

# Supply Chain Practices in the Context of an Emerging Economy

By

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Master of Science, Mechanical Engineering, 2000  
Rensselaer Polytechnic Institute

SUBMITTED TO THE SYSTEM DESIGN AND MANAGEMENT PROGRAM IN PARTIAL  
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**MASTER OF SCIENCE IN ENGINEERING AND MANAGEMENT**

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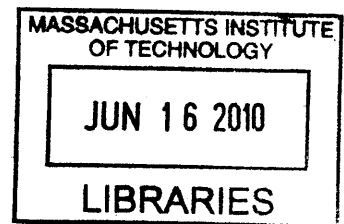
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## **ABSTRACT**

The emergence of the BRIC economies of Brazil, Russia, India and China as a formidable economic powerhouse is turning into a reality. The center of the world's economic gravity is slowly shifting towards these emerging economies. As per research performed by Goldman Sacs<sup>1</sup> the BRIC economies could become the four most dominant economies by 2050. As per their study China and India would become the dominant supplier of manufactured goods and services while Brazil and Russia would dominate in supply of raw materials. The BRIC economy today makes up about 25% of the land mass and has 40% of the world's population<sup>2</sup>.

As multinationals scramble to tap into these growing emerging markets, they have begun to acknowledge that supply chain management is an essential ingredient of a successful business strategy. Success stories of Wal-Mart, Dell and Toyota have brought in the realization that to compete and win in the market place a winning supply chain strategy is a must. This has resulted in corporations trying to benchmark their supply chain strategies against this best in class strategies. However, this kind of comparison does not always work since there are a multitude of differences between companies, industries and countries.

The existing practice of developing products and services for the developed economy and then tailoring these products for other economies around the world will not suffice anymore. Companies must now learn how to develop products for countries like India, sometimes from scratch and then tailor them for other geographies. To compete in this space of rapid economic growth firms need to analyze, design and optimize their product portfolio for emerging markets.

To develop these “no frills” products for emerging economies, the supply chain designed for developed countries is not adequate to meet the unique challenges of an emerging economy with its underdeveloped infrastructure, technology and human capital resources. To be competitive corporations should re-evaluate their supply chain strategies to customize it for emerging market

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<sup>1</sup> Ask the expert: BRICs and investor strategy from the Financial Times, Monday 2006-11-06

<sup>2</sup> <http://bricnation.com/?p=24>

conditions and in many cases build it from scratch. This thesis examines the unique characteristics of supply chain by studying successful supply chain strategies employed by Indian firms and proposes frameworks and strategies to help companies innovate in their supply chain design.

This thesis develops a generic framework to design effective supply chains for emerging economies by looking at five key elements or “Five Pillars” of supply chain. The five key elements were thoroughly evaluated to understand the key challenges in each pillar and develop effective “Customized Practices “in the context of an emerging economy. The five pillars which were evaluated were Demand and Supply Planning, Sourcing and Procurement, Operations, Transportation, Warehousing and distribution. The framework takes a holistic approach by aligning business strategies with operating principles to develop the customized practices. The framework was then validated by performing a deep dive analysis of the successful supply chain case of the Tata Nano small car. Analyzing the Tata Nano supply chain through the lens of this framework provided key insights into the supply chain challenges faced by firms operating in an emerging economy and the unique customized practices used by these firms to operate efficiently. Use of this framework will bring awareness of the supply chain challenges in emerging economies and the customized practices firms use to help guide organizations in designing and operating their supply chains.

Thesis Supervisor: Dr. Edgar Blanco

Title: Research Director and Executive Director, SCALE Latin-American MIT Center for Transportation and Logistics



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# 1. Introduction

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## **1.1. Motivation**

Increased globalization and shift of market dynamics has placed emerging economies like India and China in an exponential growth trajectory. The harness and profit from this enormous growth potential of these emerging economies it is essential for multinationals to reevaluate and redesign their supply chains to be more nimble and efficient in a different set of market dynamics. The motivation for this thesis is to take a deep dive into the drivers of efficient supply chain design in the context of emerging economies. Developing products for these emerging markets needs not only a redesign of the product portfolio but also a complete redesign of the supply chain network to leverage the unique characteristics of the emerging economies. Supply chain management is one of the fundamental issues facing today's organization. Effectively managing supply chains is critical to the success of a business. Thus it is worth exploring the structure and internal dynamics of emerging country supply chains to device effective policies.

A secondary motivation is to make a connection between the development and launch of the Model T and the Tata Nano. The Model T brought in a wave of innovation in the automotive industry including the creation of the assembly line and the production system. This led to bring in the personal automobile to mainstream consumers and helped satisfy the desire of the common man to own a car. The Tata Nano similarly brings in a new wave of innovation which aims to allow the common man in the emerging countries to own a car. This thesis will help us reflect on the process and draw parallels between the two products.



## **1.2. Objectives**

The objective of the thesis is to perform a thorough analysis of the supply chain of an emerging economy and understand the factors that contribute to its competitive advantage. This analysis will include evaluation of it's:

- Business Strategy
  - Operating Model
  - Supply Chain Strategy
  - Customized Practices
- Understand the design and structure of the Tata Nano supply chain
  - Understand customized supply chain practices used by Indian auto industry and how they can be used by global OEM's and vice versa
  - Provide a framework for key factors which influence supply chain strategy for emerging economies

## **1.3. Methodology**

The thesis follows a case study methodology. Since the objective is to understand successful strategies a case study methodology was adopted. A thorough literature review was done to develop a framework for effective supply chain management. This framework was then customized to take into account the unique characteristics of the supply chain of an emerging economy. The framework was then validated with data from various successful supply chain cases in an emerging economy. A more thorough case evaluation was also performed to validate the framework. This thesis is based on the following source of information:

- Online information available on the MIT network, which includes
- Face to face interaction with Professors, research specialists and students
- Data and information on the internet
- Existing knowledge and industry experience in supply chain
- Scientific journals, books and literature review

## 2. Background

---

*“Great firms will fight the war for dominance in the marketplace not against individual competitors in their field but fortified by alliances with wholesalers, manufacturers, and suppliers all along the supply chain. In essence, competitive dominance will be achieved by an entire supply chain, with battles fought supply chain versus supply chain” - Roger Blackman*

*“As the economy changes, as competition becomes more global, it’s no longer company vs. company but supply chain vs. supply chain” - Harold Sirkin, VP Boston Consulting Group*

The advent of the modern automotive supply chain can be traced back to the era of Henry Ford and the personal automobile, when he started on his journey to build a car for the common man. Launched in Oct 1, 1908, it changed the landscape of the American society forever. Ford embarked on a grand strategy for building automobile for the mass market with his vision as stated below:

*“I will build a motor car for the great multitude. It will be large enough for the family but small enough for the individual to run and care for. It will be constructed of the best materials, by the best men to be hired, after the simplest design that modern engineering can devise. But it will be so low in price that no man making a good salary will be unable to own one – and enjoy with his family the blessings of hours of pleasure in God’s great open spaces”- Henry Ford, My Life and Work – Oct, 1908*

Since the launch of the Model T the personal automobile industry has expanded in leaps and bounds, which brought in an exponential growth trajectory for automobile technology and subsequently a high degree of maturity of supply chain design to support the burgeoning needs of the industry. However, this expansion was mostly relegated to the developed western economies and Japan which had the means and wherewithal to be able to fund and devise complex technology and supply systems.

And exactly 100 years later after Henry Ford envisioned his dream, Ratan Tata the scion of India's largest integrated vehicle manufacturer, echoed similar observations about the need for an affordable personal mass transportation for the common man.....

*"Today's story started some years ago when I observed families riding on two wheelers, the father driving a scooter, his young kid standing in front of him, his wife sitting behind him holding a baby and I asked myself whether one could conceive of a safe, affordable, all weather form of transport for such a family. A vehicle that could be affordable and low cost enough to be within everyone's reach, a people's car, built to meet all safety standards, designed to meet or exceed emission norms and be low in pollution and high in fuel efficiency. This then was the dream we set ourselves to achieve"* - Excerpts from Ratan Tata's speech at the Nano unveiling ceremony – Oct, 2008

The race to build cheap cars which the average consumer of an emerging economy can afford will dramatically change the automotive landscape similar to what the Ford Model T did a century ago. With demand for expensive mass-market cars in the developed economies of US, Japan and EU drying up, global automakers are eyeing the emerging markets for growth opportunities. *"The main weakness of today's global automakers is that they are incapable of delivering a car that fulfills basic needs at a very low price,"* says Carlos Ghosn Chief Executive of Renault-Nissan. *"The people who have these skills are in India and China."*

As the competitive landscape shifts from individual companies to entire supply chains it is imperative for organizations to have a better understanding of their supply chain management and have a clear roadmap for supply chain alignment.

# 3. Literature Review

## 3.1. Emergence of BRIC economies

Emerging markets are going through a phase of rapid transformation and becoming centers of wealth creation. Projections by Goldman Sachs Global Economics Paper No:99 show that in 40 years, the BRICs economies together could be larger than the G6 (US, Japan, UK, Germany, France and Italy). By 2025 they could account for over half the size of the G6. Currently they are worth less than 15%. Of the current G6, only the US and Japan may be among the six largest economies in US dollar terms in 2050.<sup>3</sup>

The chart below shows the GDP projections based on demographic trends, capital expenditure and productivity growth. It gives a snapshot of how the world economy will look in the coming decades.

**GDP growth projection (Billion USD) of BRIC and G6 nations**

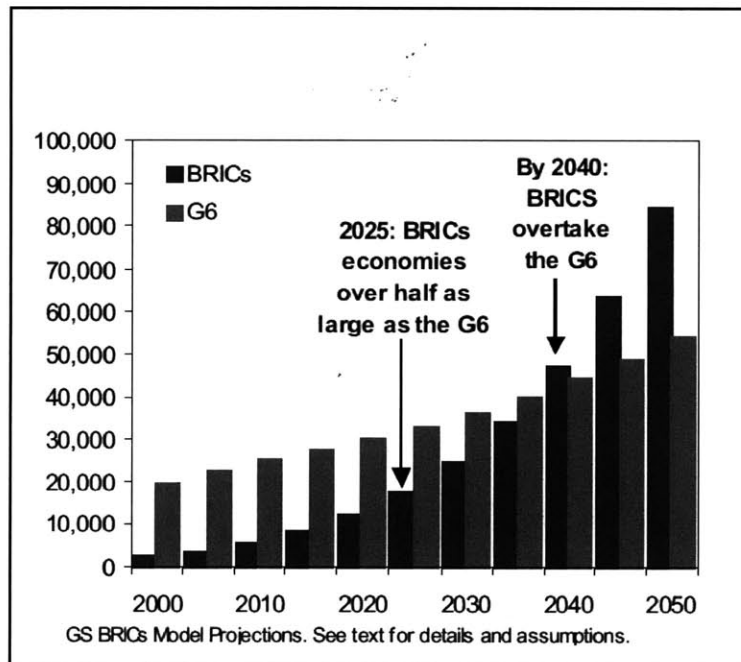


Figure 3-1, Source: Goldman Sachs Global economics paper No: 99

<sup>3</sup> <http://www2.goldmansachs.com/ideas/brics/book/99-dreaming.pdf>

As the advanced economies of today continue to shrink with respect to the overall global economy, the spending power would shift to emerging nations and BRICs in particular<sup>4</sup>. This will lead to higher consumption as BRICs middle-class consumers catch up with their counterparts in richer countries. The chart below shows the projected rise of per capita income for the BRIC economies.

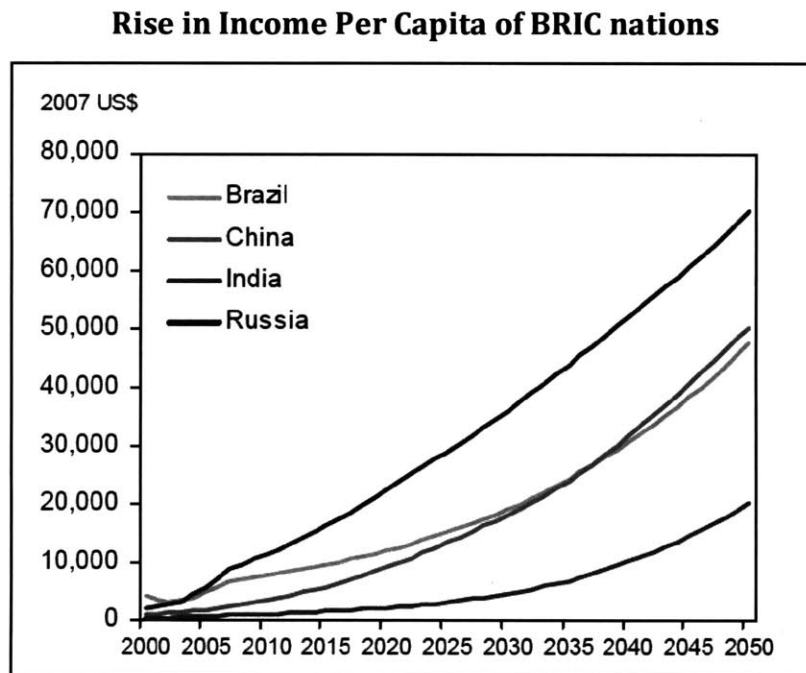


Figure 3-2, Source: GS global ECS research

The rise in per capita income would spur demand for goods in these economies. The penetration of goods is currently low as shown in chart below. As seen from the chart the penetration of automobile is currently very low and India and China have the least penetration of automotives. This offers global automakers tremendous potential for growth. The nature of goods being imported is shifting from low value added products like agricultural produce to high value finished goods like automobiles and TV sets. Among the BRIC's Russia and Brazil is further ahead along

<sup>4</sup> GS Global Economics Paper 170: "The Expanding Middle Class"

the consumption curve whereas China and India are the laggards. This provides a window of opportunity for global companies to invest in these markets.

### Penetration of goods in BRIC nations

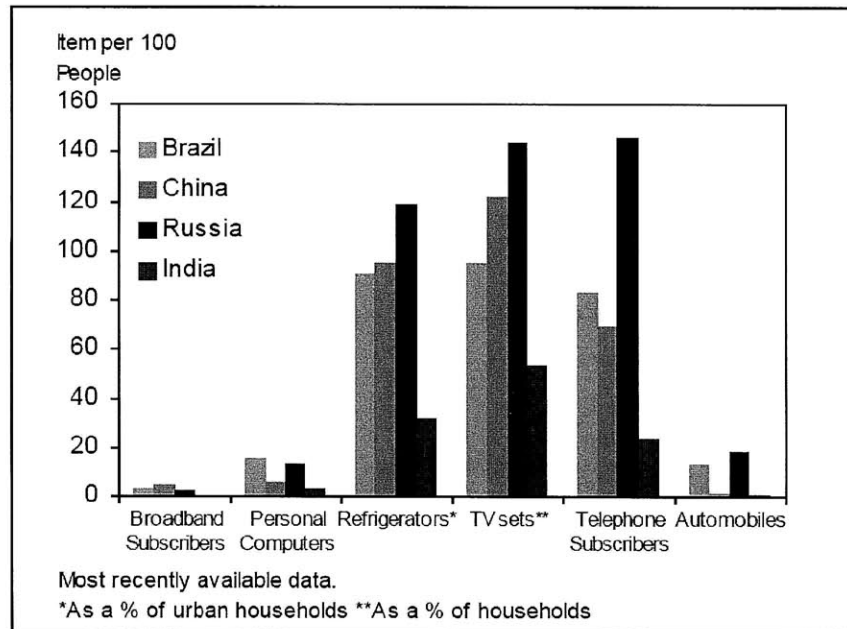


Figure 3-3: Source: National Sources, World Bank

As the influence of these countries grow it is essential that businesses are aware of the opportunities and develop strategies to capitalize on the opportunities. They should however be cognizant of the risks associated with these markets and take appropriate steps to mitigate them.

### 3.2. Economic growth in India

India is the second fastest growing economy in the world, after China. As per Angus Maddison, the noted Cambridge economic historian, on the eve of the industrial revolution (around 1770) India and China accounted for half the global output and India was the second largest economy in the world contributing more than 20% of the world output. This was followed by two centuries of relative economic stagnation. However since 1990's, the Indian government initiated a series of

economic reforms like privatization of government industries and reduction of tariffs for imported capital goods, resulting in GDP growth of 4 to 7% annually. Since 2003, India has experienced rapid growth and is among the fastest growing economies in the world as shown in the chart below.

**Historic Perspective of India Growth**

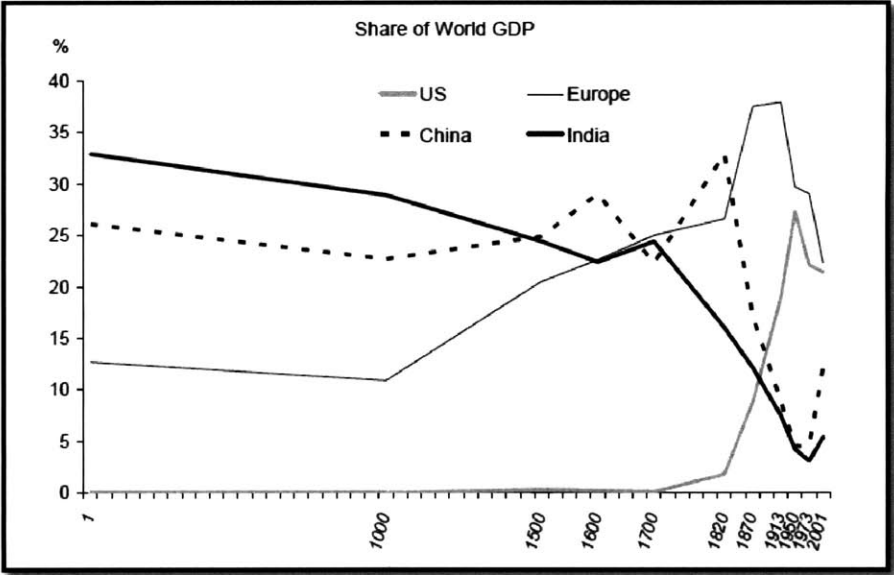


Figure 3-4, Source: Angus Maddison, The world Economy, Historical Statistics, OECD 2003

This explosive growth has been possible due to effects of increased globalization, economic reforms, growth in productivity, cheap credit, rising incomes of the middle class and a growing educated middle class that fuels consumption.

