
Analysis And Implementation: Le – Agile Supply Chain In Telecom Manufacturing

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Abstract

This paper aims to understand and analyze the design, mapping and implementation of leagile supply chain. Leanness and agility are two essential attributes of any supply chain. Where leanness may be achieved by eliminating non-value added items and time, agility usually requires the ability to configure and incorporate items to align to changing market environment. It is demonstrated how the "lean" and "agile" paradigms may be integrated and the decoupling point of transition from lean to agile supply chain be identified. The paper is focused on the Mobile devices manufacturing industry. This is an industry that needs to be agile due to the fast changing demand of handset models, while at the same time keep itself lean to minimize its cost due to the extreme competition in the industry. Case of a MNC company is analysed to draw out how the global giants devise its supply chain to keep it lean and agile. This requires development and evaluation of leagility metrics and to determine the decoupling point for a leagile supply chain, which has been practically implemented in this paper.

Keywords: Supply Chain, Electronics Manufacturing, Leagile, Decoupling Point, Mobile.

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Introduction

The supply chains span the globe as more and more companies compete on a global basis. The supply chain management (SCM) prowess of a company decides its competitive position in the market. The health of a company is determined by its excellence in the SCM, which in turn dictates a major chunk of customer satisfaction, operating performances like margin, inventory, etc. and many other key performance indicators (KPIs). The above factors find a critical importance as they help realise the amount of available finances and investments a company can make in their product and market ventures.

Over time, the supply chain has undergone a transformation into lean production from an era of mass production. The ideas of 'lean', 'agile' and 'leagile' are now being banked upon by various manufacturers. The lean thinking paradigm is now pursued by many enterprises to improve the efficiency of business processes. Off late, the paradigm of agile manufacturing has surfaced as an alternative to and possibly as an improvement to leanness. The agile paradigm is believed to be adopted in conditions where the demand is volatile, while the lean conditions are for the stable demands. It is believed that the pursuance of such arguments in isolation may lead to the loss of power of each paradigm. The utilization of different paradigm on either side of the material flow de-coupling point is however advised in some situations to enable a total supply chain strategy. This approach is what is now known as the 'Leagile' Paradigm.

Review of Literature

The ability to foresee and quickly enable changes to meet the uncertainties, through responsiveness in variability in the turbulent market is one way that an enterprise can derive benefit by adopting agile components (Fisher et al., 1994). Off late, there has been a trend where the companies that are adopting the supply chain Management (SCM) measure are also liberally adopting the leagile techniques in their SCM practices giving rise to the development of agile enterprise and lean supply chain concepts. According to Cox, this is probably the reason behind linking of the SCM and development of lean production system (Cox, 1999). Inventory elimination, cost reduction, build – to – order manufacturing, cooperation, collaboration and coordination of supply chain, Just – In – Time (JIT) system, value delivery to customers, flexibility, efficiency; and resilience are all included when the Supply chain develops the ability to perform and compete by closely integrating the internal functions, of a company, and external operations of suppliers, customers, and other channel members (Gunasekaran et al., 2008). Richards has highlighted the agile manufacturing paradigm as an alternative to leanness (Richards, 1996). It is suggested to be the step after leanness. It can be presumed that, an enterprise should strive for agility once leanness has been achieved. However, both, agility and leanness, demand high product quality and minimum total lead-time, i.e. time taken from a customer's request for a product or service until the delivery of the requested product or service (Aitken et al., 2002). Towill, in the year 1996, highlighted that an appropriate management of cycle time towards its reduction would lead to significant improvements in manufacturing costs and productivity. Companies acknowledging uncertainty and devising mechanisms to tackling it are rewarded against competitors whose responses are purely reactive (Carbone et al., 2002). Lean thinking focuses on improving supply chain by eliminating waste of all kinds, better described as 'efficiency in operation', while the agility serves the customers in a way more considered effective. Therefore the main area of focus would be cost reduction and value delivery to customers. So as to achieve a realistic integration of the supply chain it is necessary to make sure the coordination and functioning of the supply chain activities. It should be noted that the efficiency of an activity undertaken cannot be independent of interaction with other activities being carried out in the chain. Quality, speed, flexibility, responsiveness, are necessary components of an agile enterprise, to meet unique needs of customers and markets, and

the companies focusing on agility tend to be sensitive to the market, responding to unpredictable changes by exploiting their supply chains in a cost-effective rapidity (Baramichai et al., 2007).

