

A CONCEPTUAL FRAMEWORK TO ANALYSE SUPPLY CHAIN DESIGNS

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SYNOPSIS

Objectives: Supply chain design (SCD) is a concept that forms an integral part of supply chain management (SCM). Effective SCD enhances supply chain integration (SCI) which in turn contributes towards improved supply chain performance. Therefore, organisations' supply chain designs need to be analysed. This article proposes a conceptual framework to analyse organisations' supply chain designs. The objective of this article is to determine whether the proposed conceptual framework is a workable instrument with which organisations can analyse their supply chain designs.

Problem investigated: Effective SCD is a complex and demanding undertaking and has become a major challenge for organisations. Moreover, the literature suggests that organisations allow their supply chains to evolve rather than consciously designing them. Although the importance of SCD is emphasised, very little attention is given to what it entails exactly. The problem statement of this article is thus: What are the elements of SCD and how can these elements be included in a conceptual framework to analyse organisations' supply chain designs?

Methodology: The methodology used in this article comprised two phases. Firstly, a literature review was conducted to identify SCD elements. The elements were used to develop a conceptual framework with which organisations can analyse their supply chain designs. Secondly, the conceptual framework was tested in 13 organisations to determine whether it is a workable instrument to analyse supply chain designs. The respondents were selected by means of non-probability sampling. Purposive, judgmental and convenience sampling methods were used to select the sample.

Findings and implications: As mentioned, the conceptual framework was tested empirically within 13 organisations. The findings show that the conceptual framework is in fact a workable instrument to analyse supply chain designs.

Value of the research: The research will make a contribution in the field of supply chain management and more specifically in the field of supply chain design. As mentioned, very little attention is given to the specifics of SCD. This article provides a more structured approach to analysing supply chain designs.

Conclusion: SCD forms an important part of SCM and may play a role in improving performance. The conceptual framework proposed in this article will assist organisations with the analysis of their supply chain designs, which in turn may highlight potential areas in their supply chains where there may be room for improving their SCD practices.

Key words: supply chain management, supply chain design, supply chain strategy

INTRODUCTION AND BACKGROUND

Supply chains put products and services in the hands of organisations and customers. Therefore all products and services form part of organisations that constitute the supply chain. Supply chain management (SCM) links all the supply chain members in the supply chain (Lam & Postle, 2006; Mouritsen, Skjøtt-Larsen & Kotzab, 2003) by coordinating and integrating all the supply chain activities into a seamless process in the most effective and efficient ways possible (Bozarth & Handfield, 2006). SCM has become a key issue for many organisations (Cagliano, Caniato & Spina, 2006; Mentzer, 2001; Ittman, 2004). Supply chains, which form an integral part of SCM, have to be consciously designed (Bagchi, Ha, Skjøtt-Larsen & Soerensen, 2005; Persson & Olhager, 2002). SCD can be regarded as the determination of how to structure a supply chain (Saxton, 2006; Persson & Olhager, 2002) and refers to the process of determining and configuring all the required components of the supply chain and deciding how resources will be allocated and what processes will be performed at each stage by each supply chain member (Sharifi, Ismail & Reid, 2006; Chopra & Meindl, 2010; Waters, 2007). SCD, which is a critical factor in determining the efficiency and effectiveness of a supply chain (Sezen, 2008), is extremely important due to the commitment of resources over long periods of time (Santoso, Ahmed, Goetschalckx & Shapiro, 2004). SCD influences supply chain

performance (Moon, 2004), and changes in the structural design of the supply chain may improve the supply chain's performance (Persson & Olhager, 2002).

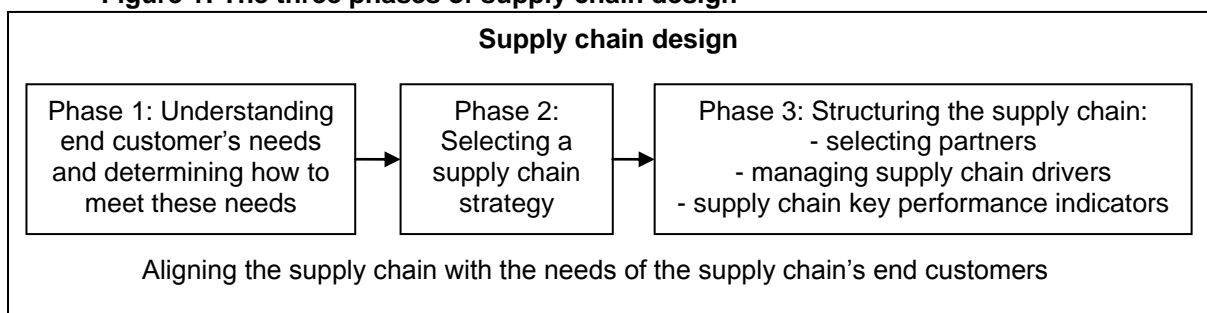
PROBLEM STATEMENT AND OBJECTIVES

The big challenge in evaluating possible improvements in the supply chain lies in the complex structure of the supply chain (Reiner & Trcka, 2003:219). SCD is a demanding and complex process (Fawcett, Ellram & Ogden, 2007) and it has become a major challenge for organisations (Shen & Daskin, 2005). Although the literature emphasises the importance of SCD (Raturi & Evans, 2005; Jespersen & Skjøtt-Larsen, 2005), very little attention is given to what this specifically entails. The problem statement of the research on which this article is based is therefore formulated as follows: What are the elements of SCD and can these elements be included in a framework to analyse organisations' SCD practices? The main objective of the research on which this article focuses was twofold: firstly, to develop a conceptual framework from the literature by identifying SCD elements, and secondly, to test the conceptual framework to determine whether it was a workable instrument for analysing SCD practices. A literature study was conducted to identify the SCD elements that were used to develop the conceptual framework. The conceptual framework was tested empirically by means of a structured questionnaire in 13 organisations to see whether it is a workable instrument for organisations to analyse their SCD practices. The article closes with a discussion of the results and conclusions of the research, which show that the framework can indeed be used to analyse SCD practices. The article contributes to the field of SCM by introducing an outline of the conceptual framework with which organisations can analyse their SCD practices.

