An Integrated Supply Chain Programme for the South African cotton garment industry – Pilot study

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Declaration

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Abstract

Cotton is used in many products for its characteristics, flexibility, and comfort. It also forms part of a very important natural fibre used in the textile industry for weaving fabrics and producing garments (DAFF, 2016a). However, the production of cotton in South Africa (SA) by local farmers decreased significantly from 2006 until 2011. Furthermore, according to the Department of Agriculture, Forestry, and Fisheries (DAFF) (2016b), approximately 40%-60% of South African cotton demand is imported. In 2005, a study was sponsored by the United Nations Development Program, and done in conjunction with the Industrial Development Corporation (IDC), Department of Trade and Industry (DTI), Human Science Research Council (HSRC), and others. The study indicated that in SA, for every R1 million output in Agriculture, 18.6 people are employed, and with regards to the Apparel & Textiles sector, 9 jobs are created for every R1 million output (CSA & De Wet, 2016). This means that if even a small portion of the high percentage of imports were to shift to local producers, there would be major opportunities for job creation and industry upliftment. Job creation could not only be focussed on raw material, but the whole Supply Chain (SC), from the farmer to the retailer. The harshness of the world we live in today puts a lot of stress on SCs to be responsive to change. Demand could shift in an instant, especially in the fashion and clothing sector, and the SC should be able to adapt to changes as quickly and effectively as possible. However, in SA, retailers tend to struggle with quick response. Furthermore, there are major pressures occurring in the textile industry from governmental institutions to become more sustainable (Perry & Towers, 2009).

Company X, a company that focuses on sustainably sourced food and fibre products, is a profitable SC engineering and trade management company. Established in 2008, company X provides sourcing of sustainably produced commodities for international and regional buyers. With regards to the textile industry, company X focusses on the production of sustainable cotton fibre as a commodity, with a specific focus on virtual integration. An Integrated Supply Chain Programme (ISCP), driven by company X, is defined as a business practice that ensures delivery of products that are fully traceable, with great integrity by means of SC optimization. It is done by virtually integrating textile SCs, with retailers, as demand-driven participants.

The ISCP was piloted by one of the leading retail groups in SA in 2014.2017 however would be the first year of implementation of the Cloud Based Information System Platform (CBISP) which will be discussed shortly. This dissertation will aim to pilot the platform by means of implementing the ISCP, and then aims to improve the ISCP through business process re-engineering.

A local cotton garment SC was implemented with a local retailer, and the ISCP brought about many advantages and opportunities for every link in the SC. The ISCP allows retailers to have full visibility and control over their whole SC. The ISCP operates by means of long-term forward contracting (volume commitments) and planning. It is done to ensure that products meet the market demand and ensure price stability for 12-months, which improves the local price point for each SC member. The ISCP offers SC transparency to ensure market credibility and improve local sustainable sourcing. It also ensures traceability to protect the integrity of

sustainable claims and to track programme impact. The ISCP assists in the process of creating long-term partnerships amongst SC stakeholders.

Even though the ISCP brings about a lot of advantages and opportunities, there is a need for a technological platform to support it. Visibility in a SC is very important, as well as traceability. Equally important is the flow of information, in both the upstream as well as downstream direction. Furthermore, forecasting and planning is required for a SC to run at its optimum capacity.

Thus, a CBISP was created by the sustainable cotton cluster and company X, to support the ISCP. This platform is designed to offer: item-level traceability; sustainable compliance and marketing opportunities; and Supply Chain Management (SCM) with full visibility from fibre production to point of sale. It allows interfacing capabilities, via the cloud, with individual Enterprise Resourcing Planning (ERP) systems in the SC.

The CBISP was partially implemented and tested in this thesis, by means of implementing the ISCP with retailer A. The data obtained in the ISCP with retailer A was used to pilot the CBISP. However, due to a lack in contracts, excessive costs to improve individual ERP systems and even lacking sufficient ERP systems in the SC, the traceability function could not be tested. Further implementation and testing of the CBISP, in future studies, is thus required to successfully pilot the complete CBISP.

Opsomming

Katoen word gebruik in baie verskillende produkte vir sy unieke eienskappe, buigbaarheid en gemak. Katoen word ook geklassifiseer as ‘n baie belangrike natuurlike vesel, wat gebruik word in die tekstielbedryf om materiaal te weef en kledingstukke te produseer (DAFF, 2016a). Die produksie van katoen in Suid Afrika (SA) deur plaaslike boere, het baie afgeneem van 2006 tot 2011. Volgens die DAFF (2016b) word 40%-60% van SA se katoenvesel ingevoer. ‘n Studie in 2005, wat geborg is deur die “United Nations Development Program,” tesame met die IDC, DTI en HSRC, het aangedui dat in SA is daar potensiaal om 18.6 werksgeleenthede te skep vir elke R1 miljoen se landbou uitsette. Volgens die tekstiele en klere sektor kan 9 werksgeleenthede geskep word vir elke R1 miljoen se uitsette (CSA & De Wet, 2016). Die gevolgtrekking kan gemaak word dat met die hoë persentasie wat tans ingevoer word, is daar geleenthede om werk te skep, asook om die industrie te verbeter, as van die produkte met slegs ,n klein hoeveelheid gelokaliseer word. In verband met werksverskaffing kan daar nie net gefokus word op die rou materiaal nie, maar op die hele ketting, soos dit van die boer na die handelaar beweeg. Die rigiditeit van die wêreld waarin ons leef vandag, sit baie stres op vervaardigingskettings om volhoubaar te wees. Aanvraag kan in ‘n oogwink verander, veral in die mode- en klere sektor en die vervaardigingsketting behoort aanpasbaar te wees tot verandering, wat ook so vinnig en doeltreffend as moontlik moet kan gebeur. In Suid-Afrika, is die kleinhandelaars egter geneig om te sukkel met vinnige en doeltreffende reaksie op die verandering in aanvraag. Verder sit regeringsorganisasies baie druk op die tekstiel bedryf om verantwoordelik te wees teenoor volhoubaarheid (Perry & Towers, 2009).

Maatskappy X, 'n maatskappy wat fokus op volhoubare verkryging van voedsel en vesel produkte, is 'n winsgewende vervaardigingsketting en handelbestuursmaatskappy. Maatskappy X, wat gestig is in 2008, verskaf ‘n diens om te verseker dat volhoubare produkte geproduseer word en sluit internasionale asook plaaslike kopers in. Met betrekking tot die tekstiel industrie, fokus maatskappy X op die produksie van volhoubare katoen vesel as kommoditeit, wat fokus op virtuele integrasie. Die “*Integrated Supply Chain Programme* (ISCP),” gedryf deur maatskappy X, word gedefinieer as 'n besigheidspraktyk wat verseker dat aflewering van produkte wat ten volle opspoorbaar is, met groot integriteit deur middel van verbruikers ketting optimalisering. Dit fokus op virtuele integrasie, tekstiel verbruikerskettings, met kleinhandelaars as vraag gedrewe deelnemers.

Die ISCP is alreeds deur een van die voorste handelaarsgroepe in SA getoets in 2014. 2017 sal dus die eerste jaar van implementering van die “*Cloud Based Information System Platform*” CBISP wees, wat binnekort bespreek sal word. Hierdie navorsingsdokument sal poog om die platform te toets deur middel van die implementering van die ISCP en ook poog om die ISCP te verbeter deur middel van besigheidsproses adressering notasie (BPMN).

'n Plaaslike geproduseerde katoen kledingstuk vervaardigingsketting is geïmplementeer met een van die plaaslike handelaars in SA en die ISCP het baie voordele en geleenthede meegebring vir elke skakel in die ketting. Die ISCP laat kleinhandelaars toe om volle sigbaarheid en beheer oor hul hele verbruikersketting te

hê. Die ISCP bedryf deur middel van langtermyn kontraktering (volume verpligtinge) en vooraf beplanning, verseker dat produkte voldoen aan mark aanvraag en prysstabiliteit vir 12 maande, wat die plaaslike prys punt vir elke verbruiker in die ketting verbeter. Die ISCP bied verbruikersketting deursigtigheid, om te verseker dat mark geloofwaardigheid verbeter word en om plaaslike volhoubare ontginnings strategie verbeter. Dit verseker volle naspeurbaarheid, om ten einde die integriteit van volhoubare bemarking eise te beskerm. Dit skep ook lang termyn vennootskappe onder verbruikersketting belanghebbendes.

Selfs al bring die ISCP voordele en geleenthede na tevore, is daar 'n behoefte vir 'n tegnologiese platform om dit te ondersteun. Sigbaarheid en naspeurbaarheid in 'n vervaardigingsketting is baie belangrik. Die vervaardigingsketting kan eenvoudig nie effektief genoeg reageer op verandering in aanvraag, sonder volle sigbaarheid nie. Ewe belangrik, is die vloei van inligting, stroomop, sowel as in die stroomaf rigting. Vooruitskatting en beplanning is ‘n vereiste vir 'n vervaardigingsketting om op optimale kapasiteit te funksioneer. 'n CBISP is dus geskep deur die volhoubare katoen cluster en maatskappy X, om die ISCP te ondersteun. Hierdie platform is ontwerp om die volgende diens te lewer: item-vlak naspeurbaarheid; volhoubare voldoening te verseker en bemarkingsgeleenthede te skep; en verbruikerskettingbestuur te verskaf met volle sigbaarheid van veselproduksie tot by die punt van die verbuiker. Dit het vermoë om via die internet te integreer met individuele “Enterprise Resourcing Planning” (ERP) stelsels in die tekstiel voorsieningsketting.

Die platform was gedeeltelik geïmplementeer en getoets deur middel van die implementering van die ISCP met handelaar A, en die verkryging van data deur die ISCP met handelaar A. As gevolg van 'n tekort in kontrakte, tekort aan fondse om die individuele bestaande ERP-stelsels te verbeter en selfs in sommige gevalle waar daar tans geen ERP-stelsels gebruik word nie, kon die platform nie heeltemal geïmplementeer word nie. Sonder behoorlike ERP inskakeling kan die naspeurbaarheid van 'n produk is ook nie getoets word nie. Die toets van die CBISP vereis dus verdere toetsing en implementering in toekomstige studies.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

List of Abbreviations

APICS	American Production and Inventory Control Society
BCCU	Better Cotton Claim Units
BCI	Better Cotton Initiative
BPD	Business Process Diagram
BPM	Business process mapping
BPMI	Business Process Modelling Imitative
BPMN	Business Process Model and Notation
CBISP	Cloud Based Information System Platform
CEO	Chief Executive Officer
CMT	Cut Make and Trim
CSCMP	Council of Supply Chain Management Professionals
CSR	Corporate Social Responsibility
CTCP	Clothing and Textile Competitiveness Programme
DAFF	Department of Agriculture, Forestry, and Fisheries
DTI	Department of Trade and Industry
EF	Ecological footprint
ERP	Enterprise Resourcing Planning
FESC	Faculty Ethics Screening Committee
GHG	Greenhouse gasses
GJ	Gigajoules
IDC	Industrial Development Corporation
ISCP	Integrated Supply Chain Programme
ISO	International Organization for Standardization
IT	Information technology
kg	Kilogram
kWh	kiloWatt-hour
LCA	Life Cycle Assessment

LOI	Letter of Intent
m	meter
m^2	square meter
ML	Master List
MOU	Memorandum of Understanding
NDA	Non-Disclosure Agreement
NYCE	New York Currency Exchange
PCF	product carbon footprint
PPII	Protected Personally Identifiable Information
RACI	Responsible, Accountable, Consulted, and Informed
SADC	South African Development Community
SASTAC	South African Sustainable Textile and Apparel Cluster
SC	Supply Chain
SCI	Supply Chain Integration
SCM	Supply Chain Management
SKU	Stock Keeping Units
SLM	Strict Low Middling
SSCM	Sustainable Supply Chain Management
TBL	Triple Bottom Line
UML	Unified Modelling Language
UV	Ultraviolet

Glossary of key terminologies used in this dissertation

Artefact:	use or produce any activity or process.
Business process management:	involves the management and coordination of business processes, and will involve business process modelling.
Business process modelling:	is a process modelling exercise that is performed in order to enhance the overall operation of a business.
Business process re-engineering:	is used specifically when business process modelling is applied to existing processes as part of a business process improvement.
Better Cotton Initiative:	a non-profit organisation that defines better farming techniques in order to grow "*Better Cotton*" or sustainable cotton.
Better Cotton Claim Units:	where one kilogram of Better Cotton will be equal to one better cotton claim unit.
Cotton gin:	a machine that separates the cotton seeds from the cotton fibre/lint
Cotton lint/fibre;	cotton lint is the fibre that derived from the seed cotton after the seed is removed in the ginning process
Cut Make and Trim:	hiring a contractor for the function of cut make and trim of garments.
Enterprise Resourcing Planning system:	a process by which a company manages and integrates important business parts.
Fast fashion:	A term used by fashion retailers to describe the move of fashion from the catwalk to retail stores in a short amount of time, to capture the current fashion trends.
Future market:	A future market is a market in which participants can buy and sell commodities and their future delivery contracts. This provides a medium for hedging and speculation which is crucial for diminishing fluctuation in prices that is caused by shortages and gluts.
Information technology platform:	any software or hardware that is used to host a service or an application.
Letter of Intent:	It is a document that contains declaration of the intentions of the writer.

Memorandum of Understanding:	It is a document that define mutual understanding on a point or issue between two or more parties. This document is normally recognized as a binding. For this document to be legally active it has to contain the following information, first the contracted parties need to be identified, secondly the subject and objectives of the matter of the agreement should be defined, there should be a summary of the essential terms of agreement and it have to be signed by all the contracted parties. Could also be known as a Letter of Intent.
Micronaire:	Micronaire (MIC) is a measure of the air permeability of compressed cotton fibres. It is often used as an indication of fibre fineness and maturity.
Model:	derived from Unified Modelling Language (UML), which streamline reality. A model may be a diagram, equation, text or verbal description and/or physical model.
Neps:	Any small entanglement of textile fibres that cannot be unravelled, which is formed during carding or ginning.
Non-Disclosure Agreement:	A written contract by which one or more parties agree not to disclose confidential information that will be shared with each other as a necessary part of doing business together.
Process mapping:	includes the linkage of different processes with one another which will form part of an audit.
Process re-alignment:	would typically be applied to current outdated existing processes, because of change in requirements for the process.
Promissory note:	A signed document, that contains a written promise to pay a certain sum to a specified person or company at a specified date or on demand.
Seed cotton:	the unginned cotton seed, with the lint still attached to the seed (commonly used as “the seed cotton is sold to the gin”).
Stakeholder:	could either be a role played by a place or a person that has a particular interest in the project or the system.
Staple length:	staple length could be defined as a property of staple fibre, referring to the average length of a group of fibres of any composition fibre.

Supply Chain Integration:	SCI could be defined as the link between SCM and integration where the level of coordination of resources (quantity and quality), synchronization of decisions, planning (timing, purchasing etc.) and methods between parties and entities within the SC could be maximised to be more efficient in every part of the SC including captured external information from consumers.
Supply Chain Management:	the management of products/operations and exchange of information (inward and outbound of business) from key components such as: supplier; manufacturer and destruction centre to demand driven consumers, to track/forecast/ determine/convert, forward and backward information, to maximise the performance (financial, efficiency, sustainability) and minimise risks of the SC.
Supply Chain:	a SC could be defined as a family of networks with multiple linked suppliers which associate with the delivering of goods or services.
Sustainable Supply Chain Management:	the connection between sustainable measures or the Triple Bottom Line and SCM, in order to improve: competitiveness; relationships with partners; profitability; the reputation of the company; and stakeholders and consumer needs, to contribute to the need of the present without compromising what would be needed in the future
System:	could be identified as any organisation or collection of entities, that collude in order to meet a set of requirements. A system could then be anything of the following: a person; a group; or a network of computers, mechanics or electronics.
Tex:	Tex is a unit of measure for the linear mass density of fibres, yarns and thread and is defined as the mass in grams per 1000 meters.
Triple Bottom Line:	refers to social-, environmental- and economic responsibilities.

Unified Modelling Language:	modelling language in software engineering, which provides a standard way to visualize a system design.
Validation:	which applies to a phenomenon that meets the requirements of something.
Value chain:	A value chain is the whole series of activities that create and build value at every step. The total value delivered by the company is the sum total of the value built up all throughout the company (including financial aspects and strategic positioning).
Verification:	applies to a phenomenon that works without error.
Warp yarn:	the warp yarns are held at tension with a frame or a loom to a cloth in a lengthwise direction.
Weft yarn:	the weft yarn, in weaving, is the thread or yarn which is drawn through, inserted over-and-under the warp yarn.

1 Introduction and background

Recent published academic literature, regarding the cotton situation in South Africa (SA) is limited. However, the latest information with regards to the cotton profile and cotton lint production are reported by clusters, departments, and independent organisation such as: the sustainable cotton cluster, Cotton South Africa (CSA), Department of Agriculture, Forestry, and Fisheries (DAFF), independent retailers, and ginners. However, these resources could be very helpful to paint a well-defined picture of the current cotton situation in SA, keeping in mind that the validity of the information may be biased. During the literature review chapters in this dissertation, it is aiming to document as much information as possible to fill the academic literature gap to some extent, with regards to the cotton industry profile of SA.

Cotton, used in many products for its characteristics, flexibility, and comfort, creates thousands of jobs in SA and globally as it is processed from farm to retail. It also forms part of a very important natural fibre used in the textile industry for weaving fabrics and producing garments (DAFF, 2016a). However, the production of cotton in SA by local farmers, decreased with 43% from 2006 until 2011. Even though, there were some increases from 2012 until 2016, the highest cotton lint production in 2012 at approximately 17 000 tonnes, is only a fraction of the cotton consumed in SA.

According to the DAFF (2016b) approximately 40%-60% of South African cotton demand is imported. This means that the textile manufacturing industry is labour intensive, thus creating much needed jobs, if cotton product production is localised specifically in the retail industry. Furthermore, South African Development Communities (SADC) countries, have cost advantages with lower labour costs over South African labour costs (DAFF, 2016b). With regards to local retailers, international competing brands like H&M and Zara, entering into the same market space than the local retailers, will also influence the competitiveness of local suppliers. According to KPMG insights, South African retailers are facing major competition, nationally and globally not only on a price scale, but the quality and speed to deliver product as well (Top risks for retail companies in SA, 2017).

Equally important is the variation of cotton lint prices in SA due to factors such as subsidising of American farmers, oil prices, the exchange rate (World statistic organisation, n.d.). Much needed support is crucial to the cotton-producing industry. Supporting institutions, such as the Industrial Development Corporation (IDC), developed a programme called the Clothing and Textile Competitiveness Programme (CTCP), which aims to secure employment and increase competitiveness in the textile, clothing, footwear, leather, and leather goods production industries (IDC, 2016). There is however a big need to create jobs in SA, and focussing on cotton production and process could bring about major advantages. Every R1 million output in agriculture, could potentially create 18.6 jobs, and for every R1 million output in the apparel & Textiles sector, could create 9 jobs.

CHAPTER 1: INTRODUCTION AND BACKGROUND

Being in the position or having the power to make a difference regarding sustainability should not be taken for granted nor be ignored by companies all over the world. Companies in the retail and distribution Supply Chain (SC) system such as the clothing industry, manufacturing make to stock products, have the power to make an enormous difference, with regards to sustainability. However, this is easier said than done. Many factors influence the occurrence of an ideal sustainable world, with ethically produced and sustainable clothing products.

The textile industry experiences major pressures from: governmental regulations-; competitive pressures-; and environmental conscious consumers (Perry & Towers, 2009). Thus, it is important for key businesses that form part of the textile SC, to design plans and to act, to minimise sustainable complications that occur in the textile industry. The term "*sustainability"* in this context refers to social-, environmental- and economic responsibilities, which could also be referred to as the Triple Bottom Line (TBL). Added pressures as mentioned earlier on the textile industry, also influence the cotton producer as well as the processor of cotton and the retailer. This is evident that the responsibility towards sustainability should be applied to the cotton sector as well.

The process of converting raw material into an actual piece of clothing or garment, forms part of various steps, which include the processing of the cotton seed into cotton lint, the cotton lint into cotton yarn, and ultimately the cotton yarn into cotton fabric, which is then cut and trimmed into a garment (Sen *et al*. quoted in Giri & Rai 2013:30). All the various steps are done by different suppliers which are divided into a ginner, spinner, fabric manufacturer, Cut-make and Trim (CMT), tier-one supplier and ultimately the retailer (Giri & Rai, 2013). Even though this SC forms part of a retail SC, one company does not necessarily or rarely own the whole SC.

Coordination of material as well as information flow is important to increase SC performance (Giri & Rai, 2013). To do so some form of integration between the different links in the SC is necessary, and unfortunately according to Wisner (2017:512) some of the obstacles of process integration is the absence of information visibility and lack of trust, which is also the case in a textile SC. In this sense "*information visibility*" could be defined as the sharing of real time data, which is essential for managing the flow of services and goods between a customer and a supplier. It is not only due to lack in willingness to share but also information technology (IT) systems that are inadequate to provide an information sharing function (Wisner 2017:513).

Planning in the textile SC is difficult without proper communication between links. Measuring sustainable impacts, sufficiently, is difficult without proper communication channels. It is thus important to consider SC integration into a cotton garment SC to improve sustainability and SC efficiency.

Another important intricate process in retail is to forecast the demand of the consumer well in advance. Which means that when the buyer places an order, then the receiving party or supplier may use this as a future demand indication. If this is done well in advance, then frequent demand updates are necessary. The lead-time at different stages of the SC differ, which ultimately means that there is a need to produce safety stock in advance,

which then causes a bullwhip[1] effect to other suppliers in the SC. This effect is caused due to persistent demand forecast updating (Wisner 2017:515). The key will be to assist in communicating the latest and most recent forecast as quick as possible from the buyer to supplier to avoid this effect. An important term used in the textile industry namely the "*quick response model*," highlights the ability to shorten the lead time and respond to rapid change in demand (Christopher & Towill, 2002). This goes hand in hand with the terms "*fast fashion*[2]."

To form these important communication channels, and solve issue highlighted previously, between the links in the Supply Chain (SC), it would be ideal to outsource this task to an external company. If the integration process uses a virtual integration approach, it will give a company the ability to replace ownership of different parts in the SC to partnerships in different parts of one functioning SC. This could be done by means of IT or an IT system which will aid in process planning, improve control over the SC and will allow collaborative execution of action (Wang *et al*., 2006).

Company X is a profitable, SC engineering and trade management company which focuses on sustainably sourced food and fibre products. Company X, established in 2008, provides end-to-end sourcing of sustainably produced commodities for international and regional buyers, with an off-shore component established in 2014, for exporting to international clients. With regards to the textile industry, company X focusses on the production of sustainable cotton fibre as commodity, which focus on virtual integration.

The Integrated Supply Chain Programme (ISCP) is supported by a Cloud Based Information Systems Platform (CBISP), which aims to trace products from farm to retail and allowing SC partners to mutually share information. Company X, in collaboration with the sustainable cotton cluster, develop the CBISP mentioned earlier. The ISCP was tested with one of SA's leading retailers, and the CBISP was developed to support the ISCP. An "*Integrated Supply Chain Programme*" (ISCP), is defined as a business practice that ensure delivery of products that are fully traceable, with great integrity by means of SC optimization. The ISCP allows long-term commitments between relevant parties. The CBISP can interface with different Enterprise Resourcing Planning (ERP) systems of the different links in the SC in the cloud. However, the CBISP has not yet been tested or implemented into a textile SC.

To test the implementation of this platform into a textile SC it is important to first define the ISCP process. The ISCP will form the basis of the dissertation as well as a large part of the dissertation which will then be supported by the CBISP.

[1]It is a phenomenon where forecasts yield SC inefficiencies. This occur when there is changes in consumer demands and the initial planning was based on forecasts which causes a company to order more goods to meet the demands.
[2] A term used by fashion retailers to describe the move of fashion from the catwalk to retail stores in a short amount of time, to capture the current fashion trends.

1.1 Problem statement

The cotton garment manufacturing industry faces many challenges as highlighted in chapter 1. Organisations currently lending a helping hand in this sector includes, but are not limited to, the IDC and clusters such as the sustainable cotton cluster or CSA. These organisations aim to unite the entire cotton value chain, by incorporating the public sector, organised labour, consumer organisations and service providers (IDC, 2016; CSA, 2015). The support from these parties will not necessarily be enough, with regards to sustaining the industry, manufacturing sustainable textile products, job creation, mutually sharing of information. Alternative options, innovations and support is thus needed. It is thus evident that there is a need for improvement in this sector, especially focussing on local production, manufacturing, and retailing.

Some other problems and areas of concern within the industry and academic research include:

i. The need to enrich scientific literature or research of the cotton value chain because relevant literature was found to be lacking and outdated.
ii. A decline in local cotton lint productions since 2006-2011 and about 40%-60% of cotton products that are imported which could alternatively if shifted local, create many jobs (DAFF, 2016b).
iii. SADC countries can produce lower cost products than locally produced products due to high labour costs in the SA industry (DAFF, 2016b).
iv. Local cotton lint prices change rapidly, which makes financing and planning very difficult (World Statistic Organisation, n.d.).
v. Major pressure occurs in the textile industry from governmental institutions to be more sustainable (Perry & Towers, 2009).
vi. Balancing the TBL in the textile industry requires SC integration in the textile SC, which is difficult to implement due to lack of trust and unwillingness to share information (Wisner,2017:512).
vii. Difficulty to implement traceability due to IT programmes preventing full traceability and lacking efficient and effective data sharing amongst SC partners (Wisner 2017:513).
viii. Rapid change in demand forecast cause a bullwhip effect which impacts supply efficiency negatively (Wisner 2017:515).

The above-mentioned problems, result in difficulty to implementing the quick response model into a SC. Even though much research has been done on the issues mentioned above, there are still problems that retailers and value partners are experiencing in SA, such as the lacking ability to be agile to change in demand and lack of financial support from government to strengthen the sector. Furthermore, improving local sourcing and empowering local manufacturing industries could potentially improve some of the issues mentioned section 1.1. It is also evident that there is a need for a solution as to how information could be shared mutually and better partnerships which would ultimately result in integrity and willingness to trust a partner. Solving this would ultimately solve the bullwhip effect to some extent and improve quick response. Lastly, there is also a need for traceability and integration in the garment manufacturing sector.

Company X developed a business model called the ISCP which aims to integrate a retailer supply chain through virtual integration. This business model was tested with one of the leading clothing retailers but there is a need to improve the ISCP to ease implementation, since the ISCP is a complex business model to implement. Furthermore, there is a need to analyse the benefits added to the local retailing industry, and to pilot whether some of above mentioned issues could be solved through the ISCP. A newly developed CBISP was developed in conjunction of the ISCP and need to be piloted to test if the CBISP could potentially strengthen and support the ISCP by means of product traceability and allowing mutually sharing of information.

1.2 Research question

Based on the above problem, the primary research question is stated as follows:

How could the ISCP be improved to ease implementation, in order to test the added values of the ISCP to the South African clothing manufacturing industry? Will the CBISP be successful to implement and support the ISCP?

To answer the primary research question, the following secondary questions are considered:

What method or tool could be used to ease the implementation of the ISCP?

With implementation, will the ISCP offers price stability to SC partners?

With implementation, will the ISCP create jobs in SA?

With implementation, will the ISCP improve local production capacity?

Will the CBISP be able to support the ISCP?

Could a cotton garment be fully traceable by means of the CBISP?

1.3 Research objectives

The research objectives for this dissertation are divided into three main objectives:

The first objective is: Building a conceptual framework for apparel manufacturing sector, specifically 100% cotton garments:

i. To examine and define important terms used in the SC sector, specifically terms applicable to the apparel sector,
ii. To map a typical cotton garment SC and explain the dynamics of cotton as a commodity,
iii. To identify current sustainability issues in the cotton garment manufacturing process,
iv. To identify technology and innovations currently available in this sector with regards to traceability, and
v. To review and analyse appropriate business process mapping (BPM) methods to apply to ISCP.

The second objective is: Piloting the ISCP business model:

i. To review and document previously tested ISCP,
ii. To strengthen the ISCP by means of BPM,
iii. To apply the ISCP to a retailer/brand, and
iv. To perform data analysis on the ISCP to generate input data to test the CBISP performance.

The third objective is: Piloting the CBISP;

i. To input data into the platform from the ISCP process, and
ii. To determine gaps in the IT system that need to be changed for successful implementation.

1.4 Research aims

Successful implementation of the CBISP, developed for the textile industry, will allow companies to have high item-level traceability, sustainable compliance and SCM, from fibre production to point of sale. Successful implementation of the CBISP, would also support the ISCP.

The production and engineering of apparel fabrics and garments, compared to other products such as automobiles and electronics, are a lot more time consuming and difficult to control, with a SC (Fan & Hunter, 20:xix). The designs of garments and fabrics should be manufactured to meet the needs of the end-users. As clothing is an intimate object that is associated with the daily lives of individuals, the relationship between physiological status and emotions are related to what an individual wear (Li & Dai, 2010:3).

To communicate the need of the customer, to the links in the SC, at high speed, is an intricate process. Delivering a product with high quality at higher speed makes it even more complex. The normal manufacturing rate of a garment varies from retailer to retailer, but it could take from 6-months up to 12-months, to finish a garment from concept to product. Longer lead times makes it difficult to plan (Ramdass, 2013). Thus, shortening the lead time or manufacturing of a garment, could increase the efficiency of the SC, because links in the SC have the ability to plan (also known as the quick response business model approach). SCM, integration and mutually sharing of information could be used to improve the movement of information in a SC (Mentzer *et al.*, 2001). However, this is easier said than done since there is a certain sense of unwillingness to share information because of competitiveness issues. The ISCP would improve the above-mentioned issues, such as increasing visibility down the whole SC, improving partnerships, shortening lead time, improving planning, only to name a few.

Even though the ISCP has been piloted with one of the leading retailers in SA, there is still a need for improvement. Improving the ISCP developed for a cotton garment SC, by means of BPM, would ease future implementation and increase the competitiveness, effectiveness, and efficiency of the model. Dealing with new innovations requires a certain sense of "work in progress" and to improve functionality of this programme,

constant updating and improvement would be key. Implementing the ISCP would produce data that would serve as input data, to test the CBISP.

In the last few decades, the clothing and textile industry has changed how it operates, the environment in which it operates and the technology used during operations. According to Ramdass (2013:3) software packages and the internet could be used to speed up the flow of information and make a SC more efficient and effective. Thus, new, and improved technology could aid in SC efficiency.

If a SC is more efficient, the company can be more competitive in the market sector. Furthermore, improvement in IT and innovation in SCM could aid in other factors and difficulties arising in the textile industry. This may include the issue with regards to sustainable responsibility. If full traceability could be yielded by means of the CBISP, it would add value to the whole SC, since a in store product could then be traced up until farm level.

The CBISP, when implemented successfully, could also decrease the amount of paperwork in a SC and also improve mutually sharing of information, improve SC visibility, improve planning of the whole SC and also to some extent lend a helping hand to move closer to balancing the TBL in the local cotton garment SC. Allowing local retailers and other links in the SC to use the CBISP, in collaboration with the ISCP could put local retailers in a higher competitive rank with regards to international retailers and brands.

1.5 Delineation of research

Integrating theoretical research and methodology with practical research methods and data analysis, is challenging. However, theoretical research and methodology paints a well-defined picture about theoretical method for research, which eases the process of applying theoretical methods to practical methods. Theoretically, it will be defined (in Chapter 2) that for certain types of data, there are certain types of methods to apply to obtain the data; analyse the data; and interpret the data.

In this research study, the initial theoretical research and methodology, explained in Chapter 2, is altered during this dissertation, after secondary data was collected. The reason for this is, when the ISCP is better understood, after secondary analysis, it is not sensible to follow the research approach defined in Chapter 2 and Appendix C, Figure C-1. The conclusion is that it would be more relevant to use the information defined in Chapter 2 as a base line, but apply it practically, as defined by the ISCP. To have a better view of the research structure, and to understand the flow of the research in this dissertation, refer to Figure 1-1. It outlines the main objective of the research structure, to ultimately answer the research questions and to reach the first research objectives though a in depth literature review, the second research objectives to review improve and implement the ISCP, and the third research objectives to input data obtained from the ISCP into the CBISP in order to pilot test the platform. This will also allow the reader to have a better view of the flow of this dissertation.

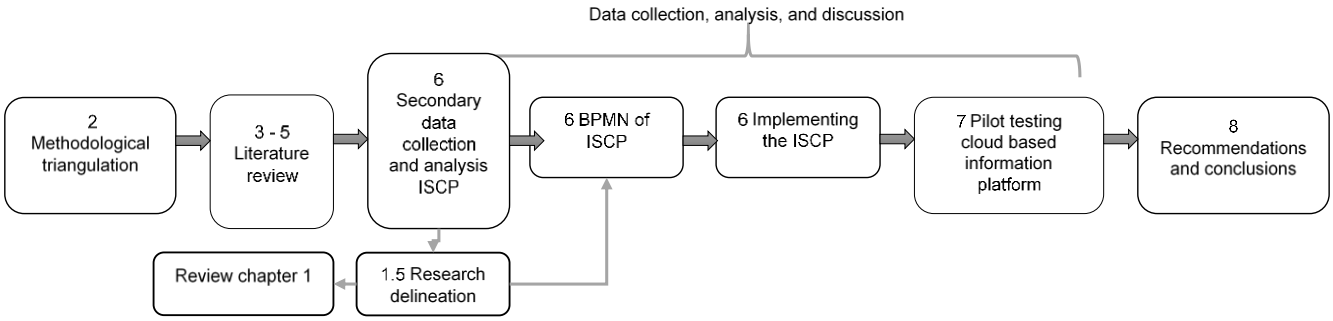

Figure 1-1. Research structure.

To have a detailed view of the reviewed research approach, where the theoretical and practical approach to this dissertation is integrated, refer to Figure 1-2.

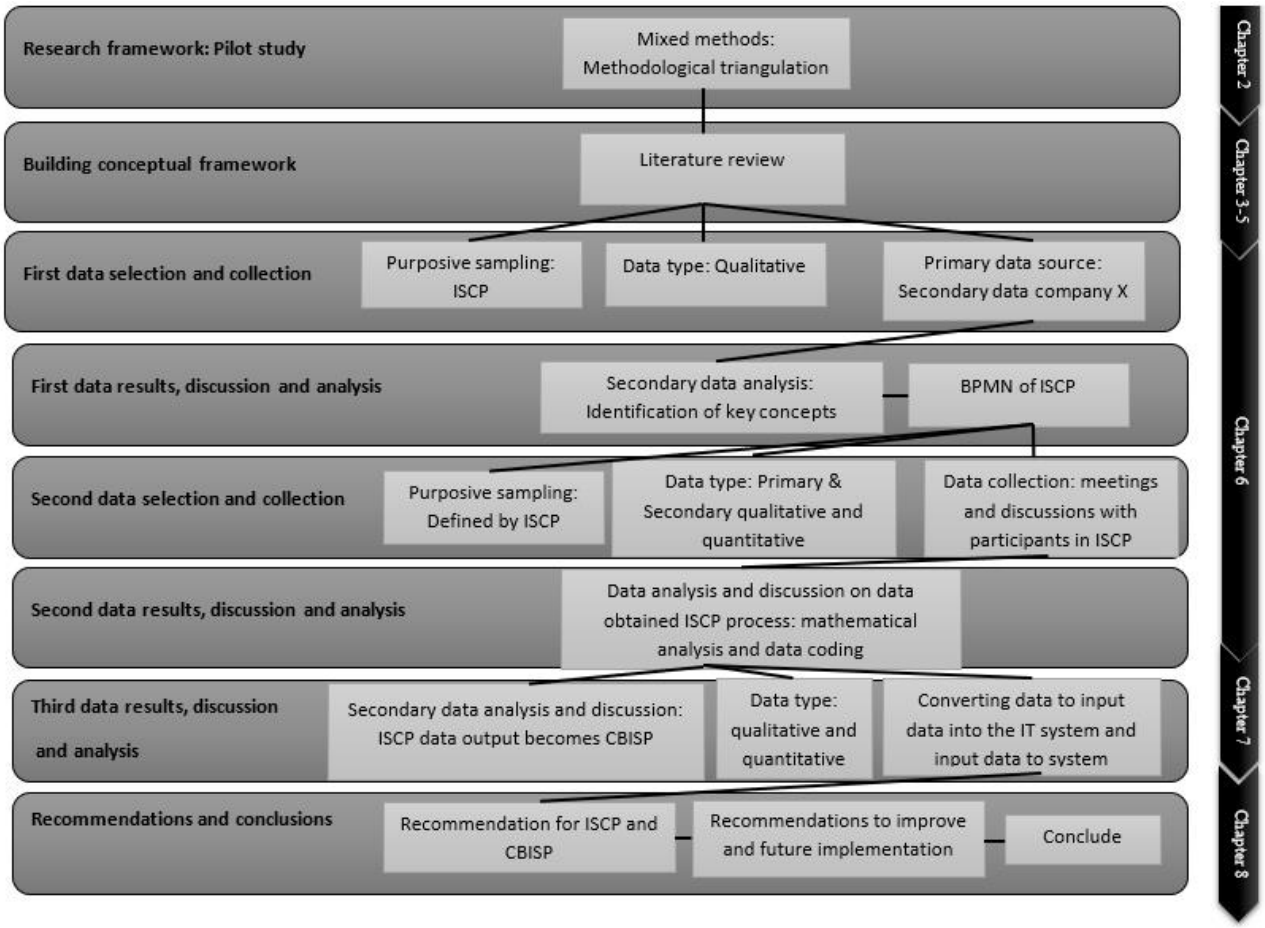

Figure 1-2. Research approach.

Chapter 2 outlines the initial theoretical research approach before the research was implemented. This means that some of the details explained in Chapter 2, will not be used during the implementation of the research. The literature review in Chapter 3-5, will build a conceptual framework for the reader and give a detailed background of the industry to the reader. The literature review chapters will allow the reader to better understand the ISCP process highlighted in Chapter 6.

Since the first part of the research question, states that "*how the ISCP can be improved*?", it is concluded that Business Process Model and Notation (BPMN) would be the best method to implement, because it is easy to understand and forms part of a universal language, allowing easier implementation of the ISCP. Furthermore, to obtain the information that is needed for the traceability platform pilot testing and to determine the added advantages to the local textile industry, an ISCP with a specific retailer or brand needs to be implemented. Thus, Chapter 6 will aim to answer the first part of the research questions. As mentioned, by implementing the ISCP, there will be data output, which will be used as input data for the CBISP in Chapter 7. As soon as the data could be entered onto the platform, the performance could be tested/piloted, and changes could be added to the system to optimize performance. It is important to note that this pilot study will form part of the whole study and will not be used as defined by Bryman and Bell (2014:209) as a pre-testing method for questionnaires, interviews or determine adequacy of instructions or research instruments. Chapter 6 and Chapter 7 will also outline the discussion and results of the ISCP and CBISP. The discussions in Chapter 6 and Chapter 7 form part of the recommendations and conclusions in Chapter 8.

1.6 Assumptions and limitations

Since the ISCP was piloted and implemented by a leading apparel fashion retailer in SA, it is assumed that the pilot test was performed accurately and yielded acceptable results. The secondary data used in this research study is also assumed to be accurate and of high-quality, based on first pilot study done by a leading retailer in SA, and receiving professional input of highly-educated personnel, as well as clusters, and governmental institutions. Furthermore, the views and opinions of experts in a specific field are assumed accurate, because of years of experience in their respective fields.

The newly developed CBISP, was developed specifically for company X. The process of implementing this into a sustainable cotton SC may be time-consuming and does need certain financial inputs. Furthermore, this process relies on links in the cotton SC that are not necessarily owned by one company and unfortunately the speed of this process relies solely on the commitment of each link in the SC, which cannot be predicted beforehand. Even though the process may have their limitations, it would allow future researchers to continue working on this, and completing this process.

1.7 Chapter overviews

According to Kotzab *et al.* (2005:21) it is important to first do an in-depth literature review to establish an appropriate conceptual framework, which identifies the relationship among variables. The following information in the section will outline the relationship between variables and identify and explain important concepts that are applicable to the research questions, research aims and research objectives.

Chapter 2: Describes the intended research and methodology of this research study. During this research study, qualitative and quantitative research is combined by means of methodological triangulation.

Chapter 3: Discussions with regards to SC terminology have been around for a long time because there seems to some confusion with regards to definitions such as Supply Chain (SC), Supply Chain Management (SCM) and Supply Chain Integration (SCI) (Ayers, 2006:3). These discussions are directed to different understandings amongst organisations and amongst person-to-person within one organisation. Thus, defining the terms that would be used in this dissertation, is of high importance. By analysing the views of different authors, with regards to these definitions would broaden the reader's understanding.

Chapter 4: This chapter consists of the dynamics and sustainable impact of a cotton SC. It is important for this dissertation to identify and give an overview of the processing and production processes of cotton garments. Furthermore, knowing how a 100% cotton garment is manufactured, how a typical SC will look for a garment and how it operates, could help to define how such a SC need to be managed and operated at maximum efficiency.

Scoping a generic SC for instance for a T-shirt is difficult because the complexity of an apparel SC is high. Thus, for the rest of this dissertation it is important to understand that not one SC fits all and not all SCs operate in the same manner, even though it may seem like it. Understanding the dynamics of a garment SC will ease the readers understanding of the ISCP.

Chapter 5: The term "*innovation*" is defined in this chapter based on different views. Then innovation with regards to a SC is defined to apply different innovations to the textile industry. Aspects such as competitive advantages, technology, and sustainable innovations and the process of being innovative, will be described in this chapter. To map the ISCP it will be important to analyse different BPM techniques and identify the best suited method to apply to the ISCP. In this chapter it is concluded that BPMN will add value to the ISCP.

Chapter 6: This chapter outline the ISCP process and BPMN description and discussion. An ISCP is defined as, a business practice that ensure delivery of products that are fully traceable, with great integrity by means of SC optimization. The ISCP is divided into five different processes namely, the design programme concept, SC mapping, the planning process, preparing for implementation and implementation.

Each phase has various sub-processes defined individually, with the relevant participants related to the sub-processes. Different organisations and companies are represented in different pools and the companies represented in the pools are as follows: company X, retailer, fabric manufacturer, yarn spinner, and cotton lint ginner. The ISCP process is implemented with retailer A, fabric manufacturer A, Fabric manufacturer B, Yarn supplier A and Cotton gin A.

This chapter also outlines the advantages that are added to each role player in the SC by participating in the ISCP process. The implementation of the ISCP is successful with retailer A and the data obtained through the process will be used in Chapter 7, to test the CBISP.

Chapter 7: This chapter outlines the process of testing the CBISP, by means of data obtained in Chapter 6. During the process of implementation some changes occurred to the system to improve the usability of the

platform. However, due to costs, time and funding limitations some parts of the platform could not be implemented, and is still in the implementation process.

