

Supply chain design approaches for supply chain resilience: A qualitative study of South African fast-moving consumer goods grocery manufacturers

**Authors:**

Assilah Agigi¹
Wesley Niemann¹
Theuns Kotzé¹

Affiliations:

¹Department of Business Management, University of Pretoria, South Africa

Corresponding author:

Wesley Niemann,
wesley.niemann@up.ac.za

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Orientation: In today's globalised and complex business environment, firms are ever more vulnerable to supply chain disruptions, originating both internally and externally from the supply chain. Supply chain resilience minimises the impact of a disruption through design approaches, which allows the supply chain to respond appropriately to disruptive events.

Research purpose: This article investigated the supply chain risks faced by grocery manufacturers in the South African fast-moving consumer goods (FMCG) industry and explored supply chain design approaches that enable supply chain resilience.

Motivation for the study: South African grocery manufacturers are faced with distinct risks. Whilst supply chain risk management studies have provided firms with certain guidelines to mitigate risk, supply chains are still vulnerable to unanticipated risks. Literature on supply chain resilience in the South African context is scant. The concept of supply chain resilience provides firms with strategies that are built into the supply chain that allow firms to react and recover swiftly from disruptions. Furthermore, supply chain resilience strategies assist firms in becoming less vulnerable to possible disruptions.

Research design approach and method: This study was conducted by using a descriptive qualitative research design. Data were collected through semi-structured interviews with senior supply chain practitioners specifically within the South African FMCG grocery manufacturing industry.

Main findings: The study found that labour unrest is the most common risk faced by the industry. Furthermore, strategic stock and supply chain mapping are of the most useful design approaches to enhance supply chain resilience.

Practical/managerial implications: The study provides managers with new insights in guiding supply chain design decisions for resilient supply chains. Through the identification of risks and appropriate solutions linked to the various risks, the study allows managers an array of options to choose from when enforcing a resilient supply chain.

Contribution/ value-add: The study contributes to the body of knowledge by being one of the first empirical studies conducted on supply chain design approaches for supply chain resilience in the South African context. The study also adds to the scarce literature on supply chain resilience in the FMCG industry, both globally and in a South African context.

Introduction

A supply chain refers to:

a network of organisations that are involved through upstream and downstream relationships, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer. (Azadeh *et al.* 2013:271)

A failure of an element in a supply chain causes a ripple effect of disruptions for potentially all associating firms, upstream and downstream (Azadeh *et al.* 2013:271; Soni & Jain 2011:933; Yang & Yang 2010:1901).

Supply chain disruptions are a reality, and it is not a matter of *if* but *when* they will occur (Glendon & Bird 2013:4). Pettit, Croxton and Fiksel (2013:57) found that the average effect of disruptions in supply chains in the United States is a 107% decline in operating income and a 7% decline in sales growth. Whilst global designs of supply chains offer access to low-cost labour and raw materials,

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firms encounter the challenges of maintaining steadiness of supply through lengthier and more variable lead times (Colicchia, Dallari & Melacini 2010:680; Diabat, Kannan & Panikar 2011:2; Pettit *et al.* 2013:46; Yang & Yang 2010:1901). The continuously changing business environment gives rise to unexpected risks and disruptions (Giannakis & Louis 2011:23).

Background

Supply chain risk management (SCRM) studies have gained increased attention and are aimed at developing approaches for the identification, assessment, analysis and management of risk areas in supply chains (Lavastre, Gunasekaran & Spalanzani 2012:829; Pfohl, Köhler & Thomas 2010:36). However, even after taking appropriate steps for risk mitigation, certain disruptions occur that are beyond the firm's control. Consequently, the concept of resilience is essential in the current business context (Bhamra, Dani & Burnard 2011:5380; Mandal 2012:48). Supply chain resilience refers to the firm's adaptive capability to prepare for unanticipated events as well as react and recover from disruptions to resume normal operations or even be in a stronger position after a disturbance has occurred (Juttner & Maklan 2011:249; Klibi & Martel 2012:291; Soni & Jain 2011:933).

Trends

Supply chain risks are driven by a variety of internal and external forces. Macro trends such as globalisation and global connectivity provide opportunities for diversification of supply yet also result in a more complex supply chain susceptible to an amplified impact of risks when they occur (Deloitte 2012:2; World Economic Forum 2013:19). The push to improve efficiency and reduction in operating costs gave rise to trends such as lean manufacturing, just-in-time inventory, reduced product lifecycles, low-cost sourcing, centralised distribution centres and supplier rationalisation (Christopher *et al.* 2011:67; Marchese & Paramaslvam 2013:6; Wieland & Wallenburg 2013:302). All of which have yielded

convincing business benefits (Deloitte 2012:2; Pettit, Fiksel & Croxton 2010:3; World Economic Forum 2013:13). Whilst these practices provide cost-reduction benefits, they increase the vulnerability of supply chains. Because of more points of susceptibility, longer supply chains have a diminished potential to absorb delays and disruptions caused by risks (Colicchia *et al.* 2010:2; Marchese & Paramaslvam 2013:195). Events that were once viewed as 'black swans', being of high impact but of low probability, now tend to occur regularly (Deloitte 2012:2).

At the same time, the era of customer focus brings service to the forefront. Customers are becoming increasingly demanding, with changing needs owing to increased globalisation and product variety, as well as cheaper substitutes for products from foreign markets (Bala, Kumar & Prakash 2010:31; Diehl & Spinler 2013:312). Furthermore, if an element of a firm's supply chain stumbles – affecting the end customer – the firm may be exposed through social media, ultimately causing some damage to the firm's reputation (Deloitte 2012:2).

Literature studies on supply chain resilience and more specifically strategies for resilience, originate from the seminal work by Christopher and Peck (2003:7). The overarching objective of the study was to provide specific techniques to be used by the supply chain industry in the United Kingdom to cope with supply chain related threats. The authors posit that supply chain design strategies, supply chain collaboration initiatives, a focus on supply chain agility and the creation of a SCRM culture can all improve the resilience of a supply chain (Christopher & Peck 2004:11; Peck 2003:12).

Various studies have emanated from the Christopher and Peck (2004:7) model for supply chain resilience. Table 1 presents a list of studies that emphasised supply chain design strategies as a means to achieve resiliency.

This study focused on supply chain design approaches, geared to building capacity, through flexibility and

TABLE 1: Review of the literature on supply chain design strategies for supply chain resilience.

Authors	Summary of findings
Christopher and Peck (2003)	Four approaches to creating a resilient supply chain: Supply chain re-engineering through design, supply chain collaboration, supply chain agility and the creation of a supply chain risk management culture.
Tang (2006)	Robust supply chain strategies: Postponement, strategic stock, flexible supply base, flexible transportation, make-and-buy decisions, dynamic assortment.
Manuj and Mentzer (2008)	Flexibility of the supply chain is seen as one of the most important factors that affect the selection of risk management strategies.
Oke and Gopalakrishnan (2009)	Risk categorization: Supply risks (imports, climate, man-made disasters, natural disasters, loss of key suppliers), demand risks (variability in demand and forecasting error). Flexibility is seen as a strong mitigating strategy.
Ponomarov and Holcomb (2009)	Resilience capabilities: Readiness, response (flexibility) and recovery.
Juttner and Maklan (2011)	Redundancy in terms of resources seem to primarily aid in the flexibility of the supply chain and consequently improve resilience.
Carvalho and Cruz-Machado (2011)	Emphasise redundancy and flexibility as important strategies for resilience.
Christopher and Holweg (2011)	Structural flexibility strategies: dual sourcing, asset sharing and postponement.
Soni and Jain (2011)	Supply chain resilience framework: Flexibility, visibility, adaptability, collaboration and sustainability.
Blackhurst, Dunn and Craighead (2011)	Five of seven automotive manufacturers discussed holding safety stock throughout the supply chain as a primary strategy to mitigate disruptions. Strategic placing of inventory was also emphasised.
Klibi and Martel (2012)	Significant supply chain modelling is used to map disruptions and include flexibility and redundancy in the supply chain.
Azadeh <i>et al.</i> (2013)	Redundancy and visibility are the most important factors for resilience.
Melnyk <i>et al.</i> (2014)	Eight categories of resilience-oriented investments: Discovery, information, supply chain design-flexibility and supply chain configuration, buffers, operating flexibility, security, preparedness and indirect investments.

redundancy, at potential pinch points to ensure continuity of operations (Christopher & Peck 2004:7; Peck 2003:12). A pinch point refers to a step in the supply chain where a disruption can seriously affect the ability of a focal firm to supply a product, therefore creating shortages in the market.

