LEAN SIX SIGMA PHILOSOPHY CREATE COMPANIES AND SUPPLY CHAINS THAT IS AGILE

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ABSTRACT

Purpose: The purpose of the study is to investigate whether a combined Lean Six Sigma (L6S) philosophy can help to improve agility on supply chain and companies. Individual organizations cannot get agility, until they invest in their supply chain's agility. Agile Supply Chain is recognized as very difficult to achieve in practice, and use of Lean Six Sigma Philosophy can be one option to get it.
Design/methodology/approach: The research follows the cases study methodology. A theory background is used with the objective of know how the executives and academics see the concept of agility in supply chain (sc) and companies. Furthermore, multiple-case study has been performed, by means of qualitative methods of data collection, such as observations, document analysis and face-to-face interviews with different specialist. Pattern matching is used to compare the empirical result with the predictive one from literature.
Findings: This research demonstrate positively that L6S can help to improve to agility on supply chain and companies. The seven companies included in the study have integrated some tools and methods from both philosophies and all have aligned L6S with good results in agility concept. Also, shows that using L6S philosophy production speed will increase and responsiveness and flexibility will improve combined with a more robust process. It has been indicated that agility implies increased variation, where a Six Sigma approach is useful controlling and monitoring such variations.
Originality/value: The research point out that a combined Lean Six Sigma philosophy develop the Agile Supply Chain and companies. Lean and Agility philosophies are

closely related, and the Lean philosophy may be one stage into the development of agility. Although at the same time, they differ in many respects.
Paper type: Case study.

Keywords: Lean Six Sigma; agility; supply chain; agile supply chain.

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1 INTRODUCTION

To retain their competitive advantage, leading companies must encourage innovation and actively be agile (Shimray and Vinodh, 2023). Marketplace in which many companies find themselves is characterized by turbulence, uncertainty, volatility and unpredictable demand (Collin and Lorenzin, 2006; Christopher and Lee, 2004; Satyendra and Anil, 2014) . At the time that market are more competitive (Hilletofth, 2012; Jafari et al., 2016), and there is an increasing demand for adapting to diverse customer requirements (Gorane and Kant, 2016; Kuo et al., 2016; Tachizawa and Thomsen, 2007; Zhang and Tseng, 2009). The importance of ability to adapt to rapid and unexpected changes is growing extremely fast (Collin and Lorenzin, 2006), specially as means of achieving a competitive edge in turbulent business environments and financial instability (Ram Matawale et al., 2016; Swierczek and Kisperska-Moron, 2016).

Due to today's dynamic business environment experiences, it has been realized that supply chains need to be more than simply fast and cost effective; they need greater agility (Craig, 2007; Lee, 2004; Ram Matawale et al., 2016). The agile supply chain management approach permit fast and cost-effective responses to

unpredictable markets, ever-changing product demand and support rapid product launches to meet changing customer desires and requirements (Mandal, 2014; Satyendra and Anil, 2014).

When seeking a more profitable, efficient, and competitive organization, companies traditionally initiate some form of Lean Six Sigma (L6S) implementation (Antony et al. 2022). Today, many large and medium- sized Swedish international enterprise work with Lean, Six Sigma, or a combination of them both, many of which have documented how L6S has improved company performance significantly.

Since using L6S has been shown to notably improve business performance, companies can only remain competitive by digitalizing their L6S practices Anass *et al.* (2021); Efimova and Briš (2022); Fortuny-Santos, *et al.,* (2020); Skalli *et al.,* (2023); Sordan *et al.,* (2020); Yadav, Shankar and Singh (2021); i.e., the merger of the two philosophies will allow companies to take advantage of the resulting synergies acting on operational excellence, providing a competitive edge in the market. However, more empirical evidence is still needed to determine the nature of their integration (SARTAL AND LLACH, 2021). Naciri *et al.,* (2022) suggests that Industry 4.0 is essential in the adoption of Lean - and when the two concepts are combined, they become an exceptional tool (SKALLI *et al.,* 2023).