Chapter 8: This chapter outlines the recommendations and conclusions, particularly with regards to Chapter 6 and Chapter 7. The recommendations for the ISCP and the CBISP were made to improve the CBISP and alternative uses of the ISCP in different sectors, as well as alternative analysis methods. The conclusions for this research study are highlighted in this chapter with a summarized overview of the ISCP and CBISP.

1.8 Conclusion

In this chapter, the research question is defined to scope this dissertation. A newly developed IT system, developed to track and trace a product from field to consumer will be piloted in this research study, to strengthen the ISCP business model that was developed and tested at commercial scale by a leading apparel retailer in SA. Chapters 3 to 5 includes the literature review section that is separated into different chapters. The literature review is used to clearly define the key terminologies, concepts, processes, and technologies to aid in answering the research questions. The research design and methodology chapter will be outlined in Chapter 2 to define what methods should be used to answer the relevant research questions.

2 Methodological triangulation

This chapter outlines the initial theoretical research approach, before the research study was conducted. It also outlines the research design and methodology of methodological triangulation (Refer to Figure 2-1 for research structure).

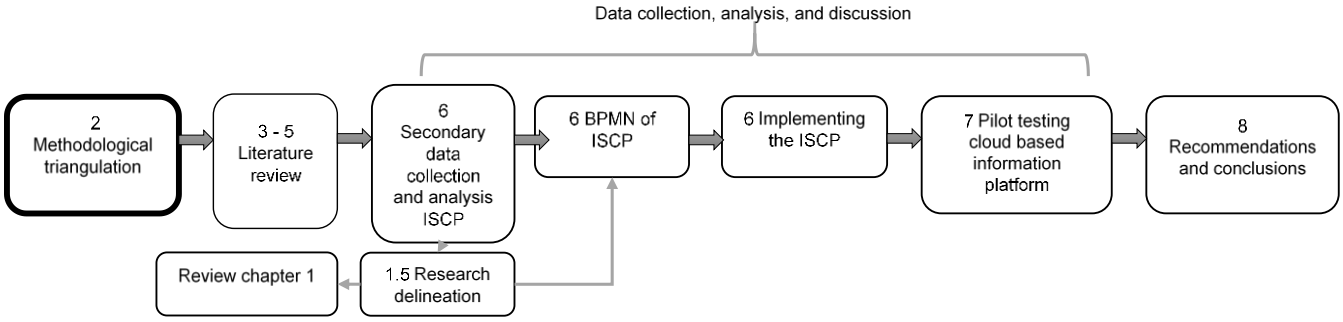

Figure 2-1. Methodological triangulation chapter in research structure.

2.1 Research design

For the research questions to be answered and to meet the research objectives and aims, it is important to choose an appropriate research design that provides a framework that will aid in data collection and the analysis of data (Bryman & Bell, 2014:100). According to Bryman and Bell (2014:100) this framework will be the "how to guide" to data collection and data analysis, in other words the research methods. When choosing the research design, it is important to remember that the evidence obtained during the research study will answer the research question and that it should be done at a high accuracy. Furthermore, according to Kotzab *et al.* (2005:16) "*all research strategies methods are flawed, often with their strengths in regard to one desideratum functioning as serious weaknesses in regard to other, equally important, goals*." There may be more than one research design applicable to the research questions but the best one should be chosen for higher accuracy. Appendix C,Figure C-1, uses an approach adapted from Bryman and Bell, (2014:32,41) to indicate the different steps and approach to the methods and design. The argument as to why the research design and methodology is discussed in this chapter.

2.1.1. Choice of research design

For this research purpose, to answer the research questions, a trial run or pilot study should be applied to the CBISP, developed for traceability purposes, to a small-scale version of the whole SC. To define data and to do this pilot study, a combination of other methods is used. It is important to note that this pilot study will form part of the whole study and will not be used as defined by Bryman and Bell (2014:209) as a pre-testing method for questionnaires, interviews or determine adequacy of instructions or research instruments. Thus, the pilot

study will ultimately reveal important information that will be beneficial for the researcher to improve the current CBISP and data collection process for the system.

It will be beneficial to use a mixed method or methodological triangulation which uses both qualitative and quantitative data in the same phenomenon. It is thus important to define what the different types of data are that may be present in a research study.

There are two types of data that could be defined as:

i. "primary" and "secondary" data
ii. "qualitative" and "quantitative" data

Primary data that is captured or collected by the researcher and secondary data, where the data was collected but not limited to other researchers, it could also be collected by other types of organisations and companies (Bryman & Bell, 2014:267-268).

Qualitative data could be defined as data that are not numerical, or stress the importance of words rather than quantification when data is collected and analysed. On the other hand, quantitative data refers to data that are numerical and use quantification rather than words (Bryman & Bell, 2014:31).

2.2 Rationale for research design choice

According to Kelle (2006:293) it is possible for all research designs and methodologies to have their strengths but it also important to consider their weaknesses, when choosing an appropriate research design and methodologies.

2.2.1. Methodological triangulation

According to Amaratunga and Baldry (2006:101) triangulation aids in qualitative and quantitative methods being viewed as an integration that compliments each other in a single project (Bryman & Bell, 2014:62). In other words, the researcher can use this to their advantage because the focus can be on the one method's strength by counteracting the other method's weaknesses. This could also be used as a tool to overcome the weaknesses of both quantitative and qualitative research (Kelle, 2006:309).

It is thus important to identify both the qualitative and the quantitative research method's advantages and disadvantages. For qualitative data, it could be established as to "why" a certain answer or response was given and provides deeper understanding to a phenomenon. This data could also be used to indicate or build a theory (inductive theory) (Bryman & Bell, 2014:9). In SCM qualitative research maximize the internal validity or realism (Kotzab *et al.*, 2005:16). Furthermore, according to Kotzab *et al.* (2005:22) it will be beneficial to use a qualitative research approach when dealing with a complex, new or dynamic phenomenon where relevant variables are not easy to identify which correlates to this research study and will therefore allow a deeper level of understanding to the relatively new phenomenon as mentioned. However, the disadvantages for qualitative

data is that data analysis is more complex, the data may be biased, it is very time consuming and requires more resources, which will be discussed in more detail.

On the other hand, quantitative data provides data of higher accuracy, it is easier to collect data and to determine sample size. The analysis of quantitative data is easier to apply as statistical analysis. This data could also be used to test a theory (deductive theory) (Bryman & Bell, 2014:9). Furthermore, in SCM quantitative research advance control and external validity or generalizability (Kotzab *et al.*, 2005:16). Unfortunately, not all possible data can be subjected as numerical data and for this reason there may be a possibility that important data is lost (Bryman & Bell, 2014). From above mentioned information it could be seen that both methods are equally important in this research study.

However, it is important to note that there are certain considerations with regards to triangulation such as the research should be conducted at high quality to yield high quality data, it should be appropriate to the research questions and this mixed method should not be conducted separately but as components related to each other. This increases the difficulty to conduct this research design because of the lack of this skill. Furthermore, it is very time consuming to conduct this research design and it is thus important to plan the research thoroughly (Bryman & Bell, 2014). Effective time management will be of utmost importance to counter this problem.

Even though there is more than one type of mixed method available in literature, it is decided to use the methodological triangulation approach instead of facilitation and complementary mixed methods, because methodological triangulation use "*quantitative research to corroborate qualitative research findings*," or it could be vice versa (Bryman & Bell, 2014:62). Facilitation mixed methods use a different approach where the one research strategy is used to aid in the other research strategy. For instance, qualitative research is used in order to facilitate quantitative research and complimentary mixed methods where both research strategies are used in order to investigate different aspects, which do not fit the objectives of this research study (Bryman & Bell, 2014:62). The main reason for choosing methodological triangulation for this research study is to confirm the validity of the research outcome.

2.3 **Research methodology**

According to Bryman and Bell (2014:383) a research method could be defined as an approach to collect data which may involve only one or more than one instrument. It is important to integrate the method with the particular chosen research design. Kotzab *et al.* (2005:3) also indicated that there is no correct or incorrect SCM methodology and that each research method will have its own advantages if it were to be applied correctly. However, it is of high importance that the researcher adheres to Stellenbosch University ethics council. To do so, an ethics application should be completed and a letter stating that the "*Faculty Ethics Screening Committee (FESC) has classified your ethics application as a minimal or low risk*" should be granted to the researcher, before any collection of data may be done. After the completion of the application

and receiving the appropriate documentation it should also be noted that according to the FESC, written permission from the institutions should be obtained before the data collection may be conducted.

2.3.1. **Chosen research methods for qualitative and quantitative research**

According to Kotzab *et al.* (2005:21) it is important to first do an in-depth literature review to establish an appropriate conceptual framework that identifies the relationship among variables. Furthermore, the second action to be implemented, described by Kotzab *et al.* (2005:22) is to build a theory that originates from previous research. This theory should have the ability to generate predicting statements that could be certified by challenging or comparing the theory with real life data about the scenario or phenomenon.

To collect qualitative and qualitative data, it is important to note that there are several methods to do so. For this research it is decided that for qualitative data collection, focus groups will be used instead of interviews. The reason for this is to identify the participant's perceptions, views as well as volumes and prices. This also allows a larger sample size than using interviews and it saves time but. However, some participants may feel uncomfortable to reveal sensitive or confidential information which may be better manageable in interviews. Fortunately, with the availability of contracts and signing confidential agreements this could be counteracted to some extent. Focus groups will be more beneficial to use in this research study, because it will save time. With a focus group discussion, it also allows the researcher to ask open ended questions rather than closed ended questions. However again the way in which open ended questions should be analysed is time consuming but it allows more information to be extracted during the discussion (Bryman & Bell, 2014:199).

The sample size associated with focus groups will be between 4-6 people dependent on the availability of appropriate participants at that particular point in time. The participants will typically be individuals that form part of ISCP of a particular retailer SC. The target population for the focus group will be Chief Executive Officer's (CEO) and people in managing positions, identified in the ISCP explained in Chapter 6. Purposive sampling will thus be used for this research study because participants will provide the most informative information regarding the research questions or topic (Bryman & Bell, 2014:154). There may be a possibility for sampling error because the participants are people with critical responsibilities towards their company and have limited time available for meetings and may not be available for conducting a focus group. Fortunately, to prevent this from happening, time management will be important, as well as collaboration with the managing director of company X. The CEO of company X, agreed to assist in the process of introducing potential participants to the researcher, to allow access to important personnel.

This research study involves the use of innovative and new SCM approaches. The participants may be more sceptical towards it, because of the unfamiliarity of the processes, or lacking experience in this field which may lead to bias information. Furthermore, because of limited resources to allow bigger sample sizes, there will be a certain amount of sample errors because of limited population groups. It is thus importance that the research answer could only be connected or are only related to company X, and the participants in the ISCP.

With regards to the reliability and validity of data for the quantitative data will be higher than qualitative data but calculation mistakes may be possible and it should be evaluated for errors.

The analysis of qualitative and quantitative data for the focus groups, will be done by going through the notes that is taken in the focus group discussion/meetings or listening to recordings to identify key remarks and concepts. To protect the confidentiality of the data and to keep organisations anonymity, data coding will be necessary. The findings of the focus group discussion and meetings could be discussed with other experts to make some informed assumptions.

Furthermore, because of the availability of secondary data that are of qualitative and quantitative nature, from company X, it could be used as a research method, in combination with focus groups (Bryan & Bell, 2014:267). Thus, in this research study, exploratory research through secondary analysis could be done on the SC of the retailer, in the textile industry (heterogeneous group). Organisational documents will be used during secondary data analysis where some of the data will be in the public domain such as annual reports, mission statements, press releases, public relations, only to name a few, in printable form or via the internet. However, some of the data may not be in the public domain such as organisational charts, policy statements, company regulations, financial and other data, and confidentiality agreements may be needed between the researcher and the company (Bryan & Bell, 2014:276). Secondary analysis will include, but is not limited to the use of public documents such as statistical information, policies. (Bryan & Bell, 2014:275). Advantages for using secondary analysis include: saving of time and costs; provides data of high quality; provides more time for data analysis; may provide new information to the old model and provides an opportunity for combination with primary data collection (Bryan & Bell, 2014:268).

Limitations regarding secondary data however include: the lack of familiarity of data; complexity of data; absence of key variable; and no control over the data (Bryan & Bell, 2014:271). Credibility could be an issue and the documents used may be a bias source and therefore a combination of data will be used, such as literature review, to increase validity of the content of documents. The reliability of the data could also be an issue, because it may vary over time and between employers. The credibility issue could be solved if the author of the documents could be contacted to get clarity of the particular terms (Bryan & Bell, 2014:272). It is also important for the researcher to use his/her own judgement as to what the quality of the secondary data is. For literature review purposes, it will be wise to use electronical sources that are reliable, based on date, author, and number of citations.

2.4 Conclusion

In this chapter, methodological triangulation was scoped in high detail. It incorporated both qualitative and quantitative data, to ultimately answer the research questions of this research study. However, it was difficult to define if this method would be successful to apply to this research study. Without a complete view of the process of an ISCP, as well as the outcomes needed for the ISCP, thus making it difficult to define the method that should be used. It was there for important to review the research method, and after more information and insight was gained into the ISCP, a research method was defined in section 1.5. It was however known that the ISCP is practically oriented, which means it was applied to real life scenarios in the pilot study. Even though some of the research, design, and methodology methods and theories, explained in this chapter was used, it was applied in a practical manner rather than a theoretical manner.

As mentioned, the proposed design in this chapter entails the use of mixed methodology classified as methodological triangulation with both qualitative and quantitative data. The data collected for both forms of data was by means of focus groups, meetings and secondary data. The focus group participants included members of the ISCP procedure explained in Chapter 6. Numerous focus group discussions and meetings were held and it was dependent on previous findings and specific subjects to answer the research questions explained in Chapter 1. Appendix C, Figure C-1 illustrates the complexity of this research design and methodology chapter and was used as a guideline through this research study. Before the research methods was applied, the researcher had to receive permission from the Ethics Committee of Stellenbosch University to do so. As the research progressed, there was a possibility that the proposed design and methods were impractical to be used and alternative research methods were applied, refer to Section 1.5 for more information.

3 Introduction and definitions to important Supply Chain terms

This chapter represents the first literature review chapter, and explains the views of different authors, and defines various SC terms used in this dissertation. The terms included are as follows: "Supply Chain," "Supply Chain Management," "Sustainable Supply Chain Management," and "Supply Chain Integration" (Refer to Figure 3-1 for more information about the research structure).

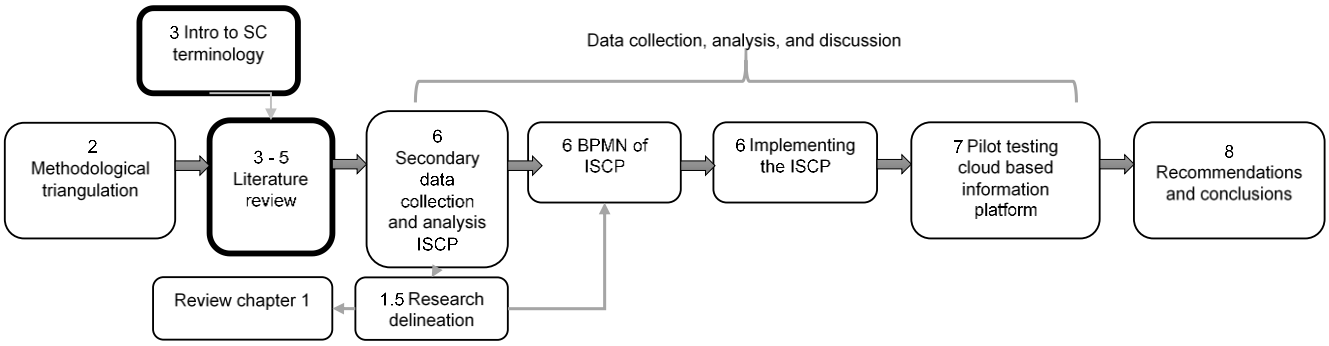

Figure 3-1. First literature review chapter in research structure, an introduction to SC terminology.

3.1 Introduction

It is important to define different SC terminology. However, there seems to be some confusion regarding the definition of a SC, SCM and SCI (Ayers, 2006:3). The reason for the confusion may be because of variations of understanding the term. Variations between organisations, as well as internal variation within one organisation may also be an issue (Ayers, 2006:5). The view of the "definer" and the application or interest of the phenomenon involved may be under narrow or broad discussion when defining terms (Ayers, 2006:3). According to Ayers (2006:3-4) the narrow discussion includes the output or productivity that occurs inside a factory, meaning excluding the raw material and disposal after use. The broader discussion includes all the activities and processes from "dirt to dust" meaning from extracting the raw material from the earth up until the conversion and distribution processes to provide the end consumer with a product. It may also be that the broader term exceeds the point after the product is consumed, meaning the disposal, reuse, or recycling of the product (Ayers, 2006:4).

It is also important to list and identify the different types of SCs because according to Elms and Low (2013) every SC is different and the core activities across different SCs in different companies also differ. Thus, different core activities require a certain set of skills and management activities (Elms & Low, 2013). When the core activity of a SC, is directed to sustainable development, it is of utmost importance to identify what is meant by "*sustainability*" as a term and why the core activity is directed to sustainability. According to Fayet and Vermeulen (2012) pressure from international institutions like non-governmental organizations,

governments, customers and internal employees and managers, towards improvement of sustainable manufacturing, have been implemented since the 1980s. Recent business practices, appealed to lower the social, as well as environmental impacts of manufacturing, and demanded shared accountability for this, with business partners along the SC (Fayet & Vermeulen, 2012). These added pressures force organisations to shift the way they used to operate, to awareness towards sustainability, in order to continue to be competitive in global markets (Fayet & Vermeulen, 2012; Porter & Kramer, 2011). Therefore, it is of high priority to develop a SC that includes sustainable measures, but how could this be achieved? Sustainability problems do not only affect the internal SC, but continues to have a big influence on the external SC as well, up until the disposal of the product, which makes it difficult to maintain or achieve without the help of other organisations and partnerships. In a SCM concept, integration of the SC could aid in fixing this problem and will be discussed in more detail shortly.

Defining terms that are commonly used in the SC environment, in such a way that illustrates the importance of this research study, is of high importance because of the complexity of the textile industry and degree of uncertainty around the terminology as mentioned earlier. By doing an in-depth review of literature from different authors of what a Supply Chain (SC); Supply Chain Management (SCM); Supply Chain Integration (SCI); sustainability and SSCM entails and what aspects are of higher importance to certain applications, could most definitely help to identify the core values of the application of these terms. Thus, this chapter will outline important definitions and will introduce the reader to SC terminology.

3.2 Defining the term “Supply Chain”

The complexity and stability of the world that we live in today has changed over the past couple of years (Christopher & Holweg, 2011), forcing SCs to increase their ability to deliver high quality products at a lower sourcing cost (Fredriksson & Jonsson, 2009). With an increase in technological capability and broader availability of high quality technology, new innovative ways of how to run or operate in a business environment emerged, which matured some of the SC strategies that have been used for decades (Christopher & Towill, 2002). Changes in the SC strategies ranges from ethical and sustainable concerns to changes in techniques and tools to measure performance that have been used in the past (Pagell & Wu, 2009). Therefore, the definition of a SC has also changed, which resulted in multiple literature reviews done by other authors which will be analysed shortly. Different definitions of a SC by other authors were summarized in Table 3-1.

Table 3-1. Different definitions of a SC by different authors.

Authors	Definition of a SC
(American Production and Inventory Control Society (APICS) in by Ayers, 2006:5)	"*The global network used to deliver products and services from raw materials to end consumers through an engineered flow of information, physical distribution and cash*."
(Ayers, 2006:5)	"*Product life cycle processes comprising physical, information, financial, and knowledge flows whose purpose is to satisfy end-user requirements with physical products and services from multiple, liked suppliers*."
(Swaminathan *et al.*, 1998)	A SC could be defined as a network that has the ability to act independently or to some extent independently in business entities, entities, which are responsible for the following: procurement; manufacturing and distribution activities that could be associated with either one or more than one families of products that are related to each other.
(Masoumik *et al.*, 2014:2)	A SC can be defined as "*a set of three or more entities (organizations or individuals) directly involved in the upstream and the downstream flow of products, services, finance, and information from a source to a customer*."
(Elms & Low, 2013)	A SC could be defined as the flow of a service or of goods from the raw materials to the finished products, which also includes solutions for the end users.

Table continues next page

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(Lummus *et al*., 2014:11)	A SC could be defined as all the activities that are associated with the delivering of a product, starting at the raw material and running through up until the consumer that includes the following: "*sourcing of raw material and parts; manufacturing and assembling; warehousing and inventory tracking; distribution across all the channels; delivery to the consumer; and the information systems needed to simultaneously monitor these activities*."

The definition by Ayers, (2006:5) mentions the term "*processes*" (refer to Table 3-1), which includes "*sourcing, designing, supporting, manufacturing, transporting, and selling of products and/or services*." Another important term used by Ayers, (2006:5) is "*product life cycle*" which is directed at the market as well as the usage life cycle of the product. However, for the purpose of this dissertation, when referring to a SC, "*product life cycle*" will not be include, but "*processes*" on the other hand will form part of the definition of a SC and will also be a very important part of the definition. Even though product life cycle is important, especially of the disposal of a product, it is not included to the ISCP for the simple reason that the ISCP only deals from retailer until farm level. According to Ayers (2006:5), like the definition by APICS (referred in Table 3-1), most of the authors recognize that a SC entails more than just the movement of materials or goods "from earth to earth" and that it could in addition include other aspects such as movement of money, information and development of intellectual capital. This is a crucial factor to recognize, especially when dealing with products that are related to "fast fashion." For instance, the movement of money between links in the SC should be considered very carefully when payment terms are negotiated and for a SC to be as effective as possible the seller should be able to carry the "risk" of not being paid, for instance 90 days, without going out of business. This aspect also links to the development of knowledge and according to Ayers (2006:6) the term "knowledge" surpasses the term "information" and also extends to innovation and the development of new products and services. As mentioned earlier the movement of information could also improve the performance of the SC.

The definition by Swaminathan *et al.* (1998) (Table 3-1), refers to a SC as a family of networks and it is critical to note that a SC should have multiple, linked suppliers thus for instance a farmer selling produce or raw materials will not be a SC but the retailer would have a SC because of linked parties that will form part of the role to deliver a product (Ayers, 2006:6). Furthermore according to Masoumik *et al*. (2014) (Table 3-1), a SC is not limited to unidirectional flows of information and products etc., but could be "upstream" or "downstream" which forms part of an important aspect of the flow direction in a SC. This highlights the need

for a programme such as the ISCP that would be discussed later to assist with unidirectional flow of information. Backward-flows of information, specifically for products such as garments include: product returns, payments, product traceability etc., which is important for retailers to be competitive (Ayers, 2006:6).

The terms "*upstream*" and "*downstream*" should also be interpreted with care because it may be that a company is in the middle of a SC which may have different meanings in this context (Ayers, 2006:9). For companies in the garment SC such as the yarn spinner for instance, upstream and downstream of information will differ from the retailer.

Confusion also tends to occur when some authors refer to a SC as a value chain (Ayers, 2006:8). It is thus critical to note that the value chain refers to financial aspects and strategic positioning etc., and a SC refers to different components that were described earlier (Ayers, 2006:9). If the term "value chain" is used in this dissertation it would refer to the above-mentioned definition.

From the discussion previously, a SC could be defined as a family of networks with multiple linked suppliers which associate with the delivering of goods or services. The delivery of a product or a service is associated with the upstream and downstream flow of a service, information, finance and products, from the raw material to the consumer (Mentzer *et al.*, 2014; Ayers, 2006:6).

3.3 Defining the term "Supply Chain Management"

The importance of SCM is highlighted by Hjaila *et al.* (2016:48), which explained that a SC consist of the following aspects in a manufacturing chain such as: "*suppliers; storage facilities; production plants; distribution centres and retailers*" etc., which may be situated in different parts of a country or even in different parts of the world, but are connected to each other through distribution systems. Thus, if all of the above mentioned are owned by a particular organization or a single organization, the SC could be managed in "a centralized way" and coordination of all of these different aspects will be of high importance to unify the flow of information to other groups or third parties (Hjaila et al., 2016:48). SCM could then be used for SC performance optimization, like financial revenues etc., to determine the logistics of the how and when the capital will flow between above mentioned aspects in a SC. This also includes the how and when the raw material should be converted into a product that could be sold to the consumer. Unfortunately, in real world terms, this seldom happens and the whole SC does not operate as one or it is not owned by one organisation alone, which causes massive problems in the management process of a SC. This is also true for garment SCs and the retailer is situated in a different location from its suppliers, and the supplier's supplier, is also situated in different locations.

SCM is used to link the objectives of a SC to the competitive strategy in order to ease decision making between competing demands in the SC (Lummus *et al.*, 2014). The competitive strategy will be discussed in detail in Section 5.3 Stevenson reasoned that Habib (2011:3) indicated why SCM is needed in a company. The answer for this is to improve operations and outsourcing, increase revenues, boost customer satisfaction, develop

quality outcomes, handling competitive pressures, improving globalization, improving the importance of IT and E-commerce and lastly expanding the complexity of a SC.

Many authors have used complicated terminology when defining SCM which limited the understanding and interpretation of the actual concepts and also limited the practical application capability (Ross cited in Mentzer *et al.*, 2001). During a study done by Mentzer *et al.* (2001) the definition of SCM is evaluated by considering the view of six different authors. This study resulted in the classification of SCM into three different classes namely management philosophy, the implementation of management philosophy and management processes.

The first class, management philosophy is described by Mentzer *et al.* (2001) as a systematic approach, where SCM will view the SC as one body and not as different sets of parts that are performing on its own. Thus, the management philosophy incorporates partnership concepts to successfully manage the flow of products from the suppliers to the consumer. Thus in summary a management philosophy has the perspective that each organisation or link in the SC could indirectly or directly affect the performance of each member in the SC as well as the overall performance of the SC (Cooper quoted in Mentzer *et al.*, 2001).

Mentzer *et al.* (2001:8) explained that in order to implement management philosophy, which is the second class of SCM, an organisation should successfully implement the following activities: "*integrated behaviour; mutually sharing information; mutually sharing risks and rewards; cooperation; the same goal and focus on serving customers; integration of processes and partners to build and maintain long-term relationships*." Mutually sharing of information, forms part of integrated behaviour for monitoring and planning processes. Furthermore, by having the opportunity to mutually share risks and rewards it could also improve competitive advantage. The reason for improving competitiveness is building partnerships and long-term relationships.

For the last class, namely management processes, Lambert *et al*. quoted in Mentzer *et al.* (2001:10-11) classified the key processes as the following: "*customers; relationship management; customer service management; demand management; order fulfilment; manufacturing flow management; procurement; and product development and commercialization.*" Mentzer *et al.* (2001) concluded by means of a figure, a certain guideline to researchers and practisioners to use in order to apply successful SCM to a company but he also states that there are room for improvement for future research (See Figure 3-2 for more information). The final definition for SCM, develped by Mentzer *et al.* (2001) could be seen in Table 3-2.

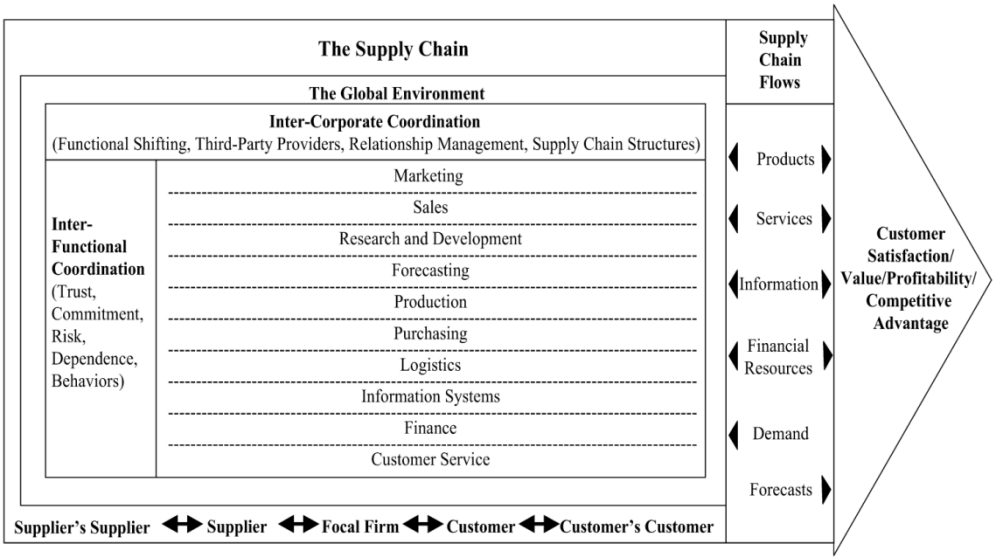

Figure 3-2. Representative of a SC model (Mentzer *et al.*, 2001)**.**

Other authors have also done an in-depth analysis of the definition and the uncertainties around this term. Refer to Table 3-2 for different definitions for different authors for SCM.

Table 3-2. Different definitions of a SCM by different authors.

Authors	Defining SCM
(Ayers, 2006:10)	SCM could be defined as the "*design, maintenance, and operation of SC processes, including those that make up extended product features, for satisfaction of end-user needs*."
(Mentzer et al., 2001)	SCM was defined as the systemic and strategic organising of traditional and tactical functions in a specific company and across business within the SC for the main aim being to improve long-term performance of the whole SC as well as the individual organisations.
(Lummus *et al.*, 2014:11)	SCM could be defined as "*an integrating philosophy to manage the total flow of a distribution channel from the supplier to the consumer*."

In addition to the definition in Table 3-2 by Ayers (2006:9), he also stated that "*logistics is not SCM*" but that it does however form part of the key principle components of SCM. Furthermore, Ayers (2006:9) explained

that SCM is associated with the planning and the management of processes that are involved with procurement and sourcing, conversion, and logistics management (Council of Supply Chain Management Professionals (Ayers, 2006:9). This is also true for managing a garment SC, because with regards to cotton as raw material, which is a natural grown fibre (DAFF, 2012), procurement, sourcing, conversion, and the management of logistics is crucial. Above mentioned information fails to include collaboration with key partners and forming strategic partnerships, but it was discussed in detail by Mentzer *et al.* (2001).

From the above mentioned information it can be concluded that the definition in this research terms are the management of products/operations and the exchange of information (inward and outbound of business) from key components such as: supplier; manufacturer and destruction centre to demand driven consumers, in order to track/forecast/determine/convert, forward and backward information, to maximise the performance (financial, efficiency, sustainability) and minimise risks of the SC (Ayers, 2006 ; Lummus *et al.* 2014 ; Mentzer *et al.*, 2001).

3.4 Defining "Sustainable Supply Chain Management"

The importance of incorporating sustainability into a SC should be considered for future generations to protect environmental-, social- and economic aspects. But how could this wide term be defined to consider all the important aspects of sustainability? Carter and Rogers (2008) suggests that SSCM is an expansion of the notion of sustainability from a business or company into the SC level. Carter also suggested that sustainability in an organisation will consist of three components and includes: natural environment, society, and economic performance (the idea of the TBL). When an organisation chooses to balance the TBL, it will not only positively affect the environment and society, but it will also bring about long-term economic value and improved competitiveness to the organisation (Carter & Rogers, 2008). External expectations demand companies to focus on the TBL as described earlier.

Furthermore, the development of sustainability could be characterised by the development that contributes to the needs for the present without compensating the future needs for generations to come (Seuring & Müller, 2008). Incorporating sustainability into a SC does not only involve the suppliers and retailer, but also includes external parties, organisations and even customers, in order to complete the life cycle of sustainable products. An overview of different views of authors with regards to SSCM is captured in Table 3-3.

Masoumik *et al.* (2014) managed to integrate the SCM definition with the TBL of sustainable development in Table 3-3. Carter *et al.* (2011) in Table 3-3 identifies more in-depth information with regards to the TBL and also concluded that incorporating sustainability into SCM is crucial for a business's license to operate in the twenty-first century. SCM is thus an important component in this licence. Standards such as the International Organization for Standardization (ISO) 14000 could be implemented in order to aid with sustainable development[3].

[3] Economic development that is conducted without depletion of natural resources.

Table 3-3. Different definitions of SSCM and a sustainable SC by different authors.

Authors	Definitions
(Seuring & Müller, 2008)	SSCM is the management of information, material and financial flows as well as participating with other companies and industries along the SC, in order to address sustainable issues such as: economic; environmental-; and social issues which will fulfil the needs of consumers and stakeholders.
(Masoumik *et al.*, 2014)	A sustainable SC is a SC that links the upstream and downstream movement of products and raw materials by recovering used items and recycling these items into the production cycle and associates with practices that are sustainability at all three dimensions such as social, economic and environmental.
(Carter *et al.*, 2011)	SSCM forms part of an organization's long-run improvement of the TBL where this includes: cost savings that are associated with reuse and recycling; lower health and safety costs; lower turnover and recruitment costs; improving work conditions; reduced labour costs; shorter lead times; improved product quality; lower disposal costs; improve organization's reputation and lastly to make the product and organization more attractive to the suppliers and the consumers.

In brief SSCM could be defined as the connection or link between sustainable measures or the TBL balance, which includes economic, social and environmental goals, and SCM, in order to improve: competitiveness; relationships with partners; profitability; the reputation of the company; and stakeholders and consumer needs, to contribute to the need of the present without compromising what would be needed in the future (Seuring & Müller, 2008; Carter & Rogers, 2008;Carter *et al.*, 2011).

3.5 Defining "Supply Chain Integration"

In 1989, an author by the name Mr Graham Stevens, whom at the time was the senior managing consultant at a company in London called Peat Marwick Meclintock, published an article about integrating the SC. At that time, SCM was only starting to immerge in companies, and academics only then started to gain interest in the subject (Stevens, 1989). Stevens (1989) urged companies to manage their SC as a whole in order to get ahead of other companies, since at that time organisations operated independently in the management of products and satisfying customers, which ultimately had conflicting agendas. In 2014, Stevens collaborated with Johnson to publish an article about the changes in SCI and also SCM over 25 years. The conclusion was that SCM's role as facilitating success in a business will not fade away. They also concluded that challenges such as the global economy, advanced changing rates, and evolution of innovative competitors will continue in the future. Since Stevens' publication in 1989, by which he classified SCI in four different stages namely: base line integration[4], functional integration[5], internal integration[6], and external integration[7]. It was concluded in Stevens and Johnsons (2016) that this evolved over time. Stevens (1989) explained that SCM advanced from baseline silos into a first level of integration beyond functions, with a second level of integration into complete internal integration and finally into external integration. By doing this there was a reduction in costs and inventory, and improvement in customer services. Stevens and Johnsons (2016) identified that from external integration, goal directed SC networks evolved, and the reason for this was due to realization of firms to share data related to demand in order to ease planning. They also concluded that further evolvement named devolved collaborative clusters immerged due to the realisation that network coordination was difficult to facilitate and that it would be cost efficient for lead suppliers to manage clusters.

Since 1989 different authors have identified important issues and different views with regards to SCI and could be seen in Table 3-4.

[4] Each department in the same company or silos, manages the SC independently.
[5] Each department in the same company will work together in order to reduce costs.
[6] Departments are connected in order to allow continues internal flow in the SC.
[7] Departments embracing flow to external suppliers and customers in the SC.

Table 3-4. Different definitions and views of SCI.

Authors	Definitions and views
(Hau Lee quoted in Ayers, 2006:48)	A company could be integrated based on the following aspects: information and knowledge sharing with partners; decision making coordination among links in the SC and the link of organizational relationships between companies and the coordination between incentives between SC partners.
(Simchi-Levi et al. quoted in Hong *et al.*, 2016:3)	The integration of a SC or SCI does not only focus on the SC but also includes SCM. SCM could be used to integrate business components such as suppliers, procurement, manufacturing, distribution and sales, and customers. These components could be integrated "*in such a way that the products are always synthesised and distributed at the right place, time, fulfilling desired quantity, quality and service level along with minimising the total cost of the system*."
(Puche *et al.*, 2016:422)	"*SCI includes coordination of: resources; decisions and methods among different stakeholders and skeleton of the overall process*." Synchronization of decisions include: joint decision making, synchronized planning and execution levels. This also includes: "*forecasts, safety stocks, order placement, order delivery, target consumer service level and pricings*."

Table continues next page

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Stevens & Johnson, 2016)	The linkages and coordination are not limited to information, knowledge and decision making, but also includes processes, people and strategies in between the different points in the SC. SCI improves the effective flow of money, materials, information and knowledge which are associated with consumer needs. SCI could be accomplished by means of technological programming and systems but according to Stevens and Johnson (2016) it is not only about the technology but includes operational integration in the organisation.

From the information in Table 3-4 and the discussion earlier, it could be concluded that the "level of integration" is important to define in order to integrate a SC. For the purpose of this dissertation, SCI would be directed to a type of integration called virtual integration. Wang *et al*. (2006) stated that virtual integration serves as a replacement of ownership with partnership. This could be done by integration suppliers by means of IT in order to strengthen SC collaboration. When external structures are exchanged for demand uncertainty control, it is an example of vertical integration (Wang *et al*., 2006). Virtual integration will allow a manufacturer to achieve internal as well as external flexibility and to access higher levels of control over their environment. Trading partners can use IT to apply two aspects of vertical coordination in the SC such as collaborative operation execution[8] and collaborative process planning and control[9] (Morash & Clinton quote in Wang *et al*., 2006). With better control and feedback and information processing and communication capabilities, provided by IT mechanisms, trading partners could achieve greater interfirm collaboration, without accepted ownership (Wang *et al*., 2006). IT systems can facilitate in collaborative decision making and coordination, and with suitable application manufacturers will have better ability to manage their operations in their SC, and coordinate with their suppliers. Wang *et al*. (2006) suggested that virtual integration is more likely to be used in firm with high uncertainty environments. Thus, demand volatility is easier to manage when virtual integration is applied, which is important for this dissertation in the garment manufacturing industry.

[8] Where IT facilitates operation between SC partners which includes purchasing, production and logistics operations.
[9] Where IT is used to aid in collaborative decision making and control over performance by partners.

3.6 Conclusion

The purpose of this chapter is to analyse and define different views of different authors in SC terminology. Even though the terms are well known in the industry, how it is viewed, is important to define. With increasing changes in technology and innovation, and companies being urged to implement sustainable measures, there is a certain sense of evolvement in SC terminology, even though the key aim of a term would stay unchanged, certain aspects and applications would change. Change is important to stay competitive in the market sector as reviewing and constant updating of terms is key. SC terminology covered in this chapter includes SC, SCM, SSCM and SCI. In order to answer the research questions, stated in Section 1.2, above mentioned terminologies had to be analysed and reviewed. The following chapter would outline the specific sector which is chosen for this research study and would outline the dynamics and sustainable impact of cotton.

4 The dynamics and sustainable impact of a cotton Supply Chain in South Africa

This chapter outlines the second literature review chapter, which aims to give an SC overview to the reader, with regards to a local cotton SC. This chapter will define important aspects of a cotton SC as well as terms used in the retail world, which will improve the readers knowledge, to better understand the ISCP explained in Chapter 6 (Refer to Figure 4-1for more information).

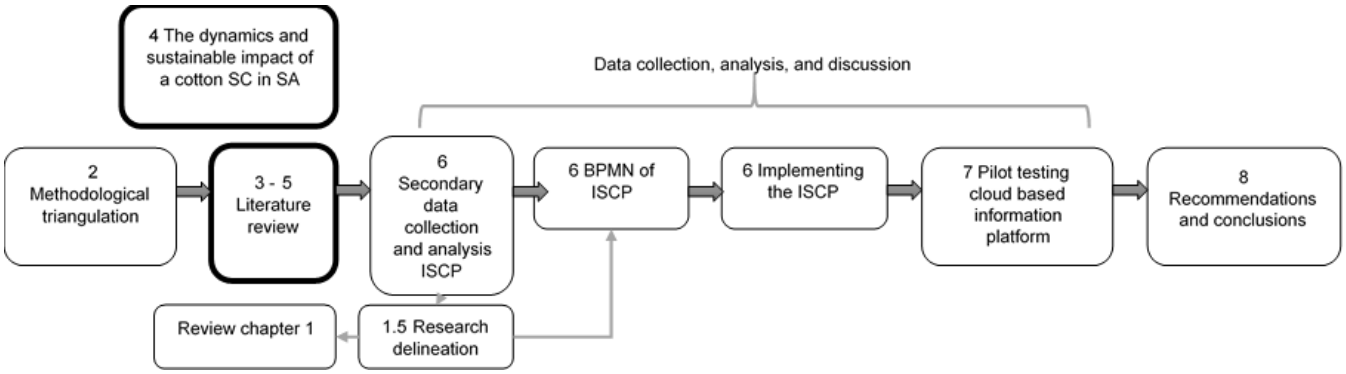

Figure 4-1. Second literature review chapter in research structure, the dynamics and sustainable impact of a cotton SC in SA.

4.1 Introduction

The textile industry is one of the fourth largest manufacturing industries in the world, of which apparels, are the most valuable component (Fan & Hinter, 2010:xix). Value chain mapping in garment manufacturing is complex and intricate. There is no "one size that fits all" process/steps or map to apply to any garment in the garment manufacturing process. However, there are certain processes that are common in the garment SC. The complexity starts to show when defining the "*raw material/fibre*," "*fibre quality*," and "*garment specifications*." Links in the garment SC operates independently, and this result in a multiple secondary, tertiary etc. SCs, that are linked to one big SC.

In order to map the various stages and processes in garment production, it is important to understand the process that will take place in order to convert a raw fibre into a fashionable garment product. There are many different types of fibres that could be used to create garments or textile products. For this dissertation, only sustainable cotton, specifically BCI cotton, as a raw material will be highlighted. Cotton is known as a natural fibre and natural fibres are favoured for its biodegradability, which are a very important factor in the TBL (Alagirusamy & Das, 2010:4). The SC that is associated with garment manufacturing involves various stages of fibre and yarn production, fabrication, garmenting manufacture, distribution and retailing (Sen *et al*. quoted in Giri & Rai 2013:30). The fibre-to-fabric conversion system has to work in a coordinated and integrated fashion in order to achieve the following goals: excellent processing performance of materials and high levels

of quality at the end product at the lowest possible cost. Furthermore, there are two subsystems: the fibre-to-yarn conversion and the yarn-to-fabric conversion (Amarjit, 1999:339).

Defining certain terms and highlighting factors such as cotton classification and characteristics, prices, and marketing, used during this process is important in order to explain the structure and flow of the SC. In this chapter a broader understanding of how a garment SC works will be defined.

