Six Sigma Projects in Supply Chain Management
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Suppliers (International)

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Warehouse

JIT PC Assembly Plant

1.2 million PC/Yr
Glasgow UK

Port

13 Transshipment Points (TPs in Europe)

Country-wide Distribution Centers (DCs)

Retailers
What SCM is

A Supply Chain is a network of organizations

Goal: Produce value for the ultimate consumer

Primary purpose:
- Satisfy customer needs
- Manage flows of goods and information
- Generate profits for itself
- Decide locations, which products to produce at what stage, how to produce and how to distribute
The Supply Chain Process

Integrated, coordinated network of value delivering business processes that procure raw materials, transform them into final products, services and delivers the product to the customers involving...

- Procurement
- Manufacturing/Assembly
- Inbound logistics
- Warehousing
- Distribution
- Outbound logistics
The Inventory Cycle

Profile of Inventory Level Over Time

Q

Quantity on hand

Usage rate

Reorder point

receive order

Place order

Receive order

Time

Receive Order

Place order

Receive order

Place order

Receive order

Lead Time
Cost Minimization by EOQ

The Total-Cost Curve is U-Shaped

\[ TC = \frac{Q}{2} H + \frac{D}{Q} S \]

Annual Cost

Order Quantity (Q)

\( Q_0 \) (optimal order quantity)

Ordering Costs
A Key Challenge in SCM

Goal is to design and manage a supply chain network that delivers high-quality products to the right customers at the right time at minimum cost.

Good supply chain management aims at reducing inventory and freeing up working capital without affecting service levels.

A great deal of inventory piles up along the supply chain due to:

- Poor quality of supplies – production may stop if there are no materials and parts in the buffer stock
- Poor management of logistics and no monitoring of lead times
- Machines break down resulting from poor quality culture, causing production interruption – again buffers are needed
- Quality of finished goods may not be high enough to support JIT mode of operation in your customer’s operations
Examples of Supply Chains operating in India – All have buffers ("just in case")

Automotive – Telco, ALL, Mahindra, Maruti
Aerospace – ADA, HAL
Chemicals – Asian Paints, Apollo tyres, Reliance
Apparel – Madura Coats, Reliance
Food – Cadbury, Parle, Amul Products, HLL
Consumer durables – HLL, P & G
Forest Products – Papermills
Construction – L & T
Pharmaceutical – Ranbaxy, Glaxo
Electrochemical – Kirloskar, L & T
Tooling, HMT, Widia, Mico
PC and Computer – IBM, WIPRO, HCL, Intel
Why bring TQM into SCM?

Each entity in a supply chain is both a supplier and a customer.

Thus, important to have a customer focused corporate vision while implementing TQM and SCM practices both upstream and downstream.

Customer-driven vision can produce a number of competitive advantages for the supply chain by:
- Helping improve productivity
- Reducing inventory and cycle time
- Boosting customer satisfaction, market share and profits
SPC – Xbar Chart Helps Control Accuracy

Average Xbar = 82.5kg
Standard Deviation of X bar = $\sigma_{\text{xbar}}$ = 1.6kg

Control Limits = Average Xbar +/- 3 $\sigma_{\text{xbar}}$

= 82.5 +/- 3 * 1.6 = [77.7  87.3]

Here the process is “in control” (i.e. the mean is stable)
SPC – Range (R) Chart Helps Control Precision

Average Range $R = 10.1$ kg
Standard Deviation of RRange = 3.5 kg
Control Limits: $10.1 \pm 3.5 = [20.6, 0]$

Process is “in control” (i.e. precision is stable)
SCM and TQM

Supply Chain Management (SCM) and Total Quality Management (TQM) are two key tools used by manufacturers and service providers to make their business competitive.

Quality: Value addition during production and delivery.

Sustaining quality throughout the chain has significant implications for reducing costs and raising customer satisfaction, hence sales.
Many end-products producers now recognize the potential benefits of partnering with their suppliers in managing quality in their supply chains.

A key example is Chrysler:
- In 1935 Chrysler’s suppliers showed a quality level of 300 to 400 defective parts per million (ppm)
- To achieve < 100 ppm for its suppliers, Chrysler forced its 2nd and 3rd tier suppliers to implement the same quality standards as its 1st tier suppliers
- Same procedures through the entire supply chain improved quality performance of all suppliers
- Chrysler also used quality as a deciding factor to reduce the number of its suppliers
Consequences of Poor Quality

➡️ Huge Buffers

• Raw, WIP and Finished Goods Inventories
• Capacity Buffers (e.g. understated capacity)
• Lead time Buffers (e.g. Overstated lead time)
Detailed Network Analysis and Management by SCM helps minimize the Total Cost

But! Many $ buffers are added due to poor quality – man, machine, materials & methods used

Diagram:

- Tier 2 Supplier
- Tier 1 Supplier
- MFg Plants
- Distribution
- Customers
Uncovering Production Problems due to Quality

We must lower the “water level!”

