Article Title Page

Article title: Supply chain strategies of manufacturers in Ethiopia

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Structured Abstract

Purpose: The paper aims to test the supply chain strategies and the linking of supply chains to supply chain strategies in line with Lee's model.

Methodology: The paper used an empirical survey of 134 large industries to test the hypothesis suggested and strengthens the existing theories.

Findings: Industries and supply chain measures are matched distinctively to their respective supply chain strategies. The order winning supply chain measures for each supply chain strategies are identified.

Research limitations: Even though the research is only one of the few on case considered, it is not without limitations. The benefits from matching supply chain measures to the supply chain strategies are not quantified. Besides, continental wise survey is needed to come with further improved theory.

Practical Implication: Different supply chain types require typical supply chain measures in order to increase competitiveness. Linking supply chain performance to the respective supply chain strategy is compulsory.

Originality: The research can be considered the only one of the few in the continent in general and a case country in particular. It is also the first of the type in the world in testing Lee's model as far as our knowledge concerns.

Keywords: supply chain strategy, supply chain performance, exploratory factor analysis, confirmatory factor analysis, supply chain metrics, efficient supply chain, agile supply chain, risk-hedging supply chain, responsive supply chain

Article Classification: Research Paper

Running Head: Supply chain strategies of manufacturers in Ethiopia

Supply Chain Strategies of Manufacturers in Ethiopia

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Introduction

In today's competitive age, many companies have not succeeded in maximizing their supply chain's potential because they have often failed to develop the performance measures and metrics needed to fully integrate their supply chain (Gunasekaran *et al.,* 2004). The main problems in supply chain (SC) performance measurements are: i) having a large number of metrics which makes it difficult to identify the critical few among trivial many; ii) failing to connect the strategy and the measurement; iii) having a biased focus on financial metrics and being too much inward looking (Gunasekaran *et al.,* 2004; Gunasekaran and Kobu, 2007) and iv) ignoring social and environmental aspects while dealing with economic aspects in greater depth (Cuthbertson and Piotrowicz, 2011). Clearly, the right choice of performance measure is critical to the success and competitiveness of the firm in the era of globalization (Caplice and Sheffi, 1994; Bhagwat and Sharma, 2007). This is particularly difficult as companies nowadays face a series of challenges like shrinking product life cycles, the proliferation of product variants, and increasing uncertainty on both the demand and the supply side. Dealing efficiently with uncertainty is one of the most crucial points in SC design (Davis, 1993). These uncertainties are demand and supply uncertainties. To reduce uncertainties, proper SC design is needed (Davis, 1993; Lee, 2002). Reducing these uncertainties improves SC performance (Davis, 1993; Mason-Jones and Towill, 1998; Geary *et al*., 2002; Yang *et al*., 2004; Prater, 2005). Due to these uncertainties, different SC strategies emerged. Because of these different types of strategies, it is practically impossible to develop a single performance measurement model that applies to all strategies. There is no 'one size fits all' approach for successful management of the SC, but different performance measures are appropriate for different strategies. Hence, setting the right SC strategy is mandatory for companies competing in the market (Fisher, 1997; Lee, 2002; Thun, 2005; Chopra and Meindl, 2007; Narasimhan *et al*., 2008; Jacoby, 2010).

Within the SCM literature, the existence of distinct SC strategies to drive performance is studied (Christopher and Ryals, 1999; Thun, 2005; Chopra and Meindl 2007; Narasimhan *et al*., 2008; Jacoby, 2010; Wagner *et al*., 2012; Wright, 2013). However, there is no universal SC strategy. Even though several authors identified different SC strategies, none of the authors developed SC measures for each strategy. Although more than one strategy may exist in the SC, identifying the respective metrics for all SC strategies is essential. However the works of Selldin and Olhager (2007) and Qi *et al*. (2009) can be recognized in developing measures for each SC strategy through empirical testing. Selldin and Olhager (2007) identified some measures based on efficient and responsive SCs. Qi *et al*. (2009) identified measures based on lean, leagile and agile SCs. However, no researcher has identified measures for Lee's (2002) SC strategies.

Despite their well-recognized importance, research on SC performance measures is still in its infancy. Most studies on SC performance measures are based on case studies of industries in highly developed countries and are highly descriptive. Very few studies have examined SC performance measures in emerging economies and cultural settings other than North America and Europe. Even though the SCs of BRICS (Brazil, Russia, India, China and South Africa) gained some momentum from the literature, there is no research revealing the practice of SC strategies and SC metrics in the Ethiopian manufacturing SCs. Besides, no one has tested the classification scheme of Lee (2002) on manufacturing industries in the world in general and Ethiopian manufacturing industries in particular. Hence, the aim of this research is to test SC strategies and their respective metrics on Ethiopian manufacturing industries.

The rest of the paper is organized as follows: Section 2 describes the theoretical background and research hypothesis, Section 3 explains the research methodology. In section 4, the results are discussed. Finally Section 5 concludes and proposes future work.

Theoretical background and research hypothesis

The studies of SC strategies and SC measures are not new. However, the right measures for the SC strategies have not yet been identified. Besides, there is clear classification of the SC strategies based on the types of companies. The majority of strategies are not tested empirically using large samples. The most common SC strategies identified by Fisher (1997) have been tested and validated by different researchers (for example Selldin and Olhager (2007)). Similarly, the classifications based on lean and agile have also been tested (for example, Qi *et al*. (2009)). But, the classification proposed by Lee (2002) has not been validated empirically; as far as we know. Furthermore, matching SC measures to the classifications is not studied. Hence, using the theory developed so far and adopting Lee (2002) classification, the classification and the match to their respective SC measures has been tested. To do this the research map is developed as shown in Figure 1. First companies are identified and classified according to their adopted SC strategy which is captured in Hypotheses 1a-1d followed by identifying the SC measures for the strategies which are captured under Hypotheses 2a-2d.

----------Insert Figure 1 near here----------

Supply Chain Strategies

The work of Fisher (1997) is a breakthrough in developing SC strategies matching product types. He asserted that those functional products are matched with physically efficient SCs

whereas those innovative products match market responsive SCs. Several authors have taken Fisher's work and collected empirical data to support and refine the theory. Supply chain strategies in fulfilling orders such as push and pull (Simchi-Levi et al. 2003) have also been studied. However, this paper concentrates only on Lee's (2002) classifications. In research, much of this work has been focused on examining two fundamental SC strategies: lean, which is roughly equivalent to Fisher's physically efficient and agile, which is roughly equivalent to Fisher's market-responsive. Some functional products may, however, also have quick response requirements of the supply chain. For example, milk and other dairy products are perishables with relatively stable demand patterns but limited shelf life. Also, companies often carry out promotions that can drastically change the otherwise stable and predictable demand patterns of products such as generic food. These cases forced some authors to extend Fisher's (1997) classification of SCs.