The fast-moving consumer goods (FMCG) industry is described as the largest industry in the world, being rapid and agile and comprising of a number of product variants (Bala & Kumar 2011:23; Kärkkäinen 2003:529; KPMG 2014:4). The manufacturing sector for grocery products faces diverse risks, such as the potential loss of key suppliers, the costs of fuel, power outages in the manufacturing plant and the fact that a limited amount of safety stock can be held to offset uncertainty (Barloworld 2010:8; Glendon & Bird 2013:4; Kärkkäinen 2003:50). The limited availability of safety stock directly links to the risk of spoilage and product recalls because of poor product quality.

Previous studies by Battezzati and Magnani (2000:416) and Bala *et al.* (2010:31) conducted in the FMCG industry in Italy and India, respectively, focused mainly on identifying the symptoms of disruptions. Diehl and Spinler (2013:312) and Diabat *et al.* (2011:2) went a step further and identified supplier risk as the most occurring risk in the FMCG industry. Nonetheless, previous studies on the FMCG industry are focused on SCRM. The progression in focus to supply chain resilience is still lacking and as such a gap in the literature exists. Table 1 provides a summary of studies conducted specifically on supply chain design strategies for resilience. Table 2 depicts studies that have been conducted specifically in the FMCG industry. The need for supply chain resilience is clear from the literature available on the FMCG industry. Various risks are faced by the FMCG industry, yet no studies have been conducted in supply chain design strategies for supply chain resilience in this particular industry.

Adequate supply chain design strategies are required to assist firms to become more resilient and less vulnerable to disturbances (Klibi & Martel 2012:883; Speier *et al.* 2011:726). However, it was unclear from previous research whether

TABLE 2: Summary of applicable literature on the fast-moving consumer goods industry.

Author	Summary of findings
Battezzati and Magnani (2000)	Identify the change in consumers demand and propose the adoption of postponement as a design strategy.
Diehl and Spinler (2013)	The study provides a risk identification framework based on the SCOR model using the FMCG industry as the core focus. Furthermore, the study provides clarification on the term SCRM. Risk is seen as an opportunity and danger or as danger alone.
Bala and Kumar (2011)	Highlights the importance of the FMCG industry. Issues identified in FMCG include supply chain adaptability and the bullwhip effect. Supply chain performance attributes-reliability, responsiveness, agility.
Bala <i>et al.</i> (2010)	Highlight various risks faced by FMCG and its impact. Provides an SCRM approach to mitigate the risks.

FMCG, fast-moving consumer goods; SCRM, supply chain risk management.

design strategies for resilience have been incorporated into firms' supply chains. This study aimed to address this gap by firstly analysing the supply chains of grocery manufacturers in South Africa to determine which risks they face. Secondly, the study builds on previous research by Battezzati and Magnani (2000:416) and Bala and Kumar (2011:23) and investigates how supply chain design approaches are used within FMCG grocery manufacturers to facilitate supply chain resilience.

Whilst most studies on supply chain resilience strategies have been carried out in Europe, Asia and North America, empirical research on the topic in South Africa remains scant (Kamalahmadi & Parast 2015:119). Furthermore, an extensive search on specialist databases such as Google Scholar and SABINET revealed that no research has been done on design strategies for supply chain resilience in South Africa.

The qualitative study was carried out in a cross-sectional manner through semi-structured interviews. This study was guided by the following research questions:

- What are the supply chain risks faced by the South African FMCG grocery manufacturing sector?
- Which supply chain design strategies are used in the South African FMCG grocery manufacturing sector to facilitate supply chain resilience?
- To what extent is supply chain mapping used by South African FMCG grocery manufacturers?
- What are the trade-offs between balancing cost savings and the implementation of costly supply chain design strategies?

Contribution to field

This study contributes to the body of knowledge by being one of the first empirical studies to explore supply chain design approaches for supply chain resilience in the South African context. The study bridges the gap of scarce literature on the FMCG industry in both global and South African contexts. The identified design approaches that facilitate supply chain resilience can add valuable insights for practitioners and academics in guiding supply chain design decisions for resilient supply chains (Ishfaq 2012:216).

Literature review

Supply chain risks in the fast-moving consumer goods industry

Supply chain risk is defined as 'the variation in the distribution of possible supply chain outcomes, their likelihoods, and their subjective values' (Colicchia *et al.* 2010:68; Diehl & Spinler 2013:313). These risks are unpredictable events caused by human or natural factors leading to a link failure in the supply chain (Yi *et al.* 2013:75). Vulnerability is the 'probability of a given risk multiplied by its severity in terms of its negative impact on business operations' (Diehl & Spinler 2013:313; Sodhi, Son & Tang 2012:2; Tang 2006:35).

Customers are becoming increasingly demanding, with changing needs owing to increased globalisation and product variety, as well as cheaper substitutes for products from foreign markets (Bala *et al.* 2010:31; Diehl & Spinler 2013:312). To address these complexities and still operate competitively, firms opt for strategies such as low-cost sourcing from different countries, centralised distribution centres and outsourcing (Christopher *et al.* 2011:67; Marchese & Paramaslvam 2013:6; Wieland & Wallenburg 2013:302). Whilst these practices provide cost-reduction benefits, they increase the vulnerability of supply chains. Due to more points of susceptibility, longer supply chains have a diminished potential to absorb delays and disruptions caused by risks (Colicchia *et al.* 2010:2; Marchese & Paramaslvam 2013:195).

Manuj and Mentzer (2008a:138) and Diabat *et al.* (2011:2) investigated supply and demand risks in the supply chain for FMCG grocery products. Additionally to these risks, macro-environmental risks were found to be of particular importance in the food and beverage product category (Marchese & Paramaslvam 2013:6). Supply risks are comprised of the reliability of suppliers in terms of delivery, quality as well as considerations such as single versus multiple sourcing, disruptions in supply, transit time variability, centralised versus decentralised decisions and risks affecting suppliers (Christopher *et al.* 2011:138; Manuj & Mentzer 2008a:138). Diehl and Spinler (2013:312) provide an example of supplier risks affecting Procter & Gamble in the United States. The West Coast port strikes in 2002 led to delays by logistics companies in the delivery of products. Procter & Gamble did not accept the strikes as an excuse for delays from the supplier. In fact, the firm expected its suppliers to have open options to counter the problem. The firm then replaced its logistics providers with more flexible logistics providers.

Demand risks are those that take place in the flow of goods from the focal firm to the market. These include stock-outs, obsolescence, demand variations because of seasonality and the bullwhip effect. The latter entails spikes in demand because of a time delay in information flow and batch ordering behaviour by consumers (Bertolini, Bottani & Lewandowski 2014:224; Diabat *et al.* 2011:2; Marchese & Paramaslvam 2013:8).