LITERATURE REVIEW: IDENTIFYING SUPPLY CHAIN DESIGN ELEMENTS

From the literature it can be concluded that SCD essentially consists of three basic phases. These phases are illustrated in Figure 1 and have to be aligned with each other (Sharifi et al., 2006). Firstly, supply chains must understand the nature of the needs of their end customers (Taylor, 2004) and how these needs can be met by some value proposition (Christopher, 2005). Each organisation must know how it can contribute value to meet the demands of its supply chain's end customers (Fawcett et al., 2007; Christopher, 2005). Secondly, organisations must select a supply chain strategy to be able to deliver value to their end customers (Taylor, 2004). Thirdly, once a supply chain strategy has been selected, the supply chain structure needs to be configured (Sharifi et al., 2006; Fawcett et al., 2007).

Figure 1: The three phases of supply chain design



Source: Compiled from Taylor (2004); Christopher (2005); Fawcett et al. (2007).

Phase one of supply chain design: End customer's needs

The supply chain's end customer is the person at the end of the supply chain who makes the decision whether or not to buy the product or service offered by the supply chain (Harrison, 2001). The customer is the ultimate judge of supply chain performance (Jeong & Hong, 2007). The end customer should thus be the starting point of any supply chain's design. The challenge is to design supply chains with the end customer's needs in mind (Christopher, 2005). Therefore, to design a world-class supply chain, organisations need to understand their end customers. They have to know who their end customers are and they have to understand their real needs (Fawcett et al., 2007).

The *value proposition* that will be used to meet these needs is simply a statement of how, where and when value is to be created for specific customers or market segments. The value proposition should form the guiding principles on which all the activities of the organisation are based (Christopher, 2004). After defining the value proposition, organisations must develop their core competencies to be able to deliver the value proposition. These have to be aligned with market winners, which differentiate an organisation's products and services from those of its competitors (Bozarth & Handfield, 2006) and can, for example, be low cost or high service levels (Mason-Jones, Naylor & Towill, 2000). Phase one of SCD can thus be divided into two sections, namely understanding end customers' needs and how to meet these needs. The research questions (RQ) that have been formulated for each of these sections in phase one of SCD are thus:

RQ 1.1: Do organisations understand their end customers' needs?

RQ 1.2: Do organisations know how to meet their end customers' needs?

From the literature, five SCD elements can be identified in phase one of SCD:

SCD element 1.1: Knowing who the end customers are

SCD element 1.2: Knowing the needs of the end customers

SCD element 1.3: Identifying a value proposition to meet end customers' needs

SCD element 1.4: Possessing a core competency to deliver the value proposition

SCD element 1.5: Identifying how to win customers' orders

Phase two of supply chain design: Selecting a supply chain strategy

Once organisations understand their end customers' needs and have determined how to meet these needs (phase one of SCD), they can select a supply chain strategy (phase two of SCD) (Christopher, 2004; Taylor, 2004; Raturi & Evans, 2005). Supply chain strategies can be defined as strategies required to manage the integration of all the supply chain activities through improved supply chain relationships to achieve a competitive advantage for the supply chain (Hines, 2004). The supply chain strategy starts with the business value proposition to customers, based on core competencies and identified market winners (which was identified in the first phase of SCD) and shows how the supply chain can contribute to achieving business goals (Tang & Gattorna, 2003).

Customers' demands will be met through the supply chain product offerings. For this reason, organisations should understand the nature of their products and must be able to devise a supply chain strategy that best fits their customers' demands (Fisher, 1997; Seuring, 2003), by also taking the associated demand uncertainties into account. If products are classified according to their demand patterns in terms of characteristics such as life cycle length, demand predictability, product variety and market standards for lead time and service (Selldin & Olhager, 2007), they fall into one of two clearly distinguishable categories, namely primarily functional or primarily innovative products. Functional products satisfy the basic needs of customers. These needs do not change much over time, which in turn means that the demand for these products is stable and predictable (Fisher, 1997). Innovative products are characterised by high levels of change in demand over short times and thus have a volatile demand (Lee, 2002; Seuring, 2003). The market winner for innovative products is service level while low prices is the market winner for functional products (Mason-Jones et al., 2000).

Different supply chain strategies will be used for different products (Ayers, 2006; Croxton, Lambert, Garcia-Dastugue & Rogers, 2006; Sadler, 2007). Supply chain strategies may be designed to be more efficient or to be more effective (Hines, 2004). Therefore, two broad supply chains can be distinguished, namely, agile (responsive) and lean (efficient) supply chains (Chopra & Meindl, 2010; Raturi & Evans, 2005). A lean supply chain works to reduce cost and waste (Vitasek, Manrodt & Abbott, 2005) by eliminating non-value-added activities, pursuing scale economies and deploying optimisation techniques to get the best capacity utilisation in production and distribution (Jacobs & Chase, 2008; Lee, 2002). Agile supply chains aim at being responsive to customer needs as well as being flexible (Jacobs & Chase, 2008; Lee, 2002). Supply chains where demand uncertainties exist require agility (Ayers, 2004; Seuring, 2003; Towill & Christopher, 2002) on, for example, time compression and quick response and on eliminating the barriers to quick response (Christopher, 2003). Therefore, it is evident that end customers' needs for functional products with a predictable

market demand should be met with efficient (or lean) supply chains and the needs for innovative products should be met with responsive (or agile) supply chains (Bruce, Daly & Towers, 2004; Fisher, 1997; Seuring, 2003; Swafford, Ghosh & Murthy, 2005).

In many cases a hybrid strategy where both lean and agile supply chains are utilised could be used (Towill & Christopher, 2002). Hybrid (or leagile) supply chains thus use a combination of lean and agile approaches within a supply chain strategy (Mason-Jones et al., 2000) and exploit the benefits of both lean and agile supply chains (Towill & Christopher, 2002).