Naim *et al*. (1999) compared lean and agile SC based on the ability to cope with uncertainty, including variations, in production volume and the degree of product variety required and concluded that products with low variety and high variability suits lean strategy whereas products with high variety and low variability suit that of agile strategy. This strategy is supported and verified by Mason-Jones and Towill (1999); Christopher and Towill (2000) and Qi *et al* (2009). Extending the classifications, some authors come with a leagile or hybrid SC arguing the position of the decoupling point identify the SC of lean and agile types (Christopher, 2000; Huang, *et al*., 2002; Agarwal *et al*., 2006; Christopher *et al*., 2006).

Lee (2002) classified the SC into stable and evolving depending on the product type with uncertainty. He briefly categorized SCs into efficient, responsive, risk-hedging, and agile SCs based on supply and demand uncertainties and product characteristics (functional and innovative products). He further dictated that functional products with low supply uncertainties are efficient while functional products with high supply uncertainties are risk-hedging SCs. Innovative products with low supply uncertainties are termed as responsive while innovative products with high demand uncertainties are agile. This classification is a sound one based on uncertainties and also this is the motivation towards this research in finding the respective metrics among others.

Huang *et al*. (2002) tried to match product characteristics (innovative products, hybrid products and standard products) to respective SC types (agile, hybrid and lean) using weighted sum to determine the desired SC strategy. There are authors who claim and support these classifications that there are three distinct classifications of SC strategies namely, lean, leagile/hybrid and agile SCs (Bruce *et al*., 2004; Agarwal *et al*., 2006; Christopher *et al*., 2006; Vonderembse *et al*., 2006;) but failed to agree in which position leagile or hybrid SC works. Some other authors like Chibba (2007) and Xu *et al*. (2007) supported this classification but further expanded the SCs by adding adaptive SCs into the category. The other classification of SC strategy is efficient and responsive. This classification is validated and tested by Davis (1993), Ramdas and Spekman (2000), Selldin (2005), Chopra and Meindl (2007), Minnich (2007) and Selldin and Olhager (2007).

Selldin and Olhager (2007) tested Fisher's model on 128 Swedish manufacturing companies if product types and SC strategies match. They matched product type (functional vs. innovative) with SC strategies (physically efficient vs. market responsive). They concluded that companies with functional products matched with physically efficient SC strategy. They also found a considerable match between innovative products and market responsive SCs. The results may also indicate that there is a match of the metrics for each SC strategy.

Qi *et al*. (2009) investigated SC strategies and tested empirically the SC strategy model that posits lean, agile, and lean/agile approaches using data collected from 604 manufacturing firms in China and found that companies can be identified based on their SC strategy according to Fisher's framework. Özkir and Demirel (2011) extended the work of Agarwal *et al*.(2006) and classified the SCs into five categories; lean, agile, leagile, risk-hedging and responsive SC and compared them based on performance attributes such as market demand, customer drivers, purchasing policy, cost, quality and lead time and service level and concluded that while quality and lead time are the market qualifiers (minimum performance expected for any SC to stay as a competitor), cost and service levels are the market winners for cost and the remaining SCs respectively.

Lo and Power (2010) carried out a survey of Australian manufacturing companies and found that even though some companies match to the theoretical model, there are significant companies which mismatched with the model. According to the authors, two-thirds of the companies follow mismatched strategy, and at the same time their operation is successful. They argue that it is difficult to generalize the classification into efficient and responsive alone.

Nagy (2010) tested Fisher's model on 79 large Hungarian manufacturing firms. Nagy (2010) found that about 52 % of companies mismatched with the model and concluded that it cannot be stated that manufacturers of functional products operate exclusively physically efficient, and those of innovative products operate market-responsive SCs. Conducting research on 418 manufacturing companies in Romania, Wright (2013) concluded that larger companies and manufacturers rather than raw material and component suppliers are more likely to use a responsive SC. She also reported a considerable amount of companies which mismatched with Fisher's model.

Through careful observations the main characteristics of SC strategies can be identified from the literature. The main characteristics of SC strategies with their respective name codes and references are shown in Table 1.

----------Insert Table 1 Approximately Here----------

Proposition 1: Ethiopian manufacturers can be mapped using the typology of efficient, responsive, risk-hedging and agile SC strategies.

Research Hypotheses
H1a: A subset of Ethiopian manufacturers pursues a SC strategy focused on efficiency
H1b: A subset of Ethiopian manufacturers pursues a SC strategy focused on responsiveness
H1c: A subset of Ethiopian manufacturers pursues a SC strategy focused on risk-hedging
H1d: A subset of Ethiopian manufacturers pursues a SC strategy focused on agility

Supply Chain Measures

It is stated that SC strategy impacts significantly on a firm's performance (Selldin and Olhager, 2007; Qi *et al*., 2009; Wagner *et al*., 2012; Wright, 2013). It is also known that the majority of authors developed generic SC performance measures while some authors identified performance measures for limited SC types. The generic measures developed so far are too large to consider for practical case study to validate them. Hence, some of the authors' developments are used for the SC performance measures. In practice, there are several

metrics in existence (Caplice and Sheffi, 1994). Hence, the pressing need is not for the development of novel performance metrics, there is a need for a method with which to evaluate existing metrics. In this regard, this study adopts the performance measures developed and identified by the researchers.

In generic terms, the performance measures identified by Beamon (1999) solved some of the difficulties in finding SC measures. In later developments, some authors list large numbers of measures in the form of literature reviews and frameworks (Lambert *et al*., 1998; Gunasekaran *et al.*, 2001; Lambert and Pohlen, 2001; Gunasekaran *et al.*, 2004; Shepherd and Gunter, 2006; Gunasekaran and Kobu, 2007, Gopal and Thakkar, 2012). Huang *et al*. (2005) developed the metrics as delivery reliability metrics, responsiveness metrics, flexibility metrics, cost metrics and asset metrics. Neely *et al*. (2005) identified measures of performance as the multiple dimensions of quality, time, cost and flexibility. Shepherd and Gunter (2006) applied supply chain operation reference (SCOR) model to identify about 132 metrics under the SCOR main activities plan, source, make, deliver and return. The authors categorized the metrics under the main performance attributes such as cost, time, quality, flexibility, innovativeness, quantitative, and qualitative.

Waters (2003) explained lean SC as efficient operations and agile SC as flexible to meet demands arguing that the main metrics for lean SC are productivity and utilization whereas for agile SC are lead times and service level. Agarwal *et al*. (2006) found that the cost and quality metrics are more suitable to lean SC, service level metrics are more aligned with leagile SC and lead time metrics are more comfortable with agile SC. Besides, Selldin and Olhager (2007) dictated that cost and delivery speed metrics are more matched with physically efficient SCs; whereas delivery dependability, volume flexibility, product mix flexibility and profitability are more aligned to market responsive SCs. Qi *et al*. (2009) identified unit manufacturing cost, inventory turnover, overall labor productivity and obsolescence cost as lean metrics where as overall product quality, customer service level, pre-sale customer service, product supports, responsiveness to customers, delivery speed, delivery dependability, volume flexibility, product mix flexibility, new product flexibility as agile metrics. This is also asserted by Behrouzi and Wong (2011) who also recommend that cost and quality metrics are more suitable for lean SC. Zaman *et al*. (2012) identified lean metrics as accuracy of forecasting techniques, total cycle time, production efficiency/line, mutual assistance in solving problems, manufacturing cost, effectiveness of master/line / day, delivery lead time, ability to response demand as delivery metrics, buyer-manufacturer relationship level and quality of delivered goods.