Macro-environment risks

Macro-environmental risks can occur at a single point in the supply chain but will ultimately affect the entire chain. Examples include economic crises, political instabilities, natural disasters and regulatory requirements which could lead to product recalls and food safety scares, especially in the food supply chain (Christopher *et al.* 2011:69; Marchese & Paramaslvam 2013:6).

In 2013, South African food manufacturers suffered from food labelling scandals because of unlawfully modifying, substituting and removing food labels. According to a report by Price Waterhouse Coopers, this came as a result

of a change in food labelling regulations which have over the years become more stringent and in turn affected the food manufacturers (Price Waterhouse Coopers 2012:32). Furthermore, local South African manufacturers are struggling to remain competitive against international rivals, partly because of labour unrest, high local wages and inflexible labour policies (Price Waterhouse Coopers 2012:31). Fluctuations in currency are another macro-environmental risk-affecting manufacturers and especially manufacturers who source key raw materials from abroad. Manufacturers face the risk of longer lead times, affecting not only product availability on the retailers' shelves but also the inability to pass any consequent price increases onto consumers (Price Waterhouse Coopers 2012:31). These incidents affect the firms' reputation as well as consumer confidence (Fast moving 2014).

Supply chain resilience

Azadeh *et al.* (2013:270) identify resilience capabilities as flexibility in ensuring effective responses to disturbances by quickly absorbing the risk. Examples include having a flexible supply base with more than one supplier to ensure an alternative supply when one of the suppliers is faced with a disruption (Colicchia *et al.* 2010:682).

Redundancy is the strategic availability of additional capacity and/or inventory at potential pinch points (Juttner & Maklan 2011:247). Redundancy also entails increased capacity to manage disturbances, such as increased safety stock as a buffer to maintain operations or multi-sourcing to avoid being affected by disturbances that may occur with the suppliers (Barroso, Machado & Cruz-Machado 2011:167; Klibi, Martel & Guitouni 2010:883; Pettit *et al.* 2010:4).

Marchese and Paramaslvam (2013:17) also identified overlapping resilience capabilities. Firstly, visibility refers to the ability to view the end-to-end pipeline from demand all the way through to supply (Pettit *et al.* 2013:47; Scholten & Schilder 2015:473). Secondly, flexibility is described as being able to adapt to disturbances quickly without considerably increasing operational costs (Ishfaq 2012:216; Melnyk *et al.* 2014:40).

In order for a supply chain to be resilient, these capabilities (flexibility, redundancy and visibility) need to be designed into the supply chain to quickly react to disruptions and maintain continuity of operations (Christopher & Peck 2004:7; Colicchia *et al.* 2010:680; Juttner & Maklan 2011:247; Scholten & Schilder 2015:472).

Supply chain design

To efficiently counter a disruption, Tang (2006:38) proposes supply chain design strategies, which through their redundancy offer flexibility to the chain. These design strategies focus mainly on strategic stock, creating a flexible supply base and flexible transportation.

Strategic stock requires firms to store inventories at strategic locations that can be shared amongst supply chain partners. In the case of a disruption, these shared inventories will allow the firms to allocate the strategic stock to the affected area (Barroso *et al.* 2011:165; Tang 2006:36). A flexible supply base involving multi-sourcing may assist in assuring continuous supply when a disruption occurs. Tang (2006:36), Barroso *et al.* (2011:167) and Ishfaq (2012:217) argue that although firms employ single sourcing strategies to reduce cost through quantity discounts, it could work unfavourably in the incident of a disruption and demand fluctuations. To avoid firms from coming to a standstill when disruptions occur within the transport segment, Tang (2006:40) suggests that transportation flexibility should be ingrained in the design of the supply chain. Flexibility can be established through multi-carrier transportation, forming alliances with various carriers to rapidly switch carriers in an event of a disruption, as well as multiple routes to guarantee smooth flows of materials along the supply chain (Colicchia *et al.* 2010:683; Tang 2006:36).

Peck (2003:46) and Christopher and Peck (2004:8) propose two additional redesign approaches for resilience. Firstly, supply chain mapping is recommended as a method of identifying pinch points, also characterised as bottlenecks, where capacity is limited or alternative options are not available. Barroso *et al.* (2011:168) describe supply chain mapping as a way of 'providing a clear view and understanding of the supply chain entities' actual capabilities as well as supply chain dynamics'. Secondly, it is essential that design approaches concerning the selection of supply chain strategies allow for an array of options to choose from.

Christopher and Peck (2004:8) refer to the notion of decentralisation versus centralisation. Although centralisation is often chosen because of its efficiency and lower costs, Christopher and Peck (2004:7) emphasise that centralisation will only reduce costs in the short run but may prove to be costly if a disruption occurs that affects the operations of the centralised facility. Inventory positioning, the number and location of distribution facilities and the ownership of the facilities in the supply chain network are valuable supply chain design considerations that enable resilience in the supply chain (Coyle *et al.* 2013:475; Klibi & Martel 2012:883).

Christopher and Peck (2004:8) suggest re-examining the trade-offs between efficiency and redundancy. The importance of strategic stock mentioned by Tang (2006:36) is also emphasised and even understood as a message that firms' executives would not be pleased to hear. The trade-off involves carrying 'just-in-case' inventory against the probability of risk and the cost incurred in doing so.

Based on the recurring design approaches mentioned by Christopher and Peck (2004:8), Tang (2006:40), Barroso *et al.* (2011:167) and Ishfaq (2012:217), this study focuses on redundancy and flexibility as supply chain design approaches by specifically making use of strategic stock, flexible supply base, flexible transportation, multiple sourcing, mapping

the supply chain and decentralisation versus centralisation considerations.

Design strategies for mitigating supply chain risks in the fast-moving consumer goods grocery manufacturing industry

According to Diabat *et al.* (2011:3045) and Diehl and Spinler (2013:316), the main risk categories namely, supply risks, demand risks and macro-environmental risks can be linked to the appropriate design approaches that enable firms to reduce the potential impact of these risks. It was found that supply risk is the most important risk in the FMCG industry due to its high frequency of occurrence and moderate impact on the supply chain (Diabat *et al.* 2011:3045). The available design approaches that enable continuity of operations are redundancy strategies, specifically multi-sourcing and strategic stock. Decentralisation can also mitigate the risk through continuity of operations by other available manufacturing facilities or distribution centres. Demand risks arising from unpredictable consumer buying patterns do not occur often but may have a high impact on the supply chain (Oke & Gopalakrishnan 2009:171). Suggested strategies to mitigate this uncertainty include postponement strategies that allow the firm to first produce a generic product based on cumulative demand and then customise the generic product at a later stage. This strategy allows the supply chain to quickly reconfigure a product in the event of a supply disruption (Yang & Yang 2010:1902). Lastly, power outages and natural disasters are macro-environmental risks that have a low frequency of occurrence. Mapping the supply chain to pinpoint bottlenecks is the design strategy of choice (Diabat *et al.* 2011:3045; Diehl & Spinler 2013:316). Table 3 summarises the three risk categories and the available design approaches.

After taking the most prevalent risks into account, their frequency of occurrence and impact, it can be seen that supply risks are encountered more frequently. There are also a number of design strategies available that can be engineered into the supply chain for resilience.

This study explored the risks experienced by South African FMCG grocery retailers and matched the applicability of design approaches for resilience.

Research design and methods

Research design

A descriptive qualitative research design was used. This research design is particularly suited to provide a rich and

TABLE 3: Link between risks and mitigating supply chain design approaches (a literature perspective).

Risk categories	Examples	Design approaches
Supply risks – high frequency and moderate impact	Delivery delays/failures; Quality issues; Inflexibility of suppliers to react to macro-environmental risks	Multi-sourcing; Strategic stock; Redundancy; Decentralisation
Demand risks – moderate frequency and high impact	Volatile demand	Supply chain mapping; Postponement; Decentralisation
Macro-environmental risks – low frequency and high impact	Power outages; Natural disasters; Strikes	Mapping supply chain for clear visibility of pinch points

detailed description of the experiences of multiple participants of a specific phenomenon or of their views, opinions or perspectives on a specific topic (Neergaard *et al.* 2009:2).

