CREATING A COMPETITIVE SUPPLY CHAIN: EVALUATING THE IMPACT OF LEAN & AGILE SUPPLY CHAIN

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Abstract

Market globalization and steep competition are increasing the need for more efficient and effective strategies in meeting evolving market demands. Adopting a more integrated approach to supply chain relationship management has been increasingly viewed as a way of meeting changing customer needs. This thesis work explores lean and agility frameworks as tools for achieving supply chain integration. Different aspects of the concepts of lean and agility and their applications in the supply chain are presented based on theoretical literature. Thus, this thesis seeks to point out the impact that the concepts of lean and agility can have on the supply chain as a whole. Four companies have been investigated in connection to the level of awareness, perception, and practical application of these tools in their supply chain. To this end, information was collected in a survey questionnaire from these four companies and supported by an interview. The results show that lean and agility are important tools to achieve supply chain integration, but respondents are yet to fully achieve the transition to lean/agile enterprise. It could be said that lean/agile supply chain is still more in theory than in practice. The level of awareness to market changes is high but there seem to be no specific way in achieving integration in the supply as there is wide variation in the way one company achieves it with respect to another. Generally, respondents are implementing lean/agile principles in cooperation and collaboration with suppliers and customers, demand pull system, and using combination of strategies. However, it is clear that adequate market information is required when trying to fit lean/agile principles into supply chain strategy. Furthermore, all respondent recognise the need for change to satisfy customer need, but the respond to change vary from one company to another. Also, there is a gradual shift from traditional focus solely on cost and profit to customer relation relationship management and customer satisfaction. Consequently, companies are organizing themselves around the customer who pulls goods and value from the producer of the goods.

Key Words: Competitive Supply Chain, Lean, Agility, Integrations, Efficiency & Effectiveness, Customer Satisfaction, cooperation & collaboration.
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List of Abbreviations

SCM: Supply Chain Management
IDP: Department of Innovation, Design, and Product Development
SME: Small and Medium size Enterprise
QFD: Quality Function Development
ASCTM: Agile Supply Chain Transformation Matrix
JIT: Just in Time
TPM: Total Productive Maintenance
MRP I: Material Requirement Planning
MRP II: Manufacturing Resource Planning
WIP: Work in Process
TQM: Total Quality Management
OEE: Overall Equipment Efficiency
CMPS: Collaborative Manufacturing and Scheduling
ANP: Analytical Network Approach
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1. Introduction

1.1 Background:
It is no question that we live in a constantly changing world, partly driven by human’s behaviour in constant acquisition of material things and the desire for continuous scientific and technological advancements. While the need for change in itself may not be considered bad, the rapidity with which it has taken place in recent times has been a major cause for concern for those businesses struggling to keep pace with. Quick product life cycle, changing customer tastes, and intense global competition are just some examples. This is not only having an impact in the way business is conducted, but it is also altering the natural environment in a strong and destructive manner.

As far as the business world is concerned, the customer, who is perceived as the ‘king’, is the driver of change in the market place. Their changing attitudes are pushing businesses to rethink their strategies, and those that are able to stand up to the challenge are taking advantage of it. For instance, customers are not only demanding products and services to be delivered at almost immediate availability, but their needs are constantly changing as well. Hence, the market is dominated by uncertainty and unpredictability. This implies that manufacturing companies, due to their dependence on customers for the products they provide, now have to perform within a global market where competition is becoming more and more difficult to ensure. The result is that the production and logistics and supply chain processes are becoming increasingly complex.

Complexity and uncertainty is what companies have to overcome in their supply chain in order to compete better. Even more, in the face of the ongoing global economic downturn in which most companies are facing shrinking sales volume and have to layoff most of their employees, it is indisputable that the way to maintain viability in operation lies in cutting cost, reduce inventory, and rendering the organization as efficient and effective as possible. In the presence circumstances, it is necessary that those factors that define business competition and success be put in place as soon as possible. Inasmuch as product durability, adaptability, and reliability are crucial for consideration, important business competitive driving forces such as speed, quality, flexibility, efficiency, innovation, and pro – activity and time to market can be determining factors. These factors have been identified by Yusuf et al. (1999) as competitive foundations of agility. In order to meet challenges and stay competitive in business, it is necessary for a company to develop a supply chain strategy that incorporates these factors.

Nowadays, a company’s supply chain strategy is becoming increasingly critical in meeting the overall goals of the company and maintaining it on a competitive platform. Kim (2006) points out that Supply Chain Management (SCM) and competitive performance are closely linked. In parallel lines of
reasoning, Ross (1998) emphasizes that “today’s enterprise must refocus its efforts away from conventional business paradigms centred around transaction management and parochial performance metrics, and towards strategies that recognize that to achieve competitive advantage companies must work together across enterprise boundaries and optimize inter-channel processes and innovative capabilities that pre-empt the competition and open whole new area of competitive space” (p. 3).

Understandably then, many companies are now focusing on improving and developing their supply chain processes because this can play a significant role in customer service and thus profitability. Therefore, developing a competitive supply chain based on speed, flexibility, innovation, quality, and responsiveness to deal with these unpredictable market situations has become an imperative for most organizations. The target is to reduce cost through increase efficiency and effectiveness. These are key characteristics of agile and lean capabilities. The development of the concept of lean production has greatly improved companies and customers’ need in terms of profitability on one hand and quality on the other. However, with a changing customer need to deliver services and products at shortest time possible, the lean concept falls short in meeting this particular need alone. This calls for the development of a supporting concept such as agility to complement lean's ability. In this sense, agility builds on lean. While 'lean' focuses on efficiency of operations and cost savings, 'agility' focuses on flexibility and responsiveness of operations. Either of these situations will not enable the organization to meet the precise need of the customer as much as a combination of both will do. Agility thus complements and builds on lean to render an organization more competitive. Lean production, a growing manufacturing improvement programme, can have an influence on the different dimensions of supply chain integration. One obvious way that an enterprise can derive benefit by adopting agile components is to foresee uncertainties and enable quick changes to meet them, through responsiveness in variability in the turbulent market (Jackson & Johansson, 2003).

The aim of this thesis work is to understand how changes in market conditions, driven by an ever changing customer demand, have resulted in the development of frameworks for integrated approach in the supply chain management, and how this has in turn contributed to a competitive advantage. The study thus seeks to point out the impact that the concepts of lean and agility can have on the supply chain as a whole. Lean and Agility are two important concepts that have been extensively documented with respect to improving the supply chain, and making it more competitive and cost – effective. However, these concepts can be confusing in some respect and may mean different things to different organizations and companies that use them. As a matter of facts, lean and agility may be applied differently in different companies. Just how do companies perceive these concepts and with what results? This thesis attempts an answer to these questions as well as others. Also, an analysis of the different principles underlying lean and agility will be made in order to understand their important in relation to
improving the supply chain and rendering it more competitive. To answer these questions as well as others, a survey questionnaire was sent to a handful of companies dealing with supply chain management. This questionnaire was backed by an interview aim to shed more light on areas where questionnaire may not fully deal with.

1.2 Thesis Specifications:
Two years of study at the department of Innovation, Design and Product Development (IDP) at Mälardalens University have culminated in this masterpiece – thesis in Production and Logistics Management. It offers me the opportunity to demonstrate my skills by applying the knowledge gained during this study programme, including experiences from company visits, interviews, course seminars, and project group reports, which constituted an important part of each course in the programme. The primary interest lies in understanding and gaining insight into issues connected to how to develop and improve a company’s supply chain, within the framework of agility and the application of lean thinking. The effects of the application of these concepts on the supply chain will be outlined in terms of market sensitivity, cost-saving, and the responsiveness to customer changing need as important performance measures.

1.2.1 Aim
The aim of this thesis work is to understand how changes in market conditions, driven by an ever changing customer demand, have resulted in the development of frameworks for integrated approach in the supply chain management, and how this has in turn contributed to a competitive advantage. The study thus seeks to point out the impact that the concepts of lean and agility can have on the supply chain as a whole.

1.2.2 Objectives
A number of objectives have been clearly defined in achieving the general set out above. These are outlined below:

1) How the market place is changing and what are the drivers of change?
2) Getting into understanding the level of interest in SCM
3) What are the SCM practices develop in respond to market changes i.e. what tools are commonly used in SCM practices in different companies and with what results?
4) A comparison of different ways of application in different companies will be made.
5) Identify level of supply chain performance
6) Identify the main attributes of lean/agile enterprise
7) Use a questionnaire to reach out to as many companies as possible.

Most of the literature review shows that research in this area of study; particularly on agility is focus on theoretical description of the concept. Therefore, this thesis work is interested in investigating through questionnaires in somewhat empirical manner what happens in companies. I am motivated by the following reasons to write on this topic: 1) Lean and
Agility though developed differently are closely related concepts and can have a synergetic effect on the supply chain; 2) different aspects of supply chain integration have a direct effect on performance; 3) even though main agility attributes have been identified, the concepts are not yet clearly defined and conceptualize; 4) developing a lean production system is an important ingredient in SCM. In this sense, SCM and lean production concept are closely related; 5) although the lean and agility paradigms may be different and were developed differently, they can be successfully combined in a well designed supply chain to improve performance and reduce cost. A number of documented cases where this has occurred have been highlighted in the latter part of this thesis (See Literature Review).

Based on a wide range of theoretical material and data collected from a number of companies, this thesis aim to analyse and suggest some possible ways through which respondent companies can appropriately create or improve their supply chain with agility and lean.

1.2.3 Problem Definition:
In the ongoing struggle for competitive supply chain management, lean and agile tools for supply chain integration may involve a substantial degree of ambiguity in terms of meaning and level of application in different companies. Even though these two paradigms have distinct historical background, they can be applied successfully in specific supply chain strategy or system design. In this light, the ambition of this thesis work is to answer questions regarding:

1) What is the degree of awareness for managing supply integration to a competitive advantage?
2) What is the extent of integration across the boundaries of the firm?
3) How are lean and agility as tools for supply chain integration perceived and applied in different companies?
4) To what extent is the company objective been met with the use of supply chain improvement programmes?

1.2.4 Project Delimitation:
Virtually every business today pays special attention on its cash flows and the ultimate cost of undertaking any operation relative to accrue profit. This study is bounded and situated in a specific context – use of lean and agile framework to improve performance of the supply chain in terms of cost savings and improved customer services, towards competitive advantage. The conclusion drawn will be based essentially on theoretical literature and results from the questionnaires. Even though the wordings in the questionnaires have been carefully done to ensure that they mean the same thing to all respondents, some misunderstanding might occur in the way respondents interpret questions. This is bound to affect the results obtain. In order to have a more representative result, questionnaires were intended for a handful of companies but only 4 responded. Most others did not find time to answer the questionnaires. Some simply did not return the questionnaires after accepting my request to provide answers, while others pointed to the company’s policy not to give out information. Clearly, this has severely
affected the way this thesis was planned and inevitably the results that have been presented.

This masterpiece is scheduled to be completed in a specific time frame – less than six months. It is highly possible not to have enough time to do everything that seems to be essential for a thorough thesis project. Therefore time is a limiting factor that will obviously have a bearing to the outcome. As a consequence, additional studies are needed in order to validate the practicability of the results obtained.

1.3 Literature Review:
There is an increasing trend that companies adopting supply chain management are more likely to adopt the agile and lean techniques in their supply chain management practices. This common practice of integrating lean production and agile principles in organizations and companies’ supply chain management practices has widely led to the development of concepts such as agile enterprise and lean supply chain. Perhaps this is the reason why supply chain management (SCM) has been linked to the development of lean production system (Cox, 1999). When the supply chain develops capabilities that render it more performing and competitive, the benefits are clear enough and include among others:

1) Waste and inventory elimination (or at least minimization) and ultimately cost reduction;
2) Demand pull or build – to – order manufacturing technique;
3) Improved cooperation and collaboration and hence total coordination of the supply chain;
4) Just – In – Time (JIT) system;
5) Improve value delivery to customers;
6) Flexibility and Efficiency; and
7) Resilience and ability to withstand unforeseen circumstances.