The measures identified above comprise of financial and operational measures. Special attention is given to those measures from Beamon (1999), Lambert and Pohlen (2001), Huang *et al*. (2005), Gunasekaran *et al*. (2001, 2004), Neely *et al*. (2005), Shepherd and Gunter (2006), Gunasekaran and Kobu (2007) and Qi *et al.*'s (2009) classifications. Based on the literature discussed above, supply chain performance measures with their name codes and references are identified as shown in Table 2.

----------Insert Table 2 Approximately Here----------

Proposition 2: Different SC strategy uses different SC measures
To test what measures are appropriate for each SC strategies, the following hypotheses is developed.

Research hypotheses
H2a: A subset of SC measures is used to pursue a SC strategy focused on efficient strategy.
H2b: A subset of SC measures is used to pursue a SC strategy focused on responsive strategy.
H1c: A subset of SC measures is used to pursue a SC strategy focused on risk-hedging strategy.
H1d: A subset of SC measures is used to pursue a SC strategy focused on agile strategy

Research methodology

In this research, data are collected through mail survey and distribution by personal contact with the respondents. The survey focused on those manufacturing companies with more than 100 employees. The target respondents within each company were managers whose work directly affects supply chain management (SCM) practice. A questionnaire survey is used in the research. The surveyed companies are categorised as: raw material manufacturer (named as raw material suppliers), component manufacturer (components suppliers) or finished goods manufacturer (manufacturer) with more than buyer-seller relationships. In this study the researchers tried to achieve reliable data by finding respondents who were well informed about the topics asked in their respective organizations. Thus, the survey instrument has been given to middle and top managers who are responsible for SCM in their organizations-including, general managers, factory managers, operation managers, product design and development managers, marketing managers and SC managers. These managers are selected because it is believed that they have enough knowledge to answer the questions asked in the questionnaire, specifically the questions concerning the SC strategies and SC measures exercised by their respective companies.

Questionnaire design and verification

The items to measure SC strategies are mainly taken from Fisher (1997), Lee (2002), Chopra and Meindl (2007), Selldin and Olhager (2007), Qi *et al.* (2009), Wagner *et al.* (2012) and Wright (2013). The questions regarding the supply chain characteristics are shown in Appendix I. In the questionnaire there are six items for each of the four strategy dimensions. Respondents were asked to what extent do you agree that the SC of your company's major product line has the following characteristics using five-point Likert scale (1= strongly disagree and 5= strongly agree). The items for SC performance measures are obtained from various literature and from companies' experiences. The measures contain both financial and operational metrics. The questions regarding the supply chain performance metrics are shown in Appendix II. The respondents were asked to what extent does your company perform compared with your competitors using a five-point Likert scale (1= much worse and 5=much better).

There also other background and profile data that have meaningful influence on the mapping of performance measures on the respective SC strategies. These include the position of the company in the SC (raw material supplier, component supplier or finished goods manufacturer), characteristics of the firm (leader or subordinate), ownership status (private, state-owned, foreign-owned or joint venture), size of the company (small, medium and large) and age (old/mature and young). The size of the company here is determined by the revenue and number of employees. The distinction in between small, medium and large companies in Ethiopia is clearly set by the country's Central Statistics Agency. Accordingly, companies

with number of employees 5-9 are labelled as small; those with 10-49 are labelled as medium and those with above 50 are considered large. Within the range of large companies this study further divides the companies into groups, (small, medium and large) based on the size of employees to investigate the effect of size on strategy. The small group contains companies having less than 250 employees, the medium group contains those with 251-550 and those with above 550 employees are in the large group. Regarding the age, newer establishments with an age of less than 20 years are considered young and more than 20 are said to be mature. This is to show how age influences the performance measures and SC strategy.

The questionnaire was prepared in English and then revised by the experts in the field and two university professors regarding its content and suitability for the respondents. The edited version was pilot tested on seven general managers of different companies in order to know whether the items suited the target audience before distribution. The items in SC strategies were widely accepted by managers but the items in performance measures were not widely recognized. Because of the feedback the number of measures was reduced from 48 to 30. The revised version of the questionnaire was then distributed to the target groups.

Data collection and non bias

Only large companies with the number of employees more than 100 are considered in this research. We did this because Li et al. (2005) suggested that those companies often engage with SCM issues.We used a database provided by the Ministry of Trade and Industry in our sampling. From the database, there were 223 large manufacturing companies in Addis Ababa and the surrounding towns. A total of 172 companies with more than 100 employees were selected from the database and contacted by telephone. However, 28 companies could not be reached because the telephone numbers were incorrect or the company had moved or closed down. Of the remaining companies, 144 completed the questionnaire. Companies with large variety and multiple production lines as well as those with unidentified SC strategies were excluded. Companies with vertical integration were omitted. Besides, those industry classifications with less or equal to three companies were also ignored. Deleting vague, missing value and incomplete responses 134 respondents were summarized as shown in Table 3 after several rounds of follow-up calls and visits, which represents an effective response rate of about 78%.

To assess non-bias, the industry distributions of the respondents and the population were compared. The industry classifications were found from Ethiopian Ministry of Trade. The code shown in Table 3 was used in SPSS software for further analysis.As shown in Table 3, the percentages of the respondents were close to the percentages of the companies in the population for most industries. To test statistically for no significance difference, a chi-square test was used (χ^2=1.68) which supported the assumption of non-bias with $p > .05$.

----------Insert Table 3 Approximately Here----------

Profile of respondents

Supply chain operational/production, supply and purchasing, marketing, product design and development, general and plant managers were targeted as respondents with special attention given to operational, SC and factory managers due to their exposure to SCM issues and

inclusive control overall of the performance of each company. The frequency of occurrence of each role and their experience within the company are shown in Table 4.

----------Insert Table 4 Approximately Here----------

Assessing reliability and validity

Using those managers as target respondents, 134 filled and returned the questionnaire successfully. The response rate of 78% is considered as sufficient when compared with Forza's (2002) claim of 20% response rate. The categories, responses and profile of the companies are tabulated and shown in Table 5. The majority of the companies are private, about 15% are state-owned, and about 28% are wholly foreign-owned and joint ventures. Regarding the position of the companies in the SC, the majority (70.9%) consider themselves as a leader and the remaining companies are followers. The majority of the companies are manufacturers (75.4%) and about 7.5% are raw material suppliers and the rest are components suppliers. The rest of the profiles can be seen in Table 5.