It is ideal to be understood that Agility may not be synonymous to lean, yet they go hand in hand to overcome major global market challenges. As a matter of fact, 'leagility', the combination of Leanness and Agility, has been the solution to the businesses of today. Naylor et al. (1999), in similar lines, stated that there need was to amalgamate the above two paradigms, than to consider them individually, for a total supply chain strategy. The fact that agile manufacturing suited to satisfy a demand fluctuation while the lean paradigm lead to cost reduction within the framework of market knowledge was what Naylor et al. described as 'leagility'.

The aforesaid Leagility is meant to be achieved by suiting the need for **responding to a volatile demand downstream, by positioning the decoupling point while ensuring a leveled upstream scheduling, from the decoupling point.** The decoupling point here is the point which separates the supply chain that satisfies customer orders from the supply chain that supplier raw material leads to production as shown in figure 1. It is also the point at which strategic stock serves a buffer between fluctuating customer orders and/or smooth production/variety output. The decoupling point positioning also associated with the supply chain efficiency as well as the effectiveness increasing issue of postponement, by moving product differentiation closer to the end user. According to Davies (1993), the risk of both stock-outs and holding excess stocks can be reduced by postponing product differentiation. Albeit, it is thought that product rationalization is where there would be the requirement of an action, as the current sales demand pull on specific products while the suppliers attempt to level schedule upstream of the de-coupling point.

A vital consciousness on 'Leagility' has been developed across the supply chains of all manufacturing sectors. In order to implement leagility in practice, there is requirement of a measurement system which is based on logical concepts. The enterprises could assess their existing Leagility level as compared to the industry benchmarks and adopt best practices to achieve leagile supply chain. But prior to that, it becomes imperative to identify the point which distinguishes the paradigms of leanness and agility in the manufacturing SC. Case study on this electronic/telecom manufacturing company attempts to develop an analytical approach to locate the decoupling point in logical manner.

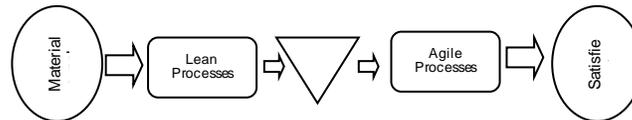
Understanding Lean, Agile and Leagile Supply Chains

Both agility and leanness demand high level of product quality. They also require minimum total lead-time defined as the time taken from a customer raising a request for a product or service until it is delivered. The total lead-time has to be minimised to enable agility, as the demand is highly volatile and thus fast moving. If a supply chain has a long lead-time then it will not be able to respond quickly enough to exploit market place demand. Furthermore the proper engineering of cycle time reduction always leads to significant bottom line improvements in manufacturing costs and productivity. Lead-time needs to be minimised in lean manufacturing as by definition excess time is waste and leanness calls for the elimination of all waste. The essence of the difference between leanness and agility in terms of the total value provided to the customer is that service is the critical factor for agility whilst cost, and hence the sales price, is crucial for leanness. However, whereas the Total Cycle Time Compression Paradigm when effectively implemented is a sufficient condition for achieving lean production, it is only one necessary condition for enabling agile supply.