The point at which real demand penetrates upstream in a supply chain may be termed the push-pull boundary or the decoupling point (Christopher, 2003). The decoupling point is thus the point in the product flow stream to which the customer's order penetrates and where real time data and forecast-driven activities meet (Mason-Jones et al., 2000). The decoupling point is an important choice in any supply chain design (Fleischmann, Van Nunen, Gräve & Gapp, 2005). Determining the decoupling point in terms of the organisation's position in the supply chain becomes essential in the implementation of the supply chain strategy because, as already mentioned, upstream from the decoupling point organisations have to be lean and downstream they need to be agile. The push-pull boundary thus indicates where the organisation switches from managing the supply chain using one strategy to managing it using another strategy (Simchi-Levi, Kaminsky & Simchi-Levi, 2003).

Downstream of the decoupling point the processes are designed to be agile (i.e. responsive) (Towill & Christopher, 2002) to make provision for the more unpredictable marketplace (Mason-Jones et al., 2000). The flow of products should therefore be market driven (Lysons & Farrington, 2006; Christopher, 2003). Upstream of this decoupling point, the processes are designed to be lean (Towill & Christopher, 2002), enabling a level schedule and opportunities to reduce costs (Appelqvist, 2003; Mason-Jones et al., 2000). Upstream organisations work to a stable demand with relatively low variety and can therefore focus on low costs (Lysons & Farrington, 2006). The following research question has been formulated for phase two of SCD, namely:

RQ2: Are organisations implementing the correct supply chain strategy based on market demand predictability, market winners and position of the supply chain's decoupling point?

The SCD elements identified in phase two in SCD to be included in the conceptual framework are:

SCD element 2.1: Determining market demand predictability

SCD element 2.2: Using specific market winners to select a supply chain strategy

SCD element 2.3: The organisation's position in terms of the decoupling point

SCD element 2.4: The supply chain strategy

A lean supply chain strategy is suggested where market demand is predictable and where the market winner is low cost. An agile supply chain strategy is suggested when market demand is unpredictable and the market winner is agility. SCD element 2.3 will be used to suggest a supply chain strategy when there is misalignment between market demand predictability and the market winners for a product.

Phase three of supply chain design: Structuring the supply chain

The supply chain structure implies the integration of the focal organisation and the links between supply chain members and must support the supply chain strategy (Defee & Stank, 2005:34). The supply chain structure thus embodies the configuration of the supply chain's processes and operations. Organisations have to identify the supply chain partners they would want to build collaborative relationships with and the extent to which they would want to manage these relationships (Raturi & Evans, 2005; Taylor, 2004). Managing specific supply chain drivers is also an important aspect of SCD (Rafele, 2004; Raturi & Evans, 2005). These drivers include facilities, inventory, transportation, information, sourcing and pricing, which interact with each other (Chopra & Meindl, 2010) and have an impact on the supply chain's responsiveness and efficiency (Hugos, 2006). Establishing the right supply chain key performance indicators (KPIs) is also an important aspect of SCD (Rafele, 2004; Raturi & Evans, 2005). Agile supply chains should adopt KPIs that focus primarily on service levels (and availability) and lean supply chains should use KPIs that focus primarily on cost

(Agarwal & Shankar, 2002; Christopher & Towill, 2001). The following research questions have been formulated for phase three in SCD:

RQ 3.1: Do organisations know who their critical supply chain partners are and how are they managing those relationships?

RQ 3.2: How are organisations managing their supply chain drivers?

RQ 3.3: On which KPI categories are organisations focusing to measure their performance?

The SCD elements of phase three that can be included in the conceptual framework are:

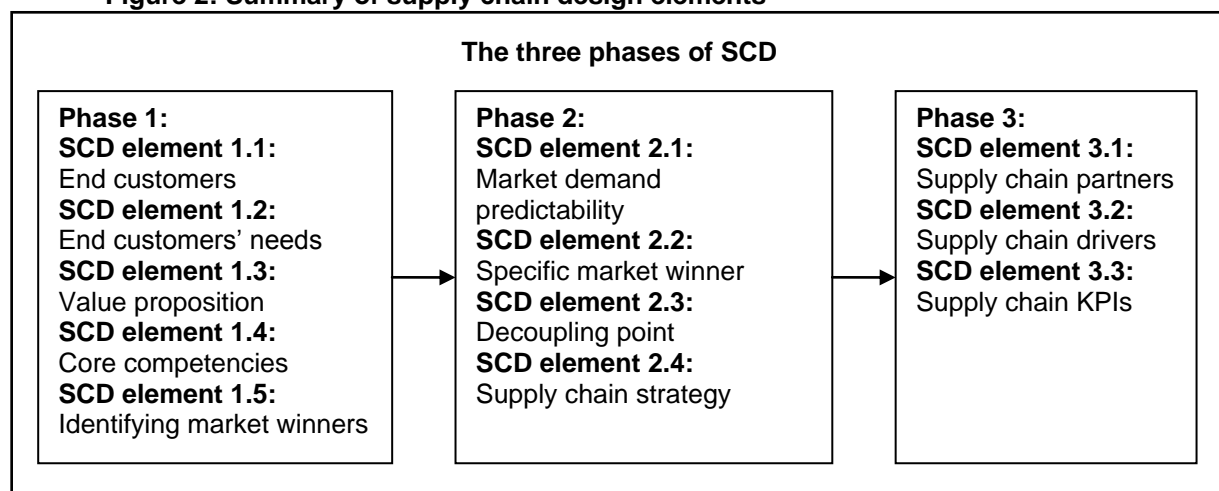
SCD element 3.1: Supply chain partners

SCD element 3.2: Supply chain drivers

SCD element 3.3: Supply chain KPIs

When Figure 1 is revisited, a summary of the SCD elements can be made for each of the three phases of SCD as identified in literature and is provided in Figure 2.

