's economy is considered highly competitive, the before mentioned challenges, as well as labour force strikes and a rigid labour market, have slowed the economic growth since 2011. The slowing economy did not help the labour situation in South Africa, with an unemployment rate of 25.1% in 2014 (Euromonitor International, 2015c). However, Euromonitor International expected the growth of real gross domestic product (GDP) to increase to 2.5% in 2015, compared to 1.5% in 2014, due to lower oil prices, additional investment in infrastructure and an increase of domestic consumption (Euromonitor International, 2015c: 6). Figure 3.4 shows the development of the GDP as well as the GDP growth rate for the years 2009-2014. Since 2011, the GDP growth rate has slowed steadily. Similarly, it seems unlikely that the target of 2.5% will be reached as current results have shown that the GDP for the first 6 months of 2015 only increased by 1.6% compared to the first 6 months of 2014 (Statistics South Africa, 2015a).

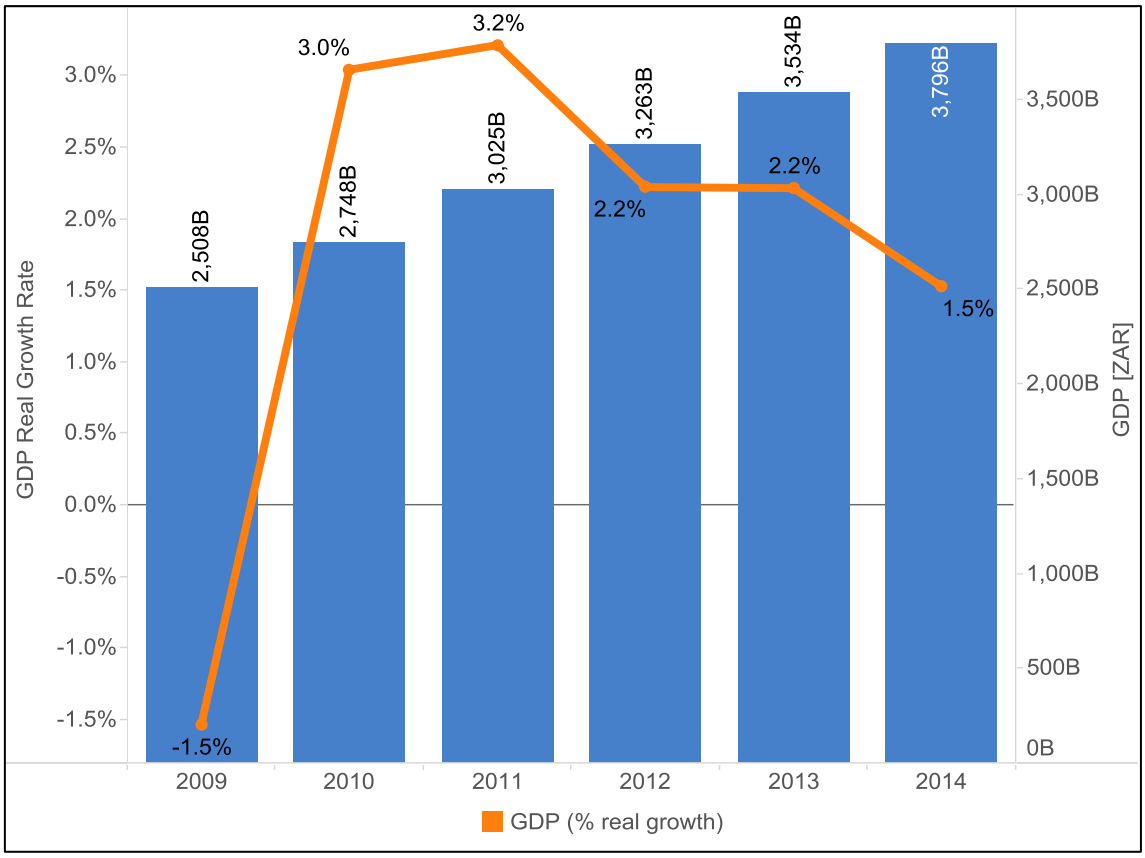

Figure 3.4: South African Real GDP Growth and GDP

(Source: Statistics South Africa, 2012, 2015a)

South Africa, Nigeria, Angola, Ethiopia and Ghana are Sub-Saharan Africa's top contributing economies, with a combined contribution of 71% to the region's GDP in 2013 (Bouhmphrey, 2014: 1). According to Euromonitor International, South Africa's GDP in 2014 was ZAR3,796BN (see Figure 3.4). The main contributors to GDP in South Africa are: finance, real estate and business services; general government services; wholesale, retail and motor trade; catering and accommodation; and manufacturing (Statistics South Africa, 2015b). Even though the GDP is expected to increase in 2015, growth rates of at least 5% will be necessary for the country in order to alleviate the problem of unemployment (Euromonitor International, 2015c). However, a 5% increase of GDP is highly unlikely, as the GDP for first 6 month of 2015 increased only by 1.6% compared to the first 6 months of 2014 (Statistics South Africa, 2015a).

The inflation rate in South Africa, which is measured in the Consumer Price Index (CPI), was recorded at 4.4% in January 2015 (Taborda, 2015). Next to the inflation rate, the Producer Price Index (PPI) was recorded at 3.5% as of January 2015 (Statistics South Africa, 2015c). The CPI measures the rate of price changes of consumer goods and services, whereas the PPI measures the rate of price changes that are charged by the producers of the goods. These two

indicators are the main measures for inflation in South Africa (Statistics South Africa, 2015c). Even though, South Africa had a generally high inflation rate in the past, the decrease of the oil price had an impact on the CPI. In 2015, the CPI of South Africa decreased to 4,6%, coming from 6.1% in 2014 (Statistics South Africa, 2016). This decreased inflation rate could result in decreasing direct material cost, as the PPI is directly related to the supplier's prices. In addition to the lower oil price, the electricity supply problems, including load shedding, is a major factor affecting the South African economy (Kovacs, 2015). A decrease in electricity output can result in increasing purchasing prices, as well as a decrease in manufacturing production.

In addition to the before mentioned economic indicators, namely GDP, GDP growth rate, CPI and PPI, it is worthwhile to have a look at the currency of South Africa. As the exchange rate can be a direct as well as indirect driver of material cost (see section 2.4.1), it is important for a company to understand the currency situation of the markets of operation. In Figure 3.5, the development of the ZAR against the USD and the EUR is depicted for the timeframe from January 2011 until end of October 2015. Within that timeframe, the Rand has depreciated against the USD by 109% and against the EUR by 73% (South African Reserve Bank, 2015).

While the weak Rand has a positive impact on exports in that they become cheaper for foreign countries, imports into South Africa are significantly more expensive. Especially for manufacturing companies that make use of global sourcing and import all or parts of their material, the weak Rand has a severe impact on cost. Furthermore, materials that are sourced from local suppliers and are related to commodity prices or have components that are sourced internationally can also be exposed to currency volatility (refer to section 2.4.1). Therefore, South African manufacturing companies need to have a clear understanding of currency-related issues and need to closely monitor the development of the South African Rand.

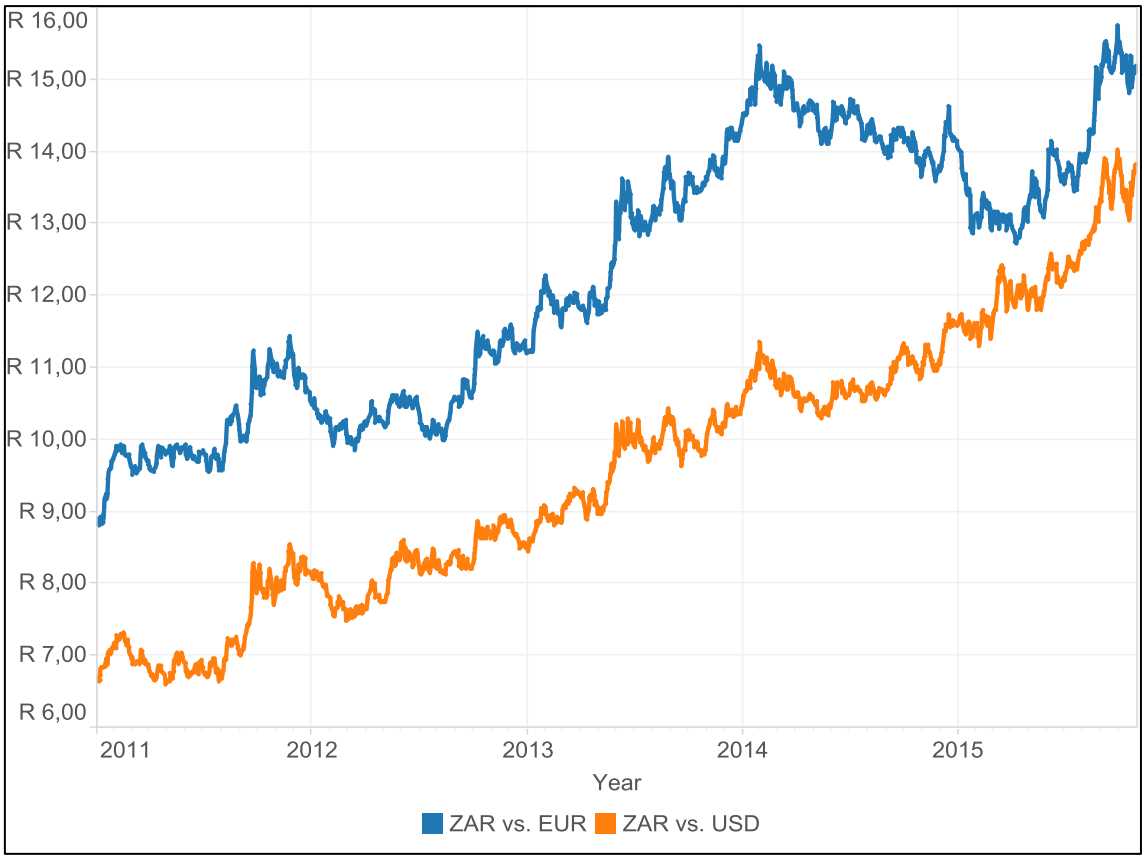

Figure 3.5: Exchange Rate Development of the South African Rand, 01 Jan 2011 – 30 Oct 2015

(Source: South African Reserve Bank, 2015)

All of the before mentioned economic indicators provide an overview of the economic landscape of South Africa. Manufacturing companies need to be aware of the developments within South Africa, as they can impact direct material cost. A weak rand and slow growth are affecting the economy of South Africa negatively. Additionally, several issues, such as the high unemployment rate, the lack of sufficient energy supply or the lack of qualified labour are challenging the business environment.

3.6 Deductions made from Literature

This chapter reviewed the literature on the South African FMCG industry. This included an overview of the FMCG industry as a whole, in order to give an understanding about the key aspects of FMCG and the main players in the industry. Furthermore, a more detailed look into the CHC sector of the FMCG is taken in order to provide a background on the PHC and OTC market. After reviewing the literature on the industry and establishing an understanding of the market, the different market players in the industry were analysed. This included a brief background on the companies and their operational setup and identified the risks that these

companies are experiencing. Additionally, the economic situation of South Africa was investigated and information on current developments was given.

The review of available literature on the FMCG industry was intended to provide an understanding about the FMCG industry as a whole. It was confirmed that products that are considered to be FMCG are consumer-packaged goods that have a short shelf life and a high inventory turnover rate. The price pressure on these high demand products is very high, due to the large competition in the industry. In order to make profit on these products, manufacturers and retailers use economies of scale. One of the major marketing techniques within the industry is to build brand loyalty with the customer, as the high interchangeability between different products bears a risk for manufacturers. It was determined that the FMCG industry is usually not as affected in times of economic downturns as other industries that relate to high investments of consumers. This is caused due to the fact that the products of the FMCG industry are almost always needed. Because of the indispensability of the products, the FMCG industry is considered one of the largest industries in the world and attracts a lot of companies that want to engage in it. Due to the high price pressure in the market, companies are always trying to optimise their cost management. The price pressure does not allow companies to increase prices and forward rising costs to the consumers. Therefore, it is essential for FMCG companies to have a good understanding and insight about its cost on all levels, as well as to be aware of the exposure to external influences.

Within the FMCG industry, the CHC market segment includes products for PHC, such as personal hygiene or beauty care products, as well as the OTC market, which includes pharmaceutical products that are directly sold to consumers without the need of a prescription. The review of this industry was needed, as it provides background on the market in which Johnson & Johnson engages. It was found that the market includes a variety of product categories offered by a variety of different players in the market. In South Africa, the total market size is large, and a market growth of 10% for PHC and 11% for OTC was recorded in 2013. Furthermore, the on-going trend of an increased number of drugs switching from prescription to OTC can therefore have a high impact on the market size, which results in profit optimisation opportunities for companies that engage within this market. Given the size of the CHC industry in South Africa as well as the highly competitive market environment, being cost efficient in manufacturing is of utmost importance. The low margins in the FMCG market ask for optimised COGS, in order to improve profits, highlighting the importance of effective procurement processes.

The review of the players in the South African CHC market revealed a number of companies engaging in a similar market environment to Johnson & Johnson. The review of these competitors should be used in order to identify similarities within operations, strategy and experienced risks in order to make assumptions about the reliability and external validity of this thesis. The competitors analysed were Adcock Ingram, Kimberly-Clark, Procter & Gamble, Tiger Brands, Unilever and Reckitt Benckiser. All of these companies engage to some extent in the CHC market and operate in South Africa. Major findings in the review of the companies included similarities in the structure and organisational setup, as well as in the risks to which the companies are exposed. Besides South Africa, all companies also engage in other international markets. The companies are all structured into different business divisions, each focusing on different categories. For example, Adcock Ingram has a business division for consumer products, OTC products and prescription drugs. Kimberly-Clark's operations are segmented into the personal care business and the consumer tissue segment. As all of the before mentioned companies engage in international markets, the literature review has shown that they are exposed to similar risks. The increasing competition within the highly competitive FMCG industry, combined with increasing cost pressure and volatile currency and commodity markets are considered major challenges across the companies. Every company has indicated that the international operations are exposed to foreign currency risk. Particularly in South Africa, the currency volatility and the depreciation of the Rand against major currencies have a major impact on purchasing prices of materials and finished goods sourced internationally. In order to mitigate the risk of fluctuating currencies, most companies use financial instruments, such as forward exchange rate contracts or swap options. As all companies are aware of the risk that fluctuating exchange rates and commodity prices bring to their business, risk management business units have been set up. Especially in global procurement, companies need to understand how purchases in other countries and currencies affect their business. As all of the companies reviewed experience the same challenges and risks, it can be assumed that a decision support tool that gives access to more transparent cost could not only be useful for Johnson & Johnson, but also for other companies engaging in similar market environments.

The literature review on South Africa's current economic situation included several key findings. On the one hand, South Africa is one of the most competitive economies in Africa due to its low business tax rates, large capacity for innovation and low bureaucratic regulations. On the other hand, it seems that South Africa cannot profit from the before

mentioned opportunities due to a low quality educational system and low skilled labour market, which results in a high unemployment rate. Furthermore, an unstable energy infrastructure resulting in power outages as well as labour force strikes have slowed the economic growth since 2011. The South African Rand has depreciated significantly against major currencies in recent times and reached its all-time low in 2015. As a result of the weak currency, imports into the country are becoming increasingly expensive. Especially for manufacturing companies that make use of global sourcing and import all or parts of their material, the weak Rand has a severe impact on cost. Furthermore, materials that are sourced from local suppliers and are related to commodity prices or have components that are sourced internationally can also be exposed to currency volatility. This demonstrates the importance of cost awareness within the procurement divisions of manufacturing companies in the FMCG industry. From the review of the available literature it can be assumed that companies that are operating in this market, and that are faced with the challenges resulting from the South African economy and its currency, have the need to further increase their knowledge and understanding of their cost structure in order to improve it.

Chapter 4 - Case Description: Johnson & Johnson

4.1 Introduction

The purpose of this chapter is to introduce the organisation on which this case study is conducted. As stated in section 1.4, the research objectives for this thesis included the development of a decision support tool that measures and analyses the impact of cost drivers on direct material cost in order to support strategic sourcing decisions. As the objectives are based on Johnson & Johnson, this chapter provides background on the company, its structure as well as its operations in South Africa. Furthermore, it explains the setup of the procurement function within its strategic sourcing operations and the status quo of the direct material cost situation. This overview is intended to provide context on where the decision support tool fits into the company and where the competitor analysis is needed.

The information on Johnson & Johnson, which is presented in the following, resulted from primary qualitative research that included discussions, conversations, as well as observations at the company. Sections 4.4 and 4.5 are a direct result hereof. As this information was gathered from within Johnson & Johnson's environment, the provided information was desensitised and no direct references to employees were made in order to protect the confidentiality agreement signed by the researcher (see section 1.7).

4.2 Overview

Johnson & Johnson is a multinational corporation that engages in the health care and pharmaceutical industry. The company is headquartered in New Brunswick, where it was founded in 1886, and is a global developer and manufacturer of medical devices, pharmaceuticals and fast moving consumer goods (Johnson & Johnson Services, 2015a). As indicated in section 1.2, Johnson & Johnson includes more than 265 subsidiaries with operations in over 60 countries. On a global level, the corporation's products are sold in more than 175 countries. In 2014, the company recorded revenues of USD74.3BN, which represents an increase of 4.2% over 2013 (Johnson & Johnson, 2015: 3).

4.3 Business Segments

As referred to in section 1.2, Johnson & Johnson is organised into three business segments: Consumer, Pharmaceutical and Medical Devices (Johnson & Johnson, 2015: 2). In this

section, a brief description of the business segments in which Johnson & Johnson is operating is provided. Figure 4.1 depicts the three business segments of Johnson & Johnson and provides information on their contribution to revenue. The pharmaceutical division generates the highest revenue (43%), and medical devices (37%). The consumer division only generates 20% of the revenues.

4.3.1 Consumer

The consumer organisation of Johnson & Johnson engages in the CHC industry. Johnson & Johnson develops, manufactures and distributes a wide range of consumer products in several categories. These categories include baby care, oral care, skin care, OTC pharmaceutical, women's health as well as wound care. The products are mainly marketed directly by Johnson & Johnson and sold to retailers as well as distributors (Johnson & Johnson, 2015: 2). These products can be considered as FMCG, as they are used each day in homes around the world (Johnson & Johnson Services, 2015d). In 2014, consumer segment sales were USD14.5BN, which represents a decrease of 1.4% to 2013 and a contribution to the corporation's total sales of 20%. The main driver of the consumer segment is the OTC franchise, contributing USD4.1BN in 2014 (Johnson & Johnson, 2015: 4).

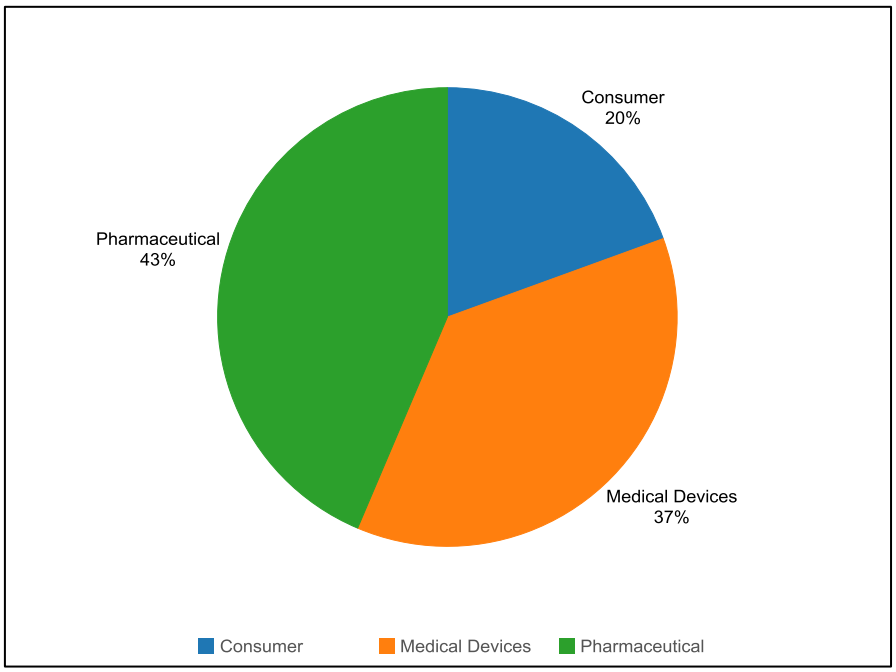

Figure 4.1: Johnson & Johnson – Sales Distribution per Segment

(Source: Johnson & Johnson, 2015: 4–7)

4.3.2 Pharmaceutical

Within the pharmaceutical business segment, Johnson & Johnson develops, produces and markets products in several therapeutic areas. It focuses on five major areas, including immunology, infectious diseases, neuroscience, oncology as well as cardiovascular and metabolic diseases. In this segment, the customer base is comprised of retailers, wholesalers, hospitals and health care professionals, to which Johnson & Johnson directly distributes its products (Johnson & Johnson, 2015: 2). Johnson & Johnson reported an increase of 14.9% in sales for the pharmaceutical segment in 2014, compared to 2013. The USD32.3BN of sales represents the largest contributor to the corporation's revenue, with 43% (Johnson & Johnson, 2015: 5).

4.3.3 Medical Devices

The medical devices segment is involved in the manufacturing and distributing of products used in the professional fields by physicians, nurses, hospitals and clinics. The products are used in orthopaedics, surgical care, specialty surgery, cardiovascular care, diagnostics, diabetes care as well as vision care (Johnson & Johnson, 2015: 2). Reported sales of the medical devices segmented were USD27.5BN in 2014, decreasing by 3.4% from 2013. The overall contribution to total revenues of the segment was 37% (Johnson & Johnson, 2015: 7). The medical devices segment of Johnson & Johnson is the largest of its kind on a global level (Marketline, 2014f: 25).

4.4 Global Procurement

Johnson & Johnson has developed a centralised global strategic sourcing function as part of their CHC organisation. Their sourcing model includes sophisticated bidding and modelling methods with a global reach, as well as the consolidation of category spend across direct materials and external manufacturing. The global procurement function is structured into global categories in order to implement global strategies while maintaining a focus on regional needs.

Johnson & Johnson's procurement function is distributed amongst all sectors, businesses and regions. It is considered as a global organisation and uses enterprise-wide category management, supplier relationship management as well as corporate and shared services across all three business segments. In general, Johnson & Johnson distinguishes between four regions: North America (NA), Latin America (LA), Europe, the Middle East and Africa

(EMEA) and Asia Pacific (APAC). However, Johnson & Johnson identified that it could be necessary to differentiate sometimes from global strategies in order to improve competitiveness within certain regional markets. Johnson & Johnson believes this is the case in South Africa, and is interested in being able to better understand the cost impacting factors on direct materials.

4.5 Direct Material Cost Situation in South Africa

Johnson & Johnson has identified several cost drivers responsible for the situation in South Africa, which need further validation and analysis. One of these cost drivers is a second-tier currency impact that Johnson & Johnson experiences when sourcing direct materials in local currency while the supplier imports parts or all of its raw materials from a foreign country. The individual impact on materials has not yet been well defined nor has it been completely understood. Therefore, Johnson & Johnson is currently not able to make strategic decisions while considering the second-tier currency impact. Currently, a model for second-tier currency impact does exist on a regional level. However, this model needs further evaluation and investigation, as it is not detailed enough at a South African level in order to make strategic decisions. This is also caused due to the fact that this model only takes second-tier currency impacts into consideration without considering other cost drivers. Even though Johnson & Johnson currently emphasises the second-tier currency impact, it is not the only cost driver of direct material cost. Other than second-tier currency impacts, other cost drivers need to be identified and evaluated, as there is no complete framework that enables visibility of all cost affecting factors. Additionally, no real benchmarking data on these direct materials and the sourcing strategies of competitors in the South African market is available, which makes it difficult to evaluate Johnson & Johnson's performance.

In 2014, an external consultancy company conducted an initial assessment of Johnson & Johnson South Africa with the objective of understanding current performance and challenges as well as to provide an external perspective to understand gaps against competitors. It also aimed to identify areas of improvement by using not yet activated levers in order to improve the GP percentage. As GP is defined as the difference of NTS and COGS, there is a direct dependency to direct material cost. Even though the consultancy did some assessments regarding benchmarking, the findings did not assist with regards to direct material cost. In relation to direct materials, the consultancy identified the sourcing location (importing vs. local sourcing) and the specifications of raw materials and packaging as key levers impacting

the GP. Therefore, they made a few recommendations to increase local sourcing as well as to conduct reviews of the different material grade and eventually use lower quality. Even though it was one of the objectives, the consultancy did not provide detailed specifics with regards to benchmarking of competitors and competitor sourcing strategies.

4.6 Salient Points for the Case

Within this chapter, Johnson & Johnson was introduced as the case company used in this thesis. Firstly, background on Johnson & Johnson, its operations and structure were presented, as well as the business of its South African entity was described. Furthermore, their global procurement function was reviewed and more background on the situation they are experiencing in South Africa was shared.

Similar to its competitors, Johnson & Johnson has segmented its business operations in three divisions, namely, CHC, pharmaceutical drugs and medical devices. The segmentation allows the company to operate in a matrix organisation format as each division has separate business functions. Within its consumer section, Johnson & Johnson offers a wide range of brands in several categories, such as baby care, oral care and skin care. Furthermore, the OTC pharmaceuticals are included in the consumer business division, which in total contributes 20% to the organisations total sales revenue. Their pharmaceutical drugs business segment focuses on the development, production and distribution on prescription drugs, while the medical devices business offers products used in the professional fields by physicians, nurses and in hospitals. Their contribution to total sales is 43% and 37% respectively.

Within its consumer division, the global procurement function is segmented across major regions. This enables Johnson & Johnson to strongly focus on regional patterns within markets. The South African operations fall under the EMEA region. The idea for this thesis and its background was derived from the fact that the Johnson & Johnson procurement function experienced increasing challenges in containing and managing direct material cost within South Africa. The main reasons identified were the currency volatility of the Rand against other major currencies, as well as volatile commodity prices, which are also affected by exchange rates. Even though some efforts have been made already, there is still uncertainty around the cost situation in South Africa. Therefore, a new way to analyse cost and the impacts of external cost drivers such as exchange rate fluctuation is needed.

Chapter 5 - Research Methodology

5.1 Introduction

The research methodology is an important part of every thesis as the chosen research methods have a direct influence on the results. In contrast to the research design, which can be considered to be the overall framework or blueprint of a research study, the research methodology focuses on the research process (Van Wyk, 2012). The research process includes the chosen tools and methods that are used in order to achieve the research objectives of a research study or thesis. Only if the chosen methods are suited to achieving the research objectives, the study is able to create accurate results.

As stated in section 1.5, the research design of this study was a case study design, which was exploratory in nature. Using a case study research design for this thesis was found to be the most suitable approach, as intensive analysis of the organisation was necessary to achieve the research objectives. Additionally, maintaining an exploratory scope was necessary, as little was known about the topic prior to the research. The primary research objective of this study, was to develop a decision support tool that measures and analyses the impact of cost drivers on direct material cost for Johnson & Johnson's consumer division in South Africa. The secondary research objectives included the identification of key competitors' sourcing processes and challenges, as well as to propose ways for implementing the newly developed tool and recommendations on how to use the tool in the decision-making process.

This chapter is intended to explain the research methodology of the research study. This includes the research methods used for achieving the before mentioned research objectives. As indicated in section 1.5, the study used quantitative and qualitative research methods and included secondary as well as primary research. Furthermore, this chapter gives an overview of the data analysis and decision support tool development process and concludes by describing the measures taken in order to ensure validity and reliability of the research results.

5.2 Methodology

In order to achieve the research objectives, this study used a combination of quantitative and qualitative research methods. Referring to section 1.5, this approach to conduct research has an advantage in that the researcher is not limited to only quantitative or qualitative research methods, and has the freedom to choose appropriate research methods (Creswell, 1994: 174).

The exploratory nature of the study was chosen due to the fact that Johnson & Johnson only has limited knowledge on its direct material cost drivers in South Africa and would like to ensure more clarity and transparency on the situation. This is in line with the exploratory research design, as exploration is necessary in order to achieve the specific research objectives. As this research is specifically conducted on the case of an organisation, an in-depth study that provides insight into a field that has not been investigated before is possible (Denscombe, 2010).

Referring to section 1.5, the research process of this study expanded over three phases: (1) secondary research, in the form of a comprehensive literature review and secondary data collection; (2) primary research in order to collect qualitative data from the case company; and (3) the decision support tool development process, which again was divided into a planning, construction and application phase. The secondary research methodology is explained in section 5.2.1. Additionally, primary research, which is described in section 5.2.2, was conducted and included the collection of qualitative data from the company in order to get detailed insight into the company's processes and challenges. By using the quantitative and qualitative data, the current state and current processes could be analysed. After the secondary research and primary research phases were completed, the decision support tool development process began. The data analysis and model development methodology is described in section 5.3.

5.2.1 Secondary Research

This research study used secondary research in order to achieve the research objectives. Secondary research is described as conducting research on already available data (secondary data) as well as on studies and research that has been conducted previously (Stewart & Kamins, 1993). Within this thesis, secondary research was conducted and included a qualitative as well as a quantitative portion. The methodology of the qualitative and quantitative research is presented in the following sections 5.2.1.1 and 5.2.1.2.

5.2.1.1 Qualitative Methodology

Firstly, a comprehensive literature review was conducted in order to provide an insight into the field of study and to build a foundation of knowledge on the research problem. This secondary research was conducted by reviewing available books, studies, articles and journals relevant to the fields of this study. In order to find the before mentioned sources of information, the research was conducted by means of online searches for the keywords of this

study. This involved researching several electronic databases, such as Emerald, EBSCOhost, ScienceDirect, Euromonitor International, MarketLine Advantage, SAGE and others, which were mainly supplied by Stellenbosch University. The literature review, which is presented in Chapters 2 and 3 of this study, helped the researcher to gain a better understanding of underlying cost management theory, as well as of existing concepts, models and approaches in the field. Furthermore, the literature review discussed the procurement function in global organisations, the fast moving consumer goods industry of South Africa and introduced the company where this research study takes place.

In order to achieve one secondary objective of this study – to verify the general validity of the decision support tool – a comparative competitor analysis was done. This included the identification of competitors that engage in similar markets of Johnson & Johnson (i.e. the CHC market), as well as an assessment of their sourcing processes and challenges they experience within the procurement function. Therefore, an extensive Internet research, including researching in databases such as Euromonitor International and MarketLine advantage, was carried out as an initial step in order to identify relevant competitors. Afterwards, more research was carried out in order to get more detailed information on the competitors. This was done with the available literature, especially by analysing the companies' annual reports. As a result, the researcher collected the identified risks and presented the findings within section 3.4, where the market players are described, as well as in sections 7.3 and 8.2.3, where the results relating to the validity of the decision support tool are discussed.

The broad screening of available literature created the theoretical framework for this research study as it identified what research had been carried out before. It was identified that further research is necessary in order to achieve the research objectives, since only limited literature that focuses specifically on a decision support tool, as needed in the case of this study, is available. The literature review was also used in order to develop the most appropriate research methodology for this study, as it identified how other researchers addressed similar problems. This included research on theoretical frameworks that focused on the development and construction of decision support tools and financial models. In section 5.3, the decision support tool development process is described, including the steps taken in order to apply the theoretical frameworks found in literature on the research problem of this study.

5.2.1.2 Quantitative Methodology

As this study has the objective to develop a decision support tool for direct material cost, quantitative data plays a major role. The decision support tool shall be used in order to identify the impact of a number of cost drivers on the direct material cost of Johnson & Johnson. Therefore, secondary research is necessary in terms of a quantitative data analysis. This analysis included a thorough assessment of existing company data in order to gain insight and knowledge on the current situation and procedures of the company. For this purpose, the company provided a large amount of quantitative data. This data included raw material data, supplier data as well as product data. As the data quality influences the validity and quality of results, i.e. the outcome of the study as a whole, emphasis was placed on data accuracy even before data collection started and throughout the complete data analysis process.

The quantitative data used in this research consists of internal company data of Johnson & Johnson. As this research study has the objective to develop a decision support model and to use the model to give information from the available data, the quantitative data analysis was an important aspect within the development of the model. First, the available data needed to be analysed in order to identify available data that can be used for the decision support tool. This included screening all available data, its validity and quality. Only after the initial data exploration that provided insights on the data, was it possible to establish a basis for the model, including its logic and methodology. The model was consequently created on a spreadsheet basis and was populated with available data of the company. Finally, the results were visualised and presented. The entire data analysis and methodology of the decision support tool process is explained in detail in section 5.3.

Even though the researcher was directly involved in the quantitative data collection process as the study continued and the need for specific data were identified, the company provided all quantitative data for this study. This means that no primary quantitative data recording of the researcher was conducted. Therefore, the acquired data needs to be considered secondary data.

Due to the nature of this study, the secondary quantitative data provided by Johnson & Johnson has a high degree of sensitivity. Referring to section 1.7, figures presented in this study have been disguised and do not represent actual company data. The data were desensitised before visualising the results in this study in order to protect the company.

5.2.2 Primary Research

In addition to secondary research, primary empirical research was conducted to gain further information and insight into Johnson & Johnson's operations and processes. Primary research is defined as new research that is conducted directly by the researcher in order to achieve research objectives (Zikmund *et al.*, 2012). Primary research was conducted in order to achieve the research objectives as outlined in section 1.4 and focuses on the decision support tool and the requirements by Johnson & Johnson towards such a model. Even though clear objectives and deliverables were established in the beginning of the study, it is important to closely monitor the situation as requirements could change quickly in an ever-changing business environment.

The primary data gathered was of qualitative nature and research methods included observations at the company facilities as well as input discussions and conversations with company personnel as well as with subject matter experts (SMEs) on data visualisation. According to Denscombe (2010), using conversations and discussions for gathering input data is an appropriate method in cases where exploration into complex areas is necessary, as they can provide in-depth information on the phenomenon. Furthermore, conversations with employees are an effective measure in obtaining information on sensitive or privileged information, as they are mostly not documented and only a small number of people have such information. In comparison to structured interviews, which are subject to tight agendas on the format of the questions and its answers, conversations and discussions have the advantage of being more flexible and allow for more exploration, as the participants can express opinions and develop ideas more broadly (Saunders, Lewis & Thornhill, 2009; Denscombe, 2010). As the study design of this research was exploratory, discussions and conversations were found to be the appropriate method for primary data collection of this study. By having conversations and meetings with personnel of the company, fundamental insight in company operations related to procurement and strategic sourcing was gathered and personal ideas related to a decision support tool were shared. This helped to identify the required outputs that are required from the model and the inputs that are necessary to determine these outputs.Furthermore observations were made at Johnson & Johnson's Sub-Saharan head office in Cape Town. According to Yin (2003: 93), evidence gathered from direct observations provide useful insight and additional information on the studied topic. Site visits to the case's facilities are optimal opportunities to make direct observations and to improve understanding of the phenomenon that is being investigated (Yin, 2003: 93–94). As this study

was conducted on the case of Johnson & Johnson, the researcher physically spent a major amount of time at the company's office in order to gain as much information as possible related to the research objectives. This included taking part in meetings with the local procurement team and having conversations with personnel from other departments, such as marketing and finance.

