
Agility in Supply Chain and its Impact : Automobile Sector

Sonu Verma^{1*},

Centre for Management Studies, Jamia Millia Islamia University, New Delhi.

Kavita Chauhan¹,

Centre for Management Studies, Jamia Millia Islamia University, New Delhi.

Shashanka K Prasad²

Centre for International Trade in Technology, Indian Institute of Foreign Trade, New Delhi

*

Abstract

Agility, in the last decades and modernizing business environments, has been advocated as a fundamental characteristic for competitiveness, aiming at increasing the organization's flexibility in new situations and opportunities. Ever changing customer demand driven fluctuations in market conditions have resulted in development of different supply chain oriented agility factors. Determination of agility factors in the supply chain of Automobile Companies has been the specific focus of this study. For this purpose, two case companies have been taken into account. Then the customer perception about both the automotive companies as a measure of operational performance has been linked with identified agility factors, for impact assessment, and as a measure of competitiveness.

Keywords: Agility, Automotive, Supply Chain, Customer Perception, Operational Performance, Factor Analysis

Introduction

Increasing global competition and increasing customer demands motivate every firm to work on products with new technology and advanced features, which shrinks product life and gives less time for product developments. Agility is a vital factor for business success in complex industrial scenario as it enables firms to successfully compete in a competitive market. Firms are increasing relying on information systems in achieving such agility throughout the supply chain. Automakers and their suppliers have had to contend with dramatic demand volatility, enormous supply chain disruptions and a competitive landscape that has been forever altered.

These changes have been accompanied by significant shifts in the marketplace. Consumers are now firmly in control, and their expectations with regard to features and value are increasing. Demand is for cars, trucks and SUVs that are fuel-efficient, with low emissions. They also want their vehicles to have the latest in electronics, navigation systems, communications systems and driver assistance capabilities.

The expectations of the day's savvy consumers are not just limited to high quality and longer vehicle life, but extend up to improved styling, performance, comfort and value. With an increased impatience and declining brand loyalty among the consumers, the automobile manufacturers and their suppliers in future may tend to redesign their supply chain with and consolidation, to build resilience.

The need for an integrated supply chain strategy is specifically recognized at this point, by the automakers and their suppliers, in order to enable them to:

- Have a better sense and forecast the ever-changing region, product category and business segment specific global consumer demands.
- Design rapidly and profitably responding manufacturing and distribution networks to effectively address the changing consumer demand.
- Consolidate and synchronize the global capacity across the internal factors, such as the production facilities, joint ventures and external suppliers.
- Improve margins and customer service by effectively re-energizing the aftermarket segments.

Today, automotive companies recognize that it is not enough to be profitable; they must also be agile enough to adapt to future changes. In other words, they need to adopt a new, pro-agile mind-set.

The world witnessed this first hand when Toyota which epitomizes lean concepts was caught off-guard by the 2011 Japanese tsunami. With a strong supplier base in Japan, and a production strategy focused on minimal inventories and capacity, Toyota quickly found itself running out of vehicles. Toyota's experience clearly demonstrated that long term profitability depends on combining a financial focus with underlying supply chain flexibility.

Literature review

Introduced in the year 1991 by researchers of the Iacocca Institute, increasing attention has been received from both researchers and industrial communities on "Agility", ever since. Many publications, since the introduction until the recent years, due to its newness, have appeared on the subject and attempted to provide a definition for the term. The definitions accepted currently relate a company's agility to be its capacity to respond quickly and effectively to changes, unexpected, in market demand (Brown and Bessant, 2003; Sharifi and Zhang, 2001; Fliedner and Vokurka, 1997; Constantin Blome et. al, 2013) with meeting the varied requirements of the customer, listed in terms price, specifications, quantity, quality, delivery and after sales service, being the aim of the company (Prince and Kay, 2003). In other words, an enterprise which, in an effective manner, reacts quickly, to the customized products and service driven change in markets. Also, the company's ability to cost-effectively produce and deliver new products is directly affected by the agility factor (*Swafford et al, 2006*). The benefits of an agile strategy include decreased manufacturing cost, increased customer satisfaction, increased competitiveness and exclusion of non-value added activities (Lin et al., 2006).

Added to the above exists trading-off among the competitive priorities as the companies realize that they cannot excel in all of them simultaneously (Burgess et al., 2005). Consequently, the competitive bases on which a company is willing to excel in determine the company's agile attributes to be enhanced. Moreover, in order to achieve the agility, several leverages, known as the agile "enablers", can be exploited by the companies (Lin et al., 2006; Rimiené, 2011). Concurrent engineering practices and the rapid prototyping tools are a few other enablers (Gunasekaran, 1998).

The supply chain agility has two fundamental building blocks, namely the supply-side competence and the demand-side competence. A firm's upstream (supply-related) activities managing proficiency is what defines the former, while the latter deals with the ability of the firm to manage

effectively the downstream functions of demand and distribution (Constantin Blome¹ & Tobias Schoenherr 2013).

'Leanness' as a possible element of 'Agility' was pointed out by Martin Christopher. He went ahead to prophesize that only a combination of both 'Lean' and 'Agile' could enable meeting the exact consumer needs, arising in a volatile market, by an organization. Until recently, the automobile industry, he argues, was known only for its lean components and faced problems due to the lack of agility. Though the concepts of lean and agile are not synonymous, they are essential to overcome the major challenges faced in a global market. The customer service level, a market winner, can be used for an example in this context for it is an agile element while the cost, is influenced by the lean factors to make it an important market qualifier. So as it ought to be summarized, today's businesses seem to depend on an amalgamation of the Lean and Agile factors to give rise to 'Leagility'. With a reasoning similar to the above, Naylor *et al.*, 1999, stated the total supply chain's strong need for a combination of the above two paradigms instead of being viewed in isolation. The factual requirement of agile paradigm in satisfying the demand fluctuation and lean paradigm in reducing the costs well within the framework of market knowledge and determining the decoupling point position formed a foundation for the above argument. The description of leagility, according to (Naylor *et al.*; 1999), is a combination of these two concepts.