----------Insert Table 5 near here----------

Content validity was undertaken to ascertain whether the content of the questionnaire was appropriate and relevant to the study purpose. In this case, the questionnaire items were derived from the literature and then checked and amended by experts in the field and university professors. Hence, it is believed that the need for content validity is met. Face validity indicates the questionnaire appears to be appropriate to the study purpose and content area. The questionnaire was also subject to a pilot test as used by other researchers. It evaluates the appearance of the questionnaire in terms of feasibility, readability, consistency of style and formatting, and the clarity of the language used. To check this validity, the questionnaire prepared by the researchers was checked by two professors. After unsuitable items were discarded, the final version of the questions was distributed in a pilot test to a group of managers of large large manufacturing firms, 33 managers responded successfully. Feedbacks from the responses were included and the final questionnaire was distributed to the target respondents. Hence, it was believed that face validity was met.

The most widely accepted measure of internal consistency is Cronbach's alpha (Sekaran, 2003). It was found that the Cronbach's alpha of the strategy dimension is 0.733 which is slightly more than the acceptable level (0.60) dictated by different authors. Cronbach's alpha of measures dimension was also more than acceptable level (0.731). Hence, the data suggest that the constructs possess sufficient reliability.

As suggested by different authors, an exploratory factor analysis was performed for each construct to ensure the unidimensionality of the scales. Prior to factor analysis, sampling adequacy using Kaiser-Meyer-Olkin (KMO) was checked and the KMO of 0.899 was obtained for both strategy characteristics and performance metrics dimensions. Field (2005) suggests that a KMO value greater that 0.5 is acceptable. The result suggested that the factor analysis would yield distinct and reliable factors. Based on this exploratory factor analysis is applied subsequently on items ES1-ES6, RS1-RS6, RHS1-RHS6 and AS1-AS6 which are accepted. Similarly, the same technique was applied for the performance measures dimension (PM1-PM30). Besides, all factors together accounted for 66.66% of the total variance in the data. Hence, the constructs are considered valid.

Regarding how to determine the number of factors in EFA, there is no consensus among researchers. However, three distinct methods are mentioned and their uses are closely related. The first uses those items with eigenvalues greater than 1; the second method is by drawing a scree plot and observing how the factor eigenvalues change abruptly. The third is parallel analysis in which alternative data are generated to compare with the original data values with average eigenvalues. In this research a combination of the first two methods is used. Fortunately, the same number of factors is observed using both methods. In CFA,

After assessing reliability and validating the EFA, determining the model fit indices for CFA continues even though there is a wide variety in the type and value of model indices used to validate the data. However, in most research papers, it is observed that the incremental fit indices (IFI) are more commonly used in addition to chi square fit. Error based Root mean error square of approximation (RMSEA) and residual based standard root mean square residual (SRMR) are also recommended by Hu and Bentler (1999) citing the cut off values of 0.08 and 0.1 and less respectively. It is also mentioned that either of the values of IFI with scores more than 0.9 are considered valid. The most commonly used IFIs are comparative fit index (CFI), Tucker-Lewis index (TLI) and Relative nonconcentrality index (RNI). It is found that a good fit for the model was found except for the higher of chi-square which is inflated by relatively large sample size. The model fit indices are chi-square = 2005.13, root mean square error of approximation = 0.063, comparative fit index = 0.92, and Tucker Lewis index = 0.91, which are better than the threshold values recommended by Hu and Bentler (1999). Furthermore, all of the factor scores of CFA model are greater than 0.5 and the *t*-values are significantly greater than 2.0. As a result, convergent validity is ensured in the study. To assess discriminant validity, the unconstrained model is compared with the constrained models of the constructs. A significant difference of χ^2 between the constrained and unconstrained models would indicate high discriminant validity. In this study, all of the differences of χ^2 are significant, which shows support the discriminant validity of the constructs.

Finally, it is important to determine whether there is a strong correlation between SC measures by using Pearson correlation analysis. In general, if the Pearson's correlation coefficients are all below 0.6, the performance metrics are mutually independent. The result found from the analysis partially supports the claims but insignificant number of performance variables shows nearer to the threshold value. However, it can be said that there are no strong relationships among SC measures.

Results and discussions

Using cluster analysis and scree plot, the significant number of factors for supply chain characteristics were identified. Figure 2 shows us that there could be up to five factors to be used for supply chain characteristics. But since the eigenvalues increase abruptly at the forth factor, the number of factors is considered four.

----------Insert Figure 2 near here----------

The four factors are believed to be independent of one another and that each factor (strategic dimension) is comprised of a coherent set of items. E.g. the efficiency dimension contains all the efficiency characteristics.The same is true for the rest of the dimensions. Hence this data can be used to further show the relations of companies to strategies. Based on this, the next step is finding the factor analysis for relationship between the companies and

the supply chain strategies. The scores in Table 6 shows that there is a greater relationship between cluster 2 and responsive SC, cluster 1 and efficient SC, cluster 3 and agile SC and cluster 4 and risk-hedging SC. Referring the codes for each constructs in supply strategy section, Table 6 tells us the relation (scores) between the strategic dimensions and SC strategies. Besides, using ANOVA to test group differences in the mean values as shown in Table 7, the results from the factor scores based on clustering can be supported. From the table, one can make inference that since the F-value for all groups/clusters are significant; it can be claimed that there are four different strategies exist in the study. In addition, looking into the higher value of the means towards each match, it is easy to claim now which clusters belongs to each strategy. To claim this, ANOVA is used. ANOVA is used to test whether there is a significance difference among clusters. It is found that there is a significance difference among clusters and as a result the hypotheses 1a-1d are met as shown in Table 7.

----------Insert Table 6 Approximately Here----------

----------Insert Table 7 Approximately Here----------

The ANOVA result for the types of industries by SC strategy is shown in Table 8. From the table, it is observed that food and beverages, glass, ceramics and plastics and consumer products favored efficient SCs. This result goes against the findings of Selldin and Olhager (2007) in which most companies were exercising responsive SCs. Most of the textiles, clothing and leather industries and metals and machinery have the highest scores on the agile SC dimension, while most of the chemicals and construction companies have the highest scores in the risk-hedging dimension. The majorities of wood, paper and furniture and transportation equipments have the highest scores on the responsive strategy dimension. This classification is applied to the majority in number of responses. It is observed that some consumer products companies replied in the responsive SC. A few numbers of textile, clothing and leather companies responded to risk-hedging SC.

----------Insert Table 8 Approximately Here----------

One-way ANOVA is used to test the effect of background and profile data like age, position, role, size, and ownership as clearly tabulated in Table 9.

----------Insert Table 9 Approximately Here----------

Regarding the ownership, it can be seen that F-value is significant on efficiency SCs in the private industries. Hence, the result shows that the majorities of private companies and joint ventures favor efficiency and responsive SCs respectively. It is seen that privately-owned companies are significantly different from from some of the other ownership types but for efficient. For the other background and profile data, i.e., size, small and large companies favor efficient and responsive SCs respectively. This means that small size companies rely on efficient SCs while the larger one prefers responsive SCs. Regarding the age of the companies, young companies favored efficient SC while mature companies favored agile SC. Finally, the manufacturer in the SC is seen significant in agile SC strategy.