The conducted conversations and discussions included personnel of different positions. The local sourcing manager for Sub Sahara Africa was the major contact point, when gathering information about sourcing processes, supplier selection, cost improvement programs, market engagement programs, as well as general information about Johnson & Johnson. Furthermore, conversations with the plant directors of Johnson & Johnson's manufacturing plants (Cape Town and East London), brought inside about the physical handling of inbound materials, challenges within the supply chain, supplier performance and plant setup. Discussions with the operational buyers and the lead buyer of both plants enabled the researcher to gain valuable information on order placement, order frequency, challenges and issues with suppliers, as well as general information about the information flow between strategic an operational procurement. The researcher also used the opportunity to take part in meetings at the South African office. This included meetings on current topics and included personnel from different departments, such as research and development, quality assurance, plant controlling and supply chain. This helped the researcher to gain a general understanding on internal processes and the workflow between the different departments. The results from these discussions were consolidated into transcribed documents and notes, relating to the individual functions and processes of the departments and employees. The gathered qualitative insight data was used for the decision support tool development process, as well as for the description of the organisation in Chapter 4.

In addition to the observations made at the Cape Town manufacturing site and offices, the researcher visited Zug, Switzerland, where Johnson & Johnson strategic sourcing headquarters for the EMEA region are located. At Zug, the researcher met with the category managers of various raw material and packaging categories and presented his progress to date on the decision support tool development. The researcher used this opportunity to receive feedback from the sourcing managers and to identify the needs and requirements they have with regards to the tool. The feedback received was highly valuable to the research, as it came from the prospective end-users of the tool, and provided an insight on how the procurement managers think.

Observing the company's operations on a daily basis helped to understand the specific need of the company with regards to the research objective and helped to identify the current status on decision support tools used for direct material cost. Furthermore, the close interaction provided guidance in several aspects, such as data quality, sources of quantitative data, operational procedures, interdependencies between departments and the overall organisational structure. In addition to the information gathered, which is in direct context with the research objectives, the observations identified areas for operational improvement, which were used in order to develop recommendations. The gathered data was received from Johnson & Johnson in a confidential environment. As mentioned in section 1.7, the data for the decision support tool was desensitised before presenting it within this document. Likewise, the qualitative information gathered on Johnson & Johnson and presented in this thesis (especially Chapter 4), had to be desensitised. For this purpose, no employees were directly referenced in this thesis, as the presented information represents the collective opinions and facts, not individual positions.

Additionally, the researcher consulted with SMEs that specialise in the development of decision support tools with Tableau. Meetings included progress presentations of the researcher and discussions on how to improve usability of the final tool. This helped to gain insight into modelling in practice and also increased reliability of the final decision support tool.

5.3 Decision Support Tool Development Process

As stated in section 5.2.1.2, quantitative data were a major resource for this study due to the research objectives set out in section 1.4. A decision support tool that is intended to provide information on cost and individual cost drivers in numerical form is by its nature dependent on quantitative data. Denscombe argues (2010) that quantitative research tends to focus on analysing variables and relations between such variables. Within this study, a decision support tool in the form of a model that investigates the relationships between multiple variables, such as cost drivers and their impact on cost, had to be developed.

Quantitative data and qualitative information were necessary in order to develop the decision support tool. This qualitative information came from the literature review on financial modelling and provided an understanding on important aspects when developing a model, as well as a framework on the necessary steps during the development process. According to the available literature on financial modelling that was reviewed in section 2.5.1, the key to

building a successful model is to answer major questions from the start. These questions should clarify the key objectives and outputs of the model, the major variables that are involved and their relationships, and the degree of detail of the model (Rees, 2008). Additionally, the literature review presented a financial model development process, which is presented in Figure 2.5. According to Tennent and Friend (2005: 6), this process should be used as a guideline when producing models, as a more valuable model can be produced in a more efficient way through a robust modelling process. Within this research study, the researcher used literature on model building (Tennent & Friend, 2005; Rees, 2008) and created a new model development process specifically for the needs and objectives of this study. A decision support tool development process was created, which included three different phases and a variety of individual process steps. The three phases of the decision support tool development process were: (1) planning phase, (2) construction phase and (3) application phase (see Figure 5.1).

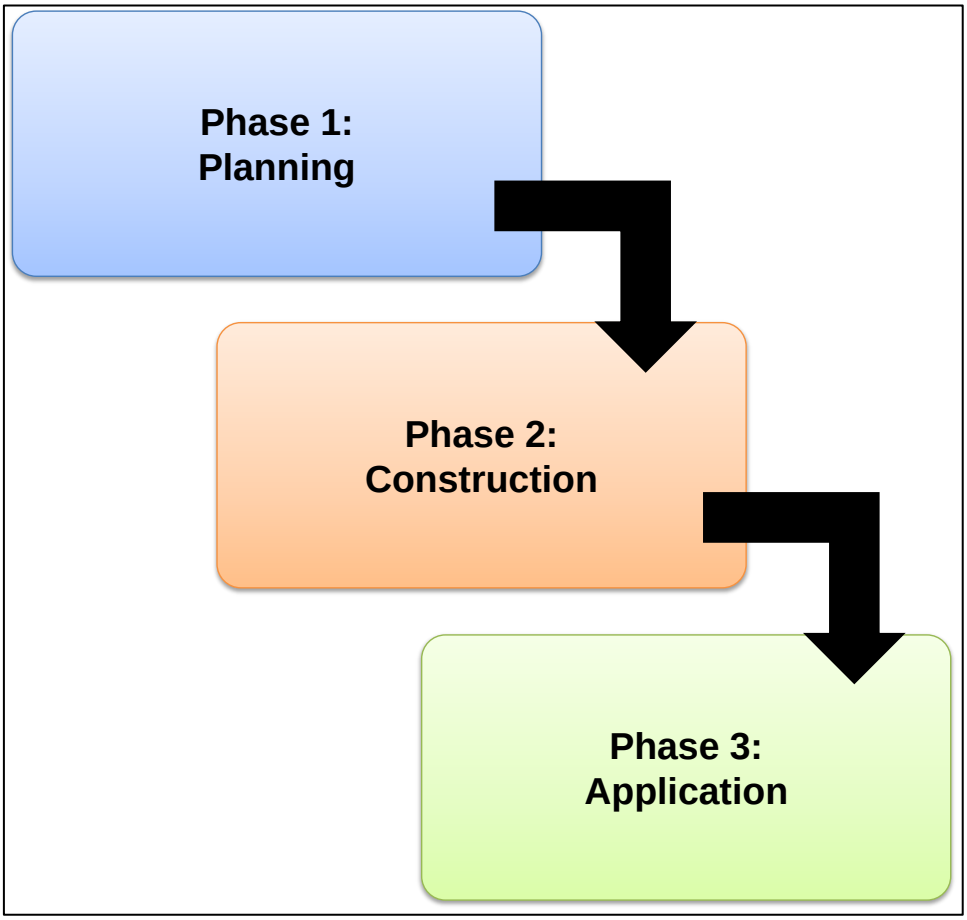

Figure 5.1: Three Phases of the Decision Support Tool Development Process

(Adapted from: Tennent & Friend, 2005; Rees, 2008)

Figure 5.2 depicts the complete modelling process followed within this research study and the individual process steps within the three different phases. In the following sections 5.3.1 -

5.3.3, the individual process steps within the different phases are explained. The results of the decision tool development process, i.e. the findings of the individual process steps as well as the final decision support tool are presented in Chapter 6.

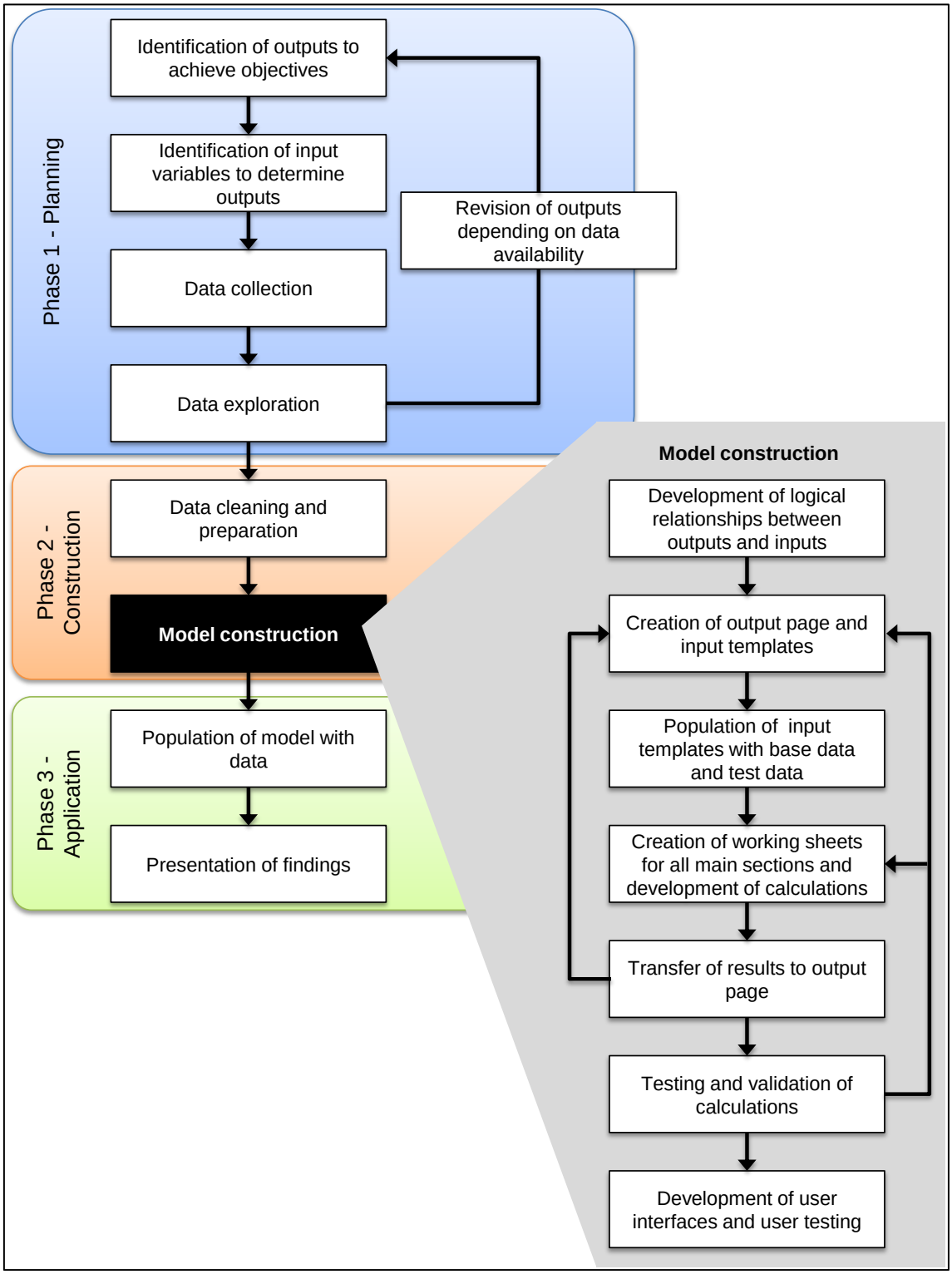

Figure 5.2: Complete Decision Support Tool Development Process

(Adapted from: Tennent & Friend, 2005; Rees, 2008)

5.3.1 Phase 1: Planning

The planning phase of the decision support tool development process included four steps that were necessary before actually building the model. All these tasks were related to planning the model while focussing on the research objectives in order to define desired outputs necessary to achieve these objectives. The four steps are depicted in Figure 5.3 and are described in detail in the following sections 5.3.1.1-5.3.1.4.

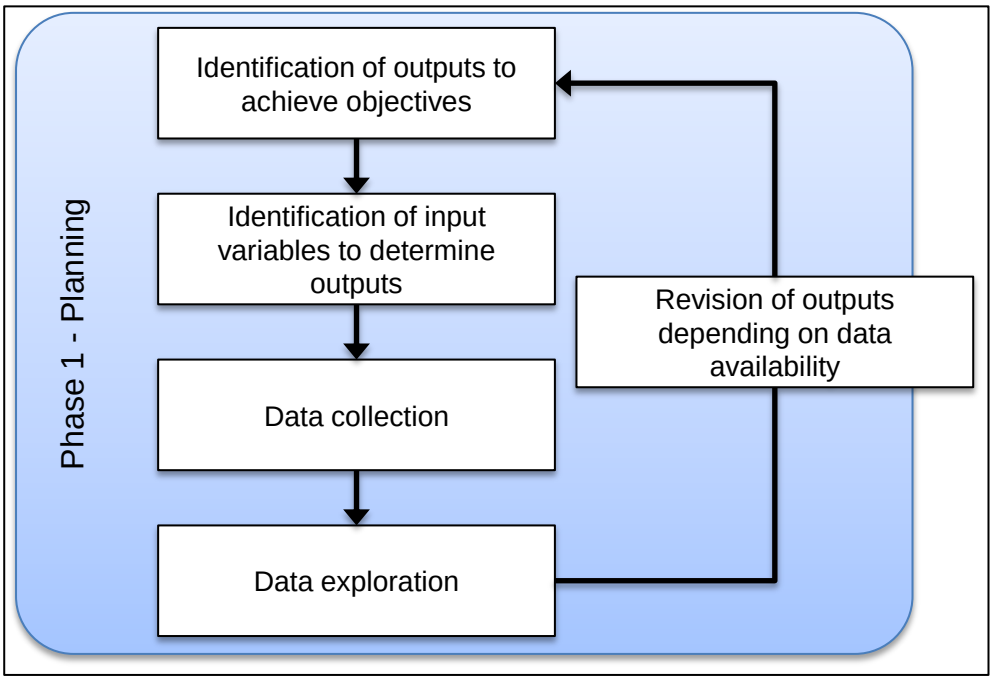

Figure 5.3: Planning Phase of the Decision Support Tool Development Process

(Adapted from: Tennent & Friend, 2005; Rees, 2008)

5.3.1.1 Identification of Model Outputs

The first step within the planning phase was to identify and define the key outputs the model should provide. A business model is intended to deliver specific information that is needed in order to answer a fundamental business question, which was asked prior to its development of the model (Tennent & Friend, 2005: 6). Therefore, the research objectives (see section 1.4) and research problem (see section 1.3) of this study were used to develop and identify the outputs that the model should deliver. As the objective of this study was to implement a decision support tool (i.e. a model) that increases transparency of the company's direct material cost and its cost drivers, defining the model outputs involved determining the major factors that influence direct material cost of the company. This was achieved by conducting a review of the literature that is available on cost management in procurement and other topics

relevant to the study. As this study was conducted on the case of Johnson & Johnson, the company also had a basic idea of the outputs that needed to be generated by the model.

5.3.1.2 Identification of Input Variables

After the outputs were identified, the next step was to identify the input variables that are necessary to determine the outputs. The inputs to the model need to be directly linked to the outputs. Therefore, a basic understanding of the relationship between the variables as well as an initial idea of formulae on how to express this relationship later in the model was necessary at this stage. This was gathered by exploring the literature on the subject of direct material cost as well as TCO in general. Furthermore, the company provided information on how they addressed the problem in the past as well as other ideas. From this point of knowledge, initial input variables were defined.

5.3.1.3 Data Collection

As soon as the initial input and output variables were identified, the required data were collected. This data collection included quantitative data, which is needed for the calculations of the model, as well as qualitative data, in order to identify relationships between variables as well as other variables that might be necessary to consider within the model. The qualitative data were collected by means of observations and input discussions as explained in section 5.2.2. This also involved discussions with SMEs in order to derive relevant input data.

The quantitative methodology was explained in section 5.2.1.2. As indicated in section 2.5.1, numerical data is essential for a financial model, as it needs to be used for calculating the outputs. According to Tennent and Friend (2005: 8), the added value of a business model is highly dependent on the quality of the data that is used to determine the outputs. Therefore, the data sources needed to be reviewed for accuracy and reliability before being used for the model. The collection of quantitative data for this study was dependent on Johnson & Johnson, being the company for which the model is developed and applied. The data that was provided is confidential company information and needed to be treated as such during the course of the study. Data collected from external sources was only used if relevant for the model and accessible within the public domain.

5.3.1.4 Data Exploration

After the data were collected, an intense process of data exploration took place. On the one hand, this was necessary due to the vast amount of available data provided by the company to

the researcher. The researcher needed to understand the relationships between different datasets and the available data attributes within these datasets. Furthermore, it was necessary to identify the root databases of the datasets provided and the systems that are used to capture the data in order to understand connections between the processes of the company and the available data. On the other hand, the researcher needed to review the results of the data collection process as soon as possible to proceed with the development of the model. The review process was important as it was used to clarify whether the input data that is needed in order to achieve the outputs is available from the collected data. The data exploration process was also used to foster and confirm the initially established relations between input and output variables (see section 5.3.1.2). Additionally, the exploration process generated new insight into the available data and new data relations could be identified.

After having reviewed the initially collected data, the researcher identified that some information that was desired in order to determine certain outputs was simply not available. Therefore, a revision of outputs (see section 5.3.1) was necessary, based on the data availability. On the contrary, the researcher made discoveries in data availability, which was not expected or considered in the initial output and input definition phase. This also led to a revision of key variables and outputs.

The data collection and exploration phase in this research study was a repetitive process. With a progressing model and increased observations and understanding of the business, the researcher was able to collect more specific data, based on the needs to achieve model outputs, than in the beginning of the study.

5.3.2 Phase 2: Construction

In the second phase of the decision support tool development process, the construction phase, which included data preparation and the actual creation of the model, was conducted. As the data had already collected in phase one, the researcher had known at this stage what data is available for the model creation. Also, the desired outputs had been defined. The construction phase, which is depicted in Figure 5.4, consisted of two process steps: data cleaning and preparation, and the model construction. In the following sections 5.3.2.1 and 5.3.2.2, the construction phase is explained in detail. Emphasis is placed on the actual model construction, which included another series of process steps.

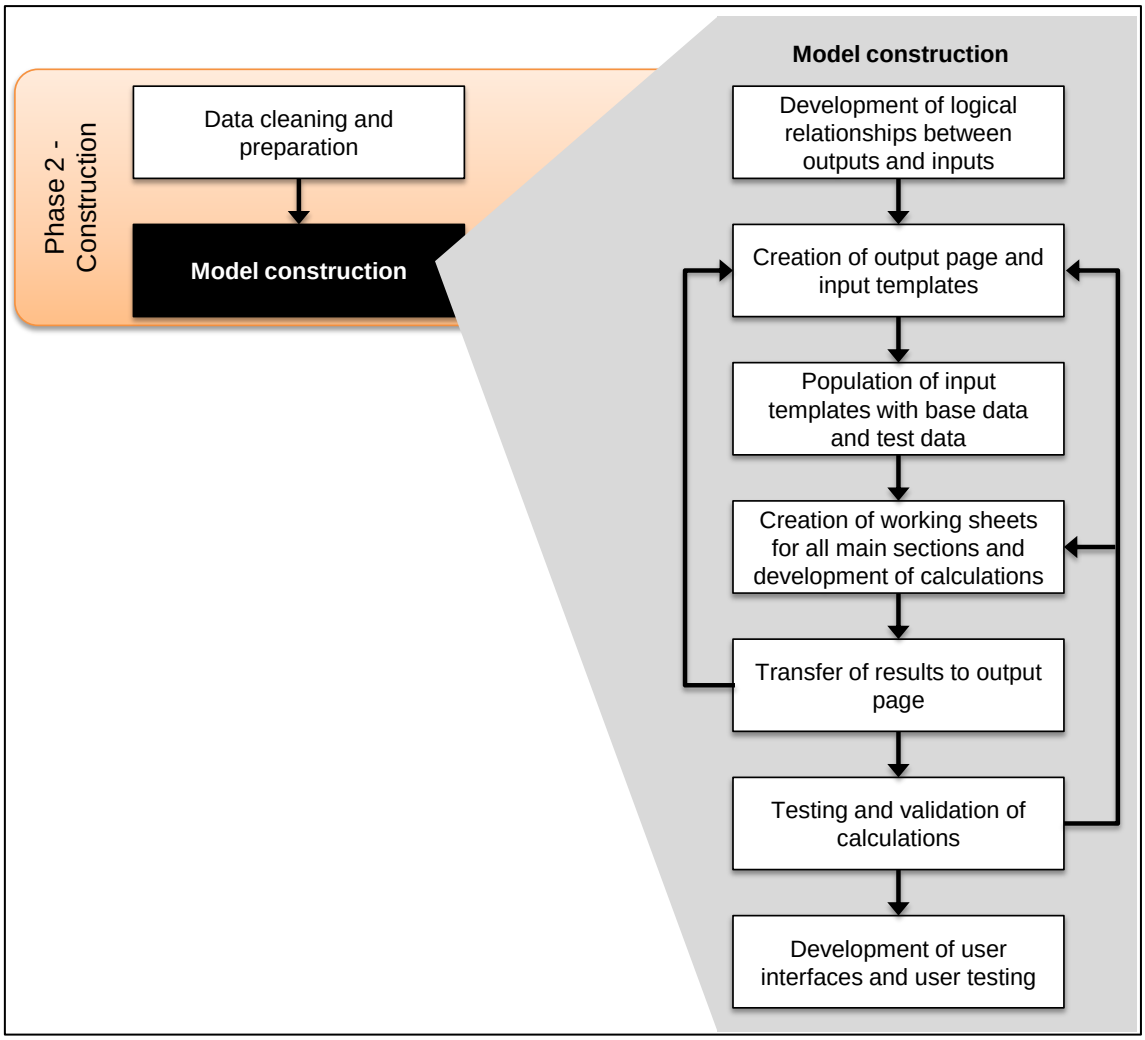

Figure 5.4: Construction Phase of the Decision Support Tool Development Process

(Adapted from: Tennent & Friend, 2005; Rees, 2008)

5.3.2.1 Data Cleaning and Preparation

Johnson & Johnson, the company where this study was conducted, provided the quantitative data. As there was a significant amount of collected data from the beginning, it was important to filter the relevant data, which could be used in the model in order to get the specific information needed for achieving the research objectives. After the data exploration process, during which the researcher explored the available data in order to get an in-depth understanding of it, the preparation of the available data and setting of defined data attributes was necessary before going into the actual model construction process.

After examining the available data in the data exploration process, the first step in the data cleaning and preparation process was to filter the available data to only data that would be needed in the decision support model. This included reducing the datasets to only specific data that was required to generate the desired outcomes. As a significant amount of datasets

was collected, the process was important and necessary, in order eliminate data that does not support the achievement of the anticipated results. Furthermore, cleaning and analysing the data before constructing the model improved the performance of the computer systems and reduced the amount of resources used in the forthcoming process steps.

Even after the data cleaning process, the data were not in the desired state to start the model construction process. As no consolidated cost model existed at this point, which included several cost drivers at the same time, the data were not consistent throughout the different datasets. Therefore, manual data corrections and adaptions were necessary to adjust the data in a normalised form. After the normalisation process was completed, it was possible to link different datasets with each other and to synchronise data between them. The data cleaning and preparation process step and its findings will be described in detail in section 6.2. As soon as the data were prepared in a way that it was usable for the model, the model construction phase could begin.

5.3.2.2 Model Construction

Within the model construction process step, the decision support tool was built. As can be deduced from the previous sections, significant planning as well as data preparation and cleaning was necessary before actually building the model and assembling the individual parts. According to Tennent and Friend (2005: 32), the construction of a model can be more efficient when a certain methodology is followed. The authors advise to break down the single tasks necessary within the construction process into transparent and structured stages. Therefore, the model construction process, being a major part of the complete decision support tool development process, was subdivided into a number of individual process steps. Figure 5.4 provides an overview of the subdivided model construction process and its individual steps. In the following sections (a)-(g), these process steps are explained.

As the model was built for Johnson & Johnson, the decision support tool was developed in a spreadsheet form within a MS Excel framework. The company uses MS Excel for the majority of their reporting tasks, as well as for all of their spreadsheet calculations. Therefore, building the model in a MS Excel format had the advantage of being aligned with Johnson & Johnson's internal resources, as no further investment would be necessary to use the model. Also, employees are already familiar with the application and no further training besides the model implementation would be necessary. However, as the importance of data visualisation was revealed in the literature review, Tableau was used in order to create an additional user

interface that allows interactive analysis of the data while visualising the results in an appealing and understandable manner. Johnson & Johnson already makes use of Tableau in functional areas other than the procurement function, and licenses are available. This means that no additional financial investments would be necessary for the use of Tableau.

(a) Relationships between Outputs and Inputs

During the first step of the model construction process, the relationships between the outputs and the inputs needed to be developed. This included the development of logical arguments that define how the outputs are derived from the inputs. A basic understanding of the relationships between the model outputs and its input variables was already established during the outputs and inputs identification phases (see sections 5.3.1.1 and 5.3.1.2). Furthermore, the data exploration phase was used to identify relationships between variables, as at that stage the researcher already knew what type of data were available (see section 5.3.1.4). Additionally, the identification of relationships between the variables was also part of the key questions that needed to be answered before building a model (Rees, 2008). Therefore, the researcher was, at this stage, familiar with the different input variables, the desired outputs, as well as with the data that was available for usage in the model. This knowledge was used in order to develop relationships between the variables and outputs, always considering the data that is available. The identified relationships and their logic were then used in order to derive the formulae, which are necessary to ultimately determine the outputs.

(b) Creation of Output Page and Input Templates

After having identified the relationships between the variables and the underlying formulae necessary for the model's calculations, the construction of the model in MS Excel started. As identified by Rees (2008), most models are very time-consuming to understand, audit, and validate. Therefore, it is necessary to provide transparency and clarity when constructing a model. In order to comply with this requirement, outputs and inputs need to be clearly separated. For this purpose, input and output sheets in the form of templates were set up in a MS Excel workbook, clearly identifying their function by having distinct sheet names. As the output page was also set up in the beginning of the process, the researcher could always stay focused on the model's deliverables. Therefore, the input and output sheets provided a guideline of what needed to be populated in the forthcoming process steps.

(c) Population of Input Templates

The next step of the model construction process was to populate the input templates and the different input sheets. For this purpose, the quantitative data that was previously provided by Johnson & Johnson as well as cleaned and prepared for processing was used. The input templates hereby provided the guideline as to which data needed to be extracted from the available raw data. This data were already the actual data used in Johnson & Johnson's procurement environment and, therefore, provided the bases for the further development process. The data used included procurement data on direct materials, consisting of raw material and packaging data, and included a significant number of attributes. Furthermore, the input data were categorised into categories of base inputs and parameter inputs in order to have a better workbook structure and a better overview of the data.

(d) Creation of Working Sheets and Calculations

Within this process step, the majority of the modelling work was conducted. This included the creation of so-called working sheets, where the different inputs are used to generate the outputs. Therefore, the previously identified relationships and formulae derived were incorporated into the MS Excel worksheets. Separate working sheets were created for the different types of calculations, which were aligned to the different cost drivers that needed to be examined. Using separate working sheets per calculation provided transparency throughout the process step, and assisted in building an easy to understand model. All working sheets followed the same structure and outline, which simplified the process of entering formulae into the specific fields as well as locating important fields, such as the results and input values, in the worksheet.

(e) Transfer of Results

In order to ensure a well-structured model that provides transparency and is easy to understand, input and output sheets were created in the second process step. After the calculations and working sheets were finalised, their results were transferred to the output sheet. By clearly separating the output pages from the workings sheets, the user has the advantage of having a centralised overview sheet, where all the results are displayed. Additionally, the user could still drill-down into the details of the calculations within the workings sheet. This process step therefore includes a basic linking of values from the workings sheet to the output sheet.

(f) Testing and Validation

After all calculations have been set up and the model was in a usable condition, the model was tested and its results were analysed. This included a crosscheck between the results and the input and workings pages, in order to validate that the calculations are working as desired. At this stage, the testing and validating of the models results was focused on the technical aspects in order to ensure accurate results, to reduce errors and to make use of efficient methods in MS Excel to keep the model as simple as possible.

(g) Development of User Interface

The user interface of a model is highly dependent on the ultimate user of the model (Tennent & Friend, 2005: 34). As this model was built in order to be used by Johnson & Johnson, it was important to identify the ultimate end users and how the model will be used. As this was a key aspect in the complete development process, Johnson & Johnson was always informed on the process of the model construction, and involved in the ultimate user interface development. This included a series of testing, where employees tested the model and used it in real life cases. Even though the model was built in an MS Excel environment, Tableau Software was used to visualise the results. In order to provide the user an ultimate experience of using Tableau, the complete model was set up in a way that it can directly extract the data from MS Excel and visualise results within Tableau.

5.3.3 Phase 3: Application

After the model was constructed and available in a usable form, phase 3 of the decision support tool development process was initiated. As can be seen in Figure 5.5, the application phase consisted of two process steps: the population of the model with data and the presentation of the findings. The tasks of this phase can be considered as the final stages of the decision support tool development process, as the model is actually used and not modified anymore.

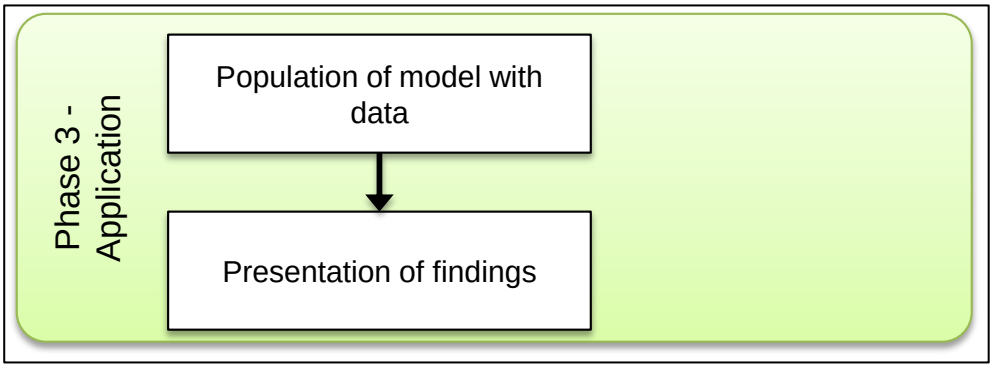

Figure 5.5: Application Phase of the Decision Support Tool Development Process

(Adapted from: Tennent & Friend, 2005; Rees, 2008)

5.3.3.1 Population of the Model with Data

Within the application phase, the first step was to populate the model with data. As the model is used in order to evaluate cost drivers of direct material cost, the model could be used in two different ways. On the one hand, an as-is analysis was done in order to evaluate the impacts of certain cost drivers in the past. This was possible, as actual data for the time frame was available. On the other hand, the model can be used in order to do a sensitivity and scenario analysis. This means that the model can be used by testing the sensitivity of direct material cost to different input assumptions. These input assumptions can be altered and changed in an efficient way, which allows the user of the model to identify main cost drivers immediately.

5.3.3.2 Presentation of Findings

After the model had been populated with data and certain scenarios have been tested, the findings of the model were presented. This included the presentation of the models results, but also of the model itself. The ultimate model was constructed in an MS Excel environment, in order to be aligned with Johnson & Johnson's existing work routines and resources. The model was presented in MS Excel format to the consumer strategic sourcing team of the company, as well as to the head of strategic sourcing for the EMEA region. Additionally, the results of the model related to the as-is analysis and the scenario analysis were presented. In order to provide a detailed overview on the model's results, the findings were visually presented by using the data visualisation tool Tableau Software. Tableau Software was used in order to provide more BI information within the visualisation and to enhance the user experience.

5.4 Validity and Reliability

A very important aspect of each research study is its validity and reliability. Only if the researcher demonstrates that the chosen research methods ensure validity and reliability of the findings, the research can achieve credibility (Denscombe, 2010: 297).

According to Maughan (2009), the term reliability relates to dependability of the measures and methods used to generate results. A reliable measure gives constant results over time, independently of who does the measuring. Therefore, reliability refers to consistency of research results when the study is replicated under a similar methodology (Golafshani, 2003). Resulting from that, the following questions can be asked in order to determine the reliability of a research study (Easterby-Smith, Thorpe & Jackson, 2011: 71):

- Will the measures yield the same results on other occasions?
- Will similar observations be reached by other observers?
- Is there transparency with regards to data collection and interpretation?

Validity refers to the accuracy of the measure and the question of whether the research really measures what it was intended to measure (Carmines & Zeller, 1979). This means that validity is all about the data itself and the methods of how the data were obtained. Graziano and Raulin (2010: 162) refer to validity as the *"methodological or conceptual soundness of research"*. In order to determine validity, Denscombe (2010: 328) distinguishes between two different assessments. With regards to the research findings, the question is whether the data and findings reflect reality. With regards to the research methods used, it is asked whether suitable indicators of the concept are measured and whether accurate results are yielded (Denscombe, 2010). Therefore, one can conclude that validity refers to the degree of accuracy and appropriateness of the data and methods, and whether the results of a study can be generalised to other cases outside the specific research context, while reliability refers to the consistency of the research instrument and whether it yields replicable results.

As the research objective of this thesis was to develop a decision support tool that is used to support strategic decision-making, validity and reliability of the results of the model need to be ensured. However, the before mentioned examples from literature also stress the importance of using valid and reliable research methods in order to achieve these results. Within this chapter, the research methodology was presented and the decision support tool development process was described, and measures to increase validity and reliability were

mentioned within the different sections. Due to the nature of this thesis, it is necessary to demonstrate the validity and reliability of the methodology followed to develop the model as well as the validity and reliability of the model itself.

In order to develop the model, a decision support tool development process was followed. This process was taken and adapted from existing frameworks on modelling, which were investigated in the literature review (modelling process of Tennent & Friend, 2005). Furthermore, the model was developed under consideration of key requirements of an effective model, as identified by Rees (2008). Using the right methodology within the research process and following approved methodology of building a decision support tools increase the validity and reliability of the model.

Chapter 6 - Decision Support Tool

6.1 Introduction

In Chapter 5 (Research Methodology), the research methodology and the different phases of the research process were presented. The three phases of the research process were: (1) conducting secondary research, (2) conducting primary research and (3) the development of the decision support tool. In order to complete the third phase of the research process and to achieve the primary objective of this thesis, it was necessary that the secondary and primary research phase provided findings that could be used in order to develop the decision support tool. The decision support tool development process that was followed in order to develop the tool was extensively discussed in section 5.3. The detailed outline of the process provided guidance throughout the development phase, as the deliverables for each of the different process steps were defined. This structured approach to the decision support tool development supported the researcher as a guideline and also provides the reader with a framework on the individual task of the development. Within this chapter, the decision support tool developed is presented. This includes the presentation of the results of the complete decision tool development process and the findings of the individual process steps.