Agile Supply Chain

The ideas of flexibility and adaptability, in order to see the business in a new perspective along with rapid and cost effective delivery of products and services with a sole purpose of fulfilling the customer's needs is now what is embedded deep within the notion of the supply chain agility. The need for a latest technological innovation or a modified product design, currently non-existent with the producing company, could be expectations of the current customers. The question that arises at this juncture is about "how a company tends to meet these unexpected expectations arising well within a rapidly changing market scenario?" And it is at this very juncture do the adaptation of agile processes and applications come into picture. With the availability and proper exploitation of the existing information technology parameters does an agile enterprise helps respond, in a cost efficient way, not only the surfaced changes but also avails to anticipate the forthcoming changes and handle them with appropriate decision making. The human resource available within an organization and its sense of innovation play crucial roles in establishing an agile enterprise. The arising changes are considered to be the part and the parcel of an agile establishment, with the available human resource driving towards the innovations that could address the need for new ideas and solutions required by the course of change.

This creativity factor helps compete, in the already competitive market, by giving rise to a whole new range of technologically sound products and services. With this, it can be understood that an organization can manage to get an edge over others, apart from sustaining its business, by adopting the agile principles. An agile organization is always changing with time to meet the requirements of an ever changing market.

As observed in due course, new opportunities are provided to an ever changing company, in order to take an advantage of the situation and do something more than its competitors.

Although there are various definitions that are put forward to address the concept of agility, the important ones can be found highlighted in this study. They are as follows:

Embracing a comprehensive response with an aspiration to avail profit out of the rapidly changing, continually disintegrating global market, for goods and services with superior quality, performance and customer configuration (Goldman et al. 1995, p. 4).

(Yusuf et al., 1999), defined agility to be a successful exploration of the competitive bases of flexibility, rapidity, innovation proactively while ensuring the quality and profitability, through integration of reconfigurable resources and best practices in a knowledge abundant environment, with the purpose being to provide customer driven products as required to stay competitive in the fast changing market scenario.

While according to (Jones et al., 2000), agility summarizes to use the knowledge available in a market along with a virtual cooperation to avail and exploit opportunities profitable in the volatility of the marketplace.

Some important aspects of the concept are highlight in the above definitions, and they call for the following:

- An approach more responsive and proactive to meet the uncertainties
- Need to meet the customer requirements via high customization of the products
- Capability to anticipate the needs of a customer and fulfill the same
- Improving the value chain through work process activities
- Speed and efficiency coupled with flexibility
- Integrating the organization along the supply chain
- Configuration capabilities development
- Skill development and training of the HR and workforce
- Improving the capabilities in technology and innovation

A business organization described to be agile is implied to be with a broad vision of new ways to conduct business in the existing market conditions, i.e. it is able to envision or perceive changes occurring in the market environment and deal with them appropriately by the developing the required capabilities.

A simple conceptual model of agility, as seen by (Sharifi and Zhang ,1999), is presented in the **Figure 1** below. Important aspects of various paradigms like the capabilities, drivers and providers of agility can be seen in the figure. The business environment changes or pressure that drives or mandates a company, to look out for new ideas to maintain its competitive advantages while successfully running its business, is regarded the "Agility Drivers". While the potentials of the company to positively respond and take an advantage of the occurring change concerns with the "Agility Capabilities" of the company. These aforementioned potentials of a company depend on its organizational structure, resources coupled with technology and innovations, summed up to be called the "Agility Providers". A strategy would be developed by a company, upon assessing its potential, to become agile in terms of competency, responsiveness, speed, flexibility, enhancing its ability to inculcate change and integrate for the purpose of provision of customized products of high quality, mobilizing the core competence and cooperation. The above attributes can be considered the main features of agility (Shereshiy et al. 2007).

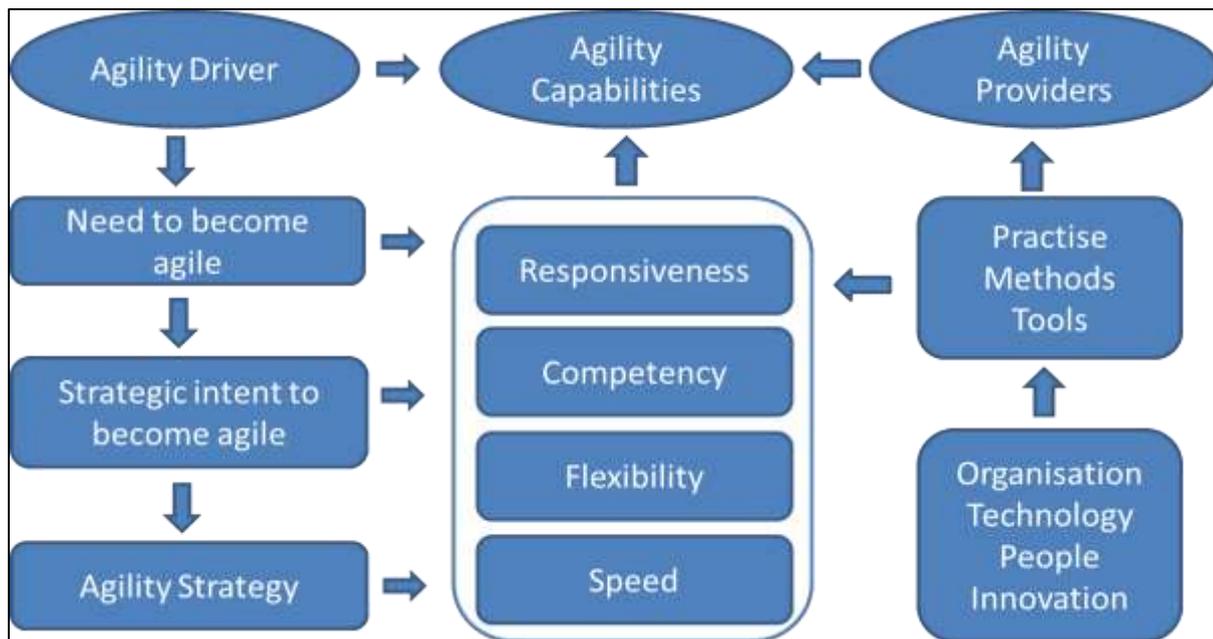


Figure 1: A conceptual Model of Agility (Sharifi & Zhang, 1999)

It was argued (Goldman et al., 1995), that the goal of agility should be focused towards the enrichment of customer. This in other words can be understood as an emphasis on delivering values and solutions, then just the products, to the customer. It is further stated that for an effective mastering, of the occurring change, is required an organizational structure that is flexible enough to accommodate rapid reconfiguration of the human and other physical resources. Characterized by a supplier - customer relationships and business - production processes integrating holistic methodology, agility at the design level, is one among the several levels of agility competition.

