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Evaluation of Effectiveness of Lean, Agile and Leagile Techniques in Supply Chain

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Abstract

This paper aims to study real time cases in the supply chain network of various industries to determine which of the three existing strategies (Lean, Agile and Hybrid) is more suitable with regard to a particular type of industry. Lean methodology typically focuses on eliminating or reducing the non-value added processes and wastes. On the other hand, Agile methodology concentrates on acting as customers' demands change in order to increase the speed to market. The hybrid strategy, which is referred to as "Leagile", combines the advantages of both the techniques. By doing so, a system can be formed which benefits both upstream and downstream in a supply chain. In our research, we aim to scrutinize the applicability of each of the three techniques specifically to typical industries and then conclude on the parameters that contribute to the effectiveness of each respective technique. The primary area of focus is towards the third methodology, which in recent studies has given better results in most supply chains than the two previous methodologies applied independently. However, we hope to map out the desired characteristics of each technique and list them in accordance with the type of industry they are used in.

Keywords

Leagile, Supply Chain Efficiency, Lean, Agile, Suitability

1. Introduction

While there are many strategies that are used in today's economies to improve supply chain performance, this paper focuses on the evaluation of Lean, Agile and Leagile philosophies. The reason for this revolves around the fact that figuratively, the metrics pronounced by the implementation of these respective strategies have performed well from a corporate standpoint over the last few decades. Through this paper, we also picture certain comparisons between strategies that are used in firms other than Lean, Agile and Leagile strategies, just to reiterate the above stated fact.

1.1. The 'Lean' Philosophy

The Lean philosophy has its roots traced back to the early twentieth century and incorporates the ideas used by both Henry Ford and the Toyota Company. Lean thinking is mainly concerned with the minimization of waste encompassing all aspects of a typical industrial setup. The extension of lean into modern supply chains has contributed to an increased overall efficiency in many industries. Practically, 'Lean' can be thought of as a way of acting or behaving rather than just a tool to implement cost cutting by eliminating "muda" (Japanese term for wastefulness). It has been proven that the social/emotional part has leveraged over the technical part (arguably in the ratio of 70 to 30 percent). The basis of determining the methods of waste reduction is to identify non-value added activities. Non-value added activities include the ones that customers are not willing to pay for and do not add any function to the product. Though it is impossible to eliminate these activities at all times, we must try to integrate, simplify or reduce them. Typically, more than 90 percent of all lead time is non-value added. The eight 'wastes' in lean are: Overproduction, Inventory Waste, Defects, Processing Waste, Waiting Waste, People Waste, Motion Waste and Transportation Waste. Common tools used in Lean include 5S, Value Stream Mapping, Poke Yoke and Setup Reduction (SMED). These

practices/ tools are typical of a manufacturing setup in which dynamic process improvement methods occupy a great deal of significance. Lean ideology is strongly associated with creating a continuous flow and sustain it. Continuous flow is achieved by incorporating 'pull' systems (Kanban Systems). Thus, lean focuses on improvement of a supply chain in the upstream phase.

1.2. The 'Agile' Philosophy

Agile systems on the other hand focus on the downstream of the supply chain. Agility in the system translates into dynamic settings that make the production process flexible to changes in demand. The implementation of agile methodology in manufacturing firms was brought about to change process settings of machines that cater to a family of products. When the topic of versatility of a production line is brought out, we need to deterministically say whether or not it becomes important for the profits of any company. The Agile methodology focuses on products that are typically the ones that see an introductory phase in the market and are prone to experiencing volatility in sales due to customer preferences. This in essence, touches upon the uncertainty of demand in the consumer market. There is a need for companies to respond quickly to these changes in demand without compromising on cost or quality. It is seen as the next step of Lean manufacturing in the sense that it focuses more on improvements in production process while Agile focuses on delivery speed and reliability. Thus, it becomes necessary to trace the product's life cycle to see if an agile philosophy would be the right for the company. The key aspect of agile is the fact that it is more towards production rather than the inventory or distribution phases of a chain. Customer order cycle (The time the customers are willing to wait) is one criterion that has to be considered before adopting agile approach in an industry. If C.O.C is short, then agile is deemed appropriate. Since agile systems evolved in the 1990's, they are more IT-enabled.

