Evaluation of Operational Models for World-Class Manufacturing in the
Indian automotive components industry

By

Anirudh Krishnan

B.E. Production Engineering (SW)
PSG College of Technology, 2009

Post Graduate Program in Management
Indian School of Business, 2013

SUBMITTED TO THE MIT SLOAN SCHOOL OF MANAGEMENT IN PARTIAL
FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE IN MANAGEMENT STUDIES
AT THE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

JUNE 2016

©2016 Anirudh Krishnan. All rights reserved.

The author hereby grants to MIT permission to reproduce
and to distribute publicly paper and electronic
copies of this thesis document in whole or in part
in any medium now known or hereafter created.

Signature of Author: _______________________________

MIT Sloan School of Management
May 6, 2016

Signature redacted

Certified by: ______________________________________

Signature redacted

~ Sharmila C. Chatterjee
Academic Head, Enterprise Management Track
Senior Lecturer of Marketing
Thesis Supervisor

Signature redacted

Accepted by: ______________________________

Rodrigo S. Verdi
Associate Professor of Accounting
Program Director, M.S. in Management Studies Program
MIT Sloan School of Management
Evaluation of Operational Models for World-Class Manufacturing in the Indian automotive components industry

By

Anirudh Krishnan

Submitted to MIT Sloan School of Management on May 6, 2016 in Partial fulfillment of the requirements for the Degree of Master of Science in Management Studies.

ABSTRACT

The automotive industry in India is among the largest sectors in the country’s economy in terms of revenue and employment. Several global auto brands are looking to make inroads into one of the fastest growing economies in the world. Global auto manufacturers today are looking to set-up a manufacturing base in India to export products to markets in Asia, Europe and the U.S.

To support the interest of global auto players in the Indian market, it is imperative to upgrade the manufacturing ecosystem in the country to meet global product standards. Tier 1 auto components manufacturers have played an important role in the industry by bridging the gap between indigenous manufacturing capabilities and global requirements. For the industry to progress and grow it is important to enhance the operational skillsets of tier 1 firms to have a percolating effect into lower tiers in the supply chain, thereby improving the overall environment.

Through depth interviews with industry experts and surveys based on Schonberger’s World Class Manufacturing framework, this thesis aims to understand the current state of operations in the Indian auto components industry and unravel what needs to be done within the next decade for the industry to become truly world-class.

Thesis Supervisor: Sharmila C. Chatterjee
Title: Academic Head, Enterprise Management Track
Senior Lecturer of Marketing
To my advisor Prof. Sharmila Chatterjee for guiding me at every step in my research process. To all the experts and veterans who shared their invaluable thoughts, ideas and visions on the Indian auto industry.

To my father Mohanakrishnan who has been my mentor at every step of my life.

And finally, to my mother Damayanthi, my wife Raji and my brother Vijay for their endless support and encouragement.
# Table of Contents

1. Introduction  
   1.1 Automobile and Automobile components industry  
   1.2 Global auto industry landscape  
   1.3 Automotive industry in India  
2. Research Motivation  
   2.1 Challenges in the industry  
   2.2 Relevance to the industry  
3. Research Framework  
   3.1 World Class Manufacturing  
4. Research Methodology  
   4.1 Secondary research  
   4.2 Primary research  
      4.2.1 Depth interviews  
      4.2.2 Survey  
5. Results and Findings  
   5.1 Insights from Depth interviews  
   5.2 Survey findings  
6. Discussion of Findings  
   6.1 Inferences  
   6.2 Recommendations: Way Forward  
   6.3 Effecting the change  
Appendix  
References
List of figures

Figure 1.1 Interactions between stakeholders in the automotive industry 11
Figure 5.1 Radar chart of survey results conducted among Indian manufacturing experts 35

List of tables

Table 2-1 SWOT analysis of Indian auto components industry 18
Table 3-1 Hayes and Wheelwright’s practices 21
Table 3-2 Comparison of world class manufacturing principles as described by Hayes and Wheelwright and Schonberger 25
Table 5-1 Survey scores by principles 36
Table 6-1 Survey results classified according to Schonberger’s assessment 37
Table 6-2 Survey results of principles with scores 3.0 or less 38
1. Introduction

India is the seventh largest economy in the world by nominal GDP, which is estimated at US$ 2.40 trillion in 2016, and is growing at a rate of about 7.5% annually (IMF, 2015). The GDP is classified under three sectors: Agriculture (17%), Industry (26%) and Services (57%) (Planning Commission, 2015). The growth in the Indian economy has been driven primarily by the services sector which also makes the highest contribution but the short and the long term outlook for the Industrial sector in India is extremely positive according to several analysts.

According to the IMF, India’s industrial manufacturing GDP at US$ 559 billion was the 6th largest in the world in 2015 employing about 24.7% of the workforce (Jain, 2015). Analysts at McKinsey forecast India’s manufacturing sector to grow to US$ 1 trillion and create 90 million jobs by 2025 (Rajat Dhawan, Gautam Swaroop, 2012). This makes the industrial sector a prime focus of the Indian government to promote growth and employment in the country.

Towards promoting the industrial sector expansion the Indian government, under Prime Minister Narendra Modi, launched the ‘Make in India’ initiative in September 2014 (Patel, 2016). The initiative focuses on encouraging multi-national and national companies to manufacture products in India for the global market. The major objective of the initiative is to focus on job creation and skill enhancement in 25 sub-sectors of the economy, including Automobiles and Automobile Components. To promote growth and Foreign Direct Investment (FDI) in manufacturing, all sectors under Make in India (except Defense, Space and News Media) permit a 100% FDI.

Having been closely associated with the Indian automotive industry for close to 5 years, my thesis focuses on analyzing the current state of the industry with reference to the evolving global industry and understanding how the industry can be prepared to face challenges in the
foreseeable future. This thesis specifically addresses the opportunities for the Indian auto components industry to remain an attractive sourcing option for the global market and what the industry needs to do to transform to ‘World Class’ manufacturing standards.

1.1 Automobile and Automobile Components Industry

The 2008 financial meltdown coupled with a period of increasing fuel prices created the global automotive industry crisis. The crisis affected manufacturers in the U.S., Europe and Asian countries severely rendering several thousand jobless. Countries took severe measures to revive the domestic auto industry such as offering tax breaks to buyers and bail outs to companies. Since the 2008 crisis, the industry is well on track to recovery. Last year was characterized as a ‘good year’ in mature car markets but developing markets still underperformed expectations with an overall industry growth of 1.5% (Lehne, 2016). 2016 is expected to be a much better year for NAFTA, Europe, China and the ASEAN markets with an estimated growth of 3.2% over the previous period (Lehne, 2016).