Agility gains its importance as it is applicable to the supply chain due to the fact that it leads in a better response towards the conditions of mounting global market competition. This concept, however, is not fully decrypted yet regarding the terms on how to measure and evaluate it. Furthermore, the ability to master agility is rendered difficult with the constantly changing attitudes of the customers. There are, not yet, any specific mathematical formulae nor computer programs to assure the effective way to success guaranteed; only indicating each company to have their own protocols to make themselves agile. Nevertheless, Goldman et al., conducted studies for over two years, by interacting with a number of companies, before they formulated guidelines to help in a company's assessment of its agility. These guidelines, better known as the 'Four Dimensions of Agile Competition', feature customer enrichment, competition enhancing cooperation, mastering the change and uncertainty organization, and People and Information impact leverage (Goldman et al., 1995, p. 73).

Based on Review of literature, we found out that most of the research in desired area of study, agility in particular, focuses on providing a theoretical description to the concept. This study, therefore, was an attempt in investigating via empirically designed approach to study what exactly is the scenario of agility of supply chain within the auto sector companies followed by understanding its impact on customer perception, which is a proxy measure of operational performance of firm.

Two Indian automobile companies have been selected to get the insights and perspectives into the concept of agility as viewed within these organizations as well as by customers. Idea was to identify the agility drivers, enablers and providers from the industry practitioner point of view and then attempt to develop linkages with customer's angle of seeing agility in these auto firms. Choice of Indian auto manufacturers was done to develop a framework of agility relevant and specific to Indian context and to assess its impact on domestic marketplace customers. Significance of the same lies not only in developing agility metrics from Indian auto manufacturing viewpoint but in identifying their relative importance as well as measuring their tangible impact on market competitiveness

Paper is further organized as follows; Section 1 gives a brief profile of two major Indian auto players followed by objectives and methodology in section 2. Section 3 describes the supply chain of Automobile company A, Agility variables from the literature review have been further identified in section 4 followed by analysis and results, Brief conclusion is given in last section 5.

1.1 Profile of Company A

Company A is the first automobile company in the world to be honored with an ISO 9000:2000 certificate. Company A is one of India's leading automobile manufacturers and the market leader in the car segment, both in terms of volume of vehicles sold and revenue earned. The company A plant has 3 fully-integrated production facilities. The fact says that, on an average two vehicles roll out of the factory in every single minute. The company takes approximately 14 hours to make a car. Not only this, with wide range of models and multiple variants, Company A fits every car-buyer's budget and any dream.

Parent company started a global launch phenomenon in 2005 in which they used to launch the vehicles globally at the same time due to this many changes occurred in Company A. The shift to Global Launch became even more important as Company A built more global vehicles, the production and launch of which coincided with those in other markets. Supply chain complexity and coordination became even more complex.

That shift has had huge implications for the supply chain 'Earlier, Company A used to bring designs from home country plant and pass them on to vendors to copycat them, Since 2005, things have changed due to this simultaneous global launch phenomena. For eg for the Indian market the Indian suppliers' input on design would also be incorporated in the final design. This led to the concept of 'concurrent engineering'. In a way, Company A moved towards collaborative modules with their suppliers, which again was a paradigm change.

Generally, Company A defines three categories of suppliers:

- Fully owned, global suppliers
- Second is large Indian companies that went in for joint ventures with foreign companies
- Third lot is small Indian suppliers, such as for sheet metal or plastic components, that operates with no foreign equity or technological collaboration.

When Company A switched to global launches, it was the third category that was largely unable to participate in the 'concurrent engineering' route. They were good at reading drawings and manufacturing them, but many lacked design skills. To remedy this situation, Company A set up a separate division within supply chain wing to identify foreign technology firms and match them with

Indian suppliers. Company A advised the third category of suppliers to get into tool design with these companies, which is generally considered easier than product design. This matchmaking exercise began in 2006 and has so far led to collaborations.

Today Company A deals with more than 400 vendors and Suppliers are grouped into clusters and are taught 'pull' and 'just-in-time' manufacturing in classrooms for a fortnight. Projects at vendor locations are also taken up for identifying where there is maximum pain: high inventory, low productivity and high manpower.

Company A is a major player in India Automobile market place. Name is not revealed due confidentiality clause.

1.2 Profile of Company B

Company B is India's largest automobile company, and it is the leader in commercial vehicles in each segment, and among the top in passenger vehicles with winning products in the compact, midsize car and utility vehicle segments. It is also one of the largest truck and bus manufacturer ranking within top five of the world auto manufacturers.

Over 8 million Company B vehicles ply on Indian roads. The company's manufacturing base in India is spread across the automobile clusters in different parts of India. The company's dealership, sales, services and spare parts network comprises over 3500 touch points.

Company B, also listed in the New York Stock Exchange has emerged as an international automobile company. Through subsidiaries and associate companies, Company B has operations in the UK, South Korea, Thailand, South Africa and Indonesia. It has launched several new products while also exporting these products to several international market. It is engaged in heavy commercial vehicles production and exports. It went for some major acquisitions and joint ventures, to gain foothold in global market, with companies in South America, Africa and South Korea.

Company B is India's major auto player in commercial segment. Name could not be revealed due to Confidentiality clause.

2.1 Objectives

- Supply Chain Mapping of Company A
- What are the most important parameters related to the agility in the automotive industry?
- How agility parameters of automobile companies can be prioritized or what is the gap between expectation vs perception for agility?
- What is perception of customer for Company A and B regarding its Market competence?
- What is impact of agility of supply chain on customer perception and consequently on operational performance of company.

2.2 Methodology

This study builds on a combination of perspectives with mixed approach, making use of mounting evidence from other research written in this area of study to point out as clearly as possible the attributes of agility in supply chain of automobile company. This was followed by employee

assessment as well as gauging customer perceptions on the same. First on the basis of literature survey some basic drivers of agility were determined, and then a pilot questionnaire was developed to identify which agility parameters are important from organization point of view. The questionnaire was sent to supply chain professionals in Company A and Company B, who in turn rated the agility parameters on the basis of their priority to shortlist top agility attributes. These questions characterize the purpose of this research work, which follows a recursive process of data collection and analysis. This was done to eliminate agility factors which were not that relevant for supply chain and do not have much impact. Final questionnaire was developed to identify the importance of remaining agility attributes and rate them accordingly. Current level and expectation of agility attributes was also included in the questionnaire. Complete response of total 39 employees from both companies was received.

