



GLOBAL SUPPLY CHAIN GROUP

Winning Global Supply Chain Advantage

Six Sigma Supply Chains

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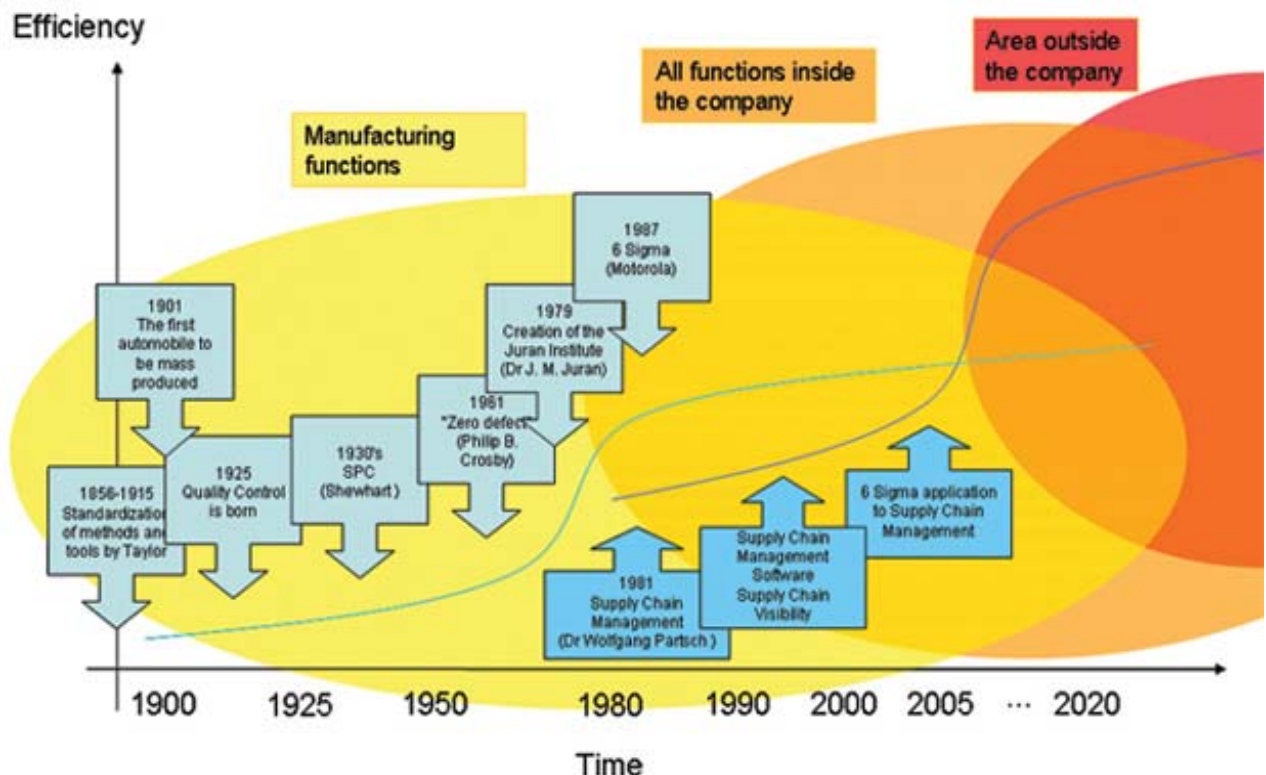
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It is estimated that in the twenty five years from 1980, global manufacturing costs shrunk by nearly 20%, while the global supply chain costs (excluding manufacturing) increased by nearly 35% in real terms. Several factors were at play – realignment of global manufacturing footprint, automation of manufacturing, higher fuel costs, structural changes in global supply chains etc. were all partly responsible this state of affairs. However, one key factor is the enormous advances made in manufacturing by focusing on the minutest parts of the processes to streamline the whole process through quality initiatives such as SPC, TQM or Six Sigma.