The face of the auto industry, the Original Equipment Manufacturers (OEMs), are primarily focused on Business to Customer (B2C). Some of the leading OEMs in the market today are Toyota, General Motors and Volkswagen. The auto parts industry, supplying parts to final vehicle manufacturers or OEMs, is the backbone of the industry accounting for 3.6% of the global manufacturing industry. The Business to Business (B2B) auto parts industry serves a large spectrum of customers, ranging from OEMs to dealers of aftermarket spares. Figure 1.1 is a schematic representation of the interactions between various stakeholders in the auto industry. There are several tiers of suppliers in the auto parts manufacturing value chain but tier 1 (T1) accounts for a disproportionate amount of innovation and development.
technological advancements in the auto industry are prompting OEMs to develop "vertical partnerships" with their suppliers (Mohr, D; Muller, N; Krieg, A; Gao, P; Kaas, H W; Krieger, A; Hensley, 2013). This allows OEMs to cut R&D costs while introducing new products much faster than before. As OEMs are increasingly growing to become parts aggregators, that is putting together outsourced solutions such as engine, transmission systems, HVAC, the role of auto parts suppliers in the supply chain is growing and more value is being created at these tiers. The total value add by suppliers has grown from 56% in 1985 to 82% in 2015 (Thomson Reuters, 2016a).

![Figure 1.1: Interactions between stakeholders in the automotive industry](image)

**1.2 Global auto industry landscape**

The global auto industry recorded sales of 90.7 million vehicles in 2015 (OICA, 2016) with an increase of 1.1% over the previous year. China sold the most number of vehicles at 24.5 million vehicles (+3.3% growth) followed by USA (12 million, +3.8%), Japan (9.2 million, -5.2%) and Germany (6 million, +2.1%). By 2020, the global auto industry is set to grow to 111 million units (Becker, 2015) with over two-thirds of the profits coming in from Brazil, Russia,
India, China (BRIC) and Rest of the World (RoW) regions. The growth in the BRIC and RoW regions is expected to outpace the growth in established markets to become three times that in established markets (Mohr, D; Muller, N; Krieg, A; Gao, P; Kaas, H W; Krieger, A; Hensley, 2013).

The automotive suppliers market is about US$ 700 billion as of 2015 (Thomson Reuters, 2016b). With global industry wide EBIT margins at 7.5% in 2014, auto parts manufacturing is an extremely profitable business to be in (Berger, 2013). The major countries for manufacture and export of auto parts in 2013 were Germany (17%), Japan (11%), US (10%), China (7%), Mexico and South Korea (5.9% each) (The Observatory of Economic Complexity, 2014).

1.3 Automotive industry in India

"To emerge as the destination of choice in the world for design and manufacturing of automobiles and auto components with output reaching a level of US $ 145 billion, accounting for more than 10 per cent of the GDP and providing additional employment to 25 million people by 2016." This is the vision of the Automotive Mission Plan 2006-2016 drafted by the Ministry of Heavy Industries and Public Enterprises department of the Government of India.

Recovering from the impact of the global financial crisis, the Indian auto industry is well on track to bounce back to record production numbers. In the year 2016, commercial vehicle production numbers are at an all-time high backed by regulations and increase in infrastructure investments. The passenger vehicles industry also grew at a healthy 10% rate last year marking record high sales of 2 million units (Balachandar, 2016). With overall passenger car and
commercial vehicle sales of 4.1 million units, India stood sixth in terms of global sales volume in 2015. As of 2013, the automotive industry contributed 7% to the country’s GDP and 22% to the country’s manufacturing GDP. Producing a total of 24 million vehicles annually (including 2W, 3W, 4W and CVs), the automotive industry employs close to 19 million people through both direct and indirect employment (CarDekho, 2015; SIAM, 2015).

Developed auto markets in the U.S., Europe and Japan have always been on the lookout for cheaper destinations to source their products. Wage differential, currency conversion factor, quality of products, IP rights, shipping distances and ease of doing business have all played a significant role in selecting a market of interest. During the 11 month period from April to February FY 15, the Indian automotive sector attracted FDI of US$ 2.42 billion, an increase of 89% over the previous year, according to the Department of Industrial Policy and Promotion (PTI, 2015). Rising cost of production in other Asian countries has forced several large global players including Hyundai, Volkswagen, Ford and Nissan to set up units in manufacturing belts in India to produce vehicles for the domestic and international market. The largest automotive corridors in India are located in Tamil Nadu (Chennai), Maharashtra (Chakan) and the National Capital Region (Gurgaon) with Gujarat and Karnataka among the emerging hubs.

Automotive hubs across India have also given rise to growth in ancillary industries manufacturing automotive components. Along with Original Equipment Manufacturers (OEMs), several global auto components manufacturers such as Robert Bosch, Hyundai Mobis and Yazaki have also moved to India to co-locate with their customers. These tier 1 auto parts
suppliers use their base in India to manufacture products for their customers in India and other Asian, European and U.S. markets owing to the cost advantage of manufacturing in India. Despite challenges like infrastructural woes and interactions with local, immature indigenous manufacturers, tier 1 auto parts manufacturers produce competitive products for the global auto industry.

The Indian auto components industry is US$ 38.5 billion annually, growing at a rate of 11% per year (Athavale, 2015). It is expected to grow to US$ 100 billion by 2020, fueled by growth in exports. In comparison, the size of the Chinese auto components industry is US$ 542 billion, growing at a rate of 5.2% annually. The growth in the automotive components industry in India is challenged by competitive market opportunities in Mexico, Poland, China, Indonesia and other Asian countries.

With the growing importance of tier 1 suppliers in the automotive industry and the evolving economic landscape in India, it is important to address the following questions:

- How can the Indian automotive components industry remain a competitive and attractive sourcing option for global OEMs?
- What should the Indian auto components manufacturers do to transform into 'World Class' manufacturing units to meet the standards of the global auto industry?

The motivation behind the research and the relevance of this study to the industry is described in chapter 2. Chapter 3 focuses on the framework used for this research and introduces the World Class manufacturing framework as described by Schonberger (Schonberger, 1996). A
comparative analysis of various other research frameworks in the area of operational excellence are also presented in this section. Chapter 4 describes the research methodology used for this research and details the secondary and primary research approaches. Chapter 5 presents the findings from the research and chapter 6 concludes this research with recommendations for the Indian auto components industry to remain competitive in the global market.
2. Research motivation

The tier 1 Indian auto components industry is dominated by established players with a global presence in the industry. While several tiers of companies below the tier 1 zone are often fragmented, populated by small and medium family run enterprises, they are an integral part of the structure of the industry. The biggest challenge faced by the industry, particularly the tier 1 suppliers, is to be able to produce globally benchmarked products of highest quality and competitive costs with this existing support structure. It is the responsibility of these tier 1 suppliers to meet the ever growing customer expectations while also empowering their sub tier zones with the technical skills, financial capabilities and resources.