In today's constantly changing environment, supply chain agility is identified as a key element of competitiveness that enables to establish a superior position by responding effectively and timely to market volatility and other uncertainties (GLIGOR, 2014; SANGARI; RAZMI, 2015). Many operations managers have included "agility" in their latest development road maps, and also some authors encourages companies to pay more attention on supply chain agility Collin and Lorenzin (2006), Lee (2004), because have realized that "agility across supply chain" is essential for companies' survival and competitiveness (CHRISTOPHER; LEE, 2004). Agility is recognized as a winning strategy for survival, growth in some business environments and become national and international leaders (HELO, 2004; MASSON *et al*., 2007; OLORUNTOBA; KOVÁCS, 2015; SATYENDRA; ANIL, 2014).

L6S appears as a management methodology that firms can employ to achieve substantial and continuous improvement in supply chain performance (ANDERSSON, 2009); furthermore seeks to make existing processes more robust

(CRANFIELD SCHOOL OF MANAGEMENT, 2003). It is an approach of development because it give solution to many problems that the companies confront today Snee (2010), and it creates extra value to organizations (TSIRONIS; PSYCHOGIOS, 2016).

Exist researches showing that L6S can generates profits into the business and improve customer relationships (JIMÉNEZ; AMAYA, 2014; TLAPA *et al.,* 2016), and that it is very effective in making the supply chain processes robust, flexible, agile and less risky (ANDERSSON, 2009; ANDERSSON *et al.,* 2014).

Today many large Swedish international companies use a combination of L6S ie. SKF, Volvo, Electrolux, Kinnarp, Alfa Laval, Ericsson group, etc. Some of them have experienced several success stories with regard to the joint use of Lean and Six Sigma (ANDERSSON *et al.,* 2014).

Building on previous literature review and the study cases of the current problem situation in Supply Chains (SCs), the paper proposes the application of combination of Lean and Six Sigma to improve agility on supply chain and companies. To address the need of getting agility on SCs and their companies, the following research question is proposed:

RQ "Can Lean Six Sigma Philosophy create Agile Supply Chain and companies?"

Face-to-face interviews and observations on-site in seven large companies, which have a combined Lean/Six Sigma philosophy, has been used and investigated with the goal of answering the research question.

The paper is structured in four more sections. Section 2 presents a theoretical framework with the conceptual development of L6S Philosophy and agile supply chain. In Section 3, it is explained the case selection, unit of analysis, data collection method, analysis, and validity and reliability. Section 4 argues the results and discussion from the interviews in place and by observations in the companies. The paper closes with Section 5, which shows the conclusions of the research.

2 LITERATURE REVIEW

Six Sigma (6S) and Lean (L) have a strong focus on processes, project work and improvement work, and they can be applied in manufacturing and service sectors (KLEFSJÖ *et al.*, 2001; MAGNUSSON *et al.*, 2003).

2.1 LEAN SIX SIGMA PHILOSOPHY

There is not any contradiction between the objectives in Lean and Six Sigma (DAHLGAARD; DAHLGAARD-PARK, 2006). Both can be appropriate approaches for organisations in order to make important progress Andersson and Hammersberg (2007), Shimray and Vinodh (2023) to improve quality, reduce variation and eliminate waste Antony *et al.*, (2003); Furterer and Elshennawy (2005); Jing (2009); Psychogios *et al.,* (2012); even across the supply chain activities Tsinopoulos and Mena (2015) or enterprise level. L6S is classificated in differents ways according each authors, such as: approach, methodology, model, philosophy, program, strategy amd system (RAJA; RAJU, 2016; YADAV, SHANKAR; SINGH, 2021).

Six Sigma is a methodology that improves business processes based on understanding, controlling variation and reduces cost of poor quality (BENDELL, 2006; CHANG-TSEH, 2007; DE MAST, 2006; HARRY, 1998 ; KANJI, 2008; TSIRONIS; PSYCHOGIOS, 2016). The 6S methodology has become one of the most significant strategies for improving and perfecting processes, products or services (KUMI; MORROW, 2006; SHAHIN; JABERI, 2011; TLAPA *et al.*, 2016) , and suggests that there is a direct correlation between the defects appearing in products and customer satisfaction (TSIRONIS; PSYCHOGIOS, 2016).