Furthermore, the sustainable impact of a cotton SC has to be defined in order to know what changes need to be made in the cotton SC in order to be more responsible towards the sustainability. Different terms with regards to sustainability is defined in this chapter, namely: “Corporate Social Responsibility” (CSR), “sustainable development,” and the “TBL”. The relationship between these terms will be defined and the importance of implementing sustainable measures into the SC will be highlighted.

4.2 The cotton SC: Production process

The cotton SC consists of six stages which include: raw material production, ginning, yarning, fabric manufacturer (weaver or knitting), garment manufacturer and retailer. The whole process and dynamics of all these stages could be summarised into one figure (See Figure 4-2). Each stage would be discussed in detail in Sections 4.2.1 to 4.2.6.

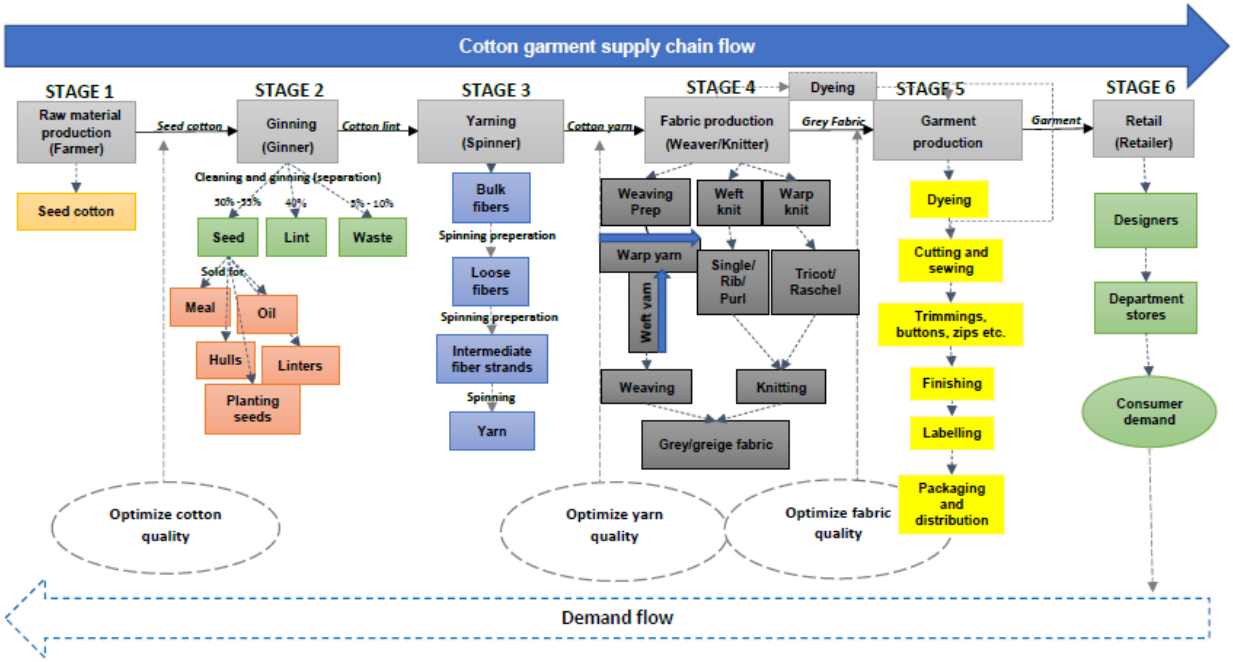

Figure 4-2. The cotton garment SC. Adapted from: (Amarijit, 1999:340, 342, DAFF, 2012:43).

4.2.1. **Stage 1: Raw material production**

The first production part of a garment SC starts at seed cotton production. The seed cotton is referred to as the harvested cotton. Cotton is produced on farms or by agricultural firms and is used worldwide in garment manufacturing (Sen *et al.* quoted in Giri & Rai 2013:30). Cotton is farmed in the following areas in SA: Limpopo Province, North West Province, Kwazulu-Natal, Northern Cape and Lower Orange river. However, cotton garment manufacturers in SA also uses cotton that are produced in other SADC countries such as Namibia, Swaziland, Botswana, Malawi, Angola, Mozambique, Tanzania, Democratic Republic of Congo, Zambia and Zimbabwe (DAFF, 2012).

Cotton grows at its optimum where summer temperatures do not drop below 25 °C. The most critical time period with regards to optimum temperature is between December and February in SA. Even though cotton essentially is a tropical crop, most cotton is produced outside the tropics. The temperature is of vital importance to consider when looking for economic cotton production areas, because the yield and fibre quality is dependent on it (DAFF, 2016a).

With regards to moisture, cotton is a drought tolerant plant and has the ability to produce good yields under dryland environment (500mm rainfall annually). Unfortunately for quality requirements, a higher rainfall is required (500mm – 1250mm annually). The Average rainfall in SA is at about 600 mm annually and therefor the most of crop production in SA is under irrigation (DAFF, 2016a).

In SA, there are various mechanical planters available and cotton farmers usually start planting in October (DAFF, 2016a). The harvesting period is about 6-months after planting and could be harvested by either handpicking or mechanically. The harvesting period is the most expensive operation in cotton cultivation. Handpicked cotton is considered to yield cleaner cotton and could take up to 2-months to harvest (DAFF, 2016a).

The price given for seed cotton is linked to the South African grading standard for lint and it is applicable to hand-picked or machine picked cotton (DAFF, 2012). However, even when the cotton is harvested carefully and under ideal conditions, there are still pieces of leaf and other impurities present in the seed cotton that needs further processing (Siddaiah *et al*., 2004).

4.2.2. **Stage 2: Ginning process**

Seed cotton in its raw form consist of cotton lint, cotton seed and non-lint material (unneeded matter or waste) (Siddaiah *et al*., 2004). Ultimately the fibre/lint (also known as lint) is the material that is used to manufacture a garment or textile product. Because only cotton lint (about 37%–40% of total mass of seed cotton) is used in the manufacturing stage, a cleaning process is needed to remove all the unwanted materials and separate the seed from lint (DAFF, 2012; DAFF, 2016).

The ginning process is used to separate the cotton fibre from the cotton seeds, which could be marketed as, but is not limited to, commodities[10] such as lint bales, cotton seeds, and compost (Amarjit, 1999:293). However, before the cotton fibre could be separated from the cotton seeds, another separation process occurs in order to remove all unwanted matter or waste to produce quality lint. The level of foreign matter (ranging between 5%-10% of seed cotton) present will determine the cleaning level needed (Amarjit, 1999:294). This separation process is done by means of mechanical cleaning equipment to remove all the waste objects (consists of plant foliage). This process is used in combination with the gin in order to then separate the cotton fibre from the cotton seeds (Siddaiah *et al*., 2004).

The ginning process is very important because it may affect the quality of the cotton. The main objectives for a cotton ginner are to produce lint that are at an acceptable quality for the grower's market and secondly to gin the cotton with minimal devaluation in spinning quality to meet consumer demands (Amarjit, 1999:293). Thus, it is important that in the ginning process the proper machinery is selected to produce the highest quality cotton lint possible. Failing to remove as much waste as possible may have negative consequences on the whole SC because it affects the properties of the fibre, waste grade and the colour grade (Siddaiah *et al*., 2004). However, regardless of advanced cleaning and ginning equipment there still remain waste objects in the ginned cotton or cotton fibre. After the cotton fibre is separated from the cotton seeds the lint is cleaned before it is baled (tightly packed mass of staple fibres) for shipment to the spinner (Siddaiah *et al*., 2004; Amarjit, 1999:339). The cleaning process uses cylindrical cleaners which will decrease the lint waste but simultaneously decrease the yarn strength (Amarjit, 1999:298). The cotton seeds that are produced during this process are sold to manufacture animal feed (DAFF, 2012:3). The lint consists of cellulose and is the most important product of cotton from a commercial point of view (DAFF, 2012:3). The cotton lint is then sold to the spinner in order to from yarn.

4.2.3. **Stage 3: Yarning/Spinning**

Yarn spinning could also be defined as the conversion from fibre-to-yarn system. During this process, the fibres are converted into yarns by using a series of processes that are divided into two primary stages namely the preparation for spinning and the actual spinning process. During the first primary stage, the fibre bales are opened, cleaned, mixed and attenuated in order to form a fibre strand (Amarjit, 1999:339). During the second primary stage the fibre strands are attenuated further, until the yarn thickness and length are acceptable as well as fibre-to-fibre cohesion in order to give the needed strength to the yarn. This process converts fibre into either single yarns or folded yarns and then the yarns are produced into fancy or regular varieties (Giri & Rai, 2013:31). A single yarn is produced when a certain number of fibres are combined through the twisting operation explained earlier which results into a low-level yarn. A higher level of yarn is when several single yarns are plied together to produce a ply/folded yarn. Fancy yarns are produced by means of designed

[10] A raw material or primary agricultural product that can be sold or bought, in this case lint bales, cotton seed and compost, all derived from the ginning process could be marketed as commodities.

irregularities, using different variations along the length to give the yarn a specific structural appearance (Amarjit, 1999:573).

During yarn manufacturing processing, micronaire, explained in Section 4.3.2, in combination with span length and strength will be used in order to produce a certain size of yarn and it will also be considered to promote yarn spinning efficiency (Amarjit, 1999:210). Other characteristics such as blend characteristics, dimensional parameters, thickness, hairiness, diameter, number of twists, geometrical dimensions and irregularities could also be used to analyse yarns (Alagirusamy & Das, 2010:237). The reason for analysing the irregularity is because the yarn production cannot be controlled if the amount of fibres varies, also the fibres are not regular in geometry and it may be possible that it is blended with foreign materials (as mentioned earlier) (Alagirusamy & Das, 2010:238). Increased hairiness is a result of fibres that detangles from the strand and it causes problems in both yarn and textile operations (Alagirusamy & Das, 2010:240). With regards to yarn diameter, the closeness of the yarn packing in the fabric could be defined and the fabric thickness is dependent on the yarn thickness. The twist in a yarn affects the structure of the yarn because it adds to geometrical change, fibre tension and mechanical stability (Li & Dai, 2010:190).

Another very important and often used term in the textile industry is “linear density” or “yarn count,” which is directed to the fineness of the yarn. The diameter does not represent the fineness because, the diameter along the yarn length is not stable and the cross-sectional shape may not be circular for the fibre and the yarn. Thus, this is expressed as either the weight of a known length of yarn (direct system) or the length of known weight of the yarn (indirect system) (Alagirusamy & Das, 2010:26-27). Normally the unit of weight is small (for instance 20 tex will be 20 grams) and the length is large (1000 meters), and in the direct system, the larger the indicated number (could be expressed as follows: tex; denier; Jute’ English cotton count or metric), the coarser the yarn. With regards to the indirect system it will be the opposite, thus the larger the indicated number the less coarse the yarn. Most commonly used measure will be tex, which is the weight in gram over 1000 meters of length thus for instance 20 tex will be 20 grams of yarn over 1000 meters of length. Different units and conversion factors of the yarn count are expressed in Appendix A, Table A-1 (Alagirusamy & Das, 2010:27).

Different technologies are associated with the manufacturing of yarn and to be competitive in the global economy, the fibre should be stronger to be processed with these technologies. Unfortunately, with increased consumer preference of 100% cotton garments, that are wrinkle resistant, requires chemical treatment that weakens the yarn (30% to 50% reduction in strength). Most commonly open end and ring spun yarn/ring spinning is used in cotton garment manufacturing (Briggs-Goode & Townsend, 2011:8). Ring spinning, “*uses a spinning frame drafts rovings, twist yarns and winds it on the bobbin continuously and simultaneously in one operation*” (Briggs-Goode & Townsend, 2011:8). Different types of ring spun yarns are combed, carded, woollen and worsted yarns. With regards to open end spinning, the fibres are less aligned and are subdivided into rotor or friction yarns. Open end spinning is faster and cheaper than ring spinning, but ring spun yarns is stronger, suitable for all staple fibres and could produce finer combed yarns in comparison to open end (Briggs-

Goode & Townsend, 2011:8). This information is important to consider when yarns are selected for specific products as well as determining a specific price point of that product. With regards to the manufacturing of a garment, both open end and ring spun yarns could be used, but it will influence the quality, weight, strength, and price of the fabric as well as the garment.

4.2.4. **Stage 4: Fabric production**

During this processing step, there may be two different ways of producing fabrics for garments. A fabric could be woven or knitted and the conversion of yarn-to-fabric is dependent on it (Amarjit, 1999:340). This stage is also the major stage of garment production (Giri & Rai, 2013).

For woven fabrics, two sets of yarns, namely warp yarns and weft yarns, are interlaced at right angles to each other, to produce a fabric. Different patterns could be used to produce different textured fabrics. The interlacing of the warp yarn and weft yarn is also referred to as a weave (See Figure 4-3). The warp yarn runs parallel down the length of the fabric and is known as an "end." On the other hand, the weft yarn will then run across the fabric and it is referred to as "picks" (Briggs-Goode & Townsend, 2011:11). The key role of the weave is to influence the behaviour of end use. Thus, the weave will influence the fabric's ability to drape, how it handles, and the appearance of the fabric.

Woven fabrics are produced on a loom, which is a system used to hold the warp threads in a tightly packed position. A desired weave could then be produced in an appropriate order. Raising some of the warp ends will create a space called the shed, allowing the weft to be inserted. In order to produce basic weaves, the loom has shafts to raise the warp yarn as desired and the number of shafts present on the loom will determine the maximum number of warp yarns, present in one particular fabric (Briggs-Goode & Townsend, 2011:11). The shafts are controlled by a mechanism called a dobby. For more complicated woven fabrics, a Jacquard mechanism is used, where the warp end is fed through rods instead of shafts, but this process is expensive (Briggs-Goode & Townsend, 2011:12).

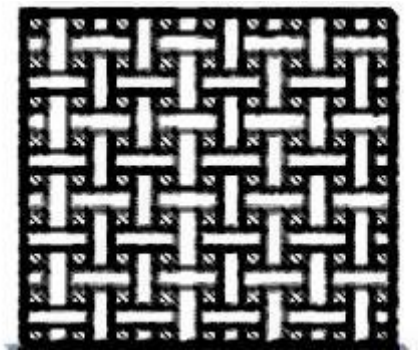

Figure 4-3. Weave pattern**.**

For knitted fabrics, the "interfacing loops" of the yarn (normally formed mechanically but could also be formed manually) could be defined as the "weft knits" and "warp knits" (Giri & Rai, 2013). During weft knitting the loops are formed one after the other in weft direction of the fabric. Weft knit can be classified as single, rib or

purl structures. In contrast, weft knitting is when warp yarns are simultaneously formed into loops and is classified as tricot and Raschel structures. Weft knitting machine could also include circular or flat knitting. Circular knitting will produce a circular tube, which is normally used in T-shirts, underwear, sweatshirts, or fleece (Briggs-Goode & Townsend, 2011:13,57). Based on the application of the garment, it will be decided what particular process will be used. For the garments used in this research study, single jersey fabrics will be used and are produced by means of a knitting technique where only one bed of needles are used, and the loops will only be intermeshed in the same direction (See Figure 4-4).

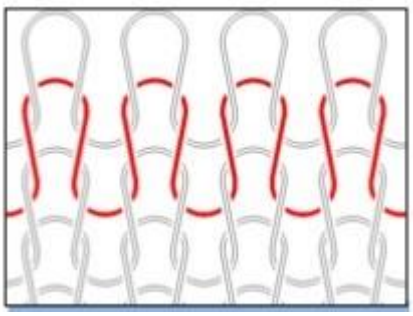

Figure 4-4. Knitting (Weft knitting, single jersey).

It is called single knit because the needles will knit one at a time. Another important weft knit used in garments is the rib structure where two sets of staggered needles are used, where the loops are intermeshed in different directions (Briggs-Goode & Townsend, 2011:13).

The yarn count, referred to in Section 4.2.3 will influence the weight of the fabric per square meter (mass per area), as well as the ends and picks per centimetre and the amount of fibre present in the fabric (Li & Dai, 2010:150). The fabric weight is often used as an indicator of thickness instead of using the actual fabric thickness itself. When a fabric is manufactured, it is done at a specific width and the width is dependent on the loom on which the fabric is manufactured (Li & Dai, 2010:53). Thus, massive change in width is unlikely and the width and weight per square meter is used to do important calculations, which is explained in Appendix F. Different garments will use different fabric width and weight, for some the width may be tubular instead of linear. The heavier the fabric, the more load will be placed on the human body, so for instance infant and child wear will require lighter fabrics than men's wear (Li & Dai, 2010:201). Other applications such as sportswear for instance will also require lighter fabric (Li & Dai, 2010:150).

The finished fabric, before the fabric is dyed is called greige cotton fabrics or grey fabric (Briggs-Goode & Townsend, 2011:73). This grey fabric is then sold to the garment manufacturing for further processing namely manufacturing garments, dyeing, printing and finishing(Giri & Rai, 2013). When a specific colour is chosen for the dyeing process, it is important that the designer understands the theoretical and practical elements of colour. The reason for this is it will influence the yarn, thread and cloth that need to be selected in order to produce printed, embroidered, woven and knitted fabric brands (Briggs-Goode & Townsend, 2011:171). In some cases, there may be a possibility that the designer requires a fabric that is woven or knitted in a specific

manner based on different colours. Yarns that are dyed in multiple colours will create differential coloured effects in apparel products (Briggs-Goode & Townsend, 2011:149). In this case the yarn needs to be dyed before the fabric is woven or knitted. In extremely rare cases the fibre could also be dyed before the yarn is spun (Briggs-Goode & Townsend, 2011:148). Either way, the finished colour fabric will then be sold for further processing to the garment manufacturer. In some cases, the fabric manufacturing process and the garment manufacturing process could be done simultaneously in one manufacturing plant.

4.2.5. **Stage 5: Garment production/manufacturing**

In the early 1900s, the concept of garment manufacturing was a standard hand-knitting procedure, using four double needles. In 1995, the first seamless garment production was introduced. With new technology arising, designers have the ability to be innovative and versatile, because three-dimensional shaping could be combined with colour and texture. There are machines available on the market that are digitally operated but it is dependent on the plant's economical capacity, for instance whether it is digital, mechanical or hand operated machines (Briggs-Goode & Townsend, 2011:58).

During the garment production, there are various stages which include designing, dyeing, printing, finishing, pressing and packaging. As explained in Section 4.2.4, dependent on the design, the fabric that is obtained from the fabric manufacturer, may already be dyed or greige fabric. If the fabric is greige fabric, a dyeing process will be done in the manufacturing process. Normally, most of the fabric design is produced in the fabric dyeing step. This is done by means of dyeing technology or dyeing machines (Briggs-Goode & Townsend, 2011:150). The greige or grey fabric could also be processed into a finished garment before it is dyed, but it may cause problems when trimmings, buttons and zips are added to the garment.

The dyeing process may also cause the fabric to shrink which should be considered in the quantifying process explained in Appendix F, where the amount of cotton lint to produce a finished garment would be calculated (Briggs-Goode & Townsend, 2011:161). Companies may have their own in-house designers or they may outsource it from designer houses.

The designs are based on market trend, demand forecast and customer preference. There is a close relationship between the design of the garment and the selection of the fabric (Li & Dai, 2010:6). As soon as the designs are selected, the selected fabric is cut into specific pieces at specific shapes and sizes in order to manufacture a specific design. The different pieces are then joined together, by means of stitching, in a specific manner based on the requirements of the design. This could be referred to as a seam, and there are different types of seam constructions for different purposes. This includes: decorative-, superimposed-, applied-, bound-, single ply construction seam, edge neatening and lapped seam (Li & Dai, 2010:188). Many retailers prefer to do the design in-house and outsource the garment manufacturing to tier-one suppliers (Giri & Rai, 2013). The appropriate base of the manufacturer will depend on lead time, location, cost, and availability (Briggs-Goode & Townsend, 2011:58). Thus, one retailer may have different tier one suppliers, based on the type of garment

that is manufactured. This allows the retailer to widen the design scope and to be more competitive in the market space.

With regards to circular tube fabrics, explained in Section 4.2.4, requires less processing at a faster pace and it is cheaper. In the garment assembly stage, circular knitted fabrics are normally referred to as "full cut and sew." During this process, pieces are cut out of the fabric and other pieces are assembled by means of an over-lock stitch, which will join the cut edges with the fabric in one stitch (Briggs-Goode & Townsend, 2011:57-58). After the fabric is formed into an actual coloured garment, trimmings could be added, which may include, but are not limited to buttons, hooks, badges, and zips. Some garment manufacturers outsource the Cut Make and Trim (CMT) step to other CMT manufacturers.

A fabric's performance and properties are influenced by the finish that is added to the fabric. Finishes could be added to improve the appearance and performance of the fabrics and may include, but are not limited to: anti-static treatments, water repellents, flame retardants, and softeners. The chemical finishes may adhere to the surface of the fabric but it may also include physical finishes such as: raising; brushing; flattening and embossing (Briggs-Goode & Townsend, 2011:28). The finishing process normally enhances the end use of the product and not the design or colour but in some cases, it could be used in the design of the garment (Briggs-Goode & Townsend, 2011:161). Pressing is done in order to remove creases and to improve the appearance of the garments.

The functional requirements of fabrics vary according to the end use of the fabric. End use includes but is not limited to: easy care; softness of touch; ability to dry quickly; ultraviolet (UV)-protection; anti-bacterial; long durability, fashion (Li & Dai, 2010:200). As soon as the garments are finished, they are labelled according to the retailers requirements, packaged in appropriate packaging material and distributed to the retail stores (Giri & Rai, 2013).

4.2.6. **Stage 6: Retailing**

As mentioned earlier, most of the retail stores have their own in-house designers. From information in Section 4.2.5, it could be established that the design of the garment is of high importance and it translates back into the SC up until fibre level. It makes it very difficult for all the links in the SC to do any planning, if there are no orders from the retailer at that stage. This also has a major effect on the lead times in each production process. Thus, the designers have a very big task at hand to be competitive in the market, stay up to date with fast fashion, and meet the deadlines for the orders. For textile products, such as towels, which are not necessarily bounded to fast fashion, it is easier to give an indication of what will be ordered in advance, when compared to apparel products. At retail level, coordination between the flow of products and information is important. Thus, it is up to the retailer to capture information flow from the consumer, demands, trends and market needs and allow the backward-flow of information to the rest of the SC (suppliers/garment manufacturers, fabric

manufacturers, spinners, ginners, farmers etc.) to this regard. It is very important to coordinate the flow of material and information and if there is higher coordination, the SC will perform better (Giri & Rai, 2013).

Retailing sectors may include a variety of retailing formats and structures as well as different approaches and operations (Giri & Rai, 2013). Thus, department stores are normally what distinguishes the different textile products for instance, home textiles, apparel and sports ware. It could also be distinguished based on price and affordability and brands. Another new age way of retailing is the use of internet and online shopping, where the products are delivered at your door (Giri & Rai, 2013). Either way the retailer is the last chain in the garment SC which delivers the finished product to the consumer.

4.3 Cotton as a commodity

Cotton is used for many purposes worldwide, and is one of the most versatile crops grown by humanity. It is distinguished by its appearance, performance, versatility, and comfort it provides to mankind (DAFF, 2012). The reason for the use of cotton as raw material in garment manufacturing, is related to its properties. Equally important is the effect it has on the buying behaviour of consumers, because natural fibres have proven to be sought after by consumers than synthetic fibres. In relation to other natural fibres, cotton fibres are quite short, and fine, soft and flexible, and is considered to exhibit good strength properties under dry and wet conditions. Commoditized products that are produced from the cotton plant as raw material includes: from cotton lint weaving and knitting yarns; from cotton seed meal, oil, hulls, linters, and planting seeds are used (DAFF, 2012).

4.3.1. Characteristics of cotton fibre

The characteristics of fibres could be divided into the mechanical properties, absorption properties, thermal behaviour, thermal conductivity, chemical and UV resistance. The fibre characteristics are directly related to the yarn properties (Alagirusamy & Das, 2010:39-40). With regards to mechanical strength, cotton as a natural fibre is weaker than synthetic fibres, thus a weaker fibre will mean a weaker yarn and could thus not be used for high-carry-load application. The elasticity or elongation and the resilience of cotton is low, which explains why cotton garments crease easily. Thus, cotton as a fibre, fails to ensure dimensional stability, because the recovery of elongation after repeated use is not possible. However, the draping of cotton fabrics on the body, which is considered as appealing, is very useful in clothing design and aesthetic (Alagirusamy & Das, 2010:41). The water absorbency of cotton is excellent, which is perfect for materials where absorbency is required such as towelling. However, because of this property, the drying process of cotton materials is slow. The moisture absorbance of other materials normally weakens the strength of the fibre, but this is not the case for cotton as it increases the fibre strength. The thermal behaviour of fibres is related to shrinkage, change in colour, melting, carbonizing, and softening, dependent on the type of fibre used. Cotton, has no melting point and only char at high temperatures. In fibre form it is not prone to shrinking and stretching, however during laundering in fabric form it may occur, and it is directly related to the tension that is introduced in the fabric

formation (Alagirusamy & Das, 2010:42). Chemically, cotton fibres are not resistant to acid but are resistant to alkaline. It has a good resistance to UV and to internal abrasion. A process called mercerisation is used, where the cotton fibres are immured into strong alkalis, where the fibre will swell and become stronger. Oxidising agents will destroy cotton if it is bleached uncontrollably. Even though cotton is resistant to UV light, it will deteriorate and weaken the fibre over extended periods of exposure (Alagirusamy & Das, 2010:43). One important property of cotton is that it has a low lustre, meaning low shine, which makes it easy to distinguish a natural fibre from a synthetic fibre, because most synthetic fibres have a high lustre (Briggs-Goode & Townsend, 2011:20).

4.3.2. **Cotton classification and quality**

The classification of cotton is based on a few factors: fibre length; uniformity of fibre length; fibre strength; micronaire; colour, and purity(as much waste remove as possible) (Siddaiah *et al*., 2004). The staple length or length of the fibre is related to the quality of the cotton and it could be divided into four classes: extra-long staple (35 mm and more); medium staple (22 to 25 mm); medium-long (25 to 28 mm) and short staple (less than 1 mm). The staple length represents the average of lint fibres on a seed and the difference in length are related to different cultivars. The short-staple is from Asian cotton, whereas the extra-long staple is normally from Egyptian and Sea Island cotton. The medium staple is from a majority of cotton fibre production worldwide and lastly the medium-long staple is from Upland cultivars (Amarjit, 1999:51). Cotton is classified as a low tenacity yarn (meaning low fibre strength), therefor natural fibres are normally used for low load-bearing application (Alagirusamy & Das, 2010:4).

The colour of cotton fibre is affected by the weather conditions and length of exposure to certain weather conditions and microorganism action, after opening of the cotton bolls[11]. It may also be affected by the harvesting and the ginning practices. Normally the cotton fibre should be a bright white colour and abnormalities in the colour will affect the quality of the fibre. Premature cotton fibres will have a yellow colour that varies in intensities due to frost or drought. Discolouration may also occur due to insects or fungi (Amarjit, 1999:329).

"*Micronaire*," one of cotton most important properties, could be defined as the "*measure of resistance to airflow of a constant weight of fibres at one air pressure*" (Amarjit, 1999:210). In easier terms, it is the measurement of the fibre fineness (Zhao *et al*., 2013). The importance of this property is critical because the maturity and fineness of the fibre directly relates to the processing of the fibre as well as the quality. The level of micronaire should not be too high[12] or too low[13]. With an increase in the level of fineness will promote the coordination of fibre-to-fibre cooperation in the yarn, which means that there will be less twist in yarn and an increase in productivity for the yarn manufacturer (Amarjit, 1999:209). If the micronaire is too high, the spun

[11] The round and fluffy clumps in which cotton grows on a cotton plant.
[12] Meaning bigger diameter may be due to excessive carbohydrate availability during development
[13] Meaning immature or smaller diameter

efficiency is very low and if the micronaire is too low, it causes neps[14] and dye defects (Amarjit, 1999:210). The micronaire fineness reading is dependent on the tex yarn that needs to be spun (reading of 3.30-3.49 MIC[15]).

The quality of the end product, directly relates to the cotton quality that is used as raw material but does not only include the raw material but many other factors and physical attributes. The physical attributes referred to earlier are directly affected by each production step, which includes the environment the raw cotton was produced in, the variety, harvesting procedures and the ginning process, which was explained in Section 4.2.2 (Siddaiah *et al*., 2004). Furthermore, the final fabric quality is directly dependent on the yarn quality (Alagirusamy & Das, 2010:236). To manage uniform cotton quality, standardize procedures are used in order to measure the physical attributes. These particular attributes are used in order to grade the cotton for commercial use (Siddaiah *et al*., 2004).

4.3.3. **Defining cotton prices**

The cotton market is extremely globalised (Cotton incorporated, n.d). Since cotton is in the global market, cotton prices would also be internationally priced. Cotton price definitions include, but are not limited to: the "New York Nearby" price, the "A index" price, the "China cotton index" and "Indian & Pakistani Sport markets" (Cotton incorporated, n.d). There is a large variation in each of these term's definitions, but for this thesis the "New York Nearby" and "A index price" definitions are considered due to their influences on cotton prices in SA.

4.3.3.1. **New York Nearby or United States cotton futures market**

Nearly all commodities are traded in futures markets. A "*future market"* could be defined as a market in which a party can sell and buy commodities and future contracts, to deliver the commodity at specified future date. The reasons for using future contracts is to minimise risk and avoid market volatility. In the New York futures market, there are five contract months which includes March, May, July, October, and December. The price stipulated in the contracts is based on what the participants are willing to buy/sell the cotton for at today's price, which would only be delivered in the future month. Thus, the term "*nearby*" refers to the contract that is closest to expiration date. For instance, in April the nearby price refers to the contract in May.

4.3.3.2. **A index price**

A trade group called the Cotlook, has published the A Index since the 1960s (Cotton Outlook Ltd, n.d.). The A Index price intends to represents the international raw cotton market. This cotton price is based on the cheapest five quotations from a selection of cotton traded internationally, meaning the average of these quotations is a methodology by which to identify the most likely or largest traded volume which are most

[14] Any small entanglement of textile fibers that cannot be unravelled, which is formed during carding or ginning.
[15] Micronaire's unit of measure

competitive. Cotlook identified the base quality as middling 1-1/8'' (used from 1 August 2015). The data used to determine the price is based on daily surveys of cotton brokers and as mentioned describes the average export prices that are offered internationally, for shipments to the Far East (where the majority of world cotton is spun into yarn). It is important to note that the A Index price tends to be higher than the New York Nearby price for the following reasons: the A index prices have a higher quality grade than the New York futures price and the A index price includes transport to the Far East.

4.3.4. **Factors effecting cotton prices historically**

Cotton prices are affected by many factors, which include the law of supply and demand, regional factors, fibre attributes, and changes from one crop to another. The main factor however is directed to the fibre attributes which will determine the fees and discounts that are associated with a certain cotton value. The grade of the cotton, staple length, micronaire, appearance, cleanliness and extraneous matter are only some of the above-mentioned attributes (Amarjit, 1999:343).

In recent years this has changed slightly where the market value of cotton is reflected upon its technological worth. As the years progressed, the trend of cotton purchasing changed. According to Amaijit (1999:344) it was difficult to estimate a value associated with technological worth to high accuracy, because there seems to be some challenges associated with it. These challenges are as follows: differences in views between organisations as to what is used to determine fibre quality, the impact of the market structure and the lacking of scientifically evaluation of the value of cotton. The first challenge is related to what part of the SC is viewed and who is viewing it (Amarjit, 1999:344). However, it cannot be only directed to one part of the SC, because for instance, if it is only viewed from the producer's point of view, the raw material still needs processing, and the way this raw material is processed will also have an influence on the quality of the end product. Other attributes such as the appearance of fibre and the cleanliness are highlighted, but further down the SC it is rather preferred not to gin the fibre to an extreme extent because it may damage the fibre, even though it is also important to consider the consequences of waste on the value of cotton as well as the manufacturing and end quality of the product (Amarjit, 1999:344).

The balance will be of high importance to establish a way to accommodate all the links in the SC. However, it is difficult because some farmers or fibre producers are reluctant to produce cotton of higher quality because of higher expenses and they would rather have higher yield and more excessive cleaning because it is coupled to incentives (Amarjit, 1999:346). On the end of the SC at the ultimate consumer, the interest of the cotton value is to be at its lowest or at discounted price (Amarjit, 1999:346), which has changed over the years, with the motivation to be more sustainable. Amarjit (1999:346) predicted that the price in the next century will be based solely on IT, fibre testing techniques and that it will continue to develop in the future.

4.3.5. **Factors influencing the cotton lint price in South Africa**

More recent academic publications with regards to the factors affecting cotton prices are limited. However, according to the World Statistics Organisation (n.d) the largest cotton lint producer in the world currently is China, following India and the United States of America (USA). Thus, the state of the harvesting season for leading cotton producers, like China would influence the world cotton price. Furthermore, the economy also tends to have a huge influence on the prices of commodities and the value of the US dollar would also influence the cotton price, because the USA is the largest exporter of cotton, currently at 40% of world cotton exports (CSA, 2017a). Other influences such as the prices or substitutes for cotton would also influence the price of cotton. The cotton lint quality attributes like fibre length, micronaire, and different classes of cotton lint, also influence the price of cotton lint (See Appendix D, Figure D-1 for more information). Other external influences such as subsidising of American farmers influence the South African cotton lint prices negatively with little local governmental support.

4.3.6. **The marketing of cotton**

Locally, cotton lint and seed are marketed in SA in three ways. Firstly, the seed cotton is sold by the farmer to the ginner, who then sells the cotton lint on its own account to the spinner and the seed producers (See Figure 4-2 for more information), it could be done directly or by using agents. Another option for the farmer is not to sell the seed cotton to the ginner, but contracts the ginner to gin on behalf of the famer by paying a ginning fee. It may also be possible for a farmer to own his own cotton gin (DAFF, 2012).

The cotton lint could then be sold to the spinner and seed user, by means of a buying contract with an organisation or they can also contract someone or a company to do it on their behalf (DAFF, 2012). Thus, the spinner will buy the cotton lint from the ginner, spin it into an appropriate yarn and then sell it to the weavers/fabric manufacturers on its own account. Another option is for a spinner to spin and weave/knit the yarn into a fabric, and then sell the fabric to the garment manufacturer (referred to as vertical integration) (DAFF, 2012).

On investigation, it could be concluded that SA has a lack in spinning capacity and thus alternative spinners from Zimbabwe, Mozambique, Mauritius could be used since they still form part of SADC countries. The main reason for this is because of continuous imports of textiles and apparels that are cheaper than locally produced cotton, yarn and fabric and the strength of Rand against the US dollar (DAFF, 2012). Thus, import costs should also be accounted for in some cases, but preferably, locally produced cotton, yarn and fabric should be used where possible.

As soon as the garment manufacturer receives the fabric, it is processed into a finished garment, before it is sold to the retailer. The garment manufacturer may outsource the CMT process and printing to other companies as explained in Section 3.3.5. The retailer, which is the last link in the SC will then sell the finished garment to the end consumer.

4.4 Sustainable impact of textile production: focussing on cotton production

With regards to sustainability, it is no secret that the global movement of the 21st century is directed to greener and cleaner living and production. With obvious changes in weather conditions, it cannot be ignored to take a stand, in order to try to fix the almost unfixable changes that occurred and make a difference for generations to come. According to Fan and Hunter (2009:xix) the universal textile fibre consumption of the apparel sector is about 48% of the whole textile fibre consumption, with high financial benefit at factory level. With an increase in annual population, the consumption of fibre also increases (Fan & Hunter, 2009:xix). Unfortunately, the textile industry forms part of the industries that are involved with pollution and depletion of natural resources. The importance of producing sustainable textiles are highlighted by the following facts: textile waste alone accompanies about 5% of all landfill space. Thus, about a million tonnes of textile products will end up in landfills yearly; textile treatment and dyeing causes about 20% of industrial fresh water pollution and it uses roughly 3 trillion tonnes of fresh water to produce 60 billion kilogram (kg) of finished fabric; the global textile industry is responsible to 10% of global carbon impact, only to name a few (Textile exchange, 2011:11).

Textile manufactures, managed to change their approach to sustainability, in order to produce textile products that are manufactured and produced under improved environmental conditions. These environmental conditions could include: saving of energy and water; minimising air pollution, and generating less by products seen as waste. Furthermore, an international set of standards that are under the ISO14000 series, are now implemented in order to improve and evaluate environmental management in the textile industry (Dawson, 2012:1). According to the global market report on sustainable textiles, the "new" way of doing business will include balancing the TBL such as profitability, social responsibility and environmental conservation. Even though the course of sustainability may have different approaches, and may differ in size, every step in the right direction counts (Textile exchange, 2011:4).

As mentioned in Chapter 1, added pressures started to force companies to be more sustainable. However Mitchell et al., (2007) argues that it is up to us, "society", to make a difference, through our choices in order to ensure a sustainable future, and that TBL as a concept could be illustrated through a series of concentric circles (See Figure 4-5 below).

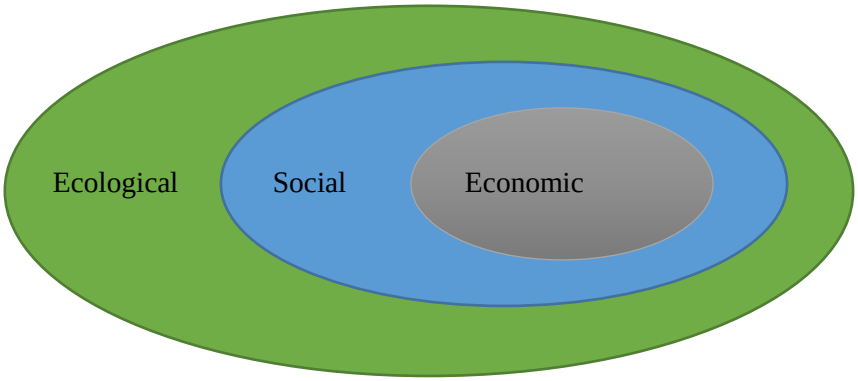

Figure 4-5. The TBL concept depicted as a set of concentric circles (Mitchell *et al.*, 2007).

According to Figure 4-5, society is in the centre and that sustainability is in fact a social goal. Unfortunately, there are constraints associated with the global environments ability to have a sustainable future. Thus, social sustainability depends on the ecological volume capacity of ecosystems worldwide. It is also important to understand that society decide how the economy will be run, thus they can decide if there will be change in economic functions or not (Mitchell *et al*., 2007). Elkington (2004:16) however concluded that the term TBL is only the beginning and there is a need for a more extensive approach that may involve a wider range of stakeholders and coordination in government policy, technology policy, tax policy, economic development policy, labour policy, corporate reporting policy. Elkington (2004:16) also stated that to develop above mentioned approach into sustainable development and environmental conservation, will be a market and governance challenge.

According to Fayet & Vermeulen (2012) increase in pressures resulted into the emergence of "*Corporate Social Responsibility*" (CSR) which emphasizes strict social and environmental performance standards. CSR could be defined as the commitment of an organisation to be ethical in order to contribute to sustainable economic development (Concept by Howard R. Bowen, who wrote "Social Responsibility of Businessmen" in 1953) (Carrol, 1999). This could be done by working closely with stakeholders, employees, and local communities to improve their business, sustainable development agenda and society. With regards to global trade, this concept is of high relevance (Boudreau *et al.*, 2015). According to Jamali *et al*. (2006) CSR is a complete set of procedures and programmes that are combined with decision making and business operations in order to ensure maximum positive impact on society.

Another well-known term used is "*sustainable development*," first defined by Brundtland (1987:41), is a development that "*meets the needs of the present without compromising the ability of the future generations to meet their own needs.*" Sustainable development also includes two important concepts: the needs referring to the world's poor, where priority should be given; and the "*limitations imposed by the technology and social organizations on the environment's ability to meet the present and future need*" (Brundtland, 1987:41). Since sustainable development was defined by Burndtland, the exact meaning of it is still uncertain and according to Ross (2009) the definition by Burndtland combined conflicting and different interests which are ambiguous.

Ross (2009) highlighted that even though most interpretations of sustainable development includes "economy," "environment," and "society," it differs where the emphasis is placed. The role of technology in meeting basic human needs as well as the nature of past human needs with regards to present needs differs significantly (Ross, 2009). Ross (2009:34) defined sustainable development as "*legitimizing 'business-as-usual' patterns of economic growth or, at the other extreme, requiring a fundamental reworking of global social-economic order*."

CSR, the TBL and sustainable development are related to each other in some way, but do differ in the area of focus. CSR would especially focus on corporate engagement which acknowledge their responsibility as a representative of society, while meeting the outlook of all stakeholders (Ebner & Baumgartner, 2006). Ebner and Baumgartner (2006) suggested through their study to use CSR as a social action of the sustainable development idea which focus on stakeholder approach. According to Sikdar (2003) sustainable development is also seen as the balance between economic development, social equity and environmental stewardship which could also be referred to in business circles as the TBL. The TBL and sustainable development term are ideas that have high interest in sustainable introduction on a macro-level (Ebner & Baumgartner, 2006).

The sustainable impact could be divided into three sections namely social, environmental and economic impact. Cotton, one of the main raw materials used in apparel production, grown in a traditional way, unfortunately involves the use of many chemicals, pesticides and other processing procedures which requires high volumes of water and energy. Thus, the influence of cotton production will be explained in the following sub Sections 4.4.1 to 4.4.3.

4.4.1. **Social impact**

In the TBL concept, with regards to social aspects, the wellbeing of any human is related to social performance. This should include the basic needs of humans, personal development and a well-balanced society (Shen, 2014). The fashion or garment SC, is very labour-intensive and sensitivity to social performance is key (Shen, 2014). On the other hand, it also holds advantages, since labour intensive industries create a lot of jobs, especially a cotton garment SC, as it moves from farm to fabric (DAFF, 2012). Building an appropriate sustainable SC that takes the wellbeing of employers into consideration is key when defining lead times, work-loads and working shifts.

According to research done by Shen (2014) the manufacturing of apparel products, normally takes place in countries that have very low labour costs (because of high labour input requirement), and which sometimes neglect implementing sustainable measures against environmental- and social issues (i.e. human rights). Likewise Boudreau *et al.* (2015) stated that companies in high-income countries, which are involved in the selling of products, rely on labour and environmental resources from other developing countries, where the local regulations are weak. This poses a very big problem in "*social responsibly"* terms. In some cases, the

stakeholders may prefer to use firms in developing countries which exceeds the local standards, this may not be the case for all organizations (Boudreau *et al.*, 2015).