### Current Largest Global Economies

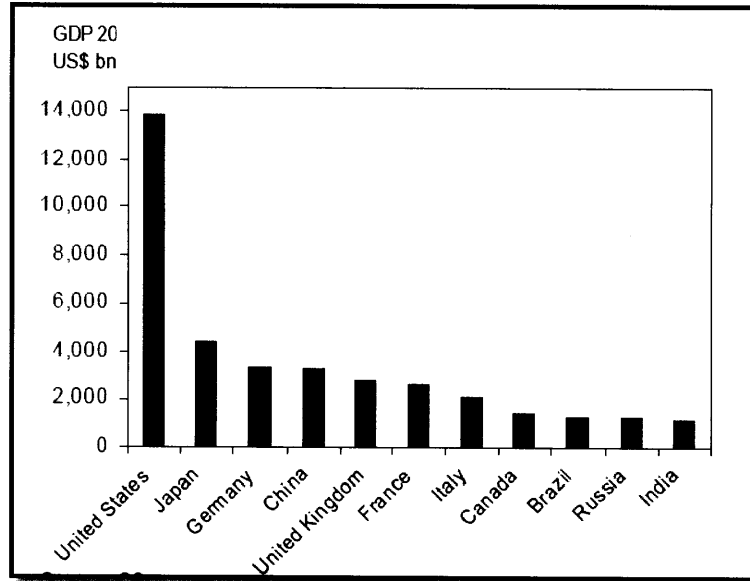


Figure 3-5, Source: GS Economics Research Issue 169

As per projections the Indian economy is expected to be the second largest, ahead of the US by 2050

### Projected Global GDP 2050

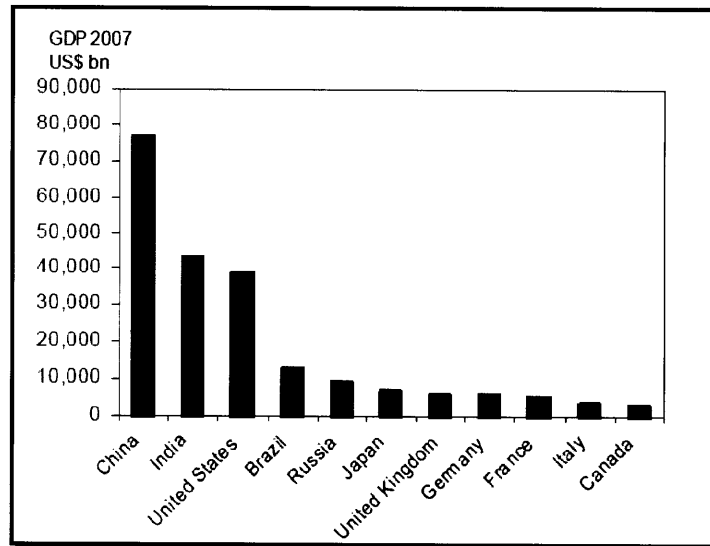


Figure 3-6, Source: GS Economics Research, Issue 169



### 3.3. Demographic Characteristics of India

India is a remarkably diverse country with 1.17 billion people, more than 1600 languages and dialects, more than 2000 ethnic groups and every major religion in the world. There is also a great diversity in education, socio-economic status and income levels. Approximately 72% of the population resides in 638,000 villages and the remaining 28% in 5100<sup>5</sup> towns and urban centers.

The median age of Indians is 25.1 yrs with the following distribution<sup>6</sup>:

**Demographic Distribution in India**

| <b>Age Group</b> | <b>Percentage of Population</b> |
|------------------|---------------------------------|
| 0 – 14 years     | 30.8%                           |
| 15 – 64 years    | 64.3%                           |
| 65+ years        | 4.9%                            |

Table: 3-1

As per Goldman Sachs economic research, India is well-positioned to reap the benefits of favorable demographics, including an ‘urbanization bonus,’ over the long term due to the continued movement of labor from rural agriculture to urban industry and services. India has 10 of the 30 fastest-growing urban areas in the world and, based on current trends, a massive 700 million people (roughly equivalent to the entire current population of Europe) will move to cities by 2050. This will have significant implications for demand for urban infrastructure, real estate, and services.

---

<sup>5</sup> Census of India: Census Data 2001

<sup>6</sup> CIA World Fact book demographic statistics

### Population Projections (Millions)

| Year     | 2000 | 2005 | 2010 | 2015 | 2020 |
|----------|------|------|------|------|------|
| Total    | 1010 | 1093 | 1175 | 1256 | 1331 |
| Under 15 | 361  | 368  | 370  | 372  | 373  |
| 15-64    | 604  | 673  | 747  | 819  | 882  |
| 65+      | 45   | 51   | 58   | 65   | 76   |

Table 3-2

Source: Based on P.N. Mari Bhatt, "Indian Demographic Scenario 2025", Institute of Economic Growth, New Delhi, Discussion Paper No. 27/2001

There is a large and growing middle class of 50 million Indians which is estimated to grow tenfold to over 500 million by 2025. They have disposable income in the range of \$4,000 to \$20,000<sup>7</sup>.

#### 3.4. Market Characteristics of India

With a population of over 1 billion, India represents a large proportion of the world's population. The Indian market can be very lucrative as it evolves into a maturing market over time, from a low consumption to a high consumption model. The consumer market in India is among the top 10 in the market with a value of 250 Billion USD (Bharadwaj et al 2005). Although it accounts for only 2% of the current world GDP, it is expected to grow to 17% of world GDP by 2050 (Engardio 2005)

India is transitioning from a developing to a developed economy and income distribution can be modeled with a pyramid structure. The Indian market can be characterized with a Bottom of Pyramid (BOP) model developed by Prof CK Prahalad. The upper income group earns greater than 20,000 USD, the middle

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<sup>7</sup> McKinsey Global Institute, Next Big Spender: India's Middle Class, Retrieved from Business Week May 19, 2007

income group earns between 2,000 to 20,000 USD and the lowest or BOP group earns less than 2,000 USD and is the largest group by population<sup>8</sup> (\*note – the numbers are adjusted for purchasing power parity). The BOP consumers are cash strapped and must therefore be accessed differently using new innovative products and services specifically designed for this market. Getting a foothold in the BOP or even the middle of the pyramid can provide any corporation with billions of new customers. The BOP market in India is worth 1.2 Trillion USD and makes up 85% of the household market. It is comprised on 924 million people of whom 78% are rural customers. The Indian rural market has been growing at 3-4% per annum, adding more than 1 million new consumers every year<sup>9</sup>.

### Bottom of Pyramid Market

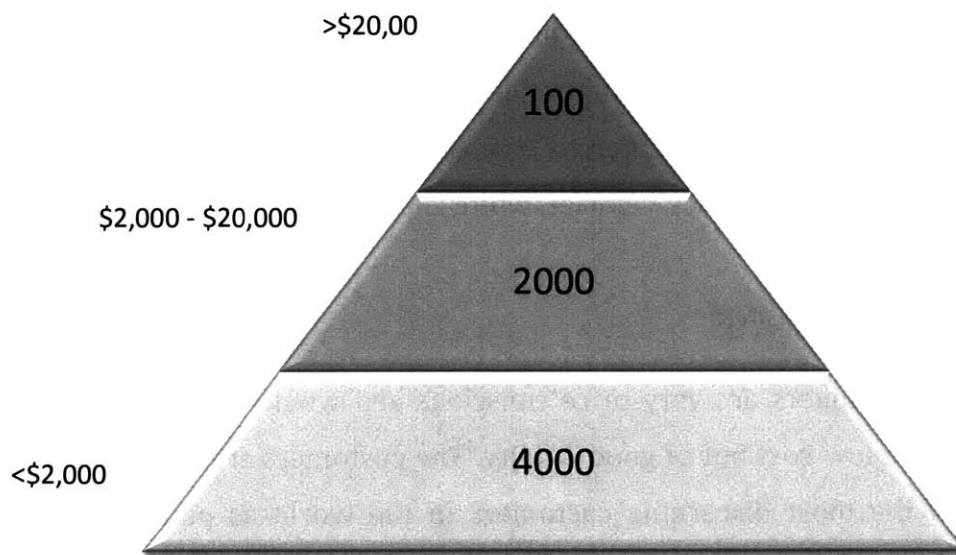


Figure 3-7, Population in Millions

Asia makes up the biggest chunk of the global BOP market with a \$3.47 trillion market, followed by Latin America (\$509 billion), Eastern Europe (\$458 billion) and Africa (\$429-billion).Sector-wise, food is the biggest BOP market (\$2.8-trillion), followed by energy (\$433 billion), housing (\$332-billion), transportation (\$179

<sup>8</sup> Managing supply Chain Operations in India, Pitfalls and Opportunities JayashankarM. Swaminathan

<sup>9</sup> IFC and World Resources Institute (WRI) study retrieved from Economic Times of India, April 28, 2007

billion)<sup>10</sup>. Many multinationals have started focusing their efforts on the BOP market which would lead to innovation for the BOP market and also for the developed world. India is a very diverse country and thus firms which develop successful supply chain for this environment can position it to be leaders in these rapid growth economies.

The Indian market is characterized by various unique characteristics as described below:

➤ *Demanding Customers*

The typical customer retains a good for a long timeframe and thus expects it to be highly durable. They demand good quality at a price they can afford. This is very different from the use and throw model adopted in most developed countries. Some expensive items are passed on from generation to generation and some are recycled in the used market. In fact there is a very flourishing used market in India for items like consumer electronics, vehicles, white goods etc.

➤ *Price Consciousness*

Indian consumers are very price conscious and would often gravitate to products which are low cost but of good quality. The customers are very value oriented and one of the most discerning customers in the world as per John Hooks, Deputy Managing Director, Giorgio Armani SpA. They demand quality good at a price they can afford. This necessitates firms to employ strategies geared towards leveraging economies of scale to design products and services which are high volume but low margin.

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<sup>10</sup> <http://www.nextbillion.net/news/indian-bop-market-stands-at-1-2-trillion>

➤ *Fragmented Market*

The market is characterized by small scale players who lack the necessary capital to invest in marketing and distribution, thereby constraining their geographical expansion. Due to lack of large players and budgetary constraints there is limited brand awareness and loyalty among consumers. This is however changing fast as big retail chains are emerging bringing brand labels and trying to establish brand loyalty.

➤ *Weak Distribution*

The distribution channels are still weak and still in its nascent stage. There is lack of modern warehousing and distribution facilities. However with the advent of modern retailing, the distribution channel is going through a transformational phase by using latest practices and technology to streamline distribution. Many global third party logistics (3PL) vendors are establishing operations in India which would help improve distribution. However, with 70% of the population residing in rural areas, with limited transportation infrastructure, it would take time to build the distribution network.

➤ *Poor Infrastructure*

India is characterized by its poor infrastructure, cold storage, and transport facilities which lead to inefficient handling of goods. The weak infrastructure poses several challenges to efficient supply chain management. The current infrastructure is a barrier to rapid development and focus. The Indian government has identified infrastructure development as a key area of focus and taking rapid steps to develop ports and highways at a pace to match consumer demand.

➤ *Underdeveloped Technology*

Technology development has progressed in a fragmented fashion in India. There are pockets of high levels of technology deployment especially in big mega cities like Bangalore; Hyderabad etc. This infrastructure was put in place primarily to support

the back-office operations of multinational corporations. The cellular communication network is also advancing in leaps and bounds helping connect millions of people every day. However, the overall technology infrastructure is still in nascent stages with very low levels of internet and communication technology penetration. Although India has a technological advantage with regards to China it still lacks the infrastructure to manage dynamic supply chain networks with interconnected assets.

➤ *Demographic Dividend*

India possesses a unique advantage which very few advanced countries possess. The demographics of India are very favorably balanced towards the younger generation which has high level of disposable income. This has been termed as the demographic dividend and India is poised to reap the benefits of a young productive population. This young population will help drive an enormous market for consumer goods in the next few decades.

➤ *Evolving Market*

India's market is evolving at a very rapid pace. This rapid growth is providing enormous opportunities for businesses. New technologies are making rapid inroads displacing traditional industries and business models. This is evidenced by rapid spread of cellular services, internet kiosks and adoption of social media by the younger generation.

### **3.5. Automotive Market of India**

The Indian automotive industry has been on a rapid growth trajectory since de-licensing of this sector in 1991. Global automakers have been flocking to India and most major auto makers have established manufacturing base in India. The auto industry has

seen average growth of 17% in the last few years and the industry turnover is estimated to be \$34 Billion.

Annual production of vehicles has gone up from 2 million in 1991 to 9.7 million in 2006. In spite of this rapid growth, the Indian auto industry is just 2.5% of global auto production and exports are a mere 0.3% of global exports.

### **Indian Vehicle Production (units/year)**

|                               | <b>2001-02</b> | <b>2002-03</b> | <b>2003-04</b> | <b>2004-05</b> | <b>2005-06</b> |
|-------------------------------|----------------|----------------|----------------|----------------|----------------|
| <b>Passenger Car</b>          | 564,052        | 608,851        | 842,437        | 960,505        | 1,045,881      |
| <b>Multi Utility Vehicles</b> | 105,667        | 114,479        | 146,103        | 249,149        | 263,032        |
| <b>Commercial Vehicles</b>    | 162,508        | 203,697        | 275,224        | 350,033        | 391,078        |
| <b>Two Wheelers</b>           | 4,271,327      | 5,076,221      | 5,624,950      | 6,526,547      | 7,600,801      |
| <b>Three Wheelers</b>         | 212,748        | 276,719        | 340,729        | 374,414        | 434,424        |
| <b>Total</b>                  | 5,316,302      | 6,279,967      | 7,229,443      | 8,460,648      | 9,735,216      |
| <b>Percentage Growth</b>      | <b>11.70%</b>  | <b>18.60%</b>  | <b>15.12%</b>  | <b>16.80%</b>  | <b>15.06%</b>  |

Table 3-3, Source: Society of Indian Automobile Manufacturers (SIAM)

Exports of auto and auto components have also seen huge increases in the range of 30% average annual growth in the last few years. Auto exports crossed \$ 2 Billion in 2006.

The auto industry in India has grown in clusters with interconnections between the clusters. The 4 main clusters are Manesar in the north, Chennai in the south,

Jamshedpur-Kolkata in the east, Pune in the west and Indore in central India. Low-cost cars are "the single most important trend in the automotive industry today," says Vikas Tibrewala, the Paris-based executive director of the Monitor Group consultancy.

### Indian Auto Exports (Number of vehicles)

|                               | 2001-02      | 2002-03       | 2003-04       | 2004-05       | 2005-06       |
|-------------------------------|--------------|---------------|---------------|---------------|---------------|
| <b>Passenger Car</b>          | 50,088       | 70,828        | 126,249       | 160,677       | 170,193       |
| <b>Multi Utility Vehicles</b> | 3,077        | 1,177         | 3,067         | 5,736         | 5,579         |
| <b>Commercial Vehicles</b>    | 11,870       | 12,255        | 17,227        | 29,949        | 40,581        |
| <b>Two Wheelers</b>           | 104,183      | 179,682       | 264,669       | 366,724       | 513,256       |
| <b>Three Wheelers</b>         | 15,462       | 43,366        | 68,138        | 66,801        | 76,885        |
| <b>Total</b>                  | 184,680      | 307,308       | 479,350       | 629,887       | 806,494       |
| <b>Percentage Growth</b>      | <b>9.74%</b> | <b>66.40%</b> | <b>55.98%</b> | <b>31.40%</b> | <b>28.03%</b> |

Table 3-4, Source: Society of Indian Automobile Manufacturers (SIAM)

The auto sector is comprised of 500 firms in the organized sector and more than 10,000 firms in the small unorganized sector. The auto component sector is the fastest growing sector. The quality of the component sector is at par with global standards as evidenced by many suppliers receiving awards like Deming, JIPM, Japan Quality Medal awards and numerous quality certifications. Majority of the exports are to the developed markets of US and Europe which have high quality standards. This indicates that the Indian auto industry is at a level of quality, productivity and capabilities to effectively integrate into the global supply chain. As per ACMA the global auto component industry is worth 1.2



Trillion USD and expected to rise to 1.7 Trillion USD by 2015. There is a general trend to drive down costs by sourcing at low cost countries. Sourcing from low cost countries is expected to go up to 375 Billion USD by 2015. Current exports from India are a small percentage of this market, but India is well positioned to leverage the off shoring trend to increase its market share of the global auto component sector.

# 4. Porters Analysis – Competitive Advantage of Emerging Economies (India)

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*“Firms, not nations, compete in international markets.” – Michael E. Porter*

## **4.1 Determinants of National Competitive Advantage in Context of Emerging Economies**

To understand what is unique in emerging economy supply chain and what gives its competitive advantage we need to analyze the four determinants of the nation’s competitive strategy.

➤ *Factor Conditions:*

Factor conditions are inputs that an industry needs to perform its operations. The inputs may be in the form of capital, labor, raw materials, favorable climate etc. “A nation will export those goods which make intensive use of the factors with which it is relatively well endowed.” What provides competitive advantage for a country like India is the availability of a large pool of knowledge workers at fraction of the cost of most developed economies. This type of competitive advantage is not inherited but created over time.

➤ *Demand Conditions*

Demand conditions are influenced by the nature of the demand for a firm’s product or services. Demand conditions may vary over time as seen by the emergence of the BRIC economies over the last decade. This is a result of the change in the nature of

the buyer needs, the growth pattern and the influence of international market on domestic demand.

➤ *Related and Supporting Industries*

The presence of a strong supply base influences the competitiveness of an industry sector. It also influences other sectors which might use its output as the source of its input. The case of the automotive sector in India is a great example. As multinationals started setting up shop, it in turn influenced the growth of auto suppliers which in turn created a positive feedback effect to make it even more attractive for multinational OEM's to increase its presence in India. Currently India serves as a global component hub to many of the large automotive manufacturers.

➤ *Firm Strategy, Structure, and Rivalry*

This could be affected by national policies and circumstances. It is determined by how firms are created, organized and managed. The more the number of firms the more is the rivalry and thus more intense is the competitive pressure. Before the Indian economy was liberalized, there was hardly any competition almost of the industries were state run. However with the opening of the Indian economy in 1991, the number of competitors vastly increased leading to creation of world class firms and supply bases.