Undertaking such a transformation by uplifting the entire ecosystem to match global standards is a unique challenge to the Indian auto components industry, where there can be cultural and language barriers between companies operating in different parts of the country. For example, tier 1 auto manufacturers operating in the Maharashtra belt and sourcing parts from the Tamil Nadu belt will have very different practices and customer-supplier relationships owing to the regional cultural differences. Tier 1 auto components manufacturers are increasingly growing into solution providers, wherein technology and product innovations occur at this zone and are passed on to OEMs. To support such innovations, they need a stable system in terms of supply partners to sustain development.
2.1 Challenges in the industry

There are several shortcomings in the Indian auto components industry. Some of the major challenges faced by tier 1 manufacturers interacting with their lower tiers in the supply chain are listed below.

*Production Technology:* Often tier 2 or tier 3 auto suppliers do not have the capability and the production technology to supply consistent product quality to meet industry expectations. Integrating information flow between supply partners can also be challenging and depends heavily on manual work.

*R&D:* While a major part of the R&D for auto components is concentrated at the tier 1 level, only a small fraction of the research is done at the tier 2 levels. Usually product designs at tier 2 and 3 are propriety to their tier 1 customers.

*Quality Systems:* The quality systems at lower tier suppliers is usually controlled almost entirely by the tier 1 players. Establishing a standard quality system in line with global certification standards like ISO 9000, Deming or Baldrige are uncommon and are addressed by tier 1 players on a case by case basis.

*Supply Chain Flexibility:* While some lower tier players might be equipped to manage supply chain challenges through flexibility in operations, other firms struggle to meet changing expectations of customers in terms of delivery timelines, schedule changes, quick changeovers and rapid new product introduction.

*Financial stability:* Lower tier suppliers often depend on one large tier 1 player as a primary source of business. Investing in expensive machinery to meet customer expectations and trying to optimize utilization of an expensive asset can render their operating processes very
costly. Several small firms fall into heavy debt because of inefficient operation of their assets and it is not unusual for tier 1 firms to bail them out or acquire them.

_Culture & Talent:_ Cultural differences across the breadth of India can be significantly challenging. Languages spoken in different parts of the country can pose a challenge in effective communication between business partners. Availability of talent at some of the tier 2 and 3 firms can also be a struggle. Constant attrition can mean that tier 1 players will have to deal with multiple stakeholders within their supply partner firms.

A SWOT analysis for the Indian auto components industry is presented in table 2-1. This analysis considers a global view of the industry and is not restricted to its interactions with other tiers alone.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Conducive business environment</td>
<td>• Consistency of quality, on time delivery and cost competency</td>
</tr>
<tr>
<td>• Skills (language/labor/IT)</td>
<td>• Infrastructure</td>
</tr>
<tr>
<td>• Young population</td>
<td>• Complex systems and corruption</td>
</tr>
<tr>
<td>• Strong regard for IP laws</td>
<td>• Geographic diversity</td>
</tr>
<tr>
<td>• Labor costs</td>
<td></td>
</tr>
<tr>
<td>Opportunities</td>
<td>Threat</td>
</tr>
<tr>
<td>• High growth economy</td>
<td>• Competition from other low cost countries:</td>
</tr>
<tr>
<td>• Global market</td>
<td>China, Thailand, Malaysia, Brazil</td>
</tr>
</tbody>
</table>

Table 2-1 SWOT analysis of Indian auto components industry

### 2.2 Relevance to the industry

Operating in these challenging circumstances, tier 1 players are forced to innovate to deliver global quality products at competitive prices and create value to the end customers or OEMs. Integrating multiple operational layers, tier 1 players often act as filters by absorbing the inefficiencies in the lower tiers. Thus, profit generation for stakeholders is an uphill operational
challenge. Continuing to remain globally competitive in the industry implies being able to bring about a holistic development in the entire supply chain at all levels and upgrading the standard of processes, products and technology. It is imperative for emerging markets to develop world class manufacturing capabilities to increase global competitiveness and to not continue relying on low-cost labor advantages (Mora-Monge, González, Quesada, & Subba Rao, 2008).

Focused improvements of tier I players will have a percolating effect on lower tier players thereby creating better manufacturing practices across the industry. Trying to improve upstream lower tier players through grassroots development will not be sustainable unless there is a strong tier I player to support these improvements.

In the ‘Make in India’ era promoting domestic manufacturing, it is critical for the domestic tier I auto components industry to be prepared to handle these challenges, rise to expectations and capitalize on this opportunity, unless it wants to be left out in the race for global manufacturing competitiveness.
3. Research framework

Having set the background for the importance of the Indian automotive components industry to India’s economy and the scope for advancement in the global scale, it is important to measure the current state to determine the preparedness of the industry for future challenges. Recent advancements in fields of Total Quality Management (TQM), Lean and Six Sigma have led to the evolution of several tools and frameworks that COOs believe are crucial for success. But largely these frameworks are solutions that have worked in industries outside India but are applied directly by Indian business heads, sometimes without much data based research or adaptation to suit local conditions. When implementing Just-In-Time practices in supply chain in the early 90s, Indian managers failed to understand the underlying concept and philosophy due to which JIT practices failed in Indian firms (Mahadevan, 1997).

The past three decades have seen significant research on frameworks for manufacturing excellence. The pioneering work was carried out by Hayes and Wheelwright in 1984 in their work ‘Restoring our competitive edge: competing through manufacturing’ (Hayes & Wheelwright, 1984) which paved the path for future research in manufacturing strategies. Through their book, Hayes and Wheelwright sought to throw light on what ails the American manufacturing industry and provide remedies by drawing examples from world class foreign manufacturers. By comparing the manufacturing practices of Japanese, German and American firms, Hayes and Wheelwright framed six key dimensions that firms can compete on to achieve manufacturing excellence. Table 3-1 presents a snapshot of Hayes and Wheelwright’s practices. The authors argue that these six dimensions are a set of tradeoffs that organizations need to
focus on. They posit that it is potentially dangerous to try to excel in multiple dimensions. They believe that “it is difficult (if not impossible), and potentially dangerous, for a company to try to compete by offering superior performance along all of these dimensions simultaneously, since it will probably end up second best on each dimension to some other company that devotes more of its resources to developing that competitive advantage.” (Hayes & Wheelwright, 1984, p. 41)

However, Flynn, Schroeder and Flynn argued in their paper titled ‘World class manufacturing: an investigation of Hayes and Wheelwright’s foundation’ that since the publication of Hayes and Wheelwright’s book, several changes have occurred in the industry that have rendered these six dimensions to behave as synergies and not tradeoffs (Flynn, Schroeder, & Flynn, 1999).