According to the global market report on sustainable textiles, companies in the textile sector should ensure that there are fair and civil treatment to all workers that are involved in the production process of textile products (Textile Exchange, 2011). Furthermore, social responsibility in SA should be directed to job creation (mitigating poverty), training and education, and developing the community (Textile exchange, 2013). The Department of Trade & Industry (DTI), developed a programme called the CTCP originated, which was mentioned in Chapter 1, and are divided into two programmes, which are handled by the CTCP desk within the IDC (DTI, 2011). The main aim is to assist in employment in the textile, footwear, leather, and leather goods industries, and to produce sustainable capacity in SA. The CTCP also assist in funding for competitiveness improvement interventions (DTI, 2011). Working in corporation with the DTI and IDC, could empower the social capability of textile industries in SA.

4.4.2. **Environmental impact**

When referring to the TBL, in environmental context, the environmental wellbeing will include the health of the environment, energy use, climate change and natural resources (Shen, 2014). According to the global market report on sustainable textiles, textile companies do not have any excuse anymore to not reduce their SC footprints (Textile exchange, 2011). In previously mentioned report, they have identified that there are many ongoing initiatives to guide companies that are publicly available (Textile exchange, 2011). The main initiative that is being used locally is the Better Cotton Initiative (BCI), a non-profit organisation that defines "better farming techniques" in order to grow "*Better Cotton*" or sustainable cotton (Shen, 2014). According to Dawson (2011) BCI also support improvements in all cotton production methods with regards to sustainability. Furthermore, according to the global market report on sustainable textiles, it is important to design a product that have a longer lifespan and that could also be recycled or reused at the end of the products life cycle. This could also increase the TBL of your company and improve sustainability.

4.4.2.1. **Water**

With regards to the depletion of natural resources, water is a very important natural resource. Therefore, the term "*water footprint"* was developed. Water footprint, is a concept that maps the impact of global water consumption (Hoekstra & Hung, 2002). Thus, when referring to the water footprint of a "nation", it is referring to the total volume of fresh water that is used by the inhabitants of the nation, for the production of goods as well as services. Previous studies about water-footprints, are limited to only the quantification of resource use such as surface water, soil water and ground water Hung, 2002). However, more recent studies indicated that the water footprint should quantify for water pollution as well. This could be done by quantifying the water requirement to dilute, polluted water to an extent where the water will remain below the defined water quality standards (Chapagain *et al*., 2006).

As mentioned in Section 4.2, cotton has to go through numerous production stages that have different impacts on water resources. Furthermore, the production stages are carried out in different locations and tracing the origin of cotton production is key, because quantifying the water footprint at farm level will be impossible if the location is not defined (Chapagain *et al*., 2006). During cotton production chain, there are two main stages that uses different water resources namely: the agricultural stage and the industrial stage. The first stage impacts water resources in three ways: evaporation of rainwater for growing cotton, withdrawal of ground/surface water for irrigation and water pollution through pesticides and fertilisers (Chapagain *et al*., 2006). This could be defined as either "green" or "blue" water use where green water is the water taken up by plants (through rainwater) and the blue water is the water uptake from plants from irrigation water (Falkenmark, 2003). On the other hand, in the industrial stage, two impacts of water could be identified as: "*abstraction of process water from the surface water (blue water)"* and the waste flow form cotton processing as pollution of water (Chapagain *et al*., 2006:188). Globally the average of water content used in the production of seed cotton is 3644 m^3/tonne and for cotton crop production is 198 Gm^3 [16]/year (equal share for blue and green water). The total water content used in fabric production, focussing on bleaching, dying and printing, also referred to as wet processing is about 360 m^3/tonne (30 m^3, 140 m^3, 190 m^3 respectively) (Chapagain *et al*., 2006).

For the finishing process the total estimated water use is equal to 136 m^3 per ton of fabric. Thus, the total water footprint for consuming cotton products was estimated at 256 Gm^3/year. The total percentage for the use of blue water is 42%, green water is 39% and dilution water is about 19% (Chapagain *et al*., 2006). Above mentioned water loss or usage could put a lot of stress on the environment, especially on already water-stressed regions due to low rainfall and drought. The BCI model, explained earlier, for instance could be used in order to reduced irrigation needs and care for the availability of water, making significant water reduction contribution to the SC at farm level (BCI, n.d).

4.4.2.2. **Land**

Another important factor is the use of land, in order to grow cotton or produce cotton. Just like the water footprint concept, Chapagain *et al*. (2006) defined the "ecological footprint" as the amount of area needed in order to produce enough cotton to sustain a population. As mentioned with an increase in population, the area of land will become limited to produce cotton and crop rotation would be the way to go in the future.

4.4.2.3. **Energy**

According to Yilmaz et al. (2005) energy has been used more intensively, which effected the health of humans and the environment negatively and energy efficiency has become an important topic in terms of sustainable agriculture production. Furthermore, as energy costs started to rise, Dawson (2011) explained that it brought about new legislation with higher concerns in chemical substances which then affected retailers to respond to

[16] billion cubic metres

concerns of consumers with regards to ethical trading (this concept includes transport). The total estimated requirement of energy to produce 1 ton of conventional cotton fibre is equal to 55 Gigajoules (GJ) that are equivalent to 280 kilowatt hours (kWh) (Dawson, 2011). Thus, implementing energy saving techniques at farm level is as important as in the production stage.

During the production stage, there is various machinery that is used in cotton conversion from fibre to fabric as explained in Section 4.2. These machines use electrical energy and due to technological development, the efficiency of energy use, could be maximized through power saving technology. The equipment or machines that uses electrical energy include, but are not limited to, air-conditioning units, lights, ginning-, spinning- and weaving- equipment, CMT equipment, dyeing and printing equipment. Another form of energy is also used through transportation between several productions steps, as well as transport to the consumer. Measuring the actual amount of energy used for the whole production chain for one particular garment is very difficult without sufficient data and traceable capability.

4.4.2.4. **Chemicals**

The use of energy and global greenhouse gas (GHG) emissions are related in some way where energy used is an indirect source of GHG. In other words, GHG emissions are generated from fossil fuels used in the manufacturing, distribution and treatment process through transport, agro-chemicals and pesticides (Textile exchange, 2013). GHG emissions consist mainly of the following gasses: Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydro and per fluorocarbons (HFCs, PFCs) and Sulphur hexafluoride (DF6) (Verfaillie and Bidwell, 2000). The estimated GHG emissions to produce conventional cotton is roughly 4.107 kg CO_2 equivalent per hectare of lint (Textile exchange, 2013). The location and travel distance between different components in the SC will have an effect on the amount of carbon that would be generated through transport (Nouira *et al*., 2016). According to Chapagain *et al*. (2006) cotton consumption accounts for major pollution and this is partly because of the use of harmful chemicals in cotton processing industries and party because of the use of fertiliser in cotton production at farm level. A quarter of all used pesticides in the USA are used in conventional cotton production (Shen, 2014). The use of these pesticides and chemicals should ideally have low toxicity to humans and should be biodegradable (Dawson, 2011).

4.4.3. **Economic impact**

Shen (2014) highlighted that the economic wellbeing of a company is related to the development of the future to be prepared, and also related to the economy. Research done by Elkington (2004:29) revealed that the original bottom line was about profit, were there was an increase in revenues without any increase in costs and that this is not the same as the economic dimension of the TBL. Furthermore profitability (the core concern to shareholders) is only one element of the economic dimension, and that the economic performance of a company is broader that shareholder profit. There are issues in order to scope the economic dimension because of the difficulty to express environmental/social costs in financial terms.

Thus, for instance environmental impacts in terms of costs may include the restoring/preventing of damage costs, which may be a way to measure the environmental impact (Elkington, 2004:29). Elkington (2004:29) stated that either way, whether it is a good or bad way of measuring the environmental cost, it could not be seen as a direct financial performance measure, it only using financial units to capture the environmental performance. In terms of sustainable markets, it is difficult to reflect the benefits and costs into the pricing of goods. Thus, economic dimensions that are helpful to use in this context is dividend payments acknowledgements, in terms of economic impact and viability of local economies rather than only looking at the number of jobs created and gross profit (Elkington, 2004:30).

4.5 **Conclusion**

The important aspects of cotton, in the garment manufacturing world, are highlighted in this chapter. Cotton, classified as a natural fibre is more sustainable than synthetic fibres used in the clothing industry. Furthermore, consumers tend to have a higher interest in buying clothing that are made out of 100% cotton, than synthetic fibres. Thus, the sustainability aspect of cotton garments is highlighted. The processing of cotton lint, into a finished garment consists of various stages namely: "*ginning*;" "*spinning*," "*fabric manufacturing*," "*garment manufacturing*," and "*retail*." This chapter also highlight and explain the complexity of a cotton garment manufacturing SC. Furthermore, this chapter also helped define important aspects to ease understanding of the dynamics of SC innovation, particularly in the textile industry, which will be discussed in Chapter 5.

5 Supply Chain innovation and business process mapping

This chapter represents the third literature review chapter and provides an overview of SC innovation and Business Process Mapping (BPM). This chapter gives the reader an overview of the process of being innovative, particularly in a SC, as well as outline important aspects of BPM, the notations of BPM and the strengths and weaknesses of BPM. Figure 5-1 provides more information on the chapters focus and the stage that is currently being addressed in the research process.

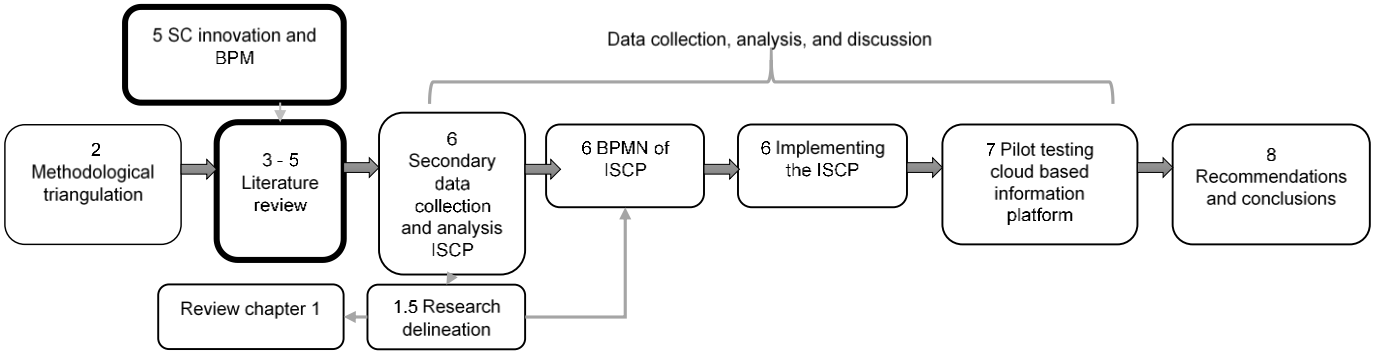

Figure 5-1. Third literature review chapter in research structure, SC innovation and BPM.

5.1 Introduction

To define SC innovation, it is important to first define the "*concept of innovation*." Flint and Larsson (2007:475) defined "*innovation*" based on different views. It could be viewed from a broad and a narrow perspective and it could be radical (new) or incremental. Normally, it is thought to only be radical and new for instance like the first computer and cell phone. The first firm or organisation to launch a radical product is known as an inventor, but there are a lot of innovations that are not radical and unique in some way. There are many failures in the marketplace with regards to innovation. The process of inventions may take years to develop and market. With regards to incremental innovations, it is not seen as an innovation, but forms part of a continuous improvement of something. There may also be a possibility of middle space innovations, where the innovation lies in between continuous improvement, incremental efforts and radical products or services (Flint & Larsson, 2007:475).

Now with a broader understanding of the innovation concept, SC innovation can be defined. Flint and Larsson (2007:477) defined "*SC innovation*" as innovation in products, services and processes that influence SCM. The power of SC innovation lies in process innovation because it is more difficult to be competitive through processes than products. SCM defined earlier, is mostly about process management, and by combining innovation with SCM bring about great potential to create competitive advantages (Flint & Larsson, 2007:477). Competitive advantages in SCM, will be described in Section 5.3. In management terms, "*process modelling*" forms an important part of any organization in terms of control of activities and management (Holt, 2009:3). Activities within an organization ranges from high level such as: "*mission statements, business processes and*

requirements," to detailed processes within an organisation, which may be carried out daily (Holt, 2009:3). Considering process modelling on the ISCP, may bring about advantages and will be discussed in Section 5.6.

SCM involves the management of areas described earlier and can also include the following, but are not limited to: transportation, inventory, warehousing, packaging, forecasting, network design, ordering procedures, customer service, and scheduling (Flint & Larsson, 2007:478). With regards to customer service, technology is one of the drivers for being innovative. Thus, the marketplace drives innovations in an industry. In the textile industry, it is very important to keep up to date with different technologies. One might think that a company that produces electronic devices would rather be a more obvious choice, the textile industry benefits a lot from technological innovations.

One other very important innovation that goes hand in hand with fast fashion and garment production is the quick response model. For instance, Zara, a Spanish apparel company uses the "quick response model" to sell sophisticated fashion at a middle-class consumer price, by developing new fashion collections faster than their competitors (Flint & Larsson, 2007:477). Thus, the quick response model could be SC innovation and will also be described in this chapter.

As described in Chapter 4, the processing of the cotton fibre into a garment requires different links in the SCs and could even form part of other SCs. The raw material could influence the quality of the end garment, and this can only be defined in a later stage of processing. Thus, high levels of traceability may have a positive influence on the SC and requires technology innovation. It would also be much easier to measure sustainability if a product is fully traceable. Sustainability innovations is important because historically, innovation was considered as an essential cause of competitiveness and success in a company or organisation. Currently innovation displays more to the direction and development of world economic as well as regional economic development (Gao *et al*., 2016). Which means that sustainable SC innovations become increasingly important for all the stakeholders in the SC, to work in a collaborative way, to influence the upstream and downstream transfer of sustainable information in the SC. Thus, the relationship between technology, traceability, sustainability, and innovation will also be described in this chapter.

5.2 The process of being innovative

There are numerous ways for innovation to develop but normally emerges in business from similar development processes or similar method of innovation development. With regards to new product development, a specific stage-gate process is traditionally used (Refer to Figure 5-2).

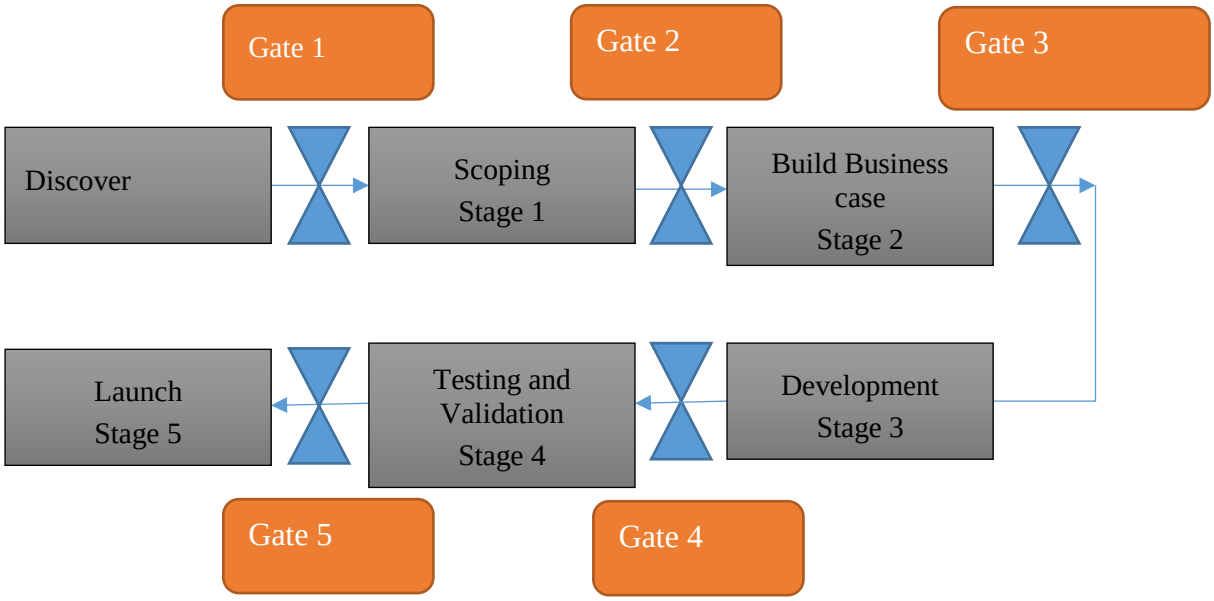

Figure 5-2. Product development stage model (Adapted from Flint & Larsson, 2007:481).

This stage-gate process and model, from idea through to launch, has been thoroughly studied by Flint and Larsson (2007:480-485). SCM is directed at services which support the movement of products by either SC partners, third party logistics enterprises or manufacturers. Thus, many SC innovations are characterised as a new service, which differs slightly from traditional product innovations (Kuczmarski & Johnston, 2005:92-94). Service innovations are thus intangible and are unique to customers. The stage gate process represented in Figure 5-2, begins with the identification of the need of the customer, or the problem at hand. This generates an idea and leads to screening, which then results into the development of a concept, a business, or an actual development. For the concept to be successful, it would then be important to test the idea before the product is launched. It is important for a service to be modified regularly, to adapt to the needs of the customer.

With regards to logistics innovation, in the idea generation phase, it is important to consider the continuity of social processes, which involves customer opportunities such as adding a stage for customer data capturing, customer clue gathering, negotiating of customer and marketplace information and inter organizational learning (Flint & Larsson, 2007:481). This model is a customer-driven process: thus, the market place would drive the innovations for this model. For clarity purposes, it is important to note that the need in the market was not created by the inventor, but the demand for a specific service was created by the inventor. The reason for this is to meet the need of the consumer. An important example that is applicable to this dissertation include

the customer relationship management software systems that allow the customer to specific information about the product or service (Flint & Larsson, 2007:482).

5.3 Competitive advantage

Competitive advantage could be defined as an advantage gained by a company, when it can provide a product that is lower in price, or who can charge more for a product at greater value, through product differentiation. Christopher and Towill (2002) suggested that the direction of competitive advantage, lies in the direction of the SC. They also suggested that it is not the companies that compete, but the SCs. SCs, explained in section 3.2, are involved in the flow of information, products, and money, thus the way they are managed is very important with regards to competitiveness. The reason for this is because a company's competitiveness is related to how the SC is managed, in fields such as the costing of a product, working capital requirements, speed to market etc. Thus, it is necessary to have a business strategy, that is suitable for what is required, to improve business performance (Perez, 2013).

Perez (2013) examined the different views of different authors, as to what SC strategy would be appropriate for a specific product or service. This author segmented this theory into two SCs, that are directed to different approaches. The one is directed towards efficiency and includes efficient-, fast-, and continuous flow SC models. The other is directed towards responsiveness which include agile-, custom-configured, and flexible SC models. Furthermore, a company's SC strategy is normally formed based on the correlation between the industry framework/market place, their unique value proposal/completive positioning, internal processes, and managerial direction. Firstly, an organisation would typically identify the factors that drives their business. Then only will they identify which SC model will best suit their company. As a rule, based on Perez's theory, a company should not apply simultaneous capabilities to one SC, even though organisations are trying to combine it. However, Perez (2013) stated that it could be possible to combine multiple parallel SCs within one organisation, that is directed to a single defined market sector with a cost framework and responsiveness position that is only suitable for the division it serves.

With regards to competitiveness and the clothing manufacturing industry, agility is one of the main drivers of competitiveness. Agile manufacturing forms part of SCs that are oriented to responsiveness, normally industries that have a very high uncertainty of consumer demand (Perez, 2013). Thus, a SC that is agile can produce products of very unique specifications, based on customer demand.

5.4 Quick response model and business model innovation

According to Fisher and Raman (2003) agile manufacturing, a SC strategy, is parallel to the quick response model based on its definition. Agile manufacturing could be defined as a manufacturing operation that could meet the unpredictable need of the consumer, in a very short lead time at lower production volumes and affordable price with high product quality (Perez, 2013).

Quick response on the other hand, is known as an apparel related initiative, which is designed to reduce lead times on manufacturing and distribution processes. This includes IT such as bar coding, improvement in logistics and improved methods of manufacturing (Fisher & Raman, 2003). Thus, the quick response model refers to a speed-to-market products such as apparel products which have the ability to move quickly through the production and delivery process which includes the raw material, component suppliers, manufacturer and retailer (including the end consumer) (Perry *et al.,* 1999).

Furthermore, the quick response model includes a structure, strategy and a set of operational methods that are intended to integrate businesses in one network or chain by means of a fast transfer of information to make a profit from it. As described in Chapter 3, the flow of information could be forward or backwards in a SC. For apparel goods, it is important to have bi-directional flow of information which brings about the innovation of quick response. Thus, in the quick response model there is an increase in velocity of information flow in both forward and backward direction (Christopher & Towill, 2002). Christopher and Towill (2002) highlighted the importance of partnerships in the SC to assure efficient flow of information. For instance, the retailer would not only communicate information back to the manufacturer, but to the textile producer as well.

Agile manufacturing is related to “make to order” products. This means producing products that the customer wants, to avoid the production of products that will not be sold at the end of the day (Perez, 2013). It is very difficult to know what the consumer wants if it is linked to fast fashion and rapid change in market space. One fashion retailer named Inditex, a Spanish apparel firm that manage a global brand, named Zara, managed to be agile, selling high end fashion products at reasonable prices, which could be afforded by the middle-class consumers (Flint & Larsson, 2007:477). Inditex has managed to develop an innovative business model. With regards to their Zara brand, they have managed to perform most of their common activities such as dying, cutting of fabric, washing, ironing, and ticketing - inhouse (vertical integration). In the case of outsourcing sewing operations, they only use workshops that are located nearest to their Spanish manufacturing facility (Amit & Zott, 2010).

Their competitiveness when compared to other companies in the apparel industry is high because they can produce new collections, much faster. Zara can produce a new collection within 3 weeks and deliver it worldwide, where the normal lead time is anything between 6- to 12-months. Inditex uses their innovative business model to rise above their competitors which has a stronger efficiency in product innovations and logistics. They manage to do so by relying on standard resources and off-the-shelf technologies to

communicate feedback from the retail shop to the design teams (Amit & Zott, 2010). Another interesting point is that Zara does not spend money on advertising, so customers must go in store to get updates on what is currently in store. This means that customers visit Zara store more than their competitors (Flint & Larsson, 2007:477).

Being responsive, agile, and having a quick response model in place also plays a big role in the sustainability of textile products. Less excess products are produced because the information will be communicated quickly if the demand of a certain product has reduced. Thus, this also forms part of innovation towards sustainability which will be discussed in Section 5.5.

5.5 Technology and sustainable Supply Chain innovations

The importance of technology in SC innovation is evident based on the information described in this chapter. According to the "*Global Market Report on Sustainable Textiles*," organisations in the apparel industry should use technologies that are available to be more resource efficient, minimize pollution, contribute to regenerative and closed loop processes and design products with longer lifespans.Furthermore, it is important to created technologies or improve on current technologies in order to be more sustainable. Flint and Larsson (2007:475) identified that for technological innovations to be effective and successful in the market place, it must be at a cost that are reachable for the consumer. There are numerous ways in which technology could contribute to sustainable manufacturing of apparel products. The type of technology and innovation would be dependent on where in the SC it needs to be applied, whether it is for the actual raw material, processing, manufacturing, distribution of the product, or for the flow of information. For instance, traceability forms part of a grey area in the fashion SC, because the actual raw material must go through numerous processes in order to create a finished garment, and it is very difficult to track and trace every single bale of cotton for instance to consumer point.

One system called BCI (explained in Section 4.4.2), created a system in August 2013, that has the ability to track and trace "*Better Cotton"*. It works on a mass-balance system, where the actual volume of sustainable product is tracked, but not the product itself. This means that starting at the ginner, the amount of BCI cotton that goes into the system, should come out of the system, regardless of its composition (if it is mixed with conventional cotton). Thus, it tracks the volumes of "*Better Cotton"* through the processing stages. This prevents traders from selling more "*Better Cotton*" than what went into the processes, to the yarn spinners (BCI, n.d). In this tracer system, they use Better Cotton Claim Units (BCCU's), where one kilogram of "*Better Cotton*" will be equal to one BCCU. As soon as all the BCCU are recorded into the system, the retailer can see how many units of BCCU went into one garment. The retailer could also trace the BCCU back to the yarn spinner, using the BCI tracer system. The BCI tracer systems allow the tracking of the movement of BCI cotton all over the world (BCI, n.d). This system proves to be successful, with regards to traceability, it could not be applied to other raw materials or conventional or organic cotton, which leaves room for improvement for future innovators.

Each link in the SC would normally have their own Enterprise Resourcing Planning (ERP) system in place. Even though the SC is connected, they would operate independently, and there may be numerous ERP systems in one SC. These ERP systems also form part of IT systems that are used in the apparel or clothing SC.

At the manufacturing and processing stage of the SC, technological innovations, may also occur. Typically, innovations would be directed to efficient use of energy and water or increased efficiency and speed on mechanical machines. More recent innovations included robotic or automated machinery that can operate independently in the manufacturing and processing process of the garment manufacturing (Fashionable Robots: Automation in Clothing Factories, 2016).

Tracing the impact of a product on the environment could be done by means of product carbon footprints (PCFs), ecological footprints (EFs) and Life Cycle Assessment (LCA), only to name a few. Doing LCA on cotton garment products with a specific design is very complicated because normally LCAs are done based on statistics and by region or by bulk production. It could however indicate the environmental as well as social impact of a specific sector (Roos *et al.*, 2016). This also applies to the EFs and PCFs methods which would be calculated over a period, using statistics. It is very difficult to trace the carbon footprint, life cycle etc. for one garment if it changes rapidly as fashion changes. This also gives high potential for technological innovations.

5.6 Business process mapping

Now with a better view and broader understanding of the cotton value chain, it is important to define how this integrated SC would be mapped or represented. Tangkawarow and Waworuntu (2016) suggested that due to an increase in business competitiveness, businesses started to optimize their existing business processes in a company. Hunt (1996:1-2) suggested that a very important management tool is BPM, that could be used to improve business performance. Furthermore, by analysing a business strengths and weaknesses of the business could be identified and improvements on weaknesses could be made (Tangkawarow & Waworuntu, 2016). Business process modelling is directed to represent some or all the different aspects, of delivering a service or product to either another organization or a customer, in order to create a united model (Aldin & de Cesare, 2009:3). According to Holt (2009:11) "*in order to produce an effective process model and description*" it is important to have "*a deep level of understanding*" of the methodology of process mapping. Thus, the following discussion would be to broaden the level of understanding of process modelling and mapping.

5.6.1. **Defining process modelling**

According to Holt (2009:3) "*process modelling*" is defined under different terms and labels which includes: "*business process modelling*," "*business process management*," "*business process re-engineering*," "*operations management*," "*process mapping"* and *"process realignment*." Holt (2009:3) defined above mentioned terms as follows:

i. "*Business process modelling*" is a "*process modelling exercise that is performed in order to enhance the overall operation of a business*" (Holt, 2009:3).
ii. "*Business process management*" involves the management and coordination of business processes, and will involve business process modelling.
iii. "*Business process re-engineering*" is "*used specifically when business process modelling is applied to existing processes as part of a business process improvement*" (Holt, 2009:3).
iv. "*Process mapping*" includes the linkage of different processes with one another which will form part of an audit.
v. "*Process re-alignment*" would typically be applied to current outdated existing processes, because of change in requirements for the process.

Above mentioned defined terms include the word "*process*" and it is important to define "*process*" in the BPM context. Holt (2009:4) concluded that the term "*process*" refers to a way of doing something that includes the doing of many activities. These activities would use or offer an artefact[17]. A single stakeholder is responsible for each activity.

Furthermore, there are various types of processes which include, but are not limited to, "*operational processes*," "*business processes*," "*financial processes*." Holt (2009:4) explained that a process could be applied differently which may include a "system," "artefact," "stakeholder," "model," "verification," and "validation." Holt defined above mentioned terms are defined as follows:

i. A system could be identified as any organisation or collection of entities, that collide to meet a set of requirements. A system could then be anything of the following: a person; a group; or a network of computers, mechanics or electronics.
ii. Artefacts could use or produce any activity or process.
iii. A stakeholder could either be a role played by a place or a person that has a particular interest in the project or the system. One person can have more than stakeholder role or one stakeholder could have a number of people's names against it. It is often that stakeholders are not people, but the role of a place, environment and organisations etc.

[17] Anything that is originates from a process or an activity or that is consumed by an activity or process.

iv. The term "model," derived from Unified Modelling Language (UML), which streamline reality. A model may be a diagram, equation, text or verbal description and/or physical model.
v. Verification applies to a phenomenon that works without error.
vi. Validation which applies to a phenomenon that meets the requirements of something.

The ISCP could also be a process, which could be applied to artefacts, stakeholders, systems, and models. With regards to process modelling the ISCP are involved with management, re-alignment, re-engineering, mapping, and modelling. This means that when referring to the term "*process modelling*" it may include all the above-mentioned terms.

A process could also take on many forms and shapes such as a set of guidelines, a work procedure, and a standard etc. The level of detail a process relates to is very important to define and it varies from very high-level process to a very low-level process (Holt, 2009:8). High-level processes include standards that are related to an industry and driven by the industry with no formal acceptance internationally or nationally (Holt, 2009:8). Medium-level processes includes internal company standards and processes. Low-level process includes internal procedures which will describe how a process can be implemented and there could be more than one way in which it could be implemented. Very-low level processes could be used to define "*guideline and work instructions such as best practise approach"* (Holt, 2009:8). It may also include techniques and methods which are internal or commercial approaches (Holt, 2009:8). For this research study with regards to the processes of the ISCP, low level processes will be included because internal processes of certain links in the SC would be described. Furthermore, the ISCP would also include very low-level processes which would describe a process for instance data analysis to convert the garment into cotton lint. There will also be medium level processes in the ISCP which includes internal company procedures to implement the ISCP.

5.6.2. **Different modelling techniques**

Processes have been modelled using different techniques which are mostly based on diagrams or visual techniques that represent processes (Holt, 2009:13). These techniques include but are not limited to the following: flowcharts; activity diagrams; "*Responsible," "Accountable," "Consulted," and "Informed*" (RACI) matrix tables; Business Process Model and Notation (BPMN). These concepts will be evaluated in terms of use, strengths, and weaknesses shortly.

5.6.2.1. **Flowchart**

A flowchart is a "*graphical modelling language*," which is used widely in processes (Holt, 2009:13). The graphical representation of a flowchart, provides the user a step-by-step interpretation of a specific circumstance or situation (Aldin & de Cesare, 2009:5). Even though it is seen as one of the basic types of diagram, it is often "*misused and poorly understood*" (Holt, 2009:13; Aldin & de Cesare, 2009:5). A flowchart's notation is recognized all over the world. According to Holt (2009:169) a flowchart notation is very flexible and has high value, which describe a process' behavior. Aldin & de Cesare (2009:6) concluded that flow charts are easy to use and to understand, and with regards to simulation, flow charts could be used as

underlying techniques. However, a flowchart notation has a single view, which could be applied to different abstraction levels, but due to this, the efficiency of process modeling is low and the model is incomplete (Holt, 2009:13,167). Another problem is that there is more than one version of the flowchart notations with variations of different symbols in different text books, standardized definitions and standards.

Even though flowcharts are easy to use and interpret it seems to have a limitation of only a single view, which would be undesirable for the ISCP to use this method of BPM, since the ISCP is intricate and complex and more options and linkages are needed for the ISCP.

5.6.2.2. **Activity diagrams**

According to Tangkawarow and Waworuntu (2016:9) "*activity diagrams are used to map workflows,*" which form part of the UML. The workflows may include steps, action and decisions, which are represented in a graphical manner (Tangkawarow & Waworuntu, 2016). According to Holt (2009:30) activity diagrams are used in low-level modelling where it is detailed, which means that it could be used in a business process where there is a discussion with customers in the beginning of development. Tangkawarow and Waworuntu (2016) indicated that activity diagrams are easy to interpret and understand, when modelled, even by a person with no technical background, and it is also illustrating clearly which activities should be performed by the outcome of decisions in the diagram (Tangkawarow & Waworuntu, 2016). When it comes to activity diagrams there are no criteria for an activity and it could be used for complex processes. However, it could be confusing if there is no distinction between activities. Unfortunately, activity diagrams could not be linked to actors or objects which will be preforming the actions (Tangkawarow & Waworuntu, 2016).

Activity diagrams would be useful to describe complex processes like the ISCP but it will be confusing if the activities could not be linked to actors since the activities are performed by different people in different organisations. It would be more beneficial for the ISCP to consider an alternative BPM.

5.6.2.3. **RACI matrix tables**

RACI exemplify "*Responsible,"* "*Accountable,*" "*Consulted,*" and "*Informed*" and RACI matrix tables are used to link the roles of stakeholders with process activities (Holt, 2009:13,12). This means that an activity within a process, may have many stakeholder responsibility and roles. The roles of the stakeholders include: responsibility, accountability, requires to be consulted-, and informed (Holt, 2009:13,12). However, this is just a basic table where there is a cross referencing between roles and activities and could be used in conjunction with flowcharts.

Even though the use of the RACI matrix table within the different organizations in the ISCP is important, it is not part of the integration process of the ISCP to define the roles and responsibilities of the stakeholders within the organizations, because the ISCP focus on integration within the different organization and there is a need to combine different aspects in one BPM. Thus, the RACI matrix table alone won't be efficient for the ISCP.

5.6.2.4. **Business process model and notation**

BPMN resulted from the business process modelling initative[18] (BPMI), which focus on the use of notations that are understood by many business users and includes UML (Holt, 2009:12). With regards to above mentioned modelling techniques, BPMN has higher semantic detail and represents the business process diagram (BPD) model. According to Aldin and de Cesare (2009:11) BPMN is a very powerful technique to use for designing business processes. It is also a well-controlled technique to model different aspects of a process in one organisation. BPMN also "*allows the representation of extended models for each process*," which allow flexible changes or modifications in any process within an extended model without changing the original model (Aldin & de Cesare, 2009:11). BPMN is easy to use and widely understood by technology and business users. BPMN is well defined and has a wide scope of different control flow and sequences, which allow inexperience stakeholders to use it. Because of the specialised notation, BPMN is a complex technique and creating a complete BPMN it is necessary to know all the notations (Aldin & de Cesare, 2009:11). It is important for the analysts and end users to understand the BPMN and it provides a platform for users to readily understand the business process. With regards to simulation, BPMN would support the development of simulation models and the technology of simulation could add value to BPMN (Aldin & de Cesare, 2009:11). The reason for this is, it allows users to visualise processes and its ability before it is implemented.

It is evident through the above the above-mentioned information that BPMN is the most suitable methodology for the ISCP since it allows a standardized notation, which could be understood by different people in different organisations. It allows high-level of detail to be modelled which is crucial for the ISCP. Since the ISCP includes different organisations it would be beneficial at a later stage to simulate the ISCP and BPMN would be a very good platform for simulation.

5.6.3. **Defining BPMN in order to apply to ISCP**

As mentioned in Section 5.6, in order to model an effective and efficient business model, the modeller should have a high level of understanding about the modelling technique. BPMN show the flow of a business process from end to end (Tangkawarow & Waworuntu, 2016). It has been designed to coordinate the flow of messages and processes between different participants which are related in activities (Tangkawarow & Waworuntu, 2016). The notations are categorised as follows: "*events*," "*activity*," "*gateway*," "*swim lane*," and "*artefacts*." These categories will be described in detail shortly. A full summary of above mentioned categories with the relative explanations appears in Appendix B, Table B-1.

[18] BPMI was developed to provide a standardized notation, that could be understood by different business users and to visualize various business languages.

5.6.3.1. **Events**

An event is represented by a circle, which indicates the start of a process (Tangkawarow & Waworuntu, 2016). An event will trigger the flow of a process or will have an impact or result. The symbols are circles with open centres and has a start, intermediate and end. The different notation symbols could be seen in Appendix B, Table B-1.

5.6.3.2. **Activity**

An activity is used to represent the work performed in a company, and is normally "*represented by a rounded-corner rectangle*" (Tangkawarow & Waworuntu, 2016:5). There are different activities which could be either non-atomic compound or atomic and are listed as follow: a task or a sub-process. A task will typically represent one unit of work which are not broken down to another level of business process detail, but a sub process is used to hide or reveal more in-depth detail of business processes (Tangkawarow & Waworuntu, 2016). When a sub process is expanded, it would then show the flow objects, connecting objects and artefacts. With regards to the sub process it has its own start and end event and the flow sequence from the initial process cannot cross boundaries (Tangkawarow & Waworuntu, 2016). There is more than one type of activity which could be seen in Appendix B, Table B-1.

5.6.3.3. **Gateway and object connectors**

A gateway is used in order to show the forking and merging of different paths and are "*dependent on the conditions expressed*" (Tangkawarow & Waworuntu, 2016:6). Objects are connected by means of a connecting object/symbol and could be defined as sequences, messages, and associations (Tangkawarow & Waworuntu, 2016:7). A sequence flow symbol would be used to show the order in which a process would be performed and is represented with a solid arrowhead (Tangkawarow & Waworuntu, 2016:6). At the start of the sequence flow there may be an object and on the end of the line represented by a diamond, would indicate conditional flows from an activity. When a diagonal slash is added to the sequence flow it means that it is a default flow from an activity or a decision that has conditional flows (Tangkawarow & Waworuntu, 2016:6). It is important to note that it is not a gateway. A message flow is added to show message flow across organizational boundaries (across different pools) and are represented as a dashed line with an open circle at the beginning and an open arrowhead at the end (Tangkawarow & Waworuntu, 2016:6). It is also used to show the flow of messages between different process participant or business entities that will send or receive them (Tangkawarow & Waworuntu, 2016:6). The notations for above mentioned appears in Appendix B, Table B-1.

5.6.3.4. **Associations**

An association is used to associate a text or an artifact to a flow object, which are represented by a dotted line, and also indicates direction to some extent with an open arrowhead (Tangkawarow & Waworuntu, 2016:6). If the arrow is directed towards to artefact, it indicates a result of a process and if it is directed away from the artefact it would indicate an input of the process. If it is directed to both ways it indicates that it has been read and updated (Tangkawarow & Waworuntu, 2016:6). The notations of associations could be seen in Appendix B, Table B-1.

5.6.3.5. **Pools and swim lanes**

The concept of swim lanes has been used by many process modeling methodologies, and it is an instrument that could be used to coordinate activates, into different categories with the purpose to demonstrate various functional responsibilities (Tangkawarow & Waworuntu, 2016:7). There are two types of BPD swim lanes in BPMN which includes a pool and a lane (See Appendix B, Table B-1). A participant in a process is represented in a pool and a pool will also act as a container in order to divide a set of activities from other pools (Tangkawarow & Waworuntu, 2016:7). A lane act within a pool where it is a sub-section in the pool, which will continue the whole length of the pool, either directed vertically or horizontally. A lane is normally used to classify and arrange activities (Tangkawarow & Waworuntu, 2016:7).

5.6.3.6. **Artefacts**

In order to provide some, extent of flexibility on basic notation BPMN was designed and artifacts could be added to a diagram in context of the business process, that is being modeled with no limit in the number of artifacts (Tangkawarow & Waworuntu, 2016:7). Tangkawarow and Waworuntu (2016:7) identified three specific types of BPD artefacts as a data object, group, and annotation. A data object is a way to show how specific data is produced or required by an activity. Associations are used to connect data objects to activities. A group could be used for grouping purposes to document or analyse something but it will not affect the sequence flow (Tangkawarow & Waworuntu, 2016:7). An annotation could be used to provide additional information via text to the BPMN diagram viewer (See Appendix B, Table B-1 for more information about the notations) (Tangkawarow & Waworuntu, 2016:7).

5.6.4. **Strengths and weaknesses of BPMN**

The process flow in BPMN is easy to understand. It allows gaps between technical and business system personnel to be filled and could be applied to very complex activities or to smaller activities. It is an easy skill to find without paying for it. A weakness is there may be some confusion in the BPMN because there is more than one way to model the same process, which may have different variations in the notations (Tangkawarow & Waworuntu, 2016:8).

5.6.5. **Important aspects to consider in process modelling**

Process modelling and processes could be very complex, which have a negative effect on the world of process modelling. Factors such as lack of understanding and poor communications could also attribute negativity towards process modelling. Other issues which should be considered is the length of descriptions which should not be too long[19] , or for that matter too short[20], since it may impact the quality of the process (Holt, 2009:9). Other issues include: whether or not it was written by a committee since view and opinions of different individuals differ; and if there are too many process models that are related or relying on one another which makes it difficult to understand (Holt, 2009:9). Sometimes a process model could be unrealistic which have insufficient connection to reality and may cause difficulty to execute or maybe it could be uneconomical to apply the process model to the real world (Holt, 2009:9). Language could also be a barrier if the written process model is not in the language of an organisation, lack of awareness of a process can be a problem since if it is printed and left on a shelf but no one is aware of it the process will only sit on the shelf (Holt, 2009:9). Thus, getting the process to the correct person would be the key for successful implementation. “Fear of failure” is a common issue, where a company may have tried it in the past but did not work (Holt, 2009:9). This doesn’t mean with improvements it will never work (“practice makes perfect”). A person or organisation’s perception about a process is very important because as mentioned, lack of understanding, due to lack in education for instance, will impact it negatively (Holt, 2009:9).

It could be concluded that the problems associated with process modelling may not be because of weakness in the process modelling itself but it may be due to inadequate level of understanding, effort, and commitment that it might fail.

[19] the length of the description of several hundreds of pages could be off putting, even-though its well written
[20] the simplicity of the process may appear to be so if it is only a few pages but often is not the case, since some standards or process may apply to different applications and short pages may cause ambiguity

5.7 Conclusion

SC innovations in the textile and apparel industry are growing every year. Since the need for sustainable manufacturing is becoming increasingly important, companies in the clothing sector will start to be innovative in order to keep up to date with new technology and trends. Following the process on being innovative could aid companies to innovate, keeping in mind that the correct SC strategies should be applied for their need. Even though the quick response model proves to be very effective and efficient in the clothing industry, other factors should be considered as well that are unique to each company in the clothing industry and should not be seen as the norm in the clothing sector. The success rate of the quick response has proven to be very high but it is very important to not assume that it would always be successful. Analysing the current situation of a SC should be taken into consideration when applying the quick response business model to any company. Technological innovation in the clothing and apparel sector is important to incorporate in a SC to keep being competitive. Furthermore, after analysing different BPM methods, it is concluded that BPMN would be used in order to map the ISCP process and to add value to the value chain in Chapter 6.

6 The ISCP designed for the sustainable retail Supply Chains

This chapter outlines the first data collection, analysis, and discussion. The chapter outlines the following: the ISCP process, which was conducted through the collection and analysis of secondary data from company X, the BPMN of the ISCP, and implementation of the ISCP which was implemented trhough the use of primary data. Furthermore, this chapter outlines the results and discussion of the BPMN process as well as the implementation of the ISCP. Figure 6-1 provides more information on the chapters focus and the stage that is currently being addressed in the research process.