➤ *The Role of Chance*

Chance could be a determining factor in creating or eliminating competitive advantage. Some countries are prone to natural disasters thus causing an extra burden on the economy which in turn disincentives firms to make investments in growth. They are beyond the control of the nation's government and could create discontinuities in competitive positions.

➤ *The Role of Government*

The role of government can significantly influence the competitive advantage of nations. The influence can be negative or positive as experienced by India after independence. The country adopted a socialist structure immediately following independence which stagnated growth. However following liberalization of the economy by the government, the country has witness a rapid phase of growth and capital infusion from overseas.

**The Determinants of National Advantage**

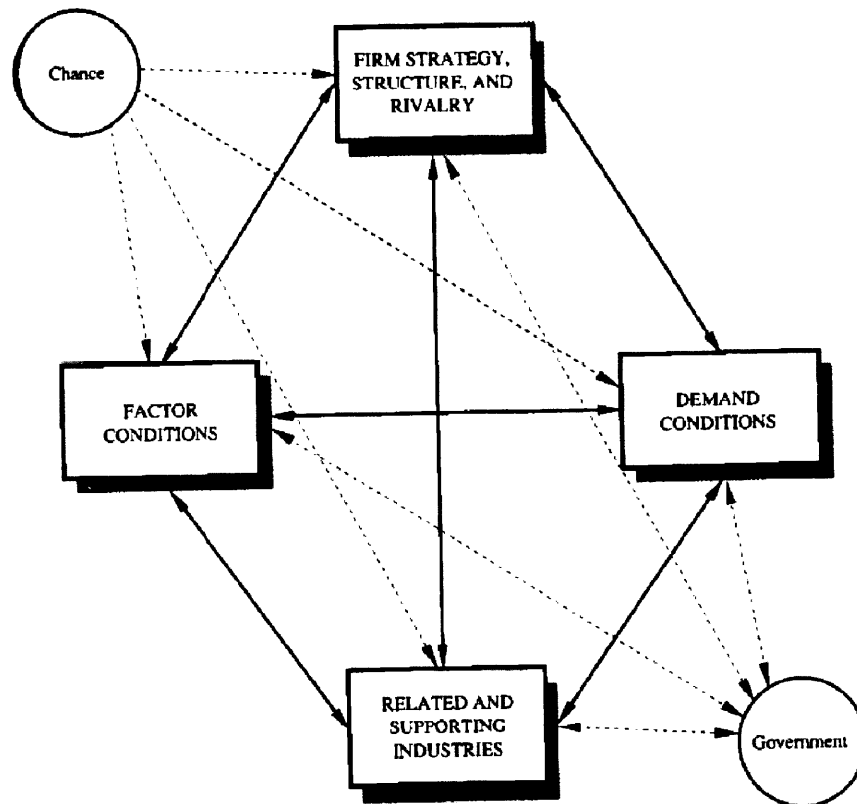


Figure 4-1, Source: Porter, Michael E, The Competitive Advantage of Nations (1998)

From the determinants above it can be seen why India is emerging as an economic powerhouse. All the factors which determine national competitive advantage are aligned in India's favor. Factor conditions are favorable due to abundance of educated workforce along with a good agricultural production and raw materials like iron and steel, aluminum, mica, silica etc. Demand conditions are also rapidly improving due to the emergence of a growing middle class with disposable incomes. FDI investments are flowing in various sectors like IT, manufacturing, services, infrastructure development etc which is resulting in development of a robust supply base and supporting industries. Firms are increasingly competing in the global landscape and thus developing advanced capabilities improving their competitive ability. The government is also playing a supportive role by liberalizing the economy and removing trade and other barriers to growth. So overall all the Porter's competitive forces are very well aligned in India's case to suggest that the country is experiencing sustainable economic growth.

# 5. Description of Supply Chain

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Supply Chain management is often referred to as efficient management of the end to end process, which starts with the design of the product or service and ends with the time when it has been sold, consumed, and finally, discarded by the consumer (Lee and Billington 1993, Swaminathan and Tayur 2003)

Supply chain management is a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time in order to minimize system wide costs while satisfying service level requirements – Simchi Levi

## 5.1 The Supply Value Chain

The source of competitive advantage lies in taking a holistic systems view of organizing all activities that are interlinked to form a value system. Although each discrete element in the chain is designed to provide unique advantages, they should create value for the overall system when put together. By employing innovations across the value chain by employing new processes, technologies, services etc. a firm can create its own competitive advantage. The figure below shows all the activities that a typical firm undertakes to create value. They are grouped under primary activities and support activities. Value chain analysis deals with analysis of both the primary and supporting activities and tailoring each of the activity to create its competitive advantage. How a firm determines to deploy its unique resources is the core of what forms its business strategy. Subsequent chapters in this thesis explore how to leverage value chain to build an effective supply chain.

## The Supply Value Chain

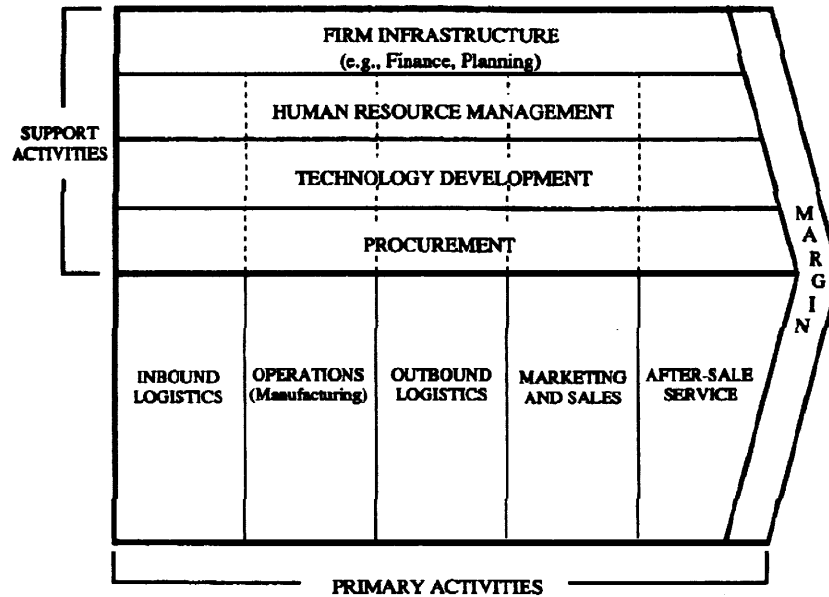


Figure 5-1, Source: Porter, Michael E, The Competitive Advantage of Nations (1998)

### 5.2 The Supply Value System

The value chain is a superset of a firm's value system which includes its external ecosystem like suppliers, distributors, retailers. The sum of the internal and external ecosystem forms the supply chain. Close collaboration between both internal and external components is necessary to form effective supply chain strategy.

#### The Supply Value System

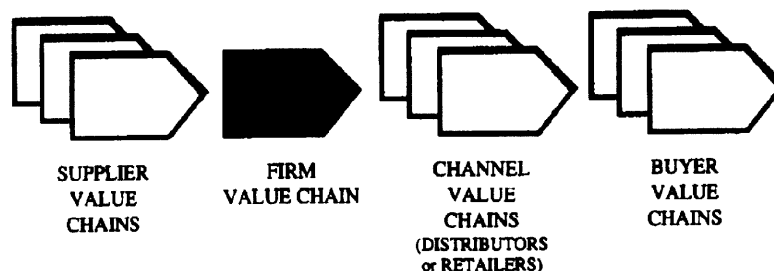


Figure 5-2, Source: Porter, Michael E, The Competitive Advantage of Nations (1998)

# 6. Supply Chain Design and Analysis

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## 6.1 The “Five Pillars” of Supply Chain and Challenges in Emerging Economies

The automotive value chain can be divided into five major value elements. It is essential to have a thorough understanding of these elements and how they differ in emerging economy vs a developed economy to properly design and manage the supply chain. The descriptions below are the functional requirements of the major value elements. Later on I will analyze how this differs between emerging and developed economy. The context of this thesis is based on building a foundation on these five pillars of supply chain, and develops a strategy around how to leverage the knowledge gained on each of the pillars to build a set of customized practices of effective supply chain management.

### The “Five Pillars” of the Automotive Supply Chain

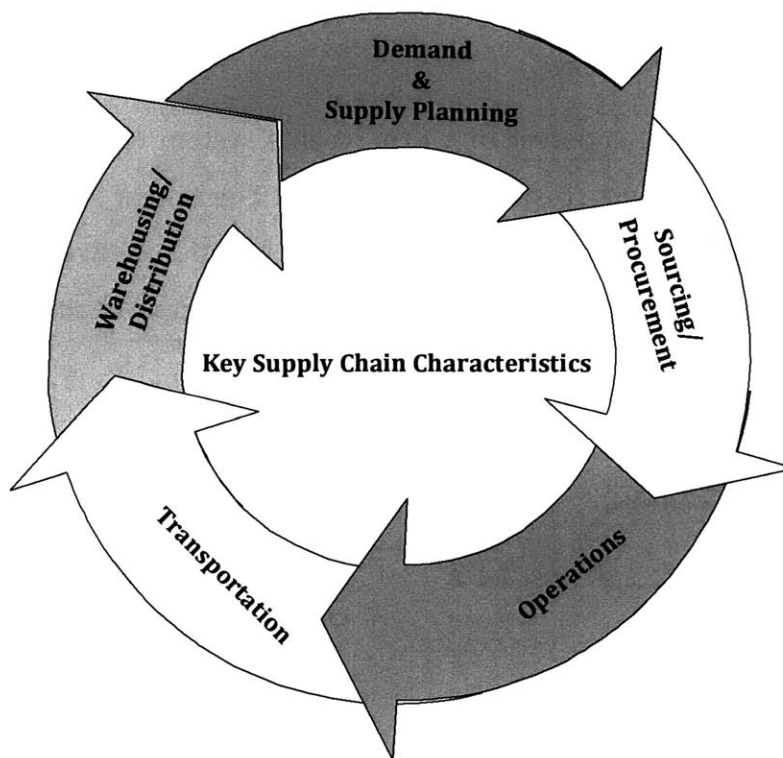


Figure 6-1



The **“Five Pillars”** are as follows:

➤ *Pillar 1 - Demand and Supply Planning*

This is used to estimate the quantity of goods or services to produce. Understanding demand is critical in supply chains to help optimize inventory levels and avoid stock-out. In Dalrymple (1975), 93% of the companies sampled indicated that sales forecasting was ‘one of the most critical’ aspects, or a ‘very important’ aspect of their company’s success. Jobber, Hooley and Sanderson (1985), in a survey of 353 marketing directors from British textile firms, found that sales forecasting was the most common of nine activities on which they reported. The methods used can range from qualitative methods to quantitative techniques. Examples of qualitative methods are judgment, market prediction, game theory, conjoint analysis, surveys etc. Quantitative techniques include simulations (Ex: Monte Carlo), neural networks, data mining, causal models etc. This information can be used to set pricing strategies, production planning, capacity planning etc. Matching supply and demand is a major challenge is an organization and carries many risks. There are numerous sources of uncertainties like lead times, transportation uncertainties, manufacturing yields etc. These uncertainties needs to be minimized using networking modeling, IT, procurement strategies etc and by building flexibility and redundancy in the system.

➤ *Pillar 2 - Sourcing/Procurement*

This is the process of acquisition of goods or services at the best cost of ownership. Procurement decisions are based on various factors like price, quality, delivery etc and could involve economic analysis like cost benefit analysis, Economic Value Added (EVA) etc. Procurement can be direct or indirect. Direct procurement is associated primarily with manufacturing settings for the production of goods and involves raw materials, parts components etc. Indirect procurement deals with resources which are enablers of operations like office supplies, IT resources, capital goods etc.

Procurement strategy can vary between the items being procured. For raw materials like rubber and steel which are commodities and thus low value added the strategy employed would be different from higher value added components like assembled parts.

A typical procurement process includes information gathering, supplier contact, background review, negotiation, fulfillment, consumption, maintenance, disposal and renewal.

➤ *Pillar 3 –Operations*

Operations include all aspects of design, manufacturing, and assembly for goods or services. It consists of converting inputs (raw materials, labor, and resources) into output (goods or services). Many activities are involved in operations like production planning, scheduling for manufacturing, equipment maintenance, plant management, materials planning, cost analysis, labor relations etc. Operations add value to the process and should be aligned with the market opportunity.

➤ *Pillar 4 - Transportation*

Transportation in a supply chain context is the movement of goods from one place to another. Mode of transport could be in the form of land, air, rail, water and space. For transportation of goods the relevant infrastructure needs to be in place like railways, trucks, airports, warehouses etc. With increased globalization transportation is taking an ever important role as the point of consumption is moving farther away from point of production. The demand for efficient transportation is rapidly growing every day and forms an integral part of the supply chain. Logistics form an important part of the transport network. It deals with all aspects of transferring products from producer to consumer which includes storage, transport, packaging, sorting, material handling, and information processing and payment transaction.

➤ *Pillar 5 - Warehousing/Distribution*

Warehouse is a commercial facility for the storage of goods. It's a critical part of an organization's supply chain. Warehouse should be easily accessible from railway, roads ports etc and should have docking and loading facilities. Typical warehouse functions include receiving, storage, order preparation, inventory management and shipping. Modern warehouses are equipped with automated equipment and software management systems for optimization and order management.

**Schematic Summary of "Five Pillars" of Supply Chain**

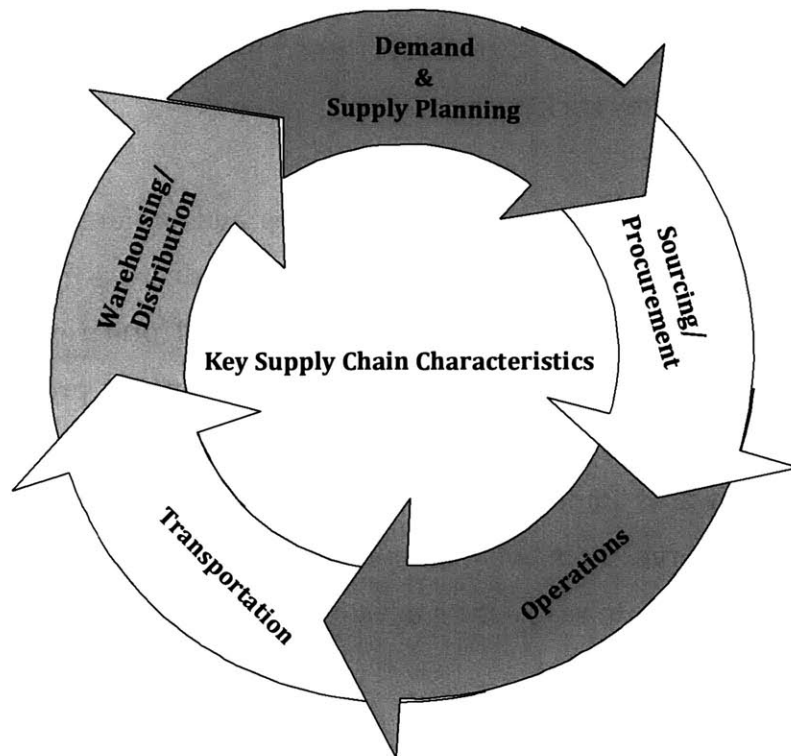


Figure 6-2

The following sections describe in details some of the value chains challenges using the five pillars framework developed.

### 6.1.1 Demand and Supply Planning

Demand and supply planning is critical component for accurate sales planning and forecasting. This function is very challenging in India due to lack of sales visibility at the Point of Sale (POS) or end customer. POS data is not well integrated in the supply chain and in most cases done manually which leads to lost sales and frequent stock-outs. This also leads to situations where high demand items are not replenished and slow moving parts are continuously ordered. Sophisticated techniques like vendor managed inventory and collaborative forecasting are tough to implement due to underdeveloped technology infrastructure. Lack of POS data and information causes the planning process to be a push strategy based on the firm's sales target and also causes other unwanted side effects like "inventory dump" and "hockey stick phenomenon".

Due to the plurality of cultures, languages and preferences, the product launch process gets very complicated as firms needs to advertise in multiple languages, and market and package products based on regional preferences. Lack of dedicated information technology infrastructure makes planning profess difficult. However dedicated efforts by governmental agencies facilitated by private partnership are working towards improving the infrastructure to address the unique challenges which will serve them well in the long run. The table below summarizes the progress made in infrastructure development since the economy was liberalized in 1991.

**Progress of Infrastructure Development in India**

| <b>Particulars</b>                           | <b>1991</b> | <b>2000</b> | <b>2005</b> | <b>AAGR %</b> |
|--|-------------|-------------|-------------|---------------|
| Railways length (1000 km)                    | 62.46       | 62.76       | 63.47       | 0.14          |
| Road length (million km)                     | 2.35        | 3.32        | 3.85        | 5.32          |
| Fixed line and mobile phone subscribers (per | 7 36        | 36          | 128         | 150.35        |

|  |        |        |        |        |
|--|--------|--------|--------|--------|
| 1,000 people)  |        |        |        |        |
| Air freight (million tons per km)                                | 493.10 | 547.65 | 773.22 | 4.73   |
| Air passengers carried (million)                                 | 10.72  | 17.30  | 27.53  | 13.0   |
| Air transport, registered carrier departures worldwide (million) | 0.12   | 0.20   | 0.33   | 14.89  |
| Container port traffic (million TEUs)                            | 0.15   | 2.45   | 4.94   | 266.01 |
| Electric power consumption (kWh per capita)                      | 295.02 | 402.02 | 457.32 | 4.58   |
| Electric power consumption (kWh)                                 | 255.65 | 408.42 | 493.78 | 7.76   |
|  |        |        |        |        |

Table 3-5, Source: World Development Indicators CD ROM 2007, World Bank

### 6.1.2 Raw Material Sourcing/Procurement

The availability of skilled and inexpensive workforce makes India an attractive supplier destination. However there are many unique challenges which a firm will face and needs to be taken into account while setting up the supply chain. One issue is scalability of supply base due to capacity constraints and disparity in capabilities between top tier and mid to low rung suppliers. As per Balakrishnan et al India has the highest number of suppliers awarded with the coveted Deming award outside of Japan, but these are mostly top tier suppliers with world-class practices. The mid to low rung suppliers, lack in critical characteristics like quality, reliability and access to latest technology. Lack of power, water and raw materials make the procurement process very challenging.