Figure 2: Summary of supply chain design elements



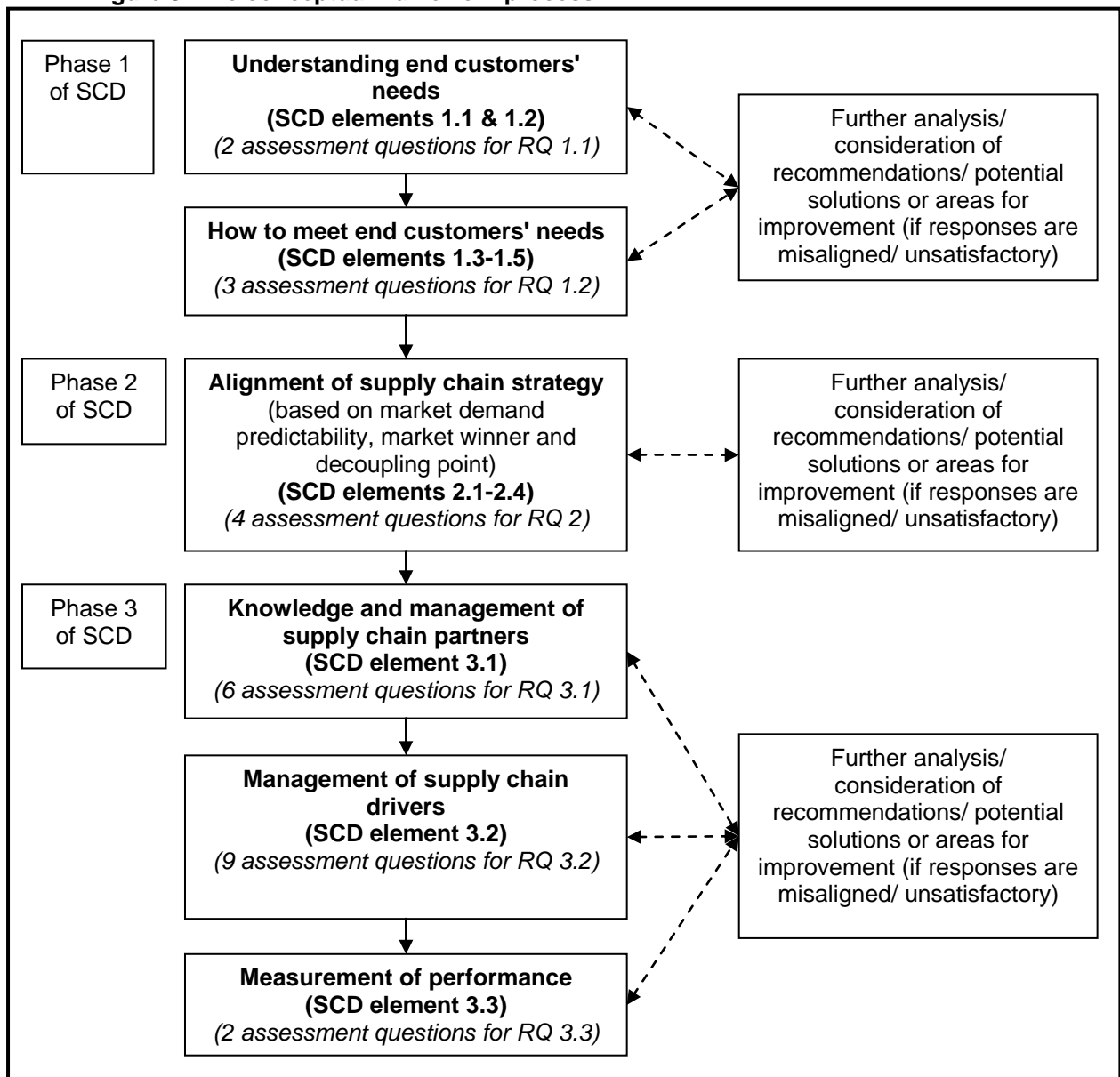
THE CONCEPTUAL FRAMEWORK TO ANALYSE SUPPLY CHAIN DESIGNS

The conceptual framework proposed in this article includes all the identified SCD elements discussed in the previous section. The basic process of how the framework functions is illustrated in Figure 3. The SCD elements of each phase in the SCD are analysed by means of assessment questions. Respondents have to provide a score for each assessment question. The responses to each assessment question provide the basis on which the conceptual framework will either refer the respondent to a next assessment question or suggest that the respondent should undertake further analysis or explore the initial responses to the assessment question to determine potential areas for improvement. The scores for each assessment question (and scales according to which they function) are explained as each phase of the conceptual framework is discussed. Briefly stated, the outcome for each assessment question can either be:

- satisfactory (which means that the response indicated at least a minimum acceptable score) or unsatisfactory (which means that the response did not at least indicate a minimum acceptable score); or
- aligned or misaligned with other responses to comply with a selected supply chain strategy.

When responses by organisations are satisfactory or aligned, they can proceed to the assessment questions in the next phase of their SCD analysis. If their responses are unsatisfactory or misaligned, they can also proceed to the assessment questions in the next phase of SCD, but they have to bear in mind the potential areas for improvement (as indicated by the conceptual framework) when continuing with the analysis.

Figure 3: The conceptual framework process



Analysis of phase one of supply chain design

Five assessment questions are used in the conceptual framework to analyse phase one of SCD to determine whether organisations understand their customers' needs and know how to meet their needs. There is one assessment question for each SCD element in phase one. Organisations have to achieve a minimum acceptable score in each of these assessment questions in this section and those that do not achieve the minimum score are provided with possible reasons (or explanations) and potential solutions to improve their SCD practices in this phase. A five-point Likert-response format (*where 1 = very limited; 2 = limited; 3 = average; 4 = good and 5 = very good*) was used to measure the elements in phase one of SCD. The assessment questions for phase one of SCD determine the extent to which an organisation:

- knows who its customers are;
- knows what the needs of its customers are in terms of service levels, product varieties, quality levels and prices;
- has identified a formal *value proposition* to meet customers' needs;

- possesses a *core competency* that creates customer-perceived value and is superior to what competition does; and
- has broadly identified how to win customers' orders.

For the testing of the conceptual framework for phase one of SCD, a score of three (3) (which indicates an average extent) was deemed satisfactory. Therefore, organisations that scored at least three for each of these assessment questions were referred to the next assessment question. However, organisations that scored less than three were referred for further analysis on these issues.