In addition to showing some basic supply chain structures figure 2 summarises the effect of the decoupling point on supply chain demand experienced by individual businesses within the chain. On the downstream side of the decoupling point is a highly variable demand with a large variety of

products, whereas upstream from the decoupling point the demand is smoothed with the variety reduced. The lean paradigm can therefore be applied to the supply chain upstream of the decoupling point as the demand is smooth and standard products flow through a number of value streams. Thereafter the agile paradigm should be applied downstream from the decoupling point as demand is variable and the product variety per value stream has increased.

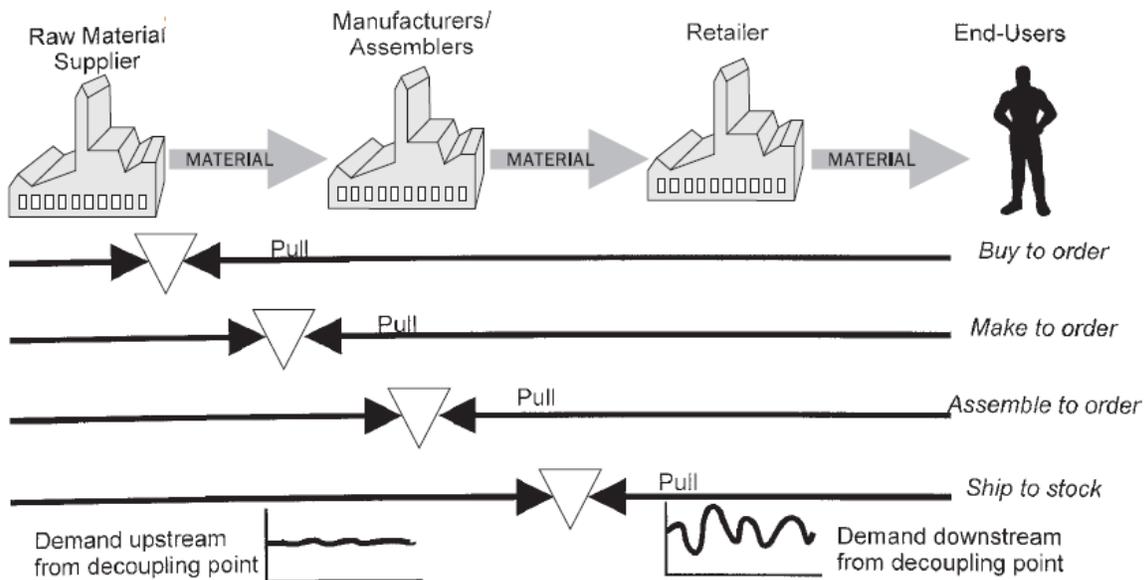
Decoupling Point



Source: Hoekstra, S., & Romme, J. (1992)

Figure 1: The leagile supply chain

Figure 2 shows how the decoupling point moves depending on the type of supply chain as determined by the demand pattern, type of semi finished product along the chain, variety, forecasting etc. We can see that the transition from lean to agile supply chain paradigms begins ideally where the demand fluctuates excessively and where the product variety level increases. Supply chain structures and the decoupling point



Source: Hoekstra and Romme (1992)

Figure 2: Varying position of decoupling points in different supply chain scenarios

Objectives

The major objectives of this research paper are listed down

- Understanding the relevance of leagile supply chain
- Understanding the design and implementation of a leagile supply chain through proper determination of decoupling point separating the lean and agile parts
- Mapping the supply chain of telecom handset manufacturers to understand the lean and agile part to determine decoupling point

- Device metrics to measure agility and leanness of the various links in telecom manufacturers supply chain
- To find if there is a considerable difference in the agility factors between a basic phone supply chain and a smartphone supply chain using hypothesis testing

This paper aims to understand and analyze the design and implementation of leagile supply chain. It will look into what goes into lean and agile supply chain and to see under which environment is a leagile supply chain the best bet for an organization.

Proper analysis of the supply chain of Company A would be done to understand the extend of 'leagile' nature .