Lack of adequate road infrastructure makes delivery times highly unpredictable. This problem is compounded in rainy monsoon season when the condition of the roads deteriorates even further bringing traffic to a standstill in many locations

throughout the country. As per study performed by Sastry and Chandra 2002, only 4% of suppliers are within 3 miles of manufacturing facility, and 50% are located beyond 300 miles. To account for the unpredictable delivery times, suppliers have to hold high level of safety stock. Industrial zones at various parts of the country were not set up taking supply chain issues into consideration.

The small and medium scale suppliers also lack in product development capabilities which cause extended product development cycles and increases development costs. To overcome this many multinationals enter into joint ventures with Indian suppliers to help them ramp up their capabilities. This lack of supplier capabilities results in large supply base for firms. In a survey by Chandra and Sastry, 2002, it was found that 63% of firms have more than 100 suppliers and 17 percent have more than 500 suppliers. Many of these suppliers are rural and managing such a large and diverse supply base is extremely challenging.

One way firms effectively manage the supply base is through creation of cooperatives which span across various industries ranging from food, textiles, housing, finance etc. This cooperative scheme helps in empowering the small suppliers and creating the mechanism of disintermediation. Some great examples of successful cooperatives are AMUL and e-Choupal. AMUL is a cooperative of 2 million dairy farmers and rivals the largest US dairy cooperative. E-Choupal is a recent example of disintermediation where technology was leveraged to form a direct link between rural supply base (farmer) with the firm (ITC). This resulted in elimination of several layers in the supply chain and connected more than 3 million farmers to the e-Choupal network.

Although there are many challenges in procurement process, a firm can still benefit from taking advantage of the cost differential and availability of abundant human capital. The government is also taking steps to improve the infrastructure and opening up the economy from overseas investment. By carefully selecting partners and forming alliances, a firm can achieve significant growth.

### **6.1.3 Operations**

Majority of firms in India are small in size and belong to the unorganized sector. The number of manufacturing firms in the unorganized sector is about 17 million compared to 127,000 firms in the organized sector. The situation is very similar in the services sector where mom and pop stores dominate the retail landscape. The primary operational driver is cost leadership, which Indian firms are increasingly using to compete globally. A good example of this phenomenon is the software services sector. Indian IT firms have been able to deliver on software projects at a fraction of the cost of global competitors from the developed countries. This was primarily achieved through low cost of operations due to availability of skilled and cheap workforce. However with time these suppliers have also made dramatic improvement in delivery and quality and bringing their service levels at par with best in class suppliers globally. Similar trend is also seen in the automotive industry where large tier 1 suppliers have been awarded the prestigious Deming awards and meet the strictest global quality certifications. Today they compete globally with the other multinationals and generate a large amount of their revenues from exports around the world.

The biggest operational challenge in India is the lack of infrastructure support in terms of ready availability of power, roads and water supply. Uninterrupted power supply, which is a critical requirement of most industries, is hard to come by in India. Due to this firms need to invest in expensive backup options like its own captive power generation unit. Similarly for transportation firms provide transportation from and to the plant to their employees as public transportation are both expensive and unreliable. By planning for these contingencies a firm can minimize its risk while maximizing its returns on investment.

### **6.1.4 Transportation**

Transportation and distribution capability determines the efficiency of a supply chain to a large extent. However, unlike other developed countries, India lacks in

terms of having an organized distribution system. It is estimated that about 87% of villages in India do not have organized distribution which houses 50% of the rural population. Thus Indian firms have to set up their own distributed network to help them sell their products or services. For example, Hindustan Lever Limited (HLL) which is a large consumer goods manufacturer caters to urban population through its 1 million retail outlets and to the rural population of 50,000 villages. Its supply chain consists of 80 factories, 150 outsourcing units, 2000 suppliers and 5000 distributors. This is an enormous logistical challenge especially in the rural sector, given the poor infrastructure and support facilities.

The trucking industry is very fragmented with very few fleet owners. Majority of trucks are owned by single owners.

#### **6.1.5 Warehousing/Distribution**

Lack of effective distribution infrastructure has resulted in addition of extra tiers to the distribution channel. Often firms use third party depots which add cost for the end customer and also create competition between other firms using the same facility. The tax structure is also very complex with a double taxation structure where goods are taxed at both federal and state level. Due to this firms have to optimize their distribution channel not only based on logistics but also on taxation structure. The government has recently implemented Value Added tax Structure (VAT) to mitigate this issue but it has still not been completely implemented in all states. The trucking industry in India is also highly fragmented. There are 2.7 million commercial fleet operated by half a million operators (ET 2005). 3PL services are limited although they have been a recent uptick in numbers. However most of the 3PL providers are focused on providing trucking services only and lack expertise in high value added services like order processing and inventory management. Lack of high volume mechanized handling facilities at airports and seaports reduce the overall efficiency of the supply chain. Governmental import export regulations add to the bottleneck at the ports.



Thus to operate in India a firm has to carefully evaluate and plan their distribution network so that it can effectively connect with the highly dispersed large population. Managing the distribution network will be a key driver for business success.

### Summary of Supply Chain Challenges in the “Five Pillars” in India

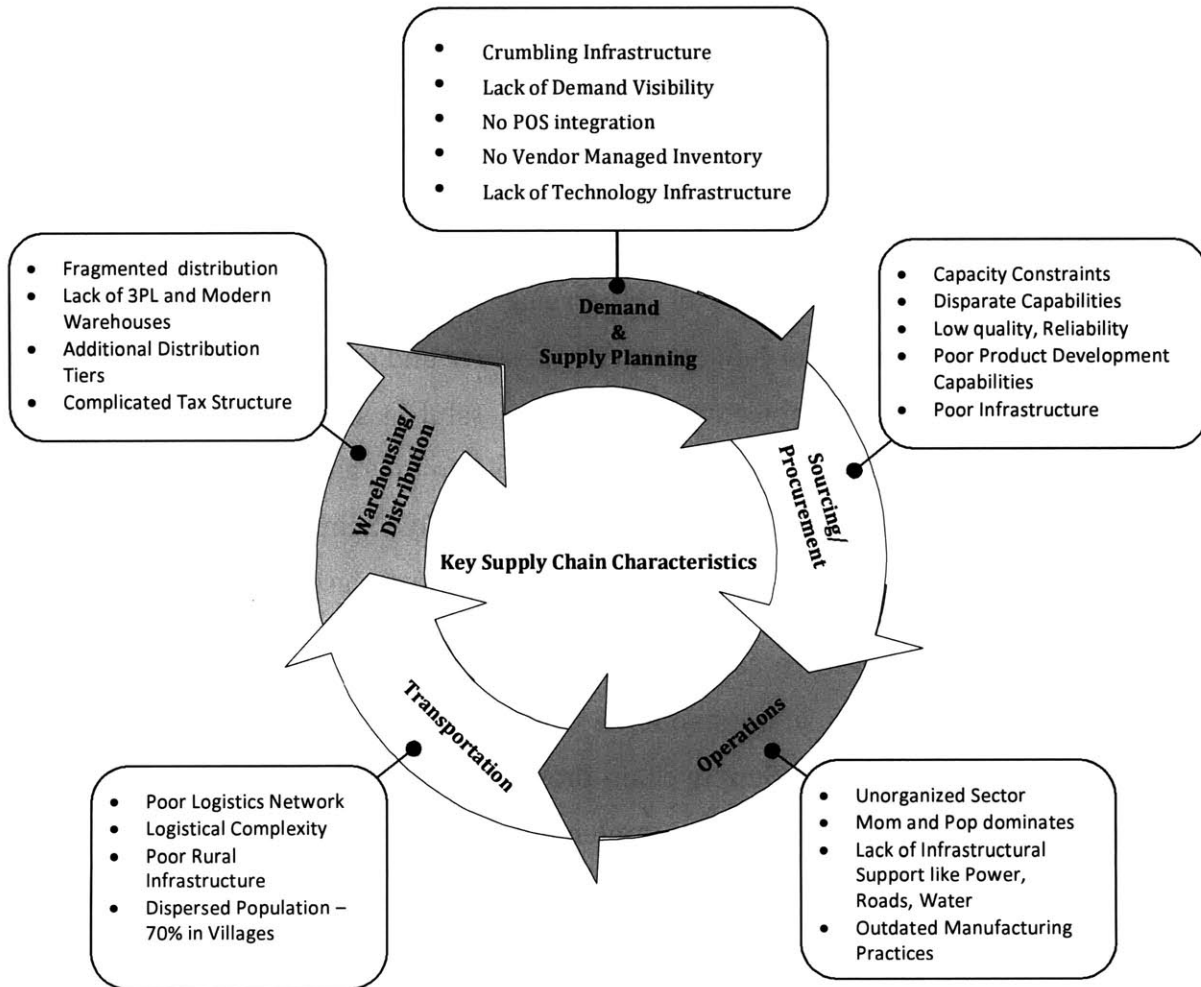


Figure: 6-3

As seen in figure above there are many challenges in an emerging economies like India. All emerging economies face similar challenges like poor infrastructure and large number of poor people. However with these big challenges come big

opportunities, like access to a high growth economy. The key to success is to convert these challenges into opportunities. New technologies and distribution systems

## **6.2 Effect of Business Strategy and Operating Principles on “Five Pillars” of Supply Chain**

Supply chain strategy is no longer the drive to minimize cost for the firm. Today supply chain strategy is driving towards the goal of full alignment with the business strategy to capture value and enable growth. Business strategy can determine to a large extent what form the supply chain design might take. Today’s supply chain is designed to not merely to react but align itself to the business strategy. However, achieving supply chain alignment with business strategy poses many challenges. On one hand product complexity is forcing suppliers to rapidly develop new capabilities. On the other hand financial pressure and ever evolving customer needs is creating conflicting objectives. To be successful in such a difficult environment, the supply chain and business strategy should follow an integrated approach that incorporates tradeoffs between business and supply chain elements. This will allow firms to generate cross enterprise efficiencies to pursue growth opportunities.

Operating principles are set of fundamental practices which do not change with time. It is crucial to understand the underlying operating principles to achieve supply chain alignment. Supply chain practices can leverage a number of operating principles based on how they are implemented.

Companies should not adopt a “one size fit all” cookie cutter strategy to model its supply chain. Each company and its associated supply networks have its unique characteristics which would require unique tradeoffs to integrate its supply network. The strategy should focus on total supply chain management through a seamless integrated flow. The supply chain strategy should not only support the business strategy and operating principles but also enhance it. The “five pillars” should not be seen as independent silos but is heavily dependent on each other.

Change in one of the pillars will affect the other pillar and thus they should all work in tandem.

### **Business and Operating Principles Linked to Supply Chain “Five Pillars”**

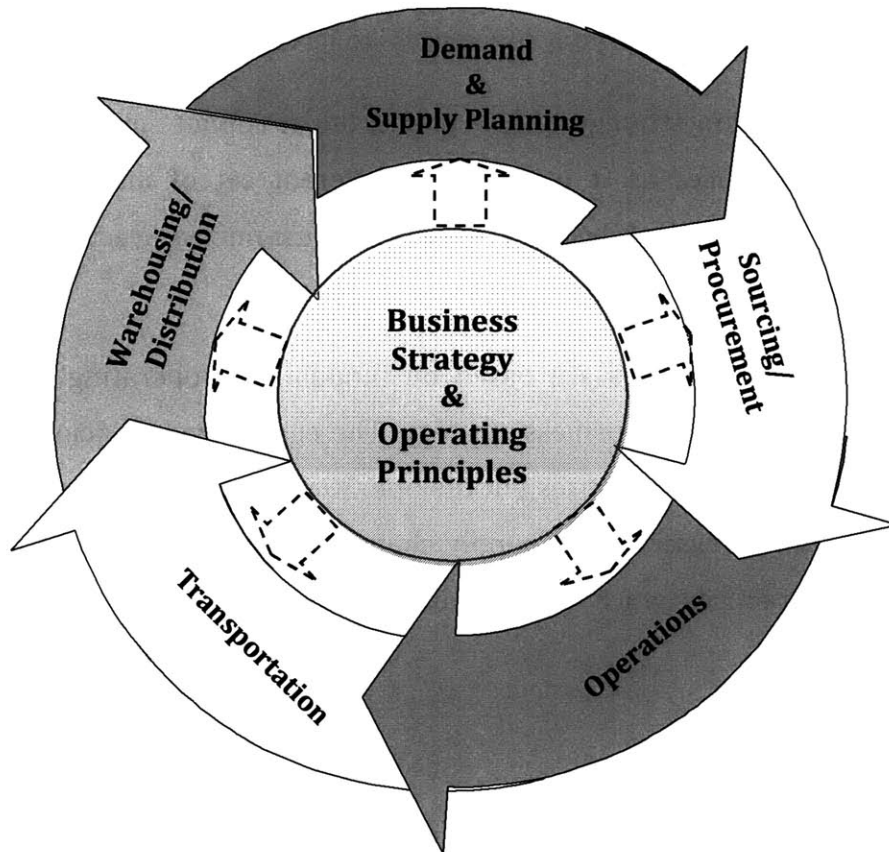


Figure 6-4

### **6.3 Developing Customized Practices for the “Five Pillar” of Supply Chain**

Once the business strategy and operating principles have been established, customized practices are developed to address the unique challenges for each of the “Five Pillars” of the supply chain. These customized practices should be in alignment with the business strategy and operating principles. It is important to limit the number of customized practices that are the most important to the strategic and operational principles as too many customized practices will dilute the focus.

Customized practices are industry practices specifically designed for a firm. For example, Wall Mart's customized practice is to leverage economies of scale and use of automated logistics enabled by a highly developed technology infrastructure. This is based on its operating principle of "expanding its sphere of influence" and "increasing transparency" with suppliers<sup>11</sup>. This in turn supports its business strategy of providing "everyday low prices" to its customers.

Nano also relies on strategy of low prices, but it cannot simply copy Wall Mart's customized practices as it operates in different set of industry dynamics and geography. A detailed analysis of Tata Nano's customized practices is presented in section 7.4

The customized practices are based on fundamental operating principles which remain stable with the business strategy. The customized principles might change with time and across industries but the operating principles do not. For an effective supply chain it is essential for supply chain personnel to create an evolving set of customized practices which leverages its underlying operating principles.

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<sup>11</sup> The Essence of Excellence by Larry Lipide

## Emerging Economy “Five Pillar” Supply Chain Framework

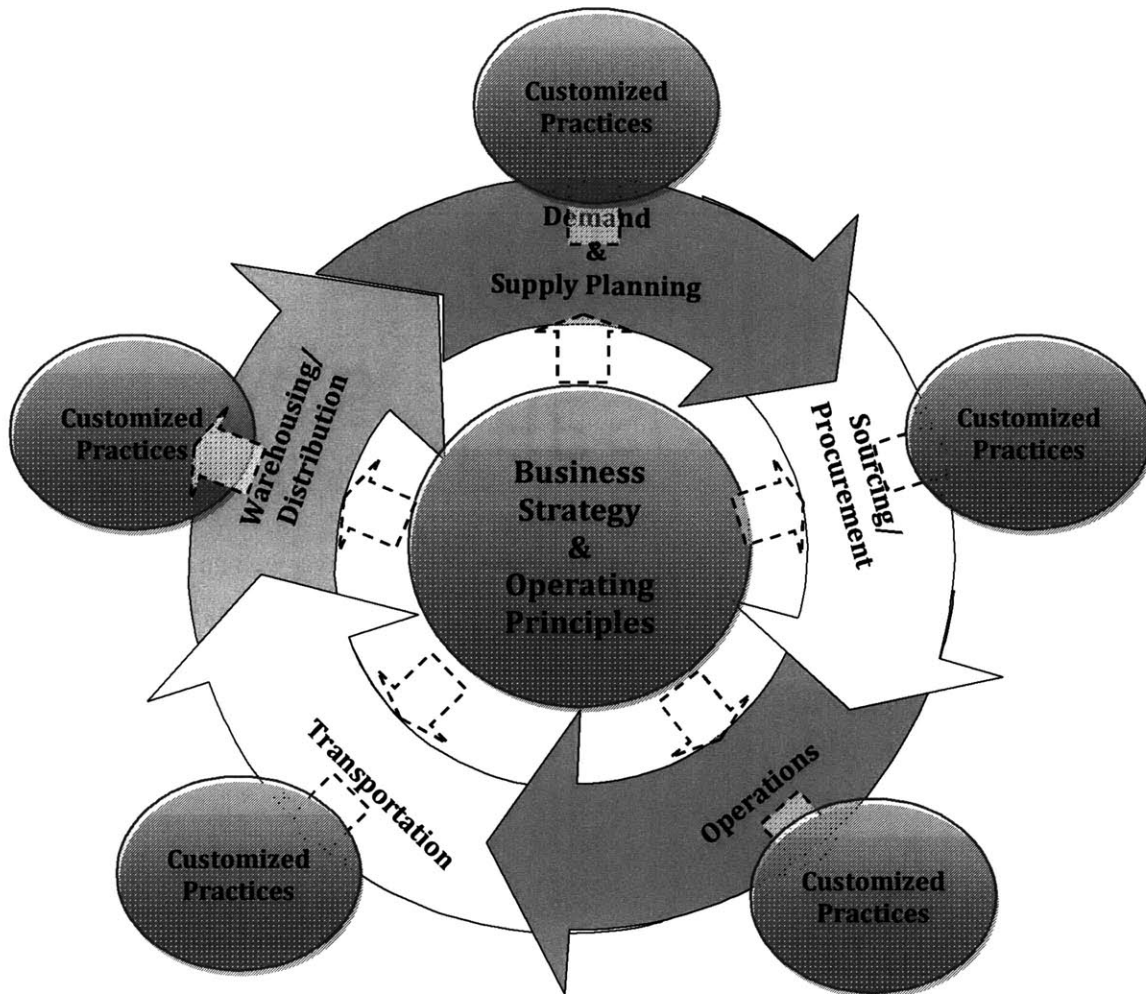


Figure 6-5

### 6.4 “Five Pillar” Model and Framework in Action – Successful Cases

The “Five Pillar” is a generic framework that can be applied to evaluate supply chains to determine if the business strategy, operating principles and customized practices are well aligned. It helps to look at the supply chain holistically and creates a systemic framework on how to evaluate all aspects of the supply chain. The table below summarizes how the “Five Pillar” framework can be applied to successful case studies in emerging economies. The table summarizes what the underlying operating principles are for various industries

and customized supply chain practices that are used by specific companies in that industry. The Tata Nano case will be expanded in further details in Section 7 where each step of the framework will be applied to develop the complete supply chain.