Analysis of phase two of supply chain design

In phase two of SCD, organisations will analyse the market demand predictability and market winner for the product, the position of the decoupling point and their selected supply chain strategy. To analyse the level of their market demand predictability, organisations will be requested to indicate the extent to which the demand for their product is predictable as opposed to being unpredictable. A continuum is used for the assessment question where a score of one indicates a high level of predictability and a score of four indicates a low level of predictability. A four-point scale is used in this case to ensure that organisations do not select the 'middle' or 'neutral' option. Organisations will also be requested to indicate what the specific market winners for their products are. A continuum is also used in this assessment question where a score of one indicates that the market winner for the product is low cost, while a score of four indicates that the market winner is agility in the form of high service levels, quality and responsiveness. A lean supply chain strategy can be suggested for products with a predictable market demand and low cost as market winner. An agile supply chain can be suggested where market demand is unpredictable and the market winner is agility.

If organisations have a predictable market demand and agility as market winner for a selected product, or if organisations have an unpredictable market demand and low cost as market winner for the product, the decoupling point will be used to suggest a supply chain strategy. If the decoupling point is downstream from the organisation, a lean supply chain strategy is suggested. Alternatively, if the decoupling point is upstream from the organisation, an agile supply chain strategy is suggested. A leagile supply chain strategy will be suggested if the organisation is positioned at the decoupling point.

In the final section of analysing phase two of SCD, organisations will also be asked to indicate on a continuum what the primary focus of their organisation's supply chain strategy is. A response of one on the one end of the continuum indicates a focus on achieving the lowest cost, achieving economies of scale and reducing waste within acceptable service levels, while a response of five on the other end of the continuum indicates a focus on being agile, i.e. being responsive and flexible concerning customers' demands and providing high service levels within acceptable cost levels. On this continuum, a response of three will indicate that the focus of the supply chain strategy is a combination of a lean and an agile strategy and that a leagile supply chain strategy is thus being used. Therefore a 'middle' or 'neutral' option is included in this instance. Organisations can establish whether there is alignment between their selected supply chain strategy and the supply chain strategy that is suggested to them on the basis of the market demand predictability and market winner for the product as well as the decoupling point (if necessary).

Analysis of phase three of supply chain design: Supply chain partners

The first section for analysing phase three of SCD analyses an organisation's *relationships* with its supply chain partners (i.e. suppliers and customers). Three assessment questions are used to establish how well organisations have identified and manage their relationships with their customers. Three assessment questions are also used for supplier relationships. Organisations will be asked to indicate the extent (*where 1 = limited; 2 = average; 3 = good; 4 = very good and NA = not applicable*) to which their organisation:

- knows who its critical supply chain partners are (where supply chain relationships need to be managed concerning processes);
- manages their critical direct (1st tier) supply chain relationships; and
- manages their critical supply chain relationships beyond 1st tier (2nd tier to n^{th} tier).

For this section of the testing of the conceptual framework a score of two (which indicates an average extent) is deemed satisfactory. Therefore, organisations that score at least two for each of these assessment questions are referred to the next assessment question. However, organisations that score less than two are referred for further analysis regarding these issues. Organisations who only know who their critical supply chain partners are to a limited extent are provided with guidance on how to identify supply chain partners as well as how to evaluate and select supply chain partners based on their compliance with certain specific factors and how these factors fit into the organisation's strategic objectives. The supply chain integration practices of organisations who only manage their critical supply chain relationships to a limited extent are analysed further. Organisations can determine in which areas they need to and want to improve by analysing their scores (*where 1 = limited, 2 = average, 3 = high and 4 = very high*) in the following potential areas:

- the level of interdependence among supply chain partners
- the long-term commitment to the relationship by supply chain members
- the level of trust among supply chain partners
- the reliability of the organisation's supply chain partners in terms of eliminating supply uncertainties such as unnecessary breakdowns and disruptions
- the sharing of supply chain risks amongst supply chain partners
- the sharing of benefits and rewards amongst supply chain partners
- the degree of collaboration achieved
- the development of any supply chain capabilities across the supply chain to optimise the supply chain
- the measurement of supply chain performance and sharing this information with supply chain partners to improve the supply chain's performance
- adherence to predetermined payment conditions
- the compatibility of essential technologies between supply chain partners
- the contribution of various supply chain members towards new product development initiatives
- the focus on total supply chain costs across the supply chain
- the focus on continuous improvement across processes
- the focus on adhering to predetermined quality levels
- the overall level of supply chain integration between the supply chain members

Analysis of phase three of supply chain design: Supply chain drivers

In the second section for analysing phase three of SCD, *supply chain drivers* are analysed (SCD element 3.2). Assessment questions are used across the six supply chain drivers of facilities, inventory, transportation, information, sourcing and pricing to determine whether the supply chain drivers are being managed in line with the selected supply chain strategy. The supply chain drivers of a lean supply chain should be managed differently to those of an agile supply chain. If discrepancies exist, organisations are prompted to determine possible reasons and/or solutions for these discrepancies. Organisations are asked to indicate where they would position their organisation in terms of how they manage their supply chain drivers along a continuum (*where 1 = a strong focus on efficiency and 4 = a strong focus on responsiveness*). A response of one on the one side of the continuum will indicate that the supply chain drivers are managed according to lean principles while a response of four will indicate that the supply chain drivers are managed with agility in mind. According to theoretical principles, if organisations select a lean supply chain strategy, they should have a response of one or two for the assessment questions. Alternatively, according to theoretical principles, if organisations select an agile supply chain strategy, they should have a response of three or four across the nine assessment questions. The assessment questions cover the following areas:

- capacity utilisation in facilities
- location of facilities
- inventory levels
- lead times
- transportation cost
- transportation frequency
- information collection
- supplier selection criteria
- pricing and profit margins

Analysis of phase three of supply chain design: Supply chain key performance indicators

Section three for analysing phase three of SCD provides an analysis of the key performance indicator (KPI) categories on which organisations focus. Organisations have to rate the following KPI categories:

- supply chain delivery reliability
- supply chain responsiveness
- supply chain flexibility
- cost measures within the organisation
- cost measures across the supply chain
- supply chain asset management efficiency

Although all these KPI categories are important, certain KPIs are essential for the selected supply chain strategy. Organisations with a lean supply chain strategy should focus on cost measures within the organisation and across the supply chain, as well as on supply chain asset management efficiency. Organisations with an agile supply chain strategy should focus on at least delivery reliability, responsiveness and flexibility. Organisations with a leagile supply chain strategy should focus on all the previously mentioned KPI categories. If organisations do not focus on the correct KPI categories there may be misalignment between their supply chain strategies and the KPI categories on which they are focusing. The conceptual framework highlights the KPI categories on which organisations should focus according to their selected supply chain strategy.