Methodology

The supply chain of Company A factory is analysed and mapped to see how the various tenets of lean and agile paradigms are currently employed. The mapping of supply chain tries to incorporate

- Measurements of leanness and agility through relevant metrics classified as generic and specific attributes as well as across supply chain links.
- The metrics are analysed to measure agility across supply chain.
- Determining the location of the decoupling point

The data collection was done through qualitative methods like interviews with subject matter experts , and through quantitative methods like survey questionnaire . Separate questionnaire was floated to get information pertaining to basic phone and smart phone supply chain to see if there is any considerable difference in the dynamics of the supply chain.

Once the mapping is done and decoupling point located, both for basic phone and smartphone supply chains.

Research Design

Exploratory Research

Exploratory research was carried out to understand the various parameters affecting leanness and agility along a supply chain

The data collection technique used is telephonic interview. The sampling done is convenient and judgement sampling and around 11 people were interviewed through semi-structured interview.

Table 1: Exploratory research for smartphone supply chain

Research Methodology (Phase I)	Exploratory
Sampling Method	Convenient and Judgement sampling
Sampling Universe	Company A Employees and Subject matter experts
Sample Size	11
Data collection method	Telephonic interview.

Descriptive Research

Descriptive research has been carried out quantify the leanness and agility parameters along the supply chain. Separate questionnaire based survey was carried out for basic phones and smartphones as well.

Table 2: Descriptive research for smartphone supply chain

Research Methodology (Phase II)	Descriptive
Sampling Method	Convenient sampling
Sampling Universe	Company A Employees
Sample Size	37
Data collection method	Survey through questionnaire.

Supply chain practitioners and production department employees of company A rated the above the above mentioned metrics on 5 point scale 1 being the best and 5 being the highest score 10n agility measure.

The agility measures of smart phone and basic phone supply chain is tested using the followed hypothesis

H0: There is no significant difference between agility measure of smartphone and basic phone supply chain

H1: There is a significant difference between agility measure of smartphone and basic phone supply chain

The test is carried out for two attributes a generic attribute, cross functional skill set and a specific attribute of production line.

The test statistic used is paired t test as both the attributes are answered by the same set of respondents.

Mapping of Company A factories supply chain

Brief of Company A factory

Company A's factory is a mobile manufacturing facility . It produces medium range smart phones and low end phones. The factory follows a semi vendor managed inventory with some of its global supply chain vendors alongside Company A.

The supply chain process start with demand planning which is initiated by the sales team based on past history and market leads .The demand given by the sales team is taken up by the global supply chain team and the master planning schedule team .They decide the confirmed supplier plan which is frozen for two weeks with the deadline set at C+2 weeks (C is the current week). No change is allowed in the frozen period (2 weeks)

Company A has outsourced raw material inventory management to third party logistics player. This big warehouse, called iHub receives inventory from all the suppliers and stores them so that it can be made available to the factory when required with minimum lead time. Company A factory internally manages its raw materials in the form of super hubs which holds just few hours of inventory meant for immediate consumption.