It can be applied in many different context and processes (Andersson et al., 2014) but a central aspect is committed leadership in all levels (ANDERSSON *et al*., 2014; HENDERSON; EVANS, 2000; SÖRQVIST, 2004). 6S based its success on the use of statistical methods for identifying defects and improving processes and at the same time responding to the voices of customers (FAZZARI; LEVITT, 2008; SHARMA; CHETIYA, 2009; TSIRONIS; PSYCHOGIOS, 2016).

Recently many large organizations as well as in small and medium enterprises (SMEs) are using 6S strategy (KUMAR; ANTONY, 2008; TLAPA *et al.,* 2016). Although some authors like Jüttner (2005) show that – with the exception of

the Six Sigma method – all traditional risk assessment processes/tools i.e: brainstorming, process mapping, impact analysis, sceneario slanning, are being adopted more widely on specific processes than the supply chain.

Lean thinking is fundamentally customer value driven (ANDERSSON *et al.,* 2014). However, a strict application of Lean philosophy may induce a lack of flexibility Dove (1999) and just in time deliveries may cause congestion and thus delays for the customer Cusumano (1994). An uncritical application of Lean philosophy might increase risk, due to subcritical safety stock, etc. It includes ideas of continuous improvements, flattened organization structures, high overall levels of quality, productivity, elimination of waste, efficient use of resources, teamwork, integration and cooperative supply chain management (GREEN, 2000; RAGHU KUMAR *et al.*, 2016; SHAMAH, 2013). Lean methodology provides a set of standard solutions to common problems and optimizes processes across the entire value chain De Koning *et al.,* (2008) Tsironis and Psychogios (2016); but every firm has to find its own way to implement the lean method: there is no universal method that applies to all (SHAMAH, 2013).

Evidence suggests that lean methods and tools have helped organizations, from various sectors, to improve their operations, processes and supply chains to find, select, organize, disseminate, and control their resources in order to gain a business advantage through controlling environmental phenomena (BELEKOUKIAS *et al.,* 2014; CHAN *et al.,* 2009; FORRESTER *et al.,* 2010; SHAMAH, 2013; VILLARREAl *et al*., 2016). The Lean philosophy addresses many logistics processes and functions relating to 'waste' of lead times, inventory stock, timeliness of deliveries etc.

Where as 6S seeks to eliminate defects and reduce variation, Lean aims on cycle time and waste elimination (LUBOWE; BLITZ, 2008; SHAMAH, 2013). Complementing this, others authors claim that implementing lean can reduce waste by 40 percent (SHAHIN; JABERI, 2011). Lean cannot bring a process under statistical control, while 6S alone cannot dramatically improve the speed of the production process and reduce invested capital, amount of equipment, materials and parts (CARREIRA, 2005; SHAMAH, 2013; TSIRONIS; PSYCHOGIOS, 2016). In conclusion, separated implementation from each one of these methodologies cannot provide the same positive effect, that if they are applied combined.

L6S philosophy emerged in the academic as a balanced approach that incorporates principles and concepts from both methodologies, attempting to create a synergy between their functionalities (ARNHEITER; MALEYEFF, 2005; FERGUSON, 2007; TSIRONIS; PSYCHOGIOS, 2016). George (2002) claims that “Lean Six Sigma helps companies flourish in a new world where customers expect, no defects and fast delivery at the minimal cost”. L6S targets to maximize shareholder value by achieving fast improvements in customer satisfaction, quality cost and speed of the process (HILL *et al*., 2011; SUNHILDE; SIMONA, 2007; TSIRONIS; PSYCHOGIOS, 2016).

These two vital strategies have been effectively integrated. It enables companies to meet and exceed customer expectations, to remain competitive Kumar and Antony (2008) by offering higher levels of product customization and technical services; in a changing and volatile global market Byrne *et al.*, (2007) George (2002); George *et al.,* (2004), while achieve impressive quality cost and delivery (QCD) performance (STENTOFT *et al.*, 2016; THOMAS *et al*., 2014). By implementing this methodology, companies could improve business environment and therefore performance Tsironis and Psychogios (2016), moreover that the success and potential benefits of combining the two concepts have been observed Assarlind and Aaboen (2014) in a wide ranging spectrum of industries (PEPPER; SPEDDING, 2010).