### Successful Case Studies of “Five Pillar” Framework

| Company                   | Industry                           | Operating Principles   | Set of Customized Practices  |
|---------------------------|------------------------------------|--|--|
| <b>Tata Nano</b>          | Transportation                     | Economies of scale, Leverage brand awareness, Value innovation                 | Supplier led product development, Vendor park, Vertical integration  |
| <b>Grameen Bank</b>       | Micro lending                      | Leverage large customer base   | Target rural poor<br>Empower women to start businesses, Bring bank to the customer   |
| <b>E-Choupal</b>          | E-marketplace for spot transaction | Match supply with demand<br>Direct access to producer                          | Village mandis<br>Real time pricing<br>Eliminate middlemen<br>Make technology accessible to the poor                       |
| <b>Mumbai Dabbawallas</b> | Delivery Services                  | Leverage human network<br>,Employee satisfaction,<br>Efficient<br>Distribution | Unique identification system   |
| <b>Amul</b>               | Dairy Cooperative                  | Robust logistics,<br>State-of-art technology<br>Cost leadership                | Democratic governance, Dealer network, Simultaneous development of suppliers & markets, Finance through internal accruals, |

Table 6-1

# 7. Case Study – Tata Nano

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The automotive industry has gone through major transitions since the modern mass produced automobile was introduced in the form of the Ford Model T. Each transition brought in its own unique set of characteristics which is detailed in section 7.1. The latest trend in the industry is the advent of the small inexpensive car for the mass market which the common man in the middle class can afford. This requires a dramatic reduction in cost without sacrificing in other aspects like quality, reliability, safety etc. India is a producer driven model as buyers are just being introduced to cars and consumers do not need much choices other than basic mobility. This is similar to Ford Model T when it was launched. However in mature markets like US it is a buyer driven model where consumer choice is important and sellers differentiate themselves by additional features and customization they can give to their customers. To build this next generation of small inexpensive cars it is necessary to make a dramatic departure from the traditional approach of making cars and building new capabilities from the ground up. Manufacturers are increasingly evaluating the entire supply chain and focusing their efforts to streamline all aspects of the supply chain.

In this case study the “Five Pillar” framework developed in preceding sections will be used to evaluate the entire process of building an efficient supply chain. Section 7.2 details the business strategy used by Tata for developing the Nano. This is followed by Section 7.3 which describes the operating principles which Tata leveraged based on the underlying business strategies. The next section 7.3 describes all the customized practices used by Tata for the Nano platform which are based on the unique challenges faced in each of the “Five Pillars”. The challenges are specific to the Indian economy and the Indian automotive market and thus the practices developed are customized for that specific set of conditions.

## 7.1 Chronological Sequence of Innovations in the Automobile Market

### ➤ *Ford Model T – Mass Production*

The origins of the auto industry dates back to 1893 with the launch of the first one-cylinder auto engine in the United States. However, automobiles of those times were unreliable, expensive and outside the buying power of the average consumer. Henry Ford came along and introduced the Model T which was half the price of the existing automobile and thus the common man could afford. It was also reliable, durable and easy to maintain.

Although the pricing was unprecedented at that time, Ford still had a profitable business model. It could achieve this by introducing a revolutionary assembly model which replaced skilled craftsmen with unskilled laborers. These workers worked on a small task which dramatically increased their efficiency resulting in cutting the time to build a car from 21 days to 4 days and reduced labor hours by 60%<sup>12</sup>. This allowed Ford to charge a price which the mass market could afford. Ford's Model T created a huge market for automobiles which replaced the horse drawn carriage mode of transportation. By 1923, majority of the American household owned a car<sup>13</sup>.

### ➤ *General Motors (GM) – Mass Customization*

By 1924, the personal automobile had penetrated the American mass market. The Model T focused on a basic functional car, with no alternate designs, color or model. In contrast to this strategy, GM devised an alternate strategy to launch a car for “every purse and purpose”. They focused on the emotional aspect of car ownership by selling cars which were exciting, comfortable, fashionable and fun to drive. This caused consumer to trade in cars more frequently, further expanding the market and also creating a whole new market for used cars. From 1926 to 1950, the number of cars sold

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<sup>12</sup> William J. Abernathy and Kenneth Wayne (1974)

<sup>13</sup> Antique automobile club of America (2002)



in the Us increased from two million to seven million with GM's share rising from 20% to 50% and Ford's share falling from 50% to 20%<sup>14</sup>.

➤ *Honda, Toyota and Nissan – Small Car*

The Japanese challenged the auto industry by building small efficient cars in contrast to the American prevailing taste for bigger and luxurious cars. The oil shock of 1970 precipitated the consumer exodus to small fuel-efficient cars manufactured by the Japanese. The Japanese gained a strong foothold in the lucrative American market by producing functional, compact, fuel-efficient cars. The Big three also adopted similar strategy by following the Japanese, but could not make a strong comeback in terms of quality and first mover advantage in the field of small cars.

➤ *Chrysler- Minivan*

In 1984, Chrysler launched the minivan which was another breakthrough in the US market and introduced a new category of automobile for mass market. It was a cross between a car and a van, handled like a car, and catered to the tastes of the nuclear family. The minivan helped catapult Chrysler into the Big Three automobile club and generated \$1.5 Billion for Chrysler in three years<sup>15</sup>. The minivan also led to the popularity of SUV's, with the market for minivans, SUV's and pickups reaching 7.5 million units, closely matching the 8.2 million new cars sold in 1998<sup>16</sup>

➤ *Tata Nano – Emerging Market Small Car*

The Tata Nano holds a spot in the Guinness Book of world records for the world's cheapest car at a starting price of Rs 100,000 (Approx \$2500). The car was designed for the working class commuter who currently cannot afford a car and depends on two wheelers (scooters, motorcycles, mopeds etc) for their daily commuting needs (Majumdar). By targeting this user base Tata Motors created a completely new

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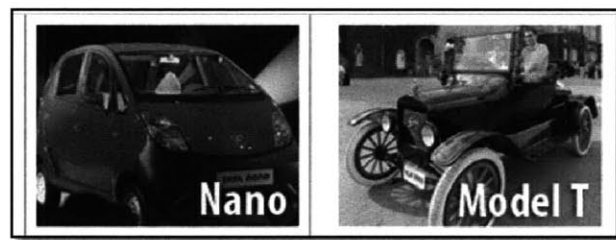
<sup>14</sup> Mariana Mazzucato and willi Semmler (1998), B

<sup>15</sup> Sanghoon Ahn (2002)

<sup>16</sup> Walter Adams and James w. Brock (2001)

customer segment which currently can only afford two wheelers. This new segment is much larger than the current four-wheeler marketplace. The car boasts not only an attractive sticker price, but also effectively competes on fuel economy which is a prime consideration for low income consumers. The car is expected to have average mileage of 20km/liter (approx. 56mpg) (Autocar). As per CRISIL, the Nano is expected to expand the Indian four wheeler market by as much as 65%.

### Ford Model T vs. Tata Nano



|                           |         |                              |
|---------------------------|---------|------------------------------|
| <b>Introductory Price</b> | \$2,500 | \$19,000 (2006 adjusted)     |
| <b>Cylinders</b>          | 2       | 4                            |
| <b>Horsepower</b>         | 22      | 20                           |
| <b>Top Speed</b>          | 60 mph  | 45 mph                       |
| <b>Fuel Economy</b>       | 50 mpg  | 13-21 mpg                    |
| <b>Windshield Wiper</b>   | 1       | Vacuum powered<br>(optional) |

Table 7-1

## 7.2 Applying the Supply Chain Framework

### 7.2.1 Tata Nano's Business Strategy –Value Innovation

The automotive industry is a very crowded space with many competitors fighting to get a piece of the market share. The situation is even tougher for the small car platform where the margins are very small. The key to success in such an environment is not just to compete in the existing market but create new ones. Such

a strategy which Tata leveraged can be termed as “value innovation” or “Blue Ocean” strategic moves. This strategy is based on an analytic framework and tools for creating and capturing value. Although the term is new, the strategy has been used for centuries which gave birth to industries like automobile, aviation, health care, the internet which blossomed into multibillion dollar industries.

Value innovation is the cornerstone of blue ocean strategy which is based on creating new and uncontested markets by creating a big step change in value for the customers and the company. Value innovation is not about cutting-edge-technology but about aligning innovation with utility, price and cost advantages. Conventional competitive strategy is based on making a choice between differentiation and low cost. However, value innovation is based on simultaneously driving costs down and driving value up for the customers as shown in figure below.

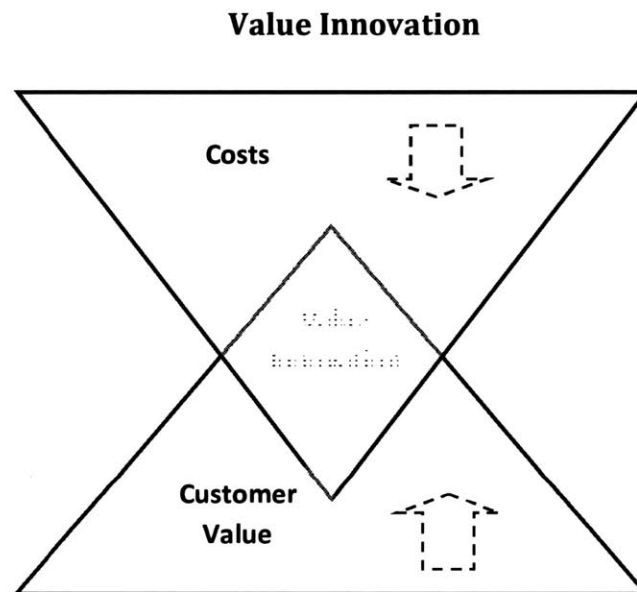


Figure 7-1, Value Innovation = Low Cost + Differentiation, Source: Adapted from Blue Ocean Strategy

Value innovation embraces the entire supply chain of the company. It involves aligning the whole supply chain of the company in the pursuit of differentiation and low cost. To pursue value innovation, Tata shifted its focus from current competition to alternatives and

noncustomers. By looking across alternatives, Tata redefined the redefined the industry by building a transportation solution which would replace the current reliance of the Indian mass market on two wheelers. In doing that Tata found an uncontested market of two wheeler users which was more than five times the passenger vehicle market as shown in figure below.

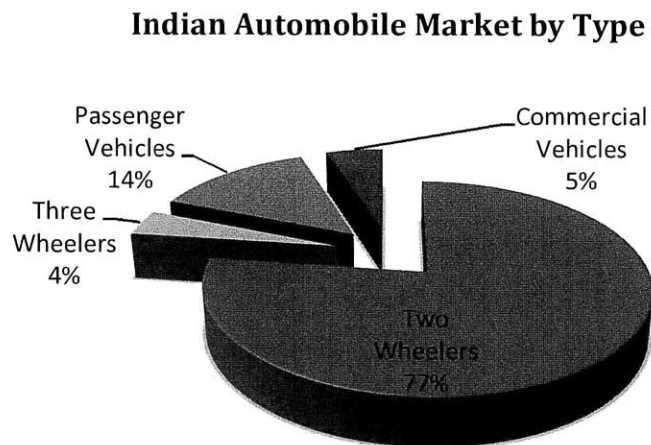


Figure 7-2, Source: Society of Indian Automobile Manufacturers

### *Value Innovation Framework*

The value innovation strategy used is based on the Four Actions Framework of blue ocean strategy developed by W. Chan Kim and Renee Mauborgne. This framework helps in developing a new value curve which barrier between differentiation and low cost. Four key elements are used to determine the competitive strategy as follows:

- What factors in the industry should be **eliminated** - These are the factors which are taken for granted but may no longer be relevant for the buyer. This provides insight to the company on how to reduce its cost structure with affecting the buyer utility.
  
- What factors should be **reduced** below industry standard – These are the factors which are provided to the customers in the quest for gaining a competitive advantage over the competitors in a red ocean market place. Most of the time these are overdesigned

features which were added to help a company differentiate itself from the competition but ultimately do not provide any significant advantage to the customer. They increase the cost with no or a very small marginal benefit.

- What factor should be **raised** above industry standards–This helps to determine the factors that will provide value to the buyers and hence should be the focus of an organizations effort. The current industry standards are not sufficient to provide the unique needs of the customers and hence there is an opportunity to add value. This helps to increase buyer value and hence create demand.
  
- What factors should be **created** which is not offered by the industry – This helps to discover entirely new source of value to the buyer which the industry does not currently offer. The process of elimination and creation helps reveal new areas for creating value. In the case of the Tata Nano when it is viewed from the lens of this strategy canvas it revealed a new outlook for the Indian passenger car industry. In the current space most of the Indian automakers were competing on similar features which made the marketplace very crowded and provided little differentiation between each other. In contrast Tata Nano broke apart from this model and created a new strategy canvas which stands apart from the industry as shown in graph below.

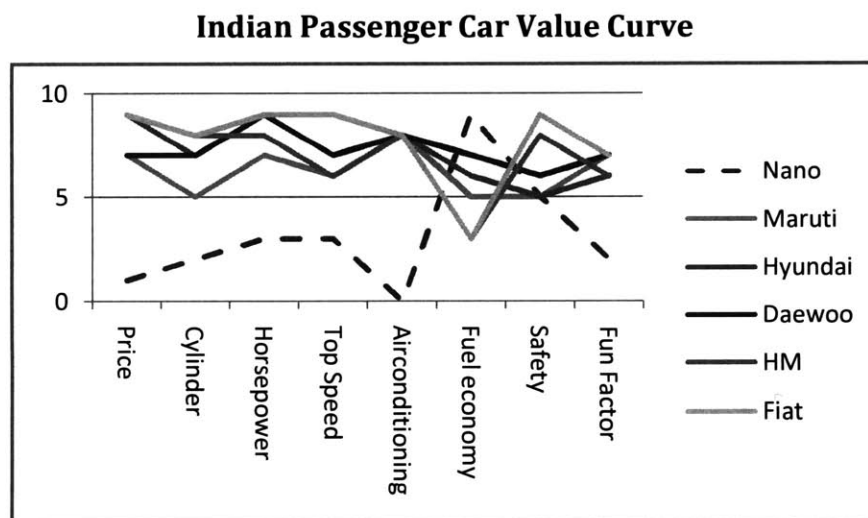


Figure 7-3

The Nano provided a no frill platform which gave consumers a basic mode of transportation at a fraction of the cost of the nearest competitor. It created a blue ocean by converting non consumers, who currently relied on two wheelers, to consumers who can afford the Nano. It focused on factors which had very high value for the customer, like price, fuel economy, reliability and safety. By applying the four actions framework a company can systematically new create value curves. The framework applied to the Nano is shown below.

### Tata Nano Four Actions Strategy Framework

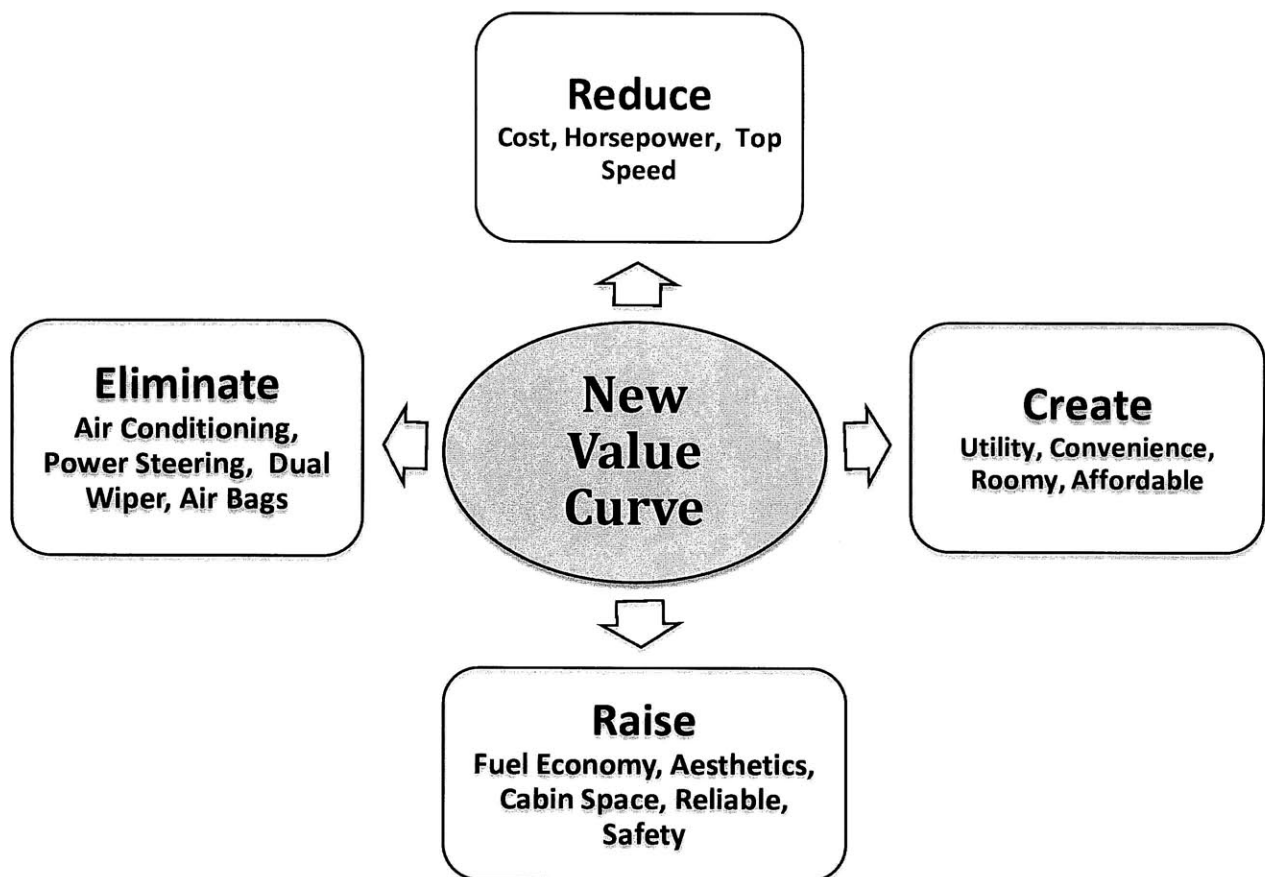


Figure 7-4, Source: Adapted from Blue Ocean Strategy

Once the strategy canvas is built it is necessary to ensure that it is based on a financially sound business model. This involves understanding that strategic sequence of determining buyer utility, price, cost and adoption.