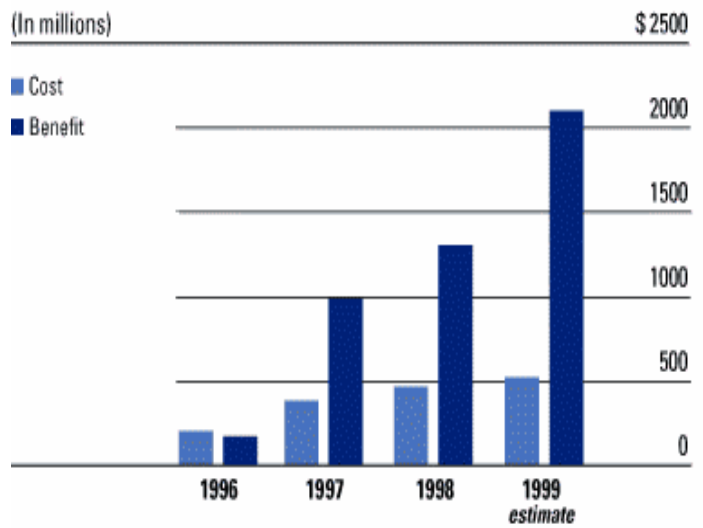
Indeed, manufacturing processes are peaking in their efficiencies. Manufacturing work management methods have evolved a lot since they were introduced by Frédéric Winslow Taylor (1856-1915) at the turn of the last century - mass production (1920s), total quality control (1970s), SPC (1980s) followed by Six Sigma have all contributed to this evolution. The success of Six Sigma in manufacturing is encouraging supply chain innovators to adapt and adopt Six Sigma methodology for controlling and improving their end-to-end supply chains. As shown in the figure below while the manufacturing efficiencies are close to peaking, supply chain efficiencies are just starting to take off. Increased adoption of six-sigma type efficiency driven initiatives in supply chain management is likely to provide the next level of innovation for the companies.





Companies of all types and sizes have been in the midst of a quality revolution. GE saved €12.3 billion over five years and added €1 to its earnings per share. Honeywell (AlliedSignal) recorded more than €814 million in savings. Medium-sized companies and large multinational companies like Sony, Nokia and American Express have all seen similar results. A commitment to rigorously apply Six Sigma has produced these results. The primary goal of Six Sigma is to improve customer satisfaction. Its business-driven focus leads to process improvement, reduced costs, and increased profits. The Six Sigma approach works well with other quality improvement initiatives such as TQM, CMMI, ISO 2000, Business Excellence Framework and others. This makes it suitable to be adopted in Supply Chain Management. Other quality initiatives, if already in place, can still be applied and will complement Six Sigma to enable holistic organisation-wide solutions with customer and business objectives at the centre.

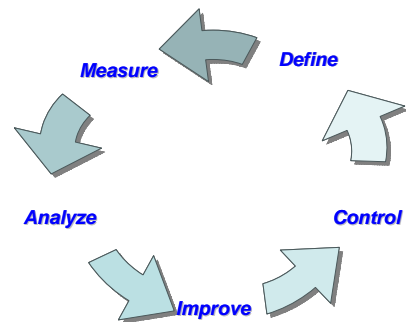
Six Sigma Progress



Source: [General Electric](#)

This article examines how companies are adapting and adopting Six Sigma methodologies to achieve efficiencies in end-to-end supply chains including manufacturing, procurement, warehousing and transportation. We will briefly start off by refreshing what is Six Sigma and how it has been used to turbo charge manufacturing over the last two decades. Then we will examine how similar methodology is adopted for end-to-end supply chains. Finally, we will see what kinds of benefits are available to supply chain innovators adopting Six Sigma methodologies.

Let us first refresh our memory on the methodology and tools used in Six Sigma approach. A typical Six Sigma project uses DMAIC methodology (Define, Measure, Analyse, Improve and Control) and uses variety of tools to capture information and analyse data. Some of these tools are QFD, Statistical Process Control, Regression analysis, PERT analysis, Cause Effect diagrams, Pareto charts etc.