To test the second proposition on the relationship between SC measures and strategies; scree plot, factor and cluster analysis are used. The scree plot is used to determine the significant number of factors for performance measures. The scree plot for supply chain performance

metrics is shown in Figure 3. From the figure we can observe up to 5 factors. Using similar techniques as of the strategic dimensions, four factor is considered.

----------Insert Figure 3 near here----------

Table 10 shows factor analysis for performance measures. In the table the dominant scores are shown and less significant values are omitted. The values in the table indicated with bold shows significance of measures with respect to each strategy. The scores shown in the table also indicates that some of the measures of agile are strongly related to the responsive SC. Similarly, some of the measures used for efficient are also can be used for risk-hedging SCs. These measures can be called common for each pairs. According to this result, PM6, PM7, PM8, PM9, PM15, PM16, PM17 and PM29 are common measures for both responsive and agile SCs. But PM15, PM17, PM9, PM29 and PM16 are more common to agile than responsive.

Similarly, PM6, PM7 and PM7 are more aligned to responsive SCs. In the same way PM1, PM3 and PM4 is common to efficient and risk-hedging SCs with PM3 more weight to risk-hedging SC. Another more important result from the mapping is PM10, PM12, PM18, PM19, PM20 and PM21. These measures are used by all industries and there are no significant differences among the strategies. The majorities of these measures are financial measures and can be concluded that financial measures are almost equally understandable and usable to all ranges of the SCs. Hence, operational measures are more important to classify SC strategies. The other one is information sharing. These measures are regarded as most important to all levels of the chains. This result is supported by Gunasekaran and Ngai (2004) dictating that effective information sharing for either lean or agile is usually an essential part of a collaboration strategy, and firms will often rely on the application of information and communication technology for this purpose. The results regarding SC measures are partially supported by Thun (2005). Thun (2005) indicate that plants that match their SC structure with the product perform better on several performance measures. Plants in efficient SCs perform better at unit cost of manufacturing, inventory turnover and cycle time. Plants in efficient SCs perform worse on fast delivery and flexibility to change volume when they handle functional products than when they handle innovative products. Similarly, responsive SCs perform better on the dimensions of fast delivery and flexibility, but worse on unit cost of manufacturing, inventory turnover and cycle time, indicating a trade-off between responsiveness and efficiency. His result has a considerable difference with the result that, no difference could be observed for on-time delivery performance, which could potentially indicate, according to Thun (2005), that *on-time delivery* functions as a key driver for efficient SCs and responsive SCs. A high on-time delivery ratio supports both, efficiency and responsiveness. In this research, however, it is slightly aligned towards agile and responsive SCs.

----------Insert Table 10 Approximately Here----------

The ANOVA results show there are significant differences among means of performance measures clustering into SC strategies. The complete ANOVA test for matching SC measures to the SC strategies is shown in Table 11. Hence, the results support the hypothesis 2a-2d.

----------Insert Table 11 Approximately Here----------

Conclusions and future work

In this study, it is found that there is distinct matching of companies to SC strategies based on the classification given by Lee (2002). Regarding types of companies matching SC strategy, it is found that food and beverages, glass, ceramics and plastics and consumer products match with efficient SCs. Companies in textiles, clothing and leather companies and metals and machinery are suited in agile category, while chemicals and construction company categories fall under risk-hedging SCs. Wood, paper and furniture and transportation equipments are categorized under responsive SC strategy. Regarding the other background and profile data, private and joint venture companies favor efficient and responsive SCs respectively and manufacturers favor agile SC. Small and large companies favor the efficient and responsive SCs respectively.

It is also indicated that efficiency, risk-hedging, agile and responsiveness strategies can be mapped independently and their respective measures are also identified. It is also found that metrics for efficient SC can be adapted to the risk-hedging SC on varying the scales of measurements. In the similar manner the metrics developed for agile SC can be used for responsive SCs in the same modifications. Regardless of the difficulty in the interdependence of the SC measures, this research is unique in matching SC measures to the strategies using sufficient samples in the same country.

Supply chain strategy based on Lee's (2002) classification is directly adopted. While the research is done in developing countries, it is of significant interest to the SCM academicians and practitioners. Also it is useful to Ethiopian and foreign companies. For Ethiopian companies, it helps to identify SC strategy to compete effectively and to evaluate how well SC models fit with theoretical findings and suggestions. For foreign companies, it shows the position of Ethiopian manufacturers towards SCM for further collaboration and entry into the country using the companies as a partner.

Though the research is one of the first in Ethiopian SCs, it is not without flaws. The research findings from the empirical testing to formulate the theory need to include those wide geographical locations. Since SCM issues are new to the World in general and Ethiopia in particular, the same problem needs to be tested on developed nations as a complement to strengthen the theory. The sample size should be increased for better accuracy in the result. The other limitation of the study is the coverage of types of industries. Since different types of industry need different strategy and measures, all industry verticals need to be addressed inclusively. Due to the short of the budget and time, all industries are not included in this study.

The SC measures and strategies identified in this research are purely based on the survey from the experts. Mapping SC measures to their respective strategies using index is the next task of the researchers. Besides, investigating the specific economic values of matching SC measures to the strategy in Ethiopian manufacturing companies is also the fertile area of the research.

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Table 1- Governing characteristics for each SC strategy with their code and source

Governing Characteristics	Code	Source
For Efficient SCs		
Minimize cost	ES1	Selldin and Olhager (2007)
Minimize inventory	ES2	Fisher (1997)
High average utilization rate	ES3	Fisher (1997)
Cost-restricted lead-time reduction	ES4	Selldin and Olhager (2007)
Long term supplier relationship with suppliers	ES5	Chopra and Meindl (2007)
Supplier selection criterion based on quality and cost	ES6	Fisher (1997)
For Responsive SCs		
Capacity flexibility for demand uncertainty	RS1	Fisher (1997)
Excess buffer inventory for demand uncertainty	RS2	Lee (2002)
Aggressive lead-time reduction	RS3	Selldin and Olhager (2007)
Supplier selection criterion based on flexibility, reliability and quality	RS4	Fisher (1997)
High level of usage of modular design	RS5	Fisher (1997)
Quick response to demand	RS6	Selldin and Olhager (2007)
For Risk-Hedging SCs		
High level of electronic market that reaches more suppliers	RHS1	
Sharing safety stock with other industries	RHS2	Lee (2002)
Pooling of inventories and resources	RHS3	Lee (2002)
Future contracts that lock-in price and delivery	RHS4	Lee (2002)
Capacity flexibility for supply uncertainty	RHS5	Lee (2002)
Excess buffer inventory for supply uncertainty	RHS6	Lee (2002)
For Agile SCs		
High level of information accuracy between partners	AS1	Agarwal *et al*. (2006)
Excess manufacturing capacity	AS2	Bruce *et al.* (2004)
Excess buffer inventory for both raw materials and finished inventories	AS3	Huang *et al.* (2002)
High delivery flexibility	AS4	Qi *et al.* (2009)
High level of new product flexibility	AS5	Christopher *et al.* (2006)
High level of responsiveness to volatile markets	AS6	Qi *et al.* (2009)