Therefore, the primary goal of supply chain management is to enhance competitive performance by closely integrating the internal functions within a company and closely linking them with external operations of suppliers, customers, and other channel members (Kim, 2006). Some companies have achieved integration through information sharing and inter-organizational collaboration. In a study to measure the degree of integration among some 149 European companies, it was found that information sharing and inter-organizational integration were underlying factors for integration with suppliers and customers in areas like supply chain design, inventory management, and customer relationship management (CRM) (Bagchi & Chu ha, 2005).

However, the degree of integration often varies from company to company depending on a number of factors and company objectives. This in turn has an influence on the level of efficiency and cost savings connected to supply chain integration. The study shows that the real purpose of supply chain integration goes beyond cost reduction; it creates value for the company as well as all partners involved.
Within the framework of an extended enterprise, sourcing decisions play an important role in supply chain integration when it comes to creating value along the chain. ‘Right – sourcing’, thus, constitutes a strategic aspect of supply chain integration. It is a strategic approach on how to practice outsourcing and ‘in – sourcing’ decisions to become more competitive. With regards to ‘right – sourcing’, a supply chain may be marked by vertical integration or virtual integration. Hammer (2001) suggests that virtual integration should be dominant over vertical integration on grounds that the entire supply chain can be designed, coordinated, and managed as a unit. Also virtual integration allows each partner to focus on those activities that it does best and allow the rest for others. This idea is supported by Goldman et al. (1995).

A wide range of literature in supply chain integration studies highlights lean and agile paradigms as complementing each other in achieving supply chain integration. The somewhat perfect union between these two concepts has resulted in the appellation ‘leagility’ (Naylor et al. 1997). Essentially, the introduction of lean thinking in the supply chain has focused on improving it by way of eliminating waste of all kinds. This is described as efficiency in operation. On the other hand, agility has built on serving the customer in a more effective way and overcoming the shortcomings of the much older lean philosophy. Cost reduction and value delivery to customers are therefore important areas of focus. This means that it is necessary for all activities along the supply chain to function and be coordinated properly in order to achieve realistic supply chain integration. This is based on the premises that each of these activities can not guarantee efficiency on their own without interaction with other activities.

Other studies have been documented to show the role of lean and agility in cost effective and integrated supply chain as well as how to achieve agile and lean enterprise. Baramichai et al. (2007) notes that companies that focus on agility are market – sensitive and will profit by exploiting their supply chains to rapidly and cost effectively respond to unpredictably changes. Their argument is based on the fact that key components of an agile enterprise like quality, speed, flexibility, responsiveness, are necessary to meet unique needs of customers and markets. They proposed a Quality Function Development (QFD) tool known as Agile Supply Chain Transformation Matrix (ASCTM) that can help companies improve agility based on the evaluation and analysis of their business environment, capabilities, and performances. In their book ‘Agile Competitors and Virtual Organizations: Strategies for Enriching the Customer’, (Goldman et al., 1995) provide answers to why organizations need agility? And why agility is an inevitable part of new industrial order? Illustrating how companies are using agility as a strategic framework for mastering change and uncertainty, the book clearly documents examples of how agility is emerging in industries as a strategic means of enriching the customer.

Martin Christopher (2005) points out that ‘leaness’ may be an element of ‘agility’ and only a combination of these concepts can enable an organization to meet the precise needs of its customers more rapidly in a volatile market.
He argues that until recently, the automobile industry was known for its leanness but face problems for lack of agility. Agility may not be synonymous to lean, but it builds upon it to overcome major challenges of the global market. For example, customer service level, which is a market winner, is taken care of by the use of agility while cost, an important market qualifier is reduced by the use of lean. It appears the solution to today business seem to depend on the combination of the lean and agile principles – leagility. In the same line of reasoning, Naylor et al. (1999) state that there is a strong need to combine these two paradigms in a total supply chain strategy rather that being viewed in isolation. The argument is grounded on the fact that while agile manufacturing is best suited to satisfying a fluctuation in demand; lean manufacturing requires level scheduling that leads to cost reduction within the framework of market knowledge and positioning of the decoupling point. The combination of these two concepts is what has been described by Naylor et al. (1999) as leagility.

The literature survey has not revealed a particular level of supply chain integration above or beyond which companies may no longer enjoy the advantages of supply chain. This raises the question whether is an ongoing process that companies have to constantly strive for or not? Another issue relates to the fact that there is no specific way to achieved integration in the supply chain and that there is even variation in the way one company may achieve it with respect to another. While some authors have pointed to internal manufacturing strategies like development of efficient scheduling system, flexible manufacturing system, etc. others such as Sezen (2008) have pointed out that supply chain design plays a critical role in achieving desired performance level. Interestingly, all the above mention features some aspects of a lean or agile framework. The overwhelming consensus in most research points to the need for new dimension of competition where mass – customization takes precedence over focus on only cost and quality. All this is connected to the ability for a business to cope with unexpected changes brought about customers’ changing need. This is the foundation of agile manufacturing.
2. Methodology

This thesis project builds on a combination of perspectives, making use of mounting evidence from other research written in this area of study to point out as clearly as possible the major issues underlying the concepts of lean and agility in relation to the supply chain management. Given the research questions, the thesis project builds on some of the aspects of interpretative approach to research. This interpretive way of doing research is one aspect of a qualitative research, in which the researcher studies things the way they function, attempting an interpretation of phenomena in terms of the meaning people attach to them. To base a thesis on qualitative judgement generates a situation that calls for a more subjective approach as opposed to objectivism in a quantitative analytical research. Analysis and qualitative theories will fuel this thesis work and will in part be expected to sustain the explanations offered.

My motivation for choosing a qualitative approach is based on argument presented by Marshall (2006) that qualitative approach, contrary to what is often thought, is neither naïvely nor subjectivist or bias, but acknowledges that research in social science could be subjective and shift the discourse to a discussion of epistemology and to strategies for ensuring trustworthy and credible studies (p. 11). Furthermore, some degree of flexibility is often warranted so that data gathering can respond to increasingly refined research questions (ibid p. 38).

Additionally, this thesis project on grounds of it theoretical base will rely on a vast reservoir of Journals and articles at the university library database as well as library catalogue. This database presents a valuable source of information relating to the subject of interest. There is already an enormous amount of academic literature in the area of lean/agile supply chain management. With this in mind, the author took special care in selecting renowned and frontline academic Journals that have made significant contribution to the area of supply chain management. This include for example, *International Journal of Operations & Production Management, International Journal of Logistics Management, International Journal of Production Economics, International Journal of Production Research, and Journal of Operations Management.* Books by Martin Christopher (2005) and Goldman et al. (1995), including computer sources, specialised database and credible internet sources will constitute other important primary source of information. Critical examination of evidence relating to the internet sources will be made given that this source of information can sometimes be misleading. Input material from the internet were found by simply performing a search on Google search engine, with key words like agility, lean, integrated supply chain management etc. With this method, I strongly believe that data and information will be found to provide answers to the research question and somewhat contribute to theory and knowledge in this area.
2.1 Questionnaire survey

On the basis of the literature survey, a pilot questionnaire survey structure and model for a questionnaire was developed to deal with the problem defined in this thesis (See problem definition above.). Surveys can be a relatively cheap and quick way of obtaining information and can provide answers to questions such as what? Where? When? How? (Bell, 2005 p. 14). These questions characterise the purpose of this thesis work, which follows a recursive process of data collection and analysis. Recursive process of data collection and analysis constitute a cornerstone of qualitative research. Even though in a survey, issues of accuracy may be raised connected to checking if the respondent really understood the questions asked, there is always an opportunity to carry out the same survey in the future. This then will provide an opportunity to verify and confirm the previous survey earlier carried out. Interview is one way of confirming a survey, which is why interview is considered a necessary part of this thesis project. Both questionnaire survey and interview are complementary.

Bryman and Burgess (1999), discuss three types of data collection in a qualitative report: 1) in-depth-open ended interviews; 2) direct observation; and 3) written documents. The Documentation analysis in qualitative report yields excerpts, quotations or entire passage from organizational, clinical, or program record; memoranda, correspondent, or official publications and report, and open-ended written responses to questionnaire and surveys (p.140). The research technique employed in this thesis work will essentially be document – based, questionnaire supported by interviews. The study thus expects to address the research questions by gathering qualitative data from interviews and survey questionnaires. Also, a review of company documents (e.g. company brochures, company website documents, annual reports, etc.) will constitute useful source of information.

A questionnaire survey was conducted throughout the month of April and May 2009, in order to collect information about supply chain management activities and current status of different companies towards lean and agile programs. The questionnaires were sent to key individuals involved with supply chain management activities in 12 different companies. The questionnaire was designed to facilitate answering and safe time for those concerned, with most of the answers requiring a YES or NO response. Out of the 12 companies targeted, 4 effectively responded to the questionnaire resulting in a response rate of 33%. Part of the results and analysis in the later part of this thesis were presented based on the responses in the questionnaire. The content of this questionnaire survey\(^2\) is included in Appendix B.

2.2 Interview

In order to obtain more detail information around the subject area which otherwise could not have been possible with the use of questionnaire alone, I

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\(^2\) Many other questions came up in the course of the thesis and were asked through telephone conversation with those who responded to the questionnaire. These additional questions are not found in the questionnaire but shade light on the different issues taken up in this thesis.
arranged for an interview with Sven Andersson of the Leax Group in Köping, on the 22\textsuperscript{nd} of May, 2009. The purpose in mind was to develop an interview guide that will answer more of the practical questions that could not have been properly dealt with in the questionnaire and which may not even be easily found in the literature. Even more, my interviewee has a wide background knowledge and experience, having work with supply chain for a long time. Therefore this interview serves as a follow up to the questionnaire method. Semi structured interview as a qualitative data technique provides me a two – way communication as well as useful insight into the way the supply chain is managed in practice from a companied.

The advantage with this tool is that the interviewee can more easily discuss more sensitive issues, and not only confirms what is already known in theory, but also provide opportunity for learning. A semi structured interview allows the opportunity to ask questions which were not previously planned base on what the interviewer sees on the field. All interviews were conducted face-to-face and promised confidentiality to facilitate candid responses. During each interview, a semi-structured interview guide was used. The guide was divided into general questions, questions on collaboration among the interviewee’s company customers and suppliers, and key practices with particular chain members.
3. Theoretical Framework of Reference:

A conceptual framework of reference is used in a research to outline possible courses of action, or to present a preferred approach through which the research will be carried out.

3.1 The Agile Supply Chain

Uncertainty, unpredictability, fragmentation, emergence of new technologies and new products especially information technology, falling prices, shrinking product life time, and new competitors in the face of the global economic downturn that the world is currently witnessing are just some of the major challenges that characterise the present business environment. Some of these changes are taking place so rapidly that for a 21\textsuperscript{st} century corporation to be successful, it needs to be flexible and adaptable, ready to cope with radical changes.

The prevalence of such market circumstances mentioned above have necessitated the need for new ways of thinking about how to achieve and maintain competitiveness in the market. Among competing organizations, the inability to meet these challenges might mean calling the shot on grounds of not being able to compete. For some, the task appear daunting but it more or less highlights the need for new ways of thinking and new generation paradigms that hold the potential for resolving dynamic and unpredictable market challenges. In a bid to provide solutions to these uncertain changes in a more successful manner, many analysts have proposed different solutions including: networking, reengineering, modular organizations, virtual corporations, high performing organizations, employee empowerment, flexible manufacturing systems (FMS), Just – In – Time (JIT) etc. (Shereshiy et al. 2007). Among these, the notion of ‘agile enterprise’ and lean manufacturing system are gaining more grounds and having greater impact.