According Pepper and Spedding (2010), L6S should be seen as a precursor to producing more responsive supply chains and leading to total supply chain transformation. In the other hand affirms, the organizations will need to be as lean as possible, providing clarity for the implementation of 6S techniques, moving forward to additional concepts such as agility and total supply chain integration.

Nowadays it is obvious that L6S has to be integrated with the other philosophies such as supply chain, agile manufacturing, sustainability, and environment friendly techniques (Green focused L6S) (SREEDHARAN RAJA; RAJU, 2016). It has also been demonstrated that 6S projects can support agility in the supply chain, which may be vital in order to control business risk (ANDERSSON *et al.,* 2005).

But the question is how to build an agile supply chain. The enterprises should focus on their network, processes and on virtual integration, as well as being customer and market sensitive (CHRISTOPHER; LEE, 2004; CHRISTOPHER; TOWILL, 2001; REMKO, 2001; REMKO *et al*., 2001). Fulfilment of an agile

environment requires factors, concepts and values that are well known in quality management. There are such tools, methodologies and values, i.e. continuous improvement, process and system views, cross-functional effort, learning organization, working together in order to involve everyone, monitoring unpredictable and predictable changes, breaking down barriers between functions, assessment of suppliers with regard not only to price, as well as focus on customers' current and future needs and expectations (FOSTER, 2007).

2.2 AGILE SUPPLY CHAIN

Considering the fact that agility as a business concept emerged early 1990s and it was first applied to flexible manufacturing systems, Gligor (2014); Zhang (2007), agility is a paradigm has generated scholarly interest since the concept arise (Gligor and Holcomb (2012); Ismail and Sharifi (2006); Oloruntoba and Kovács (2015) and his implementation it has been subsequently extended to a variety of business domains, resulting in the emergence of agility as an organizational trait (GLIGOR, 2014). Agility has become a vision for the development of logistics for some companies. The concept of agility is more frequently applied to manufacturing, but is also relevant to supply chains (CHRISTOPHER; TOWILL, 2001).

Agility has been defined by some authors as, the ability to thrive, prosper and reply rapidly in an environment of constant and unpredictable change (MASKELL, 2001; MEHRALIAN *et al.,* 2015; OLORUNTOBA; GRAY, 2006; OLORUNTOBA AND KOVÁCS, 2015; VAN WASSENHOVE, 2006). On the other hand, in those contexts where demand is volatile and the customer requirement for variety is high, a much higher level of agility is required (ARIF-UZ-ZAMAN; NAZMUL AHSAN, 2014). Agility should not only be based on responsiveness and flexibility but also on the cost and quality of goods and services. Further, individual organizations cannot get agility, until they invest in their supply chain's agility (SATYENDRA; ANIL, 2014).

The Agility in Supply Chains (ASCs) is the capability to effectively, efficiently and highly flexible be able to quickly reconfigured and respond to the dynamic, volatile and turbulent market expectations Ram Matawale *et al.*, (2016); Satyendra and Anil, (2014), besides responding customer needs. Authors in agreement with the above-

mentioned, adds that ASCs also improve enterprise´s customer service levels (MEHRALIAN *et al*., 2015; STEVENS AND JOHNSON, 2016).

Agility alone does not anymore provide a competitive advantage in supply chains, but it is rather a basic competitive requirement (Collin and Lorenzin, 2006); being the key characteristic of an agile supply chain is the reduced lead time (Satyendra and Anil, 2014). Two key ingredients of agility are visibility and velocity (CHRISTOPHER; PECK, 2004; REMKO *et al.,* 2001).

2.3 RESEARCH METHOD

The research is driven by the knowledge and experience in the theory and practice. Using multi-disciplinary and cross-functional approaches such as case studies is a good solution for logistics research, which deals with practical oriented problems (JAFARI *et al.*, 2016; NÄSLUND, 2002).

2.4 CASE SELECTION.

The research follows the cases study methodology that it is increasingly becoming accepted in this exploratory studies (EISENHARDT, 1989A; JAFARI *et al*., 2016; YIN, 2014). The case study method enables researchers to develop a better insight into a complex and relatively unexplored phenomenon Ellram (1996), that are difficult to identified with other methods (FLYVBJERG, 2006). At the same time it helps to detect the appropriate explanation to be analyzed; besides this, having multiple cases, the findings are likely to be more robust than having only a single case (YIN, 2014).