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Rationale</th>
<th>Practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workforce skills and</td>
<td>U.S. firms have neglected development of workforce</td>
<td>• Apprenticeship programs</td>
</tr>
<tr>
<td>capabilities</td>
<td>skills and capabilities; this should not be left to the</td>
<td>• Cooperative arrangements with vocational technical institutes</td>
</tr>
<tr>
<td></td>
<td>schools</td>
<td>• Internal training institutes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Extensive advanced training and retraining beyond entry level, focusing on</td>
</tr>
<tr>
<td></td>
<td></td>
<td>practices</td>
</tr>
<tr>
<td>Management technical</td>
<td>U.S. firms experience technical weakness among their</td>
<td>• Ensure a significant number of managers have engineering or technical</td>
</tr>
<tr>
<td>competence</td>
<td>managers</td>
<td>degrees</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Train potential managers, early in their careers, in a variety of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>technologies important to the firm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Rotate managers through various functions, to broaden their experience</td>
</tr>
<tr>
<td>Competing through quality</td>
<td>U.S. firms need to focus on what is important to</td>
<td>• Seek to align products and processes to meet needs that are important to</td>
</tr>
<tr>
<td></td>
<td>customers</td>
<td>customers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Long-term commitment to quality</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Strong attention to product design</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Involvement of all functions in product design and quality improvement</td>
</tr>
</tbody>
</table>
Real participation is more than simply putting employees into teams

- Develop a culture of trust between workers in various departments and between workers and management
- Routine, close contact between management and workers
- Develop participation policies to ensure that 'We’re all in this together'

Unique capabilities of equipment can’t be copied

- Invest in proprietary equipment
- Bolster ability to perform sophisticated maintenance, process upgrades and continuous improvement of existing equipment

Win the race by creating a constantly escalating standard

- Continuous improvement in small increments
- Continually adapt to changes in customer needs

<table>
<thead>
<tr>
<th>Workforce participation</th>
<th>Real participation is more than simply putting employees into teams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rebuilding manufacturing engineering</td>
<td>Unique capabilities of equipment can’t be copied</td>
</tr>
<tr>
<td>Incremental improvement approaches</td>
<td>Win the race by creating a constantly escalating standard</td>
</tr>
</tbody>
</table>

Table 3-1: Hayes and Wheelwright’s practices (Adapted from Flynn et al., 1999, p. 250)

Other authors of the late 1980s and early 90s proposed several tools for business and operational excellence. Taichi Ohno, often considered the father of Toyota Production System, introduced the seven wastes in 1988 (Ono, 1988). Toyota Production System aims to target waste reduction by focusing on customer needs. This was soon adopted as Lean manufacturing in the west. Several authors and academics have worked to introduce these concepts to managers in the west. Among them was Womack and Jones’s path breaking work ‘Machine that Changed the World’ that took the western manufacturing world by storm. The authors of the book provided tools and techniques for managers to effectively accomplish waste elimination and improve operations (James P. Womack, Daniel T. Jones, & Daniel Roos, 1990).
3.1 World Class Manufacturing

The decade of the 80s provided the industry with dozens of frameworks and management concepts to achieve manufacturing excellence. But several of these concepts failed to serve the interests of the customer, have the commitment of the entire enterprise or be fact based. In 1996, in his work ‘World Class Manufacturing: The Next Decade’ Schonberger proposed 16 Customer-Focused, Employee-Driven, Data-Based Performance principles and a tooling array that allowed companies “to assess their standing and progress toward the high reaches of world-class excellence” (Schonberger, 1996, p. xi). Schonberger drew a parallel between World Class Manufacturing (WCM) and the Olympic Games motto: *cithus, altius, fortius* – translating to faster, higher, and stronger – implying a continuous and rapid improvement process. According to Schonberger, a paradigm shift from ‘Management by Edict’ to ‘Management by Principles’ was necessary to make the transformation towards twenty-first century management of the manufacturing enterprise. Management by Principle is a fairly specific guide that applies to the entire organization, right from the top management to front line employees and not just a manual or a Standard Operating Procedure (SOP). These principles are broadly based on Haynes and Wheelwright’s earlier work and parallels can be drawn between these theories. The 16 principles as illustrated by Schonberger encapsulate much of the operational practices including Lean and TQM to provide a holistic framework for managers today.

Using a scoring system on a scale of 1 to 5 across the 16 principles, Schonberger provides a tool that allows organizations to evaluate and assess the current status and identify areas of improvement based on data. By implementing these tools in over 130 “above average manufacturing companies”, Schonberger offers industry wide benchmarks in his book.
Classifying the 16 principles under General, Design, Operations, Human Resources, Quality & Process Improvement, Information for Operations and Control, Capacity and Promotion/Marketing, Schonberger covers all aspects of a manufacturing organization that is required for achieving excellence and competitive advantage. The emphasis of the principles on not just being ‘Customer-Focused’ but also ‘Employee-Driven’ and ‘Data-Based’ signify the importance of involvement of all levels of employees within the organization and being based on hard data that can be benchmarked. According to Schonberger, the importance of the data in this assessment is to (Schonberger, 1996, p. 20):

1. Establish baseline scores and a one-step-at-a-time map for broad-based, continuous improvement.
2. Expose blind spots. A low score on one of the 16 principles raises a flag.
3. Evaluate proposals.
4. Demonstrate the logic, power and timeliness of management by customer-focused principles.

Appendix A describes the 16 principles and the five step assessment tool used in this research along with the assessment guidelines.

Table 3-2 draws a comparison between Schonberger’s 16 principles and Hayes and Wheelwright’s pioneering work on WCM.
<table>
<thead>
<tr>
<th>Hayes and Wheelwright’s WCM practices</th>
<th>Corresponding Schonberger principles</th>
</tr>
</thead>
</table>
| Workforce skills and capabilities      | - *Principle 8:* Continually enhance human resources through cross-training, development job and career-path rotation and improvements in health, safety and security  
|                                       | - *Principle 9:* Expand the variety of rewards, recognition, pay and celebration—to match the expanded variety of employee contributions |
| Competing through quality              | - *Principle 1:* Team up with customers, organizing by families of customers or products (what customers buy/use).  
|                                       | - *Principle 7:* Operate close to customers’ rate of use or demand |
| Workforce participation                | - *Principle 4:* Frontline employee involved in change and strategic planning—to achieve unified purpose  
|                                       | - *Principle 11:* Frontline teams record and own process data at the workplace |
| Rebuilding manufacturing engineering   | - *Principle 14:* Improve present equipment and human work before considering new equipment and automation  
|                                       | - *Principle 15:* Seek simple, flexible, movable, low-cost, readily available equipment and work facilities—in multiples, one for each product/customer family |
| Incremental improvement approaches     | - *Principle 3:* Dedicate to continual improvement in quality, response time, flexibility and value  
|                                       | - *Principle 5:* Cut to the few best components, operations and suppliers  
|                                       | - *Principle 10:* Continually reduce variation and mishaps |

Table 3-2: Comparison on world class manufacturing principles as described by Hayes and Wheelwright and Schonberger (Flynn et al., 1999, p. 253)
4. Research methodology

World Class Manufacturing is a tool that equips managers to evaluate the current position of their organization, compare it against benchmark and take action using a data based approach. WCM is considered by eminent academics to have contributed significantly to the evolution of operational excellence. WCM has been applied to varied industries ranging from electronics, electrical, textile, automotive, among others and has demonstrated the advantage of being able to identify pain points for organizations for effective corrective action. The methodology of this thesis comprised of secondary and primary research which are described next.