2. Case Study

2.1. Application of Lean Manufacturing in Steel Industry

Soni, Chandraker and Sinha (2013) aimed at identifying the problems involved in different departments of a steel industry and arrive at solutions by applying the lean tools. Fishbone diagram was used to analyze the root causes of the identified problems. They started by sending out a set of questionnaires to all the departments of a steel manufacturing company. Departments include Rail Mill, Billet and Bloom Mill, Plate Mill and Stripper Yard. When questionnaires with answers were ready for analysis, Stripper Yard was found to have the highest percentage of wastes. Rework contributed to a significant proportion of all the wastes under Lean. Hence, the focus was to eliminate or reduce it. The wastes from Stripper Yard existed in two forms: physical (10%) and (90%). Physical wastes are attributed to improper pouring of metal and cross-section to height ratio while Chemical wastes are majorly attributed to sudden heating and cooling of materials. They represented the causes and sub-causes of two main symptoms of waste called segregation and cracks. Significant root causes from a pool of potential ones were mapped out for the occurrence of both the symptoms. Segregation was predominantly due to the density gradient, improper flow of liquid metal and differential solidification. Blow holes formed during solidification and uneven heat treatment caused Cracks. In order to combat these issues, they proposed to reuse the ingot with defects which was possible by separating out the particular portion of material without defects. Since there is a loss in size at the end of this separation process, the resulting material was used as billets for other mills. By doing this, waste of rework was eliminated and efficient utilization of material could be done. Besides, solutions regarding the inflated time elapse during differential solidification were also provided. Mixing of materials at the right proportion at the right time along with regular supervisions helped in substantially reducing the time elapsed.

Table 1: Different types of wastes, reasons and remedies in Steel Industry

WASTES	REASONS	REMEDIES
Physical (10%)	Improper pouring of metal	• Reuse the ingot in the same plant • Ingots should be cooled at adequate rate to avoid cracking • Prolonged soaking and pouring little more metal after partial solidification
Chemical	Sudden heating and cooling of materials	
Segregation	• Density gradient • Differential solidification	
Cracks	• Uneven Heat Treatment • Blow Holes	

2.2. Application of Lean Manufacturing in Hotel Sector

Rauch, Damian, Holzner and Matt (2016) start by addressing the rare side of the coin 'kaikaku' (Radical changes) rather than kaizen. Kaizen focuses on continuous improvement of processes at operational level, whereas, Kaikaku focuses changes at organizational level. They aimed at studying the effectiveness of these Lean management techniques in hotel and hospitality sector with several case studies. Yukoi Resorts in Japan is one such example. The idea of the company was to downsize by training all personnel to perform all functions. A person working as receptionist would have to do laundry or assist in the kitchen during free time. Lunch and Dinner Buffet was also introduced in an effort to reduce the workforce which was the major concern for the company. Here, waste of people was eliminated. Similarly, Apex hotels in UK studied the end-to-end cycle of laundry process, which proved to be the largest spend in past months. With wide range of tools in place, suitability of each tool to this sector was assessed against the following four criteria.

Table 2: Validation of Lean tools with different criteria

CRITERION	DESIRABLE VALUE
Effort and Cost of implementation	Less
Time to visibility	Less
Impact on KPIs	Positive
Sustainability of Outcome and Application	More

There are many possible and proven ways to implement lean in a hotel setup. Some of them studied by Rauch, Damian, Holzner and Matt (2016) are stated below:

a) Workshops: Typically, Continuous Improvement Process (CIP) workshops and meetings used to be held in companies which were struggling to meet demands, companies which could not sustain the results of previous system or companies who were on the verge of running out of business. Today, almost all the companies believe that there is always a scope for improvement and these meetings have become common. It is attended by staffs from all the departments and leadership. Representative from the concerned department (For e.g. Kitchen) would provide the background of the problem in hand. Leader is usually trusted with the most responsibility and he dictates the dynamics of the group. This meeting happens every week/ month based on company's focus and strategy. In addition to meeting, reward system was introduced to encourage people with suggestions. A CIP board was kept in place which contained the suggestions and their status. One suggestion would be picked annually and that person would be rewarded or given a prize.