A multiple case-study approach can also provide more in-depth evidence in understanding complex relationships related to operations and supply chain management (Ellram, 1996; Tsironis and Psychogios, 2016), which are associated with the concept of L6S (Tsironis and Psychogios, 2016). In addition, an empirically valid theory can be supported mainly by multiple case-studies Eisenhardt and Graebner (2007), that can explore and explain better social phenomena that cannot be identified easily through other methods (EISENHARDT, 1989a; EISENHARDT, 1989B).

This multiple-case study has been performed, by means of qualitative methods of data collection, such as observations, face-to-face interviews, and document analysis. Multiple-case selection was used as seven large companies have been investigated, large here meaning over 500 employees.

To select the companies have been used purposeful sampling and convenience sampling (Patton, 2005). All the companies (except Dell) were chosen from a 6S association. They were selected based on their participation in a network, and it was then assumed that they understood and applied 6S. The selection of companies was also made with the following criteria: the companies must have used the principles in L and 6S for at least two years and run more than ten 6S projects. Hence, all companies have been using a combined L6S approach. Six of them had used a typical L approach before, and all of them used only TQM philosophies some years ago. The participating companies were Ericsson AB (Borås), Volvo Engine (Skövde), Volvo Cars (Göteborg), Alfa-Laval (Lund), Dell (Stockholm), Parker Hannifin (Trollhättan), and SKF (Göteborg). Covering different sectors has been also taken into consideration.

3 UNIT OF ANALYSIS

Interviews are performed with industrial engineers, middle managers, operators, Six Sigma Champions, Black-Belts, and Lean coordinators. The intention is to cover different professions with different perspectives, but at company 3, and at company 5, only one person from these companies has been interviewed, see Table 1. Face-to face interviews were performed with different personal sympathies and professions.

Table 1 -The interviewed companies and interviewees

Company	Interviewee Position
Ericsson AB	Lean coordinator Six Sigma Master Black Belt Six Sigma Black Belt
Volvo Engine	Lean coordinator Six Sigma Master Black Belt Middle Manager
Volvo Cars	Six Sigma Black Belt
Alfa-Laval	Six Sigma Master Black Belt Middle Manager
Dell	Procurement manager
Parker Hannifin	Lean coordinator Six Sigma Black Belt Middle Manager
SKF	Lean coordinator Six Sigma Master Black Belt Middle Manager

3.1 DATA COLLECTION METHOD

The findings were supported empirically by on-site interviews and by observations in five of the companies. The observation is used as a tool for collecting data, which enable the researcher to describe existing situations and to have a better understanding of the context and phenomenon under study (KAWULICH, 2005). On-site interviews and observations were also chosen to identify whether the companies had the same definition as the academy of a combined management philosophy.

Different respondents were asked the same questions, notes were written down, and the interviews were tape-recorded. In four of the companies, the interviews started with a group interview, to create a relaxing atmosphere and opportunities for the authors to explain their viewpoint. All the companies agreed to participate in the study; the interview response rate was 100 %.

3.2 VALIDITY AND RELIABILITY

Efforts have been made to increase the validity and reliability of the results in the study. The interview key was formulated and adjusted during a period. The questions have been discussed with colleagues and persons from companies before testing. The questions have been first tested on one respondent and then adjusted. One pre-interview was made at one company that only use L and TQM philosophies (Tour Andersson, Annelund). After some adjustments the real interviews were made. All the interviews were recorded and written down.

The respondents were contacted by phone and agreements on interviews and on-site observations were made. In five of the companies more than three persons were interviewed. The interviews were written down and sent to the respondents, and afterwards the companies had the opportunity to confirm or adjust the answers. The authors also attempted to select different respondents who support L and 6S in the same company.

4 RESULTS AND DISCUSSIONS

This section is about the results and discussions from the interviews in place and by observations in the companies. It addresses the complementary use of L6S, and the degree and organization of collaboration in the supply chain.