Sampling

The unit of analysis for this study was FMCG grocery manufacturers in South Africa. Twelve organisations agreed to participate, allowing for a total of 12 face-to-face semi-structured interviews. According to Rowley (2012:262), semi-structured interviews are appropriate where the interviewer seeks to gather valuable experiences and opinions in a specific industry or context. With the help of open-ended questions and adjustment of the questions, more insight could be gathered from managers, considering this is a first study of its kind in South Africa.

The final sample size was determined by the guidelines of Guest, Bunce and Johnson (2006:61) which state that 6–12 interviews are sufficient for the development of meaningful themes and valuable interpretations. Homogenous sampling, a form of purposive sampling, was used by selecting firms that hold resembling characteristics. The firms were chosen based on their belonging to the grocery manufacturing industry, a sub-group of the FMCG industry (Creswell 2012:518). This specific sampling method was used as the aim of the study was to understand a particular type of firms, namely FMCG grocery manufacturers (Polit & Beck 2012:519). The firms typically manufactured grocery products such as frozen foods, confectionary, canned and packed foods, dairy products, beverages, personal care and hygiene products amongst other products. These firms are of particular interest for investigating the phenomenon of supply chain resilience due to various key characteristics. The FMCG industry is vulnerable to disruptions because of its nature of being rapid and competitive, with high-volume product variants as well as holding products with a short shelf life (Bala & Kumar 2011:23; Scholten & Schindler 2015:474). Having a resilient supply chain is therefore of great importance.

Homogenous sampling was also used to select the individual participants for this study (Polit & Beck 2012:518). The shared characteristics used to select the participants included the following: (1) participants had to hold senior management positions such as general managers, planning managers, supply chain executives, (2) participants had to be involved in their firms' supply chain division and (3) participants' areas of responsibility had to encompass planning and locating distribution centres, managing or overseeing supply chain activities and, importantly, dealing with supply chain risks.

Procedure

A pilot study was conducted with one industry practitioner with relevant experience to verify the suitability of the questions in the discussion guide and the time required to cover all the questions, as suggested by Ey, Zuo and Han (2014:150). The feedback was positive and no significant changes were made to the questions.

Data collection was then initiated. The following 12 semi-structured interviews lasted on average 68 minutes and were conducted at the participant's office or in a meeting room at their offices. Permission to audio-record was granted in all 12 interviews.

The researcher transcribed 10 out of the 12 interviews. The remaining two interviews were transcribed by a professional transcription service due to capacity and time constraints. To ensure the accuracy of the transcripts, the researcher listened to each recording whilst reading the transcripts and making amendments to accurately reflect the actual recording.

Analysis

To analyse the data collected in this study, a thematic analysis was conducted. Braun and Clarke (2012:57) describe thematic analysis as a way of analysing data by means of identifying, organising and reporting themes within the data set. Preliminary exploratory analysis was done by listening to the audio-recordings whilst reading the interview transcripts to acquaint with the data and to generate codes (Creswell 2012:243). Applicable text segments were labelled to summarise the meaning of the segment. A list of codes was then compiled and an analysis was done to identify and combine similar codes. From the revised codes list, patterns were identified through related codes and the organised patterns formed themes that provided meaning to the data (Braun & Clarke 2012:6365). The final themes were analysed and established through their applicability to the study's research questions.

Ethical considerations

This study was approved by the applicable Research Ethics Committee at the researchers' university. Prior to the interviews, all participants were required to read through and sign an informed consent form. The consent form explained the purpose of the study and emphasised that participation in the study was voluntary and that the participant could withdraw at any time. Anonymity and confidentiality were also assured and communicated to the participant. The pseudonyms listed in Table 4 were used to protect the identity of the participants and their firms, to ensure anonymity and to encourage honest responses from the participants.

Trustworthiness

Reliability

Reliability was ensured by complying with the criteria of credibility and transferability. Firstly, frequent debriefing sessions were held with a seasoned supply chain academic, as well as with a specialist in research methodology. This allowed the study to be under scrutiny by detached individuals who offered fresh perspectives and challenged any biases and preferences by the researchers. Secondly, iterative questioning

through the use of probes allowed the researchers to elicit detailed data and uncover any deliberate lies (Shenton 2004:67). Thirdly, a rich thick description of the participants, sites and methodology was provided. Furthermore, the inclusion of the discussion guide and verbatim quotes from the participants contributed to the authenticity and vividness of this study (Polit & Beck 2012:595).

Validity

Closely tied with transferability, the criteria of dependability was met through a detailed explanation of the grocery

TABLE 4: Participants' profiles.

Pseudonym	Position	Firm	Length of interview (minutes)
P1	Planning Manager	F1	69
P2	Customer Service and Logistics Director	F2	66
P3	General Manager	F3	70
P4	Supply Chain Development Manager	F4	86
P5	Supply Chain Executive	F5	97
P6	Integrated Business Planning Manager	F6	60
P7	Head of Supply Chain	F7	58
P8	International Supply Chain Manager	F8	52
P9	Plant Manager	F9	65
P10	Supply Chain Manager	F10	56
P11	Integrated Business Planning Lead	F11	65
P12	General Manager: Supply Chain	F12	77
Average	-	-	68

TABLE 5: Frequency table of codes.

Codes	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	Frequency
Code 3: Labour unrest risk	1	1	1	1	1	1	1	1	1	1	1	1	12
Code 11: Cost versus availability trade-off	1	1	1	1	1	1	1	1	1	1	1	1	12
Code 18: Strategic stock	1	1	1	1	1	1	-	1	1	1	1	1	11
Code 1: Supplier risk	1	1	1	1	1	1	1	1	1	-	1	1	11
Code 4: Multi-sourcing	1	1	1	1	1	1	1	1	1	1	-	1	11
Code 8: Flexible transportation arrangements	1	1	1	1	-	1	1	1	1	1	1	-	10
Code 22: Global sourcing	1	1	1	1	1	-	1	1	1	1	1	-	10
Code 7: Supplier selection	1	1	1	1	1	-	1	1	1	1	-	-	9
Code 10: Mapping	1	1	1	1	1	1	1	1	1	-	-	-	9
Code 60: Strict supplier selection	-	1	1	1	1	-	1	1	1	-	1	1	9
Code 71: Moderate to high frequency of labour unrest risk	1	1	1	1	1	1	-	1	1	-	-	1	9
Code 20: Consolidation of facilities-move towards centralised facilities	1	1	-	1	1	1	1	1	1	-	-	-	8
Code 24: Flexible strategies	1	-	1	1	-	1	1	1	1	-	-	1	8
Code 44: Local packaging suppliers risk	1	-	-	-	1	1	1	1	1	1	1	-	8
Code 70: High impact of supplier risk	1	1	1	-	1	1	-	1	1	-	-	1	8
Code 74: Low to moderate frequency supplier risk	1	1	1	1	1	1	1	1	-	-	-	-	8
Code 27: Disadvantages of local sourcing	1	-	1	-	1	-	1	-	1	1	1	-	7
Code 33: Volatile demand (demand risk)	-	-	-	1	1	-	1	1	1	1	1	-	7
Code 37: Centralised model	-	-	1	-	1	-	1	-	1	1	1	1	7
Code 15: Forecast risk	1	1	-	1	1	-	-	1	-	-	1	-	6
Code 40: Electricity risk	-	-	1	1	1	1	-	-	-	-	-	-	4
Code 65: Multiple factories-Flexibility and redundancy	-	1	-	1	-	-	1	1	-	-	-	-	4
Code 66: Multiple distribution centres-Flexibility and redundancy [supply chain network]	-	1	-	1	-	-	-	1	-	-	1	-	4
Code 88: Factory redesign	-	-	1	-	-	-	-	-	-	-	-	1	2

retailers who participated in this study by clearly mentioning the different product categories represented under each retailer (Shenton 2004:67). By virtue of the differences in each retailer's context, a broader perspective of the phenomenon of resilience was offered on the general FMCG grocery retailers as was done by Hingley *et al.* (2011:321). A clear audit trail, including the interview transcripts and recordings as well as the origins and development of themes and sub-themes, was kept.