Source: Florida International University, November 12th, 2005 "Introduction to Six Sigma"

MANUFACTURING EXAMPLE

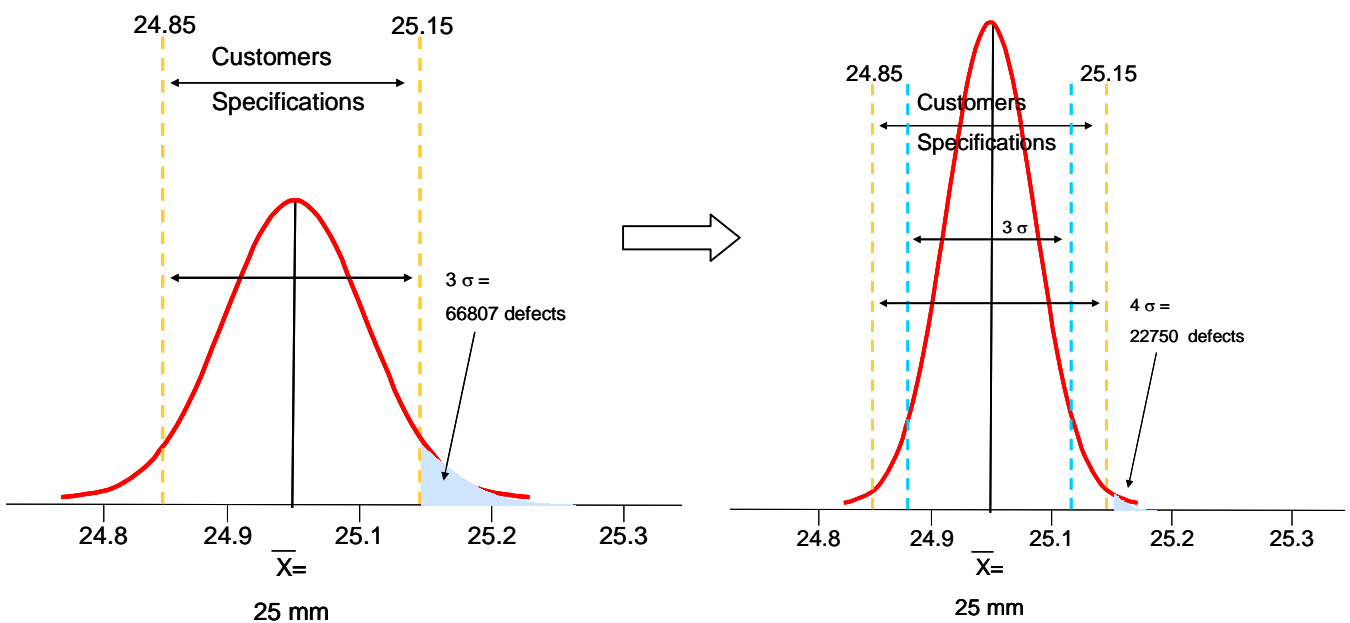
Let's consider a case study of 6 sigma application in a manufacturing industry to highlight the quality of the results reached. Each of the five steps in the diagram will be applied rigorously in order to illustrate the application and impact of Six Sigma in this situation. In this example a company producing PVC tubes by extrusion needs to decrease its rate of defects from 133,614 to 45,500 DPMO (defects per millions of opportunities). Thus in this example Six Sigma methodology is being utilized to reduce the defect rate by two thirds or by nearly 67%.

Define

A defect, in our case, is defined as a tube diameter which is not in the range of its specifications: 25.00 +/- 0.15mm.

Measure

In this example a sample of pipe is taken at regular intervals and frequency distribution is created in order to assess the quality. Currently nearly 3 sigma is falling within the specs, or in other words, the actual quality rate is 3 sigma or 86.64%. Hence the current failure rate is 13.36% or nearly 133, 614 DPMO.