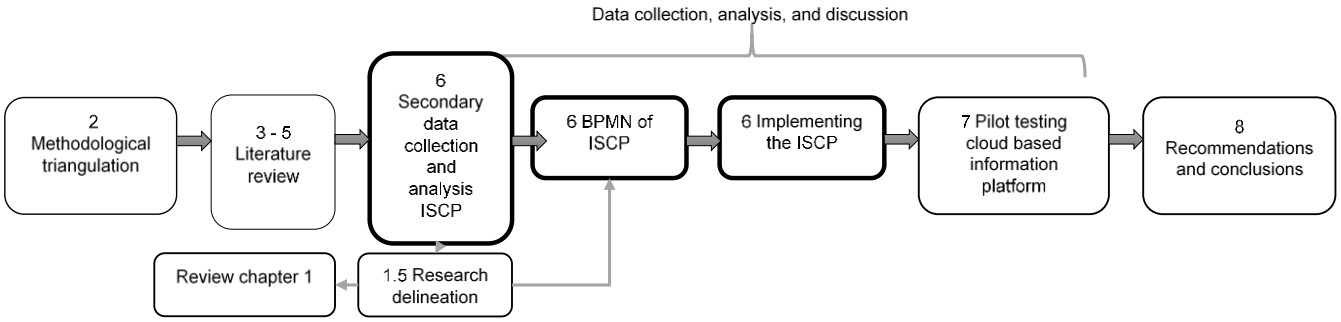

Figure 6-1. The first data collection, analysis and discussion chapter outline of research structure, with regards to the ISCP chapter.

6.1 Introduction

The importance of balancing the TBL in the apparel industry was highlighted in previous chapters. The cotton garment manufacturing industry is related to fast fashion and dependent on the quick response model, thus SC innovation is very important in this market sector. Furthermore, according to De Wet (2017) there is a major shift in consumer demand towards locally sourced, suitable, and socially responsible products. To achieve the above-mentioned points, SCI of the cotton garment manufacturing sector will be highly beneficial. This allows retailers to apply virtual integration to their SCs.

The ISCP will be supported by a CBISP to track and trace products from the farm to consumers, which will be explained in further detail in chapter 7. The ISCP will serve as a basic information platform which will be used to improve business processes and the data obtained through the implementation of the ISCP will be used to test the CBISP. This programme will further support the implementation of a quick response capability for the retailer where the business model will focus on creating the required capacity up to the greige fabric level to allow for quick response at *dyeing*, *printing* and *CMT* level. Thus, this chapter outlines the process of virtually integrating a cotton-focused apparel SC through the use of BPMN to map the various processes that are executed through the design development and improvement of the ISCP. The ISCP was tested in a pilot study in 2015 by one of the leading apparel retailers (together with company X and the sustainable cotton

cluster) in SA, but it was not combined with the newly developed CBISP at that time. Since the first implementation of the ISCP, changes and improvements occurred in order to increase efficiency. This ISCP, could also be seen as SC innovation, which allows users to: mutually share information with full SC transparency; build partnerships; remove inefficiencies, and optimize the SC whilst implementing sustainability strategies.

The outlined BPMN for the implementation of the ISCP process was done in order to successfully integrate an apparel SC for the current retailers, and in order to ensure repeatability of the process for future retailers that may want to implement the ISCP. Chapter 5 explained essential processes with regards to the ISCP innovation process and the role of BPMN in the implementation of the ISCP (discussed in Section 5.6). There are five different steps in the ISCP, which include: design concept, mapping of the SC, planning, preparing for implementation (includes testing of samples etc.) and lastly the implementation of the programme. This formed the basis of the business process in order to integrate the cotton SC. The ISCP consists of multiple sub-processes which will trigger multiple business processes within different organisations which are dependent on each other. Each sub-process and the various levels of detail within these processes are discussed in this chapter and the flow of information, messages and data is illustrated in the BPMN discussed in Section 6.2.3.

Thus, in this dissertation the pilot study will include the testing of the CBISP's integration with the whole ISCP, which is referred to in more detail in chapter 7. The previous pilot study that was implemented followed a very specific timeline, in line with the real-world events and constraints, therefore the implementation of the cotton ISCP for this research will follow a similar timeline due to the ISCP operating under "real-world" conditions. The implementation of the ISCP will be in the second year of implementation since it was tested previously and improvements could be made to the ISCP based on previous outcomes. There is a need for data coding to protect the integrity of the data as well as the anonymity of the participants in the ISCP. The ISCP is managed by company X, where they will typically work very closely with all the value adding parties within a brand/retailer and as well as with the South African Sustainable Textile and Apparel Cluster (SASTAC) service providers.

6.2 Data collection and description: BPMN for the ISCP

The integration and implementation of an ISCP is a complex task with much data that needs to be collected, processed and analysed. Thus, secondary data described in Figure 6-2 was obtained from company X, which was used to define and describe the implementation process of the ISCP. The development of business process will improve the implementation of the ISCP. The ISCP is suggested as a guideline to what information/data that needs to be extracted for pilot testing the traceability platform. The data integrity is highly reliable because the ISCP was piloted/tested and implemented by one of the leading clothing retailers in SA. Furthermore, the availability of validated secondary data, also strengthened the reason for using this data.

The secondary qualitative data obtained from company X, will be the ISCP process, which will be revised and analysed to identify key concepts and processes, in order to apply business mapping to the ISCP.

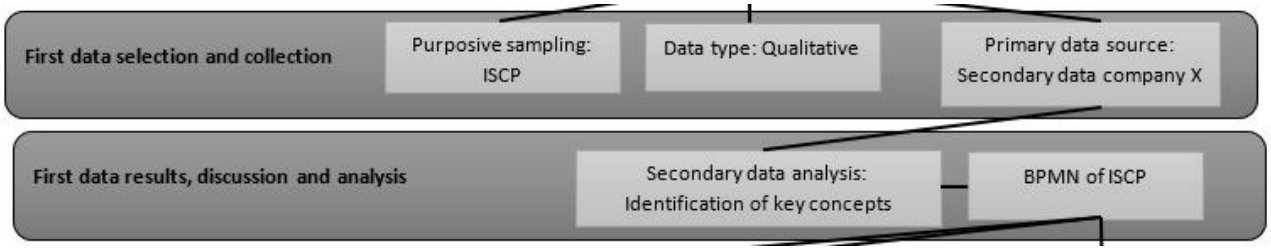

Figure 6-2. The first data set used to map the business process of the ISCP.

BPMN was not done in the previous pilot study. Thus, the information described below has been reviewed and edited in order to optimize the functionality of the ISCP.

6.2.1. **Overview of BPMN**

There are a number of version of BPMN, which include: BPMN 1.0, BPMN 1.1, BPMN 1.2 and the latest version BPMN 2.0, released in 2011 (Chinosi & Trombetta, 2012). BPMN 2.0, differs from previous versions, with regards to the addition of new characteristics, and changes in element properties. The recent version also improves the effectiveness of the methodology and broadens the scope as opposed to the previous version BPMN 1.2. BPMN 2.0 expands both process model and graphic mechanisms, and it also improves event correlation and content. It also "*extends the definition of human interactions*" and "*defines Choreography and conversation models*" which allows better modelling interactions and resolves inconsistencies and uncertainties that occurred in BPMN 1.2 (Chinosi & Trombetta, 2012:127). BPMN 2.0 allows the modeller to model different processes such as public businesses, internal business processes and private non-executable processes. Another very useful difference is that data is not part of the artefacts anymore, but form an independent element category which include input and output data, data collection objects, storages of data and messages (Chinosi & Trombetta, 2012:127). Therefore, based on these improvements BPMN 2.0 is the preferred version with which to model the ISCP business processes.

Due to wide availability of free online versions of BPMN 2.0 and limited funds for buying a licenced programme, the researcher decided to use an open source online version, created by Cambodia and contributors (Cambodia BPM, 2017). Even though the online version has some limitations it allows sufficient support and is used in this research study.

6.2.2. Defining the ISCP

The ISCP is a business practice that ensures delivery of products that are traceable, with improved integrity by means of SC optimization. Traceability is ensured through full SC transparency and visibility. SC optimization on the other hand is accomplished through business operations. The main objective of the ISCP is to develop a successful business model, which will effectively integrate the entire cotton industry value chain, from farm to end-user.

The main aim for the business model is as follows:

i. To aid in forward planning and long-term contracting in order to ensure the products meet the market demand,
ii. To provide SC transparency and integrity to ensure market credibility and retain the customers trust,
iii. To improve local sustainable sourcing,
iv. To ensure SC traceability in order to protect the integrity of sustainable claims as well as measuring the programme impact,
v. To improve the local price point for SC members, and
vi. To create long term partnerships amongst SC stakeholders and service providers to ensure scalable solutions.

6.2.3. Data analysis and discussion: Identifying key concepts of ISCP.

The ISCP is scoped in five different steps form the secondary data, obtained from company X, which is used as a baseline and represents the primary process in the BPMN, it includes the following:

i. A design programme concept
ii. Mapping of the SC
iii. Planning
iv. Prepare for the implementation of the programme
v. Implement programme

Each step is considered a sub-process, with different tasks associated with each sub-process. These tasks will be defined in the BPMN in Section 6.2.3.1. These activities can be linked to more than one role player, with flows of information between the different stakeholders, participants or organisations. With BPMN in mind, it would be important to define who the different stakeholders, participants or organisations are in the ISCP.

From the five steps mentioned above, the following stakeholders are defined in the ISCP:

i. Company X as the driver and manager of the ISCP,
ii. Retailer as the demand driven participant of the ISCP,
iii. Fabric manufacturer or tier-one supplier which may include the CMT, printing and design of garments,
iv. Yarn spinner to manufacture yarn for the fabric manufacturer, and
v. Cotton gin to sell cotton lint and fibre to yarn spinner.

The ISCP process integrates the flow of information and messages to and from the different stakeholders, participants or organisations. The main flow of information between different organisations or participants is related to price or costing and demand forecasts. There is a constant movement of information and messages between the stakeholders which means each stakeholder will be mapped as an individual "swim-lane." Therefore, the BPMN process is initiated with only one swim-lane, which is company X because they are the driver of the ISCP. This swim lane categorizes all the tasks related to the ISCP steps. By doing this, the tasks within different organisations and how they need to be connected, are defined. For more information about the notations used in Section 6.2.3.1, refer to Appendix B, Table B-1.

6.2.3.1. **BPMN 2.0 of the ISCP**

The ISCP process, is managed by company X, and thus the ISCP sub-processes are mapped in one swim-lane within the pool (the pool consists of all stakeholders involved in the ISCP process). As mentioned in Section 6.2.3, there are five steps in the ISCP process. Each step is separated with a decision gate, which will allow any participant in the ISCP to make an informed decision as whether or not they want to continue with the ISCP or discontinue the process. The steps form part of the ISCP process in BPMN 2.0 as sub-processes, and because of the high level of complexity, associated with each step, the steps are represented as collapsed sub-processes in Figure 6-3. Each step or collapsed sub-process is separated by decision gates. There are only two decision gates in Figure 6-3, namely complex and exclusive gateways. The reason for choosing complex gateways between some of the steps in the ISCP, is because it is associated with or dependent on more than one participant and there is more than one decision gate. The only decision gate represented as an exclusive gateway in Figure 6-3, is between the SC *mapping* and *planning* stage. The reason for this is because during the mapping stage the suppliers are required to sign a Non-Disclosure Agreement (NDA) which may influence their decision to become a part of the ISCP or not.

The reason for using an exclusive gateway is because it is based on one condition, in this case, the signing of the NDA, which is crucial in order to move to the next step. The same goes for the complex gateways in Figure 6-3, signing of important documentation is crucial in order to move on to the next step.

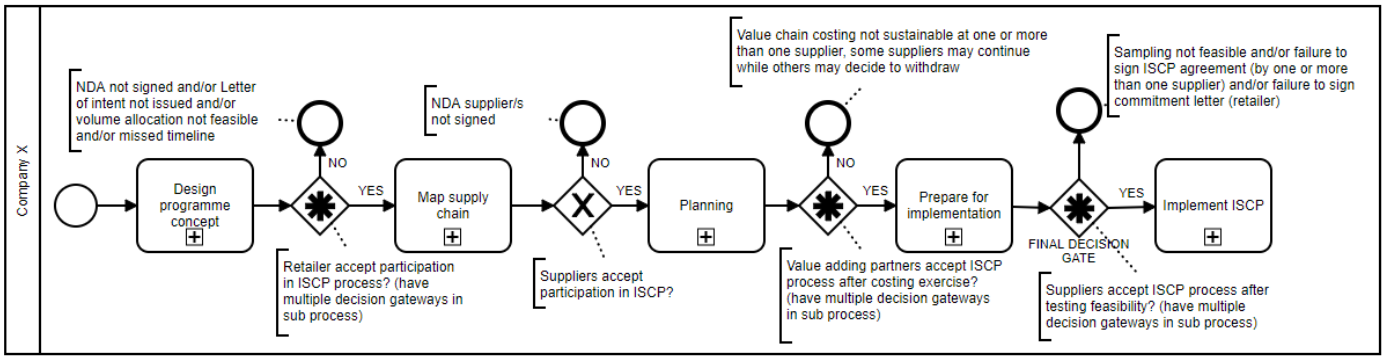

Figure 6-3. BPMN 2.0 for the ISCP process, managed by company X.

The final decision gate is between the "*prepare for implementation*" and "*implement*" step, where participants sign a particular agreement which is binding, and when the ISCP is implemented there is no turning back. Even though no time constraint is added to Figure 6-3, the ISCP operates within a certain timeframe. A full description of the timeline associated with the ISCP can be seen in Section 6.2.4. A description of all the BPMN symbols, used in Figure 6-3, could be seen in full detail in Appendix B, Table B-1s.

6.2.3.1.1. **Design programme concept sub process expanded**

The design programme concept sub-process expanded from Figure 6-3, is divided into two different swim lanes, consisting of two stakeholders - Company X and the retailer. There are a number of interactions between the two swim lanes in the form of information and data flows. Normally the personnel responsible for managing the design programme concept in company X would be the ISCP account manager and ISCP account executive. The account executive would be responsible for most of the high-level interaction such as introducing the ISCP to important stakeholders, whereas the account manager would manage the process and offers support to stakeholders and to the account executive where needed. Personnel involved with the retailer depends on previous engagements and existing partnerships. However, management, such as the CEO and internal division managers play an important role in introductory meetings and establishing relationships between all stakeholders. However, due to the limited availability of these stakeholders, it is not always possible to engage with these stakeholders in the design programme step. But it is important to get as much support from personnel in the first meeting so that the concept can be introduced to management at a later stage. The company X pool has one swim lane with an expanded sub process defined as the design programme concept. The retailer pool also has one swim lane with an expanded sub process associated with processes only related to the ISCP, specifically the *design programme concept*. It is important to note that the retailer pool does not include other internal business processes in Figure 6-4.

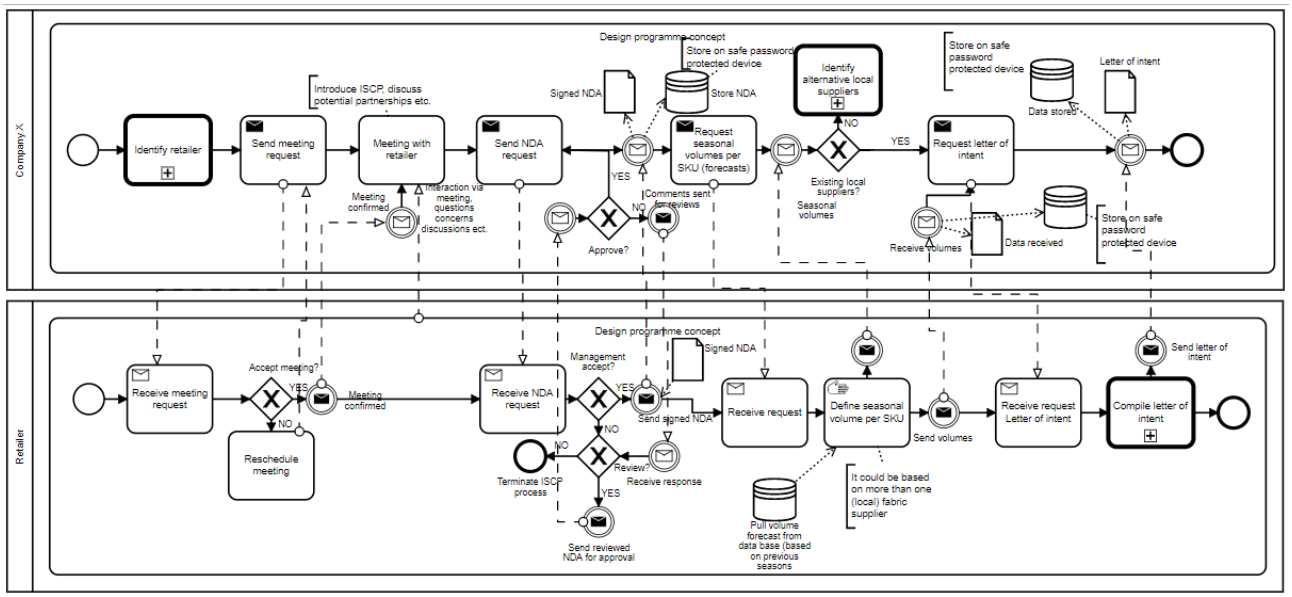

Figure 6-4. Design programme concept sub process expanded from ISCP process.

The relationship between the flow of messages, information and data between company X and a retailer is illustrated in Figure 6-4. The very first step in the *design programme concept* step, would be to identify a key retailer to involve in the ISCP process. This is mapped as a call activity, because the identification of the retailer would not form part of the ISCP process but would be done internally within company X. Building partnerships and networking is done internally and is based on previous partnerships, existing contracts, programmes and involvements with specific retailers. From this network, a retailer who wants to be involved in the ISCP, is selected. Flows of messages between company X and the retailer would allow a meeting to be set up, with the goal to introduce the ISCP to the retailer.

During the introductory session the retailer will have the opportunity to ask questions and raise concerns with regards to the ISCP. Before any organisational information can be disclosed, a NDA must be signed to protect the integrity of information shared in the ISCP process. Without signing a NDA, the process cannot be completed. The retailer has the ability to review and request changes to the NDA to suit their own internal needs as long as it stays within the scope of the ISCP. When the NDA is signed by both parties, confidential information could be requested from the retailer in order to continue the ISCP process.

The very first set of data, required from the retailer, would be the coming year's seasonal forecasted volume indication per stock keeping unit (SKU). Seasonal forecasts include spring, summer, autumn and winter. The request could be done via email and it is important for the retailer to identify who the tier-one supplier or fabric manufacturer will be per SKU. Normally the risk is split between more than one fabric manufacturer and for the ISCP it would be beneficial to choose fabric manufacturers that are already part of the retailer's value chain. It is also important to include fabric manufacturers that are reliable, with high forecasted volume indications. The forecasted volumes are based on demand and trend forecasts, and previous seasonal volumes. The reason for requesting volumes is to have some understanding of what volumes are anticipated for the next 12-months, in order to support the planning for the coming season. Furthermore, it would be important for the

retailer to choose local fabric manufacturers. If no partnerships exist with local suppliers, then there would be a need for local suppliers to be introduced to the retailers SC and value chain.

In order for further SC engagement to continue, a Letter of Intent (LOI), is to be compiled by the retailer, which states the intentions, commitments and involvement of each stakeholder in the ISCP programme. A request to compile LOI would be sent to the retailer, which is to be compiled by the retailer. In terms of the BPMN, this would be an internal call activity, as seen in Figure 6-4. All the data received in the design step, needs to be stored, on a safe, password protected device, with the necessary information back-up in place. It is important to note that the forecasts volumes indicated in the design stage, may change during the course of the ISCP, and that this information should be treated as highly confidential. For more information with regards to the BPMN, refer to Appendix B, Table B-1.

6.2.3.1.2. **Supply Chain mapping**

The sub-process expanded from Figure 6-3, namely the *SC mapping step*, has a number of higher level interactions amongst SC partners when compared to the *design programme step*. There are four different pools with relative swim lanes in Figure 6-5, which include: company X, the fabric manufacturer, the yarn spinner and the cotton gin. These are different organisations, which operate independently from one another. The flow of documentation, data and information between these four pools with respective lanes could be seen in Figure 6-5. The personnel, from company X, who are responsible for the execution of the *SC mapping stage* include: the ISCP account executive and the ISCP account manager. The engagement with personnel in the fabric manufacturing SC would typically be done by the managing Director or CEO of the fabric manufacturing company, with an internal technical team offering support to the ISCP process.

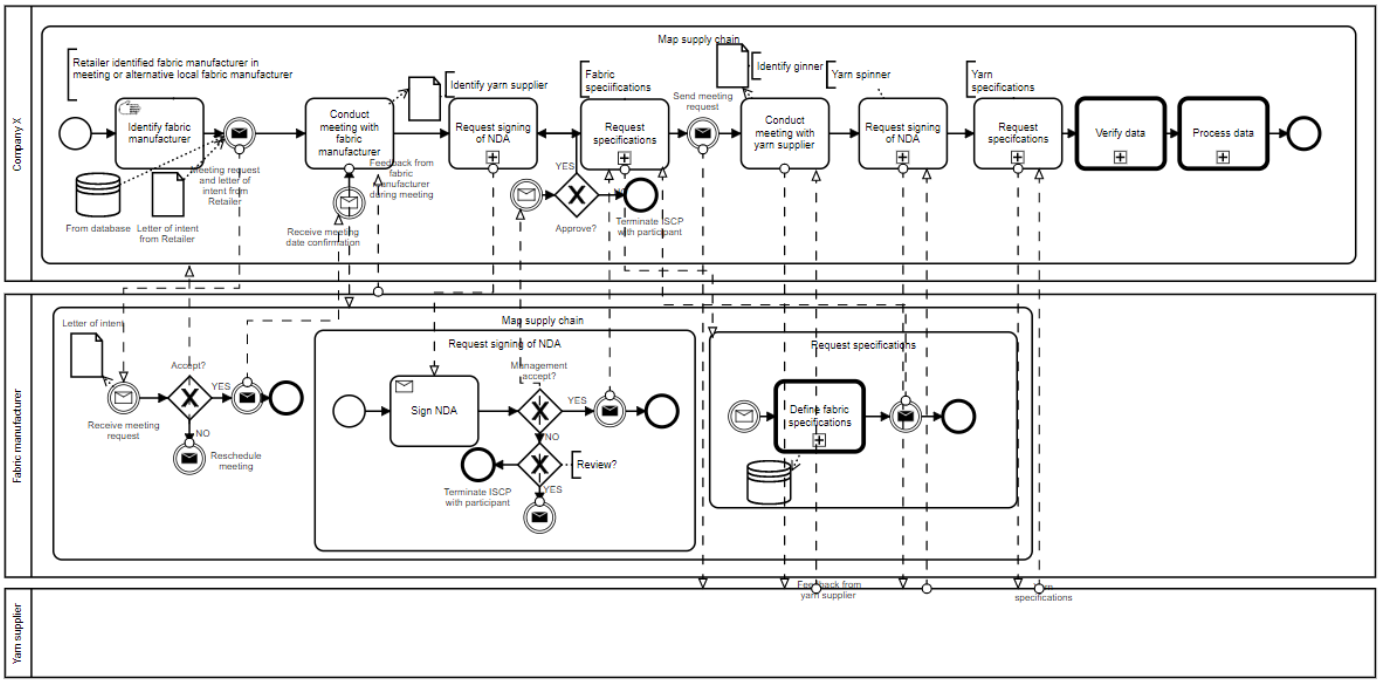

Figure 6-5. Map SC, sub process expanded from ISCP process.

The next step in the mapping of the SC is to identify who the local first tier-supplier or fabric manufacturer will be. Ideally it should be an existing fabric manufacturer in the retailer's value chain in order to minimise the risk of adding a brand-new participant into their value chain. However, there may be local retailers with limited or even no local fabric manufacturers, and in this case, company X would offer support to identify an appropriate local fabric manufacturer in order to fulfil the need of the retailer. In this case there should be sampling added to the ISCP process in order to test the feasibility of adding the fabric manufacturer to the SC, since the new manufacturer and the retailer have not worked together before. A meeting with the fabric manufacturer would be essential in order to introduce the ISCP process to them and as discussed in Section 6.2.3.1.1, a LOI from the retailer is necessary. The LOI reflects a written commitment from the retailer to the ISCP programme. Ideally there would be a volume commitment in terms of a certain number of garments, for example: 5 million white T-shirts, over the period of 12-months (not specific to SKUs). It is crucial for all

participants in the ISCP to sign a NDA in order to protect the confidentiality of all the information shared during the ISCP process.

Determining the actual cotton lint volume needed, before planting starts would require high level integration of the whole of the retailer's SC. Conducting introductory meetings with the yarn spinner as well as the ginner would also be important. The yarn spinner would be identified by the fabric manufacturer, where only local yarn spinners would be used for the ISCP process. As mentioned with regards to the fabric manufacturer, alternative spinners can be identified, with the help of company X, if there is no existing local yarn supplier in the SC. After all the NDA's with relevant parties have been signed, product specifications based on the initial forecasted SKUs identified by the retailer should be defined. A SKU needs to be translated into a specific fabric, which is then translated into a specific yarn or number of yarns. The yarns are then translated into cotton lint grades. Normally the retailer should know the fabric specifications, however it is important to verify the data's with the fabric manufacturer. The same goes for the yarns used in a specific fabric, verifying this with the spinner is essential. The selection of cotton lint grades for specific yarns is complicated since the spinner uses a specific mixture of grades to spin a specific yarn. The selection could be split into two different groups where some of the grades are selected from open-end spun yarns and others form ring spun yarns (See Appendix D, Figure D-1 for specific details). The data is processed by means of mathematical calculations and conversion factors to calculate a bulk cotton lint volume for all the defined SKUs. The calculations are done by the data analysist in company X. The complete BPMN process of the SC mapping stage in the ISCP can be seen in Figure 6-5.

6.2.3.1.3. **Planning the ISCP**

The *planning* phase is more complex than the *SC mapping* phase. There will be a flow of information, data, and documents between all the participants in the ISCP. The sub-processes, (refer to Figure 6-7 and Figure 6-8), further define the process described in Figure 6-6. In order to assist the *planning* phase of the ISCP, a planning matrix is compiled by company X's account manager, which includes: document control, timelines, personnel responsible, and a RACI chart.

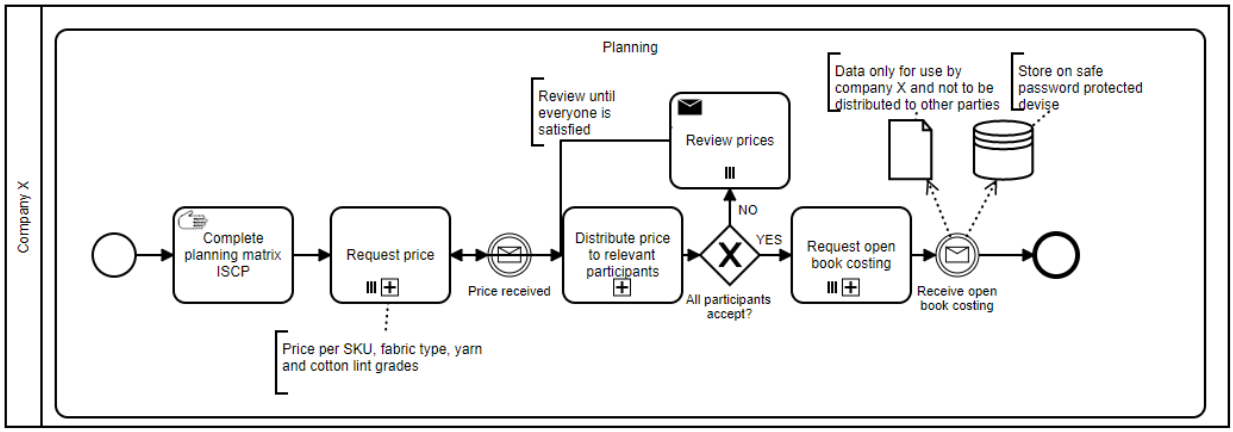

Figure 6-6. Planning, sub process expanded from ISCP process.

The costing exercise process can be seen in Figure 6-7, with an open costing exercise illustrated in Figure 6-8. Company X does negotiations, on behalf of relevant participants in the retailer's SC. Again, it would be the account manager's responsibility to ensure that the pricing exercise is executed. The personnel included within different organisations in Figure 6-7, would typically be, but not limited to the sales executive, sourcing managers, buyers; sellers etc. It is important to note that in retail, there may be more than one department linked to a SKU, therefore there will be engagement with more than one sourcing specialist, for instance: ladies wear, kids wear, men's wear etc. Further down the retailers SC, there will be less personnel involved than in the retailer pool. The costing exercise in the ISCP is done well in advance of actual orders. The price negotiations are coupled to the estimated and calculated volumes in Section 6.2.3.1.2. The distribution of the cost per garment, fabric, yarn and cotton lint grades are distributed by company X to the relevant parties. The price agreed upon in this process is fixed for 12-months. Open book costing is only done between company X and the links in the SC (See Figure 6-8).

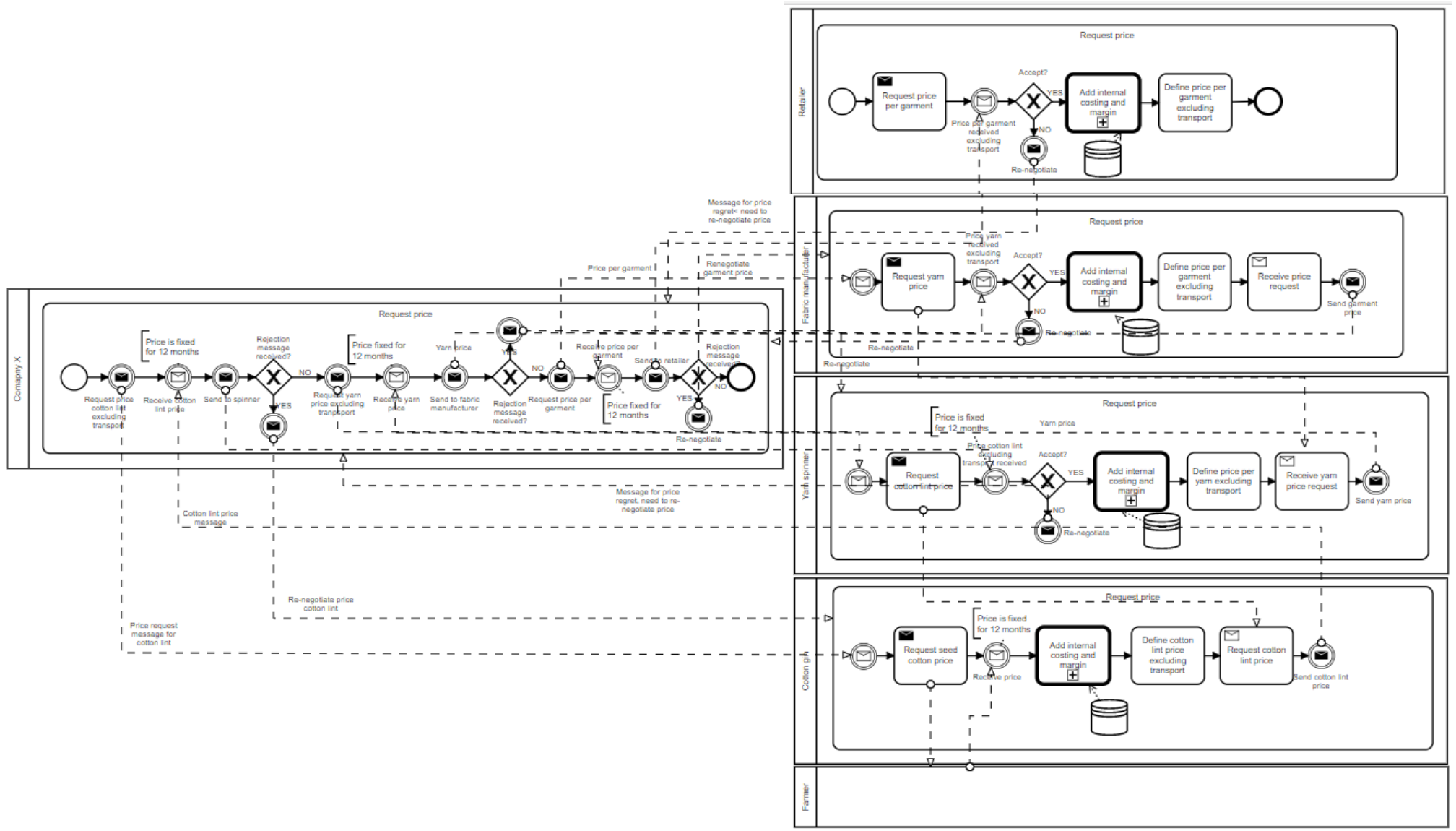

Figure 6-7. Request price, sub process expanded from ISCP planning process.

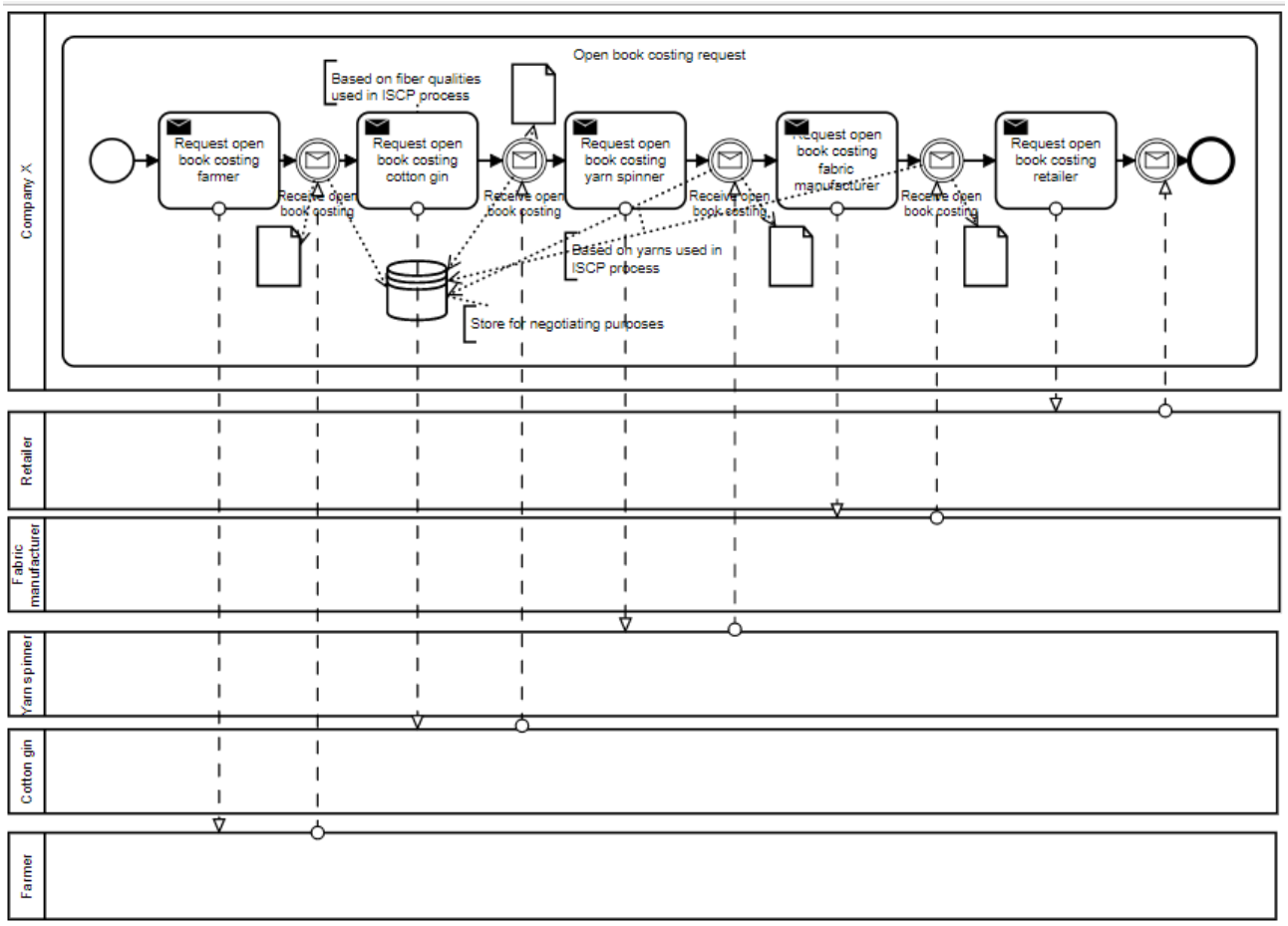

Figure 6-8. Open book costing request, sub process expanded from ISCP planning process.

The data used in the costing exercise should be stored on a safe, password protected device, and should not be distributed to the different participants in the ISCP. The open book costing would typically include the following information: raw material cost; waste costs; transport cost; facilities; utilities; finance costs and margin. This information is very useful in negotiation processes, because it allows transparency in the costs and aids in the bargaining process, in the sense that 'all cards will be on the table' and it will allow the buyer to have a better understanding of the seller's situation. This allows for all the links in the SC to make a sustainable margin and be competitive. However, when referring to transparency of costs, this does not mean that all the links in the SC would have access to participant costing information. For example, fabric manufacturer A and B will not have access to each other's costing information. However, both manufacturers will need to have more information with regards to the spinner's costing information, for negotiating purposes, since both buy from the same spinner. The same goes for sharing information with regards to volume indications. The line of sight should be selected to only participating partners, meaning both the buyer and the seller can share valuable information and the further downstream, the higher the line of sight would be. The closer to the upstream partners, the more selected the line of sight needs to be.

6.2.3.1.4. **Prepare for implementation**

Preparing for implementation is a vital stage in the ISCP process. The final decision gates are present in the *prepare for implementation* stage. The involvement off all the participants in the ISCP is crucial and therefore all the participants are added as separate pools in Figure 6-9. The account manager is responsible for the *prepare for implementations* step with the data analysist and account executive as support and other responsible personnel includes: managing directors, technical personnel, buyers and sellers from the retailer, fabric manufacturer, yarn spinner and ginner.

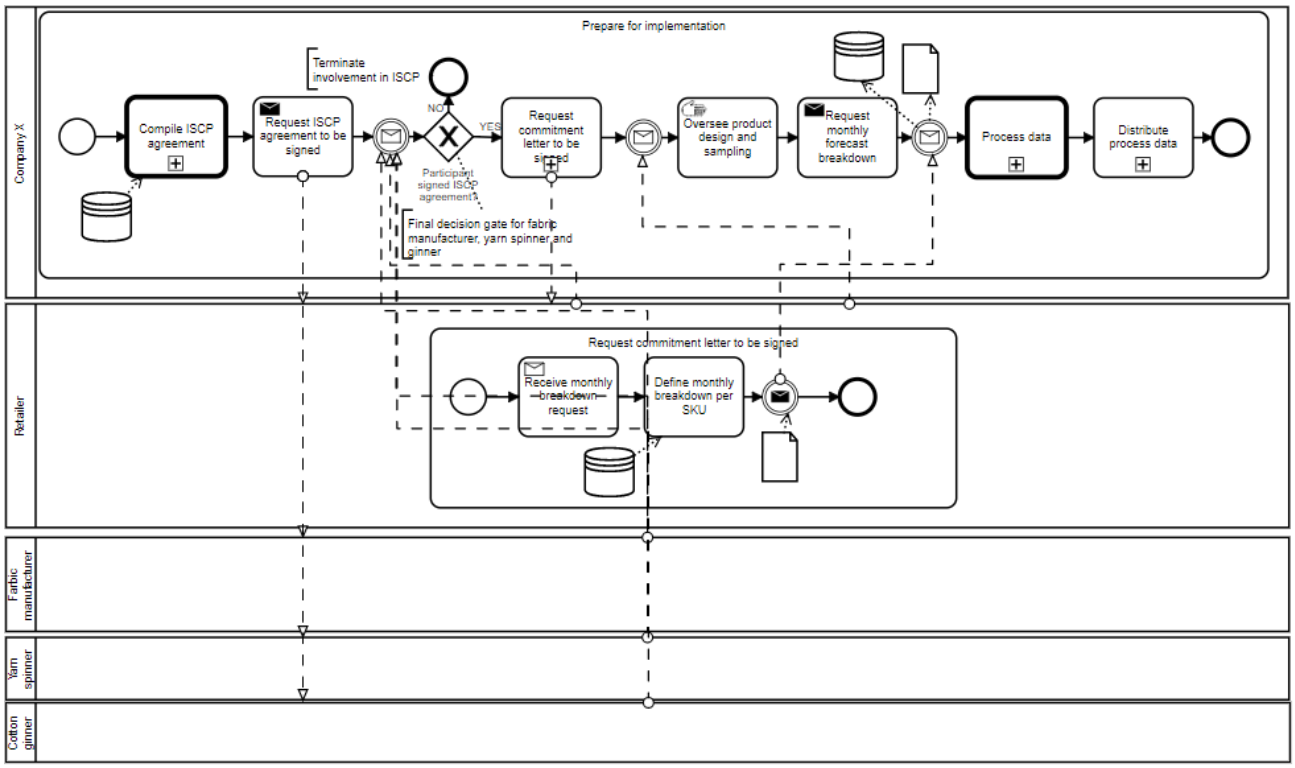

Figure 6-9. Prepare for implementation, sub process expanded from ISCP process.

The costing exercise allows participants to decide whether or not the price relating to the ISCP is feasible in their value chain or not. This means that an ISCP agreement could be compiled in order to make sure that everyone in the SC understands their commitment to the ISCP, as well as their responsibility towards the ISCP. The sub-process of the ISCP agreement process is expanded in Figure 6-10.

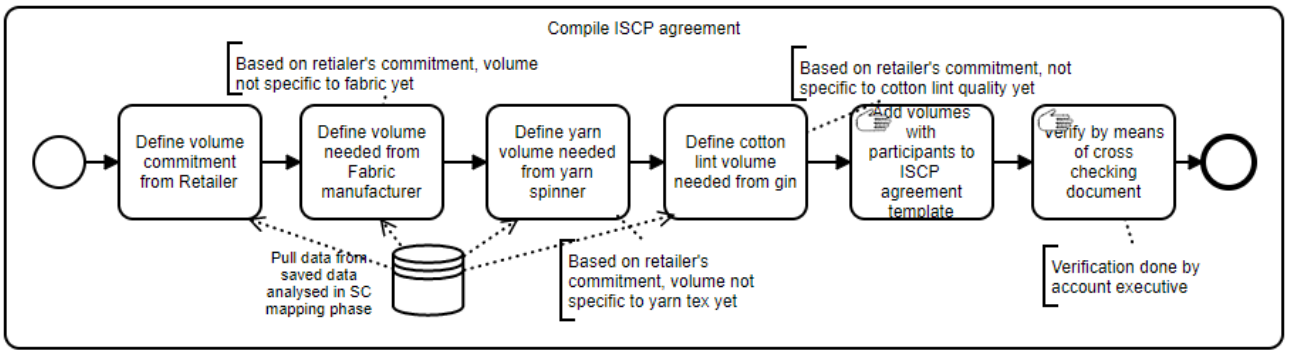

Figure 6-10. Compile ISCP agreement, sub process expanded from prepare for implementation.