4.1 Secondary Research

Literature shows that there are varying definitions of WCM and there is no universally recognized definition. WCM has a powerful application in improving the operations of an organization by focusing on establishing closer ties with all stakeholders – customers, employees and suppliers with an unwavering commitment towards self-analysis and continuous improvement and an aggressive approach to technologies that help transform strategies into realities (Jesitus, 2004). For the purpose of this research, the 9 barriers to manufacturing excellence (Huge & Anderson, 1988) and the 91 attributes of world class manufacturing systems (Kodali, Sangwan, & Sunnapwar, 2004) provided an understanding of the parameters of WCM. Successful implementation of WCM practices in a Swedish tool-making company has provided insights on practical applications (Lind, 2001). Kodali et al.’s work on justification of WCM in Indian industries through a performance value analysis was studied for an Indian manufacturing oriented application of world class manufacturing systems (Kodali et al., 2004). Felice et al.’s
work on role of WCM in auto industries in developing countries was studied to establish the relevance of world class manufacturing practices in today’s business environment (De Felice & Petrillo, 2015). Felice et al. conclude that WCM represents an integrated system that encompasses all plant processes, from safety to environment, and from maintenance to logistics and quality and that implementation of WCM helps to improve an organization’s internal system. The 16 WCM principles as described by Schonberger appear timeless – as principles are supposed to be. Schonberger believes that since the number of principles are quite large, they seem to be rather comprehensive and encompasses TQM and Lean practices collectively within these principles¹.

4.2 Primary research

4.2.1 Depth interviews

In order to understand the Indian auto components industry better, depth interviews were conducted with industry experts, independent consultants and academics. The purpose of these depth interviews was to probe deeper into what ails the industry and understand how the industry can be better prepared for challenges of the future. These interactions with experts and veterans who have been associated with the industry for several decades and have a deep understanding of the industry are expected to provide insights into the critical success factors for the future.

¹ As described in a personal email conversation with Richard Schonberger dated Mar 10, 2016
A total of 7 interviews were conducted with individuals who have 20 or more years of experience in the industry from various backgrounds. The interviewee pool consisted of the following profiles:

- Executive Director of a firm providing filtration solutions for commercial vehicles
- Independent TQM consultant with 41 years of experience in the industry
- Management consultant and turnaround specialist with 25 years of industry experience
- Training and certifications expert consulting organizations on ISO/TS standards
- Manager of operations for a tier 1 auto firm with 23 years of industry experience
- Industry veteran and retired COO of a tier 1 organization, over 45 years of experience
- Plant head of a brake manufacturing firm with 20 years’ experience in tier 1 auto industry

4.2.2 Survey

Concurrent to the depth interviews, a survey was also conducted to measure the current standing of Indian organizations in the world of WCM. For the survey, a questionnaire was designed based on the assessment tool described by Schonberger and explained in appendix A. The purpose of the survey was to capture the ideas and thoughts of a wider audience and to get more insights into the industry by studying leading organizations today. To understand the industry better by studying the operation of organizations, firms that are best-in-class in India today and are close to achieving a world class status were chosen. The expectation is that these organizations will truly reflect the state of the industry – a) in terms of the advancements in
technology, b) adaptability to changing market trends and c) domestic and regulatory challenges in the industry today. Organizations were selected such that they have been operating in the industry for more than 50 years and have achieved global certifications such as Deming prize or ISO/TS 16949.

This survey was taken by 25 individuals from diverse backgrounds – CEOs, consultants, industry veterans, experts and employees of some of these organizations. Survey takers were selected such that they have or have had close interactions with these top tier 1 auto firms in India for several years, are representative of the diverse geography of India and can add value to this study through their insights. The survey takers consisted of 7 independent industry consultants, 8 CEOs, 8 employees at Head of the Department levels of various firms and 2 academics spread across North, East, West and South of India.
5. Results and Findings

Through depth interviews and surveys, this study aims to understand the existing condition of the Indian industry and identify key areas of improvement to sustain a competitive advantage. The next sections describes the findings of the depth interviews and the survey.

5.1 Insights from Depth interviews

Depth interviews were conducted with 7 experts who have served in the industry for more than 20 years. The insights from these depth interviews have been classified into 6 distinct factors and compiled below. These insights are categorized in themes concurrent with Schonberger’s model.

5.1.1 Continuous Improvement

The common theme running across all depth interviews was the emphasis that experts laid on the importance of continuous improvement or kaizen. Various firms adopted different techniques and approaches to the process of continuous improvement. One particular interviewee, an Executive Director of a tier 1 firm, said his firm used the Theory of Constraints (TOC) methodology to keep looking for sufficiency of a solution (a sufficiency logic is defined as a cause/group of causes that guarantee the existence of an effect). By constantly looking for a sufficient solution, the organization aims to meet customer needs and design an optimized process or product to serve the customer. Further interviews also stressed on the importance of
continuous improvement within their organizations as evidenced in the quote from one of the interviews.

“Team is eager to learn global requirements and raise standards in process and product with optimum cost... The site [sic] is entitled for Differentiation through ‘Creativity and Frugal’ Manufacturing”

- Plant Manager of a tier 1 auto firm based in Chennai, India

These comments are in line with Schonberger’s Principle 3 (Continual, rapid improvement in what all customer want), 6 (Cut flow time and distance, start-up/changeover times) and 15 (Seek simple, flexible, movable, low-cost equipment in multiples).

5.1.2 Empowering employees

Another facet that the interviews revealed is the need to empower employees in an organization. Providing employees with the necessary skill set and challenging them is the recipe managers believe in to bring about strategic advantage to a firm. Bringing about a Total Employee Involvement (TEI) spanning all functions of the organization was also found to be a critical success factor.

“Company aspiring for World class should have a sustained continual improvement through Total Employee Involvement in all processes.”

- Independent consultant with 20 years of industry experience
This aligns with principle 4 (Front liners involved in change and strategic planning), 8
(Continually train everybody for their new roles) and 11 (Frontline teams record and own
process data at workplace) of Schonberger’s Customer-Focused principles of WCM.

5.1.3 Deployment of metrics

Closely aligned with empowering employees is deploying the right metrics to measure
success. Quoting an industry consultant who has worked in several tier 1 auto firms for over 20
years,

“... policy management to be deployed across all sections of employees to have goal
congruence in meeting the divisional objectives.”