Then gap analysis was done with the help of t-test to study the difference between the current level and future expectation of the level of agility parameters in the organization. From gap analysis the areas where companies need to work upon were identified. Then to rank the agility parameters on the basis of employee response factor analysis was done to identify the most important factors.

After that the most important agility variables were shortlisted from customer's perspective and then the customer response was taken for both Company B and Company A. The customer rated both the companies on the basis of some competencies as identified from experts in industry. Then mapping of customer response and agility factors was done with the help of linear regression to study the impact of agility factors on the customer for both the companies.

3. Automobile Supply Chain Mapping

In any organization supply chain plays an important role, all business processes along the Supply Chain should be interconnected and function as a unit, though with different area of competence. In this way, information, transportation and distribution, logistics, suppliers, and customers can be integrated within a common sphere.

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

The automobile supply chain like other industries begins with sourcing of raw materials, components from vendors. Some companies rely on few trusted suppliers so that they can follow best practices such as VMI (Vendor Management Inventory), whereas some like to procure from many vendors. Suppliers at Company A directly deliver the components at production facilities to avoid inventory build-up thus implementing JIT. Then the components move from one production facility to others, finally the assembled vehicles are stored in the company warehouse.

Then depending on the zone requirement the batches are delivered to particular zone and then to distributor. The supply chain of any automobile company can be visualized in the below diagram:

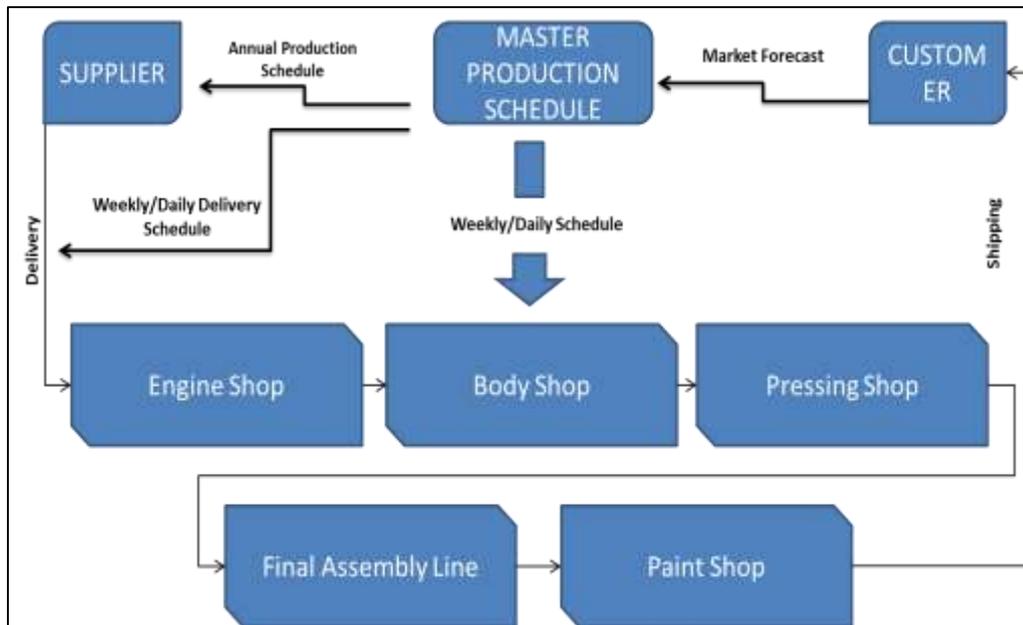


Figure 2: Supply Chain of Automobile Company

Here we can see that all the activities are guided by Master Production Schedule (MPS), it is center to everything in the supply chain. Annual production schedule, Weekly/Daily delivery schedule and Market forecast for future, all are first entered into MPS and from there data is transferred to different department in the supply chain.

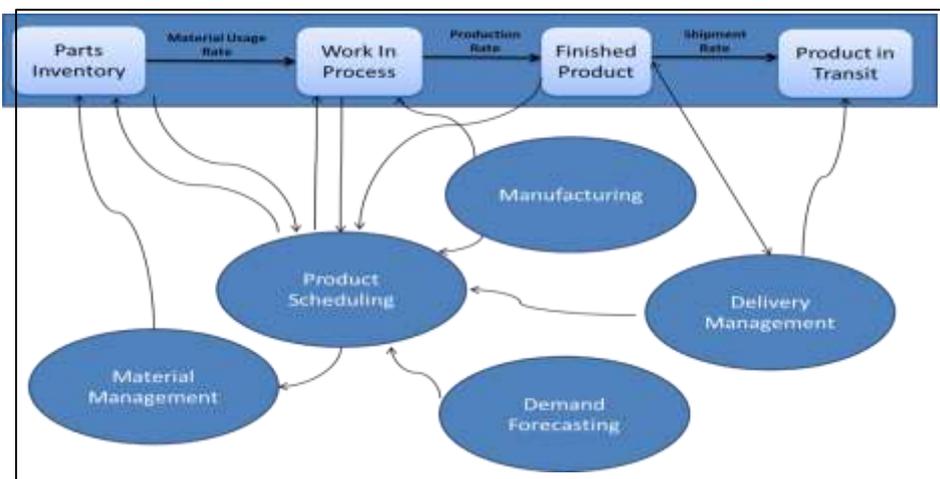


Figure 3: Assembly Line of Automobile Company

The diagram above shows the assembly line of an automobile company and various tools used in the supply chain. Different processes as used in the supply chain help a firm to be agile and respond quickly to changes.

Some of the qualities of Company A which lays emphasis on efficient supply chain are make to stock or standardized products, low capacity cushion, low inventory investment, short lead time with low cost processes with consistent quality and on time delivery, while for responsive supply chain they include assemble to order with emphasis on product variety operational strategy, high capacity cushion, just as needed inventory to enable fast delivery time, shortened lead time, customization, variety, and flexibility.