*Buyer Utility* – The offering should unlock exceptional buyer utility for mass adoption. Companies should ensure that the product or service provides the greatest utility across the buyer spectrum from consumers to non consumers. This utility should be present across the product lifecycle which includes purchase, delivery, use, maintenance and disposal. It should create a compelling value proposition for existing customers while removing all hurdles that stand in the way of converting non customers to customers.

*Target Pricing* – It is important to understand what price point will help to quickly capture the mass market. The price should be such that the buyers should not only want to buy it, but also would be able to afford it. In case of the Nano, Tata looked at the current two wheeler market. The Nano had the same core utility as the two wheeler (to provide transportation), but had a different form. However it converted non customers to customers by providing this form at a price which other competitors could not match and the mass consumer can afford.

*Target Costing*–Target costing ensures that the business model is profitable. To get to target cost, a target profit is determined to get to the target cost. The company then uses this target cost to drive its operating model and product decisions. To achieve the target cost it is often essential to come up with cost innovations by streamlining the entire supply chain. For the Model T, Ford had to scrap the traditional assembly model and adopt the assembly line. For the Nano, Tata had to build the entire end to end supply chain from scratch and introduce cost innovation at every step of the supply chain. This is discussed in more details in subsequent sections.

## Value Innovation Strategy Sequence

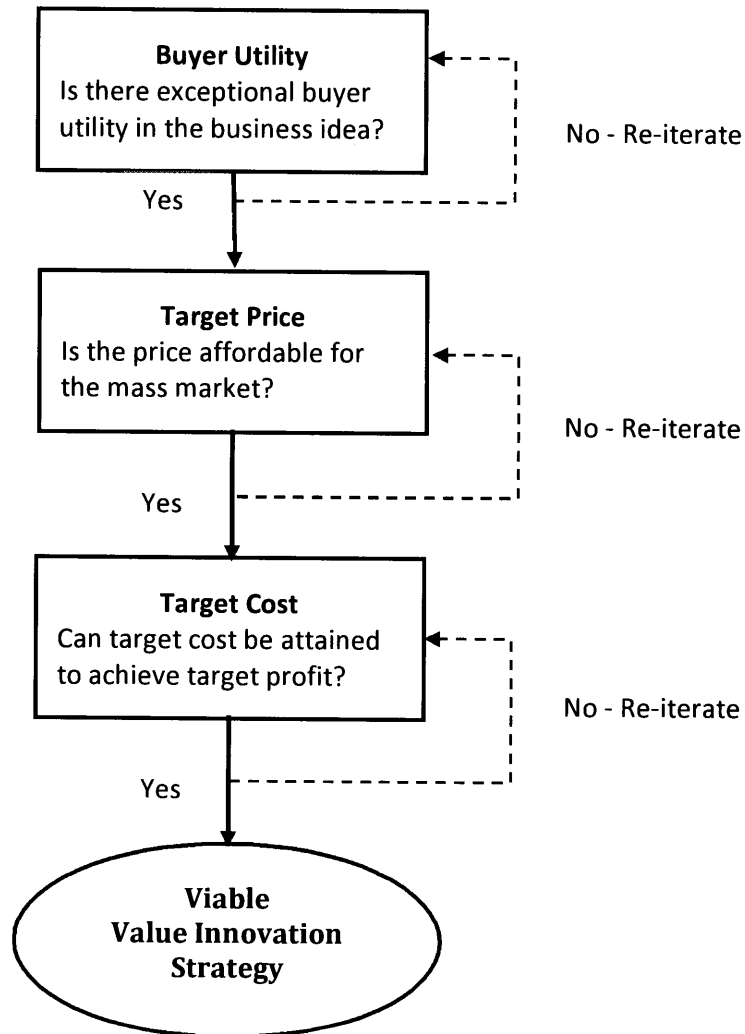


Figure 7-5, Source, Adapted from Blue Ocean Strategy

### 7.2.2 Tata Nano's Operating Principles

Tata Motors supply chain consists of Tier 1, 2 and 3 suppliers, OEM, design and assembly operations and dealer network. To keep operating costs low Tata group adopted many unique operating procedures. The overarching principle was to keep costs down without compromising on quality, safety and reliability. One strategy used by Tata was to use supply base of two-wheeler suppliers and reengineer the products for four wheelers. For example the CVT (Continuously Variable Transmission) used in the Nano was developed by Kinetic motors for scooters.



Kinetic Motors is the largest manufacturer of CVT equipped scooters in India. Similarly, Caparo supplied the composite body for the Nano, who primarily supply the two and three wheeler market. This strategy of leveraging capabilities of a similar industry was also extensively used by Tata during the development of the ACE truck which was target replacement for three wheeler auto rickshaws.

Tata Motors is renowned in India for its manufacturing capabilities which it developed over decades. They are the largest vertically integrated automotive conglomerate in India with the largest share in the automotive and commercial vehicles sector. It is the second largest commercial vehicle manufacturer in the world, fourth largest truck manufacturer and second largest bus manufacturer. Tata leverages its strong world class manufacturing capabilities to reduce cost of operations. The company follows world class manufacturing practices like lean and continuous improvement. Due to its strong manufacturing capabilities they contract out their facilities to reduce their capital cost burden. For example, Tata contracts out their state of the art paint shop to Mercedes Benz. Similarly, it contracts its body press shop to Mahindra. Below is a list of operating principles leveraged by the Tata group.

### **Nano Operating Principles**

| <b>Competitive Strategy</b> | <b>Operating Principles</b>  |
|-----------------------------|--|
| Low cost                    | <ul style="list-style-type: none"> <li>➤ Streamlined Operations</li> <li>➤ Strong Manufacturing Capabilities</li> <li>➤ Lean Manufacturing</li> <li>➤ Reduced Waste</li> <li>➤ Vertical Integration</li> <li>➤ Just In Time (JIT) Inventory</li> </ul> |
| High Quality                | <ul style="list-style-type: none"> <li>➤ Continuous Improvement</li> <li>➤ Trained Workforce</li> <li>➤ Vertical Integration</li> </ul>  |

|  |  |
|--|--|
|  | ➤ Best in Class Global Suppliers   |
| Innovative Product                                   | <ul style="list-style-type: none"> <li>➤ Joint Ventures</li> <li>➤ Streamline Operations</li> <li>➤ Efficient New Product Development</li> <li>➤ Design Innovations</li> </ul> |
| Uncontested Market<br>(Value Innovation<br>Strategy) | <ul style="list-style-type: none"> <li>➤ Target Complementary Market (two wheeler)</li> <li>➤ Bottom of Pyramid Market</li> <li>➤ Leverage Economies of Scale</li> </ul>       |

Table 7-2

### 7.2.3 Tata Nano's Customized Practices

#### 7.2.3.1 Demand and Supply Planning

##### ➤ *Vertical Integration*

The Tata group is one of the biggest conglomerates in India with presence in a wide variety of sectors from food and beverages to steel. They form subsidiaries with many leading world class corporations. Although they do not own the subsidiaries, they benefit from being associated with these subsidiaries to enable a vertically integrated model. The unique characteristic of Tata Group's vertically integrated model is that the subsidiaries are not fully Tata owned, but joint ventures between Tata and other world class manufacturer who have domain expertise in the component manufacturing sector. Since automotive is a high technology sector, this type of vertical integration helps keep the cost of monitoring low. Tata took advantage of its presence in the automotive component sector to form close alliances with the Nano project team. The subsidiaries who were involved included Tata Auto Component Systems (TACO), Tata Toyo Radiators, Tata Johnson Controls, Tata Visteon, Tata Yazaki, Tata Ficossa, Tata GS Yuasa batteries and Tata Ryerson (for the steel service center and the roll form sections) Tata Bearings for bearings and Tata Steel Tubes for the engine cradle.

Due to close relationship with Tata group these subsidiaries were willing to set up operations in the vendor park and form a close knit integrated team from the very inception of the project. For example, TACO's expertise in engineering, manufacturing and supply chain management was used by the Nano team to thoroughly evaluate the complexities of automotive supply chain. The participation of the subsidiaries in the Nano network helped immensely in building trust and transparency in the overall project.

➤ *Vendor Park*

The Tata's small car plant is modeled around a fully equipped self sustaining city. The long term vision of the Tata group is to have majority of the suppliers collocated alongside the Tata assembly plant. In Singur, the original site for the plant more than 50 suppliers was set alongside the Tata plant. Both small are large established companies including Tata Toyo, Amtek Auto, Kinetic Engineers, Bosch Chassis Systems, Caparo Engineering, Rucha Engineers, Sono Koyo Steering set up dedicated component plants to service the Nano plant. To facilitate suppliers to co-locate Tata set up a vendor park next to its plant. Joint ventures were set up, which allows both companies to share technology and best practices like that between Tata Steel and Ryerson to supply the car chassis and non load bearing components.

➤ *Joint Ventures*

A company cannot perform all activities efficiently by itself. A lever a company can use to introduce cost innovations is the formation of joint ventures. Joint ventures allow the companies to improve their capabilities without compromising their cost structure. Tata has formed joint ventures with many companies throughout the world. This allows them to leverage other company's expertise and economies of scale and closing any gaps they have in their in house capabilities. This gives them an advantage in forming vertically integrated companies. For, example Tata has a joint venture with Fiat, which gives them access to diesel engine technology. Similarly, Tata has 51:49 joint venture with Marcopolo of Brazil to build and

assemble buses and coaches for mass transit systems. In this venture, Tata will provide expertise in transmission and chassis, while Marcopolo will provide know-how in processes and systems in bus body design. For their Information Technology needs Tata used the services of Tata Technologies Limited (TTL) which provides Engineering and Design services to the automotive industry. Its client base includes Ford, GM, Toyota, and Honda to name a few. Many Tata joint ventures and subsidiaries were part of the Nano's core project and provided their knowledge and expertise to build the platform.

➤ *Government Subsidies*

Government subsidies are another factor governing the choice of location. One of the drivers for the initial choice of Singur was the high level of subsidies awarded by the West Bengal government to set up plant in that state. The local government subsidizes such efforts as it creates jobs for the locality and also helps build the local infrastructure. The subsidies were in various forms, like 100% exemption of excise duty for 10 years, 100% exemption from corporate income tax for 5 years and 30% exemption for the next 5 years, subsidized power, 650 acres of subsidized land made available through the government which was procured at the rate of Rs 8,000 per year per acre for the first 45 years and at Rs 16,000 per year per acre thereafter. Tata is expected to save 175 million USD of the estimated 200 million USD it would pay the government for the acquired land for the project.

➤ *Cheap Labor*

The choice of Singur a plant location was to leverage the high level of unemployment of the region which currently stood at approx. 47%. Opening a plant of this large a scale would have generated employment to thousands of workers benefitting both the local economy and building an whole industrial ecosystem around it. Also due to the high rate of unemployment the supply of labor is high,

thus leading to lower wages. As per the latest estimates about 18% of the employed people earn less than Rs 1000 per month (\$20).

### Demand and Supply Planning Customized Practices

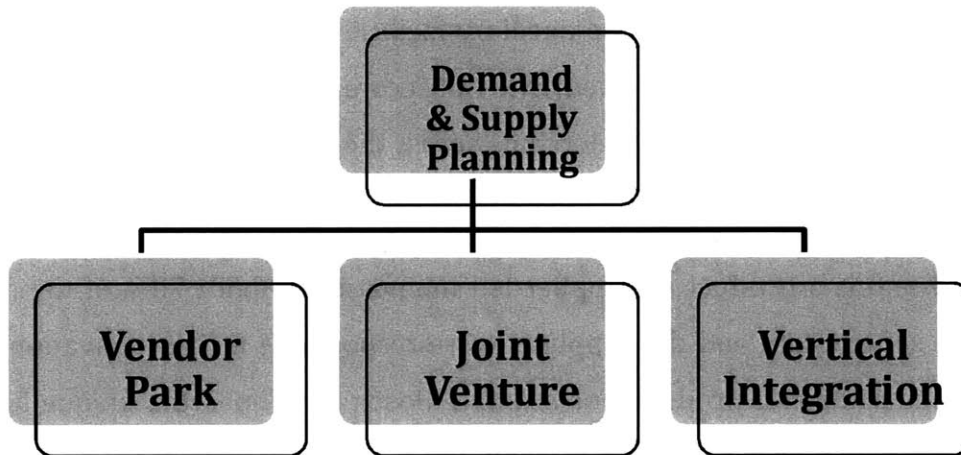


Figure 7-6

#### 7.2.3.2 Sourcing/Procurement

➤ *Suppliers Divided into Proprietary Designs and Tata Motor Design*

Tata divided its supply base into two categories – proprietary design and Tata Motors design. For proprietary designs Tata Motors employed the services of established global vendors like Bosch, for their engine management system and continental AG for their fuel supply system. Global suppliers were chosen who had presence in India so that the development costs are minimized. For example Bosch was chosen as they had a strong presence in Bangalore, India and the development was done concurrently in India and Germany. Using local design capabilities helped in keeping costs under control.

At commencement of project Tata engaged 600 suppliers and a total of 1800 supplier part combinations. Tata built strong relationship with these suppliers and made them part of the core Nano design team. The suppliers in turn developed dedicated ancillary facilities to support the Nano project. It is estimated that

suppliers spend in the tune of INR 600 crores to set up these dedicated facilities to support the Nano. Suppliers have been given very challenging targets in terms of quality and delivery. The target is to have defects less than 100ppm and a 10X reduction in warranty costs.

Over 100 suppliers converted from skeptic to partners. They formed strong links to Tata and developed dedicated ancillary facilities to support the project. Key Tier II and Tier III suppliers invested INR 600 crores. Logistics has been developed to transport 250,000 cars to dealerships across the country.

➤ *Local Source*

The Nano is a product of supplier led innovations. About 70% of the components were sourced out and the suppliers were responsible for all innovations necessary to deliver the end product. For example Bosch developed the unique fuel injection system which uses one injector feeding two cylinders turn by turn, with the help of sophisticated electronic controls. Tata took lots of care to select suppliers who had strong design, process and operations capability so that they can contribute significantly in the design and development of the car. About 97% of the car is sourced locally and the suppliers form an integral part of the development process.

➤ *Volume Contracts*

Tata went for long term volume contracts instead of the traditional annual contracts found in the auto industry<sup>17</sup>. The vendors were involved from the very beginning of the development process to help reduce costs. Suppliers were given very aggressive price targets, based on volume estimates of 250, 000 to 1,000,000 units per annum contracts. Price negotiations started at 50% of the quote and in some cases were settled at 80 to 85% of the target. If the estimated volumes are recognized, the Nano component business would be worth 25% of the domestic component business which opens up a huge market potential. Volume contracts also help to convince suppliers to relocate to OEM established vendor parks.

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<sup>17</sup> Supplierbusiness.com, Jan 14<sup>th</sup>, 2008 Newsletter

➤ *Multifunctional Components*

A factor which helps in streamlining supply chain operations is through reduction of total number of components. It also aids volume contracting as fewer parts means larger volume for each part number. By designing components which serves multiple purpose, Tata was able to keep costs in check. For example, the left and right dashboards are identical for the Nano, resulting in one part number for both left and right hand drive cards. Similarly, the door handles are same for both the left doors and right doors.

➤ *Single Source Components*

Instead of annual contracts, Tata opted for the volume contract route, to help drive down costs further. The suppliers are given significant volume commitments, with 75% of components being single sourced. "It is an opportunity for incumbent component suppliers to use their experience and scale up to meet demands of increased volume and low price," says K Kumar, Professor, N.S.Raghavan Center for Entrepreneurial Learning, IIM-Bangalore.

About half of the vendors are co-locating with Tata in their vendor park and 90% of the components are being outsourced to external suppliers.

➤ *70% of Cost of Supply Chain is Fixed at Design Stage*

It is a well known fact that majority of the cost of the supply chain is fixed at the design stage. This is due to the fact that in early stage of the product development cycle any minor change necessitates changes in both upstream and downstream of the process. Hence it is prudent to freeze design to the maximum extent in the early design stages. Since 90% of the car was outsourced to external suppliers it was very critical for Tata to engage with suppliers at the very early stages. The suppliers formed a very strong relationship from the very inception and were instrumental for the various innovations found in the car.

### ➤ *Target Pricing*

Tata used a concept called “Target Pricing” or “Target Costing”. They set \$2,500 as the price that they thought customers could pay and then worked back to attain this price level, with the help of suppliers, who were willing to take on the challenge. Rather than stripping an existing platform of features, they looked at their target customers' lives for cost-cutting ideas. For example, they opted for a smaller engine because higher horsepower would be wasted in India's jam-packed cities, where the average speed is 10 to 20 miles per hour.

The steps involved in this “Target Pricing” process are:

- Identifying the price at which a product will be competitive in the marketplace. It includes determining what features and functions the consumer wants like air conditioning, engine capacity, seating capacity etc.
- Defining the desired profit to be made on the product
- Computing the target cost for the product by subtracting the desired profit from the competitive market price using the formula:

Target Cost = Target Price - Desired Profit

The two primary levers Tata used to attain target cost was streamlining all operations and partnering with suppliers. Once the features and functions were finalized, the target cost was then given to the engineers and product designers. Target costs were assigned to each and every component/system of the car like transmission system, electrical system, and engine management system. The teams responsible for each system used this cost as the maximum cost to be incurred for the materials and other resources needed to design and manufacture the product. They thoroughly analyze every component of the system to drive down cost of the system. It was their responsibility to create the product at or below its target cost.