Visible production problems are only some of the total

Visible Productivity

Workload Imbalances

Control Specs Problems

Material Shortages

Quality Problems

In-Process Inventory

Worker Absenteeism
Dimensions of Quality

Quality Improvement

Quality improvement is the reduction of variability in processes and products.

Alternatively, quality improvement is also seen as “waste reduction” (muda).
The Link Between Quality and Productivity

Effective quality improvement can be instrumental in increasing productivity and reducing cost.

The cost of achieving quality improvements and increased productivity is often negligible.
But how does the company save $?

It does so by targeting and attacking Cost of Poor Quality Elements...

• Inspection and Test
• Rework/Repair
• Scrap
• Warranty
• Besides, the company has large hidden costs
Visible and Hidden Costs

**VISIBLE COSTS**
- Scrap
- Rework
- Warranty costs

**HIDDEN COSTS**
- Conversion efficiency of materials
- Inadequate resource utilization
- Excessive use of material
- Cost of redesign and re-inspection
- Cost of resolving customer problems
- Lost customers/Goodwill
- High inventory
How a Company averted a Supply Chain Quality Failure

• Recognize the rising dependence on Supply Chain Quality – Requirements, Time Cost

• Shift immediately to Supply Chain Collaboration

• Find Benchmarks – Quickie Tools ([http://ww.quickie.com](http://ww.quickie.com))
  - Manufacturer of cleaning tools, relies exclusively on more than 100 suppliers, many overseas
  - Needed a system to monitor and manage their suppliers quality – all the way down to the shop floor – as the products were being manufactured – implemented real-time SPC
  - Goal: Improve supplier quality. Was critical to identify problems caused by a breakdown in manufacturing process control up front rather than at the tail end of the process – after producing hundreds of products and packaging and shipping them
  - Realized benefits within just a few weeks of SPC implementation
  - Drastically reduced the risk of receiving defective lots
  - Implemented incentive programs that share savings to reward the better suppliers and reduce the costs of working with poor performing suppliers
Quality Tools that work in SCM

TQM philosophy to guide all plans, operations and activities
- Top management’s direct involvement
- Strong internal/external customer orientation
- Systematic problem solving using statistics
- Everyone participates – suppliers, organization, customers

• 7 tools to solve problems at the floor level: QS 9000 for culture
• SPC to monitor variability in all that can be measured: Sampling to provide evidence
• DMAIC projects to focus improvement efforts in meeting requirements, delivery times and cost/profit targets
Is Six Sigma Realistic? Let your customers tell you
Six Sigma Implementation: DMAIC Framework

1. Define (D)
   - Customers and their priorities

2. Measure (M)
   - Process and its performance

3. Analyze (A)
   - Causes of defects

4. Improve (I)
   - Remove causes of defects

5. Control (C)
   - Maintain quality
NISSAN Motor Company Supply Chain Problem: Logos won’t stick!

<table>
<thead>
<tr>
<th>Factor</th>
<th>Level</th>
<th>Level</th>
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<tbody>
<tr>
<td>Adhesion Area (cm²)</td>
<td>15</td>
<td>20</td>
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<tr>
<td>Type of glue</td>
<td>Acryl</td>
<td>Urethan</td>
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<tr>
<td>Thickness of Foam Styrene</td>
<td>Thick</td>
<td>Thin</td>
</tr>
<tr>
<td>Thickness of Logo</td>
<td>Thick</td>
<td>Thin</td>
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<tr>
<td>Amount of pressure</td>
<td>Small</td>
<td>Big</td>
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<tr>
<td>Pressure application time</td>
<td>Short</td>
<td>Long</td>
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<tr>
<td>Primer applied</td>
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<td>No</td>
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# NISSAN’s DOE Design Array

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<th>No.</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Gluing Str</th>
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<td></td>
<td>12.6</td>
</tr>
</tbody>
</table>

- **A** – Adhesion Area (cm²)
- **B** – Type of Glue
- **C** – Thickness of Foam Styrene
- **D** – Thickness of Logo
Factor Effects Plot

- **Adherance Area**
  - +: 4.6
  - -: 6.5

- **Type of Glue**
  - +: 5.5
  - -: 5.58

- **Thickmess of Foam Styrene**
  - +: 5.65
  - -: 5.43

- **Thickness of Logo**
  - +: 5.58
  - -: 5
QS 9000 Certification is a must for all suppliers of the Automotive Industry