b) Lean in WMS: Warehouse management has always been a platform to use Lean tools. It covers management of inventory, distribution etc., all of which contribute to the eight wastes of Lean. Different products are stored in a warehouse and efficient allocation of products inside a warehouse is of central importance to a company. Hence, there is a need to segregate products according to their importance, frequency of usage, sequence of operations they undergo and profit per unit. Hence, ABC analysis helped to solve this problem. It works according to the "Pareto rule" which states 20 percent of the products generate 80 percent of the revenue. Items were classified into levels of 'A', 'B' and 'C' on decreasing order of importance. 'A' products were stored in the most easily accessible place and 'C' in the

least accessible place. To reduce the waiting time further, bar codes and RFID were used to facilitate faster dispatch of products from and to the warehouse. Housekeeping also provides us with a scope to implement lean on similar lines. There are wastes of motion and transportation which can be studied through the use of spaghetti diagram. Material flow analysis can be done like how it was done in Apex hotels for laundry and streamline the entire flow.

2.3. Implementation of Agile methodology in the Automotive Industry

Elkins, Huang and Alden (2004) discussed the implementation of 'Agile' methodology in the automotive industry. This section is a summary of their methodology and contains qualitative inferences of the same.

A key measure of the success of a company lies in the management's evaluation of the trend in the sales or demands of its products or alternately, the industry that it is associated with. Let us examine this ideology by proceeding with the classic case of the automotive industry. We can clearly see that although demands have been steadily on the rise in the automotive sector, the customer preferences, along with advancements in technology are seeing shifts by the decades. This is in essence, is the visible change in the demand patterns of 'cars' in accordance with say, environmental awareness or fuel efficiency, cost etc. About two decades ago, the cars that were loud and noisy, consumed a large amount of fuel and were relatively affordable were the most sought after ones. Now, with increasing focus on eco-friendly solutions, hybrid cars and electric vehicles are showing a lot of promise. Mapping this shift becomes inevitable for companies in the automotive sector in order for them to streamline their production and operational decisions and tactics with the trend. Dwelling a little deeper into this topic, we see that manufacturing or production practices in any industry must reflect the volatility of demand so that the company stays competitive. Broadly, there are three types of manufacturing systems: Dedicated, Flexible and Agile. A dedicated system is one wherein the production line caters to just one particular product whereas agile and flexible systems cater to a family of products. Depending on the trend and cost-effectiveness of each of these systems, they are accordingly chosen for a particular industry. Our conclusions from an extensive market study will be detailed later. An interesting aspect that is being touched upon in this paper is the concept of a "product family". Conventional production methods are typically framed for a single product or in other words are dedicated for a single product. The idea in such cases is that the product has reached maturation in the market and will continue to sell in stable figures. In recent times, the flexible and agile production methods are drawing more attention. When we say flexible, we mean adapting to uncertain demand conditions. In layman terms, agility also means the same. However, the paper that is being studied here, clearly establishes the differences between both these terms. Agility is that concept which translates into profits for the company by minimizing set-up costs and achieving similar levels of sales as the flexible method. The aforementioned idea of 'family of products' is the way by which the ability to adapt to uncertainty had been incorporated into the production line of the company. When the trend in sales is affected by customer tastes, it is noticed that such products are typically the new ones that are being introduced in the market. When products are new, there is a good chance that the manufacturing settings associated with such products must be tweaked based on feedback so as to achieve competitiveness in the market. The point that the authors are trying to make is that if a family of products can be identified with similar settings in manufacturing (or machining), then the production line of the products such as the new ones can be designed in such a way that they cater to this need for flexibility. This is because if there are common settings in machining, then the need to revise the production line to incorporate the change needed for a product as per market requirement becomes less costly, with just a one-time investment. Identifying the common settings is crucial for any company and is ideally done through an extensive study of the various processes that take place in the production process. Once this is done, the agile system is almost good to go.