From the data collected and processed in Section 6.2.3.1.2, the volume commitment at each link the SC can be defined and documented in the ISCP agreement, which is then signed by all the participants in order to finalise the partnership and SC for the coming season. It is important to understand that these volumes are only estimated volumes, which will allow a baseline for planning, but there may be variations in volumes due to shift in demand. Signing the ISCP agreement is the last decision gate for the fabric manufacturer, the yarn spinner and the cotton gin. The retailer will have the responsibility to integrate the process for the next 12-months, by signing a commitment letter, stating the volume committed to the whole programme, which will be the final decision gate for the retailer. The sampling and product design can then be completed and more or less 6-months before the season starts, the updated monthly forecasted volume can be requested from the retailer. For different retailers there will be different timelines for when the data can be released. The data is processed by company X and distributed to links in the SC to facilitate forward planning.

6.2.3.1.5. **Implement**

If the *planning* stage is done sufficiently then the *implementation* stage will likely run with a higher efficiency. The first call activity, done by company X, will be to assist the spinner to select the correct cotton lint quality, based on the monthly projections. There is a specific range selected for open end (OE) spun yarns as well as ring spun (RS) yarns. The ranges can be seen in Appendix D, Figure D-1. The role of company X in the implementation phase is to offer support to various stakeholders and participants when factors change or shift during the 12-months of implementation. The entire process of implementing the ISCP sub-process appears in Figure 6-11. The account manager would mainly be responsible for the provision of support to participants in this process. A business rule is added in company X's sub-process of implementation to oversee and facilitate specific actions and meetings. All records of changes in the SC such as shift in demand, problems with quality etc. would be done by company X.

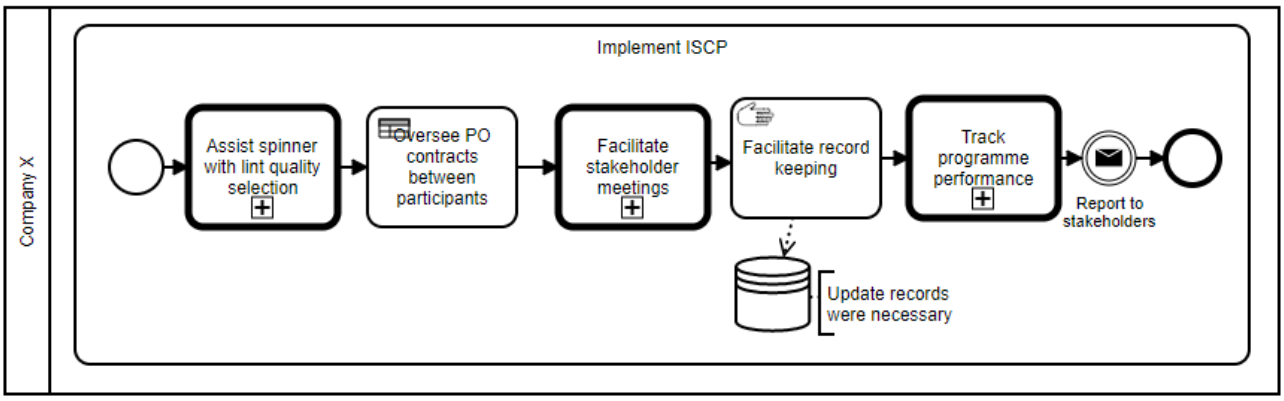

Figure 6-11. Implement ISCP sub process expanded, from ISCP process.

However, it will be important for all the participants to execute the ISCP process as agreed in the ISCP agreement. Tracking the performance of the programme requires high level message flows between participants and company X and each link in the SC. If there are any changes in the ISCP process or difficulties, it would be company X's responsibility to report to stakeholders and relevant participants. The implementation process would continue for a period of 12-months until all cotton lint projected for four seasons is depleted. This means that there will be continuous support from company X with regards to the implementation step as well as continued planning support for the following season. The process will repeat itself at the planning stage, again for the next season, while implementing the ISCP for the current season.

6.2.4. **Time-line for the ISCP**

Working with different participants, that are located in various parts of SA and Southern Africa is very time consuming, considering the availability of important personnel and travel time. With regards to the signing of documentation and finalising contracts, it would also be beneficial to establish certain deadlines for submissions of the documents as briefly described in Section 6.2.3.1. Thus, before the ISCP is implemented, it would be important to establish a strict timeline. Considering that the raw material, used in research study, is cotton, the cotton cultivation period and planting season for cotton should be considered in the timeline. However, it is stated that the process should start at retailer level, hence the timeline planning should then be done backwards.

A complete view of the ISCP time-line, from farmer to retailer, could be seen in Figure 6-12.

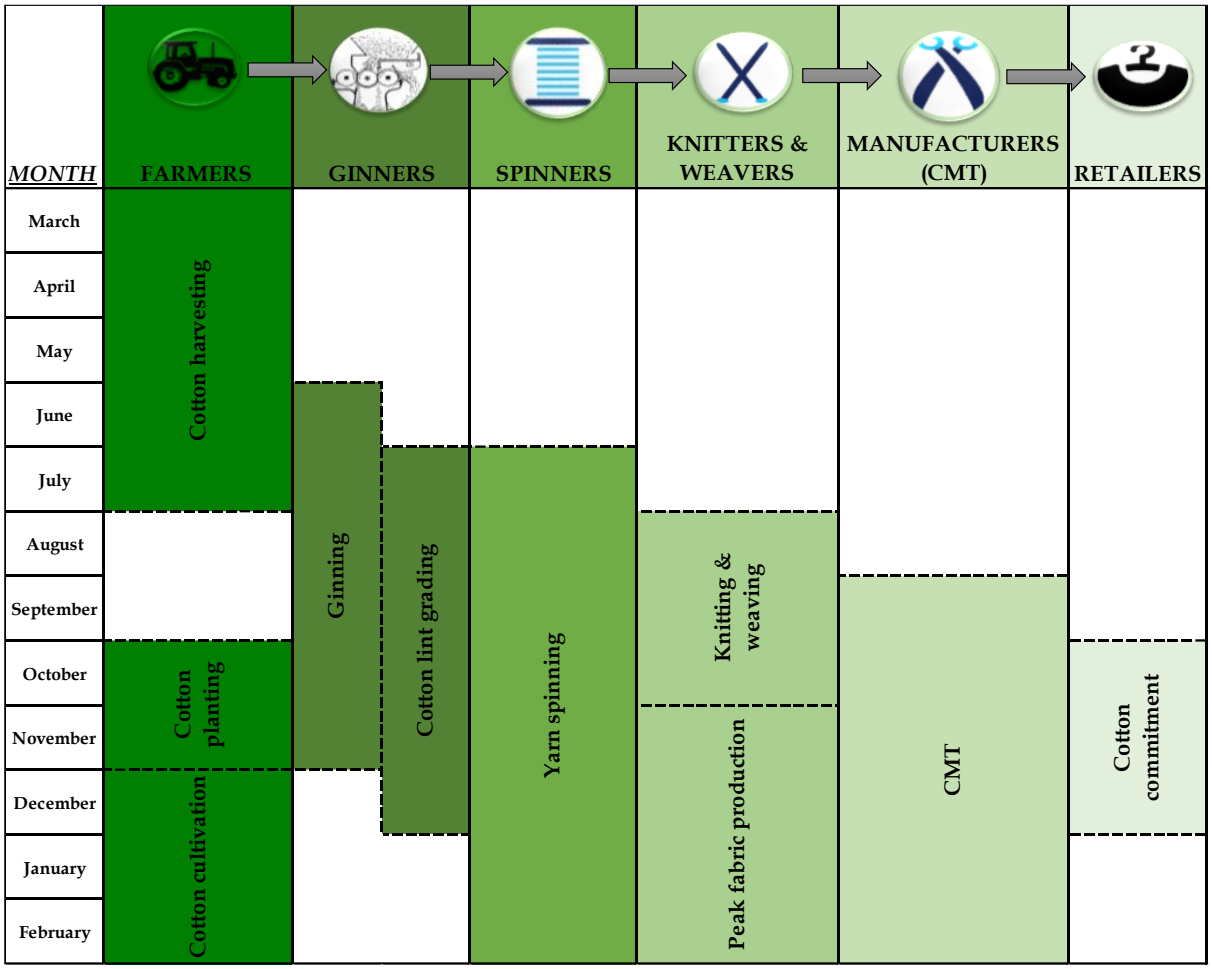

Figure 6-12. ISCP time-line form farmer to retailer.

It would be beneficial for the farmer to know what the demand for cotton will be in advance, before the cotton is planted in order to ensure better planning for the cotton planting and cultivation process. More importantly, the price that the farmer can sell their cotton for at harvesting time is important to define in order to have proper financing in place and to motivate the planting of cotton over another commodity. Thus, in the beginning of September, SASTAC must establish a price matrix based on cotton lint quality. This price is fixed for a period of 12-months. In order to retrieve the necessary information needed, before planting, it would be best to start cotton commitment planning in May/July up until September. Thus, the deadline for the estimated seasonal cotton lint volume, to be committed, will be in October, in order to provide this information to the farmer. Cotton ginning, seed grading and lint grading will commence from June until December. The spinning of yarn would normally continue to run the whole year, in order to have safety stock in place but for the first year of implementation of the ISCP. This in essence, means that the first cotton, planted in October would be at the spinner in July for the coming season. The yarn, spun from above mentioned season, will then be available for weaving or spinning from August. Garment production from the fabric will start in September for orders to be in store from October (Summer delivery). With regards to ordering of the seasons collections, the lead time

would differ from retailer to retailer. It is possible that the ordering for a season starts 3 months before delivery or in other cases the orders can come in 6 or even 12-months in advance. It is difficult to change an item of clothing's design or trend if the SC lead time is longer than 6 to 12-months. Ideally, the lead time from ordering to delivery should be as short as possible. However, if the lead time is very short, the SC connected to the retailer needs to be able to respond to such a short lead time in order to avoid late delivery. Balancing the need of the retailer and the value chain is of more importance than only pushing for a shorter lead time.

6.3 Data collection and analysis: Implementing the ISCP process

With a better understanding of the ISCP process, though BPMN in Section 6.2.3 and 6.2.4, the next step in the research approach was executed. A secondary process, in the research approach is to implement the ISCP. As seen in Figure 6-13, the sampling method is purposive, and defined in the ISCP process. Primary data as well as secondary data of both qualitative and quantitative type are used. Relevant meetings and internal focus group discussions are used in the ISCP process.

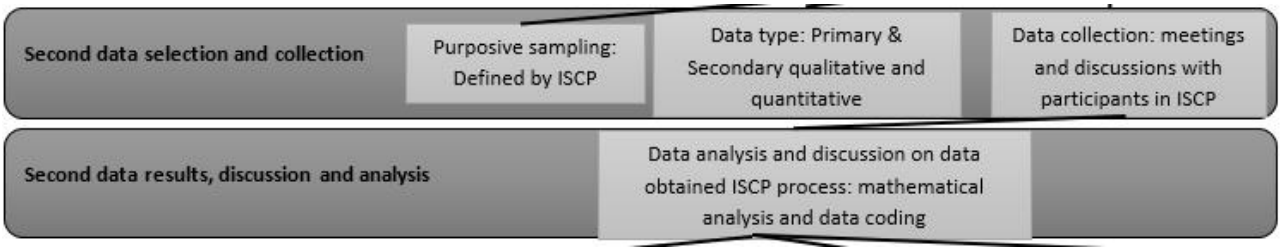

Figure 6-13. Screenshot of the second data set for implementing the ISCP with retailer A.

Findings of confidential data in the ISCP process will be protected by means of anonymity and or research identifiable codes. Protected Personally Identifiable Information (PPII) need research identifiable codes to protect the confidentiality of the data and this includes qualitative and quantitative data. A certain Master List (ML), as well as original documentations mentioned in the ML, which links the codes with the PPII is stored on a password protected electronic device and would only be made available under specific circumstances.

6.3.1 Design programme concept analysis and discussion

The first step is to identify a retailer to participate in the ISCP. Since the ISCP was already tested with one of the leading retailers in SA, it was decided that retailer A would be used to test the CBISP, further explained in Chapter 7. The data collected in the *design programme* concept is only between company X and retailer A.

The following information was extracted in the first meeting with retailer A:

i. Questions are raised about BCI cotton preferences over organic cotton,
ii. Questions are raised about the competitiveness of the price against New York's future price,
iii. Concerns are raised about cotton lint capacity and the availability of cotton lint in the 12-months period,
iv. Retailer A agreed on the need to localize production,
v. Retailer A would be able to participate in the defined timeline to start the ISCP as soon as possible, and
vi. Retailer A expressed great interest in the ISCP and would like the process to continue.

Since the time-line is very important to manage, it is crucial to engage with Retailer A in the correct time frame in order to fit into the time-line highlighted in Section 6.2.4. In order to move forward with the ISCP process, a signed NDA with Retailer A is required. The NDA includes the information such as strategic relationship, confidentiality agreements and provisions which would be valid for 2019, the duration of the sustainable cotton cluster. With the NDA in place, the data required for volume indications could be requested. The retailer uses trend forecasting to meet future customer demands. The ISCP initially allows the retailer to only add a few products to the programme, and build capacity as the programme progresses. According to De Wet (2017) consumers start to favour products that support local products which are environmentally friendly as well as socially responsible. This brought local retailers to the realisation that there is a need to develop corporate suitability strategies, in order to provide different product offerings to meet the demand of the consumer (De Wet, 2017). The demand stage, does not require the pre-definition of SKUs and product designs, but there needs to be sense of volume commitments, based on historical data. Ideally the retailer would like volumes to increase with each season, and the retailer would strive to increase production with each season, so for the ISCP the assumption is made that there would be a minimum volume commitment per season, based on historical data.

The following quantitative data is extracted during the *design programme* step: 4 million, 100% cotton single jersey garments over the period of 2 seasons which includes spring collection (2017), summer collection (2017), autumn collection (2018) and winter collection (2018). These garments are not related to specific SKUs and could be any size or design. However, for quantification purposes, a Men's extra-large (XL) white T-shirt is used. Retailer A decided to use two fabric manufacturers - fabric manufacturer A and fabric manufacturer B. In order to split the risk between the two manufacturers, 70% of the volume is allocated to fabric manufacturer A and 30% is allocated to fabric manufacturer B. Fabric manufacturer A, specialises in men's

wear, ladies wear, kids wear and infant garments whereas fabric manufacturer B specialises in ladies wear and kids wear. All the data obtained in the design programme step is stored on a safe, password protected device and treated with confidentiality. As mentioned the figures discussed above, are not related to the actual data.

For quantification purposes and in order to continue the ISCP process, there is a need for the retailer to express their intention for the ISCP, by means of a LOI. The LOI will support and ease engagement with participants in their SC. This expresses the commitment of the participants, which was never before implemented in business as usual, and the formalised documentation improved the level of acceptance and lowered resistance to the ISCP.

6.3.1.1 Why BCI cotton instead of organic cotton?

Even though, organic cotton, is manufactured in many parts of the world, with great success, locally it did not perform that well. In order to produce local organic cotton high capital inputs are required, which is not available to farmers in SA. Furthermore, the majority of local consumers do not have the money to pay a premium on organic garments. Therefore, it was thought best to rather focus on BCI, which allows a responsible cotton sourcing strategy to be incorporate in to a SC, without adding a premium to the garment cost. BCI strives to produce cotton in such a way that it is better for the producers, the environment it grows in, as well as the industry's sustainability. Also, BCI cotton aims to use less water, care for soil health and habitats, reduce harmful chemical use, as well as promote fair work relationships. Furthermore, BCI allows a system to trace BCI units which offers great advantages to a retailer. Refer to Section 5.5 for more information about BCI.

6.3.1.2 ISCP price competitiveness

Questions raised by stakeholders indicated a need to provide retailers with comparative data with regards to price competitiveness. Firstly, the Intercontinental exchange (ICE) price, for cotton, changes on a daily basis, with a range of 3-7 US cents per pound (Cotton #2 Futures, 2017). Which means that there will be a constant shift in prices, affecting the whole SC. Planning, financing, and bargaining is extremely difficult to do with a constant change in prices. Furthermore, over the past 27 years, the prices of cotton rarely increased, with the price in 2017 at 85.99 US cents per pound in comparison to the slightly lower price of 82.71 US cents per pound in 1990 (Refer to Figure 6-14).

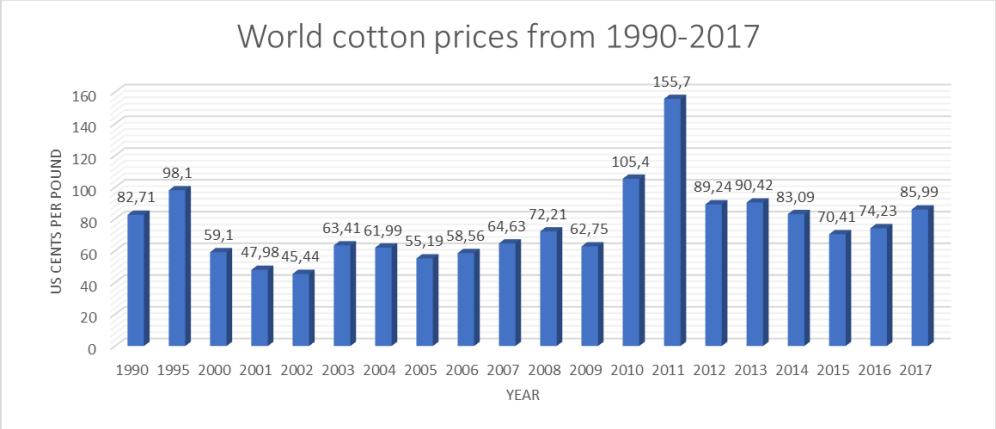

Figure 6-14. World cotton prices for the past 20 years (Source: Statista, n.d).

One of the reasons for poor price increases over the past 27 years includes subsidies in the US, with governmental support to developing countries. For a country like SA, this distorted the cotton market significantly (DAFF, 2013). For a South African farmer, without any governmental support, it is extremely difficult, to produce a product, for 20 years in a row, with almost no incline in the price received for raw material. Financing a farmer that would almost pay more to produce a product than selling it wouldn't be sustainable, meaning farmers struggled to get financing from banks. Even though a price could be fixed through forward contracting in the New York's Futures price, there will always be a risk that the price may go above the agreed price, with the farmer losing out on money. Furthermore, not only will there be a change in prices due to supply and demand, but there will also be a change in price due to the rand/dollar exchange rate. Thus, if a price could be fixed for 12-months, in Rand and not in Dollar, it will bring more stability to the price and allow farmers to do their financial as well as other planning.

Since the ISCP is implemented the year before, the base line price used for the 2015-2016 ISCP, could be compared with the A Index price as well as the commodity's futures price. The result for 2015-2016 could be seen in Figure 6-15 below. The baseline price for 2015-2016, is fixed at R21.00 at baseline Strict Low Middling (SLM) 1 1/16". It is important to note for comparison reasons the New York's Futures price, is based on the same baseline quality SLM 1 1/16" as the fixed price by CSA. The A index price is based on a higher quality, and for that reason it is more expensive.

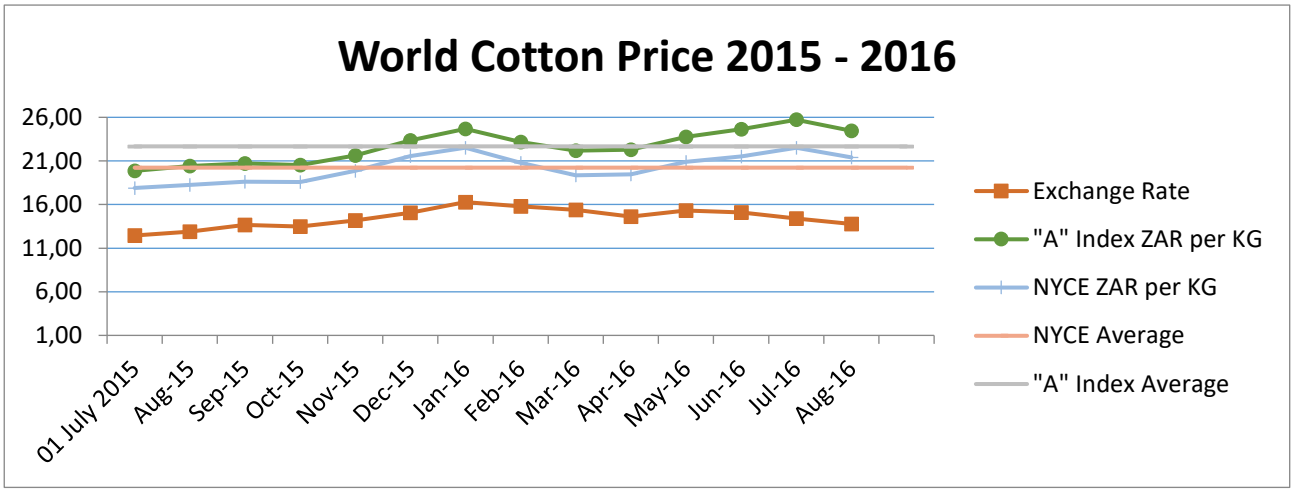

Figure 6-15. World cotton price index (Source: adapted from CSA).

Even though, at times the world cotton price went below the R21 base line, there was also times it went above it. As long as the price remain competitive during the 12-month period, it could be concluded that it is far better to work in Rand rather than Dollar. Also, a complete costing exercise through the whole value chain could be done, 12-months in advance, which will also improve SC efficiency and planning.

6.3.1.3 Local capacity issues

Local production of cotton decreased over the past few years (See Figure 6-16). Reasons for this is may be because of incorrect perceptions of cotton no longer being a feasible option to plant due to prices, decrease in international prices as explained in 6.3.1.1, more worthwhile to plant other commodities such as sunflower and maize with greater profitability (DAFF, 2016).

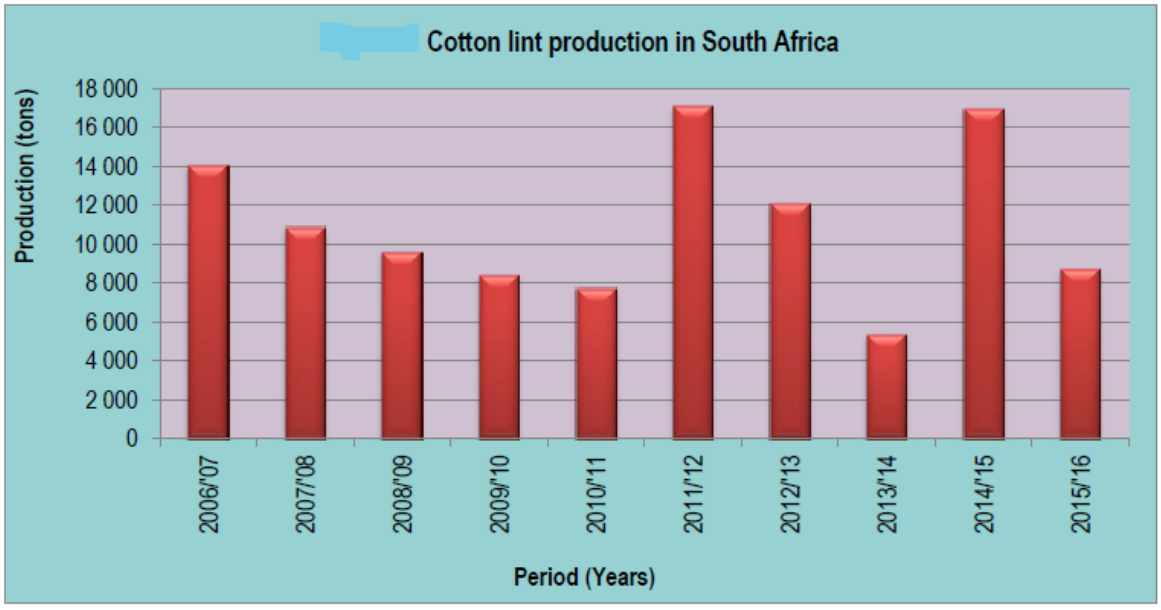

Figure 6-16. Cotton lint production in SA from 2006-2016 (Source: DAFF, 2016).

Concerns with regards to capacity will always be an issue due to the unpredictability of the yield in cotton before it is harvested. There may also be a shortfall of a specific cotton lint quality, that are used more frequently than others and shortages for a quality will only be established after the cotton lint is graded. Many factors may influence the yield and environmental factors such as drought which cannot be foreseen or predicted. Other factors such as availability of surplus labour, load shedding (in the case of SA) and strikes could also influence the capacity and availability of cotton lint. Luckily, in the case of cotton, cotton lint could be stored for a long period of time, if it is stored in the correct way. For instance, the use of polypropylene bags and older methods of bale wrapping could contaminate the cotton which will influence the dying process negatively. Unfortunately, it is costly, and factors such as moisture and temperature should be carefully monitored in order to assure little changes in cotton lint quality. What the ISCP offer, is forward planning, through forward contracting. Even though the predictability of the harvest, before the cotton is planted is unknown, there will be a sense of what the demand will be, 12-months in advance. Which means that farmers will have a better estimate of the demand, and could then calculate how much cotton should be planted. All the cotton lint used in the ISCP currently are source from one local gin A. Which means that all the ISCP's that are run in this programme will be calculated before planting season. The capacity of the local gin A is also known. This means that if the demand increases from one year to the next, it will be known 12-months in advance and alternative options could be evaluated.

The cotton lint production situation, as it was on the 2nd of October 2017, was estimated at 82611 lint bales[21] produced in SA, which is 64% more than the previous season, with another 2000 lint bales to be ginned by Swaziland gin (CSA, 2017a). This show a very high increase, and positive indication of increased cotton production in this year. This show that there should not be a capacity problem in the coming season.

6.3.1.4 Opportunity created by localizing a SC

Getting a retailer on board to localize their SC could create thousands of jobs in SA, which will reduce poverty and uplift the industry through marketing campaigns. A study done in 2005, which is sponsored by the United Nations Development Program and done with the IDC, DTI, Human Science Research Council (HSRC) and others indicated that in SA, for every R1 million output in Agriculture, 18.6 people are employed, and with regards to the Apparel & Textiles sector 9 jobs are created for every R1 million output. Furthermore, with a local production of around 50 000 bales of cotton lint in 2015/2016, and with a demand perspective from retailers in SA, at about 1.5 million bales of cotton per year, in 2015/2016, there is major opportunity for farmers to produce more cotton (CSA & De Wet, 2016). Unfortunately, SA's Agriculture sector is poorly supported in comparison to the rest of the world, and focussing on the textile industry to create jobs will bring about great opportunity. Furthermore, with regards to imports in textile products in SA, about R3.5 billion of textiles is imported in 2017. Only R1 billions of textiles are exported in 2017 (SA's exports and imports to and from specific regions for January 2017, 2017). The opportunity is major for job creation and according to the

[21] One cotton lint bale is equal to 200 kg

CSA and De Wet (2016), an increase in 8% of local sourcing in apparel and textile products by South African retailers, could create 100 000 new jobs by 2022.

Locally, the amount of small-scale cotton farmers is only around 5%, whereas in the rest of the world around 65% output on 72% planted areas are from small-scale farmers. Thus, there is also major opportunities to incorporate small-scale farmers, specifically dry land areas into the ISCP and to created job opportunities (De Wet, 2017). After programme implementation, the total small-scale farmers who delivered cotton to two local ginneries to date, is round about 1470. Of the 1470, 50% delivered into the gin that was tested in the programme and the yield factor was more or less 35.97%. The total produced by small-scale farmers in the programmes for this production year is more or less at 1836 bales of cotton lint which is just over R7,8 millions of cotton produced.

6.3.2 Supply Chain mapping

In order to introduce the ISCP to the two fabric manufacturers A and B, a meeting is conducted, with both the fabric manufacturers. The LOI offered support to ease the engaging process and allowed company X to explain the ISCP to the fabric manufacturers. Before any sensitive information could be shared between parties there is a NDA document in place with both fabric manufacturers. Again, with the fabric manufacturer, it would be highly beneficial to use an existing yarn supplier, in order to minimise risk. However, there is some issue with capacity towards local spinners, and therefore there is a need for SADC countries to deliver yarn to SA (See Section 4.3.6 for more information). For the ISCP with retailer A, one local yarn spinner A, are identified for both fabric manufacturer A and fabric manufacturer B during the meeting with both parties. Spinner A is an existing partner of both fabric manufacturers with a strong relationship. The same process is followed to introduce the yarn spinner to the ISCP process with LOI as supporting documentation. From the meeting with spinner A, it is concluded that ginner A should be used to localise the SC. For the ISCP process only one gin is used ginner A, to deliver to spinner A. The reason for only using ginner A is because of previous partnerships with the gin, and the gin was part of the programme before the retailers were involved. Luckily the gin already delivered yarn to the selected spinner which minimized risk to some extent. Refer Figure 6-17 for flow of materials from ginner to retailer.

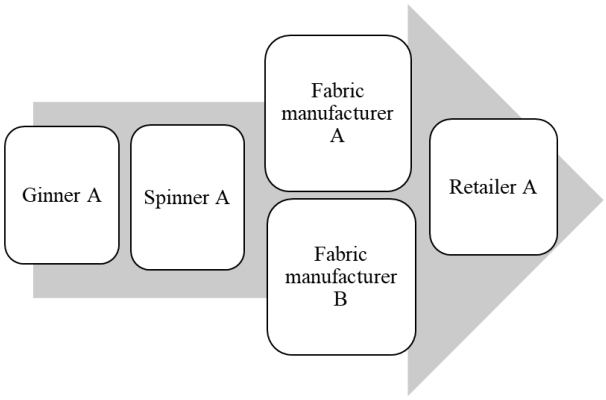

Figure 6-17. Material flow from ginner to retailer.

6.3.2.1 Qualitative and quantitative data collected and results for volume quantification

Since it was decided to use a men's XL t-shirt for the first quantification process, the fabric specifications are necessary. Typical information required to do the quantification is as follows: composition of the garment for instance 100% cotton garment (there may also be blended fabrics due to shift in demand); the fabric type for instance single jersey; the weight of the fabric per square meter (body[22] and ribbing[23]); the knitting technique or weaving losses and the spinning losses. If the fabric type is known, then to a certain extent of certainty, such as, a yarn type used to produce a specific fabric, can be identified. Sometimes the fabric manufacturer only knows the total amount of meters produced, rather than the actual rating per garment. If this is the case, then the preferred methodology is to rather use the amount of fabric (in meters produced) as an indicator, rather than fabric ratings for the first quantification process. This methodology is considered a more accurate indication of the meters of fabric needed.

The data obtained from the ISCP process from fabric manufacturer A and B, spinner A and ginner A could be seen in Table 6-1.

Table 6-1. Results for fabric, yarn and lint specifications.

SPECIFICATIONS	FABRIC MANUFACTURER A	FABRIC MANUFACTURER B
GARMENT COMPOSITION	100% Cotton	100% Cotton
SKU	Men's XL T-shirt	Men's XL T-shirt
FABRIC TYPE	Single Jersey	Single Jersey
FABRIC WEIGHT (BODY)	145 g/m^2	145 g/m^2
FABRIC WEIGHT (RIBBING)	245 g/m^2	245 g/m^2
FABRIC RATING (BODY)	0.75	0.75
FABRIC RATING (KNITTING)	0.03	0.03
YARNS	23 Tex OE (Body & Ribbing)	23 Tex OE (Body & Ribbing)
DYEING LOSSES	10%	10%
	SPINNER A	**SPINNER A**

Table continues next page

[22] The body of the garment is the actual t-shirt or fabric used to manufacture a garment

[23] A rib knit is a double-knitted fabric that is knitted in vertical patterns which is called ribbing and it has the ability to stretch crosswise direction, for instance it is used in t-shirts in the neckline area.

Table continues from previous page		
SPINNING LOSSES	13%	13%
	GINNER A	**GINNER A**
GINNING LOSSES	12%	12%

The data in Table 6-1 are related to actual data sets since single jersey fabric is normally used to produce garments like t-shirts with a fairly standard weight of 145 g/m^2. The same goes for the yarns, certain yarns are used to produce certain fabrics and even though there may be some variations in yarns which will change the weight of the fabric. With regards to the wastage percentage, the wastage is coupled to various factors such as type of weaving machine, spinning machine, ginning equipment, quality of the cotton lint and many other factors. Since this is the second year of implementing the ISCP process, the same values are used to incorporate losses than the previous year. It will differ for each and every product and an average percentage loss for dyeing, knitting and spinning is used.

In Section 6.2.3.1.2, a call activity labelled *verify data* is added. The reason for adding this to the ISCP is because during the cause of the ISCP implementation, it is noted that some of the data given by the retailer differed with the fabric manufacturer, or vice versa. However, the producing party would have better knowledge of the specifications and it would be important to do an internal validation process just to check if the data given by both parties are the same.

A full description of all the different scenarios and calculations can be seen in Appendix E. The guideline in Appendix E, was used to convert the 4 million garments into fabric volumes, yarn volumes and cotton lint volumes. It could be concluded that Retailer A needs to commit to more or less 1161.51 tonnes of ginned or cleaned[24] cotton lint for autumn, winter, spring and summer for the coming season (See Table 6-2).

[24] The calculations for cotton lint requirement included added spinning, knitting and dyeing losses.

Table 6-2. Results for converting 4 million units of garments in yarn requirement and cotton lint requirement.

Supplier	Garments (Units)	Fabric in meter (m)	Yarn in Kilogram (kg)	Cotton lint in Tonnes (T)
Retailer A	4000000			1161.51
Fabric manufacturer A	2800000	3060000	715490	813.06
Fabric manufacturer B	1200000	3517241	306639	348.45

In Appendix F, Table F-1 more information about the calculations for the values in Table 6-2 are given. The reason for using excel is because of the wide variety of functions available and it is the cheapest way to calculate and convert volumes. It also well known in SA, while a different or new programme might require staff training. From Table 6-2 , the following conclusions could be made: the retailer committed to 4 million units of garments which translates to 1161.51 tonnes of cotton lint (with all the added losses), which means the cotton gin needs to be able to deliver 1161.51 tonnes of ginned cotton lint in the next season. Furthermore, the fabric manufacturer could use the indicative meters of fabric, to do their annual planning and they use the indicative cotton yarn requirement for each fabric manufacturer, which can also be used by the spinner to do their annual planning. This ultimately means that the spinner will buy 1161.51 tonnes of cotton lint to spin 1022.13[25] tonnes of cotton yarn (where losses occur in the spinning process). If the cotton gin knows that 1161.51 tonnes of cotton lint is required for the following season, then 3226.42 tonnes of seed cotton should be produced by the farmer since only 36% of seed cotton yields cotton lint.

Anything above a 1000 tonne is feasible to implement into the ISCP programme. Using excel as a way to convert the volumes is easy to use and widely available, however, it is extremely important that the calculations are verified by stakeholders because even though the data represented in Table 6-2 seems fairly straight forward it can become very complicated, especially when there are 100's of different SKUs identified. Also working with large numbers, for instance in the millions, may also result in biased results due to human error.

Conducting meetings with various suppliers related to retailer A is easy, since retailer A informed their suppliers in advance about company X and expressed their interest in the ISCP. The only concerns that surfaced during the meetings from the supplier's side are related to: the spinning capacity (which was explained in detail in Section 6.3.1.3, and the commitment from the retailer. In the past there was no visibility form the retailer's side, meaning no commitment based on volume, 12-months in advance, and for this reason the suppliers expressed great interest in the ISCP. However, it is also noted that it is difficult for suppliers or any business

[25] Fabric manufacturer A yarn requirement + Fabric manufacturer B yarn requirement

owner, to deviate from business as usual. Thus, change management is key in order for the ISCP to be successful. There is also no line of sight upstream, or downstream which made planning, and the ability to be flexible extremely difficult.

6.3.3 Planning ISCP

In order to plan the ISCP, there is a need for document control since there is a lot of movement of information between different participants. Due to cost related issues, and to save money, it is important to use a well-known, inexpensive way to manage the flow of information, documentation etc. Since excel offers a wide variety of add-ins and functions, and almost everyone owning a laptop has access to excel, it is thought best to use this as a starting point. It is also important to note that this document need to be distributed to various stakeholders and participants that may only have access to a laptop or computer, and no other purchased programmes, management systems etc. A simple planning matrix is developed, specifically for the need of the ISCP for better document control, planning etc. The matrix is completed and compiled by the account manager and approved by the account executive.

6.3.3.1 ISCP planning matrix

The ISCP planning matrix template could be seen in Figure 6-19. This template, is adapted from the Thames Coromandel District Council (TCDC) matrix and includes a RACI chart to fit the needs of the ISCP. The matrix is divided into four sections, where the sections are classified as: SC stakeholders; team responsibilities, document control, and goals and tasks (refer to Figure 6-18 for more information).

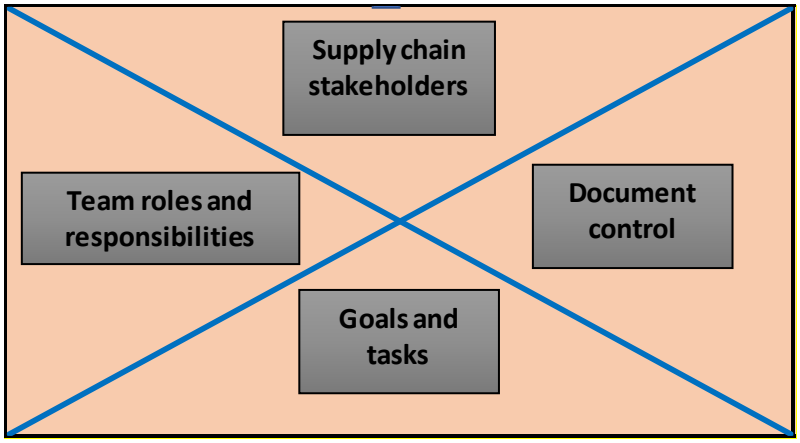

Figure 6-18. ISCP planning matrix classes.

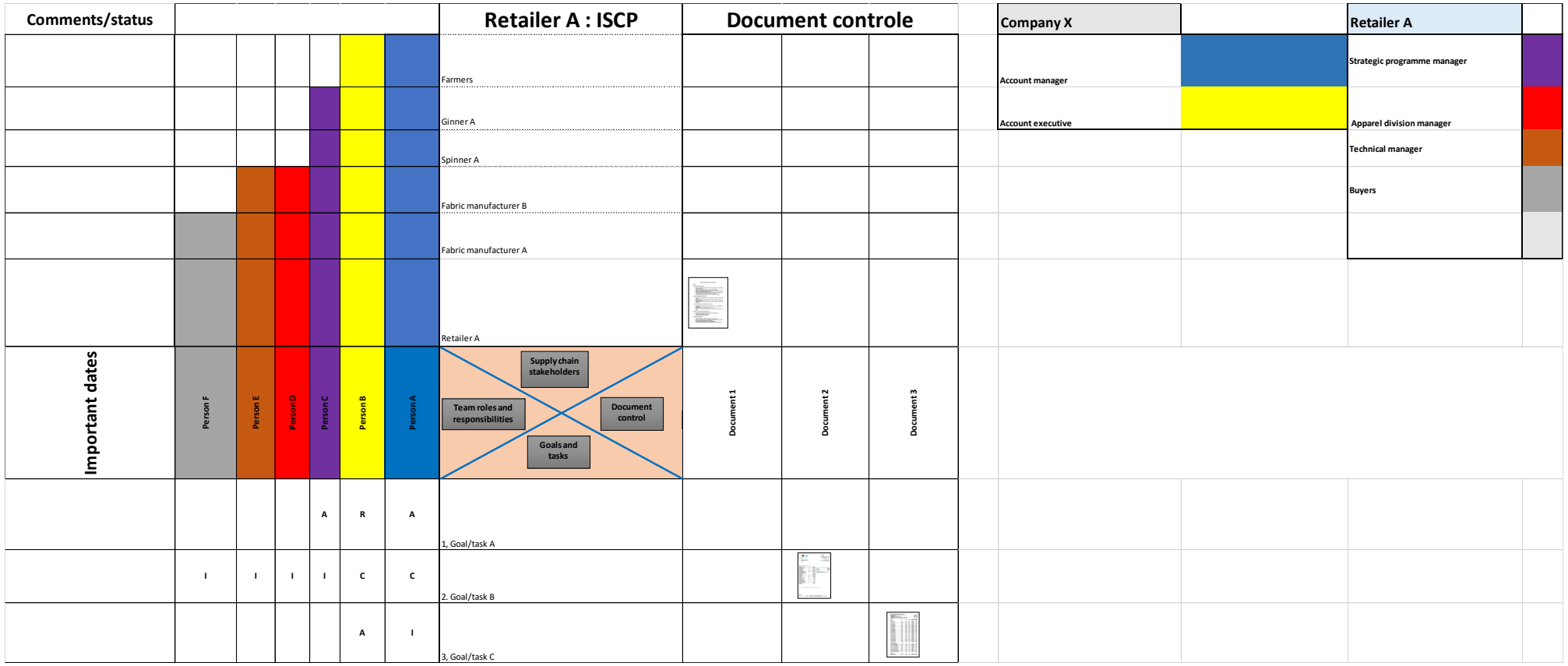

Figure 6-19. ISCP planning matrix (Adapted from TCDC and RACI).

The position of each class is important, due to the relationship between the classes. Each class is connected to another class, by means of vertical/horizontal lines that overlap. The class descriptions are oriented in a horizontally or vertically way (See Figure 6-20). The RACI matrix table (explained in Section 5.6.2.3) is incorporated between the team roles and responsibilities and goals and tasks. This allows each individual in the SC to know what their role will be in the ISCP process. Since it is a new process for all the participants the matrix allows for a better understanding between parties. Each task and goal may have some sort of document attached to it and excel allows any word, pdf, PowerPoint, email attachment or other excel documents to be attached for later viewing by other stakeholders. The document is embedded as an object in the excel spreadsheet. Instead of saving everything on one laptop or computer, and distributing each document on its own via email, only one document could distribute it. However, it does have its limitations. It has a limitation on the number of objects and the size of objects added to the spreadsheet, which may cause problems. Also, the object could be opened and edited on a separate laptop or computer which may cause confusion and create incorrect alterations to a document. With regards to the calculations this option is very useful since it is sometimes necessary to alter some incorrect calculations.