6.2 Planning Phase Results

The review of literature on financial modelling revealed that key questions need to be answered in the beginning of a model development process in order to create a successful model. According to Rees (2008), the questions that need to be asked are: *"what are the key objectives and outputs of the model, what types of variables should be included or what dependency relationships between the variables must be captured?"*. These questions were addressed in the planning phase of the decision support tool development process. The tasks within the planning phase were: (1) the identification of the model outputs that are needed to achieve the objectives, (2) the identification of input variables that determine the outputs, (3) the data collection and (4) the data exploration. In the following sections 6.2.1-6.2.4, the findings of each of the before mentioned process steps are presented.

6.2.1 Outputs

The first step of the decision support tool development process was to identify the key outputs that the model needs to deliver in order to achieve its objective. For this purpose, the primary

objective of this thesis was reviewed and objectives of the decision support tool were derived. The decision support tool objectives are summarised in Table 6.1. As defined in section 1.4, the primary objective of this thesis was to develop a decision support tool that analyses the sensitivity of cost drivers on direct material cost for Johnson & Johnson's consumer division in South Africa. This objective was generated based on the problem formulated in section 1.3, being Johnson & Johnson's lack of understanding and transparency relating to cost drivers of direct material cost, especially currency impacts. The decision support tool should be based on a financial model and focus on the financial risk exposure of Johnson & Johnson. Therefore, one objective of the decision support tool was to provide insight into cost drivers of the procurement spend and generate a more predictive view of direct material cost compared to what was available before the study. Furthermore, the tool should include the possibility to run a sensitivity analysis of external impacts on direct material cost, as well as the functionality to conduct scenario planning considering different assumptions.

Table 6.1: Decision Support Tool Objectives

Decision Support Tool Objectives		
Cost Drivers	**Forecasting**	**Scenario Planning**
• Insight on cost drivers of procurement spend • Measuring exposure and impact values of cost drivers	• Predictive view for cost drivers and impacts • Forecasting functionality	• Sensitivity analysis for procurement spend based on cost drivers • "What-if" functionality

In the following sections (a)-(c), the identified key outputs required of the decision support tool are presented. These outputs were derived from the objectives of the decision support tool, which are based on the case of Johnson & Johnson and the company's current position on direct material cost in South Africa (see section 4.5). Furthermore, the literature review on cost management in procurement, including the assessment of financial risks in procurement, was considered in the process.

(a) First-Tier Currency Impact

The first key output of the decision support tool is the first-tier currency impact on the direct material cost. As Johnson & Johnson purchases materials for its production plants in Cape Town and East London not only from local but rather from international suppliers, they are exposed to exchange rate fluctuations for purchases in currencies other than the South African

Rand. In order to adhere to the objectives set out in Table 6.1, the decision support tool needs to determine the exposure of the company's direct material spend to first-tier currency impact. Resulting from the exposure, the tool needs to compute the total impact on direct material cost. Additionally to an aggregated level, the first-tier currency impact must be presented on lower levels that provide more detail. The first-tier currency impact by category, sub-category, supplier, and material level provides detailed insight about the exposure on different levels. This is essential, as patterns and correlations can be identified with such information. For example, the company will have the knowledge about what material has the highest exposure to first-tier currency impact and which supplier is responsible for the highest first-tier currency impact. Also, analysis could reveal for example that materials sourced from a certain supplier have a different impact than similar materials from another supplier. Having this information available can significantly support sourcing decisions. Furthermore, the impact must also be presented in terms of the foreign currency that is responsible for the cost impact in order to provide an understanding on the individual currencies impact on the procurement spend. This should include the functionality for estimating future impact values based on forecast exchange rates as well as to create different scenarios for comparative analysis. Resulting from that, the decision support tool helps to answer questions such as "what is the impact on the direct material cost if the Rand depreciates by 5% against the Euro?"

(b) Second-Tier Currency Impact

In addition to the first-tier currency impact, the second-tier currency impact is a driver of direct material cost that is dependent on exchange rate fluctuations. Johnson & Johnson refers to the second-tier currency impact in the following situation: Materials and goods are sourced from a first-tier supplier in local currency. However, the first-tier supplier sources all or parts of the components of the material from a foreign country in a different currency. Therefore, the material is exposed to currency exchange rate fluctuations at the supplier level. This phenomenon results in suppliers adjusting their prices, as they are subject to first-tier currency impacts themselves. As the second-tier currency impact has already been identified by Johnsons & Johnson as a cost driver that needs further investigation (see section 4.5), determining the impact and the exposure of it are two outputs that the decision support tool needs to deliver. Similar to the first-tier currency impact and in order to achieve its objectives, the decision support tool needs to compute the total impact on direct material cost as well as the impact on a more detailed level. The second-tier currency impact by category, sub-

category, supplier, and material needs to be generated in order to provide detailed insight on the procurement spend. Patterns and correlations between suppliers, materials or categories can be identified with such information, which support decision makers when making strategic and tactical sourcing decisions. Similar to first-tier currency impact, the company will have the knowledge about what material has the highest exposure to second-tier currency impact and which supplier is responsible for the largest exposure. Also, analysis could reveal for example that materials sourced from a certain supplier have a different impact than similar materials from another supplier. Having this information available can critically support sourcing decisions. Furthermore, the impact must be presented in terms of the foreign currency that is responsible for the cost impact in order to provide an understanding on the individual currencies impact on the procurement spend. This should include the functionality for estimating future impact values based on forecast exchange rates as well as to create different scenarios for comparative analysis. Resulting from that, the decision support tool can help to answer questions such as "What is the impact on the direct material cost if the Rand depreciates by 5% against the Euro?" Furthermore, having the tool to actually measure the second-tier currency impact can result in a significant knowledge advantage during price negotiations with suppliers. As currency developments can be considered and forecasted, the company can generate different scenarios in order to estimate whether a price proposal is fair.

(c) Inflation Impact

In addition to the cost drivers directly related to foreign exchange rates, the literature review has revealed that volatile commodity prices are directly related to material cost within procurement and need to be considered as a direct material cost driver. Also, Johnson & Johnson has identified the importance of understanding commodity markets and relate to the impact on procurement spend as inflation impact. Therefore, the inflation impact is another output that the decision support tool needs to deliver. In order to obtain insight into the inflation impact, the exposure to inflation as well as the impact itself need to be determined. A decision maker that has information about the impact of inflation on an individual material, category or supplier, can use this understanding when making purchasing decisions. As a result, the decision support tool must be able to provide information on the correlation between fluctuating commodity prices and the impact it has on direct material cost. For example, it needs to be possible to answer questions, such as "how does a 5% price increase of resins affect the material spend of the packaging category?" with the assistance of the decision support tool. Similar to the previously described currency impact outputs, gaining

insight into the inflation impact on a material or supplier level can result in positional advantages during price negotiations with suppliers.

All of the before mentioned outputs are related to specific cost drivers and derived from the objectives of the decision support tool shown in Table 6.1. For each of these cost drivers, the objectives need to be achieved and the different functionalities must be provided by the decision support tool. As a next step, the input variables necessary to determine the outputs were identified.

6.2.2 Input Variables

After the outputs that the decision support tool needs to deliver were defined, the input variables that determine these outputs had to be identified. This step was necessary as the required data for these input variables could only be collected after the input variables were defined. Table 6.2 presents the identified input variables that are required in order to determine the outputs as previously defined. Referring to section 5.3.1.2, a basic understanding about the relationships was necessary during the process of deriving the input variables from the outputs. In Table 6.2, the relationship is given in terms of a basic formula that guided the researcher in the process of developing the calculations. The input variables were categorised into the categories of base inputs and parameter inputs. However, the calculation formulae of the decision support tool outputs could only be finalised after the data collection and exploration process was completed, as it needed to be ensured that the data required for the input variables were available and suited.

(a) Base Inputs

Base inputs include all input variables that are not changing during the analysis with the decision support tool. These variables can be considered as constants and the data for these variables needs to be provided before using the decision support tool. As presented in Table 6.2, base inputs consist of standard information that is necessary for further calculations. Such standard information includes basic procurement data on suppliers, such as supplier names, the materials that they supply, the total spend with the supplier, etc. Furthermore, the base inputs include variables related to procured materials, such as the material name and code, procurement spend by material, volumes, price and supplier currency. Base input variables consist of fixed procurement data and do not include fluctuating or changing variables.

Table 6.2: Outputs, Input Variables and Relationships of the Decision Support

Outputs		Inputs		Relationship
Cost Drivers	Outputs	Base Inputs	Parameter Inputs	Basic Formulae
First-tier currency impact	Exposure of Total Spend to Cost Driver	Total Direct Material Spend		Sum of spend of all purchases in foreign currency
	Impact by Supplier, Category and Material level	Supplier data - Name, spend, materials Material data - Name, spend, volumes, price, supplier currency Category data - Name, spend, materials included	Contract currency exchange rate	Difference of spend at actual/forecast currency exchange rate and contract currency exchange rate
	Forecast depending on Exchange Rate		Actual currency exchange rate	
	Scenario Planning - Functionality to build multiple Scenarios		Multiple forecast currency exchange rates for scenario planning	
Second-tier currency impact	Exposure of Total Spend to Cost Driver	Total Direct Material Spend		Sum of spend of all purchases in local currency that are exposed to second-tier currency impact
	Impact by Supplier, Category and Material level	Supplier data - Name, spend, materials Material data - Name, spend, volumes, price, second-tier supplier currency (feedstock currency) Category data - Name, spend, materials included	Exposure value - % of spend that is exposed to second-tier currency impact	Difference of spend at actual/forecast currency exchange rate and base currency exchange rate, multiplied with the exposure value
			Base currency exchange rate	
	Forecast depending on Exchange Rate		Actual currency exchange rate	
	Scenario Planning - Functionality to build multiple Scenarios		Multiple forecast currency exchange rates for scenario planning	
Inflation Impact	Exposure of Total Spend to Cost Driver	Total Direct Material Spend		Sum of spend of all purchase that are exposed to inflation
	Impact by Supplier, Category and Material level	Supplier data - Name, spend, materials Material data - Name, spend, volumes, price Category data - Name, spend, materials	Total Inflation rate by material or commodity Energy Inflation rate Labour Inflation rate	Spend multiplied by Inflation rate

(b) Parameter Inputs

In contrary to base inputs, parameter inputs are changing variables that are used in calculations and have an effect on the outputs. These parameters can be changed during the usage of the decision support tool in order to generate results, create scenarios, or conduct "what-if" analysis. In order to determine the decision support tool outputs, the parameter input variables identified directly relate to the corresponding cost driver (see Table 6.2). For example, parameter input variables include the contracted exchange rate with a supplier, which can change whenever a new contract is negotiated. Also, actual exchange and inflation rates, as well as forecast exchange rates, are necessary parameter input variables, as these variables are necessary to calculate the impact of the related cost driver. The parameters used for scenario planning, forecasting and "what-if" analysis are also required in order to provide the required functionality of the decision support tool. Furthermore, the exposure value of a material to second-tier currency volatility is a very important input variable that needs to be considered, as it needs to be part of the impact calculation.

6.2.3 Data Collection

As the decision support tool is developed on the case of Johnson & Johnson, the available data that could be used was dependent on the company. However, as Johnson & Johnson was interested in increasing its understanding about the external factors that influence its procurement spend relating to direct materials, access to a significant amount of data were provided. Even though Johnson & Johnson provided access to its data, it was still the researchers undertaking to explore where relevant data is stored, how it can be accessed and retrieved, and who the responsible people were for specific data requests. Therefore, the quantitative data collection process already included an exploration aspect. However, the data collection process focused on retrieving the previously identified outputs and the required input variables.

As a result, a variety of different datasets were collected. In an initial exploration process, three major datasets were identified as being useful in order to achieve the objectives. The three datasets included data on the direct materials business plan, the second-tier model and the inflation model (see Figure 6.1). These three independent datasets were provided in a MS Excel spreadsheet format and included data of a wide range of variables. The datasets are presented in the following sections (a)-(c) and an overview of the data variables included is provided.

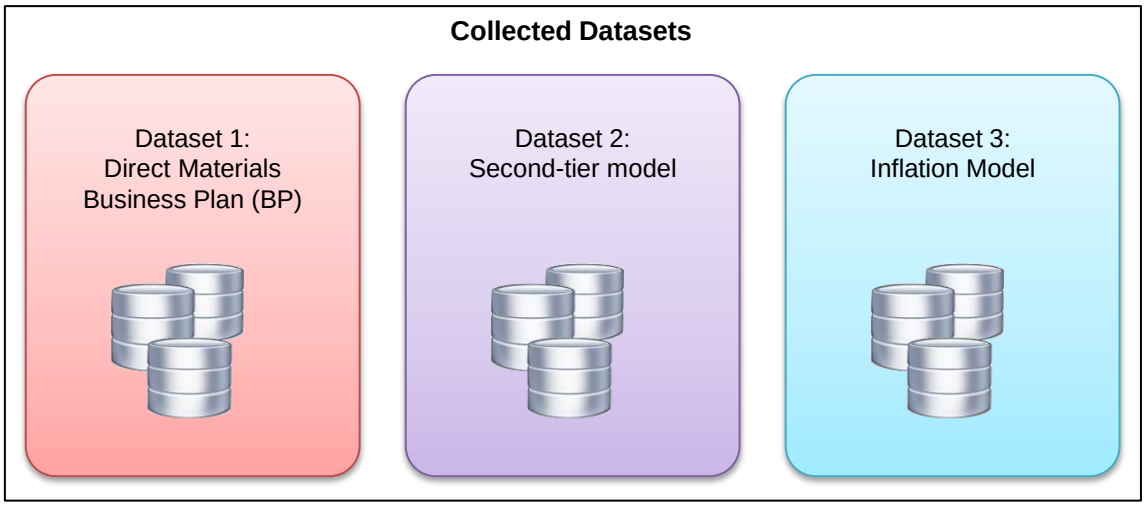

Figure 6.1: Collected Datasets for use in Decision Support System

(a) Dataset 1 – Direct Materials Business Plan (BP)

The direct materials BP provided by Johnson & Johnson includes all data related to direct materials that are purchased from the company's suppliers. The file provides a complete overview about all materials and includes a large number of data variables. Within the data sheet, each row represents an individual material, which is identified by its unique material code. The business plan file is updated on a yearly basis and consolidates all direct materials of every manufacturing plant of the EMEA region. With regards to the scope of this study, only materials of the South African plants, i.e. Cape Town and East London, were considered. The 2015 business plan file included a total of 80 column headers, each being an individual data variable of a specific material. The data variables of the materials include categorical variables, quantitative variables, as well as calculated fields that are a combination of quantitative variables. As the amount of data available was significant, the data exploration process that followed was used in order to gain insight into the available data as well as to filter the required data variables that could be used as input variables for the decision support tool.

(b) Dataset 2 – Second-Tier Model

As indicated in section 4.5, Johnson & Johnson has previously already developed a model that calculates the second-tier impact. However, the model is only on an aggregated level and does not provide the required detail on a material level. The new decision support tool is intended to deliver this required level of granular detail, especially with regards to the second-tier currency impact. Therefore, the existing second-tier model was analysed and data that was discovered and deemed useful for the new decision support tool was collected. This included

the data sheet of the second-tier model created by Johnson & Johnson. The data sheet used within the model included input variables and calculated output variables. In total, the data sheet consisted of 18 column headers, including input variables such as region, category, sub-category, supplier and supplier currency and spend, as well as output categories such as exposed spend to second-tier impact and total second-tier impact. Furthermore, the data sheet included the forecast exchange rate, which could be considered as a parameter input variable based on the classification done in section 6.2.2.

(c) Dataset 3 – Inflation Model

Johnson & Johnson has developed a sophisticated inflation forecasting model for its direct material and external manufacturing categories. This model uses past, actual and forecast data for commodity prices as well as energy and labour prices in order to predict the inflation impact on its procurement spend. The model tracks over 80 commodities and has a process for alerts in case of unexpected events. Unlike the model for second-tier impacts, the inflation model is very detailed and provides significant information. As the inflation impact was also identified as a cost driver in section 6.2.1 and is an output of the new decision support tool, the existing inflation model was reviewed and relevant data were collected. The data sheet collected included mainly quantitative data relating to the respective category. As the inflation model covers all of Johnson & Johnson's operative regions, only the data about direct materials of EMEA was collected. In total, the data sheet consisted of 60 column headers.

6.2.4 Data Exploration

In section 6.2.3, the findings of the data collection process were presented. An initial data exploration process took place simultaneously with the data collection. This was necessary, as the collected data is secondary company data of Johnson & Johnson and not all data that was initially collected was suitable for usage in the decision support tool. The identified outputs and required input variables guided the data collection and exploration process. In the process of exploring the available data, a number of issues were identified that had to be addressed before using the data.

(a) Data Quality

In order for the decision support tool to work correctly and to produce valid results, the usage of accurate input data needs to be ensured. Therefore, the datasets were explored and screened with regards to the data quality and its accuracy. Initial analysis of the datasets revealed no

major issues. This was expected as the data is in use in daily operations and errors could result in major problems. However, relatively minor issues were found. For example, within the direct material BP data, it was found that the data field containing information on "invoice unit of measure (UOM)" of a respective material occasionally contained errors. This had an impact on the related "invoice unit valuation" data field and resulted in a miscalculated material price. However, this issue was only found within an insignificant number of entries and immediately corrected. Another issue regarding data quality related to the normalisation of data fields between different data sets. The data exploration revealed that between the three data sets used, the data field on the material category was not normalised and contained different sets of values. For example, one dataset used the material subcategory "Actives/Naturals", while another dataset used "Naturals/Actives". Even though both datasets refer to the same category, the data were not normalised and further processing of the data, such as linking the datasets based on the category data field, was not possible. This issue was more relevant to the datasets and the further development of the decision support tool, as the second-tier model dataset and the inflation model dataset only provide data on category level and did not have information on material level. Therefore, a standardisation of the category variable between the datasets was a requirement before linking the data.

(b) Limitations of available Data

In addition to the data quality, exploring the data revealed some limitations regarding available data. As identified in section 6.2.3, the second-tier model dataset and the inflation impact dataset only included data on supplier, category and subcategory level. In order for the decision support tool to generate outputs on a material level, more detailed information was necessary. This included input variables such as the second-tier exposure value for each material. Another limitation was the availability of up-to-date data. Even though most data were available, some of it was out-dated, and updated information was not available. In order to ensure accurate and valid output data, the input data must be accurate as well.

Even though three datasets are presented as a result of the process, the number of datasets that were reviewed and analysed was significantly higher. Often, data that was collected, reviewed and explored was eventually declared as not useful or not necessary for the decision support tool and its objectives. For example, the data collection process included a thorough assessment on the bill of materials (BOM) of Johnson & Johnson's South African plants, which assisted in understanding what materials are needed for which final products.

Therefore, the data exploration process extended further and covered more than the previously described three major datasets. This was caused by multiple factors. First of all, the researcher needed to screen all data that is available in order to understand how Johnson & Johnson organises and structures its data, where it is stored, and who the responsible employees are that manage the data. Furthermore, it was necessary to understand connections and relationships between the datasets and how the data is created and retrieved. Additionally, finding the required data in the large and sometimes unclear IT infrastructure of Johnson & Johnson turned out to be challenging, which was also due to access restrictions. However, all of the information gathered through this extensive process could be used in the decision tool development process, as the knowledge gained helped to identify relationships between the different data variables.

6.3 Decision Support Tool Structure

Within the planning phase, the desired model outputs were defined, the input variables were identified, an understanding of the basic formulae between outputs and inputs was derived, and the required data were collected. Therefore, the construction phase was initiated, which included a data cleaning and preparation process as well as the model construction process. Within this section, the results of these processes are presented. An overview of the cleaned data that was used in order to develop the model is provided and the final decision support tool setup is presented.

6.3.1 Data Variables

The datasets collected were described in section 6.2.3 and the data exploration process (see section 6.2.4) was used in order to understand the data and the individual variables. Furthermore, issues related to the data quality and availability were identified. The significant amount of data, as well as the identified issues made it necessary to clean the data and prepare it for use within the decision support tool. As the provided data were in a MS Excel format, the data cleaning and preparation was also done using MS Excel.

The cleaning process included the removal of data that was not necessary in order to retrieve the required outputs from the dataset. Furthermore, duplicate entries were removed. Also, the spelling of data fields was checked and undesirable characters were removed. Features of MS Excel used in the preparation process included “find and replace”, “text to columns” and “remove duplicates”. Furthermore, data were formatted in a way to increase standardisation and guide the user in the construction process. During this process, attention was placed on

the identified issues presented in section 6.2.3. As far as possible, the researcher tried to resolve all errors identified within the data set, such as the "invoice UOM" and the "invoice unit valuation" data field, by addressing the issues with Johnson & Johnson in order to collect the correct data. Additionally, the material category data fields were normalised throughout the datasets. As a result, the researcher had the option to link the datasets based on the material category field. All of these measures to clean and prepare the collected data resulted in a more user friendly workbook, a reduced file size, and a well-prepared dataset that could be used for further processing in the decision support tool.

A complete list of the variables that was available for data analysis and visualisation after the data cleaning process is provided in Table 6.3. Within the Table, input variables that were required for determining the decision support tool's outputs are marked with an asterisk (*). As can be seen from the data table, the total number of input variables available for the decision support tool extends beyond the required variables. Due to the exploratory nature of the thesis, the data cleaning process did not eliminate all data that was deemed unnecessary for the decision support tool objectives. Rather, data variables that did not seem necessary for the decision support tool at this stage, but which provided information that could contribute and result in other outputs of the model that had not been defined, where retained in the dataset.

When comparing the available data variables (presented in Table 6.3) with the required base and parameter input variables defined in Table 6.2, it can be concluded that most of the required variables exist in the dataset and can be used for determining the decision support tool outputs. As identified in section 6.2.4, the second-tier model dataset only included information by supplier, category and subcategory level, and the inflation impact dataset only included information by category and subcategory level. In order to ensure a more detailed level by material, additional data would be necessary. Furthermore, additional parameter input variables were created for the purpose of forecasting and scenario planning.

Table 6.3: Data Variables after Data Cleaning and Preparation

Dataset	Variable Name	Variable Type	Description	Example
1 - Direct Materials Business Plan	Plant*	Categorical	City of plant location	Cape Town
	Material Code*	Identifier	Unique material code	1234567
	Material Code Type	Categorical	Material type (new/replacement/no change)	New
	Material Description*	Identifier	Material trade name	Material 1
	Supplier ID*	Identifier	Unique supplier code	112233
	Supplier*	Identifier	Supplier or distributer name	Supplier 1
	Current Manufacturer	Identifier	Manufacturer name	Supplier 1
	Commodity Level 1*	Categorical	Material category	CHM (Chemicals)
	Commodity Level 2*	Categorical	Material subcategory	CHM-Flavors/Fragrances
	Invoice UoM	Categorical	Invoice unit of measure (kilogram/ton/liter)	KG
	Invoice Unit Valuation	Quantitative	Invoice unit per unit of measure (1,1000)	1
	Incoterm	Categorical	Contract incoterm with suppliers	DDP (Delivered Duty Paid)
	Purchase Price (supplier currency)	Quantitative	Material price in supplier currency	10
	Supplier Currency*	Categorical	Supplier currency	EUR
	Purchase MOQ	Quantitative	Minimum order quantity	100
	Exchange Rate Utilized*	Categorical	Currency exchange rate between supplier and local currency	15
	Local Purchase Price*	Quantitative	Material price in local currency	150
	Local Currency*	Categorical	Local currency	ZAR
	RM Duties (local currency)*	Quantitative	Duty cost in local currency (depending on incoterm)	0
	RM Transport (local currency)*	Quantitative	Local transport cost in local currency (depending on incoterm)	0
	Fully Loaded RM Std Cost (local currency)*	Quantitative	Total material landed cost	150
	Total Spend*	Quantitative	Total material spend for business plan period (in local currency)	37 500 000
	Material Volumes*	Quantitative	Total purchased volumes for business plan period	250 000
	Sourcing Manager	Categorical	Name of sourcing manager	J. Doe
2 - Second-tier model	Region	Categorical	Business region	EMEA
	Commodity Level 1*	Categorical	Material category	CHM (Chemicals)
	Commodity Level 2*	Categorical	Material subcategory	CHM-Flavors/Fragrances
	Sourcing Manager	Categorical	Name of sourcing manager	J. Doe
	Supplier Currency*	Categorical	Supplier currency	EUR
	Second-tier Currency*	Categorical	Second-tier supplier currency	USD
	Supplier Name*	Identifier	Supplier or distributer name	Supplier 1
	Supplier ID*	Identifier	Unique supplier code	112233
	Contract Exchange Rate*	Quantitative	Contracted currency exchange rate with supplier or base rate for second-tier currency	13.50
	2nd Tier Forex Factor of RM*	Quantitative	Exposure of spend to second-tier currency	80%
	Feedstock	Categorical	Commodity feedstock used in material	PET
3 - Inflation model	Region	Categorical	Business region	EMEA
	Commodity Level 1*	Categorical	Material category	CHM (Chemicals)
	Commodity Level 2*	Categorical	Material subcategory	CHM-Flavors/Fragrances
	Total Inflation (%)*	Quantitative	Total inflation on material subcategory	2.00%
	Feedstock Inflation (%)*	Quantitative	Total feedstock inflation on material subcategory	1.50%
	Energy and Labour Inflation (%)*	Quantitative	Total energy and labour inflation on material subcategory	0.50%

Data variables marked with an asterisk (*) are required input variables for the decision support tool.

6.3.2 Model Setup

After the data had been prepared in a way to be used in the decision support tool, the construction of the model took place. The complete construction process was guided by the objectives of the decision support tool (Table 6.1) and the identified outputs, base and parameter input variables (Table 6.3). Furthermore, the model was built in order to fulfil key requirements of an effective model as identified by Rees (2008): being understandable in a minimal amount of time, being driven by its objectives and being free of errors.

The model was constructed in an MS Excel environment. Therefore, the format of the model was in line with the format of the input datasets. The final MS Excel workbook contained a variety of different worksheets, each being allocated a specific category (see Figure 6.2). The categories were input, lookup, calculations and output. Consistent colouring of the individual functions and sheet tabs was provided throughout the workbook. Furthermore, a table of contents provided an overview as well as a description of the individual worksheets. Within the MS Excel workbook, hyperlinks were used in order to provide a convenient way to navigate between different worksheets.

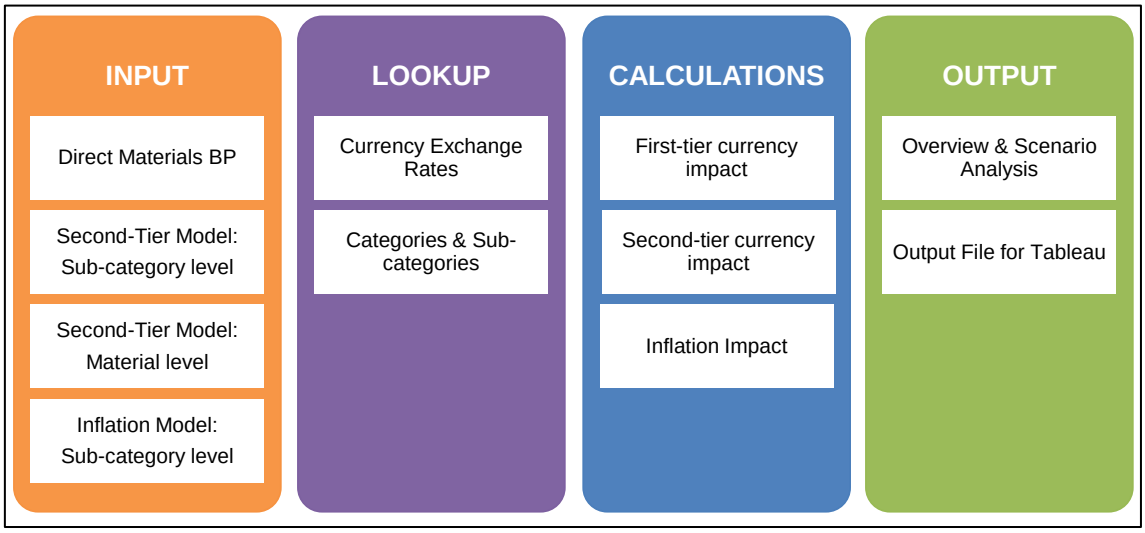

Figure 6.2: Worksheets and Categories of the MS Excel Workbook

Figure 6.2 provides an overview of the different worksheets and their allocation to the respective category. The worksheets were created according to the model construction process presented in section 5.3.2.2. In the following sections 6.3.2.1-6.3.2.3, the results of this model construction process are presented. The different worksheets are presented and the calculations that were used to determine the model outputs are provided. The table of contents worksheet of the MS Excel model is presented in Figure 6.3. Each heading represents an individual worksheet and can be accessed by clicking on the respective heading. Furthermore,

by expanding the grouping function, additional information on the respective heading is displayed (hidden in the view of Figure 6.3). This information includes a sheet description and a guideline on how to use it and – if applicable – how to input data into the respective worksheet.

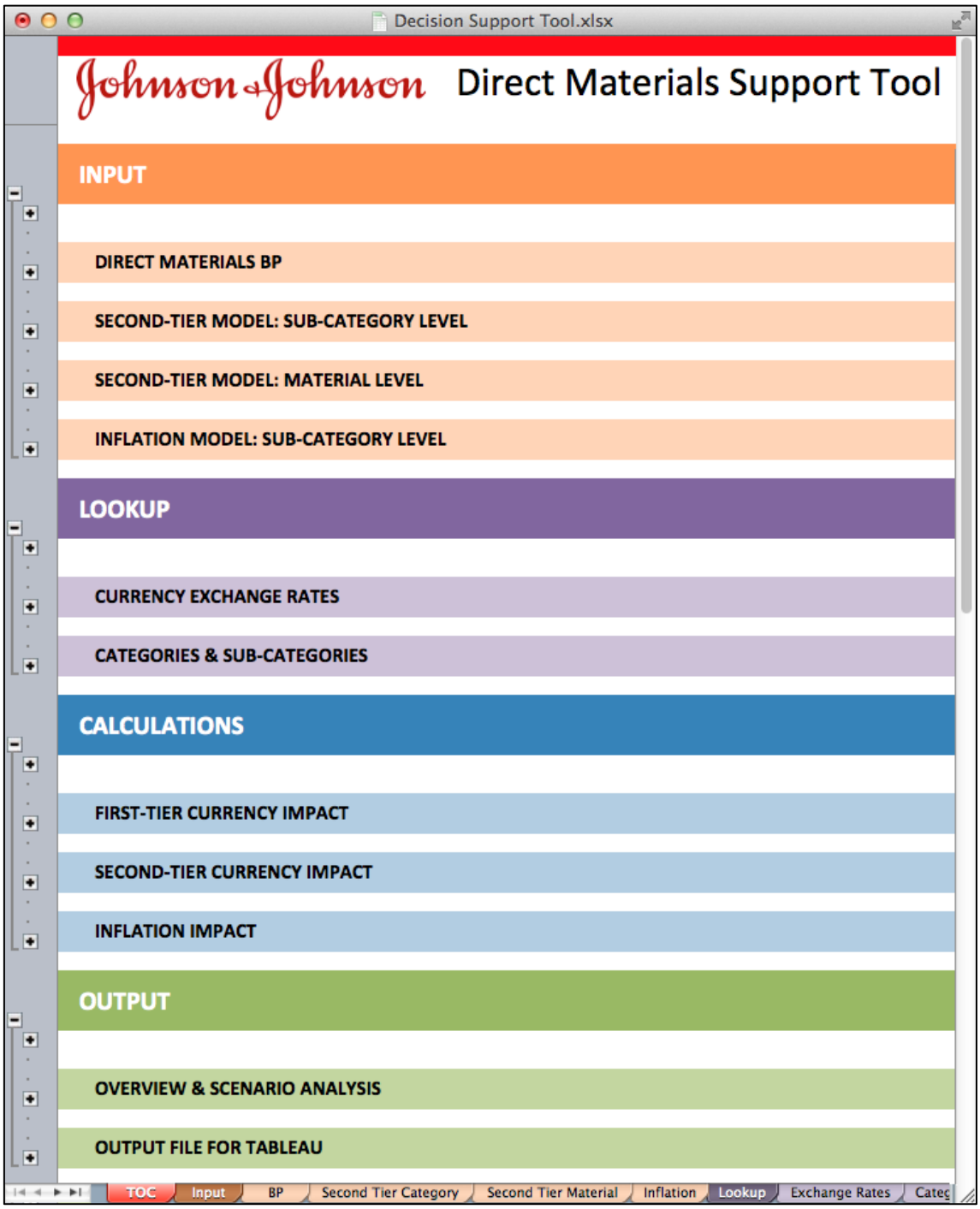

Figure 6.3: MS Excel – Table of Contents Worksheet

6.3.2.1 Input Sheets and Lookup Tables

The input section consists of four input sheets and is used in order to collect and organise all input data variables. The input overview is depicted in Figure 6.4, and the different sheets that are included in the input section are provided. It is necessary to populate the input sheets with data before using the decision support tool. The process of populating the data into the input sheets should be in sequential order, as the individual input sheets partially consolidate data and use data of other input sheets.

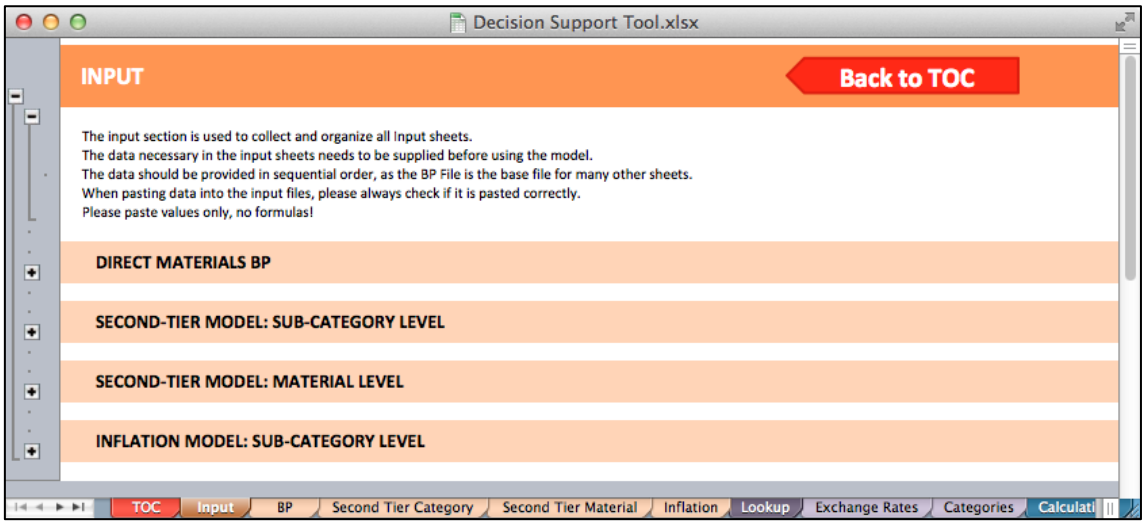

Figure 6.4: MS Excel – Input Overview

The first input sheet "direct materials BP" must be populated with all data from "Dataset 1 – Direct Materials Business Plan". As the business plan data set of Johnson & Johnson is already in a MS Excel format, the base data can simply be copied and pasted into the input sheet. In order to provide simplicity for the data inputs, the input sheet was set up in a standardised way and columns are aligned with the direct material business plan dataset. Therefore, Johnson & Johnson employees can simply copy and paste all data of the business plan dataset into the input sheet, without having to prepare the data. The workbook is constructed in a way that only relevant data variables as per Table 6.3 are used in the calculations and outputs, whereas unnecessary data remains untouched.