Deeply embedded behind the notion of an agile supply chain is the idea of flexibility and adaptability, seeing business in a new way and delivering products and services to fulfill customer need rapidly and cost efficiently. The customer who uses your product or service may require a latest technological innovative product or something slightly different from the previous product or service that the company does not have. In a rapidly changing world, how does a company meet such unexpected change in customer need? This is where the ability to manage such unexpected changes in the market through agile processes and applications comes in. Fuel by information technology, the agile enterprise has transformed the business environment in its ability not only to respond to the changes in customer need in a cost efficient way, but also to anticipate such changes and deal with them by making appropriate decisions. Human resource and innovative capability of an organization are two important building blocks in the build up to agile enterprise. Any organization considered to be agile organization makes change part and
A more responsive and proactive approach to uncertainties and changes.
• Highly customise product that meet customer requirement.
• Anticipation of customer need and developing a capability to fill it.
• Work process activities to improve the value chain.
• Speed, efficiency and flexibility.
• Organizational integration in the supply chain.
• Development of capabilities for configuration.
• Training of human resource and workforce skills.
• Technological capability and innovation.

This implies that a business or organization that is describe as agile is one with a broad vision in the new way in which business is conducted in this present system of things – that is being able to perceive or envision changes in the market environment and developing capabilities to deal with them in a proper way. Figure 1 below presents a simple conceptual model of agility as seen by Sharifi and Zhang (1999), showing some important aspects of the concepts like agility drivers, agility capability, and agility providers. "Agility
"drivers" relate to the changes or pressures from the business environments that drive or force a company to search for new ways of running its business in order to maintain its competitive advantages. "Agility capabilities" concern with the potentials and capabilities that the company needs in order to positively respond to and take advantage of the changes. The potential and capabilities of an organization to respond to changes will very much depend on its organization, technology, people, and innovation. This constitutes the ‘agility providers’. When a company assesses its potential, it then develops a strategy to become agile: responsiveness, competency, flexibility, speeds, and quickness, the culture of change, integration and low complexity, high quality and customize products, mobilization of core competence, customer, and cooperation become adopted practices. These are the main attributes of agility (Shereshiy et al. 2007). See Table 1, p.25 below for comprehensive review of the major attributes of an agile enterprise.

Figure 1: A conceptual Model of Agility proposed by Sharifi & Zang, 1999

Goldman et al., (1995) argue that the goal, among others, should be towards enriching the customer. That is delivering value and solutions to the customer rather than products. They further state that the effective mastering of change requires flexible organizational structures that allows for rapid reconfiguration of the human and physical resources. This is one of several levels of agility competition – agility at the level of design, characterize by a holistic methodology that integrates supplier relationships, production processes, business processes, customer relationships etc.

The concept of agility is useful tools that can be applied to the supply chain and make it more responsive in the face of mounting global market competition. However, this concept is not yet fully understood in terms of how to evaluate and measure it. That is how we determine what to look at or the first steps to take towards evaluating and measuring an agile organization. Even though its main attributes have been identified, the concepts are not yet clearly defined and conceptualized. In this sense, agility is hard to work with.
Furthermore, a constantly changing customer attitude renders the ability to master agile competition very difficult. No mathematical formula or well established software to this effective is guaranteed for success. This means that each company will have to set its own basis for becoming an agile company. Nevertheless, in a study conducted by Goldman et al., after two years of interacting with scores of companies, they formulated some guidelines that can help companies assess the potential impact of agility on their bottom line. They described these as the ‘four dimensions of agile competition’ – enriching the customer, cooperating to enhance competition, organizing to master change and uncertainty, and leveraging the impact of people and information (Goldman et al., 1995, p. 73).

3.2 The Lean Supply Chain
Transforming the supply chain into a lean enterprise based essentially on the principles of Toyota production system (TPS) is growing in interest. Such transformation will require enormous will and effort across the organization as well as the participation of all in terms of developing skills and leadership behaviour that can sustain the lean enterprise. Just like in the case of an agile supply chain, human resource is even more important in the case of the lean supply chain. For some companies, introducing lean thinking into the supply or any other area has not been without problems since these new ideas have to compete with deeply rooted previous ways of doing things. However, those companies that have successfully adopted and implement lean system in their business have reported success. It is this huge success of the ‘lean’ manufacturing system in industries that has made the concept very popular and is being applied to other areas of operations. It is therefore no doubt that today the lean manufacturer has extended its boundary to its suppliers and customer in order to create more value. In this connection, there has been a rapid development and proliferation of related concepts like ‘lean enterprise’, ‘lean supply chain’ etc, which are becoming very popular and drawing more attention. The challenge, however, is how to translate and apply the lean principles to a particular area of interest. The lean enterprise creates value for the consumers by eliminating inefficiencies, and makes the supply chain customer – driven. The lean philosophy is characterized by the following features or techniques which can make it adaptable to other part of the extended enterprise:

1) Continuous improvement and quality inherent in product/processes.
2) Maximises the flexibility of people and machinery.
3) Eliminating or at least minimising waste of any kind, time or material.
4) Zero inventory
5) Value stream mapping
6) Synchronous and continuous manufacturing
7) Link all processes to customer demand through simple visual tools called the Kanbans³

These programs lay the foundation on which agility can be built – an organization that is overwhelmed by large inventory, slow to respond to customers, and with poor product quality is not able to become agile. Clearly, lean organization and methods are key components for an agile company.

Lean production, also known as the Toyota Production System (TPS), means doing more with less – less time, less space, less human effort, less machinery, less material – while giving the customer what they want (Dennis, 2002 p. 13).

A similar definition sees Leanness as a means to develop a value stream in order to eliminate all waste, including time, and to enable a level schedule (Jones et al., 2000). The level schedule, which is a precondition for eliminating waste or muda, is achieved by smoothening demand. This has the overall effect of profit maximisation in the supply chain. As a matter of fact, the integration of lean principles in the supply chain aims primarily to eliminate waste along the supply chain.

Minimising waste or phasing it out completely can be achieved by applying some of lean’s principles: reducing number of suppliers, product quality, customer – oriented, demand pull, etc. Some lean activities include flow, takt time, pull system, kanban, 5S (Just – In – Time); total production maintenance (TPM); problem solving; poka – yoke; involvement; etc, the main goal of which is to provide the highest quality at the lowest cost in the shortest time by continually eliminating waste. Therefore, the lean system requires constant or continuous improvements to increase efficiency and reduce waste. The lean system embodies among other operations of a company the supply chain design. In this regard, the lean system affects the company external linkages with its customers and suppliers.

3.3 Lean and Agile Principles in the Supply Chain

It is already well known that the consumer is driving change in the market in very fast way. As a result, the implementation of lean principles alone does not satisfy the consumers’ needs precisely. Fastness in delivery and readily available products and services is an area that lean could not deal with. Agile principles incorporate into lean to fulfil this new demand. Although much of the literature on the concept of lean is deeply rooted in the automobile industry, particularly the Toyota manufacturing company, its basic tenet can be extended to other areas of the supply chain and can have a mutually beneficial relationship to the concept of agility. Christopher (2005) points out that while ‘leanness’ may be an element of ‘agility’ in certain circumstances, by itself it will not enable the organization to meet the precise needs of the customer in a more responsive manner. He added that the automobile industry, which is mostly based on lean principles, is one of the least agile industries (p. 117). Lean approach in the manufacturing industry seeks to minimise inventory of components and work in progress, ensuring a just in time environment. Lean system ensures the optimization of resources by eliminating waste.
Although Martin Christopher argues that efficiency in the supply chain may take the second place in the context of unpredictable demand, it can be said that supply chain in addition to being effective, should be efficient as well if it is to meet changing customer demand. Effectiveness refers to the ability to respond rapidly to meet the customers’ needs. Efficiency ensures that these needs are not only met in required time, but also with quality and standard that customers demand today (see SC performance below). In this sense, lean complements agility, and both concepts are mutually reinforcing rather than exclusive. This complementary factor pays off in situations where lead times are long and demands are unpredictable. The relationship between lean and agility and how they can be applied in the supply chain has been shown on the figure below. If lead times can not be reduced by adopting an agile approach, then a hybrid lean/agile approach is proposed. According to Christopher (2005), the hybrid solutions requires the supply chain to be ‘de – coupled’ through holding strategic inventory in some generic or unfinished form, with final configuration being completed rapidly while real demand is known. The goal of a hybrid strategy should be to build an agile response upon a lean platform by seeking to follow lean principles up to the de – coupling point and agile practices after that point (p. 120). In this light, both efficiency and flexibility are addressed in a hybrid model that integrates lean and agile systems, resulting in a supply chain system that is not only cost – effective but respond to customer need appropriately, and thus can stand the test of time.

This view about mutual compatibility between lean manufacturing and agility is supported by Goldman et al. (1995), who describe agile manufacturing as the assimilation of all flexible production technologies, together with the experience gained from total quality management (TQM), employee empowerment, JIT production or logistics supply, manufacturing resource planning (MRP II), and lean production, adding that these are important milestone in the journey to increasing agility (p. 328).
Along a similar line of reasoning, Naylor et al. (1999) point to the need to combine lean and agility in one supply chain via strategic use of the decoupling point. In reference to this combination, they used the term ‘le-agility’. Therefore leagility is the combination of both lean and agile paradigm within a total supply chain strategy by positioning the decoupling point so as to best suit the need for responding to volatile demand downstream yet providing level scheduling upstream from market place.

The strategic use of the decoupling point presented above is just one practical way through which lean and agility principles can be incorporated into the supply chain. The common attributes between these tools can be a force to build upon in supply chain integration. Another important strategic way that lean and agility tools can be merged in practice with the result of providing the end consumer with desired satisfaction is through the peroto curve approach (Christopher & Towil, 2003). This can be exploited in a wide variety of companies – manufacturing or distribution companies, to determine the supply chain strategy. This approach is based on the fact that demand for some part of a company products can be predictable (often in smaller volume), and therefore adhering itself to the lean principles of manufacturing. The less predictable portion (often in very high volume) can be subject to more agile approach to supply chain management. Figure 3 below shows a generic way of integrating lean and agile paradigms in a supply chain to deal with more predictable (about 20%) demand and less predictable but volatile (about 80%) demand. In a volatile market, it may occur that demand for a company’s product may be predictable in large portion than the part that cannot be predicted. The question is: what happens in such a situation prevails, should agile principles be followed by lean principles or? No mention what made on this issue.
3.3.1 Attributes of Lean and Agile Enterprise:

The table 1 below highlights major characteristics of an agile enterprise. Speed, responsiveness, and flexibility are agility capabilities (see figure 1). Agility capabilities relate to the potentials and capabilities that the company needs in order to positively respond to and take advantage of the changes. Organisation, innovation, culture of change and organizational learning of employees, and competence are agility providers.

The overall effect is to add value to the customer. As can be seen, both agility and lean require high levels of product quality and lead time. The lead time is the time from when a customer places a request for a product or service to the time when that request is met. Enabling agility on the supply chain means minimising this lead time. If demands are not met due to long lead times, then the supply chain will not be able to meet the needs of a volatile market. Lead time appears as a market qualifier under lean because the central idea behind lean is waste minimization, and too much unnecessary time means waste. Below are the characteristic and attributes of an agile enterprise. This has been adapted from (Shereshiy et al. 2007).
Table 1: Attributes of an Agile/Lean Enterprise, adapted from Shereshiy et al 2007.