The Company A Factory Overview

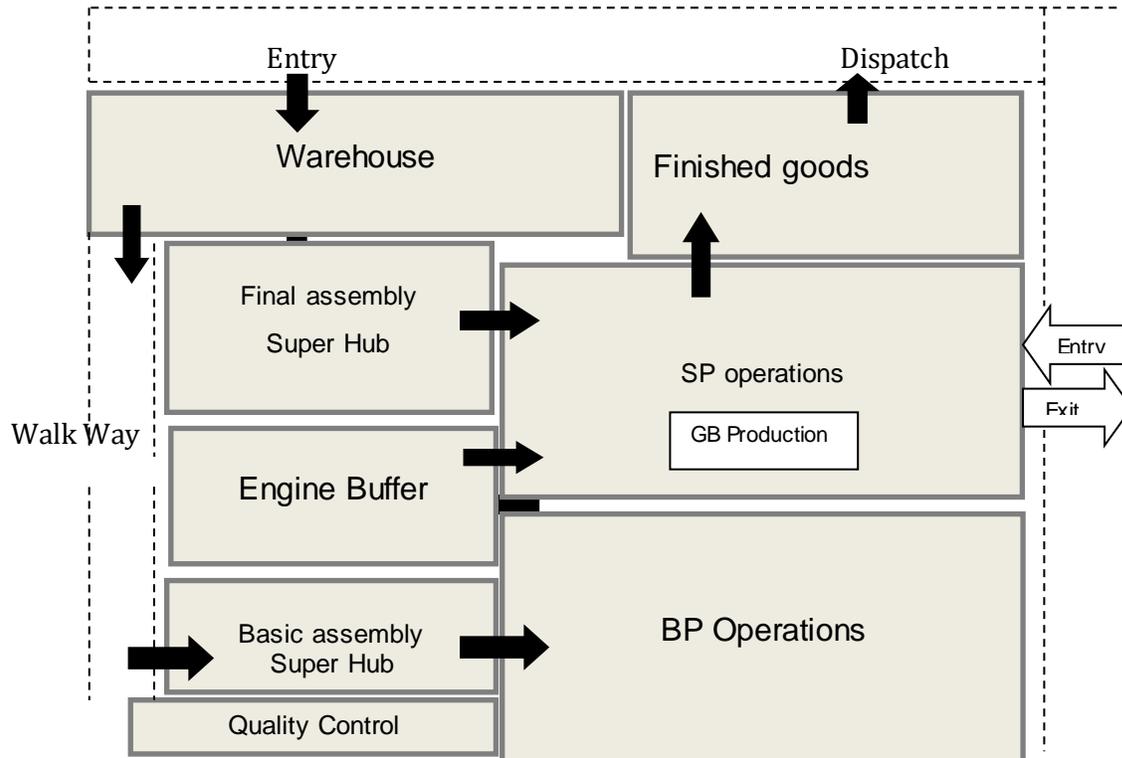


Figure 3: Schematic diagram of Layout

The above figure 3 is the layout of the Company A factory. The whole layout is so designed to minimize the material flow within the factory. The integration of the third party warehouse , finished goods storage and dispatch area with the factory is done in a logical manner with the aim being minimizing unnecessary movement.

Material management

The material management is done in Company A through

- Third Party Warehouse

Company A Super hub

- Final assembly super hub
- Basic assembly super hub
- Intermediate super hub (Engine buffer)

Third Party Warehouse (iHub)

The third party warehouse accepts goods from the suppliers, both in-house and external . It holds the goods and supplies it to the factory on immediate demand allowing the Company A

premises to be Lean. The third party warehouse is managed by third party Logistics companies on contract basis. The warehouse handles huge amount of material as it's a central warehouse for the factory

Company A Super hub

The Company A run super hub are the storehouses of materials that are in immediate demand. Depending on which stage the material is to be used the super hub are of three types

- Final Assembly super hub
- Basic Assembly super hub
- Engine buffer

Production line

The supply chain has a cellular layout an process layout which consists of mainly two kinds of assembly lines which does two different functions and the associated entities like quality check, finished goods dispatch , super hub management, third party warehouse etc .

Process Layout

The gift box production is a case of process layout as only gift box is manufactured in the area designated. This is because gift box is an input to all the assembly line and use of process layout makes the process efficient. Also keeping it as a part of assembly line is inefficient as the gift box production is much faster and the variability in gift box is very little .So its a case of continuous production.

Table 3: Characteristics of gift box production line

Demand variability	Variation in product	Responsiveness
Low	Least	High

Cellular layout

The production lines in the factory, both Engine operations (BP) and Supply operations (SP) are examples of cellular layout as they have both process and product layout features .

Figure 3 shows the production execution process at Company A factory in detail. There are two stages in the production of a mobile phone .

Engine operation (BP)

Here the basic common materials are mounted on the PCB .