The next input sheet collects the information relating to second-tier currency exposure. Therefore, the input sheet "second-tier model: sub-category level" is intended for the input of all data variables of "Dataset 2 – Second-tier model", as shown in Table 6.3. As the available data of the second-tier model is only available on sub-category level and not on material level, the input sheet "second-tier model: material level" is intended for the input of the required data on a material level. For this purpose, the worksheet automatically collects material data

from the direct material BP input sheet. After that, the worksheet needs to be populated with the missing data on a material level. In order to provide guidance for the missing data fields, the information from the category data is provided and can be used in case that material data is not available.

The last input sheet is used in order to collect the data required for the inflation impact output. Therefore, data for the input variables as identified in Table 6.3 of "Dataset 3 – Inflation Model" needs to be populated in the respective data fields.

In addition to the before mentioned input sheets, Lookup tables are included in the MS Excel workbook. The lookup overview is depicted in Figure 6.5, and the different sheets that are included in the lookup section are provided. The Lookup tables are necessary for calculations and provide further information that can be useful when using the decision support tool within the MS Excel environment.

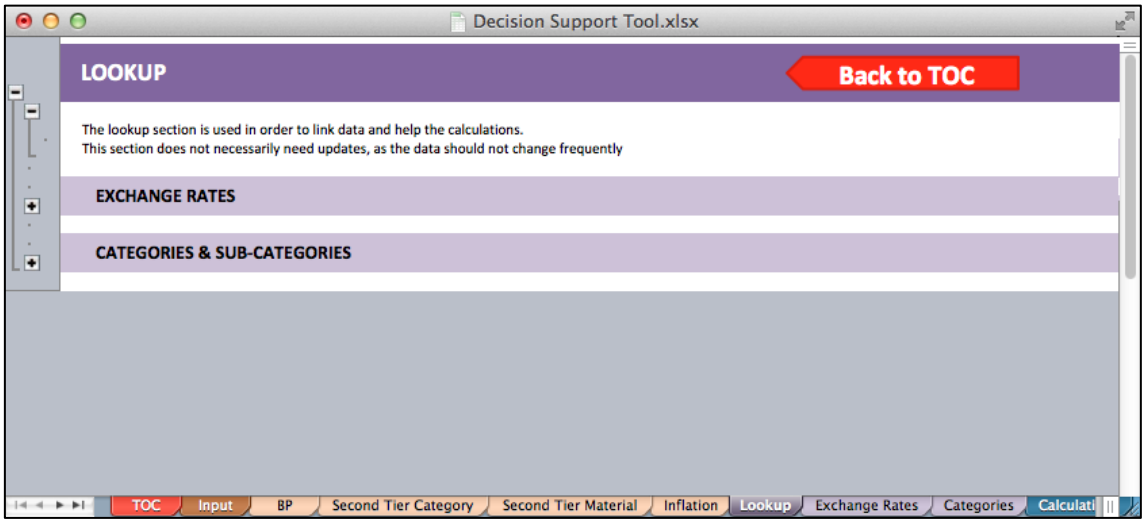

Figure 6.5: MS Excel – Lookup Overview

Two Lookup data sets are used in the model. On the one hand, the exchange rate Lookup table provides historical foreign exchange rates of major currencies. The information on this data does not necessarily need to be updated before using the tool, as it is not directly linked to calculations. However, periodical updates of the inputs should be made in order to provide users with accurate historical information. On the other hand, a Lookup table for categories and sub-categories is needed for the model. As the data exploration process showed that categories and sub-categories were not aligned between the different datasets, this Lookup table is used in order to align the respective data fields. Within this table, a complete and approved list of all categories, sub-categories, as well as its respective sourcing manager

needs to be provided. The Lookup table is then used in order to compare the data with the input datasets and to identify incorrect data fields. These fields can then be manually changed within the input sheets.

6.3.2.2 Model Calculations

A major part within the model construction process was the development of the formulae for calculating the decision support tool outputs. This process was guided by the relationships initially identified between input variables and outputs, and completed only after the datasets were collected, the input and output sheets were created, and the collected data were populated into the input sheets. Therefore, using the collected data of Johnson & Johnson was necessary in order to develop formulae and conduct calculations. The calculations sheets are consequently used in order to link the different input datasets and to use input variables in order to calculate model outputs. Within this section, the individual working sheets of the MS Excel workbook, which are used for the calculations of the individual outputs, are presented. Furthermore, the formulae and equations of how the outputs are calculated are provided.

In order to provide clear distinction between the calculated outputs, three calculation (i.e. working) sheets are used in the decision support tool. The calculations overview is depicted in Figure 6.6, and the three calculations sheets for the first-tier currency impact, second-tier currency impact and the inflation impact are provided. In line with the cost drivers identified and the required outputs of the model relating to these cost drivers (see Table 6.2), calculation sheets are used for the first-tier currency impact calculations, second-tier currency impact calculations and inflation impact calculations.

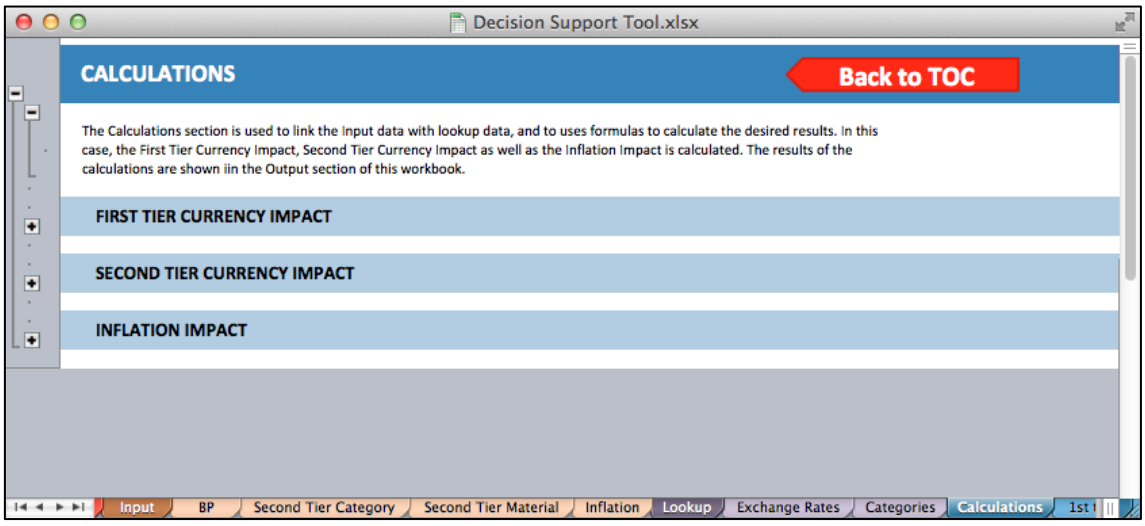

Figure 6.6: MS Excel – Calculations Overview

(a) First-Tier Currency Impact Calculation

The first-tier currency impact calculation sheet is used in order to calculate the exposure to first-tier currency risk and to determine the value of the first-tier currency impact. For this purpose, the calculation sheet uses material input variables of the direct material BP dataset. Therefore, all calculations are conducted on a material level. However, the calculations sheet does also include other input variables, such as supplier, material category and sub-category, which allow aggregation of the values on a different level.

As a first step, a MS Excel formula is used in order to evaluate whether a material is exposed to first-tier currency risk. Since the purchase of a material is only exposed to the risk of currency fluctuations when purchased in a different currency other than the local currency, the formula compares the supplier currency with the local currency. In case the two currencies are different, the material is exposed to first-tier currency risk. If a material is exposed to first-tier currency risk, the exposed spend is the total procurement spend for the material. The MS Excel formula used to determine the exposed spend is:

$$Exposed\ Spend\ First\ Tier = IF(Supplier\ Currency \neq Local\ Currency, Total\ Spend, 0) \quad (1)$$

Equation (1): Exposed Spend of First-Tier Impact

After the exposed spend is calculated, the first-tier currency impact can be calculated. However, the calculation requires a parameter input variable in the form of a forecast exchange rate related to the supplier currency. This parameter input needs to be defined by the user before calculations can be conducted. The first-tier currency impact is calculated by multiplying the total spend by the exchange rate variance of the base exchange rate (which was utilised when calculating the total spend and valid when the price was set) and a forecast exchange rate (parameter input). Therefore, the first-tier currency impact is expressed as follows:

$$First\ Tier\ Impact = Exposed\ Spend\ First\ Tier * \left(\frac{Forecast\ Exchange\ Rate}{Base\ Exchange\ Rate} - 1\right) \quad (2)$$

Equation (2): First-Tier Currency Impact

(b) Second-Tier Currency Impact Calculation

The second-tier currency impact calculation sheet is used in order to calculate the exposure to second-tier currency risk and to determine the value of the second-tier currency impact. Second-tier impacts occur when a material is purchased in local currency, but the materials include imported components that are exposed to exchange rate fluctuation. For this purpose,

the calculation sheet uses material input variables of the direct material BP dataset as well as input variables of the second-tier model dataset. As the second-tier impact needs to be determined on a material level, the input variables of the "second-tier model: material level" input sheet is used for the calculations. Resulting from that, all calculations are conducted on a material level. Similar to the first-tier currency impact calculation, the calculations sheet does include other input variables, such as supplier, material category and sub-category, which allow aggregation of the values on a different level.

The first step to determining the second-tier currency impact is to evaluate whether a material is exposed to second-tier currency risk. This information is retrieved from the input variables supplied. Therefore, the MS Excel Lookup function is used in order to link the input variables of the direct material business plan with the information of the second-tier model input sheet. As a result, all materials that are exposed to the second-tier currency impact are linked with specific data regarding the contract exchange rate, the second-tier currency as well as the second-tier forex factor. The second-tier forex factor is a percentage value that describes to what extent the material is exposed to second-tier currency impact. This value is dependent on the materials components and the proportion of sourced components from foreign countries. For example, if a material consists to 20% of a component that is sourced in a different currency, the second-tier forex factor is 20%, as 20% of the material is exposed to second-tier currency impact and exchange rate volatility. With this data, the procurement spend that is exposed to second-tier currency impact is calculated. The MS Excel formula used to determine the exposed spend is:

$$Exposed\ Spend\ Second\ Tier = Total\ Spend * Second\ Tier\ Forex\ Factor \quad (3)$$

Equation (3): Exposed Spend of Second-Tier Impact

Consequently, the second-tier currency impact can be calculated. The second-tier currency impact is calculated by multiplying the exposed spend to second-tier by the exchange rate variance between the contract exchange rate (or the exchange rate valid when setting the material price) and a forecast exchange rate (parameter input variable). Similar to the first-tier currency impact calculation, a parameter input variable in the form of a forecast exchange rate related to the supplier currency is required. This parameter input needs to be defined by the user before calculations can be conducted. The second-tier currency impact is thus expressed by the following equation:

$$Second\ Tier\ Impact = Exposed\ Spend\ Second\ Tier * \left(\frac{Forecast\ Exchange\ Rate}{Contract\ Exchange\ Rate} - 1\right) \quad (4)$$

Equation (4): Second-Tier Currency Impact

(c) Inflation Impact Calculation

The inflation impact calculation sheet is used in order to determine the value of the inflation impact by material. The procurement spend on direct materials is exposed to commodity price fluctuations, as purchased goods can have raw commodity components that are traded on commodity markets. The inflation impact is calculated by using input variables of the already existing inflation model that was developed by Johnson & Johnson. As these variables are on a subcategory level, the information needs to be linked to the material input variables. This is achieved by Lookup functions of MS Excel. In order to calculate the inflation impact by material, the following equations are used:

$$Total\ Inflation = Feedstock\ Inflation + Energy\ and\ Labour\ Inflation \quad (5)$$

Equation (5): Total Inflation Impact

$$Feedstock\ Inflation = Total\ Spend * Feedstock\ Inflation\ \% \quad (6)$$

Equation (6): Feedstock Inflation Impact

$$Energy\ and\ Labour\ Inflation = Total\ Spend * Energy\ and\ Labour\ Inflation\ \% \quad (7)$$

Equation (7): Energy and Labour Inflation Impact

6.3.2.3 Model Outputs

The output section consolidates the results of the calculations and provides an overview of the model outputs. Figure 6.7 depicts the output overview sheet, and provides links to the two worksheets included in the output section. The output section of the MS Excel model is intended to serve two purposes. On the one hand, the “output overview & scenario analysis” provides the functionality to quickly change the forecast exchange rate input parameters in order to calculate the outputs. On the other hand, an output dataset is created which is used for the import into Tableau, where the decision support tool is operated and visualised.

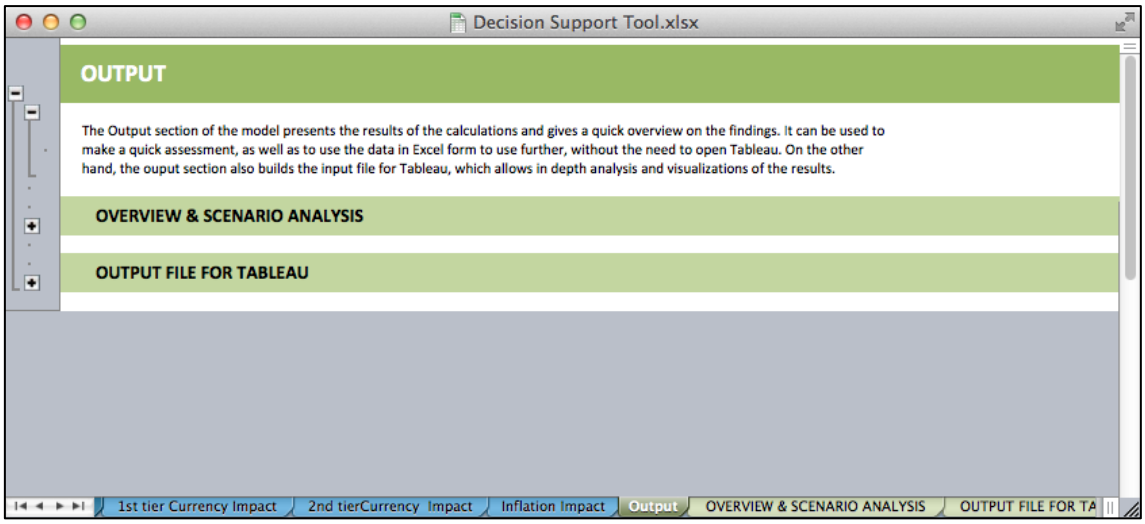

Figure 6.7: MS Excel – Output Overview

The overview and scenario analysis output sheet can be used in order to get a simple overview on the results of the calculations of the model. Forecast exchange rates can be entered as input parameters in order to calculate the model outputs. Consequently, pivot tables are used in order to summarise results and aggregate data and a data table provides information about the sensitivity of second-tier currency fluctuations on the total spend. The following outputs are provided: total spend, exposed spend to first-tier and second-tier currency impact, first-tier currency impact, second-tier currency impact and inflation impact. Additionally, a summary table provides output data by individual material and category (see Table 6.4).

Table 6.4 MS Excel – Results Data Table

Category / Material	Total Spend	First-Tier Currency impact	Second-Tier Currency impact	Inflation Impact
Category 1	14.689.243	439.392	(892.310)	(64.467)
Material 1	6.810.822	439.392	-	(64.467)
Material 2	7.878.421	-	(892.310)	-
Category 2	10.310.595	683.230	577.860	(110.671)
Material 3	5.866.947	683.230	-	(85.753)
Material 4	4.443.648	-	577.860	(24.918)
Category 3	4.497.387	(91.973)	891.722	64.135
Material 5	1.225.770	-	891.722	69.032
Material 6	3.271.617	(91.973)	-	(4.897)
Grand Total	29.497.225	1.030.649	577.272	(111.003)

The pivot tables and data tables can be adjusted by the user and changes to the input parameters result in quick recalculations. Therefore, the overview and scenario analysis output sheet gives a fast and uncomplicated overview on the model outputs. However, the functionality is limited, as MS Excel's capability of calculating large data tables can result in

slow performance. Also, the creation and updating of data visualisations requires significant time resources. As Tableau is the end-user interface of the developed decision support tool with the purpose of enhanced functionality, data visualisations and in-depth analysis, the MS Excel output sheet is supposed to only be a simple output sheet that presents the results in a summarised way.

The second output sheet presents the data table that is used as an input for Tableau Software. Within this data table, all input variables as defined in Table 6.3 are included. By using the MS Excel Lookup function, all variables of the input sheets are combined into the output data table. Also, the variables used within the calculations sheets are included in this output data table. As this data table is used as an input file by Tableau, the data table was converted to a named range in MS Excel. This ensures that the data imported by Tableau is complete. In order to generate this output sheet, no actions of the model user is required. Also, it is not necessary to define input parameters for the calculations, as the model outputs are independently calculated with input parameters that need to be defined within Tableau.

6.4 Decision Support Tool Application in Tableau

In the previous section (refer to section 6.3), the model structure and its setup were presented. As the developed model is a model-driven DSS and input datasets were collected in the MS Excel file format, the model was constructed in a spreadsheet framework. All components of the model – input, calculations and output sheets – are included in the decision support tool MS Excel workbook, which can be used in order to generate the desired outputs that were defined in section 6.2.1. However, MS Excel's capabilities relating to data visualisation is limited. In order to achieve the objectives of the decision support tool, which in addition to determining exposure and impact of the cost drivers includes a more detailed forecasting and scenario planning functionality, a more comprehensive tool is necessary which is used as the user interface of the decision support tool. As outlined in the literature review (see section 2.5.2), the user interface is the major point of contact between the decision maker and its design and format needs to be considered carefully in the development process. Therefore, Tableau Software was used in order to create an interactive user interface for the decision support tool developed in this thesis.

In the following sections 6.4.1-6.4.3, the application and usage of the final decision support tool is described. The MS Excel model was populated with the data collected from Johnson & Johnson in order to generate the output file for Tableau. Within Tableau Software, the MS

Excel model output data table was selected as the input data source and the final user interface was developed. This includes the final decision support tool, as it is used in Tableau, including a selection of key dashboards that are used in order to visualise and present the required decision support tool outputs.

6.4.1 Tableau Overview

The final decision support tool user interface is in a Tableau workbook format and consists of multiple dashboards. Each dashboard presents and visualises data in order to give the user detailed insight into the data that was previously collected and populated into the MS Excel workbook. In order to guide the user through the dashboards, a table of contents overview dashboard is shown as a start-up screen, which is depicted in Figure 6.8. From this initial table of contents dashboard, the user can navigate to any dashboard of the tool. The complete workbook is set up in an interactive format that allows the user to click through the different dashboards without having to leave full screen mode.

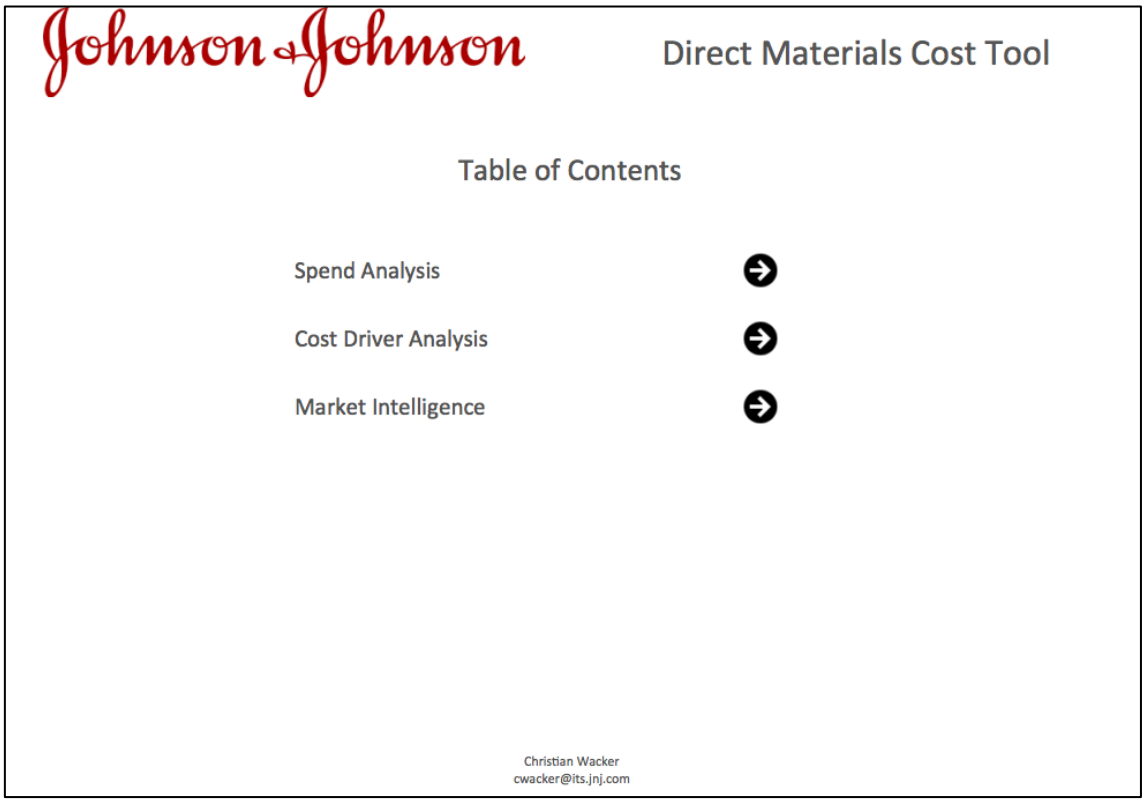

Figure 6.8: Tableau Dashboard – Decision Support Tool Table of Contents

Figure 6.9 depicts the structure of the decision support tool within Tableau. Each box of the figure represents an individual dashboard. The table of contents spend analysis and cost driver analysis dashboards are overview pages, which allow navigation to the dashboards underneath. The market intelligence field is a link to a Johnson & Johnson internal market

intelligence website. The FX Forecast Input is used for entering input parameters relating to the exchange rates, which are used for calculations. More detail on the individual dashboards is presented in the following sections 6.4.2 and 6.4.3.

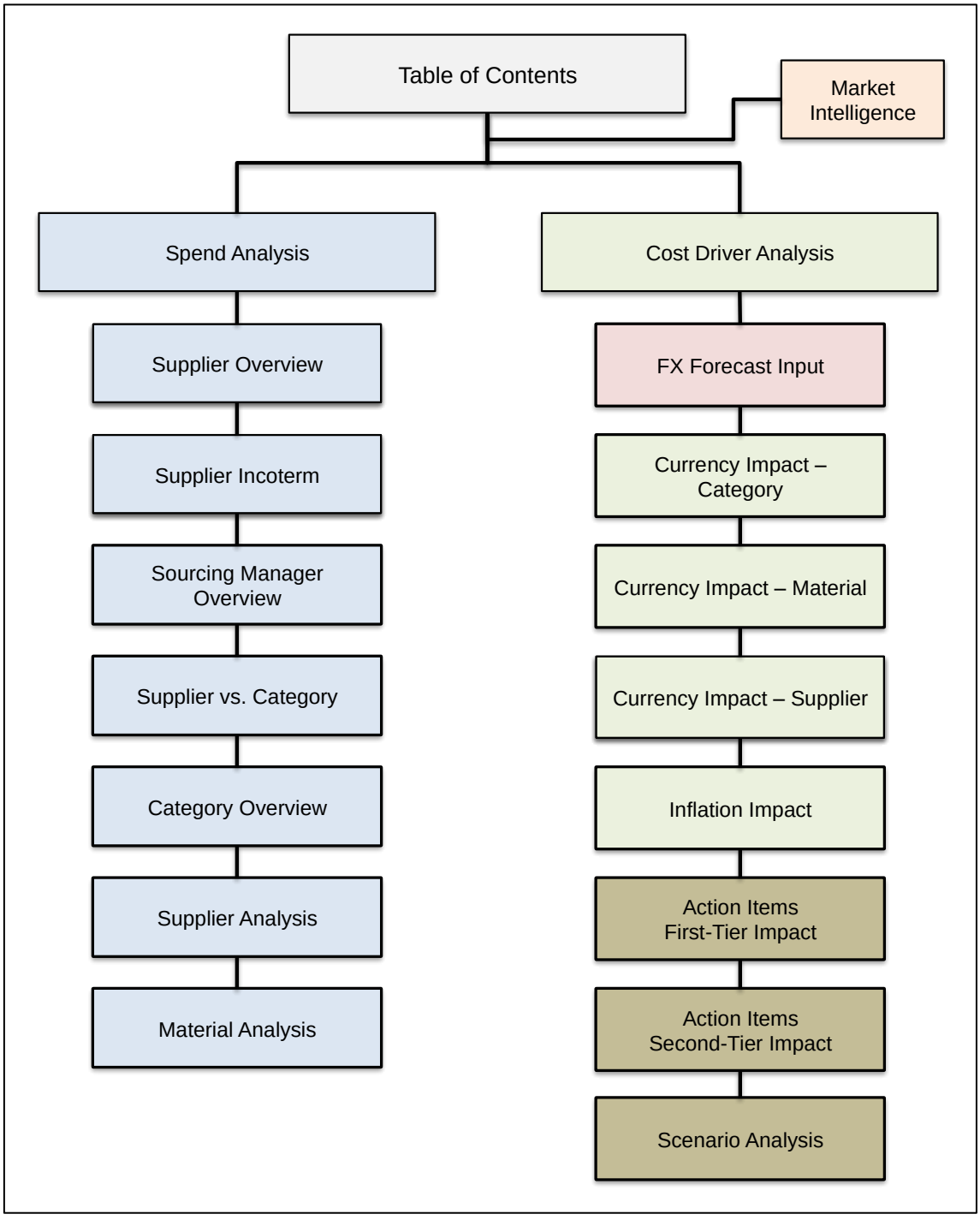

Figure 6.9: Structure and Dashboards of Decision Support Tool in Tableau

For reasons of clarity and comprehensibility, all dashboards were assigned into two broad categories. On the one hand, dashboards were created for the purpose of a spend analysis. These dashboards visualise findings on the input data variables and provide insight into

suppliers, categories and materials. On the other hand, dashboards were created for the purpose of cost driver analysis. This category consists of the dashboards that present the findings on the output variables required from the decision support tool, i.e. first-tier currency impact, second-tier currency impact and inflation impact.

6.4.2 Spend Analysis

Within section 6.3.2.3, it was explained that the output file generated with MS Excel consolidates all collected data. As Tableau uses this file as its data source, all data on suppliers, materials and categories is available for analysis and visualisation. Even though visualising the available input data variables was not defined as a main objective of the decision support tool, Tableau dashboards were created in order to explore the data and to provide better insight and understanding around the cost structure. The result is a comprehensive spend analysis that provides an in-depth understanding of the procurement spend. In total, seven different dashboards are provided in the decision support tool, each supporting the user by providing information in an effective way. By using the spend analysis overview dashboard (see Figure 6.10), the user can navigate to any dashboard of the spend analysis.

Figure 6.10: Tableau Dashboard – Spend Analysis Overview

Table 6.5 (see p. 125) provides an overview on the individual dashboards of the spend analysis and lists the different outputs that are visualised and presented in the dashboard. The overview also presents the available selection parameters, which allow users to filter data used for the visualisations as well as to modify input variables. In the following discussion, the individual dashboards are briefly described and selected dashboards are presented. Images of the complete decision support tool are provided in Appendix B.

(a) Supplier Overview

Figure 6.11 illustrates the supplier overview dashboard. Bar charts present the procurement spend of the company by supplier. The number of suppliers displayed can be changed, whereas the top N suppliers based on spend are always displayed. Furthermore, different colours within the bars represent the individual materials that are sourced from the supplier. A circle on a dual axis presents the number of materials sourced from the supplier.

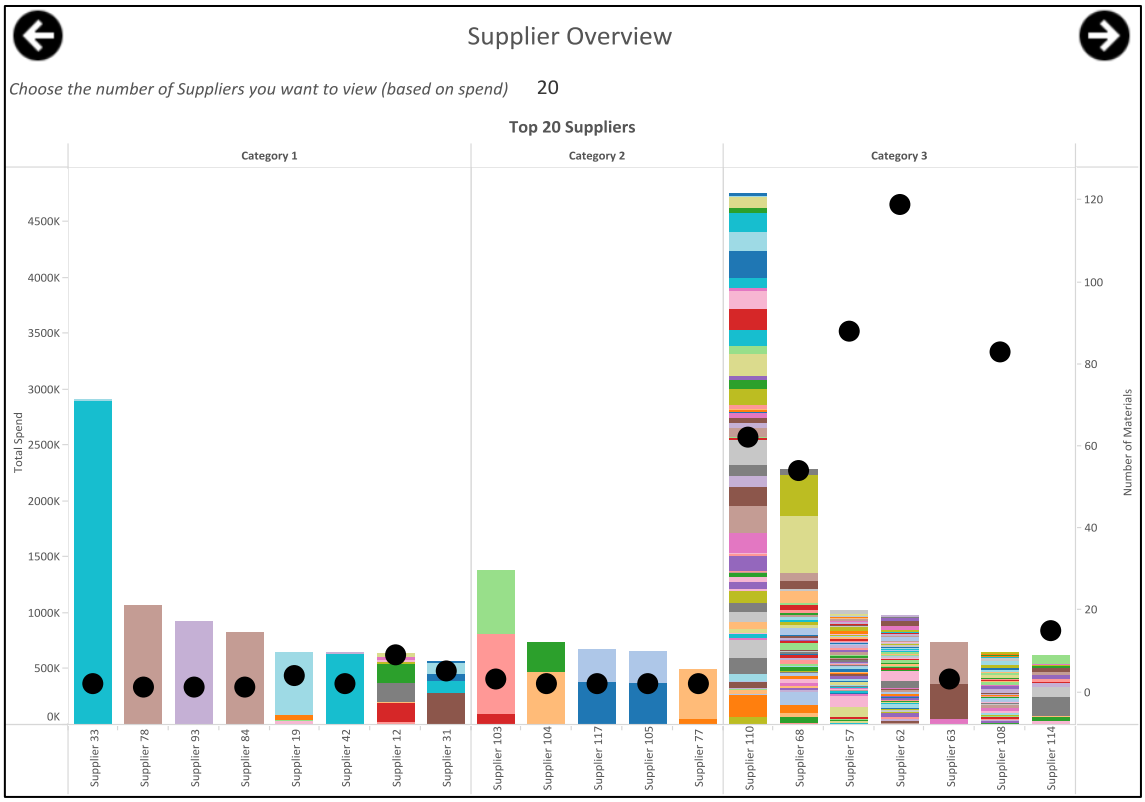

Figure 6.11: Tableau Dashboard – Supplier Overview

(b) Supplier Incoterm

The supplier incoterm dashboard is depicted in Figure 6.12. Within the dashboard, horizontal bars visualise the procurement spend by supplier. The bar colour indicates the incoterm. Additionally, a data table is used to provide a spend overview by plant location and supplier

currency. Furthermore, pie charts are displayed on a map, which display the procurement spend by Incoterm. Again, the data can be filtered by the number of top suppliers.

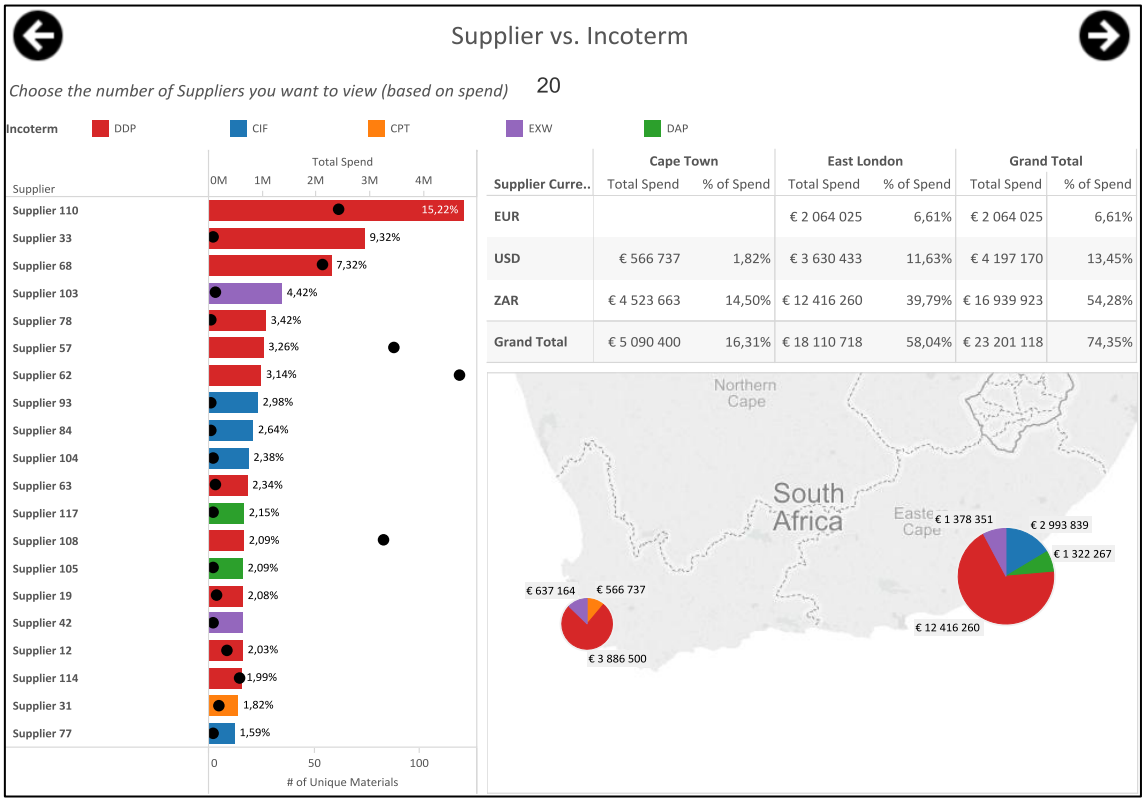

Figure 6.12: Tableau Dashboard – Supplier Incoterm

(c) Sourcing Manager Overview

As a first step, a sourcing manager must be selected. Next, a category and subcategory must be chosen. Afterwards, a supplier can be selected. As a result, a waterfall diagram will be displayed on the dashboard. Within the waterfall chart, single bars present the spend of the individual materials of the selected supplier.