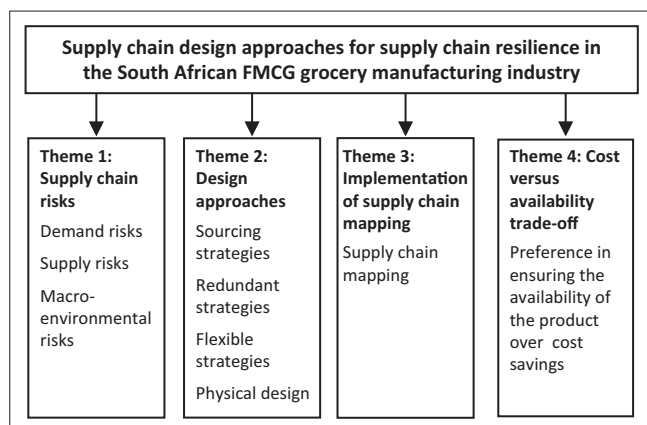
Results

The result of the thematic analysis done is shown in Appendix 1, which provides clear linkages between the main-themes, sub-themes, codes and raw data extracts. The most applicable themes were derived from a frequency table (Table 5) that quantified the number of times each code was mentioned during data collection. From these numbers, the sub-themes emerged, which then formed main themes.

Four main themes were identified from the data analysis, each of which is supplemented by sub-themes as indicated in Figure 1. Each theme is discussed below and relevant evidence from the data supplements the discussion.

Supply chain risks

Supply chain risks refer to three main risks, namely demand, supply and macro-environmental risks.



FMCG, fast-moving consumer goods.

FIGURE 1: Summary of themes and sub-themes.

Demand risks

Volatile demand was identified as a risk affecting 7 of the 12 participating FMCG grocery manufacturing firms. The risk comes because of unpredictable buying patterns of consumers that result in a sudden loss or spike in demand, making it difficult for the firms to generate accurate forecasts. The following quote highlights this risk:

They [*the grocery retailers*] try and give us a forecast or an idea but we don't get a forecast that we can plug into our planning system and then we can make to that. It's incredibly volatile and you've got on the back of that, pricing discounts, you know there are promotions which all causes volatility in your demand. (P8, Male, International Supply Chain Manager)

This corresponds with the findings of Bertolini *et al.* (2014:224), who identified volatility of demand as a major risk faced by the FMCG industry.

Supply risks

Local packaging supplier risks: Eight of the 12 participants mentioned that local packaging suppliers account for the majority of their firms' supply risks. As such, the packaging suppliers have a significant impact on the supply chain. These risks revolve around aspects such as lack of capacity, low quality as well as overpriced goods. This is illustrated by the following quotes:

Say I get a huge demand, so now I want a million bottles next week. He will say, ooh, I can't do that, I don't have the capacity to do that, because I have to put in a new mould and a new this and so forth and he can't react to that. (P5, Male, Supply Chain Executive)

The impact ... we actually lost 40% of our sales. We didn't have packaging, he couldn't supply. (P11, Male, Integrated Business Planning Lead)

Previous studies found that supply risks had a frequent rate of occurrence and a moderate impact (Diabat *et al.* 2011:3045; Diehl & Spinler 2013:316). However, in the current study, it was observed that supply risk had a low rate of occurrence but a high impact on the supply chain. The results show that local packaging suppliers pose a great threat to South African grocery manufacturers.

Macro-environmental risks

Labour unrest risk: The risk associated with strikes and low productivity is the most frequent occurring risk. All 12 participating firms experienced a labour strike in the last 5 years and were in agreement in classifying the risk as a cyclical risk. The impact of labour unrest was classified as being moderate to high, depending on whether the strike was unannounced or organised. The following quote provides a description of the industrial relations environment in South Africa for grocery manufacturers:

I think the biggest risk is labour unrest, yeah. Especially in this market where getting material in if you have a transporters strike ... a consumer is not going to stop doing his or her laundry because P9 employees are on strike. They will then go buy from somebody else. That will also lead to market share erosion. (P9, Male, Plant Manager)

In terms of the labour law, they have to give a certain amount of notice before they go on strike. The amount of notice is clearly insufficient for us to react, to do a building up of sufficient stocks before, because in the stand-up during that notice period the guys are working, but they are working at half speed. (P5, Male, Supply Chain Executive)

The international literature does not emphasise labour unrest as a significant risk. This could be due to geographic differences, as the South African industrial relations environment is quite unstable (Soki & Balchin 2014). Firms that depend on labour to produce and deliver their products are therefore highly impacted if they do not possess resilient capabilities.

Design strategies

The ability to recover from a disruption is associated with the development of responsiveness capabilities, specifically through redundancy and flexibility. The following specific design strategies illustrate these capabilities.

Sourcing strategies

In this section, criteria used in selecting suppliers and the supply base for the firms will be discussed (Tang 2006:36).

Strict supplier selection

When deciding on suppliers and supply bases, South African FMCG grocery manufacturers apply strict selection criteria. These criteria mainly revolve around quality aspects as well as price and service. Furthermore, capacity is a key factor that will determine where grocery manufacturing firms source their raw materials from. The participants mentioned that local suppliers do not have enough capacity to produce key raw materials for such big firms. Therefore, the firms opt to source globally. Moreover, the unique specifications of the products produced by the participating firms require a certain standard of quality and unique skills in the production of raw materials for the products. The participating firms reported that these specifications are best met by global suppliers. The following quotes illustrate these criteria:

In evaluating suppliers we would want to understand their supply chains and associated mitigation strategies they have in place in order to ensure consistency of supply. (P3, Male, General Manager)

Take one of our grooming products for example, they are so difficult to make that first we don't give it away to a contractor and lose that edge. And second, it's not easy to find other companies who can make that at the same level [of quality] as what we promise to our consumers. (P7, Male, Head of Supply Chain)

Global sourcing

Ten of the 12 participants mentioned that at least some of the key raw materials for their final products were sourced globally. The participants mentioned various advantages of global sourcing, including that global suppliers are more reliable and more responsive when it comes to a disruption. The following quote provides an example of the benefits of global sourcing:

In Japan, when Fukushima happened 2 years ago, they [main supplier] had a big problem in supplying us in the right quantity and there we know that we have strategic partnership with another supplier. He [main supplier's competitor] opened more capacity up when that happened. And so they mitigated the risk amongst themselves even though they are competitors. (P7, Male, Head of Supply Chain)

It is important to note, however, that manufacturers of food products, such as frozen foods, confectionary and dairy, do not share the same sentiments as the manufacturers of home care, personal hygiene and baby products. This is because manufacturers of food products make use of commodities which are produced locally.

These findings agree with the literature which indicates that sourcing globally increases the vulnerability of lengthier supply chains (Colicchia *et al.* 2010:680). However, the results from this study also indicate that, firstly, because of the unique specification of some of the products, local suppliers are unable to meet the requirements and therefore the firms have no choice but to source globally. Secondly, the firms reported that they did not face significant disruptions from the global suppliers, and when they did encounter a disruption, the supplier either reacted efficiently or the firm had an alternate supplier.