### Target Pricing Schematic

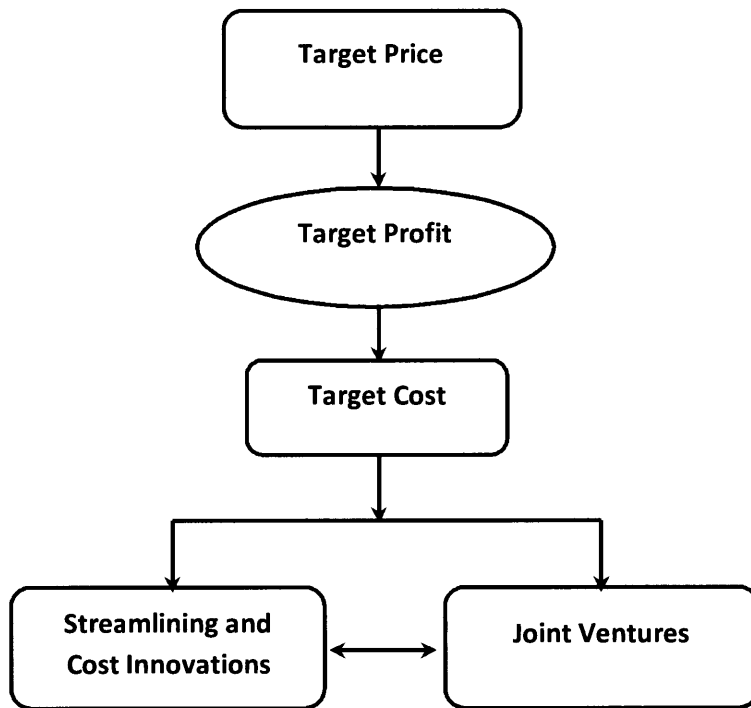


Figure 7-7, Source: Adapted from Blue Ocean Strategy

#### ➤ *Functional Collaboration with Suppliers at Early Stage*

Tata engaged the vendors very early in the process through initiatives like 3P (Production, Preparation and Process) and were asked to set up facilities near the Tata assembly plant.

Bosch, one of the world's biggest automotive OEM suppliers, supplied a stripped down version of its engine management system specifically tailored for the Nano. Bosch also developed a sensor system at a fraction of the original cost by reengineering one of its existing sensors. Similarly, Delphi designed an instrument cluster that weighs just 14 oz, compared to 2.2 lb for the models it sells in North America and Europe. These and dozens of other small incremental innovations helped yield a car that weighs just 1,322 lb, less than half the weight of a Honda Accord.

Suppliers were advised to start from scratch, rethinking every component to minimize cost without sacrificing basic performance, comfort and style. Many world class global suppliers were part of the integral supply team from the very inception of the project. Below is a list of global suppliers involved in the project and the component they provided for the Nano. As can be seen from the list many of the suppliers are world class and brought in cutting edge technology even for a low cost platform like the Nano

### **Tata Nano Suppliers**

| <b>Supplier</b>         | <b>Part/System</b>  |
|-------------------------|---|
| <b>Texspin</b>          | Clutch Bearings   |
| <b>Bosch</b>            | Gasoline injection system, starter, alternator, brake system                |
| <b>Continental AG</b>   | Gasoline fuel supply system, fuel level sensor                              |
| <b>Caparo</b>           | Inner structural panels   |
| <b>HIS Auto</b>         | Static sealing systems (weather strips)                                     |
| <b>Delphi</b>           | Instrument cluster  |
| <b>Denso</b>            | Windshield wiper system (single motor and arm)                              |
| <b>FAG Kugelfischer</b> | Rear-wheel bearing  |
| <b>Ficosa</b>           | Rear-view mirrors, interior mirrors, manual and CVT shifters, washer system |
| <b>Freudenberg</b>      | Engine sealing  |
| <b>GKN</b>              | Driveshafts   |
| <b>INA</b>              | Shifting elements   |
| <b>ITW Deltar</b>       | Outside and inside door handles   |
| <b>Johnson Controls</b> | Seating   |
| <b>Mahle</b>            | Camshafts, spin-on oil filters, fuel filters and air cleaners               |
| <b>Saint-Gobin</b>      | Glass   |
| <b>TRW</b>              | Brake system  |

|                              |  |
|------------------------------|--|
| <b>Ceekay Daikin/Valeo</b>   | Clutch sets                            |
| <b>Vibracoustic</b>          | Engine mounts                          |
| <b>Visteon</b>               | Air induction system                   |
| <b>ZF Friedrichshafen AG</b> | Chassis components, including tie rods |
| <b>Behr</b>                  | HVAC for the luxury version            |
| <b>Durr</b>                  | Lean Paint Shop                        |

Table 7-3, Source: "India's Tata low-cost Nano took a lot of high-tech" AE-Plus

Even after Tata had to move to Gujarat from their original base of Singur due to political unrest, all suppliers agreed to move with them and can accommodate the capacity requirements. To ensure smooth relationship and redress any supplier grievances in a timely fashion, Tata has set up supplier councils. This council helps resolve majority of issues include payments.

### Sourcing/Procurement Customized Practices



Figure 7-8

### 7.2.3.3 Operations

#### ➤ *Design*

The Nano at a price point of \$2,500 is equivalent to the price of a DVD player option in a luxury car. The strategy adopted by Tata to drive down the cost to such low levels is by designing the vehicle from scratch. It is estimated that 70% of the cost of the supply chain is fixed at the design stage.

The car was not over engineered like some western models, but is an example of frugal cost-effective and relevant engineering. It was designed by challenging conventional wisdom and a principle of deep frugality, which some analyst have described as “Gandhian Engineering”. Many of the standard features in western cars like air conditioning, power brakes, radios, ABS etc were eliminated from the base model to drive down cost. The car is smaller in overall dimension than the smallest car in the market; the Maruti 800, but offers 20% more interior space. This was achieved by the designers by placing the wheels at the extreme edges of the car. It is also reduced usage of steel by minimizing weight and using an aluminum engine. It achieved this without compromising any safety standards and meets all regulatory requirements. Few other examples of design innovation or “Gandhian Engineering” used in the Nano are:

- Use of one wiper instead of two which is the industry standard
- Snap on instrument clusters which eliminates the needs for screwing it in place
- Use of variable transmission instead of gearbox
- Use of tubeless tires, which is used worldwide, but is a new concept in India. By using these tires they saved Rs 50 per tire or Rs. 250 on the car
- Two cylinder non-opposed engine with a balancer shafts in the engine
- Central instrumentation console
- Trunk does not open, instead the rear seats can be folded down to access the trunk space.
- Some exterior parts of it are glued together, rather than welded

- No power steering
- Three lug nuts on the wheels instead of the statutory four nuts.
- Only one side view mirror
- Use of inexpensive polymers or biodegradable plastics instead of a full metal structure
- Mounting the engine, exhaust and gearbox in a single module in the rear for ease of assembly.
- Instead of a long-lasting bulb which lasts for 10 years, a standard-life bulb was used to keep cost down, while meeting all regulatory and warranty requirements.
- The door handle itself has 70% fewer parts than western counterparts
- Seat sliding mechanism inspired from helicopter mechanism

### Nano Design Innovations

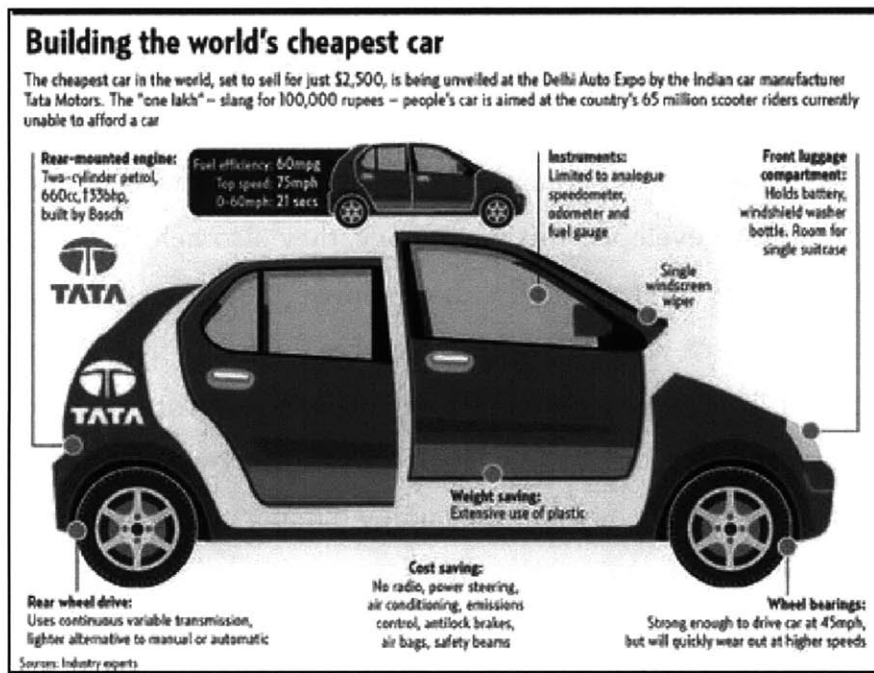


Figure 7-9, Source: Forbes Industry Reports

All throughout the design process, three key requirements were taken into consideration – cost, regulatory requirement, and acceptable performance

standards. Tata has filed 34 new patents on the Nano, most of which are related to the engine technology. As per analysts most of the breakthrough innovations are still in the pipeline, and will debut with the diesel version of the Nano. The Nano's design strategy contrasts with other manufacturers in the way it integrates various functionalities. Most western manufacturers tightly couple various functionalities resulting in a "black box" type of design for its end customer. Kathleen Franz, in her book *"Tinkering: Consumers Reinvent the Early Automobile"*, points out how the open nature of early automobile designs, led to the wave of innovations later on in the auto industry. Tata, by following an open and modular approach, is engaging its customers to customize the product to their needs and at the same time providing valuable insights to their latent needs.

➤ *Innovation in Manufacturing Process done Locally*

The Nano designed many innovative manufacturing processes either at its own R&D facilities or closely collaborated with suppliers to help them innovate. For example, Tata replaced stamping with roll forming process. Roll forming allowed commonality of tooling across various part numbers thus achieving significant savings in tooling cost, reduced number of process steps and improved productivity. Not only they developed this technology, they also helped transfer this technology to its vendors to help them drive down their costs. Another manufacturing innovation which was used extensively was the use of hydro forming for all tubular structures. This helped simplifying the production process and reduction of weight with its associated cost savings. Hydro forming allowed the use of thinner material, as a result of which body parts including bumpers are only 2.5mm thick against the standard of 3mm found in other platforms.

➤ *Inventory Management*

- JIT was used and leveraged to optimize the production process by reducing lead times as much as possible. This was primarily achieved by leveraging proximity of the suppliers by setting up vendor parks in vicinity of its

assembly operations and also minimizing the number of suppliers to streamline the process

- Multipurpose components – Unique component part numbers were minimized by innovative design which leveraged multi-functional components and careful consideration of tooling requirements. This helped reduce complexity of the overall design, obtain volume discounts and reduce total number of components.
- Seamless Integration – Tata worked with components suppliers from the very early concept phase. This ensured the early capture of design issues and accurate forecasting.

➤ *Information Management*

The Tata conglomerate due to the diversified nature of its businesses had access to the latest information management practices through its IT subsidiary arm Tata consultancy Services (TCS). They invested heavily in IT to design a very efficient supply chain. Some of the cutting edge practices they employed are discussed below.

- Implementation of SAP 3.1 and 4.6c was implemented to manage the complete life cycle of the product. The SAP implementation was the largest of its kind at that time in the Asian subcontinent.
- Tata implemented SAP SRM (Supplier Relationship Management) for end to end supply chain integration). This gave it a host of benefits as explained below:
  - Tata worked with its component suppliers to virtually integrate and simulate the complete manufacture and assembly of the Nano using Product Lifecycle Management (PLM) platform

- Use of PLM ensured that data was shared seamlessly between Tata and its various suppliers. This helped reduce the development lifecycle, streamline workflows, reduced costs and improved collaboration between various disparate entities.
- Use of Product Data Management (PDM) systems ensured that most accurate and up to date data is shared among suppliers and ensure real time integration of suppliers to business requirements and promote use of user-friendly process automation tools.
- E-procurement was used throughout to get the best pricing, create an efficient marketplace for supplier bidding and obtain significant reduction in procurement cycle time.
- SAP WM (Warehouse Management) combined with barcodes to automate warehouse operations)
  - Tata employed RF technology for real time inventory tracking to get most up to date information of inventory position all across its operations
  - RF technology also helped improve throughput at warehouses and enabled more streamlined and efficient operations and enhance capacity throughput.
- Knowledge based Engineering (KBE) in design with KNEXT (in-house software)
  - Use of customized KBE systems enabled Tata automate many standard processes and reuse existing design information like example from the highly successful Tata ACE platform. This allowed them to get a head start on the design process and helped them drive an almost 30% reduction in design cycle time
  - Use of KBE also ensures the best practices are shared across the organization and all the design information and knowledge is captured.



## Operations Customized Practices

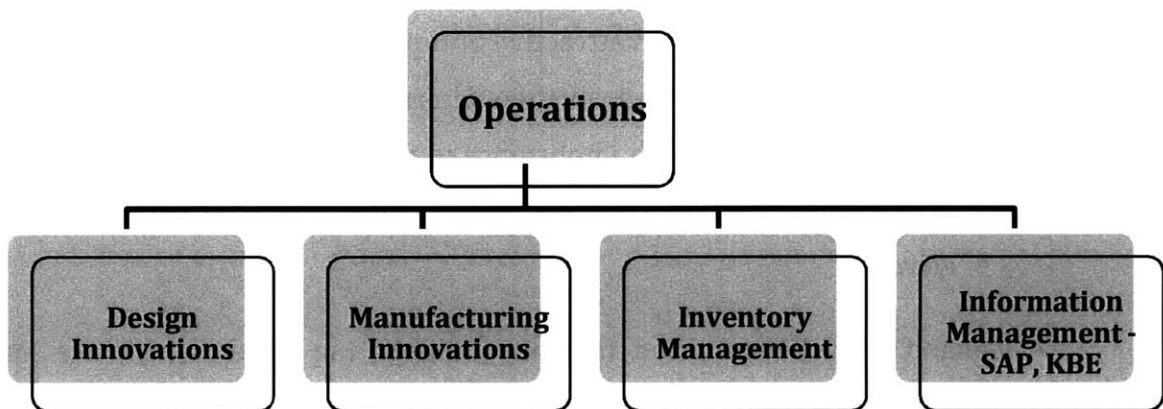


Figure 7-10

### 7.2.3.4 Transportation

#### ➤ *Facility Location*

Facility location plays an important role in supply chain network design. This is especially more critical for the Indian subcontinent where infrastructure is poor and undependable and the transportation network is not very well developed and the country lacks the modern heavy movers found in western countries. To overcome the infrastructure challenges and also leverage location to optimize supply chain dynamics, Tata Motors adopted various strategies as outlined below:

#### ➤ *Nearness to Raw Materials*

The initial location of the Tata Nano assembly plant was chosen to be Singur. This location was an incubator for Tata's new enterprises and was also close proximity to Jamshedpur (280 kms) which hosts Tata's captive iron and steel plant which provides them with one of the most critical raw materials for the Nano. Jamshedpur is also well connected to Singur via rail network which makes movement of raw material efficient. It is also close to the sea port at Haldia, which will help them for overseas export

Due to political opposition Tata had to move their plant from Singur to Sanand in the state of Gujarat. Again they had many alternate sites as many states were giving them attractive options to locate their plant. However Tata very carefully evaluated all their alternatives to choose their final site. In doing so, they paid high importance to infrastructure and connectivity. Some of the prime drivers in choosing the state of Gujarat to locate their plant were:

- Sanand is well connected to many neighboring states which are important source of raw materials. This includes the state of Maharashtra, Chhattisgarh, Orissa and Jharkhand through NH-6
- It is well connected to the New Delhi Kolkata highway through NH-2 and connected to Rajkot and Ahmadabad through NH-8
- The site is also close to the Dholera port, which is a special infrastructure project being set up to as part of the Delhi-Mumbai freight corridor. This port will help facilitate overseas export.
- Another big factor influencing the site location was its proximity to India's largest auto ancillary unit at Rajkot. This hub would supply parts for the Nano. Currently there are about 100 ancillary units in Rajkot GIDC of which 50 supply to Tata and would also support Nano in some way. Availability of schools and hospitals in the vicinity was also a factor in the decision making process

➤ *Open Distribution and Increased Modularity*

A broad pattern of innovation in the distribution system which is emerging is the concept of "Open Distribution". This innovation is very distinct for the innovation pioneered by big box retailers like Dell and Wal-Mart. These US systems are self contained "closed architecture" with highly standardized processes, facilities and services tailored to its own customer base. The "open architecture" pioneered by Indian firms offer much greater flexibility to the customer to tailor products and services as per their own unique needs. It mobilizes large number of independent

third party vendors to cater to rural customers and tailor products and services to meet their unique needs and environment. In this process these firms build a long term relationship with the customers by involving them in the development process. This allows them to get much detailed insights into the customer's needs and help to create customized solutions.

To facilitate open distribution and faster product development lifecycle, firms are increasingly adopting a modular approach to product development. Open distribution is facilitated by:

- Increased modularity in both product and processes.
- Leveraging existing third party vendors in rural areas to effectively penetrate the rural customer
- Creative leveraging of information technology and social networks to reach a wide diverse audience.

This is being adopted in fields ranging from diesel engines and agricultural products to financial services. Cummins successfully leveraged this concept when it launched its "Gensets" (power generation sets) to cater to the lower end of the market. The sets were sold in modules and was specifically designed to lower distribution costs and made it easy for distributors and customers to tailor it to their specific needs and environment. This strategy helped them become the market leaders in this segment and they are using this concept to spread their footprint globally in other emerging economies like Africa, Latin America and Middle East.