(d) Supplier vs. Category

A data table presents the spend information by category and location. A category can be selected from the data table to filter the word cloud of suppliers. Furthermore, a supplier name can be selected in order to generate a waterfall diagram of the individual materials sourced from the supplier. The bar size represents the spend on the material.

(e) Category Overview

A data table presents spend information by category and location. Bar charts display the spend by subcategory and the individual number of materials of a subcategory is displayed in circles on a dual axis. Hovering over a category of the data table highlights the respective bar charts.

(f) Supplier Analysis

This dashboard can be used in order to analyse an individual supplier. Either the supplier to be analysed can be chosen directly via a drop down list, or the sourcing manager can be selected to filter the number of suppliers. A data table consequently provides a list of all materials of the supplier, including detailed information about the material, such as price, volumes and spend. Furthermore a waterfall chart and a scatter plot give visual presentations of the data.

(g) Material Analysis

Figure 6.13 displays the material analysis dashboard. As a first step, the number of materials can be defined. Similar to the supplier parameter used within other dashboards, the data is filtered to the top N materials based on spend. A data table presents the spend information by category and location and horizontal bars represent the procurement spend by material, while the colour of the bar indicates the incoterm that is used for the individual material. Furthermore, a Pareto chart displays the relationship between the cumulative number of materials and total spend in percentage terms.

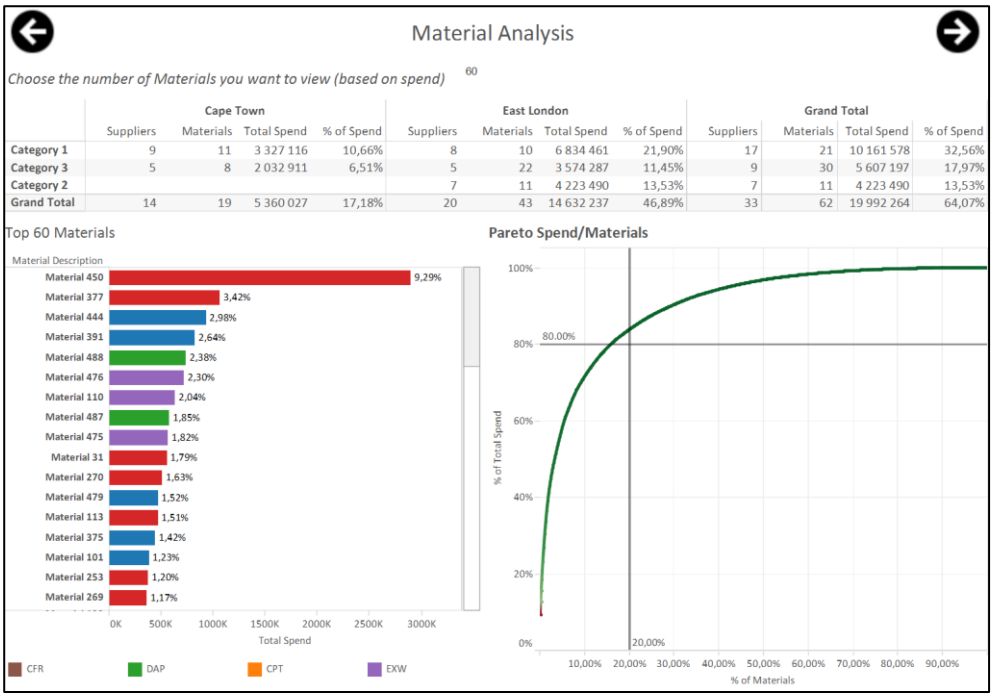

Figure 6.13: Tableau Dashboard – Material Analysis

Table 6.5: Outputs and Selection Parameters of Spend Analysis Dashboards

Dashboard Category	Dashboard Name	Outputs	Selection Parameters
Spend Analysis	Supplier Overview	By supplier and category: ● Spend ● Number of materials ● Spend of individual material	● Number of suppliers
	Supplier Incoterm	By supplier: ● Spend ● Number of materials ● Spend by incoterm By plant and supplier currency: ● Spend ● Spend as % of total spend By incoterm and location: ● Spend	● Number of suppliers
	Sourcing Manager Overview	By sourcing manager, category and subcategory and supplier: ● Spend ● Spend as % of total spend by material	● Sourcing manager ● Category and subcategory ● Supplier
	Supplier vs. Category	By category and location: ● Spend ● Spend as % of total spend ● Number of suppliers ● Number of materials By supplier and material: ● Spend ● Spend as % of total spend	● Number of suppliers ● Category ● Supplier
	Category Overview	By category and location: ● Spend ● Spend as % of total spend ● Number of suppliers ● Number of materials By category and subcategory: ● Spend ● Spend as % of total spend ● Number of materials	● Category
	Supplier Analysis	By supplier: ● Supplier ID ● Number of materials ● Spend ● Spend as % of total spend By supplier and material ● Subcategory ● Incoterm ● Supplier currency ● Local currency ● Material price ● Volume ● Spend ● Spend as % of total spend	● Supplier ● Sourcing manager
	Material Analysis	By category and location: ● Spend ● Spend as % of total spend ● Number of suppliers ● Number of materials By material ● Spend ● Spend as % of total spend ● Incoterm	● Number of materials

6.4.3 Cost Driver Analysis

In addition to visualising the collected data on procurement spend, Tableau Software is used in order to conduct the calculations that generate the required decision support toll outputs. As outlined in section 6.3.2.3, the output sheets created in MS Excel only included a basic

overview about the procurement spend and the individual impacts of the cost drivers. However, a more detailed analysis is required in order to get information on a more detailed level, which is needed in order to achieve the decision support tool objectives as presented in Table 6.1. Therefore, a number of dashboards were created in Tableau, presenting all outputs related to the individual cost drivers. As Tableau uses the MS Excel output file as its input data source, all data variables are available to perform the necessary calculations. Therefore, the same calculations and formulae as presented in section 6.3.2.2 are reapplied in Tableau and input selection parameters allow the user for quick modifications of parameter input variables. A comprehensive cost driver analysis is provided as a part of the decision support tool, including visualisations of the tools outputs. In total, the cost driver analysis consists of eight individual dashboards, each providing insight into the analysed data in order to increase the understanding on the cost drivers of procurement spend. Similar to the spend analysis, the cost driver analysis includes an overview dashboard for navigation (see Figure 6.14).

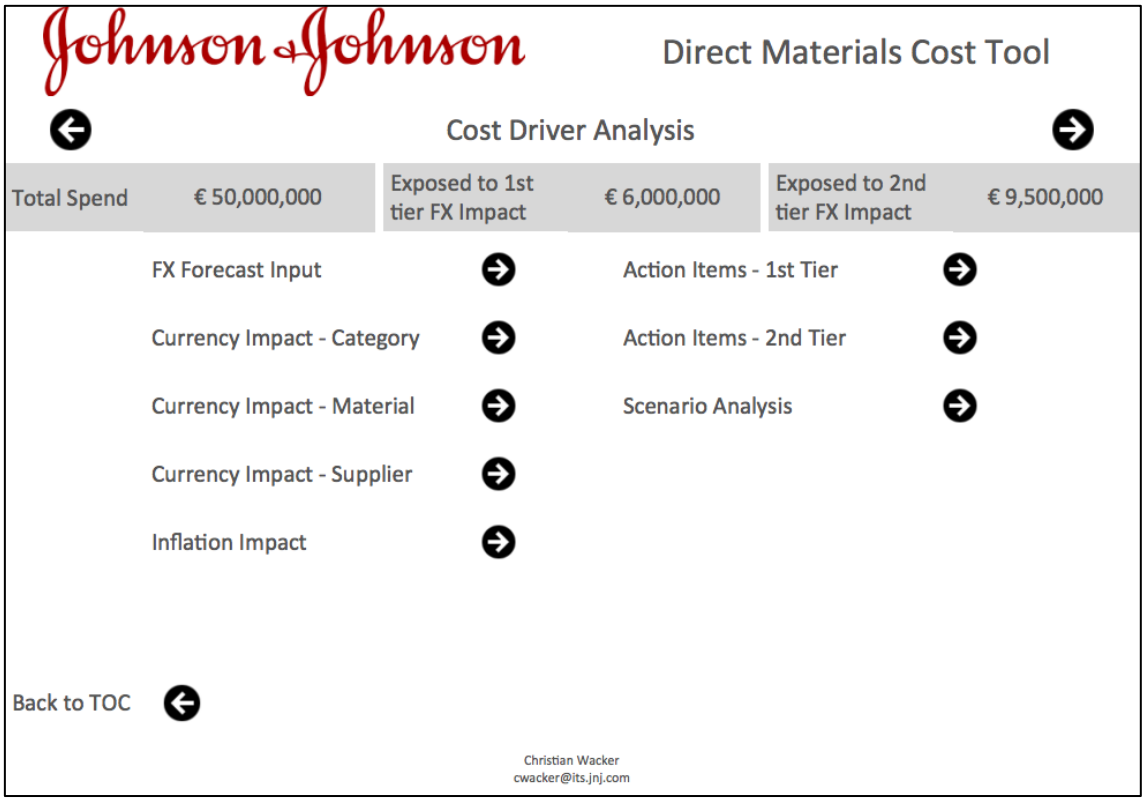

Figure 6.14: Tableau Dashboard – Cost Driver Analysis Overview

Table 6.6 (see p. 131) provides an overview of the individual dashboards of the cost driver analysis and lists the different outputs that are visualised and presented in the dashboards. The overview also presents the available selection parameters, which allow users to filter data used for the visualisations as well as to modify input variables. In the following sections (a)-

(h), the individual dashboards are described briefly and selected dashboards are presented. Images of the complete decision support tool are provided in Appendix B.

(a) FX Forecast Input

The first dashboard of the cost driver analysis is used for the input of forecast foreign exchange rates. These inputs are necessary for the decision support tool in order to conduct the calculations. Additionally, a live feed of major foreign exchange rates are provided in the form of an embedded website.

(b) Currency Impact – Category

Within the dashboard, horizontal bars visualise the calculated currency impacts on a category and subcategory level. The impacts are calculated with the foreign exchange rate inputs entered in the first dashboard. However, if an adjustment of the rates is necessary, a parameter allows modification of the exchange rates within the dashboard. Additionally, a data table aggregates the results of the total spend, the exposed spend to first- and second-tier currency impact and the actual values of the first- and second-tier impact. A category can be selected from the data table to filter the data of the dashboard.

(c) Currency Impact – Material

Two bar charts visualise the calculated currency impacts on material level. The impacts are calculated with the foreign exchange rate inputs entered in the first dashboard. However, if an adjustment of the rates is necessary, a parameter allows modification of the exchange rates within the dashboard. Additionally, a data table aggregates the results of the total spend, the exposed spend to first- and second-tier currency impact and the actual values of the first- and second-tier impact. A category can be selected from the data table to filter the data of the dashboard.

(d) Currency Impact – Supplier

Figure 6.15 displays the dashboard of the currency impact per supplier. Similar to the material view, two bar charts visualise the calculated currency impacts on supplier level. The impacts are calculated with the foreign exchange rate inputs entered in the first dashboard. However, if an adjustment of the rates is necessary, a parameter allows modification of the exchange rates within the dashboard. Additionally, a data table aggregates the results of the total spend, the exposed spend to first- and second-tier currency impact and the actual values of the first-

and second-tier impact. A category can be selected from the data table to filter the data of the dashboard.

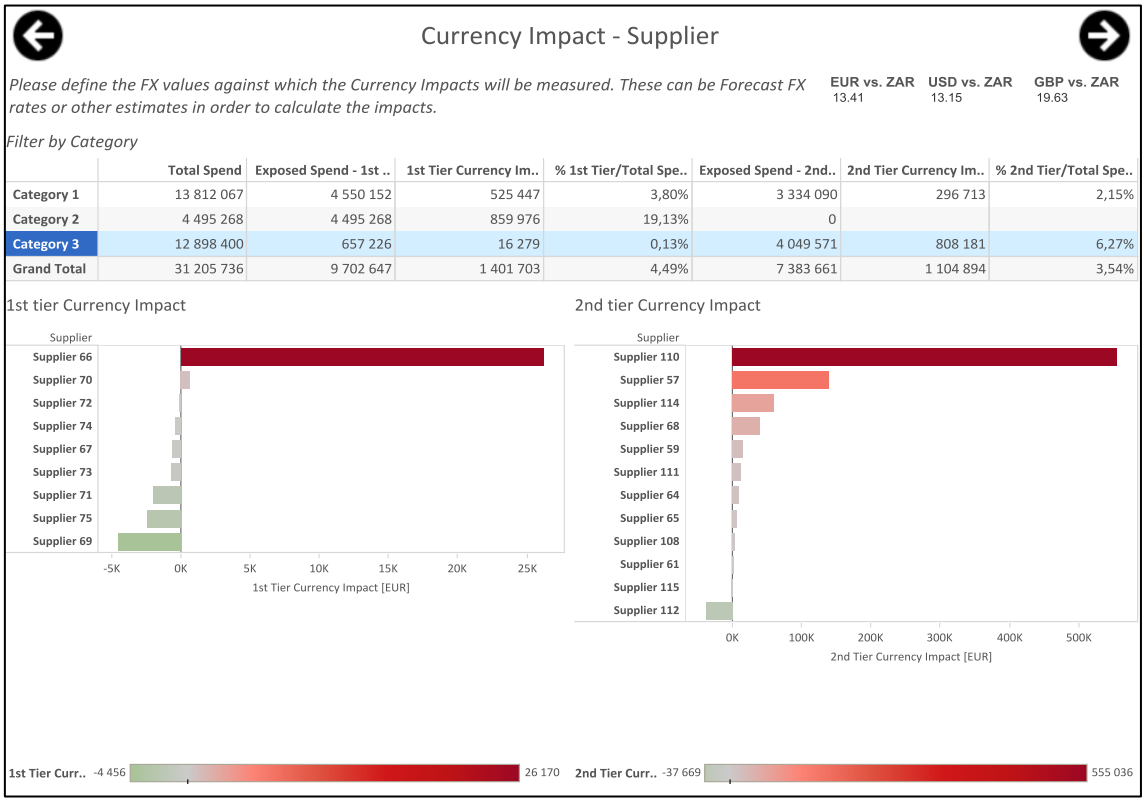

Figure 6.15: Tableau Dashboard – Currency Impact by Supplier (filtered by Category 3)

(e) Inflation Impact

The impact of inflation on the procurement spend is presented in this dashboard. A data table provides figures of the total inflation, feedstock inflation, as well as energy and labour inflation by material category. Additionally, a bar chart visualises the impact of the cost driver on a subcategory level. Selecting a category of the data table can be used in order to filter the bar chart visualisation.

(f) Action Items: First-Tier Impact

This dashboard provides a list of materials that can be considered as action items. These items are materials with first-tier currency impact that is unfavourable for the organisation. The number of materials presented in the list can be filtered by first-tier impact. The list is sorted by first-tier impact in an ascending way and visualised by horizontal bars. Additionally, selecting an action item reveals more information, such as supplier, material price, supplier currency, material spend, base exchange rate, and an adjusted material price. This adjusted

price takes the forecast exchange rate and first-tier impact into consideration, and can be considered as the target price based on the new exchange rate.

(g) Action Items: Second-Tier Impact

Similar to the first-tier impact action items dashboard, a list of action item materials are provided within the second-tier impact action items dashboard (see Figure 6.16). These items are materials with a negative second-tier currency impact. The number of materials presented in the list can be filtered by its value. Materials are sorted by second-tier impact in an ascending way and visualised by horizontal bars. Additionally, selecting an action item reveals more information, such as supplier, material price, second-tier currency, second-tier forex factor, material spend, contract exchange rate, and an adjusted material price. This adjusted price takes the forecast exchange rate and second-tier impact into consideration, and can be considered as the target price based on the new exchange rate.

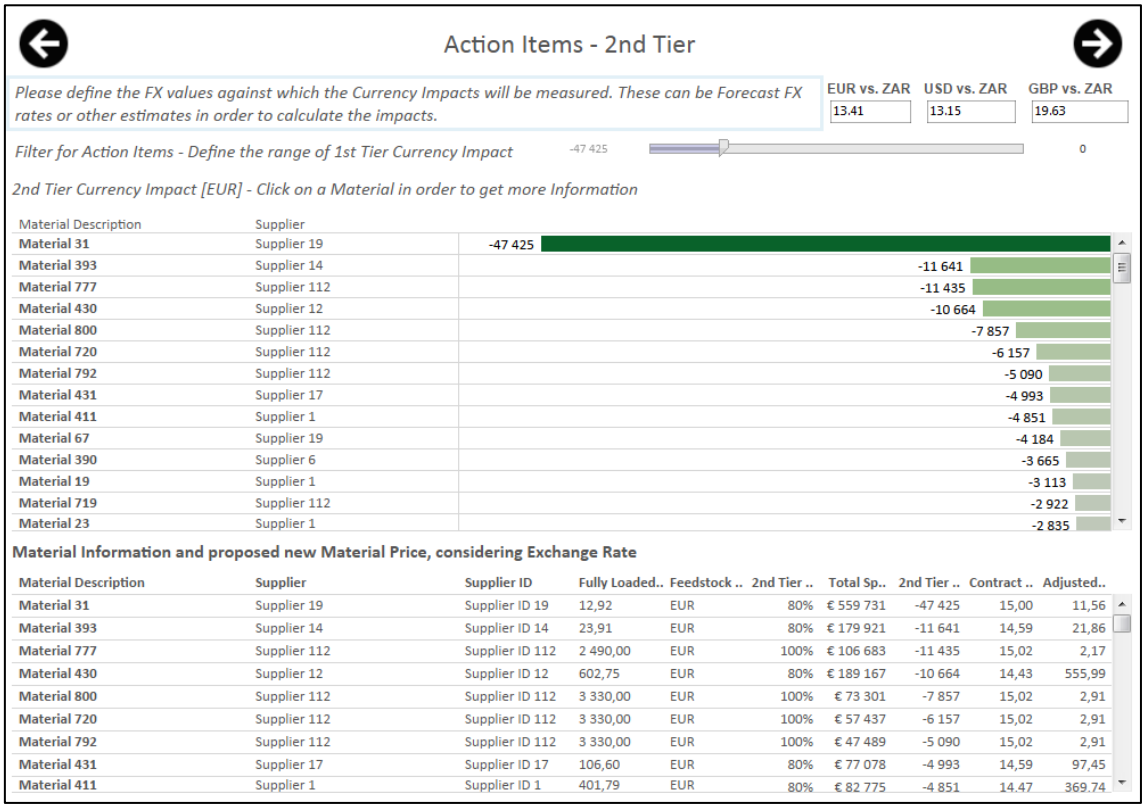

Figure 6.16: Tableau Dashboard – Second-Tier Impact Action Items

(h) Scenario Analysis

The scenario analysis dashboard provides the functionality to create two different scenarios (see Figure 6.17). The two scenarios are in addition to the already existing forecast scenario that is based on the forecast exchange rates entered in the FX forecast input dashboard. On top

of the dashboard, the aggregate first- and second-tier currency impact is presented in terms of horizontal bar charts. Similar to previous dashboards, the values are calculated based on the input exchange rate parameters. In addition to this overview, the screen is divided vertically, displaying the two different scenarios that can be interactively created by the user on each side. In order to create a scenario, the user can define a change of each exchange rate in terms of a percentage. This change can be positive or negative, and needs to be set for each exchange rate individually. As a result, the respective scenario exchange rate is presented. Consequently, the first- and second-tier currency impacts are recalculated, using the scenario exchange rates within the calculation. By scenario, the difference between to the base case is presented, and the first- and second-tier currency impact is provided and visualised with horizontal bars.

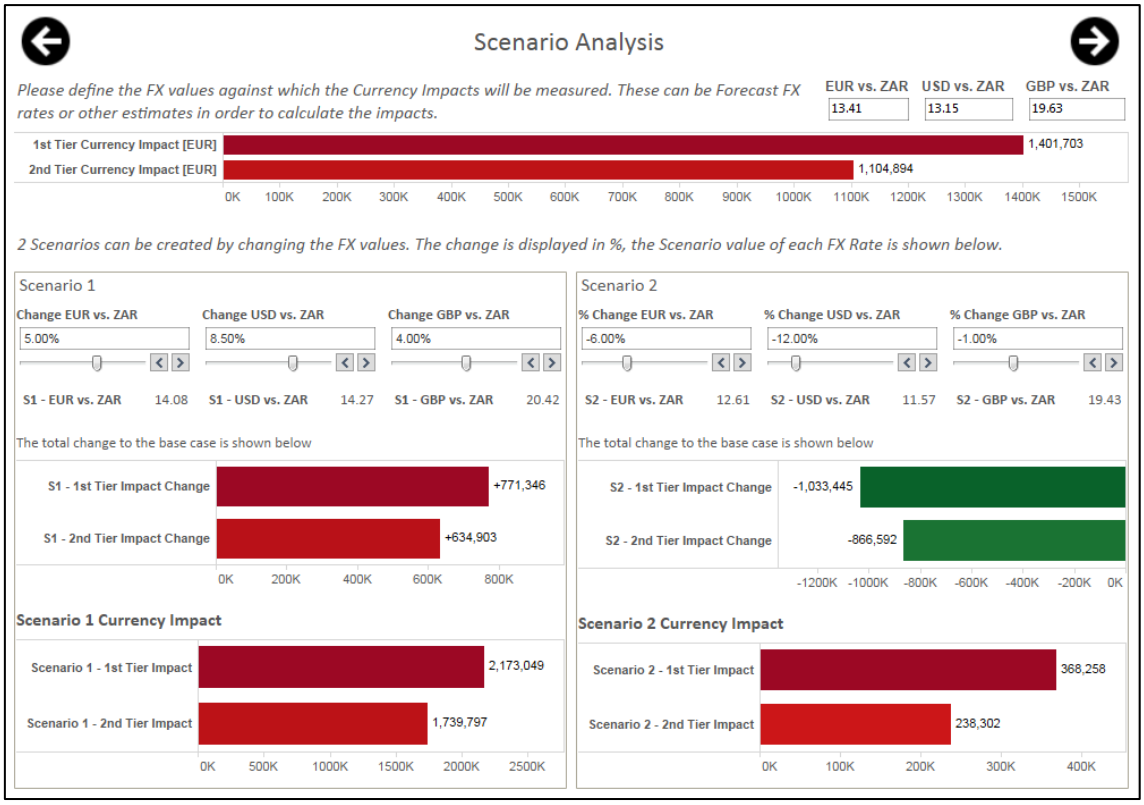

Figure 6.17: Tableau Dashboard – Scenario Analysis

Table 6.6: Outputs and Selection Parameters of Cost Driver Analysis Dashboards

Dashboard Category	Dashboard Name	Outputs	Selection Parameters
Cost Driver Analysis	FX Forecast Input	• Live market ticker of FX rates	• Forecast foreign currency exchange rates
	Currency Impact - Category	By category: • Spend • Exposed spend to first-tier impact • First-tier impact • First-tier impact as % of total spend • Exposed spend to second-tier impact • Second-tier impact • Second-tier impact as % of total spend By subcategory: • First-tier impact • Second-tier impact	• Forecast foreign currency exchange rates
	Currency Impact - Material	By category: • Spend • Exposed spend to first-tier impact • First-tier impact • First-tier impact as % of total spend • Exposed spend to second-tier impact • Second-tier impact • Second-tier impact as % of total spend By material: • First-tier impact • Second-tier impact	• Forecast foreign currency exchange rates
	Currency Impact - Supplier	By category: • Spend • Exposed spend to first-tier impact • First-tier impact • First-tier impact as % of total spend • Exposed spend to second-tier impact • Second-tier impact • Second-tier impact as % of total spend By supplier: • First-tier impact • Second-tier impact	• Forecast foreign currency exchange rates
	Inflation Impact	By category: • Spend • Energy and labour inflation impact • Feedstock inflation impact • Total inflation impact • Total inflationilmpact as % of total spend By category and subcategory: • Total inflation impact	
	Action Items: First-Tier Impact	By material and supplier: • First-tier impact • Material price • Supplier Currency • Spend • Base exchange rate • Adjusted material price	• Forecast foreign currency exchange rates • Range filter for first-tier impact
	Action Items: Second-Tier Impact	By material and supplier: • Second-tier impact • Material price • Second-tier currency • Second-tier forex factor • Spend • Contract exchange rate • Adjusted material price	• Forecast foreign currency exchange rates • Range filter for second-tier impact
	Scenario Analysis	• Total first-tier impact • Total second-tier impact By scenario: • forecast currency exchange rate after change • first-tier impact difference to base scenario • second-tier impact difference to base scenario • first-tier impact • second-tier impact	• Forecast foreign currency exchange rates By scenario: • % Change to foreign currency exchange rates

Chapter 7 - Results and Interpretation

7.1 Introduction

In Chapter 6, the decision support tool developed during this study was presented. This included a description of the results of the complete decision support tool development process and an overview of the functionality of the tool, as well as of the different outputs it generates. The model structure, its calculations as well as the application, which is used as a DSS user interface, were presented and a variety of dashboards were graphically shown. After the presentation of the decision support tool in the previous chapter, this chapter provides a discussion regarding the results of this research study. This includes not only the model's outputs and its implications for the case company, but also discusses the aspects of validity and reliability of the research results. Within this chapter, the results of the research are consolidated. Therefore, the results of the created decision support tool as well as the results of the qualitative research, i.e. the findings of the literature review as well as the findings resulting from the input discussions and observations that were presented in the case description, are included. Additionally, research limitations that the researcher faced during the study are discussed. In the following final chapter (Chapter 8 - Conclusions and Recommendations), the synthesis of the results and the literature review are used in order to evaluate whether the research objectives of this thesis were achieved.

7.2 Application of the Decision Support Tool

Within this section, the research results relating to the development of a decision support tool for managing direct material cost are discussed. The findings of the qualitative and quantitative research conducted are consolidated and interpreted. Even though the final decision support tool was already presented and described in Chapter 6, this section begins with the background on why it was necessary to develop such a tool and discusses the findings relating to this question. Afterwards, the results of the model itself, its structure, and how it can be used are discussed.

7.2.1 Need of a Decision Support Tool for managing Direct Material Cost

Within Chapter 1, the background and problem formulation were presented that derived the research objective of this thesis: the development of a decision support tool that measures and analyses the impact of cost drivers on direct material cost and provides decision makers

insight information on cost drivers. Such a tool was necessary, as a gap existed between the perceived impacts that affect material cost and the actual value of the impact, as the information was simply not available. As this problem was formulated on the case of Johnson & Johnson, it was necessary to identify and review what others had done before with regards to cost management in procurement, and whether other companies are in similar situations, in order to make claims about the reliability and external validity of the research.

The initial purpose of the literature review was to get an overall understanding of the procurement function in general, the benefits and risks of global procurement, as well as to identify practices used for managing cost within procurement. First of all, it was identified that the importance of the procurement function within organisations has only began to receive attention by top management in the last years. This is not surprising, as procurement was previously seen as a simple transactional function only, which is responsible for purchasing goods and materials. Today, procurement is seen as a strategic function of an organisation that integrates all processes related to the provision of goods and services (Leenders *et al.*, 2006). Companies use effective and efficient sourcing strategies in order to minimise procurement spend, while maintaining high quality standards and satisfying customers' needs. Especially with regards to supplier selection, decisions are not to be made by just comparing purchasing prices and transaction cost. Researchers believe that a complete understanding of all related cost that result from procurement decisions is necessary in order to make appropriate decisions. Johnson & Johnson, being the investigated company within this study, has set up a strategic procurement function and is aware of its importance. However, there is still a lack of understanding with regards to material cost and its cost drivers. Johnson & Johnson's situation therefore is similar to what has been identified within previous research and it is not surprising that they require better insight into their material cost structure.

Furthermore, the literature review has shown that several models and frameworks that intend to improve performance of the procurement function and to manage cost have been developed in the past. Kraljic (1983) was one of the first researcher that recognised the importance of a strategic procurement function and explained that purchasing needs to be part of the corporate strategy within organisations. He proposed a framework that classifies purchased items into different categories, depending on the items profit impact and supply risk. Resulting from the classification, the framework proposes further measures in order to ultimately develop specific sourcing strategies for individual items based on their classification. The items that

add significant value to the organisation, but at the same time are exposed to the highest risk are the strategic items that require the biggest attention and dedicated procurement strategies. However, in order to identify these items, an understanding of all purchased items needs to be available, which provides insight and information that enable classification.

Next to the Kraljic model that is intended to reduce procurement risk, while also at the same time leverage purchasing power to reduce purchasing spend and improve profits, the concept of TCO was developed, which intends to provide a comprehensive knowledge on all occurring costs within organisations. The aim of a TCO model is to reveal all costs relating to the purchase of an item in order to find major cost drivers. The knowledge of major cost drivers shall then be used in order to enable organisations to minimise its TCO and increase profitability. Even though a significant number of TCO models and categorisation frameworks exist, the literature review also revealed that there is no standard model for TCO. Companies need to develop their own model, based on the specific needs and requirements to the model by the organisation. Also, TCO models can be very complex and require significant resources for development and operation. Therefore, it seems that even though organisations and researchers are aware of the benefits that models such as TCO or Kraljic can bring, they are rarely applied in practice. Again, these findings are consistent with the situation of Johnson & Johnson. Observations have shown that Johnson & Johnson does not have a comprehensive TCO model in use within its procurement function, even though the need for a transparent cost structure was identified. Therefore, the development of a tool that includes aspects of TCO and which possibly could support the classification of items similar to the Kraljic model was found to be a reasonable approach.

Next to models identified and frameworks that exist, the literature review has identified several risks of global sourcing, including financial risks such as foreign exchange rate fluctuation as well as commodity price risk. These risks were also identified at Johnson & Johnson as cost drivers of their procurement spend. Therefore, further investigation into these cost drivers was necessary. As Johnson & Johnson South Africa procures many of their materials from global suppliers that use different currencies than the South African Rand, each change in exchange rate has an impact on the cost. Similar, changes on the commodity markets have consequences on material prices. Based on these findings, it was necessary to develop a tool that incorporates these cost drivers and provides insight into the risk exposure.

In the context of the FMCG industry, the literature review has identified a number of players that are exposed to the same risks relating to procurement as Johnson and Johnson. A total of six companies that engage in the FMCG market in South Africa were reviewed. Even though this research was a comparison of a qualitative nature and only data available to the public was used, the analysis showed similarities between operations and organisational structure. Furthermore, all companies analysed experience similar risks relating to the procurement of materials. The increasing competition within the highly competitive FMCG industry combined with increasing cost pressure and volatile currency and commodity markets are considered major challenges throughout these companies. Every company has indicated that the international operations are exposed to foreign currency risk. Especially in South Africa, the currency volatility and the depreciation of the ZAR against major currencies have a significant impact on purchasing prices of materials and finished goods sourced internationally. In order to mitigate the risk of fluctuating currencies, most companies use financial instruments, such as forward exchange rate contracts or swap options. As all companies are aware of the risk that fluctuating exchange rates and commodity prices expose to their business, risk management business units have been set up. When conducting global procurement, companies need to understand how sourcing from other countries and currencies affect their businesses. As all of the companies reviewed experience the same challenges and risks, it can be assumed that the decision support tool that gives access to more transparent cost could not only be useful for Johnson & Johnson, but also for other companies engaging in similar market environments. Therefore, validity of the research results is provided.

Resulting from the findings of the literature and observations of Johnson & Johnson, it is clear that a decision support tool would increase transparency of the material cost structure, as similar models and frameworks were developed before with similar objectives. Cost management within the procurement function needs to be considered as a strategic process of major importance, based on the highly competitive market environment of the FMCG industry and the many different risks to which companies are exposed. A simple and user friendly decision support tool can support the strategic decision-making process that is needed in order to cope with the identified risks and to realise the benefits of global procurement. The risks identified that Johnson & Johnson is experiencing are risks related to global sourcing that are widely recognised in literature and, therefore, can be seen as natural for companies that engage in global procurement activities. Other companies that engage in the same market environment such as Johnson & Johnson were analysed in order to evaluate whether they are

exposed to the same risks. The analysis revealed that all of the organisations investigated are experiencing similar risks relating to procurement. Resulting from that, one can conclude that the application of the decision support tool is not limited only to the case company, but also to other companies that procure direct materials on a global level.

7.2.2 Model Development and final Model Structure

The decision support tool created within this study was developed based on a structured methodology. The process expanded over three different phases, each consisting of a number of different process steps (see section 5.3). As the applied methodology to develop the model was based on financial modelling processes that were identified in the available literature, it was ensured that the model includes all the key components and fulfils all the requirements of a model-driven DSS. As identified in the literature review, a DSS consists of three components: (1) the data component, (2) the model component and (3) the user interface (see Figure 2.4). The decision support tool developed includes all of the before mentioned three components and makes use of two software applications. The structure of the decision support tool, including its components, is illustrated in Figure 7.1. The structure consists of the MS Excel part and the Tableau part. Both of theses components provide a user interface for the decision maker in order to access data. Also, both components include a data and a model component. In combination, the decision maker has to choice which program he uses to access the data, even though it must be noted that the Tableau part provides a larger functionality.