Redundant strategies

Azadeh *et al.* (2013:270) and Barroso *et al.* (2011:167) refer to redundancy as an additional capacity to maintain operations running when the supply chain is faced with a disruption.

Multi-sourcing

Eleven of the 12 participants indicated that multi-sourcing enabled their firms to maintain continuity of operations when faced by disruptions. A typical example of such disruptions is when a supplier fails to deliver raw materials due to a disruption on their side. The use of multi-sourcing as a form of ensuring continuous supply is in line with the literature as cited by Tang (2006:36). Multi-sourcing assisted South African FMCG's to mitigate the traditional risks

associated with suppliers. The following quotes highlight the use of multi-sourcing:

I've got three suppliers approved to give me that product. So easy; 50:50. 50:50 or 25:25:50. You got active suppliers. And that's the only way on key raw materials the packaging that you are going to reduce that risk. (P8, Male, International Supply Chain Manager)

Strategic stock

As illustrated in the following quote, 11 of the 12 participating firms make use of strategic stock to buffer themselves against a potential disruption:

In times we know there's gonna be an event like strikes and stuff we will then preposition stock to then just lift the whole supply chain. We can't keep it at one site so we've got a few key 3PL warehousing companies that helps us with flex. But obviously, you speak to your customer's right? Again, you preload them as well. (P2, Male, Customer Service and Logistics Director)

Storing mutual inventories at certain strategic locations therefore allow firms to withstand holdups and guarantee continuity of operations. These inventories are shared amongst supply chain partners, such a 3PL or the retailer itself.

Flexible strategies

Flexibility can amount to an organic capability, which also supports sensing disruptions and relates to the event readiness dimension of supply chain resilience (Oke & Gopalakrishnan 2009:171). The participants specifically mentioned two flexible strategies – flexible transportation and factory redesign.

Flexible transportation

Similar to the redundant strategies mentioned above, flexible transportation arrangements are considered as a critical strategy to ensure the continuity of operations when the firm is faced with disruptions. Ten of the 12 participants mentioned this strategy as key. The following statements indicate how most firms achieve this:

So when we look at outsourcing of the contract, we said let's outsource to one party that's got this flexibility within their system and access to multiple brokers so that we know if we need to flex up or flex down or there's issues with transport it doesn't affect us. (P3, Male, General Manager)

But I mean, we've got massive flex in our transportation. We can flex (pause). When I say massive flex I mean if I want to use today 80 or 100 percent more trucks, I can do that. Within 48 hrs obviously uh [we get] allocation of vehicles yeah. So then then their [3PL] base is so big. I think they got access to 35000 vehicles so (pause), we're okay. (P3, Male, General Manager)

South African FMCG grocery manufacturers also utilise flexible transportation as a means to enhance the firm's ability to receive and supply goods to and from the focal firm. As mentioned in the literature review, South African firms also exercise the choice of making use of a 3PL provider that provides agile flexibility.

Factory redesign

An additional and interesting aspect emerged from this study. Factory redesign was used to ensure continuity of production within the factory when employees were on strike and involved configurations within the facilities that built capacity and enabled continuity of operations. This strategy is demonstrated by the following quote:

We would have to consider allowing these staff to sleep on site because we can't now have a situation where your striking workforce is outside the gates and everybody else is inside. So, what we do is we create facilities within the factory where people can sleep. So we've had to manage logistics around beds, extra change room facilities, extra washroom facilities, etc. (P3, Male, General Manager)

These arrangements are made within the manufacturing facilities for the employees who are not on strike. This allows the firm a competitive edge in maintaining production activities.

Physical design approaches

The physical location of a firm's facilities is seen as a critical design approach which enables the firm to react to disruptions (Christopher *et al.* 2011:138).

Decentralised model

The ability of the firm to continuously supply goods to the customers when faced with a disruption is enhanced by a decentralised model. Over 50% of the participating firms make use of a mixed-distribution model comprised of a few big central facilities close to the manufacturing plants and expanding into various regional facilities. The following quote depicts how this model enhances resilience:

We do not only have one CDC, we have multiple CDCs. We have multiple DCs. So if one of them is impacted, we can still react from the other ones. So if one DC would burn down, for example, which is obviously a risk that can happen, we can still, with the other facilities we have, manage that risk. Same with factories. We have factories that can produce multiple products in multiple locations so if we need to switch from, let us say, our Johannesburg factory to our Durban factory, we can do that. (P4, Male, Supply Chain Development Manager)

This aspect concurs with the literature as mentioned by Christopher *et al.* (2011:138). However, the South African FMCG grocery industry is changing. Eight of the 12 participants mentioned that this is due to most of the retailers moving towards centralised distribution centres. The grocery retail industry in South Africa is concentrated with only five major grocery retailers accounting for the majority of the industry sales. Therefore, it is important where the manufacturers locate their facilities as is illustrated by the following quote:

We are strategically very aware of the fact that the industry, especially [the] retail industry, is changing. Retailer A is now centralising their distribution ... which means that we used to have to go to Polokwane to the family stores ... They go there now. We deliver in Jo'burg in their DC, so if the other retailers

start following suit, it would not make sense to have a DC there anymore. Because the industry is moving, the whole retail industry is moving. (P4, Male, Supply Chain Development Manager)

Implementation of supply chain mapping

Nine of the 12 participants mentioned that supply chain mapping is used before positioning new facilities in order to pinpoint risk areas. The technique has also been used for existing facilities. The following quote highlights the use of this strategy:

One thing that helps a lot is supply chain mapping. The better you understand your supply chain, the more you understand the risk of it and that's something that we've done over the last 10, 15 years, either when you design new supply chains but also your existing ones to improve them. (P7, Male, Head of Supply Chain)

These findings are in line with the observations by Christopher and Peck (2004:8) who state that supply chain mapping is a crucial design tool in enabling a resilient supply chain.

Cost versus availability trade-off

The final theme summarises the above-mentioned design approaches as it assesses the decisions of the firms to incur the costs of implementing the strategies to ensure resilience of the supply chain. All 12 firms mentioned that they will rather incur the costs of building capacity through the above-mentioned design approaches than save costs in the interim whilst having to pay the price of recovering from a disruption later. The following quote illustrated the firms' stand on this trade-off:

The potential cost of lost sales, should the risk materialise versus the cost of holding that additional stock, yeah those, that's the simple calculation ... What could you lose if that risk were to materialise, how material would it be to your business and would you be able to recover it? Or if not then you hold it in the strategic stock, and should it not happen well then you know, great for everybody but if it did happen we know we protected our business. (P10, Male, Supply Chain Manager)

The available literature showed some concern in firms' eagerness to incur the costs of design approaches for resilience (Tang 2006:36). However, when facing the decision of cutting costs or making the product available in the shelves, all 12 participants agreed that availability is of greater importance than saving costs.

Table 6 portrays a clear comparison between the literature and the findings from this study. In summation, examples of the specific types of risk differ in the South African context compared to studies in the literature conducted in different geographical contexts. An example would be local packaging supplier risk and labour unrest. The study brought about new design strategies implemented by South African firms, such as, flexible transportation and factory redesign. These strategies are implemented specifically to mitigate the risk arising from labour unrest.

TABLE 6: Link between risks and mitigating supply chain design approaches – a comparison between the literature and findings of this study.