<table>
<thead>
<tr>
<th>Category</th>
<th>Attributes</th>
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| Flexibility                                 | -flexible production system  
- flexible product model  
- work force flexibility  
- flexible business strategy  
- flexible organizational structure |
| Responsiveness                              | -changes to customer demand & preferences  
- changes in market trend  
- social & environmental issues  
- adjustable business objectives |
| Culture of Change & Organizational Learning | -continuous learning, innovation, & employee training  
- positive attitude to changes, new ideas, people and technology  
- continuous improvement  
- continuous monitoring of internal & external Environment to identify Changes & opportunities  
- capability for reconfiguration |
| Speed                                       | -carrying out activities in shortest possible time  
- product/service delivery time |
| Integration & Low Complexity                | -internal & external cooperation.  
- low complexity of structure, relationship between structure elements  
- flow of material, communication, & information  
- enhanced interaction between processes, products and suppliers  
- relationship with customer & suppliers |
| High Quality & Customized Products          | -value-adding content of products & services  
- quality over product life  
- short development cycle  
- enriching the customer (customer satisfaction) |
| Mobilization of Core Competence             | -develop business strategies difficult to copy  
- close relation with customers & suppliers  
- high rate of new product introduction  
- skills & knowledge enhancing technologies |
| Organization                                | - decentralised knowledge & control  
- fewer power differentials & less adherence to authority & control  
- authority tied to task & changes when task changes  
- delegation of task & decision-making  
- network communication  
- flat, horizontal, network, or virtual organizational structure  
- team work, cross-functional linkage  
- employee empowerment, job rotation  
- multiple skills training |
| Agile Work Force                            | - personal initiatives  
- interpersonal & cultural adaptability  
- learning new tasks and responsibilities  
- tolerance to uncertain and unexpected situations |

Any activity along the supply chain that consumes resources and does not create value is waste. Through continuous improvement efforts, the
application of lean thinking in the supply chain takes care of such activities along the supply chain. This can be achieved through adjusting some aspects of internal manufacturing such as reducing set up time, and cycle time, and scheduling. This has the effect of boosting efficiency and reducing cost. From the attributes of an agile enterprise summarised above, speed is an important area that can be considered under waste. Product/service delivery time and carrying out activities within the shortest possible time is crucial in avoiding waste. When an upstream activity fails to deliver on time and cause a process and/or employees to stand waiting, this ultimately affects downstream partners. It is clear that excess time anywhere in the supply chain is waste, and therefore lead time needs to be minimised as much as possible. While total cycle time compression is an important requirement for attaining a lean system of production, it promotes an agile supply chain. Waste elimination, in all its form, is an important attribute of the lean supply chain.

One other attribute of lean is its high quality and customized products and services. The design of goods and services which do not meet the need of customers is considered as waste. Integrating lean thinking throughout the whole enterprise provides a way of selecting value – creating activities to line them up in a best sequence that avoid interruption when such are needed, hence, all activity in supply chain is performed more and more effectively (Womack & Jones, 1997). The true value of a product is determined by the customer after assessing the product’s performance over the complete time period that he or she uses it. A possible problem here is for manufacturing companies to create value in terms of what they can make rather than from the customers’ own perspective. The customer is the one that drive value downstream.

This approach to lean thinking means that workers and machine will be kept extremely busy along the supply chain. In this regards, the Overall Equipment Efficiency (OEE) surely will have a decisive role in equipment running speed and time. The machine availability is a function of reliability, maintainability, and maintenance supportability of the machine. The overall equipment efficiency (OEE) is defined as follows:

\[
\text{Overall Equipment Effectiveness (OEE)} = (\text{Availability})\times(\text{Performance Rate})\times(\text{Quality Rate})
\]

A good OEE minimises the ‘six big losses’: failures and break down, set up and adjustments, idling and minor stoppages, reduced speed, defects and reworks, and start up losses. The overall effect is an increase in machine utilisation. However in a lean manufacturing environment the demand should be smooth, leading to a level schedule.

Planning constitutes an important part lean and agile supply chain. Planning should be consistent with the strategic plan for the entire manufacturing or service operation. Resource and operations planning along with location,
inventory management, forecasting, and scheduling are among the most important considerations in determining a company’s supply chain strategy. Issues connected to forecasting and inventory management have been blamed for the poor supply chain performance for companies such as Leax Group. Plan formulation should make use of a realistic assessment of the problems and opportunities associated with arranging, scheduling, controlling, and implementing the material flow. Just-in-time (JIT) delivery and Collaborative Manufacturing Planning and scheduling (CMPS) programmes should support the strategic planning in the SC. CMPS philosophy integrates concepts of lean and agile manufacturing and provides management with accurate, realistic, and up to date information towards effective production as well as materials planning and control (Jiang & Chen, 2007). With CMPS, there is an improved coordination of resources and materials in meeting customers’ demands. The level schedule is a prerequisite for the elimination of all muda (waste). By eliminating muda the businesses will maximise their profit through minimising their physical costs, as typified by Womack and Jones (1996, quoted in Mason-Jones et al., 2000). One of the most popular planning and control systems includes MRP: MRP I (Material Requirement) and MRP II (Manufacturing Resource Planning). MRP is characterised by make – to – order, large batch size, lower and intermediate volumes with flexible flows.

It can be argued that just like an agile enterprise, a lean enterprise can change to customer demand and preference in an act of responsiveness. This is embodied in the concept of ‘demand pull’. ‘Demand pull’ simply means that no upstream partner produces a good or service unless a customer downstream places a demand for it. Note that as a result of this responsiveness, small – lot even single – item production means that a particular partner only makes what is ordered when it is ordered (Womack & Jones, 1997). Instead of pushing completed products at customers, customers’ orders pull newly produced product through the plant.

One very important aspect of the lean system is the way it organizes its suppliers. The lean supply encourages the selection scheme for suppliers in order to organize them in a way that facilitate cooperation and collaboration. During the early development of lean production in the Japanese car industry, the leading Japanese lean producers select necessary suppliers in the beginning of product development stage. Although past relationship is important, selecting suppliers on the basis of proven record of performance is also crucial. This enhances the flow of material, communication, and information sharing. As fewer performing suppliers are easier to control and coordinate, the relationship between suppliers and customers is improved as well. Cooperation and collaboration within the lean supply can mean, for example, that members the supply chain can use techniques such as value engineering to break down the cost at different stages of production to the barest minimum, but ensuring a win – win situation for all even customers. Within this spirit of openness, trust, and fair treatment, different members of the supplier chain work towards innovations and cost – savings suggestions and to work collaboratively.
Some other distinguishing attributes of lean and agile frameworks had earlier been mentioned. Customer driver for lean is cost with low profit margin and for agility is availability or time to market accompanied by high profit margin. The need for information flow is highly needed in the lean framework while information is an obligation and something without which agility can be difficult to implement.

A third strategy that the authors have pointed out for merging lean and agile tools into the supply chain is the separation of ‘base’ and ‘surge’ demands.

### 3.3.2 Creating a Competitive Enterprise:

There are a number of factors that in a combined manner help to define a manufacturing company’s competitiveness including among others, production lead time, flexibility in responding to changes in demand volume and variety, quality, price, responsiveness to customer delivery requirements. Clearly, all these competitive base criteria aim to help a company deliver to its customers in an efficient and effective manner, while maintaining cost as low as possible. In the end, value is created for the customer on one hand, and the company itself and other chain members on the other hand. This can be perceived as two ends of a line in which one end seeks to ensure quality and efficiency in operations, while the other end maintains flexibility and responsiveness to customer need. The fundamental aim is to reduce cost and increase customer satisfaction. ‘Lean’ focuses on efficiency of operations and cost savings while ‘Agile’ focuses on flexibility and responsiveness of operations. Companies that have mastered these competitive bases have been able to ensure competition even in a turbulent market.

As stated earlier, the aim of integrating all the different units of the supplier network, including the external network is to achieve competitiveness. A strategic planning of the supply chain involving the incorporation of lean principles should be seen as a mechanism for continuous improvement. This might involve selecting number of suppliers as well as type of suppliers, attitude to quality, and quality of information exchange etc.

Martin Christopher (2005) points out four principles that can make a supply chain be competitive. He described them as the 4Rs – Responsiveness, Reliability, Resilience, and Relationships. He argues that agility will help drive a firm’s need to be more ‘demand – driven’, i.e. responding to customer requirements for shorter lead times, flexibility, and more customise solutions (p. 38). Uncertainty about future demands or suppliers’ ability is an issue that a firm will have to deal with in order to be reliable. He added that significant improvements in reliability can only be achieved through re – engineering those processes that impact performance. This idea can be extended to logistics and supply chain. At this point, the lean tools for ensuring reliability can be of use.

High degree of turbulence and volatility are prevalent in the present market environment today than before. A firm must manage it supply chain in such a
way as to cope with these unexpected disturbances – resilience. According to Martin Christopher, relationship in the supply chain involves firms reasoning within the partnership framework, i.e. seeing suppliers as mutually beneficial long – term partners. The idea is that the more mutual dependencies between supplier and customer increase as more processes are linked between them, and therefore making it difficult for a competitor to break in (p. 40). The management of relationship for a win – win solution has already been mentioned earlier in this report to be the core for supply chain management. A more responsive supply chain, achieve through agility, does not only enable customer to be served more rapidly, but also a high degree of flexibility and low cost resulting from a shorter pipeline between all the building blocks of the supply chain.

In addition, speed, responsiveness, inventory management, and low cost can be achieved by transforming the supply chain into a JIT/Lean supply chain model, which foster supply chain integration. Other benefits of a Just – in – Time (JIT) or lean supply chain include among others, delivery speed reliability, synchronization in scheduling and production activities, and production to order (the pull system).

McIlhatan’s definition of JIT as ‘the constant and relentless pursuit of the elimination of waste, with waste defined as anything that does not add value to the product – inspection, queue time and stock (Quoted in Mistry, 2005 p. 23).

The elimination of waste and inventory control is an important goal in the supply chain management. By ensuring the right quantity of material at the right time and place, the just – in – time philosophy works just like those of material requirement planning (MRP). This process greatly reduces queues of work in process (WIP) inventory. With direct effect on inventory, the JIT system brings about changes in inventory management techniques, which can result in smoother inventory order placement.

The JIT principle is industrial engineering base and often applied directly to product design for example. However, many JIT features can be applied to other operations in the supply chain. This requires a high degree of collaboration and communication within the supply network. JIT system often involved continuous improvement philosophy, material flow in the production system, changes in vendor relationships that are more collaborative and involve information sharing. The external supply chain – supplier, internal, and customer functions as an integral part of a whole network. In this way quality can be assured from one supplier to the other as well as reduced time for delivery – delivery reliability. Delivery reliability reduces the need for buffer or safety stock, with associated benefit of inventory reduction. Through information sharing and cooperation, the company as a whole has responsibility in assisting its external suppliers to improve quality, delivery time, and service performance.

In their book ‘The Machine that Changed the World’, which highlighted the concepts of lean production, James Womack and professor Daniel Jones
argue that the concepts of lean production should be applied throughout the value stream to drive out waste and provide real value to the customers (Kippenberger 1997). Although the main essence of the concept of ‘lean’ is to eliminate waste, the authors showed how this concept can at the same time bring about a better way to organize and manage customer relationships, supply chain etc. Waste along the supply chain can be eliminated through better integration.

3.4 Just – In – Time (JIT)
The Toyota Production System (TPS) was called the JIT system as it focused on the total elimination of waste and met the needs of a constantly changing market by providing goods and services when they are needed and in amount needed. Such approach promotes production to order rather than production to inventory. Therefore inventory control is a key component of the JIT philosophy. In a related development, the JIT concept is driven by the lean way of doing things in terms of waste reduction.

Though the JIT philosophy has been easily applicable and dominant in the automobile industry, some aspects of this concept can be particularly relevant in effective management of supply chains due to today’s competitive market environment. The result is improved productivity, reduced cost, and ultimate impact on financial outcomes. JIT driven processes can be better understood when considered within the framework of supply chain management, especially when focus is on determining how inefficiencies in the supply chain processes can be tracked and eliminated to improve firm financial performance (Jamshed, 2005). JIT processes were applied on the following areas of the supply chain: customer order, replenishment, manufacturing and procurement.

JIT system often involved continuous improvement philosophy, material flow in the production system, changes in vendor relationships that are more collaborative and involve information sharing. The external supply chain-supplier, internal, and customer functions as an integral part of a whole network. In this way quality can be assured from one supplier to the other as well as reduced time for delivery – delivery reliability. Delivery reliability reduces the need for buffer or safety stock, with associated benefit of inventory reduction. Through information sharing and cooperation, the company as a whole has responsibility in assisting its external suppliers to improve quality, delivery time, and service performance.

The above three concepts describe above: lean, agility, and JIT are so interconnected that they sometime appear to be same idea. One aspect of lean system is in inventory management to ensure a JIT production. Agility is all about time, delivering product to customer at the shortest possible time. All point to a JIT supply chain.