Table 2- Names, codes and sources of performance metrics

Metric	Code	Source
Average inventory level	PM1	Lambert and Pohlen (2001)
Backorder or stock-out	PM2	Huang *et al* (2005)
Capacity utilization	PM3	Waters (2003)
Cash to cash cycle time	PM4	Shepherd and Gunter (2006)
Cost of goods sold	PM5	Neely *et al* (2005)
Customer complaints	PM6	Behrouzi and Wong (2011)
Customer response time	PM7	Behrouzi and Wong (2011)
Delivery changes	PM8	Qi *et al* (2009)
Fill rate	PM9	Agarwal *et al* (2006)
Forecast accuracy	PM10	Zaman *et al* (2012)
Information accuracy	PM11	Zaman *et al* (2012)
Information sharing	PM12	Gunasekaran *et al* (2001)
Inventory turns	PM13	Beamon (1999)
Manufacturing lead time	PM14	Waters (2003)
New product introduction	PM15	Selldin and Olhagher (2007)
On-time deliveries	PM16	Gunasekaran et al (2004)
Product mix	PM17	Selldin and Olhagher (2007)
Profit	PM18	Selldin and Olhagher (2007)
Return on assets	PM19	Beamon (1999)
Return on investment	PM20	Shepherd and Gunter (2006)
Revenue growth	PM21	Gunasekaran *et al* (2001)
Revenue per employee	PM22	Zaman *et al* (2012)
Safety stock level	PM23	Lambert and Stock (2001)
Shipping errors	PM24	Shepherd and Gunter (2006)
Total cost of manufacturing	PM25	Zaman et al (2012)
Total SCM cost	PM26	Gunasekaran and Kobu (2007)
Unit manufacturing cost	PM27	Qi *et al* (2009)
Value added employee productivity	PM28	Waters (2003)
Volume changes	PM29	Selldin and Olhagher (2007)
Warranty/return processing cost	PM30	Shepherd and Gunter (2006)

Table 3-Industry distribution of respondents and population

Industries	No. of Companies	Code	Respondents %)	Population (%)
Chemicals	9	20	6.7	7.2
Consumer products	6	21	4.5	3.8
Construction	10	22	7.5	8.4
Food and beverages	21	23	15.7	16.7
Glass, ceramics and plastics	20	24	14.9	15.1
Metals and machinery	21	25	12.7	10.3
Textile, clothing and leather	20	26	14.2	16.1
Transportation equipments	17	27	3.7	3.5
Wood, paper and furniture	19	28	20.1	18.9
Total			100	100

Table 4-Respondents profile

	Frequency	**Percent (%)**
A. Job Title		
Plant manager	45	33.58
General manager	21	15.67
Operational manager	57	42.54
Product design and development manager	4	2.99
SC manager	2	1.49
Others	5	3.73
Total	134	100
B. Experience in years within the company		
<=2	17	12.69
3-6	42	31.34
7-10	33	24.63
11-14	18	13.43
15-17	16	11.94
>17	8	5.97
Total	134	100.00

Table 5- Company profile

	Percent (%)
A. No. of employees	
<250	38
251-550	34
>550	28
B. Annual sales (in millions of USD)	
<10	35
10-20	20
20-30	15
30-40	10
40-50	8
>50	12
C. Age	
Young	43
Mature	57
D. Ownership	
State-owned	14.9
Private-owned	57.5
Joint venture	13.4
Foreign owned	14.2
E. Position of the company in the SC	
Manufacturer	75.4
Component supplier	17. 3
Raw materials supplier	7. 5
F. Role of company within SC	
Leaders	70.9
Followers	29.1

Table 6- Factor Analysis for SC strategy dimension

Dimensions	Clusters			
	Cluster 2	Cluster 3	Cluster 4	Cluster 1
RS2	0.918			
RS1	0.892			
RS5	0.819			
RS3	0.816			
RS4	0.781			
R56	0.726			
AS3		0.973		
AS2		0.823		
AS6		0.790		
AS4		0.779		
AS1		0.733		
AS5		0.625		
RHS2			0.830	
RHS4			0.821	
RHS3			0.813	
RHS5			0.794	
RHS1			0.735	
RHS6			0.692	
ES2				0.995
ES1				0.959
ES4				0.682
ES5				0.611
ES6				0.595
ES3				0.474

Table 7-One way analysis of variance for each supply chain strategy dimension by strategy cluster

	N=27 Cluster 2	N=28 Cluster 3	N=38 Cluster 4	N=41 Cluster 1	F-Value
Efficient SC					
Cluster mean	2.76	2.23	3.42	3.75	109.04*
SE	0.05	0.06	0.05	0.03	
Risk-hedging SC					
Cluster mean	3.12	2.35	4.12	3.22	69.28*
SE	0.06	0.05	0.03	0.03	
Responsive SC					
Cluster mean	4.24	3.52	2.48	2.20	126.29*
SE	0.03	0.05	0.07	0.09	
Agile SC					
Cluster mean	3.43	3.77	2.14	1.81	143.47*
SE	0.05	0.03	0.06	0.07	

SE = standard error
*Significant at .01

Table 8-One way analysis of variances for each supply chain strategy dimension by industry sector

Industry Code	20†	21	22	23	24	25	26	27	28	F-Value
Sample Size	9	6	10	21	20	21	20	17	19	
Efficient SC										
Cluster mean	2.46	3.54	2.33	4.32	4.21	2.42	2.26	2.45	2.45	7.34*
SE	0.11	0.04	0.03	0.08	0.10	0.09	0.05	0.04	0.07	
Risk-hedging SC										
Cluster mean	4.12	2.43	3.78	2.68	2.32	2.36	2.67	2.46	2.47	4.38*
SE	0.03	0.05	0.08	0.03	0.10	0.04	0.09	0.07	0.06	
Responsive SC										
Cluster mean	2.58	1.88	2.86	2.40	2.92	2.48	2.80	3.94	4.23	3.92*
SE	0.08	0.10	0.05	0.05	0.06	0.07	0.03	0.05	0.04	
Agile SC										
Cluster mean	2.84	1.76	3.34	2.81	2.14	4.08	3.73	2.73	2.67	9.34*
SE	0.06	0.07	0.03	0.03	0.10	0.09	0.05	0.04	0.07	

SE = standard error.

* Significant at .01 level.