RESEARCH METHODOLOGY

The research methodology for the research consisted of two phases. In the first phase, a literature study was conducted on the topic of SCD to determine the elements of SCD. Numerous sources were used in the literature review. The main sources included books written by authors specifically about these topics and relevant articles in journals. The literature study was summarised in the previous sections. The identified SCD elements were included in the proposed conceptual framework.

In the second phase of the research the conceptual framework was tested in 13 organisations to determine whether the conceptual framework was a workable instrument for organisations to analyse their SCD practices. The nature of the empirical research reported in this article was exploratory and descriptive. The literature study is characteristic of exploratory research while the structured questions are characteristic of descriptive research. Triangulation, a combination of both quantitative and qualitative research methods was also used. Qualitative research was used to compile the conceptual framework from the literature and in-depth personal interviews were conducted using a small sample. Quantitative research was used in the form of a structured questionnaire. Personal interviews were used as survey method to obtain data by means of the questionnaire which was developed to cover all the areas of the framework. A structured questionnaire was necessary to ensure that various respondents would respond consistently to a given consistent set of variables within similar scenarios to ensure reliability. An extensive assessment instrument was developed to serve as basis for the conceptual framework. The functioning of the conceptual framework entails the usage of an assessment instrument which uses questions as a basis for gathering information from which organisations' SCD practices can be analysed. This made the use of a structured assessment instrument a necessity in this research. The questionnaire was pilot tested across three organisations.

The South African Sunday Times Top Brands surveys of 2009 and 2008 were used as points of departure to determine which brands of products were popular in the minds of end customers (Doke, 2009; 2008). Organisations in the manufacturing, assembly, distribution and retail sectors of these brands were included in the sample frame. The top brands of 2009 were grouped together into five categories, namely, food, drinks, telecommunication, fashion apparel and automobiles. This ensured that the supply chains of both functional and innovative products were included in the research.

Non-probability sampling was used. The respondents selected for the research sample were selected by means of purposive, judgmental and convenience sampling. In the first stage, purposive sampling was used to draw the sample from the different categories in the sample frame. After the initial stage, judgmental sampling was used to ensure that different organisations were included that, amongst them, implement lean, agile or leagile supply chain strategies. Each of these supply chain strategies needed to be tested exploratively to ensure that the conceptual framework is a workable instrument across all three supply chain strategies. This could be ensured through purposive and judgmental sampling. Due to several constraints such as limited time and unavailable respondents, convenience sampling was used in the next stage of sampling to ensure that organisations were included, who amongst them, implemented lean, agile and leagile supply chain strategies. A final sample of 13 respondents was drawn. Six of the 13 respondents ($n=6$) were from the drinks category; four in the 'food kept on the shelf' category ($n=4$) and three respondents were in the automobile industry ($n=3$).

EMPIRICAL FINDINGS OF PHASE ONE OF SUPPLY CHAIN DESIGN

Most of the organisations that took part in the research have a good or very good idea of who their customers are and how to meet the needs of their customers. The results are shown in Table 1. All the organisations have a good or very good idea of who their end customers are and how to meet the needs of their customers. Twelve of the 13 respondents identified a value proposition, possessed a core competency to meet these needs and have identified how to win their customers' orders to a good or very good extent. Not one of the respondents gave a response that indicated a very limited or limited extent regarding these issues.

Table 1: Understanding customer needs and how to meet these needs ($n = 13$)

The extent to which the organisation (where 1 = very limited; 2 = limited; 3 = average; 4 = good and 5 = very good):	Frequency of responses		
	Average extent	Good extent	Very good extent
Knows who its customers are		4	9
Knows what the needs of their customers are		7	6
Has identified a value proposition to meet these needs	1	5	7
Possesses a core competency	1	8	4
Has identified how to win customers' orders	1	5	7

EMPIRICAL FINDINGS OF PHASE TWO OF SUPPLY CHAIN DESIGN

Nine organisations have a predictable market demand for their product. Four organisations indicated that the market demand for their product was unpredictable. This is indicated in Table 2. The majority of the organisations who participated in this research therefore have a predictable market demand for the selected product category.

Table 2: Organisations' market demand predictability ($n = 13$)

Product category characteristics:	Frequency of responses	
	Predictable	Unpredictable
Market demand predictability	9	4

Three organisations indicated that their market winner was low cost while the other 10 organisations indicated that their market winner was agility. This is shown in Table 3.

Table 3: Organisations' market winners ($n = 13$)

Product category characteristics:	Frequency of responses	
	Low cost	Agility
Market winner	3	10

As already mentioned a lean supply chain strategy should be used where products have a predictable market demand and where low cost is the market winner. An agile supply chain strategy should be

used where the market demand for a product is unpredictable and where agility is the market winner. However, some of the respondents indicated that the market demand for their product was predictable and that agility was their market winner. One respondent indicated that the market demand for its product is unpredictable and that low cost was its market winner. When these options are grouped together and analysed according to market demand predictability and market winners, they can be categorised into one of four quadrants, as indicated in Figure 4.