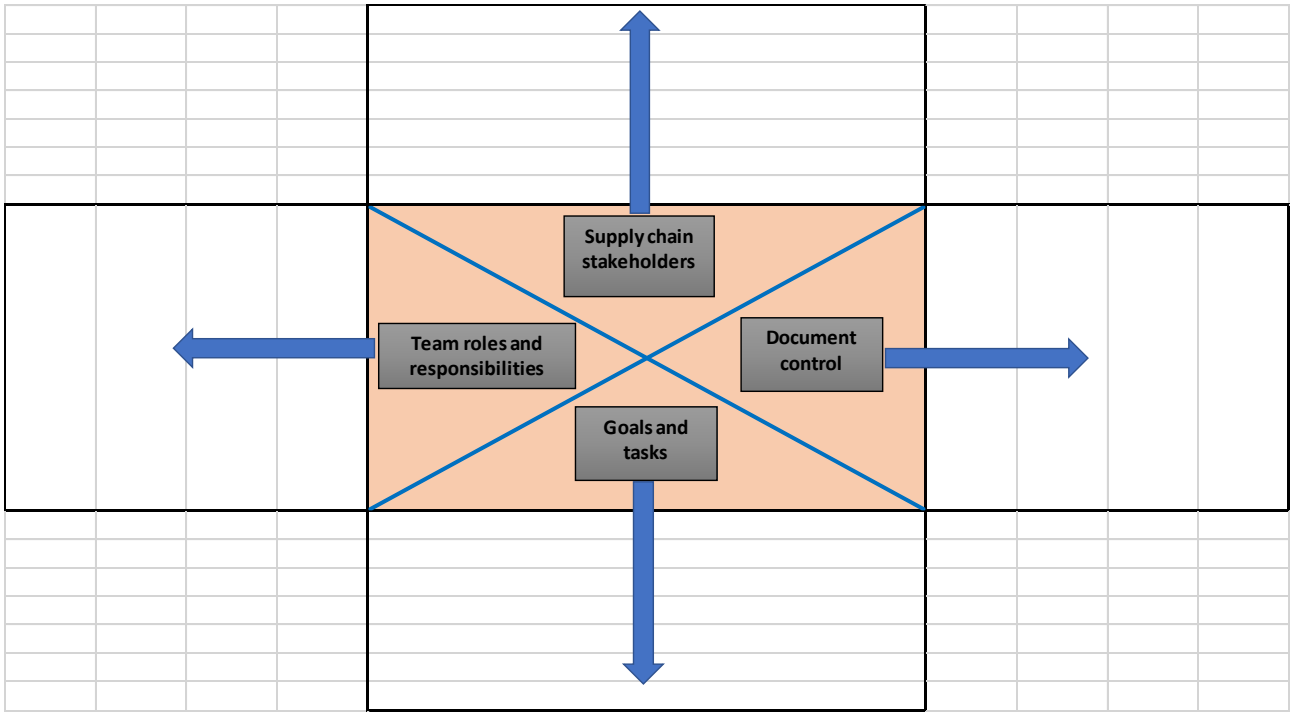

Figure 6-20. Class description directions.

Another important factor that could be added to this chart are dates. Since the ISCP are strictly reliable on a specific time-line, it is also important to link the goals and task to specific dates and deadlines. Like any business, it will not always run smoothly and there is sometimes a need to comment on certain factors relating to suppliers, a section for comments and discussions is added for reference sake. In order to connect all the participants and users of the matrix. Contact information of key stakeholders are also added.

6.3.3.2 **ISCP costing exercise**

In a traditional value chain of a retailer, every link in the SC, includes risk factoring mark-ups, exchange rate factoring, interest factoring, storage and profit. Some of these effects are caused by a lack of visibility, long-term contracting and holistic SC approach to logistics, storage and inventory. If some of these effects could be eliminated, the whole SC could be more competitive without switching between various stakeholders.

The bargaining process or costing process is normally coupled to supply and demand and the rand to dollar exchange rate. This means that within one year, or even one season, there will be differences in raw material costs as well as processes material costs. There will be a constant exchange of information between buyers in seller's in-between parties. This makes it extremely difficult to finance with a high price uncertainty. The ISCP process, allows stakeholders and participants to set a price valid for 12-months. Furthermore, a single entity which manages a commodity and its SC has a greater ability to optimize resource utilization and avoid wasted costs. Some factors such as: dyeing, finishing costs, water costs, electricity costs, and transportation costs may change within the fixed period, but the baseline raw material cost will not change. If there is a major change in costs, for instance water, then all the stakeholders will come together and discuss their options. Other changes on the prices are not permitted during the 12-month period. Negotiating prices may affect the time-line negatively and without the support of the ISCP, there needs to be a high level of trust and certainty to accept a fair price. The ISCP process allows price negotiations to run smoothly with higher transparency and also strengthens partnerships.

The higher the volume committed to a programme, the better the price. At farm level, the farmer will know the allocated volume and the price per kg cotton seed, before he even starts to plant. This allows the farmer to plan well in advance and it also improve his financing options. The same goes for the rest of the processing steps. The open book costing exercise, will only be used in specific cases where price negotiations are not running as it should, in order to prove that a sustainable margin is added and that there is no way to drop the price even more, without going out of business. The idea of the costing exercise is to ensure that all the links in the SC make a sustainable margin whilst ensuring competitiveness. Due to sensitivity of the costs related to retailer A, no results will be shown in this dissertation. However, in the previous pilot study of the ISCP, the retailer identified that their financing costs of an XL printed t-shirt are more or less 8% of the final costs. Which means if the retailer should own their own capital facility to finance their own ISCP for cotton products, more or less 8% of their costs could be eliminated (De Wet, 2017). Thus, this resulted in an opportunity for the retailer to finance their own ISCP. Currently it is possible to finance an ISCP without leaning on the balance sheet of the SC stakeholders and consolidate insurance into adapted cell captives (De Wet, 2017).

6.3.4 Prepare for implementation

In order to move to the final stage of the ISCP process, there is a need to incorporate final decision gates. The final decision gate for all the processing and manufacturing partners along with the suppliers to the retailer are signing an ISCP agreement. This agreement could also be classified as a Memorandum of Understanding (MOU). The document will be compiled by the account executive and the account manager in company X. The purpose of this document is to capture the agreement from each party in the SC for retailer A, to be part of the ISCP process. Each party in this agreement would enter into a long-term partnership and contract. This document will include the objections and description of the ISCP and the roles and responsibilities of each participant in the ISCP. Furthermore, based on the calculations and conversions done in Section 6.3.2, there will be some sense of volume commitment required from each link in SC, from the retailer to the ginner.

The commitment based on Section 6.3.2 results are as follows:

i. Retailer A committed to 1161.51 metric tonnes of cotton lint over the period of 12-months,
ii. Fabric manufacturer A committed to 3,06 million meters of fabric to be delivered to the retailer A over the period of 12-months,
iii. Fabric manufacturer B committed to 2.5 million meters of fabric to be delivered to the retailer A over the period of 12-months,
iv. Spinner A committed to 1022.13 metric tonnes of yarn to be delivered to both fabric manufacturer A and B, over the period of 12-months,
v. Ginner A committed to more or less 6 bales or 1161.51 metric tonnes of cotton lint to be delivered to Spinner A, over the period of 12-months, and
vi. The farmer need to deliver 3226.42 seed cotton to Ginner A, over the period of 12-months.

Furthermore, this document would stipulate the trade and finance factor added to the ISCP where the spinner would receive payment upon delivery of yarn and company X would assist the spinner in the quality selection processes based on the agreed price per fibre quality. Each participant in the SC should agree and sign the ISCP agreement or MOU. Persons signing the document would include the sourcing managers or CEO of various organisations in the SC. Upon agreement there will be no turning back on the ISCP and each participant would enter into a long-term commitment to the ISCP. The retailer would sign an individual agreement, called a commitment letter, with the specified volume commitment in order to use it as collateral for trade finance of cotton lint. This could also be used as an off-take agreement.

Before any product is put on the market there is a need to test product design through a sampling method. Company X, specifically the account manager, will only oversee the product design and sampling phase and will also make sure that this happens in the required time frame of the ISCP. For further planning, and moving closer to the delivery of the product, company X would request a detailed, monthly demand forecast from the retailer (from the sourcing department). This information is crucial for planning the delivery schedule and it should be done at least 3 months in advance to the actual delivery date. However, it was difficult to get all the

information from the retailer, in the correct timeframe due to commitment concerns because of resistance to change.

The first monthly projections, received in March 2017, contained SKU information. There is no change in fabric commitment, the 5 million t-shirts are distributed between men's wear, boy's wear and ladies wear. Which means that the ratings for each garment will then change in the calculations and conversion process. Due to sensitivity of SKU information, the actual information could not be represented in this dissertation. However, the percentage per department are as follows: men's wear at 50%, ladies wear at 30% and boy's wear at 20%. The conversion is done the same way as described in Appendix F.

More important aspects are the benefit the volume indications added to the whole SC. In business as usual, a fabric manufacturer would typically guess what the demand would be per fabric type. The fabric manufacturer would then order yarn based on the projected fabric type well in advance to orders from the retailers, in order to build buffer stock. This buffer stock needs to be stored, which costs money as well as no orders from a retailer yet, which means no money from the retailer. This means that the fabric manufacturer needs to have the money available to carry stock over a certain period of time. This added enormous financial pressure on a fabric manufacture. To make it worse, if there is a shift in demand to another fabric, it is only known at the time of ordering, which means that the fabric is already woven or knitted, and the fabric would then go to waste. With the ISCP in place, if there are major shifts in demand, there would be early detection, as well as early distribution of this information in order to stop production for one fabric for instance and produce another one. The shift in demand does not only affect the fabric manufacturer but also the retailer, because if there are orders for a new fabric, which are not manufactured yet, then the orders will be late and both the retailer and the fabric manufacturer will lose money.

With the ISCP, as soon as the forecasted monthly projections are received and processed, they are distributed to the various SC partners in order to facilitate forward planning on a monthly basis. It is important to separate the information and SC partner's information from one another before it is distributed to the various partners. Which means for instance only the yarn needed for fabric manufacturer A from spinner A, would be sent through to fabric manufacturer A, and it should not include information about fabric manufacturer B. All the information and data received in the *prepare for implementation* step is stored on a safe, password protected device.

6.3.5 Implement

The very last step in the ISCP process will be conducted by the account executive, account manager and trade and finance manager in company X. The trade and finance manager assist the spinner in the cotton quality selection process, based on the monthly projections. A delivery schedule is compiled per month with the relevant yarns associated with it. Even though the purchase orders (PO's) will only be between relevant parties, company X will offer support in the PO process, especially in the implementation of the CBISP. It is important to facilitate stakeholder meetings in order to discuss progress and changes during the process. The account manager in company X is responsible to store and update all the information with regards to the ISCP. All the information is saved on a safe, password protected device. Tracking the performance of the programme is very important in order to broadcast the benefits of the ISCP and to use this for further engagement with potential retailers.

During the implementation stage, the following aspects are noted:

i. The projected monthly volume for apparel products were received late,
ii. The retailer shifted some volumes from fabric manufacturer B to A,
iii. The anticipated volume allocated to fabric manufacturer B, for a 145g/m2 single jersey, shifted to blended fabrics which caused a problem in the yarn supplying department due to limited local blended fabrics,
iv. Communications between fabric manufacturer B and company X were limited due to lack of interest from fabric manufacturer B to share certain information,
v. Obtaining the open costing for each supplier in the SC is difficult, and after some delays all stakeholders supplied the necessary information and sent open costing, and
vi. Internal change management still needs to be addressed, suppliers tend to go back to business as usual and need to be reminded that the ISCP requires organisational change.

The shift in demand was unfortunate, since the first year of implementation, 100% cotton single jersey garments were highly demanded. However, the ISCP offered support in the process of obtaining an alternative yarn supplier for blended fabrics. Late receiving of projections made this process rather difficult due to limited time, which emphasizes the importance to stay within the specified timeline. Retailer A caters for middle class consumers, which means that price is very important and the shift in demand may be related to prices. A 100% cotton garments are more expensive than blended garments. And since the final quarter of 2016, there was a decrease of 3.7% in manufacturing businesses, with an overall decrease of 0.7% of gross domestic product (GDP) in the first quarter of 2017 (Stats SA, 2017). The buying behaviour may be coupled to price, as well as fashion shift, where men tend to prefer stretch fabrics rather than 100% cotton garments, which was not the case in the past. Ladies always preferred jeans for instance to have a stretch component but men not so much. The research concluded that there seem to be a shift in men's buying behaviour towards stretch t-shirts, jeans and chinos. The only way to manufacture stretch garment is by blended fabric. The demand shift would have

influenced the fabric manufacturers negatively but, due to the contract in place from the ISCP, the retailer has a responsibility to use up the agreed amount of cotton lint in the SC. Also since the retailer finances their own secured cotton they will need to pull it through the SC to avoid losing money. Even though the shift in demand was unfortunate, the ISCP proved to be crucial in times like this. In business as usual this shift would not have influenced the retailer as much, because they would have only looked for an alternative supplier, which would have influenced the fabric manufacturer severely, making them loose a lot of money.

Another interesting factor that was noted is that there seemed to be some sort of understanding that the ISCP process worked on a mass balancing principle, a retailer can shift demand from one manufacturer to another. This caused a lot of problems in the SC, especially in the ISCP, because planning was done solely for that particular manufacturer. This resulted in a conclusion to develop a simulation model in order to demonstrate the effects demand shift have on a SC.

As previously emphasized, change management is key in the ISCP, there should be a constant reminder to SC participants to remember to not go back into the old way of doing business. It is important to offer training within organisations to understand the benefits and added values to changing business practices. The problem is not everyone in a supply company is familiar with the ISCP process and principles, which causes conflict within an organisation and therefore it is important to educate everyone in the organisation.

It is well understood that sharing open costings with competitors is risky, and the idea behind the ISCP is not to remove competitiveness amongst suppliers in the local garment manufacturing industry. The idea and ultimate goal of the ISCP is to uplift the industry, increase local competitiveness as opposed to international brands, and to make sure that everyone in the SC, will make a sustainable margin. Companies were more comfortable in sharing open costings with an external company like company X, rather than with competitors.

Interestingly enough, even with the current drought issues at hand there seemed to be a growth in the agricultural sector (Stats SA, 2017). Since 2015, the cotton planted locally, increased from 8000 hectare (ha) to nearly 16 000 ha, with more or less 94 000 bales of lint, in comparison to 38470 bales in 2014. Due to drought conditions, the production fell in 2016 to 50457 bales, however still more than 2014. The 9th cotton lint estimate for 2017 are 82611 cotton lint bales as mentioned in Section 6.3.1.3. The ultimate aim for the ISCP is to increase the local cotton lint production to 300000 bales of cotton lint by 2020 (De Wet, 2017).

In Table 6-3, the increase in hector dryland planted 2016/2017, increased with 340%. Also, there seem to be a significant increase in dryland per hectare yield since 2015/2016. Which indicates a better rainfall season in 2016/2017. Also note that the total dry land yield is more or less 26% of the total cotton produced in 2016/2017, in comparison to the low 5% from 2015/2016.

Table 6-3. Estimated cotton planted vs cotton lint production 2015/2016 and 2016/2017 (Source: CSA, 2017b).

		2016/2017 (9th estimate)	*Change from previous year*	*2015/2016*
HA irrigation	*Per ha*	7301	25%	5843
HA dryland	*Per ha*	11040	340%	2510
HA total		18341	120%	8353
Yield irrigation	*Kg/ha*	4589	1%	4563
Yield dryland	*Kg/ha*	1065	68%	635
RSA production 200 kg lint bales		82611	64%	50457

Very important, this may be because of the influence of the ISCP with retailers and adding small-scale farmers to the programme. However, the ISCP has brought about opportunity in the agricultural sector with regards to cotton production.

With regards to the retailer, the ISCP offered more control over their value chain, with improved SC visibility and increased stakeholder trust, which resulted from transparent virtual partnerships throughout the SC. The retailer gained the capability to secure sustainable raw materials, optimise the SC and report to stakeholders, as well as consumers about the true sustainability impact of their products.

6.4 Conclusion

In conclusion the chapter is divided into two sections, the first section being the data collection, analysis and discussion of the BPMN process of the ISCP (Section 6.2) The second section being the data collection, analysis and discussion of implementing the ISCP (Section 6.3).

Section 6.2 outlines the BPMN as well as all the sub-processes associated with the ISCP, which is important to understand in order to implement the ISCP. The ISCP requires a certain process to be followed, because while SC partners run their business as usual, the ISCP is implemented simultaneously. Since the BPMN is a model, which uses standardized notations, the ISCP implementation process could easily be understood by different parties in the SC. BPMN allows different organisational processes to be mapped in one single map, in order to understand the internal business processes of other partners in the SC. This is important since the ISCP requires the cooperation from various SC partners at a certain period, which makes it difficult if the internal processes and stakeholder roles are not understood or known. This allows easier implementation of the ISCP by different stakeholders in the SC. A detailed BPMN is represented with additional information in order to successfully integrate a SC. The ISCP consists of five main business processes namely: *design programme concept, SC mapping, planning, prepare for implementation* and *implementation*. The ISCP should be linked to a specific timeline in order to overlap the planning phase of the ISCP with real world application. The timeline is outlined in Section 6.2.4.

Section 6.3 outlines the implementation of the ISCP. In order to test the CBISP, data is required from the ISCP. Furthermore, implementing the ISCP with a local retailer could uplift the industry and therefore it is important to implement the ISCP and to document the advantages associated with the ISCP implementation. The ISCP

is implemented with a specific retailer, namely retailer A, which was kept anonymous for confidential purposes. Retailer A has a specific SC, and relevant links in the SC offers raw material production and manufacturing services to retailer A, to produce a local 100% cotton garment.

This chapter answered some of the secondary research questions and also aim to fulfil the second research objectives, explained in Section 1.2 and 1.3, where BPM did eased the implementation of the ISCP. The BPM could also be used in future research to apply simulation models to the BPM and further improve the BPM. Implementing the ISCP offered retailers full SC visibility as well as value chain visibility, and increased partnerships amongst SC partners. It also allows price stability, over the period of 12-months, which improved the planning of the next seasons cycle and it also allowed the upstream partners to have commitment from downstream partners which improved the planning for the coming season. The ISCP allowed farmers to commit to planting cotton and this improved the local production of cotton over the past few years. Since the ISCP encourages retailers to localise their SC, major opportunities raised in terms of job creations with a goal in mind of 8% increase in local sourcing in apparel and textile products, which could create 100 000 new jobs by 2020.

7 Pilot testing the CBISP

This chapter includes the second data collection, analysis, and discussion of the research study, with regards to the CBISP. Data collected in Chapter 6 was entered into the platform in order to pilot test the platform. The pilot test consists of *planning* and *management* stages which will be explained detail in this chapter. Refer to Figure 7-1 for more information about the research structure. The aim of this chapter is to answer the second part of the research question with regards to traceability and the success of implementing the CBISP.

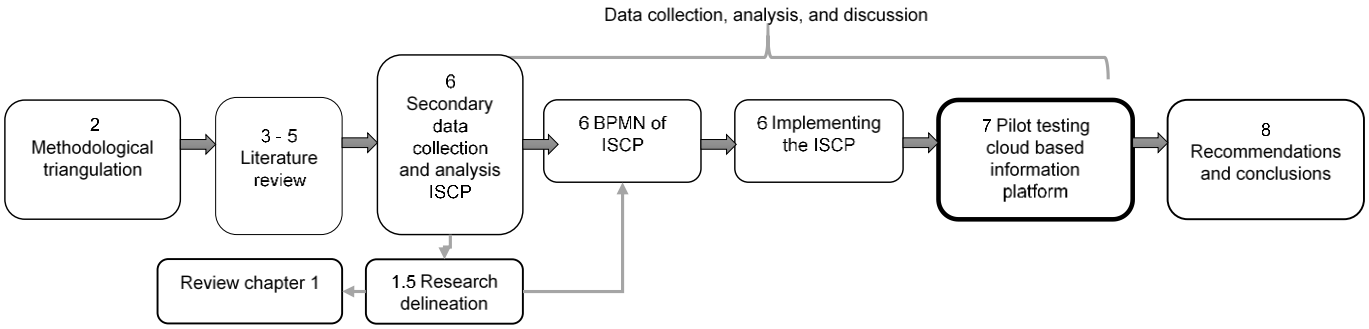

Figure 7-1. Second data collection, analysis, and discussion chapter of research structure, with regards to the CBISP.

7.1 Introduction

The idea behind the CBISP, is to develop a platform to support the ISCP. The harshness of the world we live in today, puts a lot of stress on SCs to be responsive to change. Demand could shift in an instance, especially in the fashion and clothing sector and the SC should be able to adapt to changes, as quickly and effectively as possible. However, in South Africa, clothing retailers tend to struggle with quick response. The reason for this is the lack of SC visibility and inability to act upon rapid shift in demand, since the manufacturing of a garment requires various suppliers which are not vertically integrated. Even though the ISCP brings about a lot of advantages and opportunities, there is a need for a technological platform to support it.

Visibility in a SC is very important, as well as traceability. A SC simply cannot effectively be responsive to change in demand, without full visibility. Many brands and companies, one in specific, Zara, managed to vertically integrate their SC, which means that the whole SC is owned by one entity, which also means quick response could be applied when there is a change in demand. However, it remains a challenge for SA retailers to vertically integrated their SCs.

Equally important is the flow of information, in the upstream, as well as the downstream direction. As mentioned in Chapter 6 forecasting and planning is very important for a SC to run at its optimum capacity. Even though the retailer might have some idea, what the demand would be, the fabric manufacturer or spinner may not be on the same page as the retailer. And since fashion products are demand driven, and the only entity

with customer visibility is the retailer, it is important that the retailer makes a commitment to volume and to seek help by means of the ISCP to improve visibility.

The CBISP allows users to interface their existing ERP systems with the platform via the cloud. Also, it potentially provides item-level traceability, sustainable compliance and SCM from fibre production to point of sale. By means of virtual integration through the ISCP process, explained in Chapter 6, the CBISP could be tested.

7.2 Data results, discussion and analysis: Pilot testing the CBISP

The data obtained during the implementation of the ISCP in Section 6.3, will be used in this chapter in order to test the CBISP. The data collected during the ISCP process was of qualitative and quantitative nature (refer to Figure 7-2 for more information).

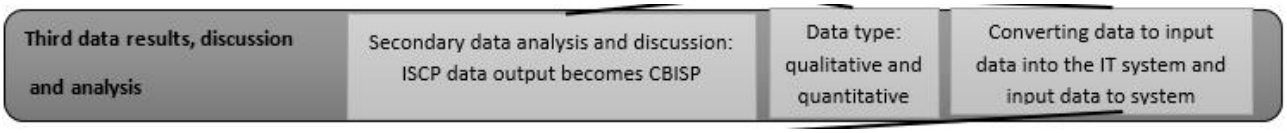

Figure 7-2. Screenshot of third data set, piloting the CBISP.

7.2.1. The structure of the cloud based information systems platform

Figure 7-3 illustrates the planning and ordering concept, with integrated factors such as volume commitment planning, cotton lint drawdown and traceability. The first phase is the planning phase where there is a need of data input, that was provided from the ISCP, which was implemented in Chapter 6. The same applies to the actual ordering where there is a need for certain documentation and pre-ordering criteria that needs to be followed to facilitate lint draw down and item level traceability. Figure 7-3 illustrates how the platform should operate when successfully implemented.

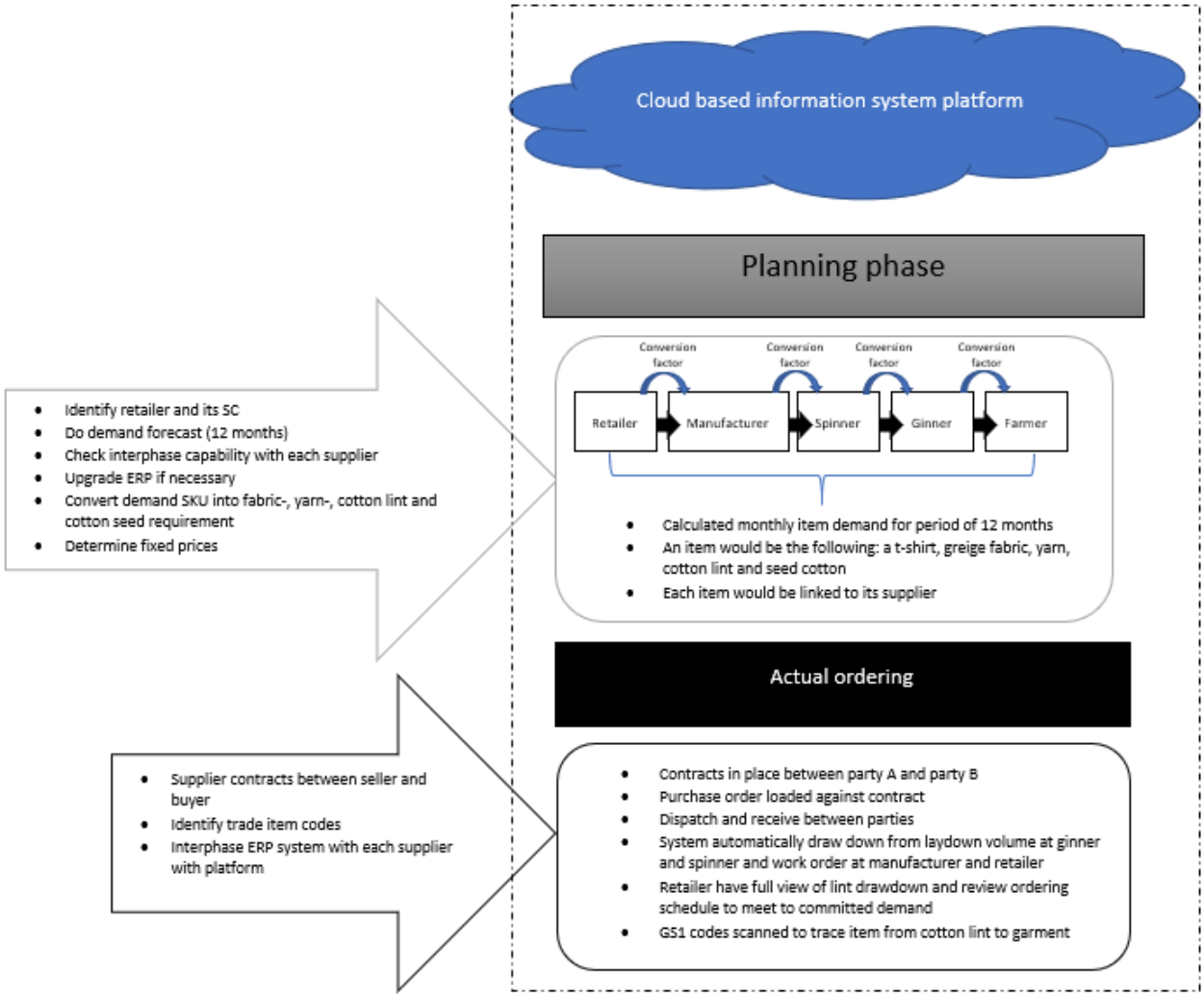

Figure 7-3. The CBISP structure with regards to planning and management stage.

7.2.2. **Creating a programme and planning items on the platform**

A *programme* on the CBISP could be seen as the SC of a retailer, which will include the department of the retailer, the tier-one supplier, the fabric manufacturer, the spinner and the ginner. There may be a possibility for a retailer to have multiple programmes, running simultaneously with different departments and different stakeholders. In programme management, there is a large collection of collative aspects that work in a collaborative way, to ensure a positive and common outcome. It requires good relationship with clients and stakeholders linked in the programme. At programme level all the demands for goods and services to support the market place should be considered.

To input data to the platform the following needs to be considered:

i. What data is needed for input,
ii. In what way should the data be presented for input, and
iii. When should the data be added.

In order to create a programme, a specific retailer needs to be identified including their SC partners, and both stakeholders must be registered on the platform. Once the retailer is identified a username and password is created in order to allow access to the platform. The same process is completed for the whole of the retailer's SC. Meetings with fabric manufacturer A, fabric manufacturer B, Yarn spinner A and ginner A, are held to identify each participant interfacing capability. A *programme*[26] of a retailer, is coupled to demand, which is defined by forecasted volumes based on past demand patterns. A *programme* is also identified months in advance to implementation. The demand is based on end consumer product quantities. All the bill of materials[27] (BOM), should be determined to manufacture and deliver a product. It is important to structure the relationship between contracts and orders within a *programme* when negotiations take place (Refer to Figure 7-4 for relationship structure)

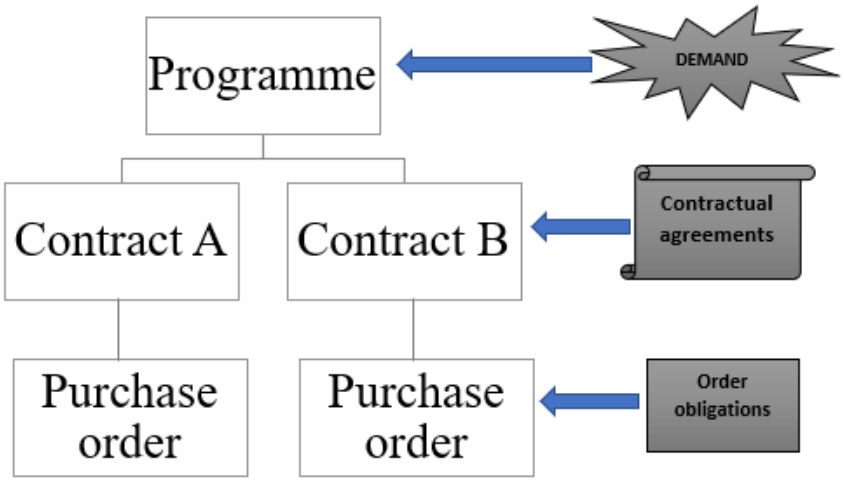

Figure 7-4. Relationship between purchase orders, contracts, and programme.

It is also important to identify the relationship between BOM and structure it, meaning all the materials that will be processed will include seed cotton[28], cotton lint, cotton yarn, greige fabric and generic t-shirt. Creating hierarchy structures, will ease data input and understanding of data structure (Refer to Figure 7-5). Thus, it is important to create a hierarchy structure for all the processing steps to create a finished t-shit for retailer A.

[26] SC of the retailer with respective stakeholders (this is not referring to a computer program)
[27] Is a list of raw materials, sub-assemblies, intermediate assemblies, etc. and quantities to manufacture a product.
[28] Unginned cotton seed, before the seed is separated from the fibers.

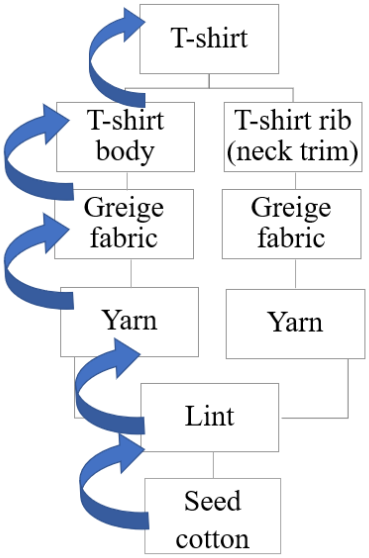

Figure 7-5. Processing and item class (planning items) hierarchy structure.

The required seed cotton should be added to the hierarchy structure in order for farmers to get an indication of how much seed cotton should be yielded, which will give them an indication of how much cotton should be planted. It is also required to create a programme hierarchy structure for each retailer. From data obtained in Chapter 6, Figure 7-6 illustrates the relationship among partners in retailer A's SC. It also illustrates the parent child relationship among partners.

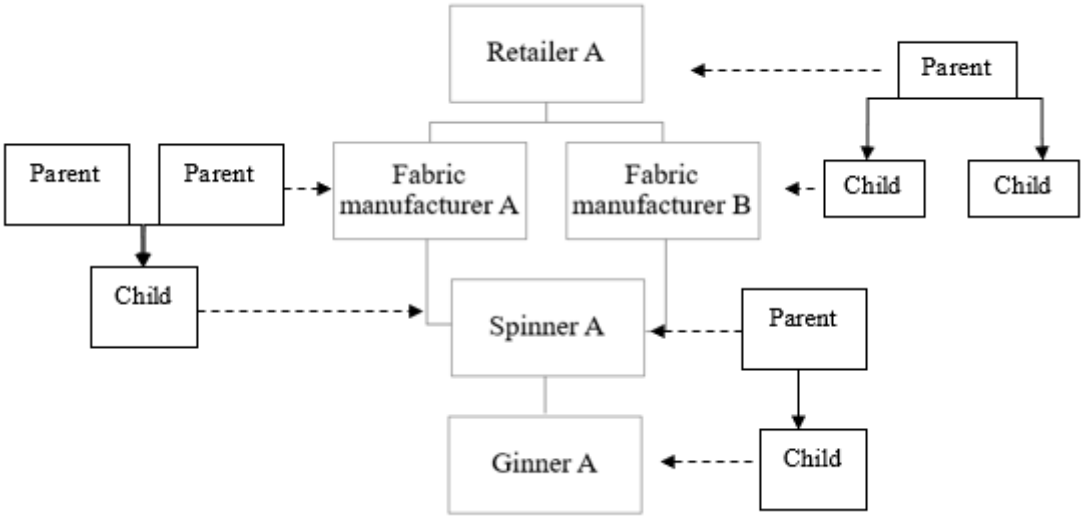

Figure 7-6. Programme hierarchy for retailer A.

When a programme is created on the platform, then the item categories will be linked to a parent of the programme. For instance, in order to move from the seed cotton, to the cotton lint structure (in Figure 7-5), a planning item or trade item should be created, in order to then link it as a parent and child with respective conversion factors and lead time. When the planning items are created, further description is defined in the

planning item, instead of saying yarn, the yarn type for instance 23 Tex OE is added. The planned item is then linked to an item class, which is pre-defined on the platform, so for this instance the item class would be yarn. The unit of measure also needs be defined when a planning item is created.

The list of items created for data to be added to the platform from Chapter 6 is listed below in Table 7-1. As mentioned the item levels need to be structured in a parent child relationship, with conversion factors and lead times associated with it. The parent child relationship could be seen in Table 7-2. All the conversion factors related to the parent child relationship are presented in Figure 7-7.

During the data entry process a number of platform functionality errors where discovered where the first entry did not allow any changes or delete options if a mistake was made. Therefore, this was one of the functions that needed to be added to programme to improve usability. Also, the unit of measure was not specified for all the items added to the system and this was also updated during this process.

Table 7-1. Item description, item class and unit of measure.

Item description	***Item class (Prefixed on platform)***	***Unit of measure (Prefixed on platform)***
T-shirt	Retail	Each
T-shirt body	Generic	Each
T-shirt ribbing	Generic	Each
145 g/m^2 Single Jersey	Greige	Meter
220 g/m^2 Single Jersey	Greige	Meter
Yarn 23 Tex OE	Yarn	Kilogram
Cotton lint	Lint	Kilogram
Cotton seed	Seed cotton	Kilogram

Table 7-2. Parent child relationship between planning items.

Parent	**Child**
T-shirt	T-shirt body
T-shirt	T-shirt ribbing
T-shirt body	145 g/m^2 Single Jersey
T-shirt ribbing	220 g/m^2 Single Jersey
145 g/m^2 Single Jersey	Yarn 23 Tex OE
220 g/m^2 Single Jersey	Yarn 23 Tex OE
Yarn 23 Tex OE	Cotton lint
Cotton lint	Cotton seed

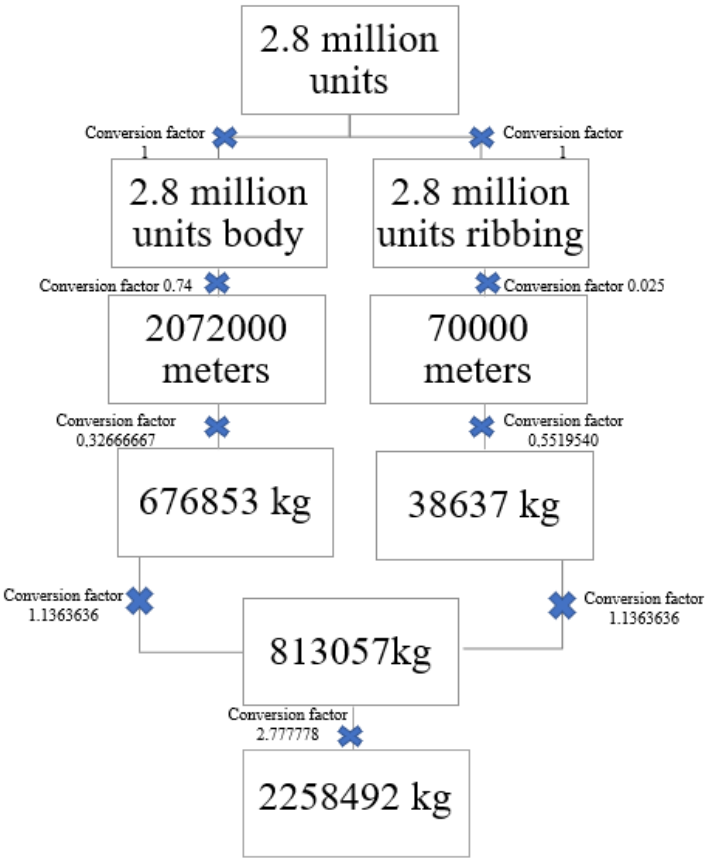

Figure 7-7. Parent child relationship and conversion factors for programme with retailer A.

The data used to define conversion factors is derived from Table 6-2 and Appendix F, Table F-1. An addition of conversion factor between cotton lint and seed cotton was calculated based on a 36% yield of cotton lint after ginning.

The programme plan is created under retailer A with regards to fabric manufacturer A. Which means that there will be a programme for both fabric manufacturer A and fabric manufacturer B, with retailer A, and it will be two separate programmes. A typical screenshot of what is added to a programme could be seen in Figure 7-8.

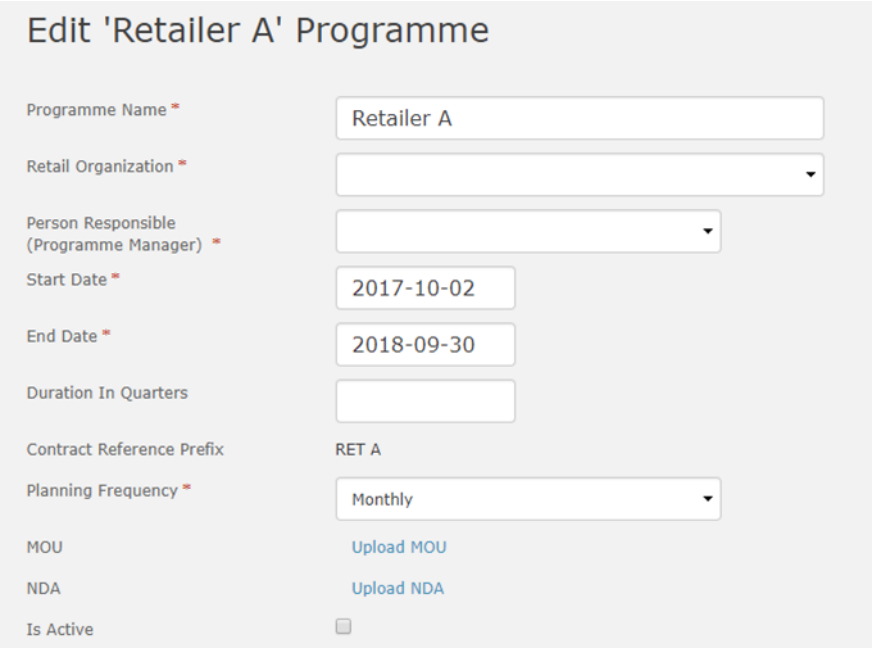

Figure 7-8. Screenshot of creating a programme.

It includes an option to attach the signed NDA and ISCP agreement or MOU to the programme. The programme is created in accordance with the time-line in Section 6.2.4. Thus, from summer delivery, starting in October, until the end of September the next year. The planning can be done on a monthly, quarterly or yearly basis, dependent on the retailer's preference. Figure 7-9 show a typical view of the platform from where planning is done, and items added, based on information listed in Table 7-1. When the planning items are linked to a parent child relationship, with conversion factors and lead times (as described in Figure 7-7, then the hierarchy structure will look like illustrated in Figure 7-10. The delivery schedule could be seen in Figure 7-11.

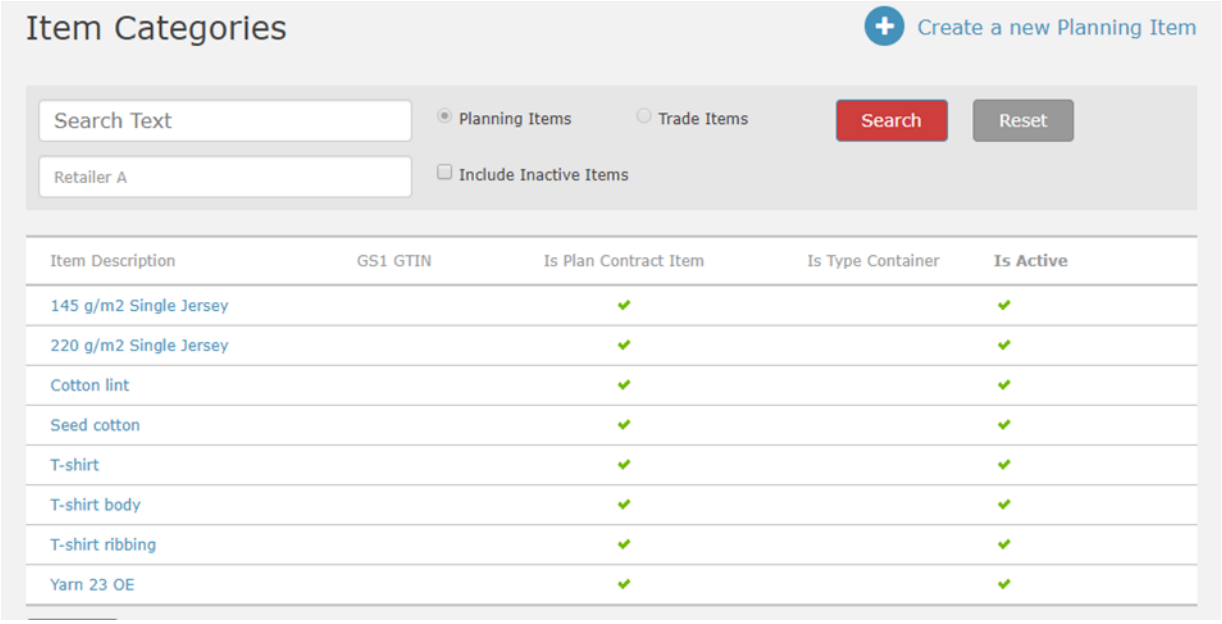

Figure 7-9. Creating planning items.