† Industry sector and their respective codes are given under Table 3

Table 9-One way analysis of variance for each supply chain strategy dimension by background and profile data

A. Ownership Sample Size	**Private N=77**	**State N=20**	**Foreign N=19**	**Joint N=18**	**F-Value**
Efficient SC					
Cluster mean	2.85	2.26	2.63	2.42	4.63*
SE	0.1	0.07	0.04	0.06	
Risk-hedging SC					
Cluster mean	3.12	3.23	2.77	2.48	1.32
SE	0.06	0.05	0.09	0.03	
Responsive SC					
Cluster mean	2.56	1.78	2.84	3.2	3.92*
SE	0.07	0.04	0.06	0.09	
Agile SC					
Cluster mean	2.74	2.46	2.34	2.81	1.14
SE	0.06	0.04	0.08	0.12	
B. Size Sample Size	**Small 51**	**Medium 46**	**Large 37**	**F-Value**	
Efficient SC					
Cluster mean	3.76	3.14	2.44	5.67*	
SE	0.09	0.03	0.07		
Risk-hedging SC					
Cluster mean	3.18	3.26	2.97	1.34	
SE	0.06	0.05	0.09		
Responsive SC					
Cluster mean	3.43	3.48	3.64	4.42*	
SE	0.11	0.09	0.08		
Agile SC					
Cluster mean	2.76	2.68	2.84	2.14	
SE	0.03	0.06	0.09		
C. Position Sample Size	**RMS 10**	**CS 23**	**M 101**	**F-Value**	
Efficient SC					
Cluster mean	2.74	2.96	2.63	1.13	
SE	0.03	0.14	0.08		

Risk-hedging SC				
Cluster mean	3.14	3.23	3.41	1.05
SE	0.03	0.05	0.09	
Responsive SC				
Cluster mean	2.86	2.78	2.82	1.05
SE	0.11	0.09	0.08	
Agile SC				
Cluster mean	2.84	2.56	3.34	4.62*
SE	0.06	0.05	0.03	
D. Age Sample Size	**Young 10**	**Mature 77**	**F-Value**	
Efficient SC				
Cluster mean	4.64	2.56	19.30*	
SE	0.1	0.13		
Risk-hedging SC				
Cluster mean	2.44	2.23	1.04	
SE	0.07	0.06		
Responsive SC				
Cluster mean	3.14	3.32	0.82	
SE	0.1	0.07		
Agile SC				
Cluster mean	2.72	3.56	2.49*	
SE	0.05	0.06		

M= Manufacturers RMS = Raw Material Suppliers CS=Components Suppliers
SE = standard error.

* Significant at .01 level.

Table 10-Factor analysis for measures dimension

Performance Measures	SC Strategies			
	Agile	Responsive	Efficient	Risk-hedging
PM15	**0.89**	**0.632**		
PM17	**0.87**	**0.543**		
PM9	**0.76**	**0.75**		
PM11	**0.75**	0.492		
PM3			**0.524**	**0.722**
PM25	**0.67**	0.421		
PM29	**0.66**	**0.625**		
PM16	**0.61**	**0.539**		
PM24	**0.6**	0.419		
PM14	**0.58**	0.478		
PM30	0.44	**0.596**		
PM23	0.42	0.197		**0.672**
PM7	**0.6**	**0.893**		
PM6	**0.53**	**0.89**		
PM8	0.73	**0.733**		
PM2	0.34	**0.624**		
PM27			**0.867**	**0.516**
PM26			**0.832**	0.442
PM28			**0.801**	0.477
PM13			**0.662**	0.455
PM22			**0.594**	0.499
PM18			0.49	0.142
PM21			0.355	0.179
PM19			0.309	0.173
PM20			0.227	0.008
PM4			**0.556**	**0.552**
PM1			**0.523**	**0.542**
PM5			0.497	**0.844**
PM10			0.461	0.463
PM12	0.16	0.08		

Table 11-One way Analysis of variance for each supply chain strategy by performance measures

	N=27 Responsive SC	N=28 Agile SC	N=38 Risk-hedging SC	N=41 Efficient SC	F-Value
Efficient Performance measure					
Cluster mean	2.44	2.58	3.48	3.78	12.24*
SE	0.03	0.05	0.05	0.06	
Risk-hedging performance measure					
Cluster mean	3.12	3.35	4.02	3.42	16.38*
SE	0.04	0.05	0.03	0.08	
Responsive performance measure					
Cluster mean	4.84	3.62	2.58	2.60	6.52*
SE	0.08	0.03	0.05	0.04	
Agile performance measure					
Cluster mean	3.40	4.17	2.44	2.31	3.49*
SE	0.06	0.08	0.09	0.1	

SE = standard error.

* Significant at .01 level.