## Transportation Customized Practices

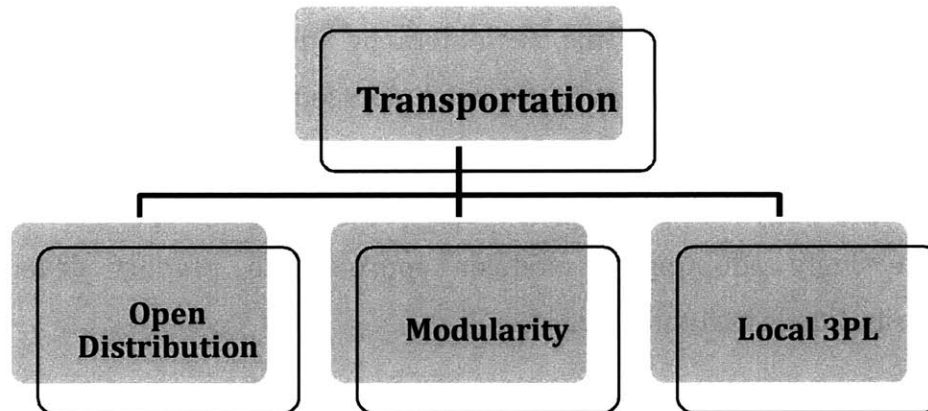


Figure 7-11

### 7.2.3.5 Warehousing/Distribution

#### ➤ *Distributed Assembly Model – JIT and JIS model*

The relentless quest for operating efficiency has resulted in highly standardized business processes with few key suppliers. As customers gain more power, the traditional distribution model needs to be reengineered to meet the needs of the very demanding customers who expect tailor made value added solutions.

One of the very innovative aspects of the Nano, which has not garnered much attention, is its modular design approach to facilitate distributed assembly. The components that go into the Nano has been constructed in such a manner that it can be transported as separate kits, just like a bicycle, and assembled locally at point of sale. The kits would be assembled and serviced by local entrepreneurs.

As per an interview with Ratan Tata by Times of India here is his vision of how a distributed assembly would work:

*"The first thing I would like to do is get a mature product in the Indian market and seed this market effectively. My aim was that I would produce a certain volume of cars and create a very low cost, very low break-even-point plant that a young entrepreneur could buy. A bunch of entrepreneurs could establish an assembly operation and Tata*

*Motors would train their people, would oversee their quality assurance and they would become satellite assembly operations for us. So we would create entrepreneurs across the country that would produce the car. We would produce the mass items and ship it to them as kits. That is my idea of dispersing wealth. The service person would be like an insurance agent who would be trained, have a cell phone and scooter and would be assigned to a set of customers. This is just a concept. He will deal with their problems on a self employed basis and would be paid by the assembler and the customer. It would be satisfying if the small car created 10-15 satellite groups of young engineers who could get together and do a business. They would never be able to get normally into assembly of cars. I think it will be a very satisfying thing for me to see them succeed. What we will do outside India will be a conventional distribution system. Find an assembly plant and assemble the product in the conventional form."*

*Also as per Tata "Nano, designed with lot of replicability, modularity and reliability. The engine can be replaced from the cradle from underneath and changed if necessary. The design is extremely modular, extremely interchangeable, and packaged for left hand drive and right hand drive to meet future export requirements".*

As per the plan developed by Tata, Completely Knocked down (CKD) kits from Tata plants in Pant Nagar, Pune and Sanand would be ferried to warehouses throughout the country to be assembled. The dealers would then assemble, warehouse, display and sell the cars. On firm order they would withdraw, assemble and sell the car. The company would provide tools to assemble the car in existing garages and also facilitate the setting up of new ones in rural locations. This resembles to the modular furniture business pioneered at IKEA. It also provides a social dimension by promoting rural entrepreneurship. They are also in talks to set up warehousing facilities in class A and Tier II cities. Tata won't elaborate on the exact details of this innovative distribution scheme, and will only say "the distribution system will be a variant from the norm. It will remove some of the layers in distribution and service." The end goal is to design a low breakeven point assembly kit for local entrepreneurs.

➤ *Shorter Lead Times*

Lead time reduction helps to reduce inventory and improve responsiveness of the supply chain, reduce waiting times and delays. Strategy adopted by Tata to reduce lead time and facilitate JIT (Just in Time) manufacturing was to locate many of the critical component suppliers in their vendor park which is located adjacent to their assembly plant. 97% of the vendors are local and the plan is to have almost half of them located in the vendor park. This is to ensure that JIT can be implemented given India's poor and unreliable infrastructure.

➤ *Optimal Transportation Network – Truck Optimization Software, Lead Time Map*

It has been estimated that 70% of the cost of the supply chain is fixed at the design stage. To help design the most efficient supply chain Tata engaged with majority of the supplier's right from the concept phase. Tata paid lot of attention to the supply chain network design from a very early stage which included determination of plant locating, vendor location, location of distribution centers and warehouses, drawing up the optimum transportation network, utilizing backhauls etc. Doing this improves supply chain efficiency by reducing inventory, eliminating waiting times and delays, increasing utilization of warehouse and trucks, optimizing etc.

Inventory reduction efforts ultimately helps drive down cost as it reduces working capital requirements, reduces warehousing and obsolescence costs. To help reduce inventory various schemes, like use of real time RF tracking in the warehouses, were devised to minimize demand fluctuation, improve inventory replenishment accuracy and improve inventory record accuracy. Lead time maps and truck optimization software was used to improve truck utilization. Similarly, to improve warehouse utilization, simple techniques like increasing storage space height, addition of mezzanine level was used to improve storage capacity for a given footprint. Beyond the initial plant at Sanand, Gujarat, Tata is planning to build additional plants across the country to leverage logistics and taxation structure of various states.

➤ *Local 3PL*

The Third Party Logistics (3PL) scenario in India lags significantly behind most western economies. The Nano ecosystem is however set to bolster the demand for sophisticated 3PL vendors who can service the stringent delivery and quality requirements of the automotive OEM like Tata. With the advent of 3PL providers manufacturers can expand their distribution capabilities across the country, even to remote rural locations. According to Frost & Sullivan *“the encouraging growth in global and intra-Asian level trade of Indian auto components sector has created many avenues for 3PL adoption and more can be expected due to India’s active participation in the regional free trade agreements. This is bound to improve prospects for auto components’ 3PL market.”* Improved logistics can help reduce waste by reducing damage to components during transport and enhance the overall value of the supply chain. This sector faces numerous challenges. Hence, Frost & Sullivan says that 3PL service providers need to effectively tackle the challenges to meet customer expectations and deal with existing players in the unorganized sector to establish their market presence.

To tap into the enormous logistics potential of the country, many domestic players are partnering with multinationals to bring in cutting edge 3PL services to the country. For example, Transport Corporation of India (TCI) has partnered with Matsui to provide end-to-end logistics management to leading manufacturers of the automotive industry. *“Today, every new small car that is launched brings with it new technology and car parts, which are mostly imported. This has not only increased the scope of services offered by the logistics sector but has also led to a paradigm shift in the various dimensions of auto logistics,”* says P K Jain, Director, Transystem. As per industry estimates, logistics account for 2-3% of sales for automobile industry and 3 – 4% for the auto component industry. This market was pegged was INR 35 Billion in 2006-07. Given the high demand, other big logistics players like Allcargo Global Logistics, is setting up logistics parks across the nation to streamline logistic service for the auto industry.

## 8. Discussion

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Emerging economies like India are rapidly developing into hotbeds of innovation. The Tata Nano is not a product of any dominant technologic innovation. The underlying technologies in the Nano have been there for decades. Even contrary to popular belief, the assembly line pioneered by Ford for the Model T was adopted from the meatpacking industry<sup>18</sup>. Companies like Tata are redesigning entire supply chains and business processes to reduce cost not just by few percentage points but at an order of magnitude to their counterparts in more developed economies. The resulting “no frills” product promise to touch more people’s lives than ever in the history of mankind. These resulting advances termed as “frugal engineering” is not just about exploiting cheap labor, but redesigning entire supply chains to cut out unnecessary costs. The Tata Nano is an example of dozens of cost cutting tricks employed all across its supply chain. This was made possible by rethinking all aspects of supply chain from demand and supply planning, to procurement, operations, transportation and distribution (or the “five pillars”).

Just as Henry Ford redefined the automotive industry, the Tata Nano is applying principles of supply chain re-engineering, technology and business model innovations and economies of scale to unlock vast new markets. Majority of the innovations in emerging economies are incremental in nature and targeted at the “bottom of the pyramid” market. It consists of innovative ways of redesigning supply chain and processes to reach billion of new consumers in the emerging markets. Just as Henry Ford ushered in the assembly line, Japanese the lean production methodology, the emerging economies are bringing in a new wave of “no frill’s products. This new supply chain paradigm will help fulfill the needs of some of the world’s poorest people who were previously excluded from the market economy. Just as the Japanese invented JIT

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<sup>18</sup> Andrew Hargadon (2003), Blue Ocean Strategy Page 197



to compensate for the lack of storage space, these emerging economies are cutting costs to the bone and eliminating all but the most essential features of a product or service.

The framework proposed in the thesis helps to identify the critical characteristics that will govern the success of supply chains in emerging economies. It helps to map out the process, which systematically steps through the business strategy, operating model, supply chain strategies to the set of customized practices. It is important to note that there is each of the steps is an integral part of the overall framework and a holistic approach is needed to be successful. There is no silver bullet which will lead to an effective strategy, and the framework will provide the guiding principles that will determine supply chain superiority. The supply chain should support, enhance and be aligned with its business strategy and operating model. To do so, it should come up with its own list of customized practices based on the guiding principles underlying the proposed framework. These customized practices are unique to the firm and the industry and cannot be ported to other firms and industries.

**Process flow for “Five Pillar” Supply Chain Framework**

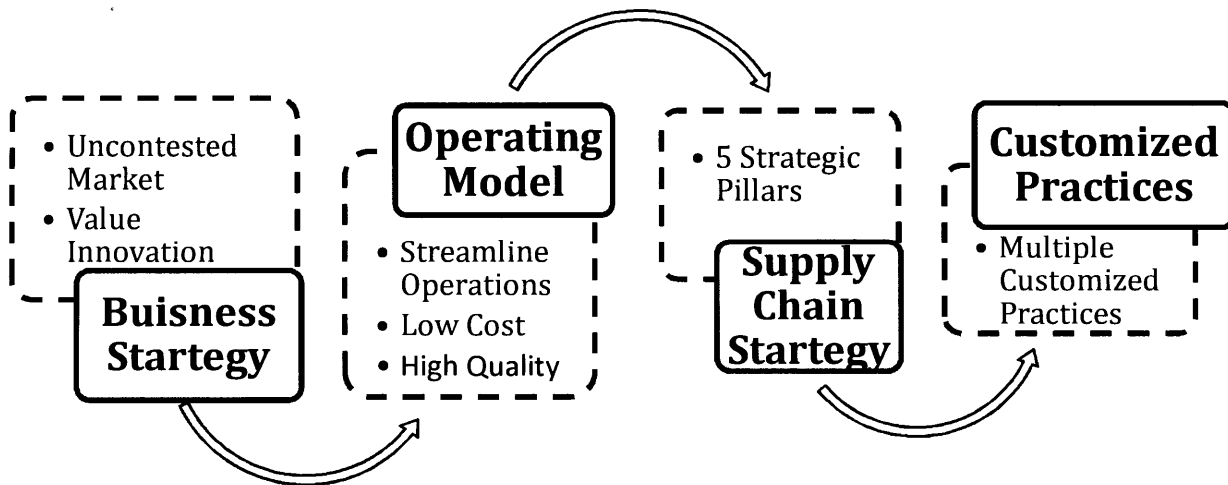


Figure 8-1

To design of the Nano supply chain is shown with the help of the process flow above. It works sequentially as shown and starts with the business strategy and then moves to

the operational strategy. Based on these strategic and operational objectives a set of customized practices are developed to address each of the strategic pillars of the supply chain. In the course of the exercise the process might need to be reiterated to ensure that all the building blocks are in perfect alignment and support each other. For the Nano project the table below summarizes the operational challenges and how Tata designed customized practices to address each of the operational challenges to arrive at a balanced supply chain design.

### Summary of Tata Nano customized Practices

| <b>Supply Chain Pillar</b> | <b>Operational Challenges in Emerging Economy</b>   | <b>Customized Practices</b>   |
|----------------------------|---|---|
| Demand & Supply Planning   | <ul style="list-style-type: none"> <li>➤ Crumbling Infrastructure</li> <li>➤ Lack of Demand Visibility</li> <li>➤ No POS integration</li> <li>➤ No Vendor Managed Inventory</li> <li>➤ Lack of Dedicated Technology Infrastructure</li> </ul>                                 | <ul style="list-style-type: none"> <li>➤ Facility Location</li> <li>➤ Vertical Integration</li> <li>➤ Joint Ventures</li> <li>➤ Vendor Park</li> </ul>  |
| Sourcing/ Procurement      | <ul style="list-style-type: none"> <li>➤ Capacity Constraints</li> <li>➤ Disparate Capabilities</li> <li>➤ Low quality, reliability</li> <li>➤ Lack of access to latest technology</li> <li>➤ Poor Infrastructure</li> <li>➤ Poor Product Development Capabilities</li> </ul> | <ul style="list-style-type: none"> <li>➤ Proprietary and Tata Motor Design</li> <li>➤ Local Source</li> <li>➤ Volume Contract</li> <li>➤ Single Source</li> <li>➤ Target Pricing</li> <li>➤ Functional Collaboration</li> </ul> |
| Operations                 | <ul style="list-style-type: none"> <li>➤ Unorganized Sector</li> <li>➤ Lack of Infrastructural Support</li> </ul>   | <ul style="list-style-type: none"> <li>➤ Design Innovations</li> <li>➤ Manufacturing Innovations</li> <li>➤ Inventory Management</li> <li>➤ Information Management</li> </ul>   |
| Transportation             | <ul style="list-style-type: none"> <li>➤ Poor Logistics Network</li> <li>➤ Logistical Complexity</li> <li>➤ Poor Rural Infrastructure</li> <li>➤ Dispersed Population – 70% in Villages</li> </ul>  | <ul style="list-style-type: none"> <li>➤ Open Distribution</li> <li>➤ Modularity</li> <li>➤ Local 3PL</li> </ul>  |

|                              |   |   |
|------------------------------|---|---|
|                              | <ul style="list-style-type: none"> <li>➤ Complicated product launch due to plurality of cultures</li> </ul>   |   |
| Warehousing/<br>Distribution | <ul style="list-style-type: none"> <li>➤ Lack of Organized Distribution</li> <li>➤ Lack of Modern Warehouses</li> <li>➤ Additional Distribution tiers</li> <li>➤ Complicated tax structure</li> </ul> | <ul style="list-style-type: none"> <li>➤ Distributed Assembly</li> <li>➤ Short Lead Times</li> <li>➤ Optimal Transport Network</li> </ul> |

Table 8-1

**Summary of Tata Nano Customized Practices**

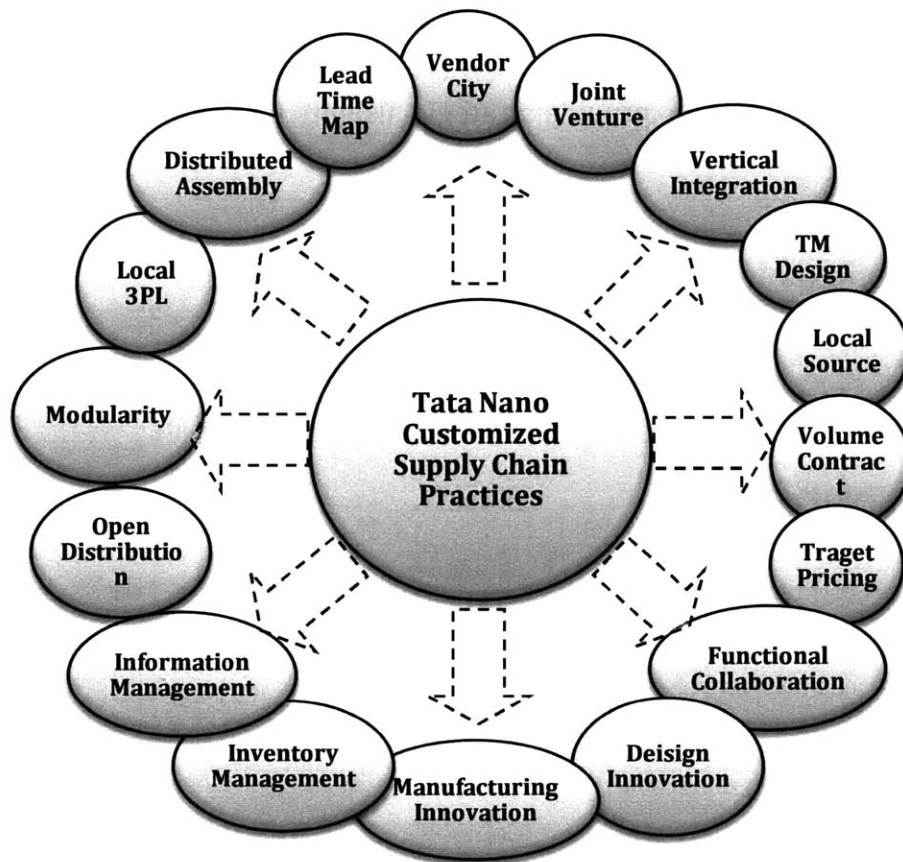


Figure 8-2

This “Five Pillar” framework developed is a generic framework which can apply across industries and companies. As shown in Table 6-1 the framework can be applied to a variety of industries ranging from Banking (Grameen Bank) to Delivery Service (Mumbai Dabbawallas) to Co-Operatives (Amul). In the case of the Mumbai Dabbawallas the key underlying principle was to leverage the low cost human network (Dabbawallas) to build an efficient distribution system. A key challenge in this case was how to manage this complex distribution system without having access to sophisticated technology infrastructure. The customized practice used to address this challenge was to design a unique identification system (a simple color coding system) which the low cost human network can use to determine the destination of the “Dabbas” (lunch boxes).

Use of this framework can thus provide strategic insights into developing highly efficient supply chains.

# 9. Conclusions

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The thesis establishes a framework for developing and building supply chains in emerging economies. A study was performed to understand the unique challenges and complexities of emerging economies. These challenges were then mapped to the “Five Pillars” of supply chain strategy and to address each of the challenges customized practices were developed. These practices were then evaluated to ensure that they were in alignment with the business strategy and operating principles of the firm. The “Five Pillar” framework was validated with multiple case studies and a thorough evaluation was performed to map this framework to the Tata Nano car.

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