- Independent industry consultant

This resonates with the views of another TQM consultant who also believes in daily
management to measure the right success parameters and design incentives for employees
according to the overall goal of the organization.

Drawing a parallel with Schonberger’s WCM principles, this aligns with Principle 13
(Align performance measures with customer wants). In his book on World Class Manufacturing,
Schonberger classifies customer wants into quality, speed, flexibility and value and recommends
organizations define and measure only first order metrics aligned with these customer needs.
5.1.4 Team work

Based on the interviews, team work came out as another critical success factor. At least 2 interviewees mentioned that team work and cross functional teams were important to provide a quick response to changing customer needs. This is in line with Schonberger’s first principle (Team up with customers; organize by customer/product family) where he stresses the need to structure the internal organization by customer teams for the firm to be customer centric.

“The key aspect for the company to become world-class is to concentrate on improving the robustness of daily management and improve the culture of team working.”

- TQM consultant with 40 years of industry experience

5.1.5 Branding

The urge to be globally competitive and to become global OEM suppliers was prevalent among tier 1 firms. As commented by an industry expert during the interviews,

“There is a great urge in tier 1 companies to become global OEM suppliers. Tremendous efforts are on to achieve this objective. There is a National awareness to be globally competitive.”

- Industry veteran and former CEO of a tier 1 auto manufacturer

To achieve a high visibility in the global market, a large number of firms are striving for global certifications like ISO/TS and Deming prize. Schonberger’s 16th principle (Promote/market/sell every improvement) describes these efforts succinctly. At the highest level
of this principle Schonberger suggests 'reverse marketing' where a firm choses the customers it wants to serve.

5.1.6 Leadership & Culture

Another common theme in the interviews was the stress on Leadership and Culture of the organization. The sustainability of operational excellence was felt to depend largely on the quality of the leadership team. There was significant agreement among experts in reinforcing the basics of TQM and daily management by integrating these efforts into the culture of the organization. One turnaround consultant believed that management styles that are not typically top-down and encourage more open discussions and flow of ideas from all levels of the organization will help empower employees while also maintaining a balance of power within the organization. He cited the example of recent product recalls and failures in the auto industry to be a symptom of failure of leadership to set the right culture and style. A combination of grass-root employee involvement and top management commitment towards operational excellence was seen as the key to achieving world class status for an organization.
5.2 Survey Findings

A survey was designed based on Schonberger's 16 principles and was conducted among 25 individuals of varying backgrounds and experience in the industry. A similar assessment tool as described by Schonberger was used to evaluate the responses from survey takers.

Out of a maximum possible score of 80, scores from the survey ranged from 34 to 61. Referring to the assessment table, all scores lie in the middle ranges of the spectrum: Childhood, Adolescence and Adulthood stages. None of the survey results pointed to organizations either in the early stages or the mature stages of World Class status. Figure 5.1 is a graphical representation of the survey scores. The radii of the radar chart represent the 16 principles and the average of scores across each principle from the survey respondents is plotted in the graph. Scores range from 0 to 5 for each principle.

Survey of World Class Manufacturing practices among Indian manufacturing organizations

Figure 5.1 Radar chart of survey results conducted among Indian manufacturing experts
The above chart is a representation of the current status of the Indian auto components industry in the world of World Class Manufacturing. Stacking up the survey results along the 16 principles is listed in table 5-1.

<table>
<thead>
<tr>
<th>Principle</th>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Team up with customers; organize by customer/product family</td>
<td>3.00</td>
</tr>
<tr>
<td>2</td>
<td>Capture/use customer, competitive, best-practice information</td>
<td>2.50</td>
</tr>
<tr>
<td>3</td>
<td>Continual, rapid improvement in what all customer want</td>
<td>3.60</td>
</tr>
<tr>
<td>4</td>
<td>Front liners involved in change and strategic planning</td>
<td>3.00</td>
</tr>
<tr>
<td>5</td>
<td>Cut to the few best components, operations, and suppliers</td>
<td>2.30</td>
</tr>
<tr>
<td>6</td>
<td>Cut flow time and distance, start-up/changeover times</td>
<td>2.55</td>
</tr>
<tr>
<td>7</td>
<td>Operate close to customers; rate of use or demand</td>
<td>3.50</td>
</tr>
<tr>
<td>8</td>
<td>Continually train everybody for their new roles</td>
<td>3.20</td>
</tr>
<tr>
<td>9</td>
<td>Expand variety of rewards, recognition and pay</td>
<td>2.55</td>
</tr>
<tr>
<td>10</td>
<td>Continually reduce variation and mishaps</td>
<td>3.55</td>
</tr>
<tr>
<td>11</td>
<td>Frontline teams record and own process data at workplace</td>
<td>3.95</td>
</tr>
<tr>
<td>12</td>
<td>Control root cause to cut internal transactions &amp; reporting</td>
<td>2.50</td>
</tr>
<tr>
<td>13</td>
<td>Align performance measures with customer wants</td>
<td>3.65</td>
</tr>
<tr>
<td>14</td>
<td>Improve present capacity before new equipment &amp; automation</td>
<td>2.40</td>
</tr>
<tr>
<td>15</td>
<td>Seek simple, flexible, movable, low-cost equipment in multiples</td>
<td>3.30</td>
</tr>
<tr>
<td>16</td>
<td>Promote/market/sell every improvement</td>
<td>3.75</td>
</tr>
</tbody>
</table>

Table 5-1: Survey scores by principles
6. Discussion of Findings

6.1 Inferences

Interviews with experts revealed prevalent practices in the industry and the gaps to achieve World Class status. Results from the survey reinforced the perception of experts with numeric and comparable data. All organizations scored between 34 and 61 points in the assessment scale indicating that they are at different stages of reaching the world-class status and efforts are being taken by organizations across the industry towards being globally competitive. Recalling the assessment table from Schonberger’s framework, classification survey scores of organizations according to the guideline is presented in table 6-1.

<table>
<thead>
<tr>
<th>Assessment classification</th>
<th>No. of organizations reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-24 points – Eyes open, first steps, early learning</td>
<td>0</td>
</tr>
<tr>
<td>25-38 points – Childhood: Trial and Error</td>
<td>1</td>
</tr>
<tr>
<td>39-52 points – Adolescence: Checklists and guidelines</td>
<td>13</td>
</tr>
<tr>
<td>53-66 points – Adulthood: Policies</td>
<td>7</td>
</tr>
<tr>
<td>67-80 points – Maturity: Principles</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 6-1: Survey results classified according to Schonberger’s assessment

It is interesting to note that none of the organizations reported scores in the early stage of the assessment table indicating that there is an awareness among leading tier 1 automotive companies moving up the ladder towards world-class status. There were no reported scores in the ‘Maturity’ segment of the table either showing that while some organizations were progressing towards becoming world-class, they still have some way to go before becoming truly global. A large portion of the survey respondents, about 62%, reported scores in the Adolescence stage of
evolution and another 33% reported scores in the Adulthood stage. Such organizations in these categories should be the focus for the next decade to propel the Indian automotive components industry into the global landscape and to attract investments in the sector.