4.1. Agility metrics

Agile enterprises require a number of distinguishing capabilities or “fitness” to deal with the change, uncertainty and unpredictability within their business environment. These capabilities consist of four principle elements (Giachetti et al., 2003):

- **Responsiveness:** which is the ability to identify changes and respond quickly to them, reactively or proactively, and recover from them
- **Competency:** which is the ability to efficiently and effectively reach enterprises’ aims and goals
- **Flexibility/adaptability:** which is the ability to process different processes and achieve different goals with the same facilities
- **Quickness/speed:** which is the ability to carry out activity in the shortest possible time

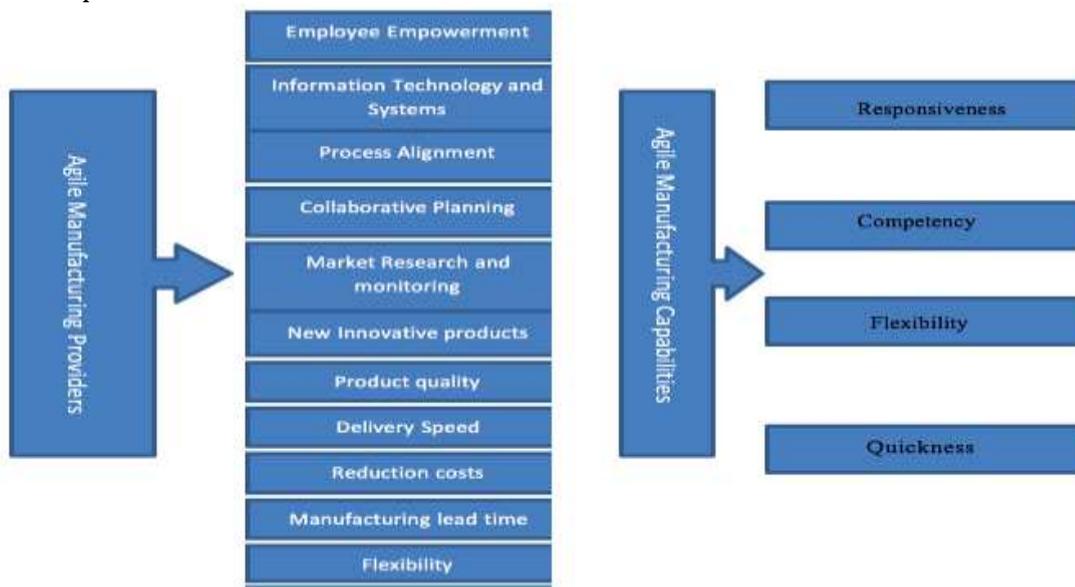


Figure : 4 Agile manufacturing providers and capabilities.

Furthermore, underpinning these four principles is a methodology to integrate them into a coordinated, interdependent system, and to translate them into strategic competitive capabilities (Sharp et al., 1999). These must be taken into account if an organization is to carry out agile enterprise. Following are some of the agility attributes which have been taken from different research papers:

Variables	Sub-variables	Citations
Employee Empowerment	Education and learning	Breu et al., (2001); Gunasekaran et al.,(2008)
	Innovation and creation	
	People flexibility	
Information Technology and Systems	Skills in IT(information technology)	Agarwal et al., (2007); Gunasekaran et al.,(2008); Swafford et al., (2008)
	RFID (Radio frequency identification)	
	Exchange of information	
Process Alignment	Co-managed inventory	Christopher,(2000);Braunscheidel,(2005); Agarwal et al., (2007)
	Collaborative product design	
	Synchronous supply	
Collaborative Planning	Leverage partners' Capabilities	Christopher, (2000); Agarwal et al.,(2007);Gunasekaran, et al.,(2008)
	Focus on core competencies	
	Act as network orchestrator	
Market Sensitive	Customer orientation	Christopher, (2000); Agarwal et al., (2007); Lin et al., (2006);
	Monthly feedback	
	Market behaviors	
New innovative products	Fast introduction of new Products	Swafford, (2003); Braunscheidel, (2005);Baramichai,(2007);Agarwal et al., (2007)
	Technological innovation	
Product Quality	Approved quality	Agarwal et al., (2007)
	Performance quality	
Delivery speed	Timeliness of delivery	Sharifi and Zhang, (1999); Agarwal et al., (2007); Yeung, (2008)
	Delivery reliability	
Reduction Costs	Penalty cost	Patil et al., (2014); Agarwal et al., (2007);
	Inventory cost	
Manufacturing lead time	Increase production capacity	Sharifi and Zhang, (1999); Swafford et al., (2006); Agarwal et al., (2007)
	Reduce setup time	
Flexibility	Supply flexibility	Swafford, (2003); Braunscheidel, (2005); Lin et al., (2006);
	Manufacture flexibility	
Environmental Pressure	Political factor	Sharifi and Zhang, (1999); Braunscheidel, (2005);
	Economic factors	
	Social factors	

Table 1: Agility attributes for Automobile Industry

4.2 RESULTS OF ANALYSIS

T-test to conduct Gap-analysis

Result of the first questionnaire for calculating the gap analysis between the current and expectation level of agility in the organization is given below in the table. Relevant agility attributes short listed by domain experts in auto supply chain were rated further by SC professionals (employees) based on their current applicability and adoption in both company A and B. These attributes were rated on a 7-point scale with for 1 least and 7 for maximum level.

We can see that almost every agility factors requires some improvement; it also depends on the importance which they play in the supply chain. Some agility factors play bigger role, hence they require more focus and attention from organization. We can see that both Company A and Company B lack in Innovation & Creation and New Product launch.