- This is a highly automated assembly line with almost continuous production happening at a very fast rate
- The number of BP lines are more than twenty.
- There is one dedicated NPI (New product introduction) line where the new product production testing is done before the launch to check for the viability
- The daily production capacity of BP lines is around 24-30 k phones
- These also include the lowest cost phones which are produced for huge volumes and is almost continuous
- The end products from this phase is either final phone(low cost phones) or Engines or Modules

Table 4: Characteristics of BP line.

Demand variability	Variation in product	Responsiveness	Setup Time
Low	Low	Moderate	4 to 8 hours

SP stage

Here the final device specific customizations like different body covers ,localization (keypad , software etc) are done. This is also a cellular layout which lesser automation There are around more than 15 lines for Supply operations (SP) .

- This is more labour intensive and a smaller assembly line .
- Here the customization of the product happens.
- There are more than 15 lines.
- The per line daily capacity is approximately 72k phones
- The number of phones produced is high because the line is smaller and time per operation is faster
- The change over time is very fast as it is more labour intensive and the most important thing is the skill set to work on different models

Table 5: Characteristics of SP line.

Demand variability	Variation in product	Responsiveness	Setup Time
Higher	Very High	Moderate to low	0.5 – 2 hours

As evident from the production line diagram, the demand is pretty stable till the engine line as the production happens as per level schedule based on weekly plan. The semi finished product till this stage is highly uniform with very little variation hence the aggregation of demand makes it stable and predictable

Through the data obtained from personal interviews and survey, agility and leanness has been measured along the supply chain for a basic phone. The basic phone is one which has bare minimum features which are core features for any mobile phones and which have less variety and simple design and are high volume low cost phones .

We have tried to analyze how the focus changes from leanness to agility as we move down a supply chain. The initial focus as expected is to minimize the inventory to attain leanness .This is evident from the diagram shown below.

Table 6: Supply chain performance calculated from the survey for basic phones supply chain

Supply chain characteristics /attributes	Agility Score	Agility Measure
Procurement	2.66	Low-Moderate
iHub	2.90	Moderate
SuperMarket	2.14	Low
Production line	1.72	Low
Dispatch responsiveness	4.71	Highest

Generic attributes	Agility Scores	Agility Measures
Cross functional skill of people	2.91	Moderate
Quality check response time	3.93	High

Supply chain link	Lean factor	Agile factor
Demand planning	Nil	Moderate
Sourcing /Procurement	High	Low
Third party warehouse	Low	Moderate
Company A Warehouse-Basic assembly	Highest	Low
Production line	Moderate	Low
Dispatching	Lowest	Highest

We can see that till third party warehouse ware house stage the trend or leanness and agility is not matching the remaining trend. That is because these elements do not form a part of Company A's control and are related to Company A through contract only . Therefore the suppliers as well third party warehouse has their own leanness and agility requirement dictated by the necessities of the contract. The leanness reduces as we move towards finished goods and dispatch because inventory is accumulated here to meet sudden spurge in demand as well as constraints of the dispatching .

The agility factors we see is high for Third party warehouse because it has huge inventory as much as around 1-3 months inventory. This is because some of the suppliers of the factory are foreign suppliers Hence materials come in bulk according to economical lot sizes from these suppliers .Also the lead time is very high so there is a need to keep high inventory to make the process decently responsive.