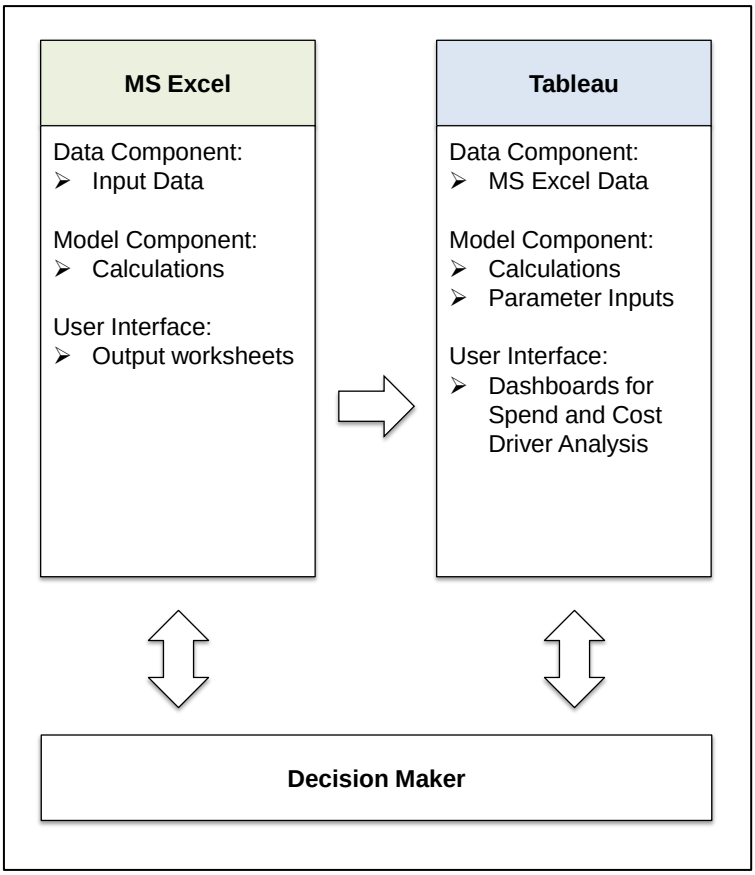

Figure 7.1: Decision Support Tool Structure

On the one hand, MS Excel is used in order to collect all the input data. MS Excel was chosen as an application to collect all input data, as Johnson & Johnson works in a Microsoft environment and employees are familiar with the application. Therefore, a smooth implementation of the model into the organisation is possible. The decision support tool created can be considered a model-driven DSS, as it uses financial calculations as well as simulation and "what-if" analysis in order to examine sensitivities between variables. As one of the characteristics of a model-driven DSS is its accessibility and usability, developing the model in a spreadsheet-based application was the most feasible. The MS Excel model, which was presented in section 6.3, includes all three components of a DSS. The input worksheets are the data component of the DSS. All calculations and outputs depend on the data stored in the input sheets. Therefore, it is essential that all entered data are correct and in the correct format in order to receive accurate results. The input data of the decision support tool developed used different datasets and included a number of different variables (see Table 6.3). The data were collected from Johnson & Johnson and leveraged already existing models on direct material cost. The data collection, exploration and cleaning processes were described in the previous chapter. Due to the amount of data, this process required significant time and interaction with Johnson & Johnson in order to collect the necessary data for the required

outputs. Furthermore, several parameter inputs were identified that are needed for the model's calculation. The result was a comprehensive data component of the decision support tool, which consists of multiple inputs. The inputs to the decision support tool are illustrated in Figure 7.2 and consisted of the direct materials BP file, the second-tier impact model, the inflation model, as well as parameter inputs. The wide range of inputs to the data component shows that a comprehensive data set was created, that used all available data necessary in order to create a functional decision support tool.

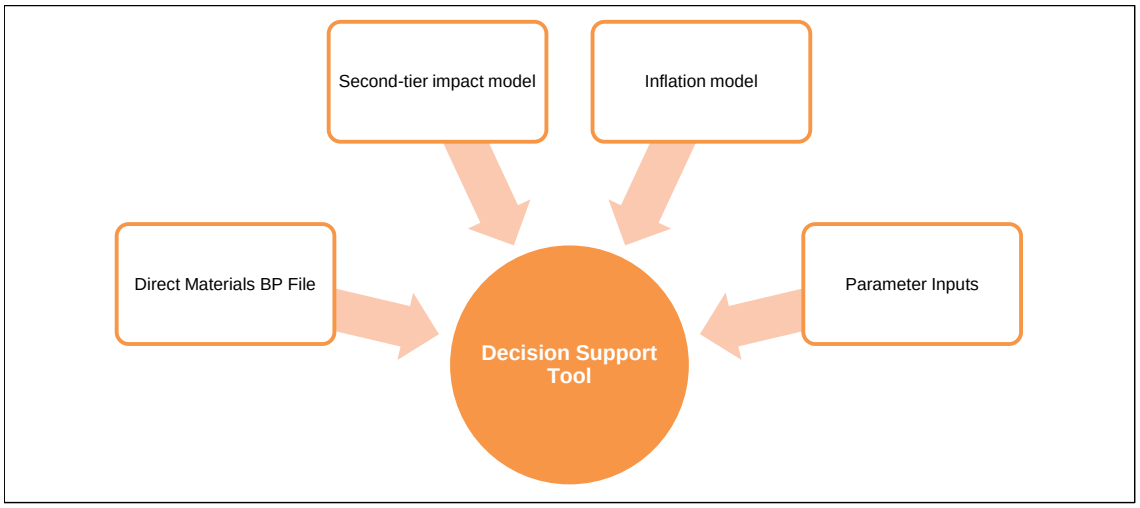

Figure 7.2: Decision Support Tool Data Component

Next to the data component, the MS Excel workbook also contains a model component as well as a user interface component. The model component consists of multiple calculation sheets, which use algebraic formulas in order to derive the desired outputs. These calculations use the date of the input variables, i.e. base inputs and parameter inputs. The user-interface of the MS Excel workbook is the MS Excel application itself. Output worksheets provide a simple overview of the calculations results. Furthermore, the output section of the workbook creates an output file for Tableau, the second software application used for the decision support tool.

Using Tableau as a second application for the decision support tool was necessary due to multiple reasons. Firstly, the MS Excel workbook created is very large and consists of many different worksheets. Even though the user has the functionality to navigate through a number of worksheets in order to get to the desired outcome, the many different inputs result in a complex structure of the MS Excel workbook. This could discourage employees that are inexperienced with MS Excel to use the decision support tool. Additionally, during the development of the model, the application itself was found to be very slow and unresponsive

at times, due to the large file size of the workbook. This was caused due to the amount of included worksheets, formats, data, macros and calculations that use Visual Basic for Applications (VBA). In order to overcome some of these issues, the workbook was structured into different sections (input, lookup, calculations and output). Furthermore, a table of contents sheet provides an overview of all worksheets at a glance and provides the functionality to navigate to a desired sheet by using hyperlinks. Additionally, information and guidelines on how to use the workbook and how to enter data is provided within each sheet. This provides first-time users all the information necessary to operate the tool.

Nevertheless, the significant amount of data and the calculations of the model made it necessary to use another program that enables the user to have faster access to information. Furthermore, the desired "what-if" capabilities within MS Excel and the visualisation of the results are limited in functionality. As identified within the literature review, it is essential for a DSS that the layout of the user interface is appealing to the user and that visualisations and functionality are provided in an effortless manner. Especially when the amount of data that needs to be analysed is very large, it is important that the DSS provides the functionality to analyse and investigate the data in order to get information in the fastest possible way. By using Tableau for the decision support tool, these requirements were met.

The Tableau file uses one of the outputs of the MS Excel workbook as its source data. Therefore, the data component of the decision support tool remains in the MS Excel environment, as Tableau directly connects to MS Excel. The advantage here is that no additional input data is required for Tableau, which reduces the manual effort when updating data. Calculations, which use the data component of MS Excel as input data in order to generate results, build the model component of the Tableau decision support tool. Furthermore, a number of input parameters need to be defined directly within the Tableau application in order to provide the functionality of a "what-if" and scenario analysis. All of this happens directly within the Tableau application, the user-interface of the decision support tool. Therefore, the user can access the Tableau file directly in order to get the complete functionality and without having to manually input any data files. The decision support tool within Tableau consists of a number of different dashboards that provides the user with analysis related to direct material cost (see section 6.4). The Tableau file created for Johnson & Johnson includes dashboards for two categories, i.e. the spend analysis and cost driver analysis. Even though Tableau is not a program that is used by Johnson & Johnson employees

on a daily basis, the decision support tool is set up in a way that it is easy to understand and self-explanatory.

As shown in the literature, using Tableau for data visualisation and analysis has many advantages. Users benefit from the responsive user interface and the functionality of the tool. Filters can be applied to the data and results are shown instantly. There is no need to change the source data in case a different visualisation or different analysis is required. Therefore, questions asked by decision makers can be answered faster and without the need for additional resources. As identified in literature, appealing visualisations are paid more attention than poorly formatted visualisations. Therefore, much attention was placed on the look of the visualisations during the development, resulting in dashboards that are clean and organised with regards to their layout, colouring and structure. Another advantage of Tableau is its functionality to create visualisations and dashboards very quickly. Even though a number of dashboards have been created already, users of Tableau always have the possibility to create new visualisations based on their specific requirements. This is also helpful relating to the storage of the data component of the decision support tool, as it implies that the MS Excel workbook does not need to be shared with every employee that wants to use the tool. Therefore, the input data and MS Excel decision support tool can, for example, be stored at a centralised location where only an administrator or dedicated owner can change the input data.

In order to conclude the discussion, one can reconsider the literature on the requirements of developing a model and the key elements that need to be addressed within the process. According to Rees (2008), the key objectives and outputs of the model, the types of variables that are necessary to derive these outputs, and the relationships between the variables need to be defined before the development of a model. All these elements where addressed during the planning phase of the model development process of this study (refer to section 6.2). As a result, the final decision support tool fulfils the key requirements of an effective model, which were defined in section 2.5.1.1. Table 7.1 provides an overview of the individual requirement and explains how the decision support tool fulfils the requirement.

Table 7.1: Key requirements of an effective model

Model Requirement	Provided model criteria to fulfil requirement
It requires shortest possible time to understand	• Easy to understand structure within MS Excel and Tableau environment • Overview sheets and dashboards • Quick navigation between different sheets and dashboards through hyperlinks • Guidelines within applications that guide the user on how to use the tool and how to enter data • Appealing visualisations and consistent layout between sheets, incl. colours used and types of visualisations
It is driven by objectives	• Objectives were defined prior model development (refer to section 6.2.1) • Generates outputs relating to cost drivers, forecasting functionality and scenario planning • Additionally, a spend analysis provides in-depth insight into the procurement cost structure
It does not contain errors	• Input data was collected, explored, cleaned and prepared before population into the tool • Structured documentation of each process step during model development • Extensive testing and validation of calculations • Successful user testing

The highly structured approach of how the decision support tool was developed supports the aspects of validity and reliability of the research. All process steps were documented and extensively presented within Chapter 6 of this thesis. Therefore, the possibility to repeat the study and develop a similar model is provided.

7.2.3 Model Outputs and Results

In the previous section (refer to section 7.2.2), the findings relating to the structure of the decision support tool and its development were discussed. It was found that the model fulfils the requirements of a comprehensive DSS and includes all the necessary components. Furthermore, the development process applied was adapted from recognised processes identified in literature. Resulting from that, other researchers have the possibility to recreate a similar model, increasing the research study's validity.

The model was developed based on the case of Johnson & Johnson. The data that was collected from the company was used in order to develop the model and test the calculations. As a result, the decision support tool conducted calculations with actual company data and results for the company were generated. However, these strategic results were exclusively used for exploratory evaluation of the decision support tool in order to show what the results could look like. The results of the analysis using the decision support tool are company

confidential and are not shared within this thesis. All results of the decision support tool that were presented in Chapter 6 were desensitised and used for demonstration purpose only. Therefore, this section discusses the outputs and possible results of the decision support tool, without looking at actual results.

(a) MS Excel

As presented in Chapter 6, the decision support tool consists of two parts and can be used in MS Excel or in Tableau. Even though Tableau is considered the major application to use the decision support tool, the MS Excel file is just as important, as it represents the data component of the tool. Furthermore, the MS Excel file also includes part of the tool's functionality and provides basic results. The "output overview & scenario analysis" sheet provides the user with a basic overview on the results of the models calculations, based on the input parameters that were entered by the user. Results such as the total spend, the exposed spend to first- and second-tier currency impact as well as the actual values of the first- and second-tier impact and inflation impact is provided. These results provide the user with basic information on the procurement spend, as well as the individual cost drivers. Basic questions, such as "What is the exposure to the first-tier currency impact?" can be answered with the MS Excel outputs. If more detail is needed, however, the MS Excel functionality is limited. Even though a data table provides more information on individual category and material level, the user is always required to change the pivot table so that desired information is displayed. This especially limits the tool for inexperienced users, who are not familiar with pivot tables. Furthermore, the data is only displayed in the form of data tables, which take time to understand and are not appealing in their layout. This is also a result of MS Excel's limitations relating to data visualisation.

As indicated in Chapter 6, the MS Excel outputs include a data table that provides information about the sensitivity of second-tier currency fluctuations on the total spend (see Table 7.2). Within the given example of Table 7.2, the exchange rate between the Euro and the Rand is 13.41 and the exchange rate between the Dollar and the Rand is 13.15. In this scenario, the second-tier currency impact is EUR 481,907. Additionally to the impact at the current exchange rates, the data table provides the value of the second-tier impact for a large number of different scenarios. For example, if the Euro increases by 3% and the Dollar by 10%, the second-tier impact is expected to be EUR 777,903. On the other hand, if the Euro devaluates by 5% to ZAR 12.74 and the Dollar 3% to ZAR 12.76, the second-tier impact would be only

EUR 372,671. Even though this data table is basic in its functionality, it provides a quick overview on the sensitivity of the second-tier currency impact to different exchange rates.

Table 7.2: MS Excel – Sensitivity Analysis for Second-Tier Impact

			2ND TIER CURRENCY IMPACT - SENSITIVITY ANALYSIS										
			EUR										
			-10%	-5%	-3%	-2%	-1%	0%	+1%	+2%	+3%	+5%	+10%
			12.07	12.74	13.01	13.14	13.28	13.41	13.54	13.68	13.81	14.08	14.75
USD	-10%	11.84	117,788	166,448	185,912	195,644	205,376	215,108	224,840	234,572	244,303	263,767	312,427
	-5%	12.49	251,187	299,847	319,311	329,043	338,775	348,507	358,239	367,971	377,703	397,167	445,827
	-3%	12.76	304,547	353,207	372,671	382,403	392,135	401,867	411,599	421,331	431,063	450,527	499,187
	-2%	12.89	331,227	379,887	399,351	409,083	418,815	428,547	438,279	448,011	457,743	477,207	525,867
	-1%	13.02	357,907	406,567	426,031	435,763	445,495	455,227	464,959	474,691	484,423	503,887	552,547
	0%	13.15	384,587	433,247	452,711	462,443	472,175	481,907	491,639	501,371	511,103	530,567	579,227
	+1%	13.28	411,267	459,927	479,391	489,123	498,855	508,587	518,319	528,051	537,783	557,247	605,907
	+2%	13.41	437,947	486,607	506,071	515,803	525,535	535,267	544,999	554,731	564,463	583,927	632,587
	+3%	13.54	464,627	513,287	532,751	542,483	552,215	561,947	571,679	581,411	591,143	610,607	659,267
	+5%	13.81	517,987	566,647	586,111	595,843	605,575	615,307	625,039	634,771	644,503	663,967	712,627
	+10%	14.47	651,387	700,047	719,511	729,243	738,975	748,707	758,439	768,171	777,903	797,367	846,027

As a result, one can conclude that using MS Excel for the use of the decision support tool should only be considered when data is collected and an initial assessment of the data is necessary. The MS Excel file should rather be considered as the data component of the whole DSS, rather than the file where in-depth analysis takes place. Initial results can be retrieved from the file, which can be used in order to answer simple questions, as well as to identify whether the input data is in the correct format to produce valid results. Nevertheless, the MS Excel decision support tool is a standalone tool and is not dependent on other data files or other programs. In order to achieve the decision support tool objectives, however, a more detailed analysis of the data were necessary and a more interactive tool was required. As a result, Tableau was chosen as an additional user-interface.

(b) Tableau

In section 6.4, the Tableau application of the decision support tool was presented. Being in a Tableau workbook format, the decision support tool consists of a number of different dashboards that provide visualisation and in-depth analysis of the data and supporting the user in an efficient and effective way. The analysis and its results are categorised into spend analysis dashboards, which include direct material cost information on supplier and material basis, as well as cost driver analysis dashboards, which present an in-depth analysis of the individual cost drivers.

The dashboards of the spend analysis provide insight into the cost structure of the complete direct material spend. Hereby, it uses all data that was initially provided within the input

sheets of the MS Excel workbook, which builds a comprehensive database that is analysed. The result is a comprehensive spend analysis that provides an in-depth understanding of the procurement spend. Even though it was not the objective of the decision support tool to visualise already existing data on the direct material spend, observations at Johnson & Johnson have shown that employees often need to analyse spend data on an ad-hoc basis. This results in individual employees extracting data from a base data file in order to create charts and data tables to show the material spend on a certain material, or on a certain supplier. Therefore, a significant manual effort was necessary in order to get the desired information from the data. With the new decision support tool, the spend analysis provides such information immediately and allows exploration of the data without the need to manually adjust the data source. Therefore, the spend analysis dashboards and their functionality can be seen as an added value that was created as a result of the decision support tool development. The spend analysis consists of seven dashboards in total that provide a number of outputs to the decision support tool user. The outputs include spend information on suppliers, materials, material category, incoterm used, sourcing manager responsible for the material and many more (see Table 6.5). For example, the supplier overview dashboard provides an overview on all suppliers, the spend on these suppliers, as well as the material category into which the suppliers' materials fit. Furthermore, the number of different materials is indicated and shown within the supplier bar charts by different colours. Therefore, this dashboard alone provides a user with comprehensive information on a company's suppliers. From the analysis, one can derive a risk assessment on supplier diversification and one can easily identify suppliers that are most important to the company.

All of the spend analysis dashboard transform the raw data that was provided as input data of the decision support tool into information that can be accessed in an appealing way. The outputs enhance transparency of material spend and, therefore, enable decision makers to identify supplier risks. Furthermore, the information of the dashboards can be used in order to strategically prioritise materials or suppliers, based on the spend on the items. Resulting from that, the tool can be used in a similar way as the model developed by Kraljic (1983), and specific procurement strategies can be developed based on an items prioritisation.

Next to the spend analysis dashboards, the dashboards of the cost driver analysis provide the user of the tool with a comprehensive overview of the identified cost drivers. As identified during the development process, the objectives of the decision support tool focused on transparency of cost drivers, a forecasting functionality, as well as the possibility to conduct

scenario planning. Resulting from the presented dashboards presented in Chapter 6, one can conclude that all these objectives are achieved and that the tool can provide the required information. In contrast to the spend analysis, where the tool only visualises already available data, the cost driver analysis uses the presented calculations in order to generate results. The dashboards of the cost driver analysis provide a detailed insight on the individual cost drivers and, therefore, increase transparency of the procurement cost structure.

Three separate dashboards provide information on the currency impact on the direct material spend. The first- and second-tier currency impacts are generated based on the forecast exchange rates provided by the user. Resulting from that, the exposed spend and impacts are visualised on a category, material as well as supplier level. As the results are visualised, the user can immediately identify the materials, categories and suppliers that are impacted by exchange rate currency fluctuations. The result of the currency impact is a monetary value and can be positive or negative. A positive currency impact, e.g. “100,000 EUR”, is displayed as a red bar and can be considered unfavourable for the company. A positive value means that the direct material spend is expected to increase due to price increases of supplier which are caused by the forecast exchange rates. On the contrary, a negative currency impact, e.g. “-100,000 EUR”, is displayed as a green bar and can be considered favourable for the company. This is due to the fact that the forecasted exchange rate would result in supplier price decreases and, therefore, in a reduced procurement spend.

Having the currency impact value and exposure available gives the procurement organisation of a company a competitive advantage. The information can be used in order to make strategic sourcing decisions to optimise direct material spend. In instances of favourable exchange rate development, the company can use the information during negotiation rounds with suppliers and request lower purchasing prices, or the application of other exchange rates. Resulting from this, actual savings can be realised. On the other hand, items with unfavourable currency impact developments can be identified and evaluated. For these items, the company could investigate alternative suppliers, where currency impacts would be lower. Furthermore, switching to local suppliers would be an alternative in order to eliminate the currency impact completely. It can be concluded that having an understanding of the exposure to currency impact leads to a wide variety of possibilities and opportunities for procurement function of an organisation.

Additionally, the decision support tool provides the user with so-called "action-items" that require special attention. The dashboards for first- and second-tier currency impact provide the user with a list of items that are expected to have favourable currency developments from the view of the purchasing company. Therefore, sourcing managers can use the lists to identify potential materials for cost savings and proactively approach suppliers in order to renegotiate applicable exchange rates or material prices. Figure 7.3 depicts the second-tier action items dashboard and "Material 31" is highlighted as an example. For this example, the forecasted exchange rates used are randomly selected exchange rates at the time when the demonstration model run took place. The model is constructed in an interactive way that lets users change forecast exchange rates easily, so that quick what-if assumptions can be made.

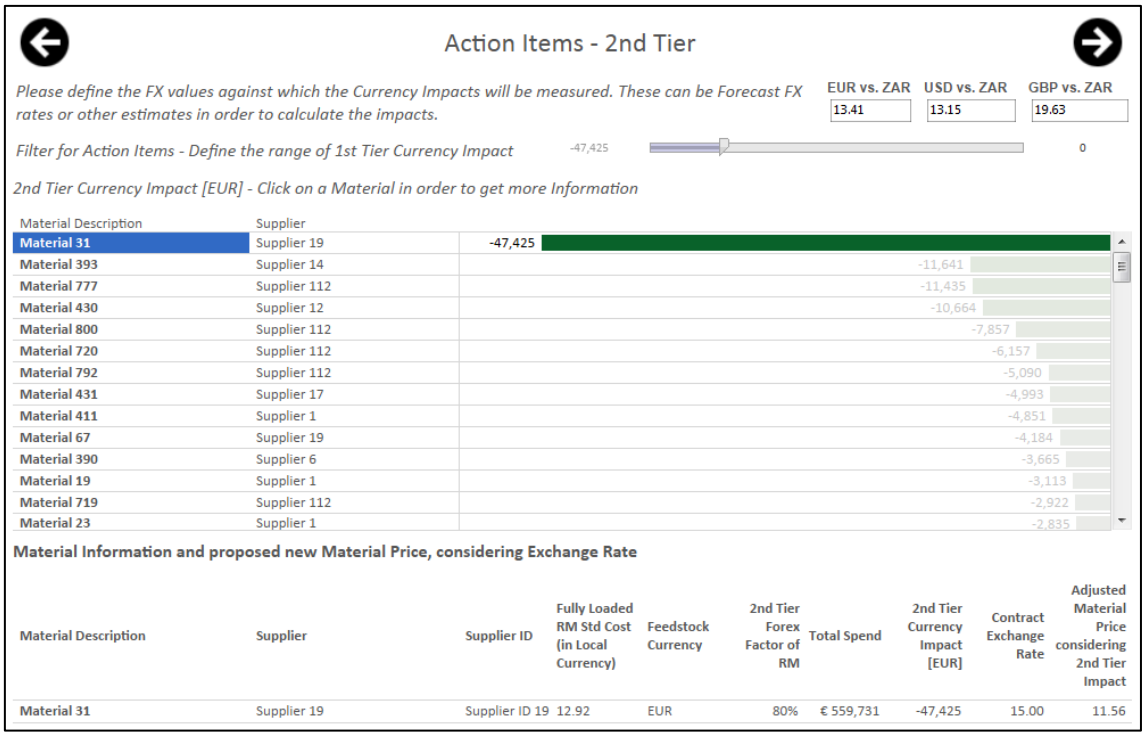

Figure 7.3: Example of an Action Item exposed to Second-Tier Impact

For "Material 31", which is sourced by "Supplier 19", the entered exchange rate parameters result in a second-tier impact of EUR -47,425. The negative cost impact means that the company has the opportunity to realise cost savings. This is caused by the contract exchange rate with the supplier, which is higher than the forecasted exchange rate (15.00 vs 13.41). Therefore, the company should approach the supplier and renegotiate the price of the item. The action list dashboard even provides an adjusted material price, which takes the exchange rates into consideration. In this case, the adjusted material price in local currency would be 11.56, instead of the actual price of 12.92. Having this knowledge within one place provides the procurement professional with a competitive advantage within price negotiations, and also

helps to identify cost saving opportunities. Resulting from that, one can conclude that the decision support tool not only provides the information in an easy to understand format to support decision-making. The decision support tool also provides the user with optimised solutions that enable cost savings.

As currency developments are often unpredictable, the currency impacts calculated are only as accurate as the exchange rate forecasts. For this purpose, the tool provides the functionality to build separate scenarios, enabling the user to see the effects of different developments at the same time. Figure 7.4 presents an example of a scenario analysis with two scenarios.

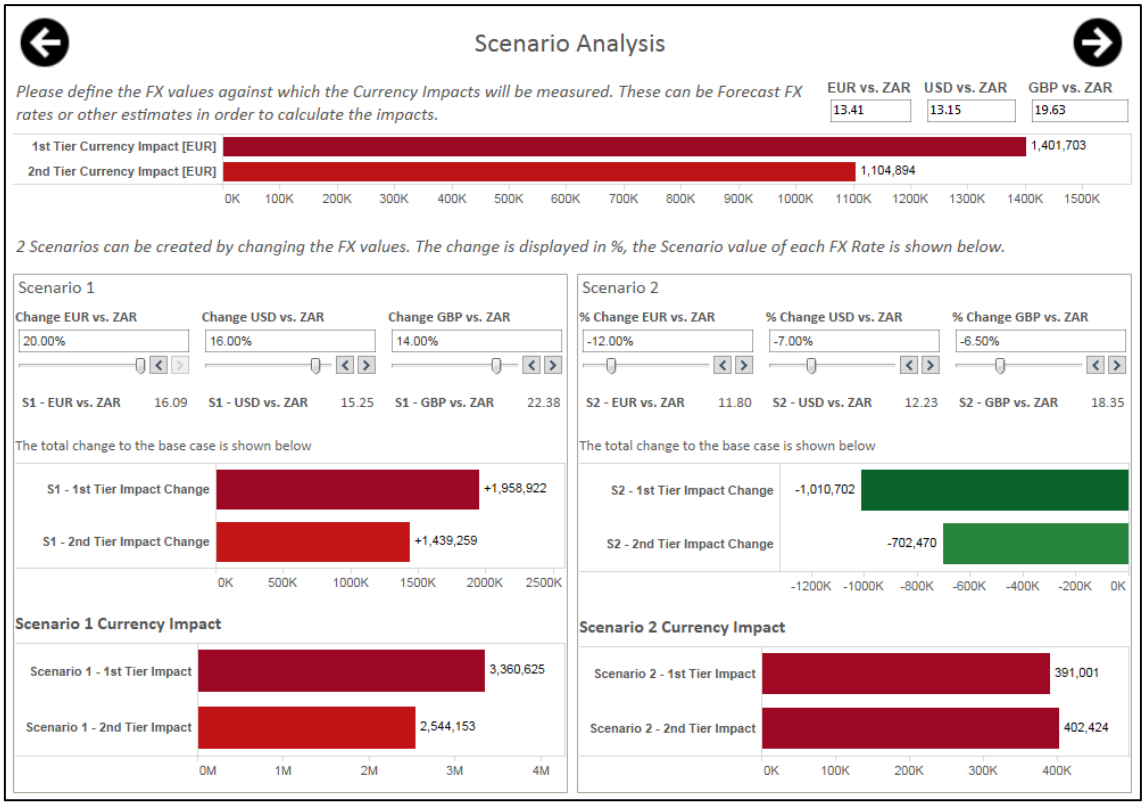

Figure 7.4: Example of a Scenario Analysis

In addition to the base scenario, which yields a first-tier currency impact of EUR 1,401,703 and a second-tier impact of EUR 1,104,894 based on the entered exchange rate forecasts, two scenarios were created within the dashboard. Within "Scenario 1", which is displayed on the left hand side, it is expected that the South African Rand is expected to devaluate against major currencies in future. As the ZAR has devaluated heavily in the recent past (see section 3.5), a further decrease of value is not unlikely. Therefore, this scenario, where the Rand is expected to drop against the Euro, Dollar and Pound by respectively 20%, 16%, and 14% can be considered as a real life scenario that companies are confronted with. Within the example, the first-tier and second-tier currency impact is expected to increase as a result of the

exchange rate forecast by EUR 1.96 million and EUR 1.43 million, respectively. As a result of building such a scenario, the company can estimate future procurement spend. The knowledge that is gained by understanding what happens to the direct material spend can be used in strategic decisions, such as supplier selection or price negotiations. In the example scenario, which results in a massive cost impact, companies can for example consider using future contracts with suppliers in order to lock exchange rates or use alternative suppliers to reduce the exposure of currency impacts.

Next to the currency impacts, the decision support tool also includes an analysis of commodity inflation. The dashboard provides an overview of the expected inflation on a material category level. Increases of commodity prices are positive values and displayed as red bars. Expected decreases are displayed as green bars, having negative values. Resulting from that, the user is provided with information on whether the procurement spend per material is expected to increase or decrease because of the commodity inflation impact. Such information can be very useful during negotiation situations with suppliers. As found as a common practice at Johnson & Johnson, suppliers often justify price increases based on raw material cost increases due to commodity inflation. With the support of the model developed, sourcing managers can immediately review whether the rationale for a price increase is in accordance with true inflation. Even though suppliers often use commodity inflation as a reason to increase material prices, prices are rarely decreased when commodity prices decrease. Therefore, the decision support tool can be used as an opportunity to improve material spend by proactively addressing suppliers for price negotiations where commodity inflation has a positive impact on the sourced materials.

As a result, one can conclude that the decision support tool that was developed during the research, supports procurement decision makers in many different ways. The tool transforms raw data into decision-making information and provides transparency of the direct material cost structure. Detailed insight into materials and suppliers can be used in order to manage, control and improve direct material cost. Furthermore, the tool provides opportunities to leverage cost drivers and to identify risks to which one is exposed. The literature on cost management in procurement has shown that a complete understanding of the cost structure is essential in order to make strategic sourcing decisions and identified that making use of the TCO concept is a profound method to achieve it. Similar to the TCO concept, the decision support tool can be used to minimise total procurement spend. Even though the decision support tool does not cover all TCO components as it focuses on the procurement part and its

cost drivers, it can be considered as an adapted TCO approach. As identified in the literature review, there is no standard TCO model and adaptions need to be made based on the requirements and purpose of its application. For Johnson & Johnson, the application of the decision support tool can build the basis for cost structure knowledge within the procurement function. Furthermore, it creates opportunities to expand this knowledge in future into a comprehensive TCO model.

7.3 Validity and Reliability

The planning phase of the decision support tool development process was a key part for ensuring validity and reliability as it included the identification of model outputs and input variables, as well as the data collection and data exploration process. Each of these process steps were completed with great attention to detail, in order to ensure the validity and reliability of the collected data, which ultimately influences the validity of the results (Denscombe, 2010). As Johnson & Johnson provided the data used for the decision support tool, the data sources were verified for reliability and the data itself were analysed for validity. This was done in close coordination with Johnson & Johnson employees. Furthermore, all steps within the development process were documented in order to increase transparency about how the data were collected, how the data were interpreted and which data sources were used.

The same applied for the construction phase of the model. The extensive data cleaning and preparation process was done with extreme care and attention to detail, due to the significant amount of data available. In order to increase validity of the final data that was used in its cleaned and prepared state, the data were presented to the company in order to get approval. The complete model construction phase was documented in detail, in order to enhance the replicability of the decision support tool. The documentation ensures that the construction of the model as well as the complete decision support tool development process is replicable and can be applied to other cases. The model construction phase also included a validation process, which focused on the technical aspects of the model in order to ensure accurate results. For this purpose, the researcher consulted with external SMEs that specialise on model development with Tableau. Feedback received was that the model and its calculations work as intended and the layout and structure of the Tableau workbook fits its purpose (De Wet & Keet, 2015).

After the model was constructed, it was populated with data. Within this application phase, the model's outputs and results were visually presented to key stakeholders of Johnson & Johnson. This process was also used to ensure validity of the results, as well as reliability, as multiple scenarios were tested to ensure whether the model yields the same results. Furthermore, the used data of Johnson & Johnson was tested more than once and an additional dataset that was generated from historical data were tested. The decision support tool provided results for all data sets tested. The results obtained prove that the decision support tool does not depend on the dataset provided by Johnson & Johnson, but can be used with other data as well.

Throughout the decision support tool development process, the researcher worked in close coordination with the key stakeholders at Johnson & Johnson in order to enhance validity and reliability of the model's methodology and results. This was possible due to the significant amount of time spent at the company's offices and the opportunity to work with the employees in a real work environment. The results obtained of the decision support tool were shared with Johnson & Johnson in order to evaluate validity. Even though Johnson & Johnson did not have the information on its cost drivers on a detailed level as provided by the model, sourcing managers identified similarities to the existing model on a category level. In addition, given the detailed methodology that was used to generate the results, the employees support the model's results. Therefore, internal and measurement validity of the decision support tool was obtained.

As the decision support tool was developed and tested on the case of Johnson & Johnson and no data of competitors or similar FMCG companies was available, it was not possible to prove external validity of the decision support tool. As one secondary objective of this study was to verify the general validity of the decision support tool, a competitor analysis was used in order make assumptions about the generalisability of the tool. The literature review on the FMCG industry in South Africa has proven that companies that engage in the same markets as Johnson & Johnson are exposed to the same risks related to procurement. Resulting from that, one can assume that these companies also experience similar cost drivers as Johnson & Johnson relating to foreign exchange rate fluctuation and commodity inflation. Therefore, the developed decision support tool can also be applied to other companies within the industry. Although the actual figures of the results can be very different between the organisations due to their operations and setup, the decision support tool generates the same outputs

independent from the amount of data or the actual figures of the data source. As a result, one can conclude that the general validity is proven for the decision support tool.

7.4 Limitations of the Study

Limitations of the study were identified during the research, as well as after the completion of the study. Even before research at the case company was conducted, the researcher had to sign a non-disclosure agreement due to the sensitive and confidential company data involved in the study. This implied that no sensitive information of Johnson & Johnson could be shared within the thesis. Therefore, the actual results of the decision support tool were not shared. The dashboard images and data tables resulting of the decision support tool development presented in this thesis are demonstrative examples that truly reflect the results. All figures and values were desensitised before being presented within this thesis. Even though this was a limiting factor relating to the discussion of actual results of the decision support tool, it was not a limiting factor with regards to the research objective of this study as a whole, as actual figures are not necessary to demonstrate the outputs of the tool.

As explained in section 7.3, a limiting factor to external validity of the research was the availability of alternative data. Due to the fact that the research was conducted as a case study on Johnson & Johnson, the data that is required to use the decision support tool could only be collected from the case company. As the input data required is very sensitive and includes information on suppliers, materials, prices and many more confidential items, competing companies do not publish the data within the public domain. Therefore, the decision support tool was only tested with the available data of the case company. As this limitation was known from the beginning, one objective of the thesis was to identify competitors that engage in the same markets as Johnson & Johnson in order to make assumptions regarding the external validity of the decision support tool. For this purpose, the literature that was available within the public domain relating these companies was used to identify similar procurement risks. Resulting from the analysis of the competitors, it was concluded that they are exposed to similar risks as Johnson & Johnson, and the decision support tool developed could be useful for other organisations.

Chapter 8 - Conclusions and Recommendations

8.1 Introduction

Organisations that engage in global sourcing activities always strive to improve profitability by reducing cost. For this purpose, organisations need to have a comprehensive understanding of their procurement spend and its cost drivers. The catalyst of this study was the concern of Johnson & Johnson, who identified a lack of visibility on its procurement cost structure and assumed that it could improve the management of material cost with a better understanding on cost-driving factors. Therefore, the aim of this study was to close the gap of uncertainty relating to cost drivers of direct materials and to increase transparency of the procurement cost structure. As a result, primary and secondary research objectives were derived with the aim to provide a clear understanding and a more predictive view of direct material cost in order to support strategic decision-making.