Average of all the ratings was taken for 18 agility attributes given by employees (supply chain professionals)

S. No.	Agile Attributes	Current	Expectation	Difference
1	Education & Learning	4.69	6.03	-1.34
2	Innovation & creation	3.87	5.66	-1.79
3	Skills in IT	4.03	5.61	-1.58
4	RFID	3.43	5.03	-1.6
5	Exchange of Information	4.21	5.45	-1.24
6	Co-Managed inventory with vendor	4.46	5.87	-1.41
7	Collaborative product design	4.08	5.69	-1.61
8	Synchronous supply	4.28	5.62	-1.34
9	Customer orientation	4.56	5.9	-1.34
10	Monthly feedback	4.05	5.62	-1.57
11	New Product Launch	4	5.89	-1.89
12	Technological innovation	3.84	5.39	-1.55
13	Production capacity increase	4.72	6.03	-1.31
14	Reducing set up time	4.13	5.56	-1.43
15	Timeliness of delivery	4.46	5.97	-1.51
16	Delivery reliability	4.23	5.67	-1.44
17	Supply flexibility	4.64	6	-1.36
18	Manufacturing Flexibility	4.21	5.56	-1.35

Table 2: Result of Employee Response

Paired t-test was performed on the data above to see whether a gap exist between existing level and expectation of agility attributes in the organization or not. From the table below we can see that the p value for the paired t-test is significantly lower than 0.05, at 95% confidence level hence we can say that there exists a difference between the two values and employees of both the organization

Company A and Company B feel that the current values of agility factors are not sufficient and there is scope for improvement in almost all the factors.

Paired Samples Test							
Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval		t	Df	Sig. (2- tailed)
			Lower	Upper			
	.38949	.09180	-1.60036	-1.21298	-15.322	17	.000

Table 3: Paired t-test result

Factor Analysis to rank the agility attributes

Now to rank the agility parameters according to their importance we can apply Factor analysis on the employee response regarding the agility attributes.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.871
Bartlett's Test of Sphericity	Approx. Chi-Square	631.843
	df	153.000
	Sig.	.000

Table 4: Factor analysis significance level

In the above table we can see that KMO value is 0.871 and the p value is less than 0.05, at 95% confidence level for chi-square test which shows that the correlation matrix of variables is not an identity matrix and therefore sample is adequate and factor analysis can be applied to data.

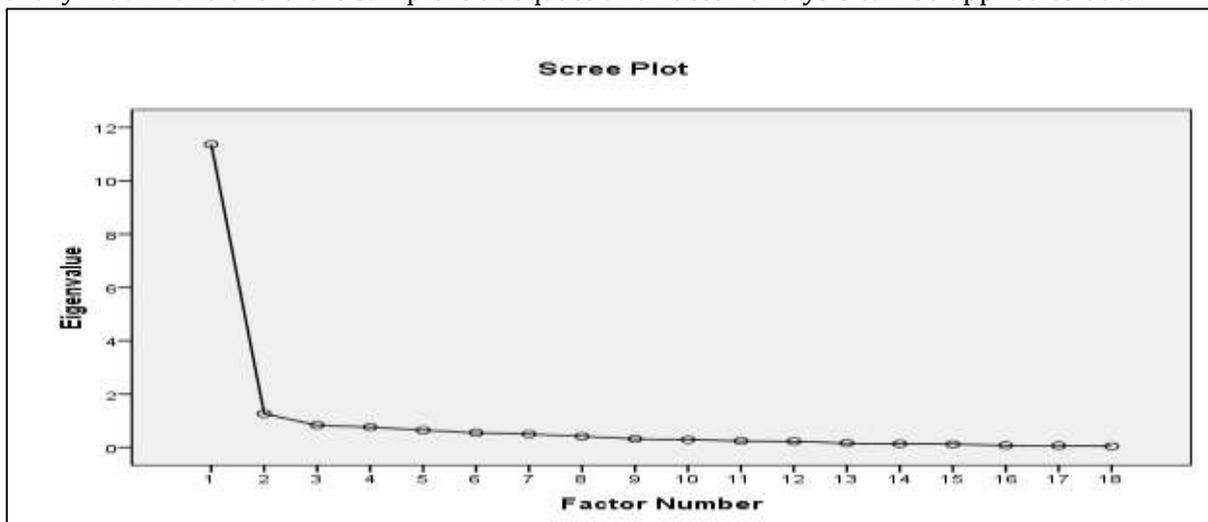


Figure 5: Screen Plot of Factor Analysis

From the Screen plot we can say that 3 factors can be extracted so we specify 3 factors. We can see from total variance explained (Table 5) that 69.9% of variance is explained by 3 factors for each of

these factors a label was given on the basis of similarity of attributes and the functions they perform in the supply chain.

Table 5 Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	11.369	63.163	63.163	11.085	61.581	61.581	4.811	26.730	26.730
2	1.264	7.022	70.184	.950	5.276	66.857	4.474	24.858	51.588
3	.832	4.620	74.804	.542	3.013	69.870	3.291	18.282	69.870
4	.760	4.223	79.027						
5	.647	3.596	82.623						
6	.548	3.047	85.670						
7	.501	2.786	88.456						
8	.418	2.323	90.779						
9	.319	1.773	92.551						
10	.289	1.606	94.158						
11	.241	1.338	95.495						
12	.226	1.257	96.753						
13	.157	.870	97.623						
14	.133	.737	98.360						
15	.118	.655	99.015						
16	.074	.411	99.426						
17	.063	.348	99.774						
18	.041	.226	100.000						

Extraction Method: Principal Axis Factoring.

Eigen values of more than one were selected for factor extraction. Principal component analysis with varimax rotation was used to get the final factor loadings of variables. Values of 0.5 more were considered as shown in table 6.

Factor 1: Dynamic responsiveness : Delivery Reliability, Supply flexibility, reducing set up time, Collaborative Product Design, Production Capacity Increase, Timeliness of delivery, manufacturing flexibility.

Factor 2: Customer centric mobilization of Core Competencies: Technological Innovation, Education and Learning, Innovation and Creation, skills in IT, Exchange of information, customer orientation, monthly feedback.

Factor 3: Integration & Information Collaboration: RFID, Co-managed inventory with vendor , Synchronous supply, New Product launch

Table 6: Rotated Component Matrix^a

	Component		
	1	2	3
Education & Learning		.654	
Innovation & creation	.522	.668	
Skills in IT		.625	
RFID		.529	.643
Exchange of Information	.505	.668	
Co-Managed inventory with vendor	.512		.580
Collaborative product design	.602		
Synchronous supply	.506		.735
Customer orientation		.732	
Monthly feedback		.667	
New Product Launch		.518	.706
Technological innovation		.860	
Production Capacity increase	.788		
Reducing set up time	.772		
Delivery reliability	.785		
Supply flexibility	.600		
Timeliness of delivery	.708		
Manufacturing flexibility	.720	.506	

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.^a

a. Rotation converged in 11 iterations.