In addition to scientifically determining the ways by which agility can be introduced into the system, the company should also conduct a feasibility analysis by mapping out costs associated with the stages of manufacturing with and without the introduction of agility (incorporating all aspects such as taxes and any other indirect costs) and then decide on the reliability of the Net Present Value (NPV) based on the study. The combination of both these aspects when clearly put on paper will ideally be able to throw clarity on whether the system is suitable. According to the authors, the concept of agility shows a lot of promise in the automotive sector. The inferences are that, in the upstream of a supply chain, the agile system is found to be effective for implementation (especially in the case of an automotive company –as it comes under the cadre of an industry that is experiencing volatility in sales) due to its associations with rapidity and cost-effectiveness.

An analysis of the typical ratings for factors that are determinants of the feasibility of implementation of a particular system (Dedicated, Agile or Flexible) in industry reveals that there are six such factors whose weights are described in Table 3. The scale of the weights is such that a score of '0' implies a low impact of the factor on the system, '0.5' implies a medium impact and '1' implies a high impact.

Table 3: Comparison Factors and their associated weights for Dedicated, Agile and Flexible systems

Comparison Factor	**Dedicated**	**Agile**	**Flexible**
Initial Investment Cost	0	0.5	1
Cost to introduce new models	1	0	0.5
Time to introduce new models	1	0	0.5
Production Volume Capability	1	0.5	0
Equipment Reusability for other machining applications	0	0.5	1
Capability to introduce new models	0	1	0.5

An optimum score on the contour plot of these categorical values would give the decision maker clarity on whether or not to go forth with the implementation of the respective system. It is seen that the right combination of scores points to an 'agile' system when it comes to a product that is experiencing changes in customer demands.

2.4. Implementation of Agile systems in the food sector

Bolseth and Alfnes (2001) states the strong correlation of agile systems with supply chain. A characteristic that is clearly being pointed in both cases is that of the decline in the sales volumes of the food products over the years. This has been the case especially over the last decade which, at the management level translates as a need for innovation and the introduction of new products according to customer preferences and market needs. As we have seen earlier, agile systems are the best suit for such industries or companies which anticipate the incorporation of changes in product design or machining courtesy of the market situation. In case of Rockwell Automation, the scenario has been presented in such a way that if there are two main components in the process chain which have to be tweaked in order to achieve agility, they are the 'Material' and 'Machine' components. Reasons for this have been quoted as follows: When it comes to the food industry, Raw Material plays a gigantic role in determining quality, nutritional content and marketability. In recent times, the customer's tastes have been aligned with nutritional interests that reflect the list of ingredients that are used in the food products. This essentially goes on to say that unlike the automotive case as seen before, machining is certainly critical, but not the single best determinant of the agility of the system. Although the concept of 'family of products' still holds good, the distinction here is that purchasing decisions concerned with the raw materials have to be spot on and that the buffer of the raw material stock should ideally be able to satisfy the volatile demand.

As mentioned earlier, machining and tooling is critical too. Here, the two articles reach consensus that identification of a breaking point (referred to as a 'decoupling' point) in the process flow is important in determining that stage in the process chain which will provide a method to showcase a standard product to the customer. The term 'standard product' here refers to the prototype or a base which can be modified to create a new variant of the food product that goes into the consumer market. As reviewers, we draw parallels here to the flexible production line as discussed in the automotive case. If a decoupling point is successfully identified amongst a family, then it becomes easier to incorporate changes in the production processes. This has typically been found to be the point between the primary and second processing stages in a standard food and drink manufacturer's production setup. In the second article, the concept of flexibility of work force has also been talked about in view of agility in the system. Interestingly, this crosses with the lean management of the production setup. What the author essentially means here is that the identification of the right number of skilled workforce for deployment across various process chains is critical for a company in achieving agility, as it enables the producer to cater to a variety of products just by toggling between skilled assets who understand the market needs. As we proceed with the study of a 'Leagile' system in the next section,

we will see how the lean management of workforce (minimal workforce) crosses with worker flexibility (agility) in achieving a great system efficiency.