6.2 Recommendations: Way Forward

Looking at the scoring pattern by principles, from table 5-1 it is evident that of the 16 principles, 8 principles scored 3.0 or lower which is the median in the scoring spectrum by each principle. These principles clearly outline the areas that organizations need to work on to improve their performance and develop a global competitive edge in manufacturing. Table 6-2 lists the principles that scored 3.0 or less in the survey.

<table>
<thead>
<tr>
<th>Principle</th>
<th>Description</th>
<th>Score</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Cut to the few best components, operations, and suppliers</td>
<td>2.30</td>
<td>Lean</td>
</tr>
<tr>
<td>14</td>
<td>Improve present capacity before new equipment &amp; automation</td>
<td>2.40</td>
<td>Lean</td>
</tr>
<tr>
<td>2</td>
<td>Capture/use customer, competitive, best-practice information</td>
<td>2.50</td>
<td>Cont. Improvement</td>
</tr>
<tr>
<td>12</td>
<td>Control root cause to cut internal transactions &amp; reporting</td>
<td>2.50</td>
<td>Lean</td>
</tr>
<tr>
<td>6</td>
<td>Cut flow time and distance, start-up/changeover times</td>
<td>2.55</td>
<td>Lean</td>
</tr>
<tr>
<td>9</td>
<td>Expand variety of rewards, recognition and pay</td>
<td>2.55</td>
<td>TEI</td>
</tr>
<tr>
<td>1</td>
<td>Team up with customers; organize by customer/product family</td>
<td>3.00</td>
<td>Cont. Improvement</td>
</tr>
<tr>
<td>4</td>
<td>Front liners involved in change and strategic planning</td>
<td>3.00</td>
<td>TEI</td>
</tr>
</tbody>
</table>

Table 6-2: Survey results of principles with scores 3.0 or less

To gain a competitive advantage in manufacturing and to achieve world-class status, this study, through interviews and surveys, shows three distinct areas that organizations in Indian auto components industry need to work on to upgrade the entire supply chain.

1. Lean Manufacturing

2. Total Employee Involvement
3. Continuous improvement through benchmarking

6.2.1 Lean Manufacturing

Lean Manufacturing is the philosophy of ‘doing more with less’. Lean is a term first coined by John Krafcik in 1988 (Krafcik, 1988) describing the assembly production process in automotive plants. In essence, Lean is a principle of creating greater value for the customer while eliminating waste. Womack and Jones recommend that organizations consider three fundamental business issues while embarking on a lean transformation to guide the organization: Purpose, Process and People (James P. Womack et al., 1990). There are several scientifically established Lean tools and techniques which organizations apply to achieve a lean operation to eliminate Muda, Mura and Muri – the 3Ms of wastes in Lean Manufacturing. From table 6-2, principles 5, 6, 12 and 14 point in the direction of Lean implementation in manufacturing and across the supply chain extending to supply partners.

6.2.2 Total Employee Involvement

When bringing about a shift in the management system, it is critical to involve employees at all levels of the organization to sustain changes effectively. Motivating and incentivizing TEI within the organization promotes local innovation within the firm which can not only eliminate but also prevent waste generation, making the organization leaner. In line with Deming’s principle, that Schonberger also echoes, moving away from executive level numeric goals to team goals can help build greater commitment among employees to achieve far reaching results.
Principles 4 and 9 from the above table clearly indicate the emphasis that firms need to lay on promoting TEL. Expert interviews also revealed the importance placed by managers on TEL to achieve operational excellence. Effective implementation of TEL and active involvement of Human Resources in empowering employees will yield sustained results in the path towards world-class.

6.2.3 Continuous Improvement through benchmarking

Operating in a market without visibility of customer expectations or the competencies of competitors will not get an organization very far. Being able to see outward and learn from customers and competition will allow an organization to grow its competencies. To excel and continue to remain competitive, an organization must keep upgrading its resources, products and skills by constantly benchmarking and improving. Benchmarking process can be done against competition and also against customers to gain valuable insights into best practices. Continuous improvement processes with benchmarking will allow an organization to push the efficient frontier in the industry by constantly rotating the Shewhart Cycle (Plan-Do-Check-Act).

Principles 1 and 2 of Schonberger's principles focus on creating greater value to the customer by working closely with the customer and capturing best practices in the industry. Continuous improvement was yet another aspect that the interviews brought to light as a process to empower the organizations with a unique competitive edge.
6.3 Effecting the change

In conclusion, making significant progress and seeing results in achieving a world-class manufacturing system in the Indian auto industry can take at least a decade. But table 6-1 shows that sustained efforts in the right direction are bound to bring greater opportunities to the industry in the future. Effective implementation of Lean techniques involving empowered employees coupled with constant benchmarking can help organizations measure progress towards a vision of achieving a ‘world-class’ status. To quote Schonberger, the essentials of a ten-year plan for the industry should include:

1. Shifting an organization’s mind-set toward management by principles.
2. Ensuring principles are customer focused, driven by all employees, and based on factual data.
3. Keeping a score on the progress against principles.
4. Improving step by step across all principles and not just certain principles.
5. With evolving market scenarios, re-evaluating the scores by benchmarking to improve continuously.
## Appendix A

Management by Principle: Schonberger’s five step assessment tool

**Principles of Customer-Focused, Employee-Driven, Data-Based Performance**

(Schonberger, 1996, p. 24-27)

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>General</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cross-functional project teams</td>
<td>Sustained yearly QSFV (Quality, Speed, Flexibility, Value) improvement rates of 50% or more in all key processes</td>
<td>Team up with customers; organize by customer/product family</td>
<td>Capture/use customer, competitive, best-practice information</td>
<td>Continual, rapid improvement in what all customers want</td>
<td>Front liners involved in change and strategic planning</td>
</tr>
<tr>
<td>2</td>
<td>Customer/client representatives on project teams</td>
<td>95% improvement in Q, S or F in most key processes</td>
<td>Customer/client representatives for each focused unit</td>
<td>Broad implementation of better-than-best practices for customer service</td>
<td>Sustained yearly QSFV (Quality, Speed, Flexibility, Value) improvement rates of 50% or more in all key processes</td>
<td>Frontline teams help develop strategies and set numeric goals, self-monitored</td>
</tr>
<tr>
<td>3</td>
<td>Focused work-flow teams (cells) for key product/customer families</td>
<td>90% improvement in Q, S or F in most key processes</td>
<td>Entire enterprise reengineered by customer/product families</td>
<td>All associates involved in customer/competitive/best-practice assessment</td>
<td>95% improvement in Q, S or F in most key processes</td>
<td>Frontline teams plan/implement cross-functionally with other teams</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td>Focused work-flow teams (cells) for key product/customer families</td>
<td>Systematic customer surveys; full scale benchmarking for key processes</td>
<td>90% improvement in Q, S or F in most key processes</td>
<td>Frontline teams continuously plan and implement process improvement</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>Customer/client representatives for each focused unit</td>
<td>Customer/client representatives for each focused unit</td>
<td>90% improvement in Q, S or F in most key processes</td>
<td>Frontline teams assist in planning and implementing changes in won processes</td>
</tr>
</tbody>
</table>