4.1 SIX SIGMA AND LEAN IN GENERAL

Usually, the solution and prevention of the problems or risk can be divided into three areas: quantitative, qualitative, and innovation problem solution (SÖRQVIST ; HÖGLUND, 2007). For quantitative problems, 6S philosophy is often most suitable. L philosophy should be recommended when the solution is of a qualitative nature; all the companies were in agreement regarding that point. However, they have integrated some tools and methods from both philosophies.

In the 6S improvement cycle (Improve-phase), innovation is required. For innovation of new products or service, Design for Six Sigma (DFSS) is appropriate to use, but not all companies have begun using DFSS. When the process has controlled variation, continuous work with the process to monitor and complete step-by-step improvements must be required. The last stage in the L improvements cycle (perfection) is appropriate for this purpose. This step pertains to the elimination of non-value-adding elements (waste) and is a process of continuous improvement. “There is no end to reducing time, cost, space, mistakes, and effort” (MCCURRY; MCIVOR, 2001).

According to all the companies, after closing a 6S project it is appropriate to work with this phase, or something similar, which has also been promoted in TQM for some time. Five of the companies have even taken one-step further and introduced a lighter 6S improvement cycle in which daily improvements are included, Ericsson calls it the light DMAIC.

In summary, the following conclusions can be drawn from the seven company interviews: 6S is the problem solving philosophy and L assists in governing the everyday work that involves all employees and creates a standard platform in processes, workstations, and product assortment. 6S and its tools help solve the problems that are too advanced for the philosophy of Lean and its tools. Even if they have Lean, Kaizen, and 6S projects, all the companies have aligned L and 6S by using the 6S philosophy and DMAIC methodology as a common platform in all projects. 6S has provided them with a common language.

4.2 AGILE SUPPLY CHAIN AND COMPANIES

According to the data collected, Lean philosophy has become well established in logistics, providing elements like the following:

- Integrated flow in small batches, which supported fast respond.
- Just-in-time delivery, which leads to low inventory and visibility.
- A pull rather than a push function throughout the supply chain, thereby creating a demand flow.

- Close integration from material supplier to customer through partnerships, which reduce in-bound lead time and visibility.
- Simplified information flow, processing and processes, which improve the visibility and velocity.
- Rapid changeover of tools and procedures, which improve velocity.
- Visibility of the product streams as well as by looking closer to the value adding time, by using value-stream mapping.

Lean and Agility philosophies are closely related and the Lean philosophy may be one stage into the development of agility. At the same time, they differ in many respects. Agility may be reached in other ways than through Lean. Its aim is to prepare the organization to adjust rapidly and efficiently for changes beyond its immediate control, while Lean favours large flows, predictable demand, low product variety and otherwise stable conditions. For example, eliminating inventory – one key feature of applying Lean philosophy – may be counterproductive to the need to respond quickly when sales unexpectedly surge.

The companies were also asked questions about if the Lean and Six Sigma philosophies had improved visibility and velocity and how they are handling above concepts and methods. According to all companies, visibility and velocity can be improved if companies combine Lean and Six Sigma in their processes. Lean manufacturing addresses process flow and waste whereas Six Sigma addresses variation and risk control.

However, all the companies stated that Lean cannot solve all the problems, and if Lean and Six Sigma are combined the speed of the products will be increased and the responsiveness and flexibility will be improved and the process will be more robust. This, in turn, leads to quicker response to changes; all of the studied companies also agree that, to reduce in-bound lead time, it is necessary to collaborate and have cross-functional process teams. It is also important to have explicit agreements and clear communications. Other solutions to quicker response to customers have been introduced through Six Sigma projects and Lean philosophy:

- More manual processes.
- Small batches which have the right quantities.

- Parallel processes that have more flexibility than big automation cells.
- More flexibility in rules and routines for the workers.
- Have an alternative supplier, but always have a main supplier.
- Making decisions on fact regarding how many products should be stored to manage customers' changing demands.
- Work order monitored more often.
- Collaboration and more frequent discussions with partners about order quantities, etc.

In a risk perspective, agility means a reduction of the risks for low sell-through and for lost customers, due to the inability to meet the customers' expectations. The effect of lost customers can be difficult to measure but may be considerable. Agility may be implying increased variation, where a Six Sigma approach is useful to control and monitoring such variations. This is indicated by the present investigation.