Hence from the above we can say that finally 3 factors are important for an organization from agility point of view , Dynamic responsiveness, Customer centric Mobilization of Core competencies, and Integration & Information Collaboration.

Customer response on Agility variables taken from customer perspective

Below is the measure of perception of customers for both Company A and Company B for some attributes which directly or indirectly are influenced by agility in supply chain, taken on a seven point scale(1 for the least and 7 for the highest agility) from customers point of view.

Customer perception	Company A	Company B	Difference
Changes to customer demand & Preferences	5.32	3.44	1.88
Continuous Improvement	5.00	3.33	1.67
Learning Organization	5.09	3.58	1.51
Quality Vehicles	5.55	3.48	2.07
First Time Right Design	5.09	3.54	1.55
Flexible Product Model	5.45	3.48	1.97
Work Force Flexibility	4.86	3.33	1.53
Flexible Business Strategy	5.14	3.59	1.55
Responding to Competition	5.27	3.44	1.83
Product/Service delivery time	5.45	3.70	1.75

Table 7: Result of Customer Response

We can see from the above table that for every agility attribute customer thinks that

Company A is way ahead of Company B, and this is also evident from the fact that shares of Company B are declining month and month. The gap for some factors such as changing to customer demand & preferences, quality vehicles and flexible product model is highest which highlights the fact that Company B is not able to launch new vehicles in the recent years and is falling behind its competitors.

Mapping of Customer Response with Employee Response

Now to check the influence of agility factors on the customers the customer response variables in table were reduced to two dimensions by Exploratory Factor analysis conducted separately for Company A and B. KMO for EFA in each case was .670 and .680 respectively for A and B. Two factors were extracted for each case company from customer response variables with a total variance explained being 58.24% and 59.37% respectively for company A and B.

Table: 8 Company A :Rotated Component

Matrix^a

	Component	
	1	2
Learning Organization	.074	.906
Quality Vehicles	.480	.078
First Time Right Design	.128	.713
Flexible Product Model	.800	.144
Work Force Flexibility	.928	-.001
Flexible Business Strategy	.700	.154
Change to customer demand & Preferences	.030	.797
Continuous Improvement	.296	.342
Responding to Competition	.842	.082
Product/Service delivery time	.788	.158

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.^a

a. Rotation converged in 3 iterations.

Table: 9 Company B :Rotated Component

Matrix^a

	Component	
	1	2
Change to customer demand & Preferences	.627	-.193
Continuous Improvement	-.184	.895
Learning Organization	.363	.835
Quality Vehicles	.670	.074
First Time Right Design	.464	.454
Flexible Product Model	.752	.297
Work Force Flexibility	.761	.170
Flexible Business Strategy	.826	.165
Responding to Competition	.710	.209
Product/Service delivery time	.669	.043

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.^a

a. Rotation converged in 3 iterations.

Two factors extracted for Customer perception for company A were given following label:

Factor 1A :Business and product Agility

Factor2A :Progressive market orientation

Similarly two factors extracted for Customer perception for Company B were named as:

Factor1B :Business and product agility

Factor 2B :Continuous learning

Four Multiple regression models were developed separately for each of the Factors extracted for customer perception above for Company A and B keeping them as dependent variables and the 3 factors extracted for agility of automotive supply chains as independent variables. Agility scores for all three factors A1 (Dynamic responsiveness), A2 (Customer Centric mobilization for core competencies), A3 (Integration & Information Collaboration) were calculated and regressed on Customer perception Factors 1A,2A,1B,2B . Results and regression statistics are summarized in table below.

Model	Dependent Variable	Independent Variables	R ²	F	Significance level
Model 1	F1A(Business and product agility)	A1 (Dynamic responsiveness) A2 (Customer Centric mobilization for core competencies) A3 (Integration & Information Collaboration)	.451	4.655	.015*
Model 2	F2A(Progressive market orientation)	A1 (Dynamic responsiveness) A2 (Customer Centric mobilization for core competencies) A3 (Integration & Information Collaboration)	.308	2.517	.093**

Table 10: Mapping for Company A customer perception on agility factors

*Found significant at $\alpha = .05$

**Found significant at $\alpha = .1(10\%)$

Model	Dependent Variable	Independent Variable	R ²	F	Significance level
Model 1	F3B (Business and product agility)	A1 (Dynamic responsiveness) A2 (Customer Centric mobilization for core competencies) A3 (Integration & Information Collaboration)	.392	4.301	.017*
Model 2	F4B (Continuous learning)	A1 (Dynamic responsiveness) A2 (Customer Centric mobilization for core competencies) A3 (Integration & Information Collaboration)	.092	.674	.578

Table 11: Mapping for Company B customer response on Agility factors

*Found significant at $\alpha = .05$

We can see that for company B as compared to company A the mapping of agility factors on customer response factors is not that great as R² for F1B as well as F2B is lower than F1A and F2A. Model 1 explained 45.1% of variance in F1A due to agility factors, and was found to be significant with p value of F statistic at .015. Partial regression coefficient of A₂ and A₃ were found to be significant. Model 2 explained 30.8% of variance in F2A due to agility factors and overall model was found to be significant at 90% confidence level. Partial regression coefficient of A₁ was significant. Model 3 explained 39.2%

Variance in F1B due to agility factors and was found to be significant with a p Value of .017. Partial regression coefficient of A1 was found to be significant. Model 4 explained only 9.2% Variance for F2 B (< 25%) due to agility and overall model was not significant with p value of F statistic at 0.578.

Conclusions

In the employee response it was seen that there is still a gap between the current level and expected level of agility in both the companies, Company A is known for its supply chain still there is some gap and the two areas where both the companies lacked are Innovation & Creation and New Product launch. Hence it can be inferred that Indian automobile companies need to invest in R&D to stay ahead of their foreign counterpart in terms of launching new products and come out with innovative car launches in the future.

Similarly, when customer perception was asked regarding both the companies it was seen that Company B was way behind Company A. For factors such as changing to customer demand & preferences, quality vehicles and flexible product model the gap was highest. Hence it can be inferred that the reason behind the declining share of Company B is lack of new product launches in past 2 years and vehicles not standing to other competitor's vehicle in terms of quality and flexibility.