2.5. Application of Leagile in Distribution of Laundry, Cleaning and Paper Products

Kisperska-Moron and De Haan (2011) through a case of Polish distributor, explained when and why lean is useful over agile methodology and vice-versa. It was early 1990s when the economic system in Poland was volatile. Their study was about a Polish company distributing Laundry, cleaning and paper products. That was the time distribution system came into picture as an interlink between manufacturers (MNCs) and retailers.

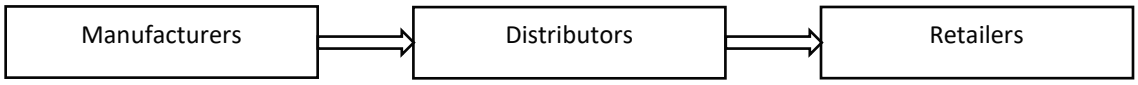

Figure 1: Supply Chain Network

The local distributors faced competition from all around the world. The main aim of MNCs, distributors and retailers was to capture the market amidst heavy competition. The market was fragile and companies had to be aggressive to gain an edge over others and this aggressive strategy followed Agile manufacturing principles where meeting customers' demands in the fastest way possible was put at the forefront. Reaction time was made as low as 24 hours in order to attract attention of the customers. On the flip side, companies had to tradeoff between their push strategy and customer's pull. Later, this was made possible by the advancements in information and communication technology. Retailers could go easy and more flexible when it came to reacting for changing demands because of the IT systems in place. Around 2007, the number of distributors significantly reduced as they started to acquire and merge. The trend changed from being supplier's market to buyer's market. The competition for distributors have reduced and the reaction time has reached a saturation level. Companies started to be concerned about their high investment to achieve agility. With highly sophisticated forecasting methods, companies started to have optimal safety/buffer stocks which reduced the turnover time. On-time delivery was no longer a huge issue but reliability was. Hence, they increased the traditional reaction time of 24h to 48h in such a way that customers' satisfaction is not lost, ensuring high reliability and a decent response time. To validate the mixed model of lean and agile over different stages of the product lifecycle, they suggested the following four elements

a) Market Sensitivity
b) Virtuality
c) Process Integration
d) Networking

Initially, when the company followed agile methodology they satisfied all the four elements. They aspired to become leaders of the market and were market-sensitive. With huge investments, networking and process integration were made easier. While following lean methodology, virtuality was exploited to the highest extent. Optimal Inventory policy came into existence and waste of inventory along with many other non-value added processes were reduced. Though agile focuses more on the downstream portion of supply chain and lean focuses on upstream, satisfying customers demands and gaining their satisfaction remained a given. It is with this adaptive nature of the distributor, they could gain the goodwill of customers in the start and sustain as the market economy changed (Danuta Kisperska-Moron and Job de Haan, 2010).

Table 4: Transition from Agile to Lean

1990s (Agile)	2000s (Lean)
New and Fragile Market, More uncertainty	Established Market, Less Uncertainty
Companies were aggressive in capturing the market	Advancements in Information and Communication Technology
Priority was to deliver is shorter periods than competitors	Priority was to implement waste reduction maintaining customer satisfaction
Reaction time< 24 hours with compromise in reliability	Reaction time: 24 to 48 hours with increase in reliability
First, Fast and Best	What, When needed

3. Conclusion

As for the 'Lean' and 'Agile' philosophies individually, it is clear that the suitability of one of the two is dependent on the nature of the final product that the chain is catering to. If there is market uncertainty, then the natural choice for a producer would be to go for the 'Agile' method, whereas if the objective is to minimize working costs for an established product with relatively constant sales level, the 'Lean' philosophy could work wonders in the upstream phase of the chain. At the start of a product's life-cycle, the 'Agile' methodology would be appropriate because of the need to capture the market combined with the fact that the product design needs to be changed based on review. At the maturation phase, the 'Lean' philosophy would be ideal for the company as this is where the product becomes stable in the market.

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5. Biographies

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