Risk categories	Examples of risks in each category (from the literature)	Design strategies (from the literature)	Examples (from this study)	Design strategies (from this study)
Supply risks – high frequency and moderate impact	Delivery delays or failures Quality issues Inflexibility of suppliers to react to macro-environmental risks	Multi-sourcing Strategic stock Decentralisation	Delivery delays or failures (P11); Quality issues leading to product recalls (P5); Local packaging supplier's unreliability	Multi-sourcing Strategic stock Supply chain mapping
Demand risks – moderate frequency and high impact	Volatile demand	Supply chain mapping Postponement Decentralisation	Volatile demand causing the firm to under or over produce and under or over supply. For example, promotions done by retailers leading to unpredictable buying patterns (P7)	Supply chain mapping- understanding the supply chain
Macro-environmental risks – low frequency and high impact	Power outages Natural disasters Labour Strikes	Mapping supply chain for clear visibility of pinch points	Labour unrest (P9); Electricity risk (P4)	Mapping supply chain for clear visibility of pinch points Strategic stock Flexible transportation. Factory redesign (e.g. generator equipped – P4); Backup raw materials and production equipment

Source: Adapted from Diabat, A., Kannan, G. & Panikar, V., 2011, 'Supply chain risk management and its mitigation in a food industry', *International Journal of Production Research*, 50(11), 3045 and Diehl, D. & Spinler, S., 2013, 'Defining a common ground for supply chain risk management – A case study in the fast-moving consumer goods industry', *International Journal of Logistics Research and Applications* 16(4), 316. <http://dx.doi.org/10.1080/13675567.2013.813443>

Discussion

Outline of the results

The aim of the study was firstly to explore the types of supply chain risks South African FMCG grocery manufacturers face. Secondly, this study investigated how the design approaches used by firms facilitate supply chain resilience.

Based on the frequency of occurrence and the impact of risks on the supply chain, the South African FMCG grocery manufacturers face three main risks. These include labour unrest risks emanating from the macro-environment, volatile demand leading to inaccurate forecasts and supply risks arising specifically from local packaging suppliers.

In order to facilitate supply chain resilience through supply chain design approaches, the firms indicated that they opted to source globally rather than locally. One reason is that local suppliers struggle to react to disruptions in the supply chain, which poses a threat to the focal firms' continuity of operations. Multi-sourcing and strategic stock are two of the main redundant design strategies used by South African FMCG grocery manufacturers. These two strategies enable the firms to maintain continuity of operations. Most of the participating firms indicated that they have flexible transportation arrangements, such as contracts with various third party logistics providers. Lastly, in terms of physical design strategies, the firms currently follow a mixed-distribution model which allows them the flexibility of having various facilities in case one of the facilities is affected by a disruption.

Supply chain mapping has been used by most of the participating firms in this study. The technique is not used only before locating new facilities but also when reassessing existing design strategies.

When deciding between implementing costly design strategies to anticipate risks and remaining cost effective by not implementing these design strategies, all 12 firms unanimously agreed that risk readiness is more important

than cost savings. These decisions are guided by the underlying common factor that lost sales and market share losses due to unpreparedness of the firm are more costly than the implementation of these design strategies.

Practical implications

Although supply chain design approaches are known in theory and applied in practice, the study provides new insights to confirm the importance of these approaches in enabling resilience and reducing the impact of possible disruptions. Design approaches, such as strategic stock and multi-sourcing, are used by firms but are not recognised for their inherent resilient capabilities. The findings of this study, therefore, structure the elements within design approaches in an organised manner, allowing managers to clearly link the strategies to the main risks. Furthermore, the study was mainly carried out on multi-national firms and, as such, it can provide contributions and recommendations to be followed by smaller grocery manufacturers. Managers can apply this to firstly understand the relevant risks that they are facing within the industry and consequently this study will also guide them as to what the recommended approach should be when they are considering supply chain resilience.

Limitations and recommendations of the study

This study was carried out within the boundaries of the South African FMCG grocery manufacturing industry and its findings can, therefore, not be transferable to the greater FMCG grocery industry. Future research should expand on other industry players such as grocery retailers. Furthermore, this study focused only on a portion of the model proposed by Christopher and Peck (2004:7) and other aspects that enable a resilient supply chain were, therefore, not included. It is, therefore, recommended that future research undertakes to answer the question: 'What other approaches facilitate supply chain resilience?' This would allow for a more complete perspective on important strategies that facilitate supply chain resilience. This study was carried out mainly in large firms that implemented a large number of the strategies mentioned. A study can be done to investigate smaller

retailers to determine the transferability of this study across multiple-sized firms.

Conclusion

The objective of this article was to identify the supply chain risks that FMCG grocery manufacturers face and to match supply chain design approaches tailored to facilitate supply chain resilience. The study was carried out using a descriptive qualitative research design through 12 face-to-face semi-structured interviews conducted with supply chain practitioners in the South African FMCG grocery manufacturing industry.

The main risks identified in this study are labour unrest risks emanating from the macro-environment, volatile demand leading to inaccurate forecasts and supply risks arising specifically from local packaging suppliers. Labour unrest is the most commonly faced risk within the South African grocery manufacturing industry. This may be the case due to the fact that South African grocery manufacturers are highly dependent on labour, especially within the transportation leg of the supply chain. Most importantly, the industrial relations environment in South Africa is unstable and firms are, therefore, faced with significant risks resulting from labour unrest.

The design approaches implemented by South African FMCG grocery manufacturers correspond to those suggested by Azadeh *et al.* (2013:270), Barroso *et al.* (2011:167) as well as Christopher and Peck (2004:8). In addition to these strategies, the participating firms have also employed factory redesign strategies to ensure preparedness for labour unrest risks. Thirdly, on the aspect of supply chain mapping, this study corroborates the literature. It was found that supply chain mapping is of extreme importance in identifying risk areas and in ensuring that firms employ the most effective combination of design approaches to mitigate the risks (Barroso *et al.* 2011:168).

Furthermore, the study indicates how the South African FMCG grocery industry is structured based on the concentrated industry composition of five main grocery retailers. This has major implications in terms of the new direction that these main grocery retailers are leading the industry towards centralised distribution models. These, in turn, will affect the design approaches to be implemented.

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Competing interests

The authors declare that they have no financial or personal relationships which may have inappropriately influenced them in writing this article.

Authors' contributions

This article is based on the MPhil dissertation of A.A. A.A. was therefore the main researcher. W.N. assisted as supervisor with the conceptualisation, literature review and research instrument. T.K. provided methodological and technical guidance.

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Appendix 1

TABLE 1-A1: The link between the codes, sub-themes and main themes identified in this study.