For Company A, the result of perception of agility from customer point of view was better linked with the agility factors from organization point of view. For example, factor of Business and product agility for company A were positively associated with customer centric mobilization of core competencies and Integration and Information collaboration with higher R square value. Whereas for company B it was linked with dynamic responsiveness positively but with lower R square value. Similarly for company A we see that progressive market orientation is positively linked with dynamic responsiveness. Hence it can be said that Company A is more responsive than Company B in terms of launching new vehicles, developing products which are more superior in terms of quality and responding to competition.

Study shows that among the major Indian Automotive market players Company A displays a better customer perception and taken as a proxy for operational performance both customer related factors show a positive association with agility factors of supply chain, whereas for Company B one customer factor is weakly associated with only one of agile supply chain factors.

Above analysis shows that customers perceive company A being associated on the higher side on agility as compared to company B which reflects in market share capturing around 47% of Indian pie of automotive market with a meagre contribution of less than 3.5% for company B in the current year. Company A incremental volumes are more than what other companies sell in a year. The market performance of the Companies reinforces the fact that for effective operational performance maintaining agility in supply chains is an imperative to sustain the market positioning.

Acknowledgement: This paper is based on the thesis to be submitted by the corresponding author for PhD degree awarded by the Jamia Millia Islamia University, New Delhi.

Bibliography

1. Agarwal, A., Shankar, R. and Tiwari, M.K., 2007. Modeling agility of supply chain. *Industrial marketing management*, 36(4), pp.443-457.
2. Baramichai, M., 2007. *Supplier partnership establishment under uncertainties for agile organizations*. LEHIGH UNIVERSITY.
3. Blome, C., Schoenherr, T. and Kaesser, M., 2013. Ambidextrous governance in supply chains: The impact on innovation and cost performance. *Journal of Supply Chain Management*, 49(4), pp.59-80.
4. Blome, C., Schoenherr, T. and Rexhausen, D., 2013. Antecedents and enablers of supply chain agility and its effect on performance: a dynamic capabilities perspective. *International Journal of Production Research*, 51(4), pp.1295-1318.
5. Braunscheidel, M.J., 2005. *Antecedents of supply chain agility: an empirical investigation*.
6. Brown, S. and Bessant, J., 2003. The manufacturing strategy-capabilities links in mass customization and agile manufacturing-an exploratory study. *International Journal of Operations & Production Management*, 23(7), pp.707-730.
7. Breu, K., Hemingway, C.J., Strathern, M. and Bridger, D., 2002. Workforce agility: the new employee strategy for the knowledge economy. *Journal of Information Technology*, 17(1), pp.21-31.
8. Christopher, M., 2000. The agile supply chain: competing in volatile markets. *Industrial marketing management*, 29(1), pp.37-44.
9. Fliedner, G. and Vokurka, R.J., 1997. Agility: competitive weapon of the 1990s and beyond?. *Production and Inventory Management Journal*, 38(3), p.19.
10. Giachetti, R.E., Martinez, L.D., Sáenz, O.A. and Chen, C.S., 2003. Analysis of the structural measures of flexibility and agility using a measurement theoretical framework. *International journal of production economics*, 86(1), pp.47-62.
11. Goldman, S., Nagel, R. and Preiss, K. (1995), *Agile Competitors and Virtual Organizations*, van Nostrand Reinhold, New York, NY
12. Gunasekaran, A., 1998. Agile manufacturing: enablers and an implementation framework. *International Journal of Production Research*, 36(5), pp.1223-1247.
13. Gunasekaran, A., Lai, K.H. and Cheng, T.E., 2008. Responsive supply chain: a competitive strategy in a networked economy. *Omega*, 36(4), pp.549-564.
14. Prince, J. and Kay, J.M., 2003. Combining lean and agile characteristics: creation of virtual groups by enhanced production flow analysis. *International Journal of production economics*, 85(3), pp.305-318.
15. Lin, C.T., Chiu, H. and Chu, P.Y., 2006. Agility index in the supply chain. *International Journal of Production Economics*, 100(2), pp.285-299.
16. Mason-Jones, R., Naylor, B. and Towill, D.R., 2000. Engineering the leagile supply chain. *International Journal of Agile Management Systems*, 2(1), pp.54-61.
17. Naylor, J.B., Naim, M.M. and Berry, D., 1999. Leagility: integrating the lean and agile manufacturing paradigms in the total supply chain. *International Journal of production economics*, 62(1), pp.107-118.
18. Rimiené, K., 2011. SUPPLY CHAIN AGILITY CONCEPT EVOLUTION (1990-2010). *Economics & Management*, 16.

19. Sharifi, H. and Zhang, Z., 2001. Agile manufacturing in practice-Application of a methodology. *International Journal of Operations & Production Management*, 21(5/6), pp.772-794.
20. Sharp, J.M., Irani, Z. and Desai, S., 1999. Working towards agile manufacturing in the UK industry. *International Journal of production economics*, 62(1), pp.155-169.
21. Shaw*, N.E., Burgess, T.F., De Mattos, C. and Stec, L.Z., 2005. Supply chain agility: the influence of industry culture on asset capabilities within capital intensive industries. *International Journal of Production Research*, 43(16), pp.3497-3516.
22. Swafford, P.M., Ghosh, S. and Murthy, N., 2006. The antecedents of supply chain agility of a firm: scale development and model testing. *Journal of Operations Management*, 24(2), pp.170-188.
23. Swafford, P.M., Ghosh, S. and Murthy, N., 2008. Achieving supply chain agility through IT integration and flexibility. *International Journal of Production Economics*, 116(2), pp.288-297.
24. Vinodh, S., Patil, A., Sai Balagi, T.S. and Sundara Natarajan, P., 2014. AHP-PROMETHEE integrated approach for agile concept selection. *International Journal of Services and Operations Management*, 18(4), pp.449-467.
25. Wu, Y. (2005). INFORMATION SYSTEMS INTEGRATION MECHANISMS WITHIN SUPPLY CHAIN AGILITY IN THE CHINESE AUTOMOTIVE INDUSTRY. *University of Warwick*, 11.
26. Yusuf, Y.Y., Sarhadi, M. and Gunasekaran, A., 1999. Agile manufacturing:: The drivers, concepts and attributes. *International Journal of production economics*, 62(1), pp.33-43.
27. Zhao, X., Huo, B., Selen, W. and Yeung, J.H.Y., 2011. The impact of internal integration and relationship commitment on external integration. *Journal of operations management*, 29(1), pp.17-32.