3.5 Supply Chain Relationship Management
A couple of years back, the relationship that existed between companies, customers, and suppliers, sub – suppliers, etc. had little or no cooperation
among each other. This traditional way of seeing other members of the supply chain as stand-alone entities has made way for a more revolutionized approach in which each member of the supply chain is perceived as vital partner and treated as integral part of the whole organizational system, through collaboration and cooperation. The basis for this new perception in the supply chain lies in the fact that individual partners of the chain possess core competence that can be harnessed by other partners to mutual advantage, hence the need for supply chain integration. Today, supply chain management and supply chain integration in particular is perceived by many as solution to present market competition (Gunasekaren et al., 2004). Supply chain comprises all activities associated with the flow and transformation of goods from the raw material stage through to the end user (Quoted in Shepherd & Gunter, 2005).

Within the framework of supply chain integration, it is worthwhile to mention that the present era of globalization has broken down barriers and boundaries among nations as well as among corporations, and this has open up new opportunities and paves the way for cooperation and collaboration. Market globalization has intensified competition worldwide, forcing companies to adopt competitive strategies that enable viability. I.e. within the manufacturing industry for example, companies turn to handover activities that they cannot perform well to other companies that possess core competence over these activities (outsourcing). Gunasekaran et al. (2004) points out that the growth and development of supply chain management is driven not only by internal factors but by external factors such as increasing globalization, reduced barriers to internal trade, improved information availability, and even environmental concerns. Even more, within the presence global business environment, no company can operate alone much less succeed as an island. Any malfunction or losses incurred by one partner upstream is eventually transmitted through the chain downstream to affect other partners. This implies that all must cooperate to a win–win end. Virtual organisation, then, is a dynamic model or tool for agile competitors (Goldman et al. 1995, p. 201). Virtual organization integrates core competence, resources, and customers market opportunities. Opportunism, excellence, technology, open borders, partnership, cooperation, and trust are key characteristics.

It is to be understood therefore why companies have been taking advantage and exploring the opportunity for core competence and innovative capabilities that can be found among the networks of their business partners to a competitive advantage. It is this awareness to the need for interconnectedness and relationships management among partners that has given birth to a wide range of literature and research in the area of supply chain management (SCM), supply chain integration, and the notion of the extended enterprise etc (Ross 1998, p. 1). These researches have highlighted the utilisation of management philosophies and techniques like Just – In – Time (JIT), Total Quality Management (TQM), computerize information tools, total productive maintenance (TPM), etc. to achieve a highly competitive supply chain base on agile and lean principles. As a matter of facts, some authors have even concluded that supply chain management is centred on
the management of relationships. This view of supply chain management is reflected in the definition of supply chain management proposed by Martin Christopher. This definition is presented in the section that follows:

### 3.5.1 Defining SCM

Martin Christopher (2005) defines supply chain management as:

> ...the management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole' (p. 5).

Some other definitions have been proposed on supply chain management, each of which carries a central idea about supply chain as a management philosophy: control the material flow from supplier through distribution centre to customer, facilitating the outbound flow of inventory and information, enterprise integration, and the development of close ties with channel partners. In any case, what is clear from these definitions is that supply chain management as a management philosophy seeks to bring together all networks of partners in a closely linked partnership in order to facilitate the flow of material in the system, with the end result of satisfying the customer. However, managing the relationship between partners has become complicated. For example, the Leax Group, one of the respondent firms to the questionnaire, experiences huge inventory build up along its supply chain as the company relies heavily on forecasting to meet customer demand. The consequence is a huge capital tied up along the chain, which ultimately have effect profit. One of the goals for this company is to reorganize it supply chain, with the introduction of lean and agile principles and with aim of having full control cost and inventory along the chain⁴.

A typical supply chain is depicted in **figure 4** below. This is a simplified model. But the supply chain of today looks more complex than this. The complexity stems from the unlimited size of chain that increasingly linear fashion that grows into a network. This is because there can be multiple suppliers and suppliers to suppliers as well as multiple customers and customers to be included. The major task for a company is to design this network in such a way as to have much control over the level of inventory as it is the case for the Leax Group mention above. This means that in this network, Tier 1 supplier including the numerous suppliers that lie below it must perform well in the business, and see themselves as an integral part of the chain.

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⁴ The revelation was made during an interview with one of company staff and internet sources as well.
3.5.2 Market Qualifiers and Market Winners:

As James Womack and Daniel Jones have pointed out in ‘The Machine that Changed the World’, the concepts of lean production can be applied throughout the value stream to drive out waste and provide real value to the customers. Profit maximization comes from cost minimization, which in turn is a direct effect of waste elimination. Within the framework of lean system, a company achieves waste elimination through smoothening the demand, hence, leading to a level schedule. Market situation may demand cost leadership in which case the order winning criteria is cost, or service leader in which the order winning criteria is service level, or a combination of both. As (Figure 5) below that quality, lead time and service level are market qualifiers for the lean tool while quality, cost and lead time are market qualifier for the agility tool. Interestingly, cost, a market qualifier for agility tool, turns out to be a market winner for the lean tool. The connection between these order winning criteria is that while service level needs to be maximised, cost must be reduced in order to improve performance along the supply chain. They present two performance indicators. The lean market winner is the benchmark that the application of lean tool in the supply chain seeks to address. This cost, which is essentially physical costs, comprises all production, distribution, and storage costs in the supply chain. In a similar situation, service level that is a market qualifier under lean tool turns out to be a market winner for the agility tool.
3.6 Supply Chain Performances:

As earlier mentioned in this thesis, supply chain performance is now increasing perceived as critical means for attaining a competitive edge over others competitors. The role that a resilient and well – performing supply chain can play in operational planning and control as well as company’s strategic goal is not to be overemphasised. The questionnaire response rate reflects the importance that companies attach to their supply chain performance improvement. Traditional way of measuring performance based on cost alone has giving way to more innovative approach incorporating non – cost performance measures like quality, flexibility, time, and the need for customer satisfaction. This is summarised in Figure 7 below.

3.6.1 Cost Vs Non – Cost Measures:

Traditional supply chain performance measurements have focused essentially on cost and a combination of cost and customer service (Beamon, 999). The reliance on a single performance measure like cost is increasingly unrealistic and fails to paint the whole picture. Beamon (1999) argues that reliance on such single performance measures can even stand in contradiction to the strategic goals of an organization.

Today, in the face of evolving market situations resulting in a more and more complex city in the supply chain, financial measures like cost no longer singly defined performance in the supply chain. In addition to cost, there is there emergence of other performance measurement indicators (customer – oriented) that have been described as equally important. For example, Goldman et al. (1995, p. 241) points to the need to ‘enriching and pleasing the customer’. Customer satisfaction, clearly, is an important indicator of supply chain performance. Others include information flow or information sharing and supplier satisfaction etc. These are all qualitative indicators and as such it makes it difficult to incorporate them into quantitative models that have been developed.
Ashish et al. (2006) present a framework for modelling performance of lean, agile, and ‘leagile’ supply chain on the basis of interdependent variables, by means of analytical network approach (ANP) (see figure 6 below). This supply chain performance model, unlike other models, uses a combination of performance indicators – cost, lead time, quality, service level to measure the performance of the supply chain. The point is that by using ANP on supply chain one can evaluate the influence of various performances on specific supply chain objective such as responsiveness. The analysis was performed on three levels:

1) Supply Chain Performance Determinants which include lead time, quality, cost and service level.
2) Supply Chain Performance Dimensions which include market sensitiveness, process integration, information driver, and flexibility.
3) Supply Chain Performance enablers.

![Figure 6: ANP based framework for modelling metrics of supply chain performance by Ashish et al. (2005)](image_url)

It is clear from the above model that the driving force for a supply chain performance is the supply chain performance enablers: delivery speed, new product introduction, customer responsiveness, collaboration across...
enterprise boundary, data interchange, means of information, and flexibility. Sharifi & Zang (1999) have described these enablers in their conceptual model as agility capabilities. Theses are the parameters that in turn render the supply chain performance dimensions: market sensitiveness, process integration, information driver, and flexibility, to be strong. This in turn leads to a positive effect on the overall cost, lead time, quality, and service level, which constitute supply chain determinants. Current market situations require increasing service levels and quality in union with low cost and small lead times. According to Naylor et al. (1999), these metrics are key features of lean and agile manufacturing and constitute value deliver to the customer. In this value metrics, customer satisfaction comes from meeting customer requirements, fitness for use, continuous improvement, elimination of waste, customer support, flexibility to meeting demands, concept and order entry to deliver, design and engineering, quality assurance, inventory etc.

3.6.2 Efficiency and Effectiveness:
The question is: just how do we know that a supply chain is performing well or not, and what are the performance measures that can be identified? Beamon, (1999) points out that when analysing system performance, qualitative evaluations such as ‘good’, ‘bad’, ‘adequate’, ‘fair’, ‘poor’ should be ignored in favour of quantitative measures which may rely on numerical performance measure. Quantitative evaluation itself sometimes may not adequately describe the performance of the system in question. How to measure supply chain performance, without doubt, has been an important area of research within supply chain management. Neely et al. (1995) definition of performance measure centres on effectiveness and efficiency. While effectiveness is the extent to which customers’ requirement are met efficiency is a measure of how economically the firm’s resources are utilized when providing a given level of customer satisfaction. They define performance measurement as the process of quantifying the effectiveness and efficiency of action. Organizations that perform well by satisfying their customers with greater efficiency and effectiveness than other competitors are likely to achieve their goals. Efficiency in the utilisation of a firm’s resources when providing customer satisfaction can be directly translated into reduced cost and profitability.

Therefore, Figure 7 below summarises the relationship between all the main elements of supply chain performance measure. As it can be seen, non – cost measures are closely linked to effectiveness in operations with the supply chain, while cost measures are connected to efficiency.
All in all, performance measurement within the supply chain underscores a wide range of issues including the need to emphasis the following key areas:

- Supply chain design strategy
- Information sharing
- Flexibility
- Resource management
- Suppliers evaluation
- Effectiveness of scheduling techniques
- Lead time.

However, different circumstances within different firms may necessitate different and specific system characteristics for measurement. Gunasekaran et al. (2004) notes: “a measurement system should facilitate the assignment of metrics to where they would be most appropriate. For effective performance measurement and improvement, measurement goals must represent organisational goals and metrics selected should reflect a balance between financial and non-financial measures that can be related to strategic, tactical and operational levels of decision making and control”.

Figure 7: Framework for supply chain performance measure, adapted from De Toni & Tonchia, (2001)
3.7 Information Sharing in the Supply Chain

Information systems need to support integrated operations. With an explosion in information and communication technology (ICT) and the structuring of global transportation systems, new opportunities are being offered to coordinate design, marketing, distribution processes with other global partners to form a ‘virtual’ company, capable of responding to any customer opportunity. The use of the computer systems and the integrated software can significantly increase the agility of the extended supply chain. Software decreases supply chain lead times by allowing information to be entered once and then using it where needed along the extended network. Through shared information and process alignment, a synchronized supply chain can be achieved in which for example, a single schedule for the entire network, information about quantity demanded, and inventory is monitored. Data flow through the whole network is ensured so that everyone knows what is happening to others. Information flow from the suppliers upstream through the internal operations to the customer downstream is the basis for collaboration towards supply chain integration.

Developing and maintaining a long term relationship with the network of suppliers is vital in order to derive benefit of a synchronized supply chain. Such relationships should be based on mutual trust, in which a win – win scenario is generated from both parties. Goldman et al. (1995) emphasizes that cooperation enhances competitive capabilities, and that as a foundation on which virtual organizations rest, cooperation entails trust (p. 209). Trust is an issue that has often limited the extent of information that one company may desire to share with another. The response from the questionnaire shows collaboration beyond the companies’ border to be practically inexistence for all respondents. Perhaps trust and the need for privacy are underlying factors. However, to protect the trust relationships that underlie that access from abuse, models for sharing intellectual property to mutual advantage will be needed. Successful examples have been documented of an explosive increase in the number of corporate collaborations of all kind: Apple partnered with Sony to bring its Macintosh PowerBooks to market more quickly and more efficiently than Apple could have done on its own, IBM, Motorola, and Apple jointly developed the PowerPC chip and operating system, etc (ibid p. 210).