Sigma	Quality Level	Failure Rate	DPMO
1	38.29%	61.71%	617,075
2	68.27%	31.73%	317,311
3	86.64%	13.36%	133,614
4	95.45%	4.55%	45,500
5	98.76%	1.24%	12,419
6	99.73%	0.27%	2,700
7	99.95%	0.05%	465
8	99.99%	0.01%	63
9	100.00%	0.00%	7
10	100.00%	0.00%	1
11	100.00%	0.00%	0
12	100.00%	0.00%	0

Analyze

In the analysis stage, two types of analysis are carried out. Firstly, we calculate how much improvement is required in order to meet the quality guidelines. For example, in our case we are looking for defect rate of no more than 45,500 DPMO which translates into 4 Sigmas. This analysis is facilitated by the simple statistical table outlining the Quality Level, Defect Rate and Failure Rates.

Secondly, we identify and validate the right root causes of the problems the team should be focused on. In this example, based on a Cause Effect analysis, the two key root causes of product variance are:

- Variance in quality of PVC pellets
- Variance in steam heater operating temperature

Improve

In this part, we identify, evaluate, and select the right improvement solutions. We also develop a change management approach.

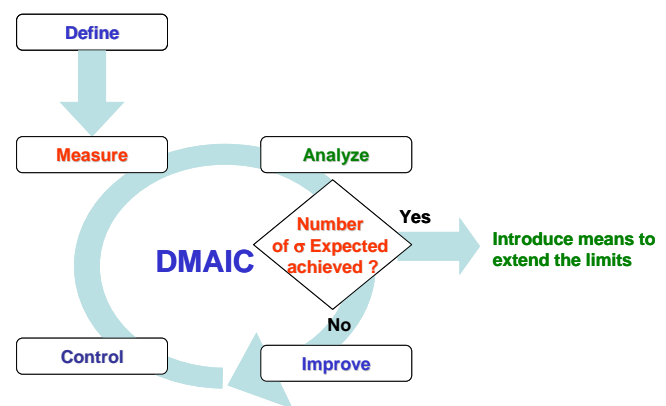
In our example, to achieve the necessary quality improvement, the process is expected to reach 4 sigma or 95.45%. The options to reduce the variance in product are:

- Redesign the steam heater
- Install a feedback controller to manipulate the steam valve to enable tighter control of the operating temperature
- Combination on the above

Control

Here we determine the approach to be taken to achieve the targeted results. We estimate costs, risks & ROI. We also understand how to disseminate lessons learned, identify replication and standardize opportunities/processes.

Thus the DMAIC cycle is used to create the continual improvement process – as shown in the attached figure.



Application of Six Sigma to Supply Chain Management – Procurement, Warehousing and Transportation

Six Sigma approach can be equally effectively applied to other streams of supply chain to streamline processes, achieve efficiencies and eventually save cost.

As an example, one of our clients perpetually had delays in their logistics department; both inbound and outbound logistics were affected. They tried everything from increasing the number of staff, training the employees and even upgrading their IT systems. However, time and again they saw their customers complaining about delays and eventually switching over to their competition. Having invested heavily with no favourable outcomes, obvious and easy way out for the management was to blame their suppliers, 3PL and contractors. They started focusing on fixing the problems outside

their realms. This only resulted in affecting their relationship with their suppliers and contractors. The conundrum was that they have been suppressing the symptoms for a long time instead of fixing root causes. The key thrust of their approaches was not customer satisfaction but to ‘speed up the process’ that is causing the delays. Thanks to their newly appointed GM (Operations), who has had exposure to Six Sigma methodology in his previous employment, they then introduced a holistic approach of Six Sigma and started using related tools such as VOC, QFD, Cause Effect Analysis, Pareto Charts etc during the problem investigation phase. They uncovered several problems in many of their processes, and set targets for the desired outcomes from each functional area.

Following tables shows various activities within supply chain processes which could be measured and improved using a six Sigma approach. For brevity some of the activities are only shown at a higher level. For example in order management only Order Processing function is shown in full detail and others such as Quoting and Fulfilment are shown at a higher level.