The production line (BP) adds the following levels of variation

- Level 1 :Dual DIM vs Single SIM

The agility level is high in the procurement side because that is again mandated by the contract and hence the suppliers will have to compromise on leanness to ensure that responsiveness is maintained

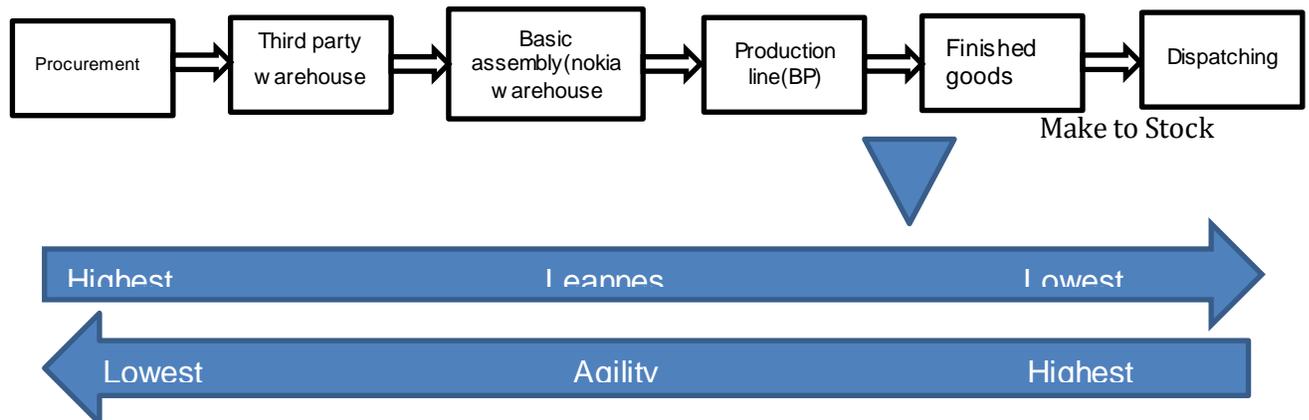


Figure 4: Location of the decoupling point for BP line

The decoupling point hence can be traced to the finished goods stage where we have the chain changing the focus from lean to agile. This is similar to a make to stock supply chain design. The higher cross functional capacity of the employees allows for more agility in the final production line as this production line is less automated and hence requires more human involvement. The higher cross functional capability of the shop floor employees reducing the setup time in the assembly line. The inventory levels are higher for finished goods side because it should cater to the dispatching requirements and should be available well in time for the dispatching to happen hindrance-less. The agility factors were high for the dispatching stage because of the flexibility in the dispatching process as anything can be dispatched to any zone without much prior arrangements, ofcourse at extra cost. These are mandated by the contract which Company A has with the third party logistics providers.

Analysis of Decoupling point in the supply chain of a smartphone

A smartphone is generally lower volume and higher price compared to a basic phone. Its production process is more complex and longer than that of a basic phone.

The supply chain is similar till BP production line post which we have engine buffer for storing the semi produced phone, called modules or Engines. The production line does a level production as the final production line is faster than the BP line and hence it runs on a level strategy (continuous). The engine buffer there for has higher level of inventory than the stages before. so we see a change in the supply chain paradigm here leanness to slowly agile. The engine buffer acts as the input for the SP production line which further adds to the agility as these lines cater to higher levels of design variation.

The production line (SP) adds the following levels of variation on top of what is provided by BP line.

- Level 2 : Color of plastics like back cover etc
- Level 3: Software customization (Like language in the software)
- Level 4: Key pad customization (again language on the key pad)

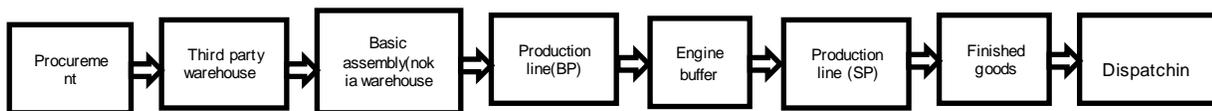
Hence the extend of agility is a lot more in a smartphone supply chain post the Engine buffer.