Figure 4: Products according to market demand predictability and market winners

		Quadrant B (7 responses) MISMATCH	Quadrant C (3 responses) MATCH
Agility			
Market winner			
		Quadrant A (2 responses) MATCH	Quadrant D (1 response) MISMATCH
Low cost			
		Predictable	Volatile
		Market demand	

Therefore, a lean supply chain strategy can be suggested for the two respondents in Quadrant A and an agile supply chain strategy can be suggested for the three respondents in Quadrant C. This is indicated by the shaded quadrants. However, the seven respondents in Quadrant B need to further analyse their responses because they have indicated that their market winner was agility and that their market demand for the product was predictable. Similarly, the one respondent in Quadrant D also needs to further analyse the response because it indicated that the market winner was low cost and that the market demand was volatile. This contradicts what literature suggests. If these eight organisations were satisfied with their responses after analysing them, their position in terms of the decoupling point in their supply chain would be used to suggest the right supply chain strategy for them. After analysing the decoupling points of these eight organisations, it was suggested that five of them should use a leagile supply chain strategy and that three of them should use an agile supply chain strategy.

The focus of organisations' supply chain strategies is tabled in Table 4. Three respondents indicated that the focus of their supply chain strategy was aimed at being lean (low cost). Seven respondents indicated that they were focusing on a leagile supply chain strategy and three respondents indicated that the focus of their supply chain strategy was on agility. Table 4 also shows the supply chains that are suggested to the organisations according to the market demand predictability as well as the market winner (and decoupling point if necessary) of the selected product. Table 4 shows that some organisations are using a different supply chain strategy to what is suggested to them by the conceptual framework. This information can be used to analyse their SCD practices and establish whether they are in fact implementing the correct supply chain strategy. Upon further analysis, it was found that seven organisations were implementing the supply chain strategy that was suggested to them. Six organisations were implementing a different supply chain strategy to the one being suggested to them.

Table 4: Focus of organisations' supply chain strategy (n = 13)

	Frequency of responses		
	Lean	Leagile	Agile
Suggested supply chain strategy	2	5	6
Selected supply chain strategy	3	7	3

EMPIRICAL FINDINGS OF PHASE THREE OF SUPPLY CHAIN DESIGN: SUPPLY CHAIN PARTNERS

Table 5 shows the results of the empirical findings in terms of organisations' relationships with their customers and Table 6 shows the results of the empirical findings in terms of organisations' relationships with their suppliers.

Table 5: Organisations' relationships with their important customers (n = 13)

The extent to which the organisation (where 1 = limited; 2 = average; 3 = good; 4 = very good and NA = not applicable):	Frequency of responses			
	Limited extent	Average extent	Good extent	Very good extent
knows who its supply chain partners are	1		2	10
manages critical direct (1 st tier) partners			6	7
manages 2 nd tier to n th tier relationships	6	3	2	1

From Table 5 it becomes evident that the organisations could effectively manage their 1st tier supply chain relationships with their customers. Only one organisation indicated that it had a limited knowledge of who its supply chain partners were (at a 1st tier level). However, when the situation is analysed beyond the 1st tier, it seems that the relationships with customers were more difficult to manage. In fact, six organisations indicated that they were managing their supply chain relationships with their customers beyond the 1st tier to a limited extent. One organisation did not respond to the assessment question for its 2nd tier relationships. Upon further analysis of these six organisations, the potential areas for the improvement of their supply chain integration practices with their customers were identified by the conceptual framework as follows, namely to:

- improve the level of interdependence between supply chain members (one organisation);
- share supply chain risks amongst supply chain members (two organisations);
- share benefits and rewards amongst supply chain members (two organisations);
- develop supply chain capabilities across the supply chain to optimise the supply chain (two organisations);
- adhere to predetermined payment conditions (one organisation);
- improve the compatibility of essential technologies between supply chain members to ensure the seamless flow of materials between partners (three organisations);
- enhance the contribution of supply chain members towards new product development initiatives (six organisations);
- improve the compatibility of essential technologies between supply chain members to ensure the mutual sharing of accurate relevant information (two organisations);
- focus on total supply chain costs across the supply chain (three organisations);
- focus on continuous improvement across processes (three organisations); and
- improve the overall level of supply chain integration between the organisation and supply chain partners (one organisation).

Table 6 shows that organisations are managing their relationships with their 1st tier suppliers effectively. In fact the organisations' management of relationships with their suppliers was successful to a higher extent than with their customers (refer to Tables 5 and 6). Nine organisations were managing their suppliers (1st tier) to a very good extent.

Table 6: Organisations' relationships with their important suppliers (n = 13)

The extent to which the organisation (where 1 = limited; 2 = average; 3 = good; 4 = very good and NA = not applicable):	Frequency of responses			
	Limited extent	Average extent	Good extent	Very good extent
knows who its supply chain partners are			1	12
manages critical direct (1 st tier) partners			4	9
manages 2 nd tier to n th tier relationships	4	5		1

The situation changed when organisations' relationships with their 2nd tier suppliers were considered. From the responses it was clear that it is difficult to manage supply chain relationships beyond the 1st tier. Three organisations did not respond to the assessment question regarding their 2nd tier relationships. Four organisations were managing these relationships with their suppliers to a limited extent. When these four organisations' supply chain integration practices were analysed further, the potential areas for the improvement of their relationships with their suppliers were identified by the conceptual framework as follows, namely to:

- improve the level of interdependence between supply chain members (one organisation);
- share supply chain risks among supply chain partners (three organisations);
- share benefits and rewards among supply chain partners (one organisation);
- develop supply chain capabilities across the supply chain to optimise the supply chain (one organisation);
- improve the compatibility of essential technologies among supply chain members to ensure the seamless flow of materials between partners (two organisations);
- enhance the contribution of supply chain members towards new product development initiatives (four organisations); and
- focus on total supply chain costs across the supply chain (three organisations).

EMPIRICAL FINDINGS OF PHASE THREE OF SUPPLY CHAIN DESIGN: SUPPLY CHAIN DRIVERS

The findings of the three different supply chain strategies, namely lean, agile and leagile, are tabled in Tables 7, 8 and 9. Table 7 reports on the organisations with lean supply chain strategies while Table 8 reports on the organisations with agile supply chain strategies. Table 9 reports on the organisations with leagile supply chain strategies.