Major fallout of collaboration and cooperation in the supply chain is the emergence of tools and techniques that can help defined the order fulfilment process of an organization. These include vendor management inventory (VMI), inventory placement, continuous replenishment programme (CRP) and radio frequency identification (RFID) (Krajewski et al., 2005). VMI is a model for managing demands. Basically in this model, the supplier manages the customers’ inventory within the specific stock to keep in hand, through information sharing. The customer benefits in terms of the inventory level that can significantly be reduced as well as the risk of running out of stock. On the other hand, direct access to information on real demand means that the supply benefits from having a much better plan and schedule for production and distribution, hence improving capacity utilization. The need to remain
closely connected to each other and share information means the formal approach in which organizations acted independently, making their own forecasts, is to be discarded. VMI presents a perfect model of cooperation within the supply chain with the out coming being a win – win situation for both parties.

Closely working with suppliers through VMI to achieve synchronization can significant reduce inbound lead times. In this situation, both parties benefit: the customer through higher levels of availability and reliability and the suppliers through reduction in their need to carry safety stock, and often a better use of capacity (ibid p. 133). Long lead times mean slower respond to customer requirement and can be costly. Time sensitivity in the market today can be traced to shortening product life cycles, customer drive for reduced inventory, and difficulty associated with forecasting. A shorter lead time would mean reduce error in forecasting market demand.

3.8 Supply Chain Design

Strategic design of the supply chain is another critical issue to be considered. In decisions relating to design, one needs to consider number of suppliers and system for selecting and evaluating them, and a way of settling possible differences between company and suppliers. The issue was clearly noted in the questionnaire response. Krajewski et al. (2005) note that three criteria that firms often consider when selecting their suppliers are price, quality, and delivery reliability. As a matter of facts, this point was reflected across all the four companies not being clear about which factors that guide them in selection of suppliers. Due to the desire to meet shareholders expectation on profit, finding a supplier that offer low price is an objective. However, customers demand product with high quality and to be delivered on time. Poor quality delivery or failure to ensure on time delivery can mean huge losses of customer goodwill and commitment. Managing the above trade – off is often an issue that most company have to deal with in a competitive market. Long term relationship with suppliers is very important to the survival of the organization. It has been quite difficult getting information on supplier chain design, which shows that this aspect of supply chain management has been paid less attention. Supplier proximity and supplier delivery route path are some key aspect to consider when designing a supply chain. All business processes along the SC should be interconnected and function as a unit, though with different area of competence. In this way, information, transportation and distribution, logistics, suppliers, and customers can be integrated within a common sphere.

The location of the SC is an important supply chain strategy in managing inventory. For a manufacturing company, the design of the SC primarily should control the flow of materials in the chain (inventory control). Manufacture to order is an essential lean strategy that aims to eliminate unnecessary inventory in the SC. This inventory normally exists in various ways such as raw materials (RM), work – in – process (WIP), finished goods (FG), etc. Since material flow along the SC will determine the level of inventory, supply chain integration in terms of supplier to supplier, supplier to
firm, as well as customer to relationships and order fulfilment process have a significant impact on inventory levels. Make – or – buy decisions are also important when designing a SC. Many companies have realised the importance of this decision and have redesigned their SC to outsource some part of their activity.

It is important for a company to understand the nature of demands for its products or services when developing a supply chain strategy. Therefore two important fallout of SC design are:

1) Efficiency and
2) Responsiveness.
3) Resilience and risk management
4) Free flow of goods and information

Krajewski et al. (2005) points out some qualities of an efficient supply chain as make to stock or standardized products, low capacity cushion, low inventory investment, short lead time with low cost, emphasis low process with consistent quality and on time delivery, while for responsive supply chain include assemble to order with emphasis on product variety operational strategy, high capacity cushion, just as needed inventory to enable fast delivery time, shorten lead time, and emphasis on fast delivery time, customization, variety, and flexibility.
4. Results

This thesis work set out to provide answers relating to companies interest in SCM as well as the level of perception and application of lean and agility as strategic tools for competitive supply chain in theory and in practice. A wide range of theoretical literature was surveyed, coupled with interview and feedback from questionnaire to some manufacturing and distribution companies. It was one of these thesis objectives to reach out to as many companies as possible with the questionnaire in order to provide more evidence to results. However, out of all the companies targeted, only 4 effectively responded by completely filling in the questionnaire and sending them in within the due dates.

Table 2: Distribution of respondent companies according to position in the SC

<table>
<thead>
<tr>
<th>Company</th>
<th>Sector</th>
<th>No. of Suppliers</th>
<th>Position in the SC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leax Quality AB</td>
<td>Automotive Component</td>
<td>More than 20</td>
<td>Manufacturer &amp; Supplier to main manufacturer,</td>
</tr>
<tr>
<td>Enics Sweden AB</td>
<td>Industrial &amp; Medical Electronic</td>
<td>180</td>
<td>Distributor/Dealer of main manufacturer</td>
</tr>
<tr>
<td>Luvata Sweden AB</td>
<td>Metals</td>
<td>---</td>
<td>Manufacturing &amp; Supplier of solutions/services</td>
</tr>
<tr>
<td>Avure Technology AB</td>
<td>Metal Application/Use of high Pressure</td>
<td>240</td>
<td>Supplier of main manufacturer</td>
</tr>
</tbody>
</table>

In Table 2, the companies that respondent to the questionnaire survey are shown according to sector and position in the supply chain, and include Leax Quality AB of the Leax Group AB, Enics Sweden AB, Luvata AB, and Avure Technologies AB. This resulted in a response rate of 33%. This is not to imply that companies are not interested in managing their supply chain for competitive performance. Even those companies that failed to turn in their questionnaire revealed in a telephone conversation that they work closely toward rendering their supply chain faster and efficient, but could not return the questionnaire for policy reasons. Therefore there is great interest in supply chain management in companies.

The interest in supply chain integration is tempered with insufficiency in available resources as indicated by some respondents. All the companies agree that they grapple with the problem of having to please their customers even when faced with insufficient labour, capital, and technological resources. As one worker pointed out in the interview, “we have to do much with less”. This is having a significant impact in practical implementation of lean/agile supply chain management in companies that responded to the questionnaire. Due to the advantages that lean and agile supply chain provide, these companies have great interest in becoming agile but have not yet successfully gone through the transition.

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5 It is difficult to pinpoint a particular sector for each company as most of them cut across sectors. The sector with main activities was used.
Respondents were asked to supply information on the progress in the different practices and methods adopted for supply chain integration. Therefore key aspects of the questionnaire include: 1) identifying the most significant driving forces for changing environment and competitive market place, 2) supply chain management policies and practices: practices develop in response to this changing environment: agility drivers, strategies and capabilities adopted by respondent companies, 3) the effect of company supply chain strategy on customers and suppliers, 4) responsiveness, 5) cooperation within and beyond enterprise. It is worth noting that these constitute some the objectives that were set out in this thesis work. Figure 8 below summarises some activities and ways the companies work to render their supply chain more efficient and effective in the face of growing competition. This figure is based essentially on the respond given on the returned questionnaires.
In the light of figure 8 there are a number of ways that respondents try to enforce agility and lean in their supply chain management:

1) By cooperation and collaborating with their suppliers
2) By cooperating and collaborating with their customers
3) By adopting a pull system of production  
4) By adopting a combination of competitive strategies  
5) By cutting down on the number of suppliers where necessaries  
6) By reducing their lead times which is long in some cases  
7) Decentralised decision-making structure  
8) Sourcing strategies

As it can be seen, respondents turn to adopt a combination of competitive strategies, i.e. they show flexibility in business strategy rather than just focusing on one strategy. See **Figure 9** below:

![Figure 9: All respondents adopt a combination of competitive strategies](chart.png)

Such competitive strategies adopted may include product quality, cost leadership, and or service leader. However, in addition to the above mentioned strategies, Avure Technologies AB emphasis technical leadership while Enics Sweden AB places less emphasis on product quality & services. Avure embraces new technologies and innovation to differentiate itself than any of the other three companies. The extent to which supply chain strategy contributes to overall company goals varies among respondents. Although Avure Technologies AB emphasis technical leadership, they still see lead time reduction as an important goal of supply chain management while for others, a combination of quality, lead time and cost are targets. This explains why in the returned questionnaire, Avure indicated adherence to on time delivery from suppliers, on time delivery of systems to customers, on time delivery of spares to customers, total lead time from customer order to delivery etc. Therefore there is the tendency for the performance of the supply chain to be seen in terms of delivery performance. Whatever be the case, all respondents indicated that the purpose of their supply chain management strategy is to create value for all parties, while paying special attention to the customer. That is why customer satisfaction was ranked high by all.

Since recognizing signals and changes in the marketplace are of primary importance in developing a competitive strategy, all respondents except Avure Technology identify the following as the most significant factors that drive changes in business environment and rendering the market competitive:
increasing pressure on cost, quick delivery time, and demand for individualised products and services, and need for increased innovation.

Figure 10: Forces Driving Changes & Competition in Market

As shown in figure 10, all respondent see delivery reliability as a force to reckon with. These factors that drive changes in the market are more or less similar to pressures that customers bring to bear on the companies and constitute agility drivers mentioned earlier in the theoretical framework of this thesis (see figure 1) In order to satisfy and gain a better market share companies must respond to these customer demands appropriately. This brings about competition in the market and the need for agility providers necessary to take control of the market changes. The potential and capabilities of a company to respond to changes will very much depend on its organization, technology, people, and innovation. These constitutes the ‘agility providers’ earlier shown in agility model.

Cooperation with suppliers and customers in order to facilitate flow of information between them is a major way of sustaining business from the
respondent standpoint, but cooperation beyond enterprise boundaries is very low and nonexistence in 3 out of 4 cases as the following figure 11 shows

![Figure 11: Cooperation with other enterprise virtually absent](image)

As a matter of facts, only Luvata admits to cooperating beyond the company boundary. Cooperation not only within the company is vital for sustained competition. All the companies in this case say they are trying to develop and maintain good relationship with their suppliers. As shown on figure 12, this relationship involves even cutting down on the number of suppliers where necessary. In a telephone conversation with the supply chain manager for Enic Sweden AB, she pointed out that in recent years their number of suppliers has been trimmed down to 180 from previous over 400. Leax Group, Luvata, and Avure technology AB indicated that their number of suppliers shown in table 2 is actually a reduction from previous higher numbers and that they could even reduce further with time. When asked on which bases or parameters that defines such reduction in number of suppliers, a mixture of responses involving price, quality, and delivery reliability was given. It is therefore not clear how these companies manage the trade off between price, quality, and delivery reliability when it comes to selecting their suppliers. Therefore as the following figure shows, cutting down on the number of suppliers after evaluating their performance is one way that companies are working to improve their supply change performance. However, only 50% of the companies (Avure and Enics) admit to having any metric in place for measuring performance.

![Figure 12: Reducing Number of Suppliers is a way working with the SC](image)
To achieve agility, respondents adopt manufacturing to order which shows a major tendency to specialise products according to changing nature of the business environment. However, the interview revealed that manufacture to order is more of a theoretical concept that actual practice. Most companies that respond yes to manufacture to order practice a certain level of manufacture to stock. The idea of a combination of manufacture to order and manufacture to stock is becoming so common.

Figure 13: Flexibility in Meeting Customer Need—respondents adopt different kinds of flexibility

Organizational structure and flexibility in meeting customer need are important requirement for lean and agile enterprise. As shown above, flexibility ranges from product volume to people flexibility, depending on the company overall aim. Decentralised structures make easy flow of material, communication and information between different organizational structures and systems components. This is even much easier for small size company like Avure Technology AB. While the use of tools like JIT, MRP, continuous improvement culture of change, etc is common, less emphasis is placed on VMI, CRP, inventory placement etc.