Table 7: Supply chain performance calculated from the survey for a smart phones supply chain

Supply chain link	Lean factor	Agile factor
Demand planning	NA	Lowest
Sourcing /Procurement	High	Low
Third party warehouse	Low	Moderate
Company A Warehouse-Basic assembly	High	Low
Company A warehouse-Final Assembly	High	Low
Company A warehouse -Engine Buffer	Medium	Low
Production line (Modules)	Medium	Low
Production line (SP)	Low	High
Dispatching	Lowest	Highest

Supply chain function	Agility Score	Agility performance
Confirmed order book flexibility	1.5	Lowest
Procurement	2.18	Low
iHub	2.89	Low- Moderate
SuperMarket	2.14	Low
Production Line(BP)	1.53	Low
SuperMarket -Engine buffer	2.14	Low
Production Line(SP)	4.24	Highest
Dispatch responsiveness	4.75	Highest

Generic supply chain attributes	Agility scores	Agility measures
Demand variability responsiveness	2.97	Moderate
Cross functional skill of people	3.67	Moderate
Quality check response time	3.78	High



Assemble to order



Figure 5: Location of the decoupling point for SP line.

Positioning of the decoupling point after the engine buffer makes the whole supply chain something like an assemble to order supply chain. After this point agility increases from engine buffer to the smart phone line where customization of SP phones takes place as per the customer order. The agility factors were high for the dispatching stage because of the flexibility in the dispatching process as mentioned for BP lines.

Comparison of Smart phone and Basic phone supply chain

The smartphone and basic phone supply chain has been compared based on position of decoupling point and agility measures. It is clear that the decoupling point is closer to the end customer in basic phone supply chain compared to a smartphone supply chain owing to the fact that the smart phone supply chain has more variability.

A paired t-test has been done on the agility measures of cross functional skill set and agility of production line and results can be seen in table 8.

H1 There is a significant difference between agility measure of smartphone and basic phone supply chain in cross functional skill set

Table 8. Agility comparison between smartphone and basic phone based on cross functional skill set

Data	
Hypothesized Mean Diff.	0
Level of significance	0.05

Intermediate Calculations	
Sample Size	37
DBar	0.7568
degrees of freedom	36
S_D	1.0647
Standard Error	0.1750
t Test Statistic	4.3234

Two-Tail Test	
Lower Critical Value	-2.0281
Upper Critical Value	2.0281
p-Value	0.0001
Reject the null hypothesis	

H2: There is a significant difference between agility measure of smartphone and basic phone supply chain in production line

Agility comparison between smartphone and basic phone based on production line

Data	
Hypothesized Mean Diff.	0
Level of significance	0.05

Intermediate Calculations	
Sample Size	37
DBar	2.2973
degrees of freedom	36
S_b	1.4311
Standard Error	0.2353
t Test Statistic	9.7645

Two-Tail Test	
Lower Critical Value	-2.0281
Upper Critical Value	2.0281
p-Value	0.0000
Reject the null hypothesis	

It is clearly evident that with a 95% confidence interval we can say that the smart phone supply chain has more agility compared to a basic phone supply chain. This is inline with our expectation of agility measures because smart phone supply chain is more flexible, product variability, higher demand variability, lesser level of automation and caters to more product types

Conclusion

A leagile supply chain can help any organisation achieve the market winners. Cost and Service levels are fundamental that can help insulate itself from its competitors. Within the leagile supply chain the market winner attribute is availability of product as per market needs, the prime requirement for incorporating agility. However, cost, lead-time, and quality are market qualifiers. Hence the additional need for lean production to be engineered into the supply chain as appropriate to the product.

The Company A factory has a supply chain whose decoupling point classifies it as a make to stock supply chain for basic phones and assemble to order supply chain for smartphones. While the positioning of the decoupling point is imperative to achieve the leagile paradigm, by developing the metrics of leagility across supply chain this paper provides a framework to differentiate between the lean and agile portions of supply chain and focus on the leanness and agility metrics that can be

improved along the supply chain to make it more efficient and more competent globally. Also the study is centred on mobile manufacturing operation and hence we cannot generalize it for a general electronics supply chain. Further research can be done to identify leagile paradigms in other electronics manufacturing firms.

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