Table 7: Responses from organisations (with a lean supply chain focus) in terms of the management of their supply chain drivers (n = 3)

SCD element (as identified in the supply chain drivers)	Frequencies in terms of organisations with a lean supply chain focus	
	Lean	Agile
Capacity utilisation	3	
Location of facilities		3
Inventory	3	
Lead time	2	1
Transportation cost	3	
Transportation frequency	1	2
Information	1	2
Supplier selection criteria	1	2
Pricing/ profit margins	1	1

The shaded areas show where there is alignment according to theoretical principles in the literature on how the supply chain drivers should be managed for lean supply chains. However, it is evident from Table 7 that there are several areas where organisations who have lean supply chain strategies are not managing their supply chain drivers according to what is suggested in the literature for lean supply chains (Chopra & Meindl, 2010; Hugos, 2006). Suggestions identified by the conceptual framework in this regard were to:

- centralise the location of facilities;
- focus on ensuring stable reliable lead times (rather than trying to reduce the lead times). Longer reliable lead times are sufficient due to a predictable market demand;
- reduce transportation frequency which should result in a decrease in transportation costs;
- not invest too much in information systems because the market demand was predictable;
- focus on low prices (total cost) within acceptable service levels as supplier selection criteria; and

- base their pricing and profit on low margins and high sales volumes.

Table 8: Responses from organisations (with an agile supply chain focus) in terms of the management of their supply chain drivers (n = 3)

SCD element (as identified in the supply chain drivers)	Frequencies in terms of organisations with an agile supply chain focus	
	Lean	Agile
Capacity utilisation	1	2
Location of facilities	3	
Inventory	3	
Lead time	3	
Transportation cost	2	1
Transportation frequency		3
Information		3
Supplier selection criteria		3
Pricing/ profit margins	2	1

The shaded areas show where there is alignment according to theoretical principles in the literature on how the supply chain drivers should be managed for agile supply chains. However, in Table 8 it also is evident that there are several areas where organisations with a supply chain strategy focused on agility were not managing their supply chain drivers according to what is suggested in the literature for agile supply chains (Chopra & Meindl, 2010; Hugos, 2006). Using the conceptual framework for further analysis, organisations with an agile supply chain strategy should consider the following options, namely to:

- allow for excess capacity to be flexible to meet unexpected fluctuations in customers' demands;
- decentralise the location of their facilities closer to their customers;
- consider maintaining a wider variety of inventory stocks (and even safety stocks) to ensure that customer demand is met;
- reduce lead times to improve customer service if it is required;
- increase transportation cost (by means of more frequent deliveries or faster and more expensive modes of transport) if customers demand prompt delivery; and
- base pricing and profit on high margins and low sales volumes if the market is not big enough.

Table 9: Responses from organisations (with a leagile supply chain focus) in terms of the management of their supply chain drivers (n = 7)

SCD element (as identified in the supply chain drivers)	Frequencies in terms of organisations with a leagile supply chain focus	
	Lean	Agile
Capacity utilisation	7	
Location of facilities	4	3
Inventory	7	
Lead time	5	2
Transportation cost	6	1
Transportation frequency	2	5
Information	1	6
Supplier selection criteria	4	2
Pricing/ profit margins	6	1

The findings in Table 9 show that it seems as though the majority of the responses for capacity utilisation, location of facilities, inventory management, lead times, transportation cost, supplier selection criteria and pricing policies are managed according to lean principles. Transportation frequency and information systems are managed according to agile principles. One organisation did not respond to the assessment question on supplier selection criteria. Due to the nature of leagile supply chain strategies, each supply chain driver will have to be analysed individually for leagile

supply chain strategies. Each organisation will need to consider the various options and recommendations provided by the conceptual framework to make a decision on how they want to manage these supply chain drivers.

EMPIRICAL FINDINGS OF PHASE THREE OF SUPPLY CHAIN DESIGN: SUPPLY CHAIN KEY PERFORMANCE INDICATORS

Table 10 shows the finding of organisations' responses in terms of the focus of their supply chain KPIs. Organisations could rate more than one KPI as being equally important as others. Organisations could thus rate more than one KPI category as being most important to them. Organisations with a lean supply chain strategy should definitely have cost measures as a priority in their organisation. Two of the three organisations indicated that cost measures within their organisation presented the most important category. One organisation indicated that asset management efficiency was the most important category. Organisations with an agile supply chain strategy should focus on supply chain reliability, supply chain responsiveness and supply chain flexibility. Two organisations with an agile supply chain strategy rated supply chain reliability as most important, while only one respondent rated each of supply chain responsiveness and supply chain flexibility as most important KPI category. Organisations with a leagile supply chain strategy should focus on all the supply chain KPI categories. Seven organisations were focusing on supply chain reliability KPIs, while only three organisations rated supply chain responsiveness KPIs as most important KPI category. Only three organisations rated cost measures within the organisation and supply chain asset management efficiency KPIs as most important KPI categories, while only two organisations rated cost measures across the supply chain as most important KPI category. The conceptual framework highlights the importance of the various KPI categories for each of the supply chain strategies.

Table 10: Top KPI categories for organisations (n = 13)

KPI category	Frequency in terms of most important KPI category. Organisations with:		
	Lean supply chain	Leagile supply chain	Agile supply chain
Supply chain reliability	1	7	2
Supply chain responsiveness		3	1
Supply chain flexibility			1
Cost measures in organisation	2	3	3
Cost across the supply chain		2	
Supply chain asset management efficiency	1	3	

CONCLUSIONS AND RECOMMENDATIONS

From the literature it was concluded that SCD essentially consists of three phases. Twelve broad supply chain design elements across the three phases of SCD were identified from the literature study. These SCD elements were included in the conceptual framework to form the basis on which SCD practices can be analysed. Empirical research was conducted to test whether the conceptual framework could be used as an assessment instrument to analyse SCD practices. The empirical research indicated that organisations could use the conceptual framework to analyse each phase of their organisation's SCD. If organisations were satisfied with their SCD practices, they were directed to a next phase of the analysis. However, the conceptual framework could highlight areas where organisations may not be aligning their SCD practices with their supply chain strategy. These potential areas for improvement could then be further explored to determine whether organisations could in fact improve their SCD practices to possibly improve their supply chain performance. The empirical research concludes that the conceptual framework is in fact a workable instrument in helping organisations to analyse their SCD practices.

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