The objective of this thesis was to develop a decision support tool that measures and analyses the impact of cost drivers on direct material cost, on the case of Johnson & Johnson. For this purpose, the main cost drivers had to be identified and a tool had to be created that could be easily implemented into the organisation's operations. Furthermore, a comparative competitor analysis had to be conducted in order to provide information on whether other companies that engage in similar markets as Johnson & Johnson are experiencing similar challenges and are exposed to the same risks procurement risks.

This chapter presents the major conclusions derived from the findings of the thesis. It reflects on the research objectives of the study and concludes whether the objectives were achieved. Furthermore, practical recommendations and opportunities for future research are provided. The chapter closes with concluding remarks from the researcher.

8.2 Research Objectives: Summary of Findings and Conclusions

As a result of this thesis, a fully developed decision support tool is presented that provides visibility and transparency on direct material cost and its cost drivers. The creation of the model was based on a structured methodology, which expanded over several phases and consisted of secondary research, in the form of a comprehensive literature review and secondary data collection, primary research in order to collect qualitative data from the case

company, and the decision support tool development process, which again was divided into a planning, construction and application phase.

The structured approach was beneficial to the research results from the beginning. The literature review on procurement in global organisations provided the researcher with the required knowledge on the procurement function, its benefits and risks, and helped to identify the cost drivers of procurement spend. Additionally, existing practices of cost management within the procurement function, such as the concept of TCO as well as financial modelling approaches, were identified and reviewed. Furthermore, the literature review that covered the FMCG industry and the players that engage in the market was used in order to uncover similarities between competitors and Johnson & Johnson, and to make assumption on the external validity of the research. In addition to the secondary research, the researcher spent significant time at the offices of the case company in order to conduct primary research. As a result, the researcher gained in-depth knowledge on the business processes of Johnson & Johnson and developed an understanding on the specific need towards a decision support tool. With the knowledge of the literature review and the primary research on hand, a detailed decision support tool development process was set up and executed that included three phases and a significant number of different process steps. The result of the complete research process is a decision support tool for global procurement that includes several cost drivers and offers functionality regarding forecasting and scenario planning. As research objectives have been set before the research process started (refer to section 1.4), conclusions relating to the individual research objectives are provided in the following sections 8.2.1-8.2.3.

8.2.1 Development of Decision Support Tool

The primary objective of this thesis was to develop a decision support tool that measures and analyses the impact of cost drivers on direct material cost and provides detailed insight into the procurement cost structure. Furthermore, the tool should provide the ability to provide a predictive view on the procurement spend including potential impacts of cost drivers.

The decision support tool that was developed during the research process provides all of the before mentioned functionalities and fulfils all requirements that were set out in the objectives. The decision support tool developed, which was described and presented in detail in Chapter 6 and discussed afterwards in Chapter 7, is a comprehensive tool that transforms procurement spend data and transforms it into valuable insight information that can be used for strategic decision-making. In addition to the required functionality to provide insight on

the cost drivers of procurement spend, their potential impact on total cost and the functionality to provide forecasting, scenario planning and sensitivity analysis, the tool also provides the functionality to explore the organisation's cost structure. Therefore, the "spend analysis" outputs can be considered as an additional result of the decision support tool that was not required based on the initial objectives of the thesis. The "spend analysis" part of the decision support tool provides a significant number of dashboards that increase visibility and transparency of the procurement cost structure. These outputs enable decision makers to uncover hidden risks and opportunities within their spend data. The different dashboards provide an insight on the cost drivers identified of direct material cost, and provide the potential impacts of the first-tier currency impact, second-tier currency impact and the inflation impact. Furthermore, the tool includes the functionality to do a forecasting analysis of the individual impacts and provides measures to develop different scenarios to immediately see how different forecast affect the procurement spend. Resulting from the different possibilities of how the tool can be used and the different outputs it provides, the decision support tool can provide several benefits to an organisation.

The detailed insight into the cost structure of individual materials and suppliers provides a comprehensive understanding of the spend distribution within the organisation. As a result, procurement professionals can identify opportunities within the cost structure. The increased visibility on total cost that is provided by the tool can therefore be used in order to reduce cost and mitigate risk, as well as to manage suppliers. Therefore, strategic procurement decision-making can benefit from the information provided by the tool. As the tool provides a predictive view on potential cost impacts, the information can be used during supplier negotiations in order to improve profitability. Furthermore, the tool can be used in order to effectively monitor the spend distribution and to identify patterns within the data. In combination with data on the risk exposure, such information can generate increased awareness on items or suppliers that are exposed to external cost drivers, such as fluctuating exchange rates or commodity prices. Using the tool in combination with accurate forecasts for these cost drivers can help to identify warning signs relating to the procurement spend. Furthermore, the tool can be used to identify opportunities to minimise cost resulting from external developments. For this purpose, the tool provides a list of materials that are impacted in a positive way from expected developments. Price re-negotiations with suppliers of these materials can result in cost savings.

Overall, one can conclude that the objective of developing a decision support tool was achieved. All identified outputs that were required from the beginning are provided in the final decision support tool that was developed during the research process.

8.2.2 Usability of the Decision Support Tool

In addition to developing a decision support tool that provides specific outputs, a secondary objective of this thesis was to ensure the usability of the tool. In order to achieve this objective, attention was placed on the decision support tool's structure, setup and layout throughout the development process. Furthermore, the literature review provided knowledge on important components of a decision support tool, as well as on data visualisation.

As a result of the development process, the decision support tool consists of two different parts. On the one hand, MS Excel is used in order to collect all input data as well as to provide a basic overview of the model outputs. On the other hand, Tableau was used in order to provide an interactive user-interface with several data visualisations and dashboards. The advantage of using Tableau instead of MS Excel in order to assess the information is that Tableau is interactive and has a responsive visualisation feature. All dashboards provide information in a clear and efficient way so that users understand the results quickly without obstacles. While other BI software applications can restrict users based on one's technical knowledge, Tableau is easy to use and data can be visualised in multiple ways without changing the source data. Therefore, users can access all information and use the decision support tool even without the input data on their systems, allowing fast and convenient access. The Tableau file is also constructed in a way that the users can access all data in one location by navigating throughout the different dashboards interactively. Furthermore, the decision support tool can be continuously improved and adapted to improve the quality and accuracy of the outputs. Organisations can change the content of the tool based on their specific requirements and add dashboards and visualisations in order to specifically answer a question that occurs at a later stage.

Reflecting on the initial objective, it can be concluded that the usability of the decision support tool is provided and the chosen user-interfaces fulfil the requirements in an effective and efficient way to access information. Based on the fact the decision support tool uses a MS Excel file as input data source, which can be located at a centralised network location within an organisation, the implementation of the decision support tool is convenient and simple. In

combination with the easy to understand user interface of the tool, the functional usability is ensured and the objective achieved.

8.2.3 Validity of the Decision Support Tool

Another objective of this thesis was to **verify the general validity of the decision support tool** and to identify whether it can be applied to other cases outside the scope of the research.. For this purpose, a comparative analysis of companies that engage in the same markets as Johnson & Johnson was conducted. This competitor analysis was intended to identify whether the risks and cost impacts to which Johnson & Johnson is exposed to is also recognised and experienced by its competitors. The results of the analysis should be used in order to make assumptions on the validity and reliability of the research and whether a decision support tool can also be applied for other organisations.

The analysis conducted was based on literature that was available within a public domain. As a result, several companies that compete in the same markets as Johnson & Johnson were identified. Furthermore, it was discovered that companies experience similar risks relating to procurement. On the one hand, all major companies are engaging in global procurement activities and thus are exposed to exchange rate fluctuation. On the other hand, the risk that is related to fluctuating commodity prices and its impact on supplier prices was also shared between the identified companies. As these risks and their impacts were the catalyst to develop a decision support tool for direct material cost for Johnson & Johnson, one can assume that the decision support tool developed can also be used within other organisations. Even though the competitor analysis was only of a comparative and exploration nature, and included only data that was available within a public domain, the identified similarities are significant. Therefore, one can conclude that the objective was achieved, which enabled the research to make assumptions relating to the generalisation of the decision support tool and that it can be applied to other companies engaging in similar markets as Johnson & Johnson.

8.3 Recommendations and Remarks for Implementation

Even though the decision support tool was developed on the basis of the case company, i.e. Johnson & Johnson, the findings of the research suggest that the model can also be applicable for other organisations. Based on the results of the research process and the final decision support tool, the following recommendations are made relating to implementing and applying the tool in practice.

(a) Data Quality and Availability

The quality of outputs of any data analysis tool depends on the quality of the input data. For this reason, a high level of data quality and accuracy needs to be ensured in order to generate valuable results from the decision support tool. Within the data collection and exploration process conducted at Johnson & Johnson, several issues with the available data were identified, such as data fields that were not normalised between different sources or errors in quantitative data. As a result, significant time was required to clean and prepare the data for further analysis and usage within the decision support tool. Therefore, it is recommended to do a data normalisation and data warehouse update in order to clean and align data throughout the organisation. The standardisation of data ensures its correctness and reduces the amount of manual effort that is necessary to prepare data for usage within the decision support tool. Furthermore, a cleaned and up-to-date database would also benefit the quality of other projects and analyses that rely on similar source data.

As has been identified during the data exploration process (refer to section 6.2.4), the available data relating to the currency exposure was limited to category level. In order for the decision support tool to generate more accurate results regarding the second-tier currency impact, the second-tier forex factor is necessary on a material level. As this information is only available from the supplier, it is recommended to Johnson & Johnson to request this information during price negotiations and contract conclusion. A standard template could also be sent out to all suppliers in order to provide the information, thereby reducing the internal effort to identify exposure values.

(b) Ownership

In order to improve implementation of the decision support tool, there should be one dedicated person that is responsible for the tool. The task of the decision support tool "owner" includes the maintenance of the tool, i.e. updates of input data, as well as taking the appropriate measures to store the tool in an accessible way. Furthermore, the person needs to act as an administrator that has the privilege to grant access rights and permissions, and as the main contact person in case of enquiries. Having a dedicated model owner helps organisations to implement the decision support tool in the beginning as well as to keep the tool updated.

(c) Implementation and Management Support

For a successful implementation of the tool, it is recommended that guidelines and user manuals are created which are then handed over to the company. For the case of this thesis, the researcher has developed documents to support the implementation and handover process. Additionally, the MS Excel workbook that was created includes a to-do guideline on how to use the tool and how data is inserted. Furthermore, meetings with key stakeholders of the organisations should be held to present the tool and its outputs. In a best case scenario, the handover or implementation process should already include the appointed model "owner".

Additionally, a decision support tool implementation needs to have complete management support and key stakeholders have to be involved in the implementation process. Therefore, it is recommended that organisations provide training sessions to employees that will work with the developed tool. Also, dedicated Tableau training sessions could be offered that provide users with a new skill set that enables them to create their own visualisations and dashboards for the decision support tool. This knowledge could be leveraged for other projects and data analysis tasks as well. The role of management, especially in the implementation phase of a new tool, is of utmost importance. Only if management supports and encourages the usage of the model, will people work with it. Therefore, management support is the key to long-term success and acceptance of the decision support tool.

In order to further engage with the decision support tool, management could define targets or KPIs that relate to the model outputs. As similar data were not available before, the organisation did not have the possibility to predict the potential impact of a cost driver. With the support of the tool, such information is now available. As a result, actual impacts on procurement spend can be compared with predicted values in order to see whether opportunities to minimise cost were realised.

(d) Modifications

Even though the decision support tool developed within this thesis presents a comprehensive model that includes significant amount of data and generates results for a variety of questions, new developments within the business environment can result in new demands. Therefore, it is recommended to not see the tool as set in stone, but rather as a foundation that can always be modified as requested. For example, the model can be expanded by additional currencies that need to be examined or additional cost drivers that are identified. Also, as the model of this thesis was developed on the case of Johnson & Johnson, adaptions are required when the

tool would be applied to other organisations. However, these adaptions would be minimal, as the tool is already set up in a standardised way, which enables easy integration with source data. Furthermore, the decision support tool was only developed with Johnson & Johnson's procurement data of the South African division. It can easily be expanded to cover all areas of operations. It is recommended that the tool is implemented and used for a certain period of time, before making assessments on required modifications. Afterwards, the model owner should collect the required adaptions and make the changes on a centralised version of the tool. This reduces manual effort of multiple persons and ensures compliance throughout the model users.

8.4 Future Research

As a result of the research process of this thesis, a newly developed decision support tool was presented that provides visibility of procurement spend and its cost drivers. The decision support tool generates a variety of different outputs and uses an interactive user-interface in order to communicate with the user. The tool was developed on the case of Johnson & Johnson and can be considered as a practical model that can be utilised in daily operations of organisations. The outputs that are generated through the usage of the tool were not available before, and therefore, provide areas for further research. Also, the limitations regarding the scope of the research open areas for additional investigation. Within this section, areas for future research are presented.

Firstly, research can be conducted in order to evaluate the feasibility of the decision support tool outside of Johnson & Johnson. Even though this thesis was able to make assumptions regarding the generalisability of the tool to companies that engage in the same markets as the case company, the decision support tool could not be tested with external data. Additionally, a research study that uses a broader scope and tests the model with different datasets can be used to identify and compare actual outputs of the tool. Such data can further be used in order to identify patterns relating to the cost-drivers of procurement, and whether all organisations are effected by cost drivers in the same way.

Another area for research is risk mitigation strategies. As the decision support tool generates detailed insight into how an organisation is exposed to external cost drivers, such information can be used in order to develop strategies to mitigate the risk and lever against these cost drivers. Results of such a study could identify ways on how to use information from the decision support tool and develop ways to reduce total cost.

Additionally, a follow up research study could expand on the idea of the decision support tool to develop a comprehensive TCO tool for the complete supply chain. As identified within this thesis, the decision support tool only deals with a part of total supply chain, being the procurement function and the cost of sourcing. A tool that also includes all follow up costs that are related to the procurement of a material could provide even further insight into the cost structure, thus enhancing the decision-making process.

8.5 Concluding Remarks

The decision support tool that was developed during this thesis provides a new and innovative way to analyse procurement data and its cost drivers. Even though a number of different frameworks and models to enhance visibility and transparency of an organisation's cost structure exist, they are rarely used in practice. Based on the case of Johnson & Johnson, who identified a lack of visibility on its procurement cost structure and assumed that it could improve the management of material cost with a better understanding on cost-driving factors, the aim of the research was to develop a new tool that can be used in practice within procurement organisations. The result is a creative and effective decision support tool that makes use of enhanced data visualisation techniques in order to provide predictive views on direct material cost. The research conducted to develop the decision support tool was based on a highly structured methodology that included primary as well as secondary research. This extensive research process ensured a sound methodology in order to provide valid results. Additionally, it can be concluded that not only the decision support tool developed can be seen as a contribution to research, but the applied methodology can also be used in order to develop other models or decision support tools for different purposes.

As the results of the research have shown, the usage of the decision support tool can yield many benefits for the company. The decision support tool enables organisations to anticipate changes in volatile markets in order to increase its competitive advantage. Using the information that is provided by the tool enables decision makers to make strategic sourcing decisions in order to minimise procurement spend. Even though the risk of foreign exchange rate fluctuation and volatile commodity prices cannot be removed completely, the decision support tool can be considered as an enabler to control the risk and to derive dedicated actions to minimise the impact of these risks.

Being a case study on Johnson & Johnson, this research directly contributed to the procurement function at the company. The decision support tool presented within this thesis

was tested successfully and implementation of the tool has started. Furthermore, initial results of the tool and feedback received was positive, as users were amazed by the functionality, responsiveness and look of the user-interface of Tableau. Therefore, the way forward for further usage of the decision support tool within Johnson & Johnson is paved.

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Appendices

Appendix A The FMCG Landscape

Figure 1: Companies and Brands of the FMCG Industry

(Source: Baker, 2012)

Appendix B Decision Support Tool – Tableau Dashboards

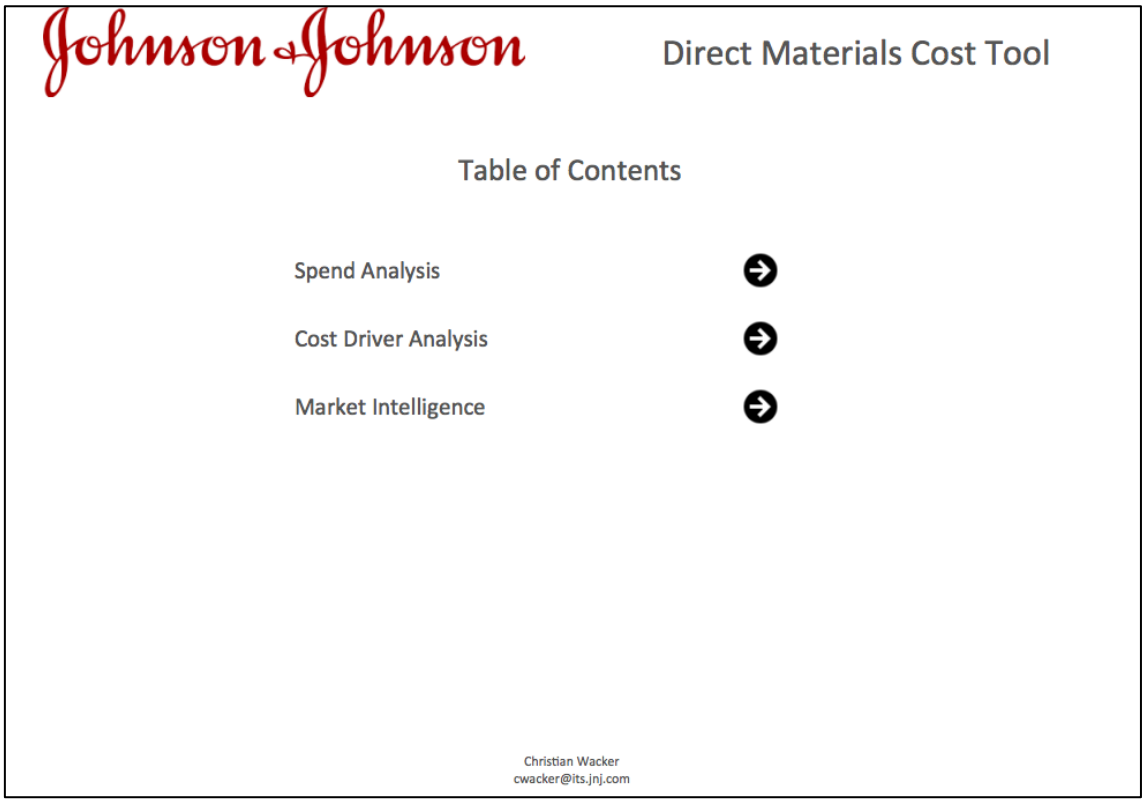


Figure 2: Table of Contents

Figure 3: Spend Analysis Overview

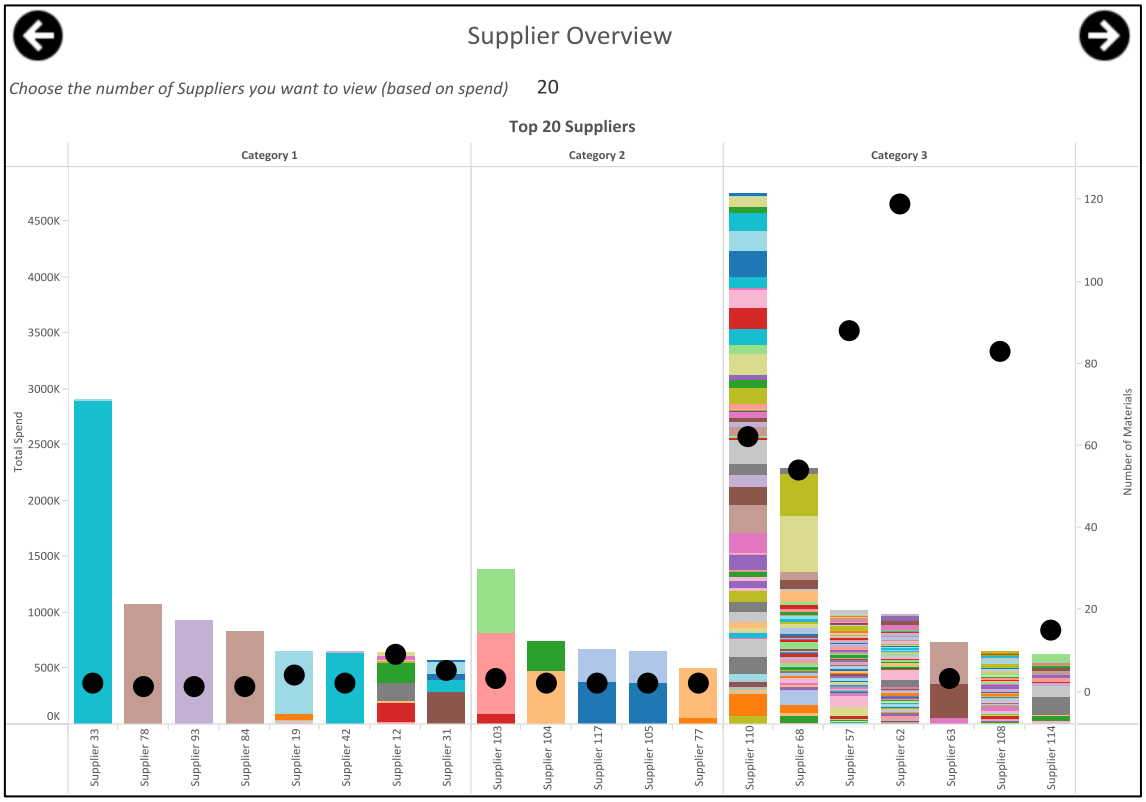


Figure 4: Supplier Overview

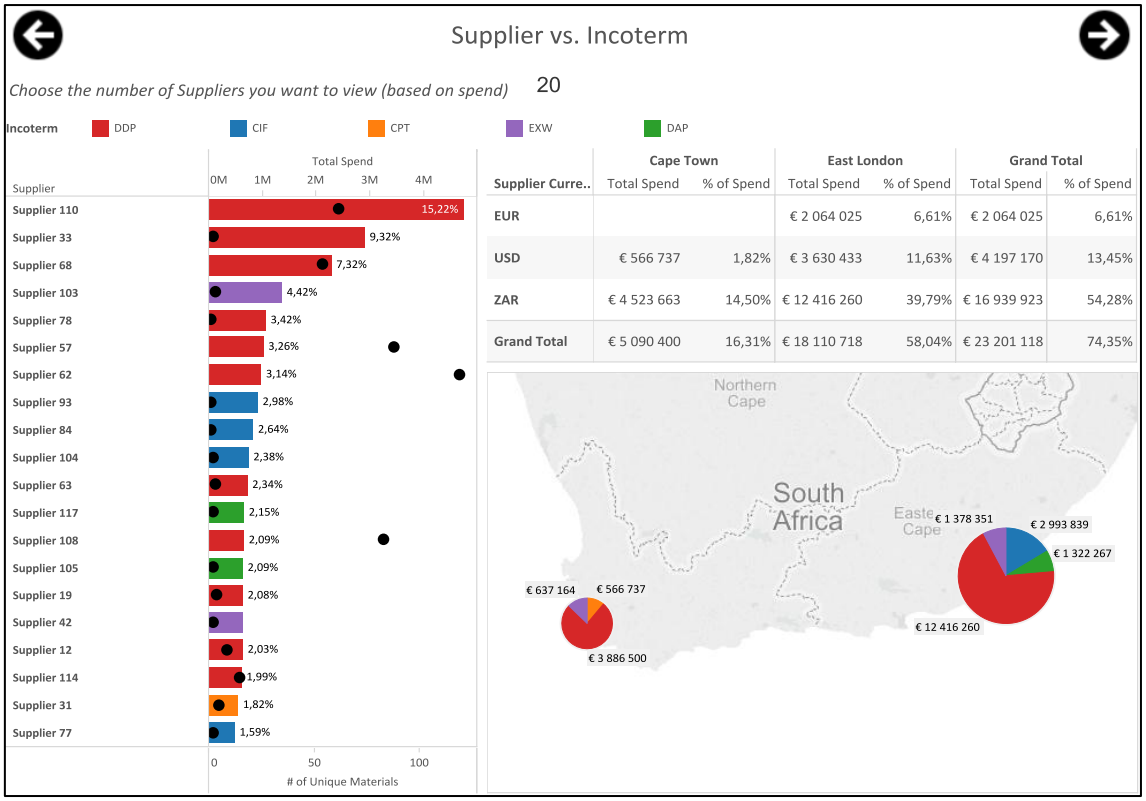


Figure 5: Supplier Incoterm

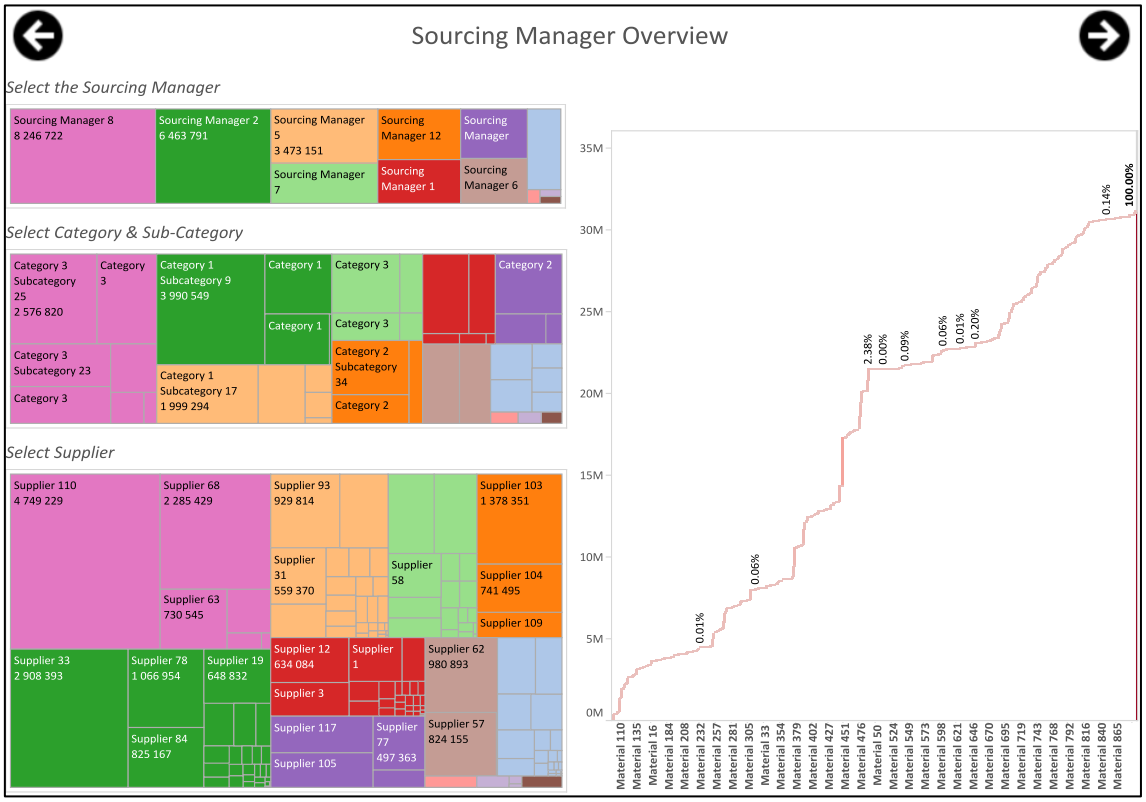


Figure 6: Sourcing Manager Overview

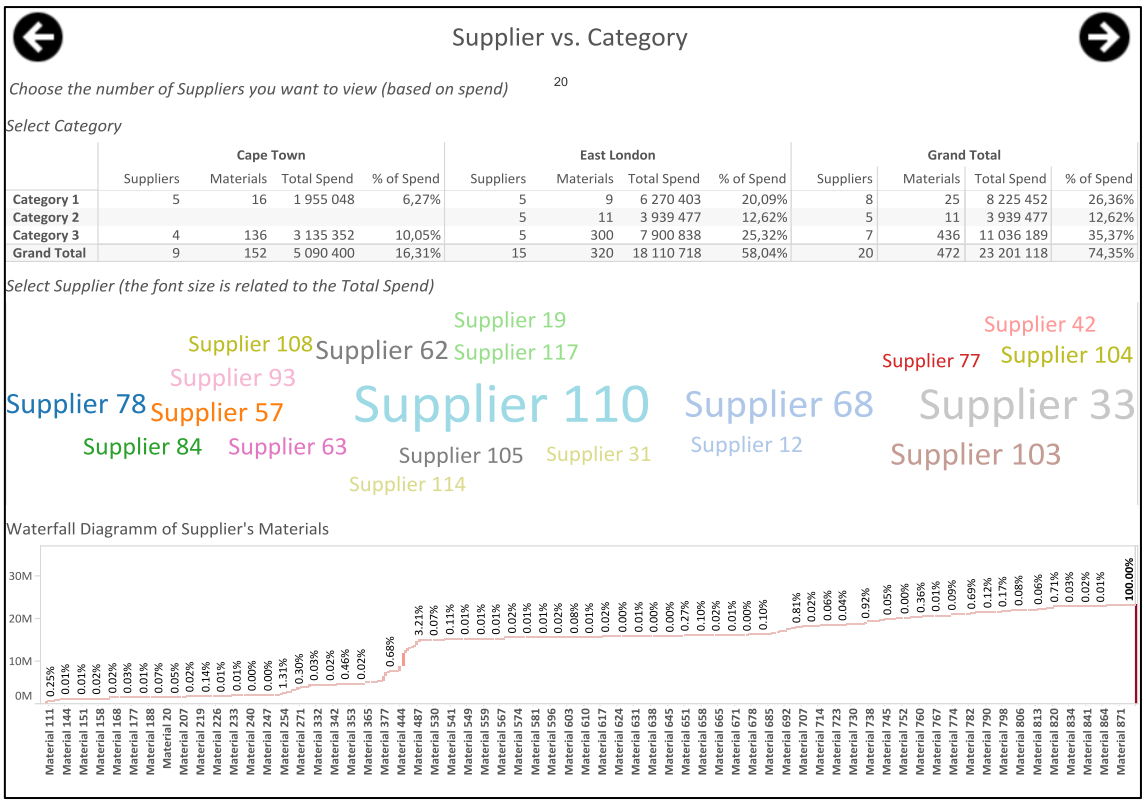


Figure 7: Supplier vs. Category

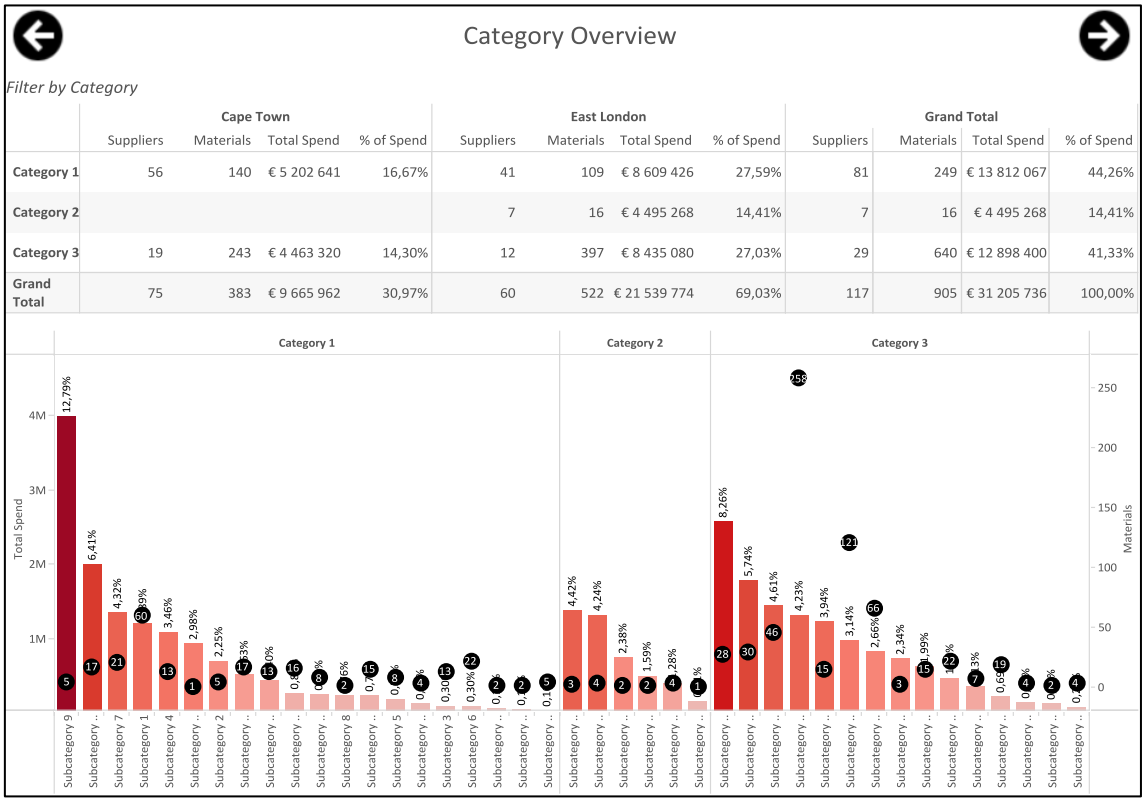


Figure 8: Category Overview

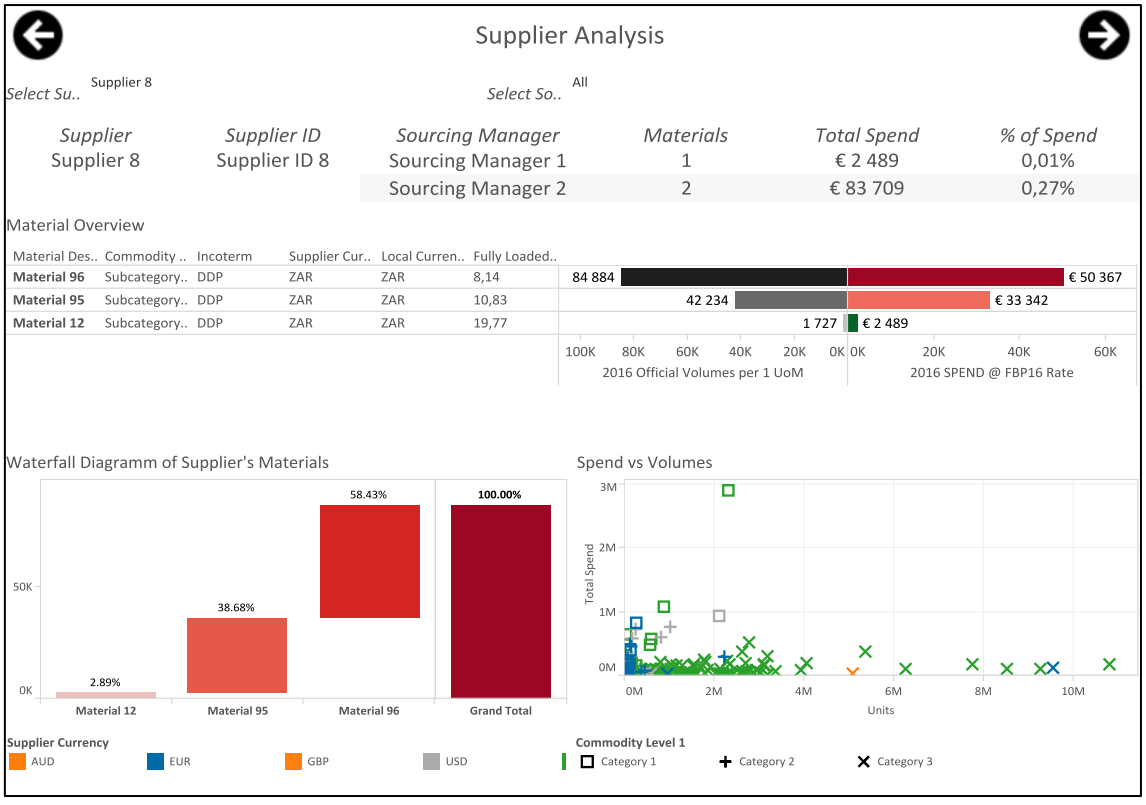
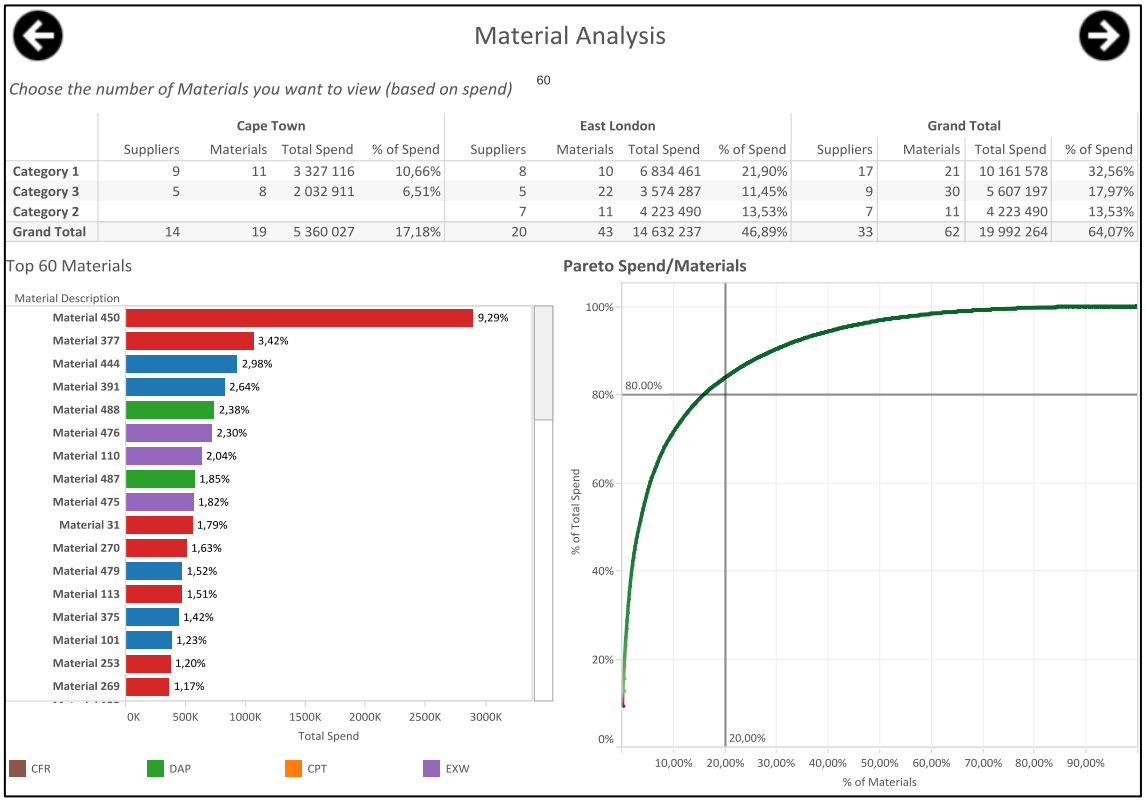