Raw data extracts	Codes	Sub-themes	Main themes
So the biggest thing that you have in FMCG and you got exactly what it stands for, its fast moving consumer goods is volatility in demand. Ok so you do not get a forecast from our customers. We ... they try and give us a forecast or an idea but we don't get a forecast that we can plug into our planning system and then we can make to that. Really it's gonna be a lot of historical data, a lot of trend analysis to read the market, to try and read the demand. And it's incredibly volatile and you've got on the back of that, you'll have pricing discounts, you know there are promotions, you'd have um activities that will be either a launch of a new product or a revamp of a current product which all causes volatility in your demand. So the biggest area we all have and sometimes this is a generic industry issue is trying to read our demand so we can supply according to that (P8)	Volatile demand risk	Demand risks	Supply chain risks
I will tell you, we had a bad one, last year, it is the only bad one we had. The supplier came here, and not his fault either and it's a, you know, what, we had picked up a toxin in the maize, that goes into the pet food. So, we ran and bought and invested in a multimillion rand machine to, now all is tested before it comes out and that created a huge recall for us. We pulled up all the stock we had in July 2014. All the stocks that we had produced in that month, we pulled back from the trade. That took us about 4 months to recover, because, typically you will find out as you grow in supply chain, to be, just make that note, you will see that in practice, when you are short of stocks, when your supply is low, your demand will triple (P5)	Supplier risks	Supply risks	-
Packaging, is almost...for the product that we are, we have a little bit of safety stocks and a little bit of that and we supply out of that. But now all of a sudden you have to get all of it, say I get a huge demand, so, say, now I want a million bottles next week. He will say, ooh, I can't do that, I don't have the capacity to do that, because I have to put in a new mould and a new this and so forth and he can't react to that. (P5) The impact ... we actually lost 40% of our sales, we were delisted for that specific range but it was a small range. We didn't have packaging, he couldn't supply. We we lost ... and and in the grocery um market right? If you have a small category, it's very easy for them to delist you and that everything costs money. (P11)	Local packaging supplier risk	-	-
I think the biggest, the biggest risk is labour unrest, yeah. Especially in this market where getting material in if you have a transporters strike then you've got a problem. And then you also have our own union activities that is also a problem to get product out this is also a problem. So you almost have like what you would call a strike season if you like where you don't know what's going to happen right. That's one of the biggest risks that we face. You still have to pay uhh those people that don't go uhm, they're not so productive people like me who don't go in strike and who've got no clue to handle the machine. Right. So you actually find that there is huge losses that are incurred during that time. (P9)	Labour unrest risk	Macro-environmental risks	-
If something happens that we don't know is going to happen, let's say, we have, a fire, or something like that, a major disaster, then we are going to have a problem, depending on what plant it is, if it is a mayo plant, we may look to one of our competitors, maybe, to ask to pack some for us, or we must say, no, we don't do that, we sell what we have got there, or we set up another plant very quickly, besides what we have we set up another. (P5)	Limited backup plans	Operational risks	-
Um then obviously another (sighs) I know is really a it is a risk but um you know electricity. So it's a challenge for us you know. Um we've managed to mitigate that through coming up with an agreement with the Councils and saying working on a low curtailment programme to say we agree that we won't that we will not use electricity during this time so that it's uh more predictable for us. Because for us if it's a unplanned shut down, it costs us a lot of money because you just lose everything that's sitting on the line, all that product that's sitting on the line gets dumped. Because the line stops and you just can't do. So that's a risk for us um. (P6)	Electricity risk	-	-
Can imagine a big corporate like F 2 and the economies of scale they get with buying at one or two or three specific vendors. So those economies of scale outweighs everything. (P2) Global suppliers, the risk is not as high with global suppliers for some reason. I don't know why but we don't have issues that many issues with global suppliers. The risk is much higher locally. (P11)	Global sourcing	Sourcing strategies	Design approaches
And another one is in Japan, when Fukushima happened 2 years ago they had a big problem in supplying us in the right quantity and there we know that we have strategic partnership with another supplier. He opened more capacity up when that happened, although they are competitors but in the end the know they need to, they couldn't, they could've made a fortune out of charging more because there was shortage in supply but they understand that we are kind of together in that with P & G but also with our main competitors like [inaudible] and uni charm (min33). And so they mitigated the risk amongst themselves so even though they are competitors. (P7)	Supplier responsiveness	-	-
In evaluating suppliers we would want to understand their supply chains and associated mitigation strategies they have in place in order to ensure consistency of supply In evaluating this we take into account the associated costs and risks. (P3) Take one of our grooming products, are very centrally sourced globally so the blades that you cut into a razor there are 1.2 or 3 production places in the world where we make those only and their source. They are simple to ship and cost effective and they can in terms of the way how to make, they are so difficult to make that first we don't give it away to contractor and lose that edge. And second it's not easy to find other companies who can make that at the same level as what we promise to our consumers. This is how we source products into the country.	Strict supplier selection	-	-
I've got three suppliers approved to give me that product. That piece of packaging or that raw material. Actual dual sourcing or multi-sourcing means am actually buying from them now. So easy 50:50. 50:50 or 25:25:50. You you got active suppliers. And that's the only way on key raw materials the packaging that you are going to reduce that risk. Because I can tell you now, the way that we work here, you can't have a guy lying dormant and then suddenly you say 'Oh my goodness, the guy am buying from he's had a fire. I need to turn the guy on'. You gonna be ... he'll take up to 2 weeks to be turned on. (P8)	Multi-sourcing	Redundant strategies	-
In times we know there's gonna be an event like strikes and stuff, we we push up safety stock. We will then preposition stock to then just lift the whole supply chain take it to another and another 5 or 7 days. So again you know we can't keep it at one site so we've got a few key uh 3PL warehousing companies that helps us with um flex. So we'll flex into those and then obviously with the 38 locations, we just take them to maximum stock holding. And then obviously, we can put some containers down in Tembisa. Interesting stuff uh at selected sites where you can actually get more stock into the supply chain. But obviously, you speak to your customers right? Again, you preload them as well. So you fill them backdoor, you fill their sites as well. (P2)	Strategic stock	-	-
Good question actually. So when we enter the contract with the 3PLs, within the 3PL contract we've got various models. So you move from a fixed dedicated fleet that is yours full-time that's operated by a third party into a model where you only make use of a broker from external. So again it gives you flexibility as well. So if broker A can't help you, you've got broker B, C, D, E, F on the books. So when we look at outsourcing of the contract, we said let's outsource to one party that's got this flexibility within their system and access to multiple brokers so that we know need to flex up or flex down or there's issues with transport as it doesn't affect us. And that's that's why we meet that option. (P2)	Flexible transportation	Flexible strategies	-

Appendix 1 continues on the next page →

TABLE 1-A1 (Continues...): The link between the codes, sub-themes and main themes identified in this study.

Raw data extracts	Codes	Sub-themes	Main themes
We would have to consider allowing these staff to sleep on site because we can't now have a situation where your striking workforce is outside the gates and everybody else is inside, you can't now send them out after a shift because they're going to get beaten up, they're going to get followed home, they're going to get petrol bombed, their houses, all kinds of things. So what we do is we create facilities within the factory where people can sleep. So we've had to manage logistics around beds, we've had to manage logistics around extra change room facilities, extra washroom facilities, people need to bath uh people need to be fed etc. (P3)	Factory redesign	-	-
We do not only have one CDC, we have multiple CDCs. We have multiple DCs. Close to the things, so if one of them is impacted we can still react from the other ones. So if one DC would burn down, for example, which is obviously a risk that can happen, we can still, with the other facilities we have, manage that risk. So yes, there might be a delay in supplying products to stores because now they need to drive 12 hours further but we can still supply. So I think that is how we mitigate a lot of our risk in supply chain. Same with factories. We have factories that can produce multiple products in multiple locations so if we need to switch from, let us say, our Johannesburg factory to our Durban factory, we can do that. Yes, it will be more costly, yes, it will imply more primary transport costs, but we can do that. (P4)	Decentralised model	Physical design approaches	-
We are strategically very aware of the fact that the industry, especially retail industry, is changing. With experience with Pick n Pay now centralising their distribution... P4(B): which means that we used to have to go to Polokwane to the family stores and the Hypermarket and the supermarkets of Pick n Pay...They go there now. We deliver in Jo'burg in their DC, so if the other retailers start following suit and we are left with really the moms and pops stores in Polokwane, it would not make sense to have a DC there anymore. So we are very aware of that fact and, you know, so we will be strategically probably not developing in those areas. Because the industry is moving, the whole retail industry is moving. (P4) South Africa has got a very um developed retail model here ok. So you got 5-6 big retailers dominating the market here. Ok so you don't have situations like India or the Middle East um where you've got thousands of small customers and you go to probably 10-20 medium sized customers. Here, we very fortunate to have a strong concentration of 5 big guys that make up probably 80% plus of the market that you can focus and service accordingly. Yes, you not gonna get to every call it Mom and Pops store but you you try to but they're not gonna impact your business as much as not servicing the main principles at a very high level. So we very fortunate. If you don't service Shoprite, Pick n Pay at the highest level, they know how the games played. They'll buy from someone else. (P8)	Consolidation of facilities-move towards centralised facilities	-	-