Figure 14: Method of production
Vendor management inventory (VMI) offers the opportunity for the supplier to have access to the customer inventory information, and therefore tracking and keeping it at a required level. It is then easy to fulfil orders by placing stock closer to the customer at a warehouse, wholesaler, or retailer. When inventory of goods (in this case forward inventory placement) are placed near the customer, time to delivery becomes faster and smoother. This kind of relationship where supplier constantly monitors customers demand permits them to develop programmes to replenish these needs in a continuous manner. This is the idea of the continuous replenishment programme (CRP).

Figure 15: Type of Organizational structures adopted
5. Analysis

The fundamental idea behind supply chain integration such as reducing cost in supply chain processes, lifting service level, maintaining high quality, and keeping inventory at a reasonable level are, in the main, the same for all companies. An analysis of the questionnaire from the companies that responded to the survey shows that the specific reason for supply chain integration can be traced to either one or a combination of the fundamental ideas mentioned above. As an example, one of the results above indicates that all companies adopted a combination of strategies centred on quality improvement, cost reduction, and service level improvement. From a theoretical standpoint, it is often difficult and not common for companies adopting more than one of these strategies since their effective implementation may require total commitment and supporting organizational arrangement as well as skills and resources (Porter, 1998). Perhaps in the combination of strategies adopted, one of them receives more emphasis than others.

Even more, these companies face problems of resource availability. For example, human resource is an important building block on the road to lean/agile supply chain. Human resource development and training in personal initiatives, learning new task and responsibility, tolerance to uncertainty and unexpected situation, multiple skill training bring about agile work force – an important attribute of an agile enterprise.

![Human Resource Training](image)

Figure 16: Respondents don’t place emphasis on human resource training

As figure 15 shows, all respondent place much less emphasis on human resource development and employee training. This has an effect on employee skills and flexibility vital for an agile organization. The interview highlights much lower employee flexibility than what was mentioned in the questionnaire. From a theoretical point of view, a successful agile company must operate in a way that allows it to synthesis new productive capabilities very quickly. These capabilities may be synthesis from the human and physical resources that are internal to the company but are distributed to its various department or divisions. Organizational structure and people within a company are therefore important in attaining and maintaining the process of continuous improvement and change as well as agility and lean in general. Developing this knowledge asset of a company can serve a learning base, a
mechanism through which its employees can access and share good practices and initiatives throughout the organization in a continuous fashion. In this way, when an organization succeeds to implement and develop its knowledge assets and learn faster than its competitors, it can lead to a sustainable competitive advantage. The basic outcome is that it strengthens the company’s capabilities to meet future challenges related to social, economic, and environmental management. The survey show that respondent do not place emphasis on developing the knowledge assets of their employees through training and re–training. This is bound to depreciate the skills of the employees and flexibility in terms of innovations in new technologies and applications.

Organizational learning should be seen as a fresh ground for improving performance of a company. This knowledge asset of a company, as it is also called, is the potential for learning based on appropriate information relevant to company. This means that for such a company to derive complete benefit from this action, it must develop a mechanism through which its employees can access and share good practices and initiatives throughout the organization in a continuous fashion ((Epstein, 2007). It should also be able develop the spirit of willingness to learn even from outside knowledge- absorptive capacity. Therefore, the development of capabilities to withstand competition is closely connected to the learning process. In a company these capabilities can be embodied in four areas: skills and knowledge, physical technical systems, managerial systems, and values and norms. Skills and knowledge relates to organization’s employees and their expertise and qualification. Values and norms act as guide as to what kind of information and data are considered, and therefore lead to a screening and control tool for whoever is concerned with information collection. Values, norms, and knowledge when they are effectively communicated has the potential to ignite employees with a spirit to contribute and support the organizations overall strategy.

Many firms look to continuous improvement as a tool to enhance their core competitiveness using supply chain management. Continuous improvement and culture of change within a company embodies total quality management (TQM), just – in – time (JIT) supply chain and logistics systems etc. These constitute important management programmes that the respondent companies are constantly striving for. Even more is the fact that they are important milestones in the quest for agile enterprise and therefore should be seen as a means to attaining set objectives rather than just end to themselves. Apart from one case (Avure Technologies AB), the respondents have shown a high interest in the implementation of these programmes in order to improve their supply chain performance.

Contrary to theoretical literature, respondent companies show less interest in the following:

1) External cooperation-Cooperation beyond enterprise boundaries, except Luvata
2) Innovation and employee training, multiple skill training
3) Decentralised knowledge and control
4) Work force flexibility, team work,
5) Flexible organisational structure
6) Flow of material, communication, and information

In relation to table 1, these are all important attributes of a lean/agile enterprise, and therefore they to be taken care of. These are also important in driving the supply chain to be better, faster, cheaper, and closer.

![Figure 17: Measurable outcome of Supply Chain Management](image)

As figure 16 points out, these are measurable outcomes of supply chain management that Martin Christopher (2005) discussed. In any case, one message comes out clear: awareness among the respondent companies as to the necessity to make adjustments reflecting new changes in business environment has never been so important. As the result of this thesis shows, these changes are driven by customer requirement on cost, quality expectation, delivery reliability, and demand for individualised products and services. While the drivers of change are almost the same in the companies, response to these changes is taking place differently. For one thing, getting a company to adopt lean and agile responses may be quite another matter, and for another thing, some of the companies have agreed that it is not always easy to change from an old way of doing things that people are already so used to. This is particularly true when it comes to making employees to adopt lean principles. This may be quite challenging, yet, it turns out to be beneficial in the long run. Agility and lean providers, i.e. methods, tools, and practices that lead an organization to be known as a lean/agile enterprise vary for most of the respondent companies. Theoretical discussions on lean/agile concepts do not perfectly tie in with practical application of these concepts in different companies.

The drivers of change lead a company to assess its capability to respond to the changes. Agility capabilities concern with the potentials and capabilities that the company needs in order to positively respond to and take advantage of market changes. The potential and capabilities of an organization to
respond to market changes will very much depend on its organization, technology, people, and innovation. Although the respondents see themselves as possessing lean and agile capabilities, there is still much to be done on the road to lean and agile supply chain integration. For instance, contrary to the result from the questionnaire, it emerged from the interview with one of the respondent companies that with a very long lead time and a much capital tied up along the supply chain, the performance of its supply chain is not at its best. However, there is a reported improvement in supply chain performance linked to increased collaboration with suppliers and customers.

In a study conducted by Goldman et al., after two years of interacting with scores of companies, they formulated some guidelines that can help companies assess the potential impact of agility on their bottom line. They described these as the ‘four dimensions of agile competition’ – enriching the customer, cooperating to enhance competition, organizing to master change and uncertainty, and leveraging the impact of people and information (Goldman et al., 1995, p. 73). According to Goldman, an agile competitive environment is where the people skills, knowledge, and experience are the main differentiators between the companies. Thus, continuous work force education and training are integral to an agile company’s operations and represents an investment into future success. Similarly, Jackson and Johansson (2003) divide agility capabilities into four main dimensions: (1) product-related change capabilities, (2) change competency within operations, (3) internal and external co-operation, and (4) people, knowledge, and creativity. The first dimension is related to the product-related strategies and operation needed to respond to the change and uncertainty of the market. The change competency within operations concerned with competencies, methods, and tools required managing long- and short-term changes within the production system. Cooperation refers to the ability of enterprise departments to cooperate between each other and ability of whole enterprise to cooperate with suppliers and customers. The final dimension relates to the need to place knowledge and ability of employees as a basis of all actions dealing with the turbulent market changes.

For all respondents, changes in the market have led to a gradual shift from traditional focus solely on cost to other key objectives which are determinants of business success today such as information system, more personalized order fulfilment, and order fulfilment lead time reduction, quality improvement, changes in order quantity, or customer relationship management as a whole in the supply chain. These are all concepts that have received enormous attention in theoretical literature and constitute significant pressure that customers put on companies today. The conceptual theory of agility emphasis competitive base: speed, innovation, proactive, quality, and profitability as essential elements in ensuring flexibility and adaptability. For Avure Technology AB and Enics Sweden AB, the change in focus from cost to other innovative measure like lead time and quality, serve as important performance measurement metrics. Avure emphasis on time delivery while for Enics KPI and continuous improvement. The Leax Group and Luvata Sweden AB do not
have any performance measurement metric currently. But Leax indicated in the interview that they intend to use quality and delivery time in the near future. Clearly, these have a direct effect on how the customer is served and as a consequence, customer satisfaction is being ranked high among all respondents.

The level of customer satisfaction is an important indicator of the level of supply chain performance. Figure 7 shows a framework for supply chain performance measure, highlighting cost and non-cost performance measures which work together to render the supply chain efficient and effective respectively. As it can be seen, this framework is a system approach that incorporates all elements of agile and lean tools for supply chain performance, rather than focusing on just one. In comparison to theoretical description, it can be understood why respondent companies shift focus in supply chain performance from cost to other indicators like lead time, quality, productivity, and speed. The 4Rs – responsiveness, reliability, resilience, and relationship, which Martin Christopher (2005) points out in theory, result from the application of a system approach involving lean and agility principles. He argues that agility will help drive a firm’s need to be more ‘demand – driven’, i.e. responding to customer requirements for shorter lead times, flexibility, and more customise solutions.

Since the focus is on enriching the customer, it is important for each company to develop a procedure for evaluating customer satisfaction. The Leax Group uses survey and consultation as a means to evaluate customer satisfaction. Other respondents fail to indicate which procedure they use. This is an important performance indicator and a key element of any company supply chain strategy. Customer satisfaction itself is a complex process that can vary from individual to individual and even different in the way different companies measure it. It is worth noting that some companies have their overall business strategy without having a specific supply chain strategy. The supply chain strategy is important in operational zing and supporting the overall company strategy; it is more tactical and defines how operations will be performed in order to be competitive and reach business goals. However, the 4 companies have demonstrated a remarkable distinction in the way to attaining these goals and strategies. It may even differ further when it comes to big corporation with global interest compared to small companies and small and medium size enterprises (SME). This point to the fact that the supply chain needs for a small company may differ from that of a much larger company. No supply chain strategy is the most suitable and applicable in all cases. A supply chain improvement strategy that a company decides to adopt is a reflection of company overall strategy. This is because the supply chain management strategy can either act a support function or a driver of company overall strategy. It is therefore important to check if a particular strategy is beneficial or not, otherwise an alternative strategy might worth trying. The respondents have argued that their respective supply chain strategies create value for their customers and therefore the overall business goal. But to what extent these goals are attend is another matter. The Leax Group AB and Enic Sweden AB admit that their supply chain strategy attain company overall business goal to
a greater extent, while for the case of Avure Technology AB and Luvata Sweden AB, it is attain to a certain extent. The overall business goal could be fastness in delivery, service level, or differentiation through low cost, in which case these can be aligned with the supply chain strategy.

A company’s overall aims and objectives including its supply chain strategy are also a function of the type hierarchical structure operated. This organizational structure defines the way activities will be carried out. Except for Leax Group AB which operates a kind of a matrix organizational structure, all other responded admitted to having a functional type of organizational structure (see fig 14). Functional organization is more centralised and does not give room for enough flexibility especially concerning employees skills require in lean and agile systems. Even more, it is suited for standardized products. The kind of organisational structure a company has is very important in supply chain management because this play a key role in how the supply chain strategy is developed and executed. A functional oriented organizational may result in more adherence to authority and less freedom to develop personal initiatives. At the end of the day, whatever organizational structure selected should serve the company in the best possible way. In this regard, it will depend on a number of conditions which prevail in the company and important questions that need to be answered: centralised or decentralise decision making process? What kind of products to you have and how many? What is the technology is available for the company? And what is the size of your company?

Selecting the number of suppliers and how to work with them is an important aspect of lean/agile organization. As much as there is a procedure for evaluating customer satisfaction, there should be a procedure for selecting and evaluating suppliers’ performance. If a supplier fails to perform well either in terms of quality or services, it will have a run down effect right through the company to the customer. As a consequence, it does not suffice to choose a supplier solely because such a supplier is a source of cheap components. While pressure may be put on a company by its stakeholders on the need to be profitable, price alone should not dictate the choice of a supplier. In today business requirement service and quality play a key role as well. For instance, if a supplier fails to deliver its product on time to due to some reason, its customer will eventually fail to deliver to its own customer as well. Such low service level can make a company unreliable in the face of the customer who may turn to more reliable sources, and this can create losses for the company.