	Functions	Unit of Measure	Current Average	Current σ	Expected Average	Expected σ	How to improve options
WAREHOUSING	Receive (a 20 tonne truck load)						
	Schedule dock door	Daily Accuracy	95%	5%	99%	1%	Dock door schedules published in advance to counteract last minute hiccups
	Unload	Minutes	30	15	25	5	All equipment and staff needed are assigned to the activity
	Verify count	Accuracy	95%	10%	99%	2%	Staff available to complete the task
	Check for damage	Accuracy	70%	20%	95%	5%	Staff available to complete the task
	Resolve exceptions	Minutes	90	30	40	40	Documented exceptions and escalation guide
	Update inventory records	Minutes	120	75	30	15	Train the order entry staff; create user guide
	Put Away						
	Identify storage location	Accuracy	80%	20%	95%	5%	Storage location identified and approved in advance
	Move product to storage	Accuracy	90%	10%	99%	1%	All equipment and staff needed are assigned to the activity
	Update inventory location record	Minutes	90	60	30	15	Train the order entry staff; create user guide
	Picking						
	Group products into customer order	Accuracy	80%	20%	99%	1%	Approved and locked in customer order; changes to be handled as exceptions; proper labelling of products using a standard naming convention
	Verify order	Accuracy	95%	5%	100%	1%	Staff available to complete the task
	Update inventory location records	Minutes	90	45	30	15	Train the order entry staff; create user guide
	Services						
	Build store level pallets	Accuracy	75%	25%	90%	10%	Staff available to complete the task; multi-skilled staff to use the idle time
	Repackage product	Accuracy	90%	10%	95%	5%	Appropriate equipment, material and staff needed are assigned to the activity
	Pre price product	Accuracy	80%	10%	95%	2%	Customer order should accompany the pricing details
	Shipping						
Schedule outbound carrier	Accuracy	80%	30%	95%	5%	Up-to-date outbound carrier database, standardize terms and condition	
Check in equipment	Accuracy	95%	10%	99%	2%	All equipment and staff needed are assigned to the activity	



	Functions	Unit of Measure	Current Average	Current σ	Expected Average	Expected σ	How to improve options
	Load	Hours	10	2	8	0.5	All equipment and staff needed are assigned to the activity
	Update inventory records	Minutes	180	110	120	30	Train the order entry staff; create user guide
CUSTOMER SERVICE - ORDER MANAGEMENT	Quoting						
	Order Processing						
	Receive order	Accuracy	95%	10%	99%	2%	Staff training- knowledge of products and noting down the details
	Validate the quote if applicable	Minutes	20	10	10	3	Staff available to complete the task; as part automated procedure
	Customer verification- new or old	Minutes	20	15	10	2	Regular updates of the customer database
	Validate contract details	Accuracy	90%	20%	99%	2%	Quality checkpoint - Review of contract, follow up & training
	Validate PO with customer agreement	Accuracy	90%	20%	99%	2%	Quality checkpoint – review PO, get approval & training
	Check for export controls and denied party status	Accuracy	85%	30%	99%	2%	Quality checkpoint – review
	Validate orders	Minutes	120	60	90	30	Quality checkpoint – review
	Configuration	Minutes	180	100	90	30	Quality checkpoint – review, training
	Pricing	Accuracy	95%	10%	99%	1%	
	Credit Check / Payment						
	Fulfilment lead time	Accuracy	90%	20%	95%	5%	Increase communication and streamline interfaces
	Terms and conditions	Accuracy	80%	20%	99	1%	Easy to understand – well documented
	Approvals	Hours	48	24	3	1	Remove duplication of effort, electronic sign-off
	Validate commission details	Minutes	60	30	30	10	Staff training and user friendly process documentation
Fulfilment							
Customer Care							
Billing & Collection							
Returns							
TRANSPORTATION ORDER	Transportation Planning						
	Calculate cube and weight	Accuracy	90%	20%	95%	2%	Staff training and availability of appropriate tools
	Consolidate LTL Orders	Hours	8	2	3	1	Staff training and availability of appropriate tools
	Select Transportation Mode	Accuracy	80%	20%	95%	5%	Up-to-date database and adequate resource availability
	Select Carrier	Hours	12	5	4	1	Up-to-date carrier database, involve carriers in advance speed up selection process
	Tender Order to Carrier	Accuracy	85%	10%	95%	5%	Standardise the tendering process;
	Order Tracking						
	Carrier Payment						
Performance Tracking							