5 CONCLUSIONS

This research aimed to investigate if L6S Philosophy can create Agile Supply Chain and companies, and the answer is yes. The companies included in the study have integrated some tools and methods from both philosophies and all have aligned Lean and Six Sigma with great results in agility.

The companies realize that lean cannot solve all the problems, and if Lean and Six Sigma are combined the speed of the products will be increased and the responsiveness and flexibility will be improved and the process will be more robust.

In this comprehensive exploration of problem-solving philosophies and their applications within various business contexts, several noteworthy insights emerge. The research prominently features the 6S and Lean (L) philosophies and sheds light on their roles in addressing quantitative, qualitative, and innovative challenges.

Finally, it is also worth highlighting:

1. Problem-Solving Philosophies: The research discerns a tripartite classification of problems: quantitative, qualitative, and innovation oriented. For quantitative issues, the 6S philosophy emerges as the preferred solution, while qualitative matters are best tackled with Lean (L). Companies universally concur on this distinction. However, an

intriguing facet is the integration of tools and methods from both philosophies, highlighting the pragmatic approach that many organizations adopt to address multifaceted issues effectively.

2. Innovation and DFSS: The companies emphasizes the pivotal role of innovation in the 6S improvement cycle, particularly in the Improve phase. It suggests the use of Design for Six Sigma (DFSS) for innovating new products or services, although not all companies have fully embraced this methodology yet. This underscores the evolving nature of problem-solving strategies and the willingness of companies to explore new avenues.

3. Continuous Improvement: A recurrent theme in the research is the notion of continuous improvement. The Lean philosophy's final stage, termed "perfection," aligns with this concept as it centers on eliminating non-value-adding elements (waste) and fostering ongoing enhancements. The text cites the axiom that there is no end to reducing time, cost, space, mistakes, and effort, underlining the enduring pursuit of operational excellence.

4. Alignment of 6S and Lean: One of the key takeaways is the alignment of 6S and Lean philosophies, with the 6S philosophy and DMAIC methodology serving as common platforms for problem-solving across all projects. This alignment not only streamlines operations but also fosters a shared language and approach within organizations, enhancing collaboration and effectiveness.

5. Lean in Logistics: The companies highlights the well-established presence of Lean principles in logistics. These principles, including integrated flow, just-in-time delivery, and streamlined information flow, have significantly improved operations within this domain. Lean principles extend from material suppliers to end customers, reducing in-bound lead times and enhancing visibility and velocity throughout the supply chain.

6. Lean and Agility: An intriguing comparison arises between Lean and Agility philosophies. While they share common objectives, such as efficiency and responsiveness, they diverge in their approaches. Lean leans towards stability, large flows, and predictability, while Agility prioritizes rapid adaptability in the face of unforeseen changes. This contrast underscores the nuanced nature of problem-solving philosophies and their adaptability to diverse contexts.

7. Improved Visibility and Velocity: Companies unanimously assert that the combination of Lean and Six Sigma methodologies enhances visibility and velocity within processes. Lean's focus on process flow and waste reduction complements Six Sigma's emphasis on variation and risk control. This synergy not only accelerates product speed but also fortifies responsiveness, flexibility, and overall process robustness.

8. Quicker Response Strategies: To enhance response times to customer demands, companies have introduced a range of strategies, including manual processes, smaller batch sizes, flexible parallel processes, adaptable rules and routines for workers, diversified supplier networks, data-driven decision-making, and intensified collaboration with partners. These multifaceted approaches underscore the agility and versatility of modern problem-solving methodologies.

9. Risk Mitigation through Agility: The text underscores Agility's role in reducing risks, particularly those associated with low sell-through and lost customers due to unmet expectations. Agility's capacity to handle increased variation is complemented by Six Sigma's ability to control and monitor variations, serving as a crucial risk mitigation strategy.

In conclusion, the research provides a comprehensive panorama of how organizations strategically approach problem-solving and process improvement through philosophies 6S and Lean. It highlights the adaptability and synergy of these philosophies, their capacity to drive innovation, and their integral role in achieving continuous improvement. Moreover, it emphasizes the ongoing evolution of problem-solving strategies, underlining the need for organizations to remain agile and responsive in the face of changing business landscapes.

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