Figure 9: Supplier Analysis



	Cape Town				East London				Grand Total			
	Suppliers	Materials	Total Spend	% of Spend	Suppliers	Materials	Total Spend	% of Spend	Suppliers	Materials	Total Spend	% of Spend
Category 1	9	11	3 327 116	10,66%	8	10	6 834 461	21,90%	17	21	10 161 578	32,56%
Category 3	5	8	2 032 911	6,51%	5	22	3 574 287	11,45%	9	30	5 607 197	17,97%
Category 2					7	11	4 223 490	13,53%	7	11	4 223 490	13,53%
Grand Total	14	19	5 360 027	17,18%	20	43	14 632 237	46,89%	33	62	19 992 264	64,07%

Figure 10: Material Analysis

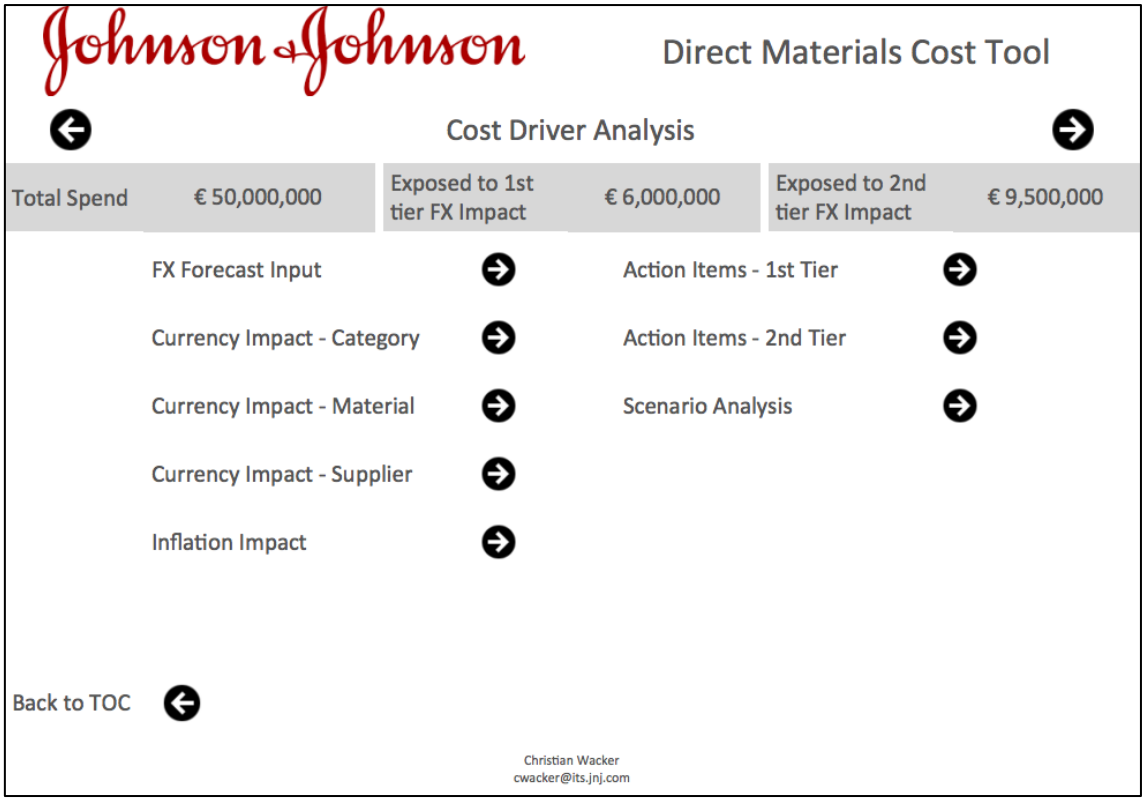
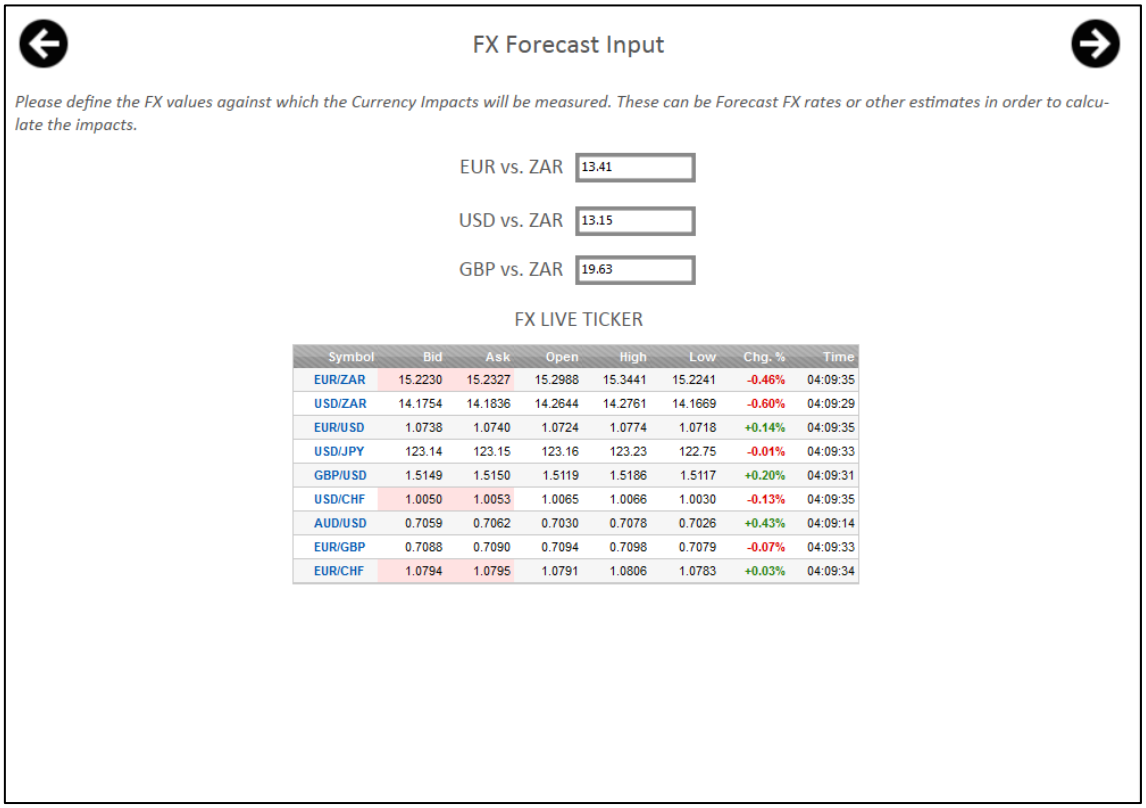
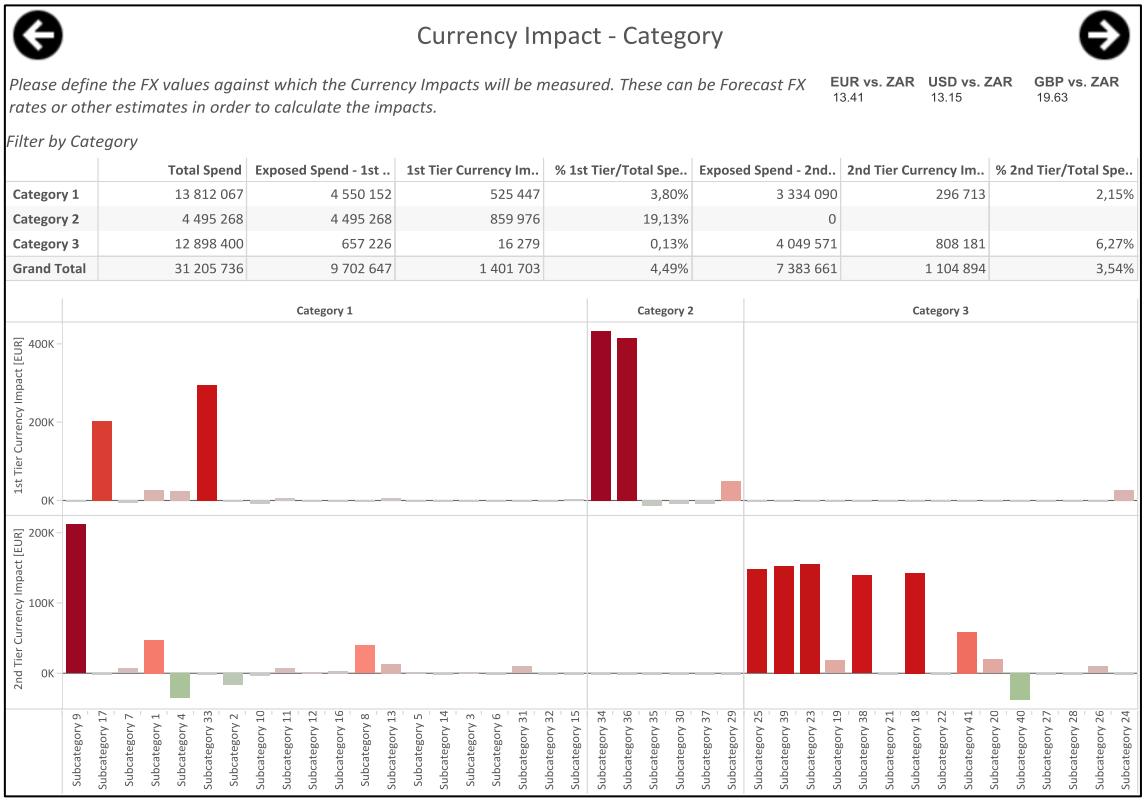


Figure 11: Cost Driver Analysis Overview



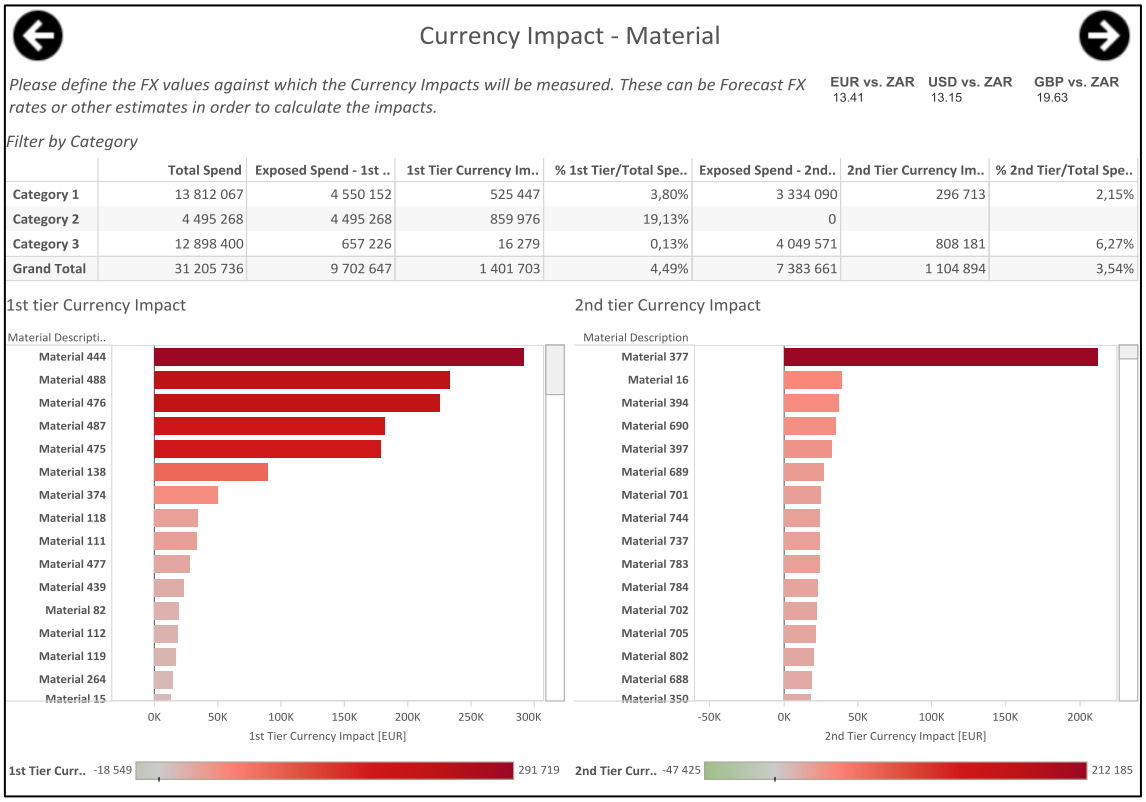
Symbol	Bid	Ask	Open	High	Low	Chg. %	Time
EUR/ZAR	15.2230	15.2327	15.2988	15.3441	15.2241	-0.46%	04:09:35
USD/ZAR	14.1754	14.1836	14.2644	14.2761	14.1669	-0.60%	04:09:29
EUR/USD	1.0738	1.0740	1.0724	1.0774	1.0718	+0.14%	04:09:35
USD/JPY	123.14	123.15	123.16	123.23	122.75	-0.01%	04:09:33
GBP/USD	1.5149	1.5150	1.5119	1.5186	1.5117	+0.20%	04:09:31
USD/CHF	1.0050	1.0053	1.0065	1.0066	1.0030	-0.13%	04:09:35
AUD/USD	0.7059	0.7062	0.7030	0.7078	0.7026	+0.43%	04:09:14
EUR/GBP	0.7088	0.7090	0.7094	0.7098	0.7079	-0.07%	04:09:33
EUR/CHF	1.0794	1.0795	1.0791	1.0806	1.0783	+0.03%	04:09:34

Figure 12: FX Forecast Input



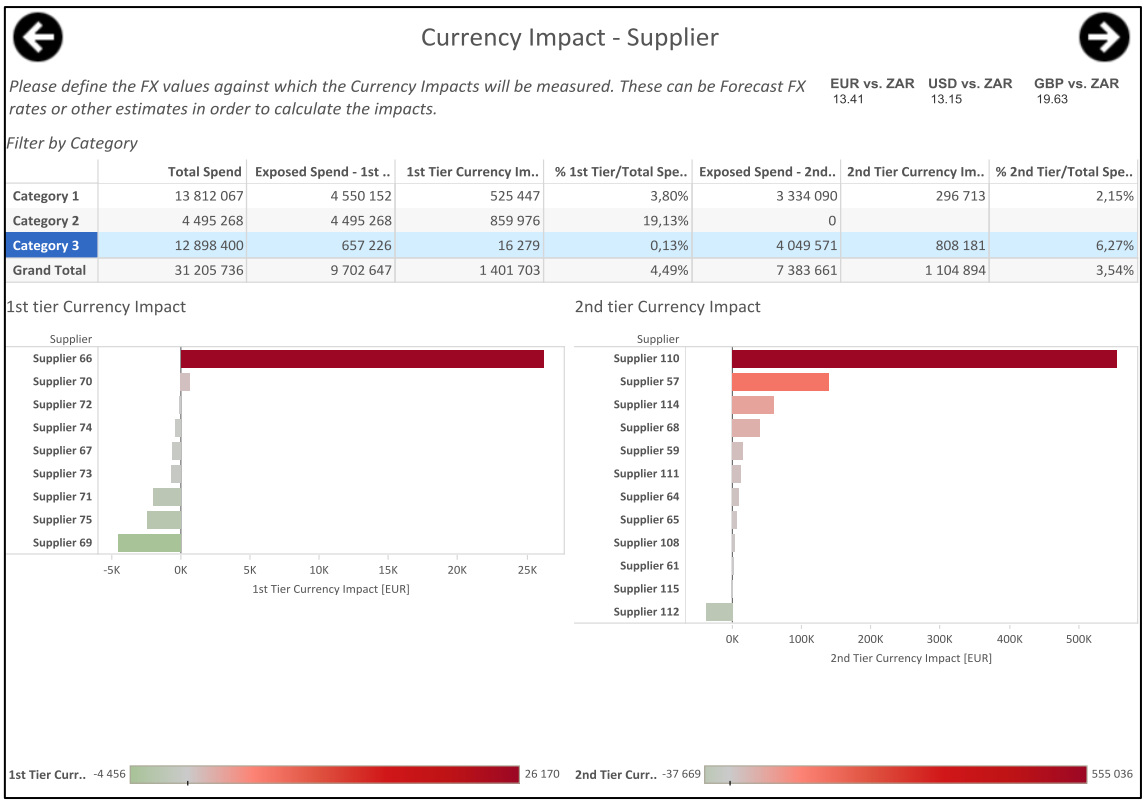
	Total Spend	Exposed Spend - 1st ..	1st Tier Currency Im..	% 1st Tier/Total Spe..	Exposed Spend - 2nd..	2nd Tier Currency Im..	% 2nd Tier/Total Spe..
Category 1	13 812 067	4 550 152	525 447	3,80%	3 334 090	296 713	2,15%
Category 2	4 495 268	4 495 268	859 976	19,13%	0		
Category 3	12 898 400	657 226	16 279	0,13%	4 049 571	808 181	6,27%
Grand Total	31 205 736	9 702 647	1 401 703	4,49%	7 383 661	1 104 894	3,54%

Figure 13: Currency Impact – Category



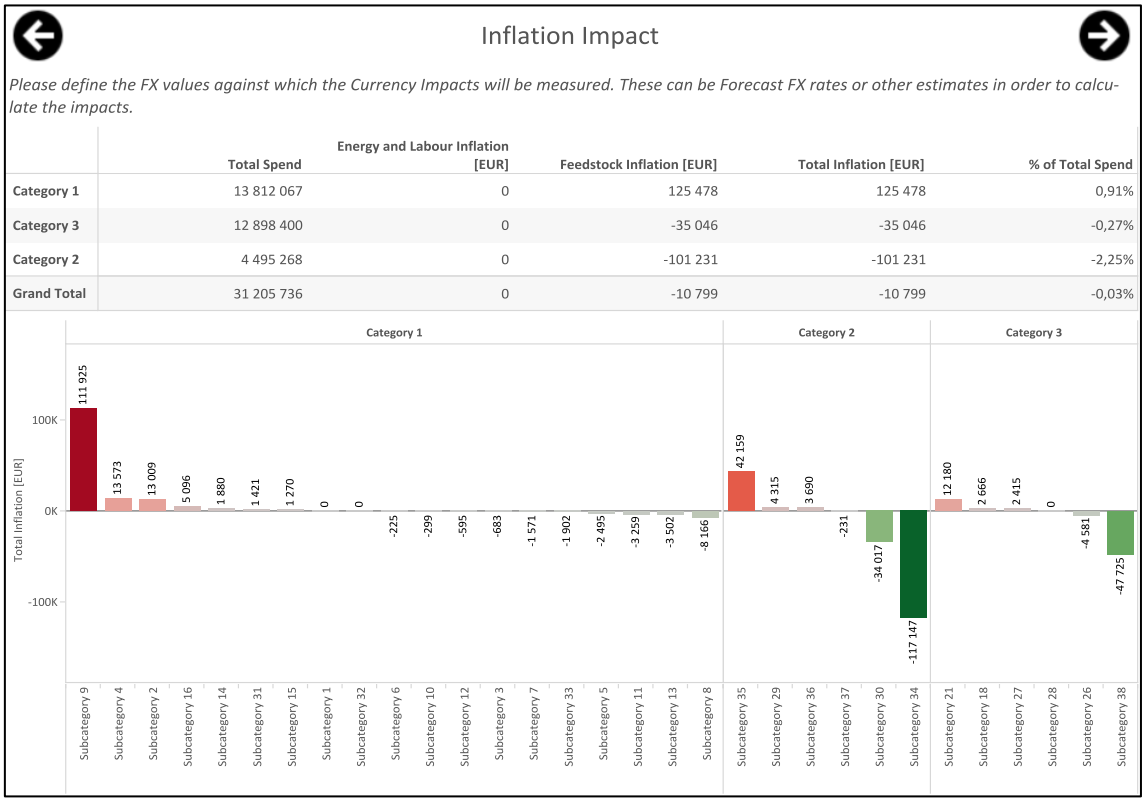
	Total Spend	Exposed Spend - 1st ..	1st Tier Currency Im..	% 1st Tier/Total Spe..	Exposed Spend - 2nd..	2nd Tier Currency Im..	% 2nd Tier/Total Spe..
Category 1	13 812 067	4 550 152	525 447	3,80%	3 334 090	296 713	2,15%
Category 2	4 495 268	4 495 268	859 976	19,13%	0		
Category 3	12 898 400	657 226	16 279	0,13%	4 049 571	808 181	6,27%
Grand Total	31 205 736	9 702 647	1 401 703	4,49%	7 383 661	1 104 894	3,54%

Figure 14: Currency Impact – Material



	Total Spend	Exposed Spend - 1st ..	1st Tier Currency Im..	% 1st Tier/Total Spe..	Exposed Spend - 2nd..	2nd Tier Currency Im..	% 2nd Tier/Total Spe..
Category 1	13 812 067	4 550 152	525 447	3,80%	3 334 090	296 713	2,15%
Category 2	4 495 268	4 495 268	859 976	19,13%	0		
Category 3	12 898 400	657 226	16 279	0,13%	4 049 571	808 181	6,27%
Grand Total	31 205 736	9 702 647	1 401 703	4,49%	7 383 661	1 104 894	3,54%

Figure 15: Currency Impact – Supplier



	Total Spend	Energy and Labour Inflation [EUR]	Feedstock Inflation [EUR]	Total Inflation [EUR]	% of Total Spend
Category 1	13 812 067	0	125 478	125 478	0,91%
Category 3	12 898 400	0	-35 046	-35 046	-0,27%
Category 2	4 495 268	0	-101 231	-101 231	-2,25%
Grand Total	31 205 736	0	-10 799	-10 799	-0,03%

Figure 16: Inflation Impact

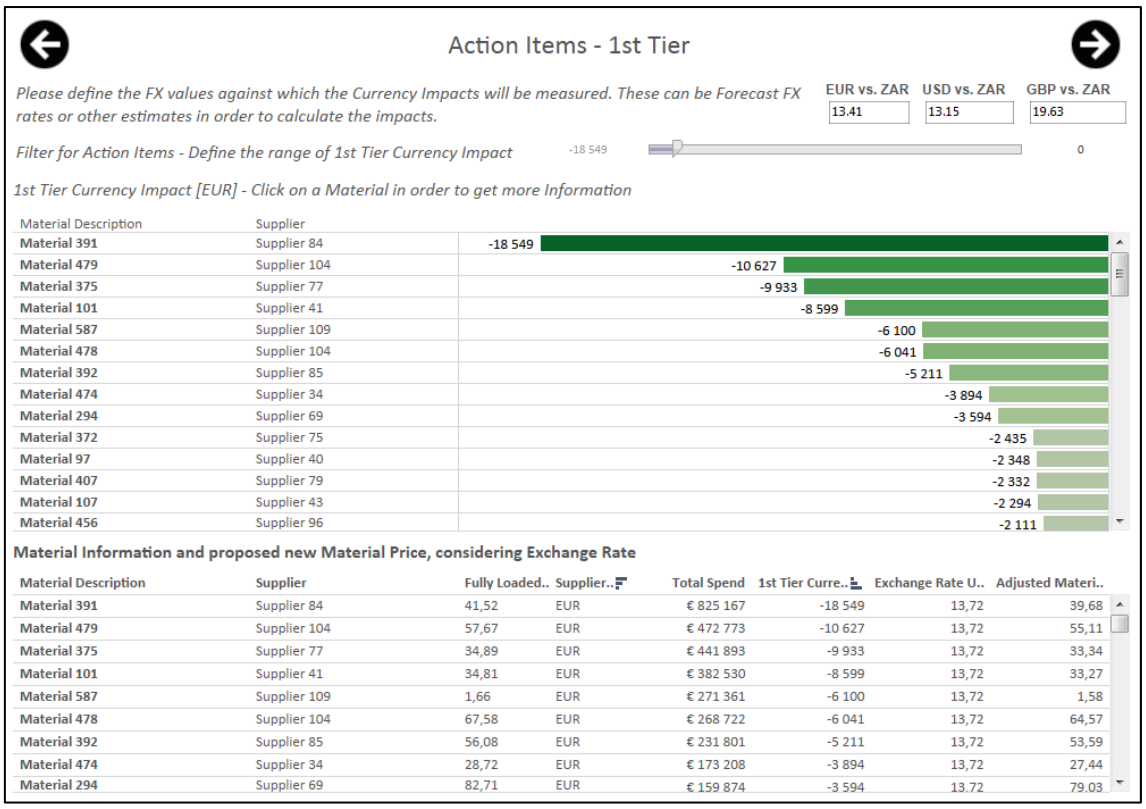


Figure 17: Action Items – First-Tier Impact

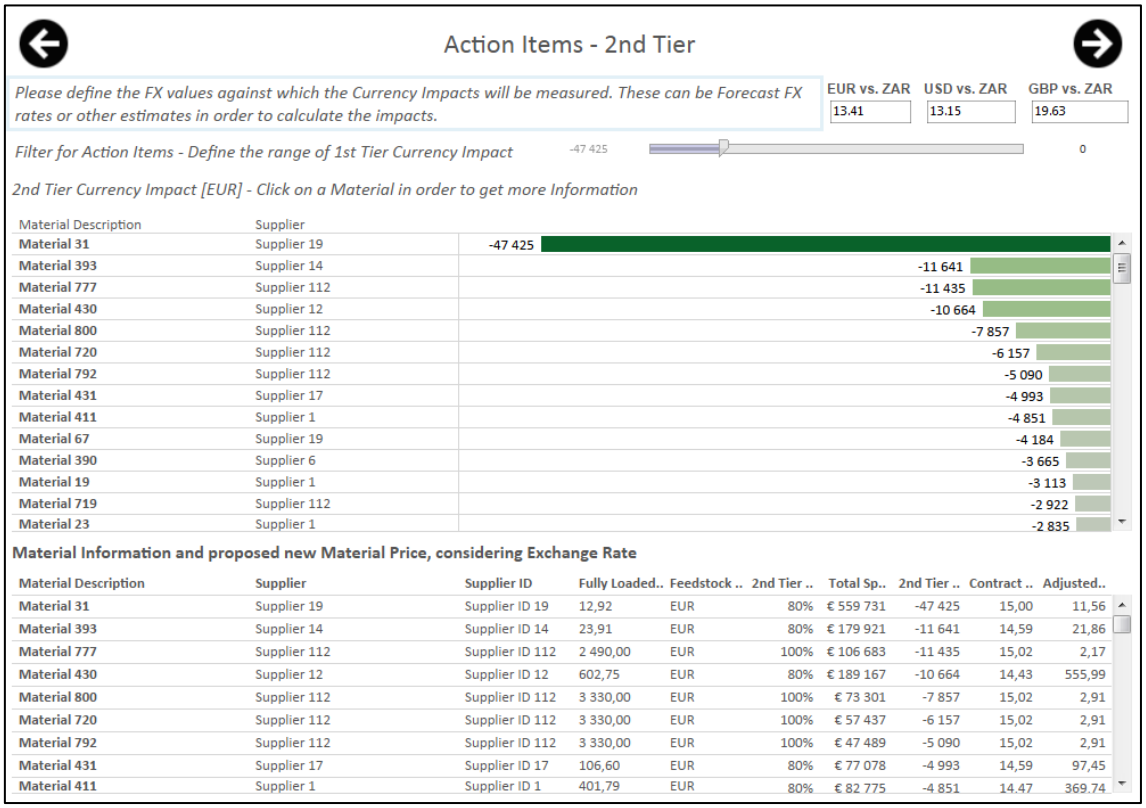


Figure 18: Action Items – Second-Tier Impact

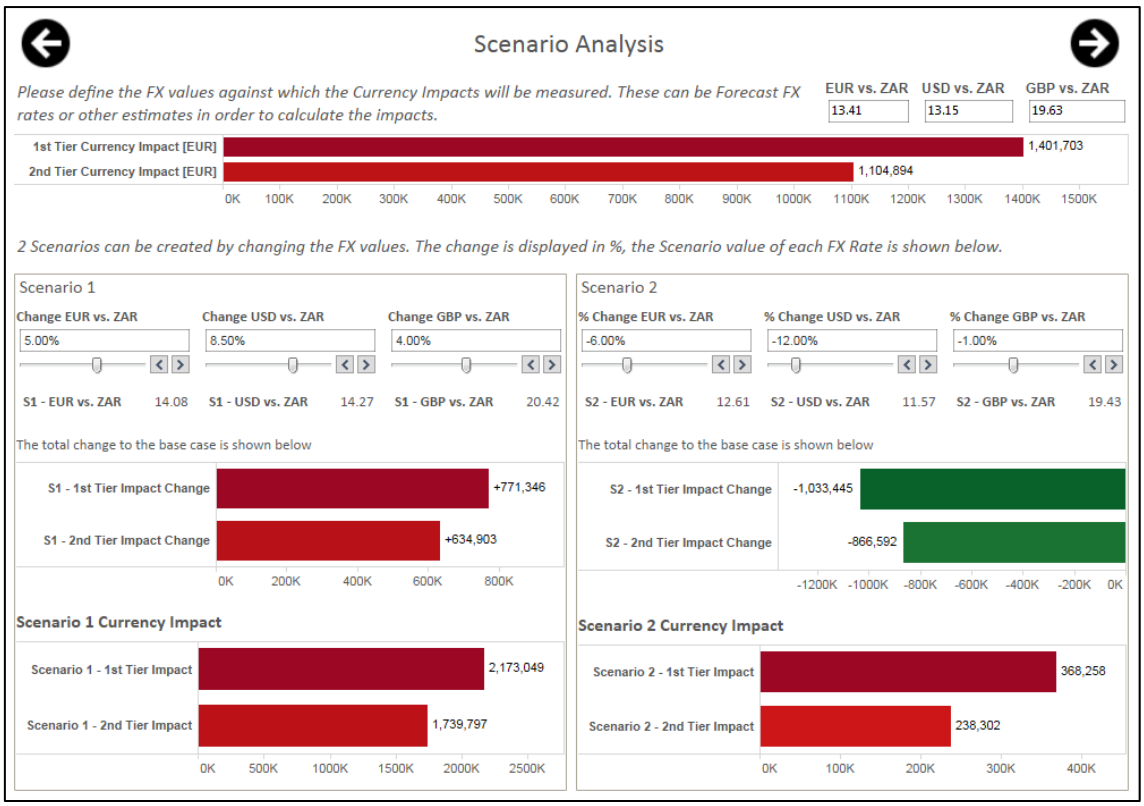


Figure 19: Scenario Analysis