To meet changes in market place, respondents are to a certain extent employing tools like Just – in – time (JIT), continuous improvement culture of change and innovation management, use of efficient planning and control systems such as MRP, mechanism for detecting changes in market, supplier selection, communication and information accessibility, and delivery reliability. Without doubt, these initiatives are creating significant revenue growth opportunities for many firms. E.g. in a study conducted by Jamshed (2005) describing the evolution of an integrated lean and agile supply chain
processes that employ just-in-time (JIT) lean manufacturing approach of a supply chain management innovation, most of the profitability was attributed to changes relating to the adoption of JIT principles in the supply chain. Specific efficiencies and cost savings that resulted from gradual implementation of JIT driven processes in the supply chain was tracked. Also, by incorporating improvements and lean principles in production processes in the supply chain, managers can determine how inefficiencies in the supply chain process can be tracked and eliminated to improve customer requirements and hence financial performance of the firm.

This thesis originally intended to gather evidence from a wide range of companies working with the supply to support result obtained. However, the fact that only barely 4 companies turned in their questionnaire have a significant impact on this results. This raises an important question related to uncertainty and sensitivity in these results. Uncertainty in these results relates to the quality of the evidence used to support these results obtained. One objective was to reach out to as many companies as possible and since this was not met, it definitely have an impact on this result. However, the quality of the literature sources was strong enough to give support to the results in this thesis. The quality of the source of evidence e.g. literature sources is of central importance in thesis work, This thesis relies main on peer reviewed papers in international journals as well as relevant books as literature source. On the other hand, sensitivity of results is about what happen to the results if evidence or data are changed. Certainly, the results would have been different if a large number of responded were involved or if the some more questions were introduced in the questionnaire, or existing questions were framed in a different way.
6. Conclusion and Recommendations

This thesis has covered a wide range of issues on the ‘raison d etre’ of supply chain integration using agile and lean tools, drowned from different theoretical literature. Changes in the market, brought about by an ever changing customer demand have resulted in the development of lean and agile frameworks for integrated approach in the supply chain management. The 4 companies are employing different strategies to attain their supply chain management goals but all are aiming to reach a common goal – attaining an efficient and effective supply chain in terms of cost and service to customer. This is generating different levels of agility. While they may be some common elements to consider, like intensifying cooperation and collaboration with suppliers and customers, there is no specific route to follow in attaining agility or lean in the supply chain. This may be connected to the fact companies have different sizes and as well as their different business strategies. The supply chain needs for a small company may differ from that of a much larger company. No supply chain strategy is the most suitable and applicable in all cases. Each company does it its own way depending on its business objectives.

In other words, the level of lean and agility is not the same everywhere. Agility and lean providers, i.e. methods, tools, and practices that lead an organization to be known as a lean/agile enterprise vary for most of the respondent companies. This thesis could not explain why this variance among the respondents. It appears that nature of the products or services and other circumstances such as the specifics of a company’s supply chain (demand variation, inventory holding costs, etc.) determine which strategy will produce the desired results. Lean and agility tackle two important order winning market criteria – cost and availability respectively. Lean and agile supply chain strategies can co-exist in company supply chain, and the application of a hybrid lean/agile supply chain strategy has contributed to a competitive advantage for some companies. However, due to overlap between lean and agile paradigms, it appears that there are still some problems about how to combine them to a suitable end for each respondent. This is further compounded by a constantly changing customer attitude which renders the ability to master agile competition very difficult. No mathematical formula or well established software to this effective is guaranteed for success. This means that each company is setting its own basis for becoming an agile company.

Judging from this survey, the primary essence of lean/agile supply chain builds on delivering value to the customer by optimizing the performance of the entire supply chain to work as a unit. Therefore the customer has been perceived in this survey as the king, reflected in the fact that he does not only ‘pull’ goods but also ‘pull’ value from the producer. It is therefore not surprising why the enterprise have indicated an organization around the customer not the hierarchy and also work around a selected number of suppliers with
innovative skills. Lean and agile supply chain have been adopted in the supply chain as a way of facilitating the free flow of demand information in one direction and, in response, the timely and free flow of goods and services in the other direction in an integrated manner. The real purpose of supply chain integration goes beyond cost reduction; it creates value for the company as well as all partners involved. This study has shown that this idea is not shared in same manner by all respondents.

Discussing the generalization of the results and conclusion are important parts to be taken up in this thesis. In this connection, it is important to note the delimitation or system borders. Therefore it is important to mention that this analysis was based on those companies that respondent to this survey (limited to only 4) and cannot be generalized to cover all companies. This, as already been mentioned, is a major limitation of this thesis work. However, given the results obtained the following recommendation can be made:

1) Some of the respondents which have already embrace some aspects of lean thinking have partners along the supply chain who are yet to adopt lean principles fully. It is important to have all the partners go the lean way in order to achieve a complete success e.g. tier 2 and 3 suppliers. It is a system approach requiring the participation of all partners in the value chain. Whether they have heard about lean or not, sub tier suppliers not already actively applying lean concepts in their facilities will most likely need a substantive introduction to the details of lean techniques (Lean awareness training) such as value stream mapping, 5S, flow manufacturing and takt production, and set up reduction.

2) Traditional hierarchical structure that business inherited from historical human organization, where decision - making is centralised, should give way to a modern management approach of decentralised decision – making. The hierarchical management approach worked well in the past but may not fit into the present changing environment.

3) The company should be dynamic and more of a learning organization with employing training and retraining. This may be expensive but people are a knowledge asset and when they are trained to flexibility and innovative skills, the company benefits. Some companies complain that these skills will be taken to other organizations when the employees leave them and therefore no need for training.

4) One of the defining aspects of lean/agile supply chain integration cooperation and collaboration within and beyond company borders. This may mean developing tools and techniques that can help defined the order fulfilment process of an organization. These include vendor management inventory (VMI), inventory placement, and continuous replenishment programme (CRP). A shorter lead time would mean reduce error in forecasting market demand. These concepts have been explained on page 47.

5) With the supply chain becoming increasingly complex, it is important more specialization of different channel members in specific activities
such as warehousing. More companies are reducing their number of transactions through outsourcing and focusing on specific ones.

6) Adopt a more proactive attitude to supply chain management related issues. This kind of attitude helps to improve supply chain visibility in the company. The Leax Group has been rather reactive to its supply chain issues which have led to many problems.
7. List of References:

Processes and Value Chain, 8th Ed, Prentice Hall, New Jersey, USA.


8. Appendix

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B. Structure of questionnaires

(Most of the Questions require YES or NO)

1. Do you have an organizational structure? --------------

2. If YES, which type of organizational structure do you have? -----------

3. Do you have a core competence? (I.e. activity that you do better than competitors)? --------

4. Which competitive strategy do you pursue?
   a) Product quality -------------- (YES or NO)
b) Cost leadership -------------- (YES or NO)
C) Cost & Service leader ------- (YES or NO)
d) Service Leader ----------------- (YES or NO)

5. Do you have a supply chain strategy for the Company? --------------

6. Does your supply chain management strategy create value for your customer? ----------

7. Four elements or measurable outcome of Supply Chain Management drive customer value: better, faster, cheaper, and closer. Which one(s) are you identified with?
   a) Better------------------ (YES or NO)
   b) Faster------------------ (YES or NO)
   c) Cheaper------------------ (YES or NO)
   d) Closer------------------ (YES or NO)
   e) All of above---------- (YES or NO)
   f) Non------------------ (YES or NO)

8. Does the company have any metric that is used to measure/assess supply chain performance? --------------

9. What metric do you use? --------------------------

10. To what extent do you see supply chain strategy contributing to the overall achievement of corporate and marketing goal?
    a) not at all  -------------- (YES or NO)
    b) to a certain extent------ (YES or NO)
    c) great deal---------------- (YES or NO)

11. Does the company have any mechanism to detect changes in the business environment that can affect company goals? --------------

12. Which is/are most significant pressure put on you by customers?
    a) Demand for individualised products and services -------------- (YES or NO)
    b) Quicker delivery time and time to market -------------- (YES or NO)
    c) Quality expectation increasing -------------- (YES or NO)
    d) Sudden changes in order quantity -------------- (YES or NO)
    e) All the above -------------- (YES or NO)
    f) Non -------------- (YES or NO)

13. Do you have any procedure for evaluating customer satisfaction? ----------

14. Do you cooperate with other enterprises? --------------

15. What is the Degree of cooperation with other enterprises?
    a) high -------------- (YES or NO)  c) Low -------------- (YES or NO)
    b) medium -------------- (YES or NO)  d) non -------------- (YES or NO)

16. What is the motivation for cooperation? --------------------------

17. Is there any procedure for selecting your suppliers? --------------

18. Any procedure for evaluating suppliers’ performance? --------------

19. Is there mutual trust between your suppliers and you? --------------

20. Do you any problem of product delivery from suppliers? --------------

21. If YES, what kind of problem? --------------------------

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22. Do you put much emphasis on developing your human resource through training and retraining e.g. problem solving and team-building skills? 

23. How would you rate the flexibility of your employees?
   a) 20-40% (YES or NO)  
   b) 40-60% (YES or NO)  
   c) 60-80% (YES or NO)  
   d) 80-100% (YES or NO)

24. How would you rate employee skills?
   a) 20-40% (YES or NO)  
   b) 40-60% (YES or NO)  
   c) 60-80% (YES or NO)  
   d) 80-100% (YES or NO)

25. Any positive attitude to changes, new ideas, people, and technology? 

26. Do you frequently introduce new product and improve models of existing ones?
   a) Introduce new products (YES or NO)  
   b) Improve models of existing ones (YES or NO)  
   c) Both (YES or NO)

27. Which method do you adopt?
   a) Manufacture to order (YES or NO)  
   b) Manufacture to stock (YES or NO)  
   c) Both (YES or NO)  
   d) Non (YES or NO)

28. Which flexibility are you identifying with?
   a) Product volume flexibility (YES or NO)  
   b) Product model/configuration (YES or NO)  
   c) Organization and organizational issues flexibility (YES or NO)  
   d) People flexibility (YES or NO)  
   e) All of the above (YES or NO)

29. Do you make information accessible to suppliers and employees? 

30. Do you empower employees to work in team even team across company boarder? 

31. Which is the extensive set of abilities that provide productivity, efficiency, and effectiveness of activities towards the aims and goals of the company?
   a) Strategic vision (YES/NO)  
   b) Appropriate technology (hard and soft) (YES/NO)  
   c) Technological ability (YES/NO)  
   d) Products/services quality (YES/NO)  
   e) Cost effectiveness (YES/NO)  
   f) High rate of new products introduction (YES/NO)  
   g) Change management (YES/NO)  
   h) ALL (YES/NO)

32. Decision making structure: centralised or decentralise? (YES for centralised and NO for Decentralised)

33. Continuous improvement culture of change? 

34. Easy Flow of material, communication and information between different organizational structures and systems components

35. Which do you identify as the driving force for Competition in marketplace?
   a) Rapidly changing market (YES or NO)  
   b) Increasing pressure on cost (YES or NO)  
   c) Increasing rate of innovation (YES or NO)  
   d) Decreasing new products time to market (YES or NO)  
   e) Responsiveness of competitors to Changes (YES or NO)

36. What is your order lead time? 

37. What schedule techniques do you used?
   a) Just in Time (JIT) (YES or NO)  
   b) Material Requirement Planning MRP (YES or NO)  
   c) Enterprise Resource Planning (ERP) (YES or NO)  
   d) Non (YES or NO).
38. What is you Overall Equipment Efficiency (OEE)?

39. How many suppliers do you have?

40. What is the company’s position on the supply chain?
   a) Main manufacturer
   b) Main supplier to main manufacturer
   c) Secondary supplier of main manufacturer
   d) Distributor/dealer of main manufacturer
   e) If none of the above, which one are you?

(I would deeply appreciate it if this questionnaire is completed and returned to me before 2009.05.24)

Many thanks!!!