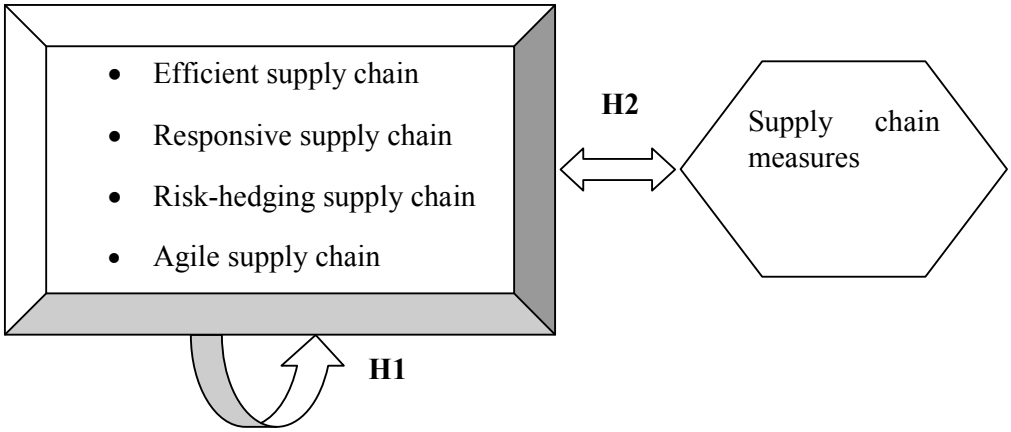

Figure 1-Research map

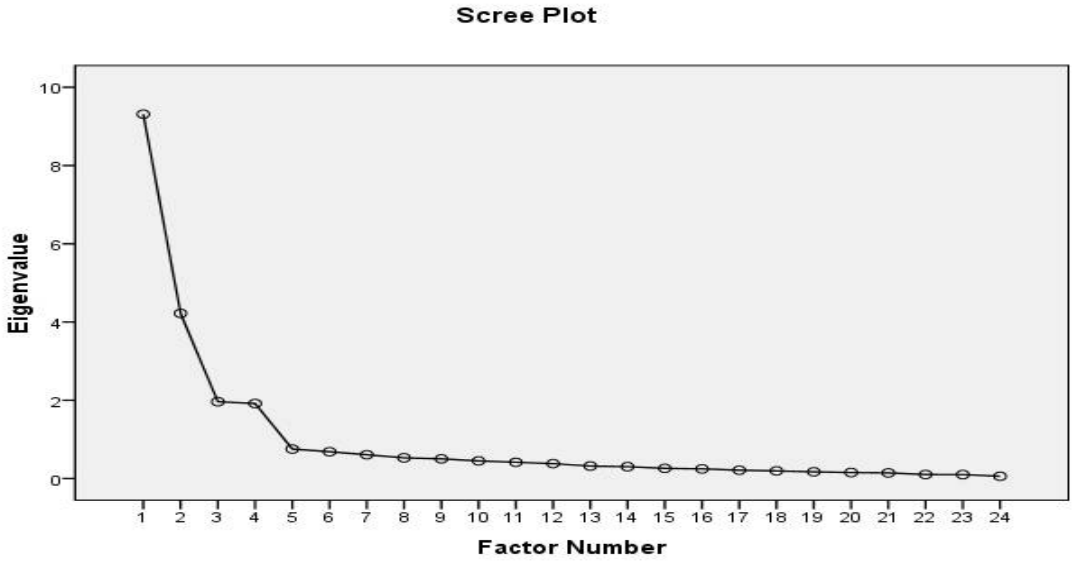

Figure 2-Scree plot to show number of possible factors for SC characteristics

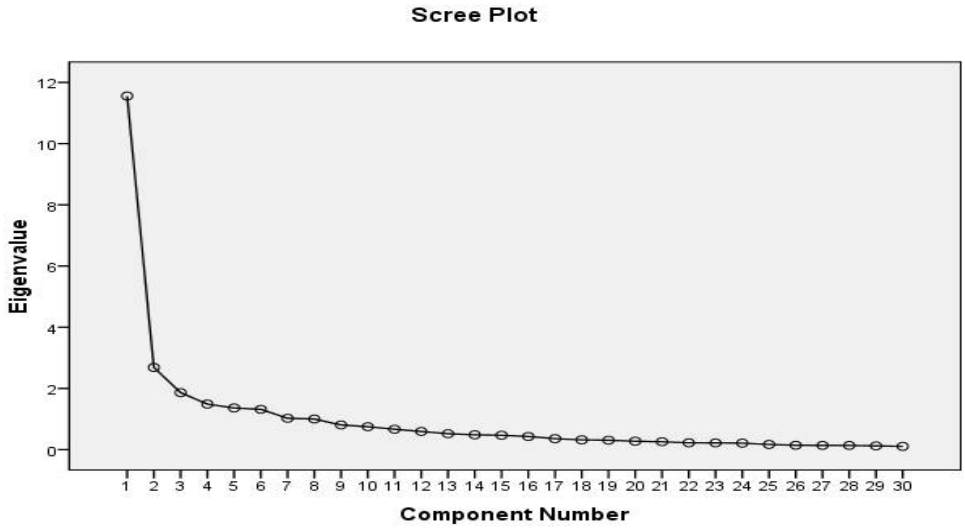

Figure 3-*Scree plot to show number of possible factors for SC performance measures*

Appendices

Appendix I-Questions for supply chain characteristics for main product line

Code	Item
ES1	It is important in the overall SC design to minimize cost
ES2	It is important is the inventory strategy to minimize inventory throughout the chain
ES3	It is important in the resource strategy to maintain high average utilization rate in the chain
ES4	It is important in the lead time strategy to reduce lead time at restricted cost
ES5	Your company maintains long term relationship with suppliers
ES6	Your company's supplier selection criterion is based on quality and cost
RS1	Your company maintains capacity flexibility for demand uncertainty
RS2	Your company keeps excess buffer inventory for demand uncertainty
RS3	It is important in the lead-time strategy to invest aggressively in ways to reduce lead-time
RS4	Your company's supplier selection criterion is based on flexibility, reliability and quality
RS5	Your company use high level of modular design
RS6	It is important in the overall SC design to respond quickly to demand
RHS1	Your company has high level of electronic market that reaches more suppliers
RHS2	Your company shares safety stock with other companies
RHS3	Your company pools of inventories and resources
RHS4	Your company make future contracts that lock-in price and delivery
RHS5	Your company maintains capacity flexibility for supply uncertainty
RHS6	Your company has excess buffer inventory for supply uncertainty
AS1	Your company has high level of information accuracy between partners
AS2	Your company keep excess manufacturing capacity
AS3	Your company maintain excess buffer inventory for both raw materials and finished inventories
AS4	Your company has high delivery flexibility
AS5	Your company has high level of new product flexibility
AS6	Your company has high level of responsiveness to volatile markets

Appendix II-Questions for supply chain performance metrics

Code	Item
PM1	To what extent does your company perform compared with your competitors in terms of average inventory level?
PM2	To what extent does your company perform compared with your competitors in terms of backorder or stock-out?
PM3	To what extent does your company perform compared with your competitors in terms of capacity utilization?
PM4	To what extent does your company perform compared with your competitors in terms of cash to cash cycle time?
PM5	To what extent does your company perform compared with your competitors in terms of COGS?
PM6	To what extent does your company perform compared with your competitors in terms of customer complaints?
PM7	To what extent does your company perform compared with your competitors in terms of customer response time?
PM8	To what extent does your company perform compared with your competitors in terms of delivery changes?
PM9	To what extent does your company perform compared with your competitors in terms fill rate?
PM10	To what extent does your company perform compared with your competitors in terms of forecast accuracy?
PM11	To what extent does your company perform compared with your competitors in terms information sharing?
PM12	To what extent does your company perform compared with your competitors in terms of information accuracy?
PM13	To what extent does your company perform compared with your competitors in terms of inventory turns?
PM14	To what extent does your company perform compared with your competitors in terms manufacturing lead time?
PM15	To what extent does your company perform compared with your competitors in terms of new product introductions?
PM16	To what extent does your company perform compared with your competitors in terms of on time deliveries?
PM17	To what extent does your company perform compared with your competitors in terms of product mix?
PM18	To what extent does your company perform compared with your competitors in terms of profit?
PM19	To what extent does your company perform compared with your competitors in terms of return on assets?
PM20	To what extent does your company perform compared with your competitors in terms of return on investments?
PM21	To what extent does your company perform compared with your competitors in terms of revenue growth?
PM22	To what extent does your company perform compared with your competitors in terms of revenue per employees?
PM23	To what extent does your company perform compared with your competitors in terms of safety stock level?
PM24	To what extent does your company perform compared with your competitors in

	terms of total cost of manufacturing?
PM25	To what extent does your company perform compared with your competitors in terms of shipping errors?
PM26	To what extent does your company perform compared with your competitors in terms of SCM cost?
PM27	To what extent does your company perform compared with your competitors in terms of unit cost of manufacturing?
PM28	To what extent does your company perform compared with your competitors in terms of value added employee productivity?
PM29	To what extent does your company perform compared with your competitors in terms of volume changes?
PM30	To what extent does your company perform compared with your competitors in terms of warranty or return processing cost?