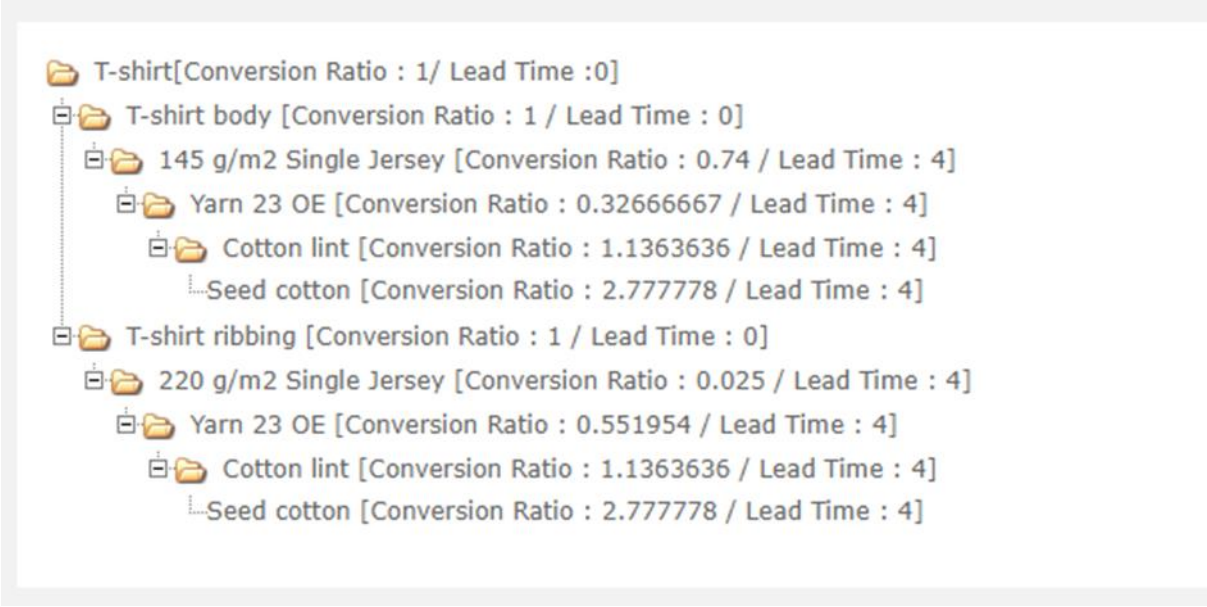

Figure 7-10. Conversion rations, lead time and hierarchy structure view on platform.

Start Jun 17 -12 -6 -3 -1 Start +1 +3 +6 +12 Oct 18 End Show Cumulative Show Class Totals

Programme Item Demand

Item Description	Jun 17	Jul 17	Aug 17	Sep 17	Oct 17	Nov 17	Dec 17	Jan 18	Feb 18	Mar 18	Apr 18	May 18
T-shirt					225,810	233,333	233,333	233,333	233,333	233,333	233,333	233,333

Calculated Item Demand

Item Description	Jun 17	Jul 17	Aug 17	Sep 17	Oct 17	Nov 17	Dec 17	Jan 18	Feb 18	Mar 18	Apr 18	May 18
T-shirt body					225,810	233,333	233,333	233,333	233,333	233,333	233,333	233,333
T-shirt ribbing					225,810	233,333	233,333	233,333	233,333	233,333	233,333	233,333
145 g/m2 Single Jersey				155,959	167,096	178,236	167,096	172,666	189,376	155,956	178,236	167,096
220 g/m2 Single Jersey				5,268	5,645	6,021	5,645	5,833	6,397	5,269	6,021	5,645
Yarn 23 OE			48,082	59,624	59,623	59,623	57,700	65,393	59,623	55,776	59,623	59,623
Cotton lint		48,082	67,752	69,938	65,566	67,752	72,123	67,752	69,938	61,195	69,938	65,566
Seed cotton	121,420	182,128	194,271	188,199	182,127	206,412	182,129	194,269	188,199	176,058	188,199	182,127

Figure 7-11. Demand forecasted data on a 12-month delivery schedule, calculated monthly.

No interfacing is done in the planning phase, the programmes are loaded manually on behalf of retailer A, by company X. The only entities that have access to the planning programme phase is retailer A and company X. The reason for this is if other competitors within one retailers programme, were allowed to see this information, it will reveal data that is of a sensitive nature. Ideally the loading of programmes should be done by the retailer, but since this is the first year of implementation, company X assisted with this process. Staff should be trained to load programmes in the coming planning period. Also loading the planning items to the platform is time consuming because there is no save function of a programmes planning items[29], in order to us the same planning items in another programme, which becomes challenging when 100's of SKUs need to be added to the programme.

A request was made by the ISCP developer for the view of planning programmes, to be restructured, in order for all the suppliers in retailer A's SC to see the intended delivery schedule. However, incorporating changes as significant as this will require man-hours, and ultimately be very expensive. It was concluded after the implementation of the ISCP that there is a need for the yarn spinners to have access to this kind of information in order to determine their delivery schedule. Even though the ISCP does offer this kind of information, the platform is a more reliable tool to distribute this information compared to excel spreadsheets. The ISCP also consists of a tool to change the monthly demand manually when the actual monthly forecasts are received. Another option to consider is to add an automatic data export function to the platform, which could then be used to distribute to relevant data to relevant parties, without breaching confidentiality, which may be a cheaper option to consider, than to change the structure of the programme. It could also be a short-term solution to the visibility problem.

[29] Planning items of one programme could not be carried over to another programme, it need to be added again for a new programme

Also, it is possible to add all the programmes related to one retailer, for instance to add both fabric manufacturer A and B to one programme, refer to Figure 7-12.

Figure 7-12. Conversion structure and hierarchy for both fabric manufacturer A and B.

However, this way of representing data is sometimes not possible or even helpful, since some of the underlining departments are separated, for instance sportswear from apparel products which will include one fabric manufacture and not the other. Also, from the greige fabric conversions, there is no separation between fabric manufacturer A and B. Thus, the amount of cotton lint per fabric manufacturer will be unknown. It depends solely on the retailer and how it operates and how the data is structured.

7.2.3. **Manage programme**

The CBISP allows participants to store and upload important documents, such as meeting minutes, manuals, standards, and signed documents. The documents can be loaded in a protected view format, which will only be visible to relevant parties. The tool only allows documents to be added once, which means it saves time and documents can be carried over to other parties and following planning years.

The CBISP is programmed to interface via the cloud with individual ERP systems. The interfacing allows tracking of Global Standards (GS)1[30] codes and links the codes between suppliers, to be traceable. After the first meetings with the relevant suppliers, only the ginner and spinner, had the capability to interface without significant financial inputs, which means that the SC partners that are financially impacted are the fabric manufacturer's, due to their inability to instantly interface with the ISCP. The interfacing time-line for all the

[30] Identify companies and products based on bar codes as well as electronic product codes (EPC) etc.

suppliers was supposed to be September 2017, and due to financial implications and lack of internal contracts, the system could not be implemented to its full potential. Another problem was that there were no available trackable trade item codes related to the ISCP programme with retailer A and fabric manufacturer A and B. This means that at the fabric manufacturing stage, a fabric is manufactured in bulk and then it is used to manufacture different garments which is not necessarily only for the ISCP programme with retailer A. Therefore, some of the garments of one particular fabric will go into business as usual programmes and not ISCP programme. However, it does not make sense to only manufacturer a piece of fabric just for the ISCP programme, if they have other customers require the same fabric to be delivered at the same time.

The same problem occurs at the yarn spinning stage, for example: even though the customer may require 40 tonnes per month, of a particular yarn, for the ISCP programme. The spinner would manufacture 200 tonnes which is the maximum capacity produced per month, were the balance will be sold to other suppliers. Ideally, the purchase orders and contracts will be linked to a programme, as seen in Figure 7-4, This will automatically drawdown the anticipated cotton lint volume, in order to show the retailer what the orders progress, as well as how many orders need to be pushed in order to meet the predicted cotton volume within 12-months.

Adding purchase orders and contracts manually is possible, but due to lacking of contracts between suppliers, a purchase order cannot be made, since a contract is a pre-requisite for the purchase order. Another problem that was noted is that the order numbers or trade item numbers could not be traced[31] back, since fabrics are woven or knitted in bulk and then cut into various ratings for garments. Thus, it could not be added to the platform manually because of lack of GS1[32] codes or trade item numbers. It was decided to work on a mass balance system in order to keep track of amount of fibre used in each link of the SC. Adding purchase orders manually is also very time consuming since there could be 100's of different SKUs within one fabric manufacturer therefore, there is room for error when added manually.

[31] From the spinner to the retailer.
[32] A GS1 code is a unique identifiable code that is linked to trade items, which could be obtained by means of GS1 company prefix form a GS1 member organisation.

7.3 Conclusion

This chapter outlines the pilot test of CBISP, by means of data collected in Chapter 6. The purpose of this chapter is to answer research questions relating only to the CBISP. The main question around the possibility of a garment to be fully traceable, by means of the platform is not answered, where at this stage, full traceability could not be tested or implemented due to the following reasons: Firstly, the inability to implement the platform fully due to SC partners lacking basic ERP systems or existing ERP systems are outdated with very high costs to update; Secondly, the SC partners lack supplier contracts between buyers and sellers; and Thirdly, there is an absence of internal GS1 identification keys or trade numbers at some links of the SC which are needed to scan barcodes, and finally, the lack of time to implement another programme with another retailer to test traceability.

However, the reason for the system not being traceable is not due to the system that is incomplete but rather the industry that needs support for updates and improvements, before it can be implemented. It did however benefit some of the links in the SC, which were ready for implementation and forced companies that were not ready to start thinking about upgrading their internal ERP system. These issues highlighted the need to upgrade in order to have more visibility and control over a trade item's traceability.

For future research, the implementation of the platform should continue, in order to fully understand the benefits, it might bring to the industry. Even though the implementation was unsuccessful in this research study, it did answer the research question with regards to "*allowing forward planning, SC visibility and better control over the SC?"* because it did enable SC visibility for the retailer which improved planning. However, since there was an absence of contracts between buyers and sellers, the drawdown function of cotton lint was not implemented and manual drawdowns were done (in excel) in order to track orders against planning.

The CBISP is easy to use but it has limited visibility with regards to the rest of the SC, and improvements for this should be done. With regards to adding data to the platform, it is relatively easy to use, but it does require training at all levels. Small changes such as editing and deleting functions were added in the pilot study as well as change in units of measure. The system in its current state, is ready for implementation, and fully functional however, the participants in the ISCP are not yet ready for interfacing. Options to consider in future research is to add an automatic export function to the platform which imports into excel, in order to distribute relevant data to relevant parties manually. However, this is not a suitable long-term solution but more like a "quick-fix" option, and restructuring the platform would be needed as a long-term solution. The platform is currently being tested with other retailers, which operates differently than retailer A's platform, and the success of the implementation will be determined in the near future.

8 Recommendations and conclusions

This chapter explains and outlines all the recommendations with regards to the ISCP and the CBISP, as well as the textile industry. The conclusions were made based on research done in Chapter 6 and Chapter 7. Refer to Figure 8-1 for more information about the research structure.

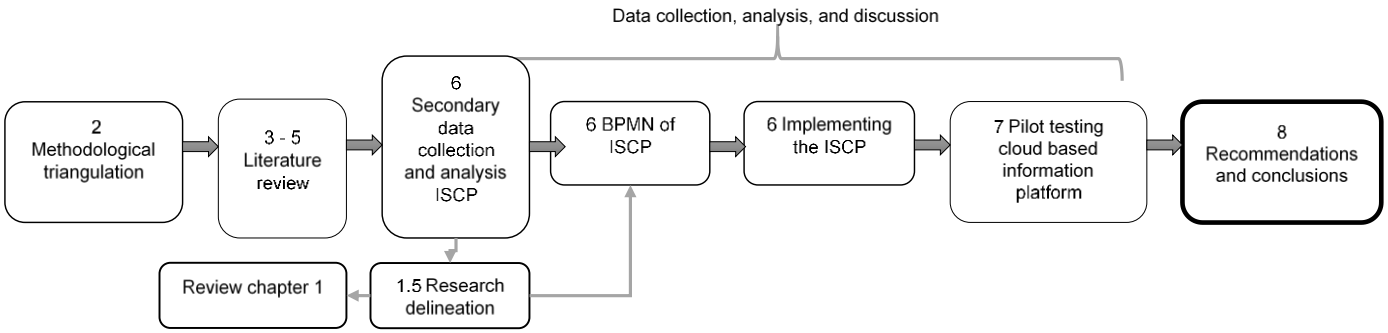

Figure 8-1. Recommendations and conclusion chapter in research structure.

8.1 Recommendations

Implementing the ISCP with a local retailer in SA, uplifted the local garment manufacturing SC, and highlighted certain aspects of the industry. The potential of the ISCP was also noted. Thus, while the ISCP was implemented, it was noted that there is a shortage of local blended yarn suppliers and spinning capacity. Thus, it is recommended that there is need to add alternative yarn suppliers, in Southern Africa, to the ISCP programmes in the future, that spin blended yarns. Furthermore, there is still a need to increase the spinning capacity in SA for 100% cotton yarns. Also, the reopening or investing in yarn spinning facilities in SA is important to consider in the future. With the success of implementing the ISCP with garments, it is recommended that other cotton products such as towels, kitchen cotton products, sanitary products and cosmetic products also be added to the ISCP with alternative retailers related to the products. Also, it is recommended to consider other sustainability factors such as recycling or water saving initiatives, reduced electricity usage and recycling raw materials for future implementation of the ISCPs. The ISCP could include the potential of cotton seed production and processing in SA. Also, other recommendations to give a better view of the ISCP and increase the views of the benefits of the ISCP could include: developing a simulation model to simulate a garment SC, which could broaden the understanding of a retailer, what the effect on the whole SC will be if the ISCP is implemented. Implementing a methodology such as system dynamics could also benefit the ISCP by fully understanding the behaviour of the various stakeholders and business processes which are complex system due to the multiple causal relationships and interactions.

Since the ISCP model is business orientated, it could be altered and modified to fit to other industries like the food industry for instance. With major food wastage and sustainability issues in the food sector, the ISCP will bring about positive influences in the food industry when implemented and the CBISP could bring even more opportunity towards visibility in the food sector. Crop rotations, during cotton lint cultivations could be considered when the ISCP is implemented in the food sector with small-scale farmers being added to the food sector as well.

Due to issues raised in the pilot study of the CBISP, it is recommended to make supplier contracts between parties a pre-requisite for the ISCP in order to avoid supplier contracts to be absent in the ordering and trading phase. It would also be recommended that company X, look into alternative funding options to further uplift the industry, where ERP systems and other technologies are lacking. In order to improve the functionality of the CBISP, it is recommended that a function to improve visibility to all the suppliers in a retailer's SC is implemented. Piloting a technology for the first time won't be perfect and flawless and it would be recommended to use alternative retailers in order to test the CBISP.

With regards to the textile industry, recycling plastics and using it in the clothing manufacturing industry is becoming more and more popular and it is recommended that a local plastic recycling initiative should be considered as a major opportunity in SA. Since the production of cotton increased in the last 2-3 years there is major opportunity to look for alternative uses for seed cotton to produce local products and additives in many industries such as cosmetics, healthcare, industrial, biofuels, and food.

8.2 Concluding remarks

Implementing the ISCP with a local retailer in SA not only uplifted the local garment manufacturing SC, but also highlighted certain aspects of the industry, and the potential of the ISCP. Thus, while the ISCP was implemented, it was noted that there is a shortage of local blended yarn suppliers and spinning capacity. Thus, it could be recommended that there is a need to add alternative yarn suppliers who spin blended yarns in Southern Africa to the ISCP programmes in the future. Furthermore, there is still a big need to increase the spinning capacity in SA for 100 % cotton yarns as well, and reopening or investing in yarn spinning facilities in SA is important to consider in the future. With the success of implementing the ISCP with garments, it is recommended that other cotton products such as towels, kitchen cotton products, sanitary products and cosmetic products could also be added to the ISCP, with alternative retailers related to the products. Also, it is recommended to consider other sustainability factors such as recycling or water saving initiatives, reduced electricity usage and recycling raw materials for future implementation of the ISCP's. The ISCP could include the potential of cotton seed production and processing in SA. Also, other recommendations to provide a better view of the ISCP and increase the potential benefits of the ISCP could include:

- developing a simulation model to simulate a garment SC, which could broaden the understanding of a retailer, and illustrate the effect on the whole SC if the ISCP is fully implemented; and

- implementing system dynamics on the ISCP which could benefit the ISCP by fully understanding the behaviour of the ISCP as it is a hugely complex and inter related system.

Since the ISCP model is business orientated, it could be altered and modified to fit other industries like the food industry for instance. With mayor food wastage and sustainability concerns in the food sector, the ISCP could potentially bring about positive influences in the food industry when implemented, and the cloud based information system would bring even more opportunity towards visibility in the food sector. Crop rotations, could be considered when the ISCP is implemented in the food sector with small scale cotton farmers being added to the food sector as well.

Due to issues raised in the pilot study of the cloud based information platform, it is recommended to make supplier contracts between parties a pre-requisite for the ISCP in order to avoid supplier contracts to be absent in the ordering and trading phase. It is also be recommended that company X needs to look for alternative funding to further uplift the industry, where ERP systems and technology is lacking. In order to improve the functionality of the cloud based information platform, it is recommended that a function to improve visibility to all the suppliers in a retailer's SC is developed. Piloting a technology for the first time won't be perfect and flawless and it is recommended to use alternative retailers in order to test the cloud based information platform.

With regards to the textile industry, recycling plastics and using it in the clothing manufacturing industry is becoming more and more popular and it is recommended that a local plastic recycling initiative should be considered as a mayor opportunity in SA. Since the production of cotton increased in the last 2-3 years there is major opportunity to look for alternative uses for seed cotton to produce local products and additives in many industries such as cosmetics, healthcare, industrial, biofuels, and food etc.

8.2.1. **Integrated Supply Chain Programme**

The research structure, explained in Chapter 6, aimed to answer the first part of the research questions in Section 1.2 and aimed to answer the second research objectives explained in Section 1.3. The main aim was to improve the ISCP, though BPM, to test the added benefits of the ISCP which includes aspects such as price stability, improve local capacity and create jobs in the textile sector.

However, this is not the only advantages to the industry and the following conclusions have been made. The ISCP does not only benefit one party in the SC but offers support and advantages to all the participants in the SC. The ISCP's purpose is not to remove or reduce competitiveness amongst participants, but aims to empower the industry, specifically the local retailing garment sector. The aim for the ISCP is to facilitate forward planning, through long-term contracting, to ensure that the products meet the demand of the consumer. The ISCP could be used to communicate important marketing information to consumers, and also ensures market credibility and SC transparency. A single entity managing a commodity and its SCs or distribution process has a greater ability to optimize resource utilization and avoid wasted costs, hence the ISCP supported this

statement. The ISCP improved long term partnerships amongst stakeholders. The ISCP model received an international recognition as a leading business model for virtual SCI at the 2016 international textile exchange conference in Germany.

8.2.1.1. Business process model and notation of the ISCP

Since the ISCP was implemented with another retailer A, it was important in this research study, while reviewing the ISCP, to improve it. BPMN allows a company to integrate business processes from different organizations in one view, in order to better understand the impact of the ISCP on different SC partners. Following the ISCP method on its own is one thing, but trying to balance it with a real-world situation or phenomenon requires coordination of business as usual processes. Thus, the use of BPM to gain an understanding of the processes on various levels was key in communicating the business processes to stakeholders. The BMPN could also be understood by anyone since a universal notation language is used. It also allows better understanding of why a certain phenomenon should take place in a specific time-line.

8.2.1.2. Added advantages and opportunities to local retailer

With regards to the retailer, the ISCP allows improved control over their value chain, due to better SC visibility. It may increase stakeholder trust, through transparent virtual partnerships throughout the SC. The ISCP allows the retailer to purchase only BCI cotton which is seen as a sustainable raw material. The total transparency of the SC allows the retailer to market their products with high certainty. It also allows retailers to set sustainability goals and be able to account for it in the future with certainty.

Increasing local garment production by shifting international demand to local demand creates jobs. With import substitution of 10% of only four basic items to local, could create 15000 jobs, for 25% 37000 jobs could be created and 50% 75000 jobs could be created. If 25% of the four basic items, were to shift to locally produced items, R4.9 billion could be added to the economy (De Wet, 2017). Any direct involvement with the ISCP along the value chain will be recognised for Enterprise and Supplier Development points (for qualifying entities) on the B-BBEE scorecard.

8.2.1.3. Added advantages and opportunities to manufacturers and spinners

In business as usual, fabric manufacturers had no indication of what the demand from the retailer would be when fabric manufacturing started. This means that there was no downstream visibility to the retailer, as well as the consumer. This resulted into buffer stocks that needed to be manufactured, and stored at own risk and costs, with no commitment as to if there even will be an order for that particular fabric. The ISCP allowed manufacturers to have better line of sight upstream, as well as downstream. The ISCP offers quality selection support for the ISCP. A major advantage is price fixation and stability for 12-months. This means that they will be able to do more efficient planning. The data extracted from the ISCP especially assisted in the delivery scheduling of the spinner, also increased planning efficiency. The ISCP increased the need to use local spinners and uplifted the spinning industry in SA. As mentioned in Section 8.2.1.2, BCI cotton is used in the ISCP

which allows manufacturers and spinners to get BCI certification. Sourcing from only one local cotton gin, improved spinning capability because of less contamination and higher quality.

8.2.1.4. **Added advantages and opportunities created for ginners and farmers**

Since the first pilot study of the ISCP, the local gin used in the ISCP is owned, only by farmers. Historically a gin was not owned by the farmers and a ginning fee was payed or the seed cotton was sold to the gin. By owning the gin costs are reduced. With a 12-month contract and commitment from the retailer, at a specific price point, the farmer and gin could do forward planning in order to estimate what needs to be planted to fulfil the demand. Area cotton planted in SA increased from 8000 ha to nearly 16000 ha from 2014 to 2015. In 2015 around 94 000 lint bales were produced over the 38470 bales in 2014. In 2016 due to drought the production fell to 55000 bales of lint, and for 2017 there is an estimated 82611 bales of lint. Since 2014, the cotton lint production improved significantly due to the ISCP. The aim for 2020 is to produce 300000 bales of cotton lint. An initiative to increase small-scale farmers was also included into the ISCP which allows small-scale farmers to sell their cotton to the gin and make a profit. The ISCP supported the growth of small-scale cotton farmers and uplifted the agricultural sector with an increase of local cotton lint production of almost 50% in the last 2 years.

8.2.2. **Cloud Based Information System Platform**

Since the CBISP was not implemented before, a pilot study was conducted, to answer the research question which states "*could a cotton garment be fully traceable*?" in Section 1.2. By testing the platform not only the traceability function was tested but other functions as well, like, what needed to be added or changed to make the system more successful.

The following conclusions were made: the usability was tested and some changes such as edit and delete functions were made in order to improve the usability of the system. Furthermore, adding planning programmes to the platform requires training and when understood it is fairly easy to add it to the platform. Adding all the planning items manually is time consuming and there is room for error and planning items cannot be saved and re-used in different programmes. The visibility of the programmes is limited to the retailer.

There is a need for other suppliers in the SC to have visibility of the demand scheduling and is still done manually via excel and there is a large room for error. Changes are required to improve visibility, but it will cost money. The platform allows the data to be distributed on a monthly delivery schedule with lead times, which is a very useful tool. All the documentation related to the ISCP could be loaded onto the platform and protected view could also be incorporated.

Interfacing with some of the participants in the ISCP was unsuccessful due to limited funding to upgrade existing ERP systems or absence of ERP system. In order to load a purchase order manually to the system requires supplier contracts which was also not available or in place which restricted any orders to be loaded and the drawdown of cotton lint to the planning programme could not be seen on the platform. The traceability

function works on GS1 identifiable codes which should be coded internally, which was also lacking at some of the suppliers. The fabric manufacturers work on bulk production which makes it extremely difficult to have trade item traceability. Thus, manual mass balancing was used to determine (in excel) the lint draw down as order came through. Thus, implementation of the platform was unsuccessful due to external factors. The platform should be re-assessed and re-implemented with another retailer to test its traceability capability. Even though, the platform was unsuccessful with regards to traceability, it did allow users to gain advantages from the platform. The CBISP, received an Innovation Award at the Outsystems 2015 Global Conference in Lisbon.

Overall the study achieved the aim of addressing issues regarding local cotton production and processing capacity, sustainability, price instability, SC visibility, SC efficiency, response to demand shifting, and traceability. A number of recommendations have been made and the study successfully contributed to the knowledge base of implementing an ISCP for cotton garments in SA.

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APPENDICES

A. Yarn count conversions

Table A-1. Unit conversions for yarn count.

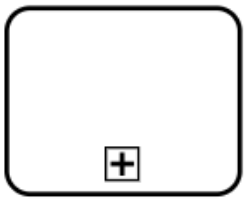
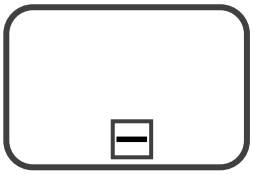
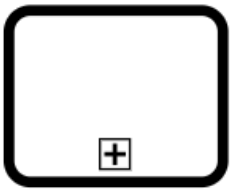
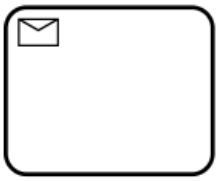
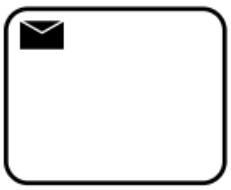
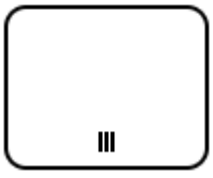
	Direct system			Indirect system	
From	To tex	To denier	To jute	To English	To metric
Tex (nt)	1	9.0 Nt	0.029 Nt	590.5/Nt	1000/Nt
Denier (Nd)	0.11 Nd	1	0.0032 Nd	5315/Nd	9000/Nd
Jute (Nj)	34.45 Nj	310 Nj	1	17.14/Nj	29.02/Nj
English (Ne)	590.5/Ne	5315/Ne	17.14/Ne	1	1.693/Ne
Metric (Nm)	1000/Nm	9000/Nm	29.02/Nm	0.5905/Nm	1

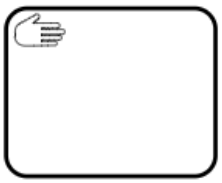
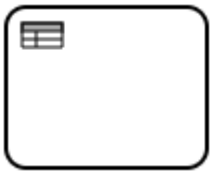
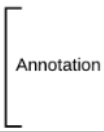
(Source: Alagirusamy & Das, 2010:28).

B. BPMN symbols and meaning

Table B-1. BPMN symbols and descriptions.

Categories	Symbol	Description
Swim lanes: Pool and lane		A pool is used to represent major participants in a process and could separate different organisations from one another. A pool could have one lane, or more than one lane. The lane is used to categorize the activities within a pool according to a role or a function.
Start event		An event symbol to indicate that a process started. It is a circle drawn with a thin line.
Intermediate event		A symbol that represent an intermediate event in a business process
Message intermediate catch event		An intermediate event which represents the catch event of a message. This triggers events to influence the course of processes. The message is not limited to letter, emails, or calls etc.
Message intermediate throw event		An intermediate throw event, is an active event that is triggered during a process or at the end of the process.
End event		A symbol that represents the end of a business process
Activity: Task		A normal task is a single action that occurs in a business process. This task cannot be broken down into further level of business process detail.

Activity: Sub process collapsed		A sub process which is collapsed are used to hide additional levels of business process detail. The plus sign indicates that the sub process is collapsed.
Activity: Sub process expanded		A sub process expanded would show the flow objects, connecting objects and artefacts.
Activity: Call activity (sub process collapsed)		A call activity refers to a process that is external to the process in the definition. It is differentiated from other activities with a thick border.
Task: Receive task		A receive task would be the opposite of the send task where the task would wait for a message to arrive in a different pool or external participant.
Task: Send task		A send task could be used to send a message to an external participant or another BPMN pool. Once the message is sent then the task would be completed. A message flow notation could be used to link the task to a participant.
Task: Parallel mutli instance		Multi-instance activities are performed more than once with different data sets.

Task: Manual task		A manual task is used where an activity should be done manually.
Task: Business rule		A business rile is a specific type of service or activity that is maintained within one business working group.
Gateway: Exclusive event based		An event is being evaluated to determine which of mutually exclusive paths would be taken.
Gateway: Complex gateway		Complex gateways are used to model complex synchronization behaviour
Connections: sequence flow		An arrow that represents the flow of data and connecting the flow of processes or objects in a sequential manner.
Connections: message flow		A symbol that represents the flow of messages from one process participant to another
Connections: associations		An association is used to connect artefacts or text with flow objects, it could also indicate directional flow.
Data: Data store		Data store allows an activity to retrieve data or update stored information
Data: Data object		A data object is used to show data that is required or produced in an activity. A data object may have a state that depict how the object is updated within a process and is shown under the name of the data object in brackets.
Artefacts: Annotation		An annotation is used to describe additional flow parts of the business model or describe the group.

C. Methodological triangulation

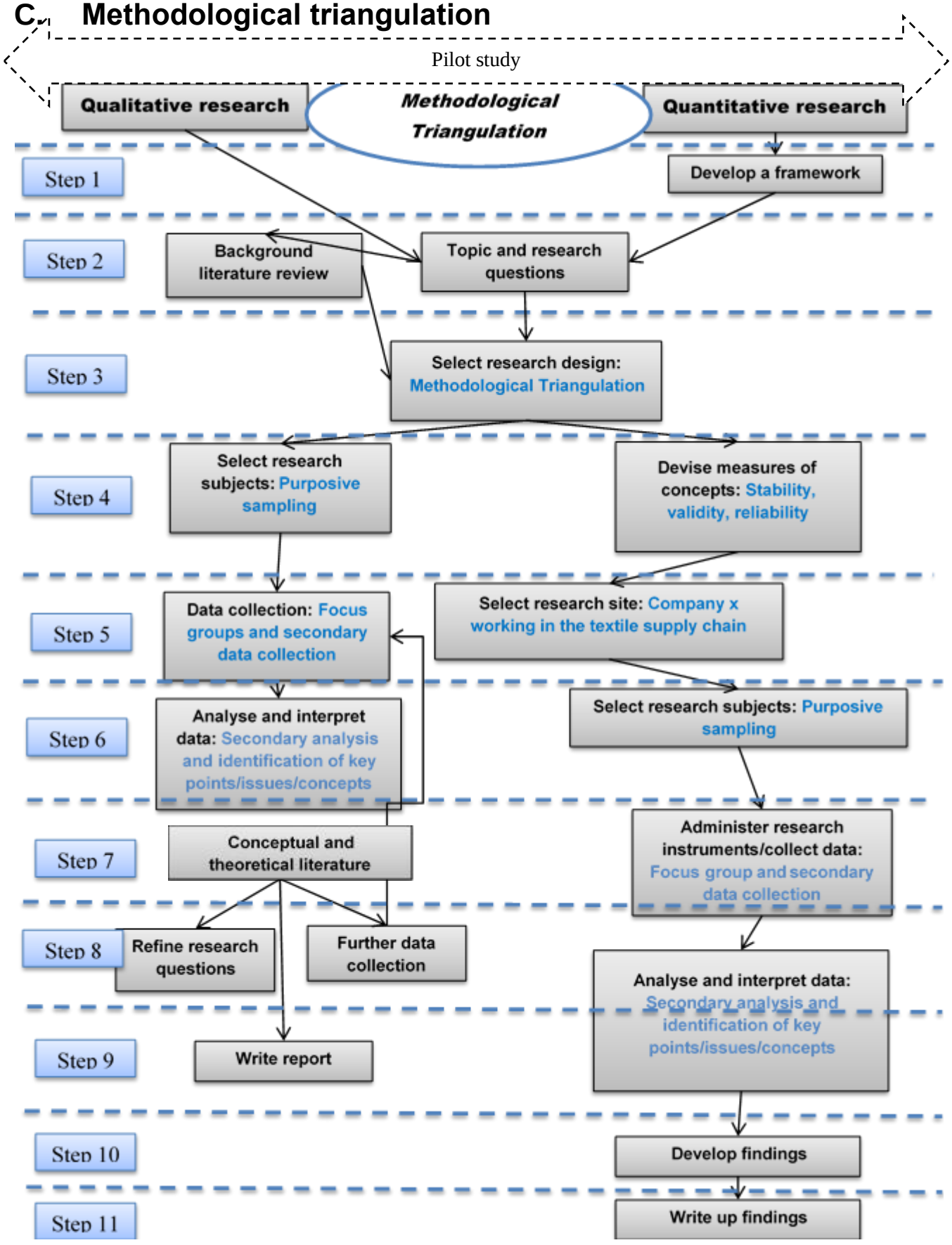


Figure C-1. Methodological triangulation (Adapted from Bryman & Bell, 2014:32,41).

D. Cotton lint grading system, SA versus USA.

B	A2	A1	AO	AX	CLASS	CLASS	AX	AO	A1	A2	B
1,03	1,06	1,09	1,13	1,18	HVI STAPLE	HVI STAPLE	1,18	1,13	1,09	1,06	1,03
1 1/32"	1 1/16"	1 3/32"	1 1/8+"	1 3/16"	STAPLE	STAPLE	1 3/16"	1 1/8+"	1 3/32"	1 1/16"	1 1/32"
	3.30 - 3.49	3.00 - 3.29	3.30 - 3.49	3.30 -3.49	MICRONAIRE	MICRONAIRE	3.30 -3.49	3.30 - 3.49	3.00 - 3.29	3.30 - 3.49	
GRADE					South African Grading	USA Grading	GRADE				
		RS	RS		DEAL	Good Middling		RS	RS		
		RS	RS		DIRK	SM		RS	RS		
	OE	OE			DOLY	MIDDLING			OE	OE	
	OE	OE			DUNS	SLM			OE	OE	
					LFY	LM					

*RS = Ring Spun
*OE = Open end

Figure D-1. SA cotton lint grading vs USA cotton lint grading (Adapted from CSA).

E. Guideline for calculating meter-, yarn- and fibre requirements for garments

To start the quantification process, it is important to start at retail level to convert the specific fabric or garment into total meters, yarn and fibre required for two seasons over a period of 12-months.

When data is received from various retailers, it may be represented in different ways such as:

i. Total meters of a specific fabric that could be used for multiple garments, that are calculated based on the previous production year
ii. Total number of units or stock keeping units (SKUs), that are calculated based on the previous production year (This could be multiple fabrics with multiple fabric ratings)

Calculations based on total meters received

The total meters received would be for a specific fabric type, for instance: **145 g/m^2 single jersey** and **100% cotton fabric**. Because the total meters are already defined it is not necessary to define the rating at this stage because the rating won't be known at this stage and the rating will not be used in the calculations. The garment manufacturer however works on a standard **width** per specific fabric and this would be important to define to convert **meter of fabric** into kilogram of yarn. As soon as the total required yarn is calculated then this should be divided into the specific yarn types in weight per 1000 meter's (**Tex**) or English cotton count (Number English or Ne). Again, one fabric could have multiple yarns.

To convert meters of fabric into total kilogram of yarn the following needs to be defined:

i. Total meters of fabric (m)
ii. Fabric weight per square meter (g/m^2)
iii. Fabric type
iv. Fabric composition (fibre level) and percentage (how much of that particular fibre are present in the fabric)
v. Yarns used to produce the specific fabric
vi. Losses occurring during fabric manufacturing process

The conversion process could be done as following:

Amount of meter of fabric (A)*(100%) x width in meter (B) = amount of square meter of fabric (C)

Thus: A(m) x B(m) = C (m^2)

**Make sure to account for percentage of fibre if the fabric is not 100% cotton*

Now amount of square meter of fabric (C) x weight per square meter (D) = total weight of fabric (E)

Then: Total weight of fabric = total weight of yarn (After losses has been deducted) (E)

In the production process of the fabric there are two losses:

i. Dying loss (more or less 10%)
ii. Weaving/Knitting loss (more or less 3%)

These losses may vary from fabric to fabric based on the type of equipment used etc.

Thus, a total of the dying and weaving or knitting losses should be accounted for to define the total amount of yarn.

Total weight of yarn (E) / (100%-13%=87%)or (1-0.13=0.87)(F) = Total weight of yarn before losses or total yarn required (G)

Based on how many yarns were used in the fabric the total required yarn could be worked out based on a percentage value. Sometime they would not be able to give the percentage of yarn used and it then needs to be calculated. In weaving they normally define the yarns as warp yarns and weft yarns. The warp yarns are directed longitudinal or length wise and the weft yarns are transverse.

Some specifications indicate the number of picks and ends of a specific fabric. The picks could also be seen as the amount of yarn treads (per inch) present in weft direction and the ends the amount of yarns (per inch) present in the warp direction. Meaning the difference between the picks and ends will give an indication of the percentage of yarn used per square meter.

For instance, if the ends of a fabric per inch is 50 and the picks of a piece of fabric is 24, then it means that 2.54 cm x 2.54cm of fabric has 50 warp yarns and 24 weft yarns. Meaning in 1 square centimetre there are in total 50+24 = 74 yarns in total.

Thus, the percentage warp yarns will be (50/74*100%) and the percentage weft yarns will be (24/74*100%).

To convert total kilogram of yarn into total kilogram of fibre the following needs to be defined:

i. Total yarn required (G)
ii. The total losses during the yarn spinning process, based on the specific spinning method (more or less 12%)

Then the conversion process could be done as following:

Total weight of yarn before losses or total yarn required (G) / (100% -spinning loss % or 0.88)(H) = Total fibre required for total meters of fabric defined earlier (I)

Calculations based on total SKUs or units received

When a retailer provides, information based on **number of units or SKUs** the conversion of data start to become more complicated. Because the units could be based on **more than one fabric** at **more than one fabric weight** etc. They may be able to provide information with regards to how much units will be for what type of fabric but the **ratings** would be unknown. Thus, more assumptions would have to be made in the beginning of the volume calculations. For instance, of that total SKUs or number of units, what would the bulk rating or the average rating be? Because the SKUs may range between Men's and Women's ware as well as

boy's or girl's ware or even baby ware, it is difficult to assume an average rating to start with. As the process progresses, and the orders starts to become clearer, only then actual ratings could be used.

To convert units into meter of fabric the following needs to be defined:

i. Fabric type
ii. Total units or SKUs
iii. Garment rating (m)
iv. Fabric composition (fibre level) and percentage (how much of that particular fibre are present in the fabric)

The conversion process could be done as following:

Total units (A) x garment rating (m)(B) = *total amount of meter of fabric (m)(C)*(100%)

**Make sure to account for percentage of fibre if the fabric is not 100% cotton*

In order to convert meter of fabric into kg of fabric the following needs to be defined:

i. Fabric weight (g/m^2)
ii. Fabric width (m)
iii. Tube size for knitting
iv. In weaving the only information needed will be fabric weight and width of that fabric
v. In knitting, there could be a possibility that the garment is knitted in a circular tube then another conversion factor is used

The conversion for meter of fabric into kg of fabric in weaving:

Total amount of meter of fabric (m)(C) x fabric width (m) (D) = Total number of square meters of fabric(m^2)(E)

Then: The number of square meters of fabric (m^2)(E) x fabric weight (g/m)(F) = *total grams of fabric (g)(G)

****The grams could be converted to kg by dividing the total grams of fabric with 1000***

The conversion for meter of fabric into kg of fabric in spinning:

If the tube is 98 then it would be ((100000/(98*2))*fabric weight))))(H)

To convert kg of fabric into kg of yarn required the following needs to be defined:

i. Losses during the woven or knitting process
ii. Dying losses during fabric manufacturing
iii. Conversion for meter to kg

The conversion for kg of fabric into kg of yarn for in weaving:

Total grams of fabric (g)(G)/1000 / (100%-13%losses or 0.87) = Total kg of yarn required (I)

The conversion for kg of fabric into kg of yarn in spinning:

Total meter of fabric (m)(C) /Conversion kg to meter (H)= total kg of yarn after losses (J)

Thus, need to account for spinning and dyeing losses

Total kg of yarn(J) / (100%-13%losses or 0.87) = Total kg of yarn required before losses(I)

To convert total kilogram of yarn into total kilogram of fibre the following needs to be defined:

i. Total yarn required (I)
ii. The total losses during the yarn spinning process, based on the specific spinning method (more or less 12%)

The conversion from kg of yarn to kg of fibre for spinning losses:

Total weight of yarn before losses or total yarn required (I) / (100% -spinning loss % or 0.88) = Total fibre required (K)

Based on how many yarns were used in the fabric the total required yarn could be worked out based on a percentage value of the total yarn in kilogram calculated.

F. Calculations and conversions factors

Table F-1. Excel spreadsheet: calculations and conversion Section 6.3.2.

First volume commitment calculations			**OE/23 Tex**	**OE/23 Tex**	
	Units	**Specifications**	**Body**	**Rib**	**Grand totals**
Fabric type		Single			
Fiber content		100% Cotton			
Weight	GMS	145	145	245	
Total units Fabric manufacturer A	units	2 800 000	2800000	2800000	
Total units Fabric manufacturer B	units	1 200 000	1200000	1200000	
Total Units projected 16/17 (Fabric manufacturer A & B)	units	4 000 000	4 000 000	4 000 000	
Fabric Rating Mens	meter	0,74	0,74	0,025	
Total garment percentage	%	100%	100%		
Total meters fabric	m		2960000	100000	3060000
Total meters fabric after losses dyeing (10% and 3%) and weaving/knitting	%		3402299	114943	3517241
Meters per kg (added dyeing and weaving/spinning loss)	m/kg		3,5	2,1	
Aprox kg's of yarn	kg		966933	55195,40	1022129
Yarn Fabric manufacturer A	kg		676853	38637	715490
Yarn Fabric manufacturer B	kg		290080	16559	306639
With added waste during spinning of yarn	%		12%	12%	
Total fiber after waste added	kg		1098788	62722	1161510
Fiber Fabric manufacturer A	kg		769152	43905	813057
Fiber Fabric manufacturer B	kg		329636	18817	348453
Total ton of fiber needed	**ton**		**1098,79**	**62,72**	**1161,51**

Waste breakdown		
Fiber loss spinning	%	12
Loss dyeing	%	10
Loss knitting	%	3
* All information in blue will change if manufacturer changes		