---

| 1 | Cross-functional project teams | 50% improvement in quality (Q), speed (S), or flexibility (F), in a key process | Customer/client representatives for each focused unit | Capture/use customer, competitive, best-practice information | Continual, rapid improvement in what all customers want | Frontline associates assist in planning changes in own jobs | Team up with customers; organize by customer/product family | Capture/use customer, competitive, best-practice information | Continual, rapid improvement in what all customers want | Frontline teams help develop strategies and set numeric goals, self-monitored |

---

42
<table>
<thead>
<tr>
<th>Step</th>
<th>Design</th>
<th>Operations</th>
<th>Human Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Cut to the few best components, operations, and suppliers</td>
<td>Cut flow time and distance, start-up/changeover times</td>
<td>Operate close to customers; rate of use or demand</td>
</tr>
<tr>
<td>5</td>
<td>Average reductions of 90% for all products and services</td>
<td>Cross-functional teams achieve 90% average reductions</td>
<td>Entire flow path for key items synchronized to rate of use or demand</td>
</tr>
<tr>
<td>4</td>
<td>Average reductions of 80% for all products and services</td>
<td>Experts help achieve 80% average reductions</td>
<td>80% of flow path synchronized to rate of use/demand for key items</td>
</tr>
<tr>
<td>3</td>
<td>Average reductions of 50% for all items</td>
<td>Associates achieve 50% average reductions across all processes</td>
<td>50% of flow path synchronized to rate of use/demand for key items</td>
</tr>
<tr>
<td>2</td>
<td>50% fewer parts/operations and suppliers for all key items</td>
<td>In key processes associates cut get-ready/setup, flow time and distance 50%</td>
<td>Final process synchronized to rate of use/demand - all key products or services</td>
</tr>
<tr>
<td>1</td>
<td>50% fewer parts/service operations or suppliers for a key product or service</td>
<td>Train associates in readiness, setup/changeover, queue limitation</td>
<td>Final process synchronized to rate of use/demand for a key product or service</td>
</tr>
<tr>
<td>Step</td>
<td>Human Resources</td>
<td>Quality &amp; Process Improvement</td>
<td>Information for Operations and Control</td>
</tr>
<tr>
<td>------</td>
<td>----------------</td>
<td>-----------------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>Systematic, public recognition/celebration of achievements</td>
<td>Training in &amp; use of &quot;7 basic tools&quot; of statistical process control</td>
<td>Training in fail-saving, process simplification, root cause control</td>
</tr>
<tr>
<td>2</td>
<td>Variety of low-cost/no-cost awards to both teams and individuals</td>
<td>Capability analysis for key processes; rework, defects &amp; lateness cut 50%</td>
<td>Work-flow, quality, internal scheduling &amp; labor transactions cut 25%</td>
</tr>
<tr>
<td>3</td>
<td>Investing in employees via training, cross training, cross careering</td>
<td>1.0 capability for key processes; rework, defects, &amp; lateness cut 95%</td>
<td>Internal transactions cut 50%; 50% of external transaction by EDI</td>
</tr>
<tr>
<td>4</td>
<td>Pay of skills/knowledge; team/unit bonuses (no piecework)</td>
<td>1.33 Cpk; defects below 100 parts per million; re-work &amp; lateness cut 95%</td>
<td>Internal transactions cut 75%; 75% of external transactions by EDI</td>
</tr>
<tr>
<td>5</td>
<td>Profit/gain sharing; stock/stock options</td>
<td>2.0 Cpk (Process capability index); defects below 10PPM; rework &amp; lateness cut 99%</td>
<td>Internal transactions cut 99%; 99% of external transactions by Electronic Data Interchange (EDI)</td>
</tr>
<tr>
<td>10</td>
<td>Continually reduce variation and mishaps</td>
<td>25+ mostly team suggestions/associate, mostly implemented by associates</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Expand variety of rewards, recognition and pay</td>
<td>Frontline teams record and own process data at workplace</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Control root cause to cut internal transactions &amp; reporting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step</td>
<td>Information for Operations and Control</td>
<td>Capacity</td>
<td>Promotion/Marketing</td>
</tr>
<tr>
<td>------</td>
<td>----------------------------------------</td>
<td>----------</td>
<td>-------------------</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>5</td>
<td>Align performance measures with customer wants</td>
<td>Improve present capacity before new equipment &amp; automation</td>
<td>Seek simple, flexible, movable, low-cost equipment in multiples</td>
</tr>
<tr>
<td>4</td>
<td>Second-order metrics (e.g., labor productivity, variances) no longer managed</td>
<td>Operators become technicians; downtime cut 80%</td>
<td>90% of equipment owned by focused teams/cells or is highly flexible/movable</td>
</tr>
<tr>
<td>3</td>
<td>QSFV are dominant metrics in all processes</td>
<td>Experts teach operators to do repairs; downtime cut 50%</td>
<td>60% of equipment owned by focused teams/cells or is highly flexible/movable</td>
</tr>
<tr>
<td>2</td>
<td>QSFV are dominant metrics in key support departments</td>
<td>Experts help operators take over their own PM and housekeeping</td>
<td>30% of equipment owned by focused teams/cells or is highly flexible/movable</td>
</tr>
<tr>
<td>1</td>
<td>QSFV are dominant metrics in key operations</td>
<td>Preautomation (short flow paths, exact placement, housekeeping, etc.)</td>
<td>10% of equipment &quot;owned&quot; by focused teams/cells or is highly flexible/movable</td>
</tr>
<tr>
<td></td>
<td>Training in universal customer wants: speed, flexibility, quality, value (QSFV)</td>
<td>Training in total preventive maintenance (TPM) and process simplification</td>
<td>Seek/ convert/ upgrade marginal equipment to dedicated or high flex uses</td>
</tr>
</tbody>
</table>

**Scoring:** Score one point for each step, for each of the sixteen principles. Scores range from 1 to 5 for each principle, 1 being the lowest and 5 being the highest, and the maximum possible score is 80.

**Assessment:** Total score ranges and categories

11-24 points – Eyes open, first steps, early learning

25-38 points – Childhood: Trial and Error

39-52 points – Adolescence: Checklists and guidelines

53-66 points – Adulthood: Policies

67-80 points – Maturity: Principles
References


Rajat Dhawan, Gautam Swaroop, and A. Z. (2012). Fulfilling the promise of India’s