To illustrate application of the Six Sigma process to supply chains we use a small example given by Schneider Electric relating to its order management process for electrical boards:

Situation

Due to several big changes, the following problems appear:

- Clients folders inaccurate: quotation and electrical plans
- Loss of reliability in order entering (mistakes)

These problems lead to an increase in the delivering delay and a decrease in the client's satisfaction

Objectives

- Lower the non conforming folders to below 5%
- Increase the data entry accuracy to 95%

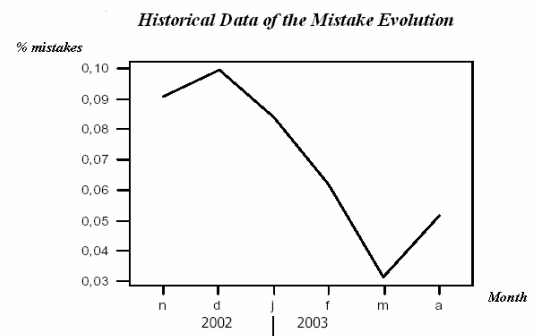
Define

Voice of customers – VOC (Critical to Quality - CTQ)

- For final customers: Delivery in-full, on-time, in-specs (DIFOTIS)
- For internal planning and control customers: An accurate data entry in SAP to facilitate supply chain planning and control

Measure

Accuracy was measured as % mistakes in this case. Monthly data accuracy ranged between 0.03% and 0.1% over the period, as shown in the adjoining figure.

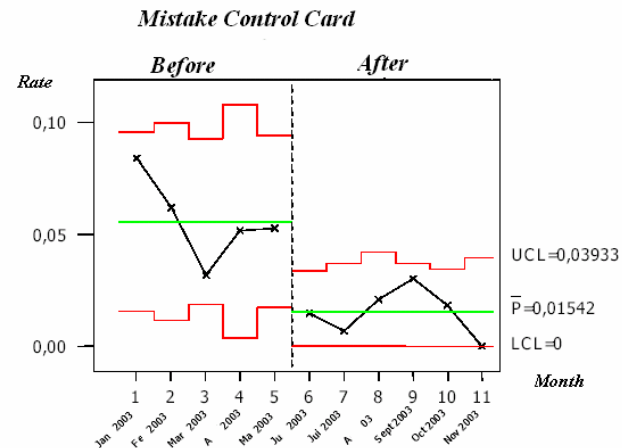


Analyze

Problems (Effects)	Consequences	Causes
The customers complain of late deliveries	<ul style="list-style-type: none"> • Loss of customer confidence • Loss of market share • Churn 	Incomplete orders
The sales administration staff receive incomplete customer information from the sales teams	Late deliveries	Sales team do not have full information on customers
Prices discrepancies between quotations and invoices	Loss of customer confidence	Sales and invoice systems not synchronised
Logistics department receives orders with mistakes	<ul style="list-style-type: none"> • Late deliveries • Non-conforming deliveries 	<ul style="list-style-type: none"> • Lack of training • Incomplete system information

Improvements

- Creation of standardized processes for order management
- Centralization of the order management process and co-location of order management team
- Up-skilling of order management staff
- Encourage and incentivise sales force to send complete and correct files to the sales administration
- Frequent root cause analysis for delays; followed up with prompt action to remove root causes.
- Monthly follow-up of non-conforming deliveries.



Results

- Direct measured economic profit: €46,000 for Schneider (error rate reduced to 1% from 5% at the beginning of project)
- Indirect (non-measurable) benefits included
 - Increased customer satisfaction
 - Customer retention
 - Reduced delivery times
 - Reduced re-scheduled or missed deliveries
 - Better transportation planning
 - Better revenue recovery
- Better knowledge of the complete process by all staff
- A collective awareness of the commercial consequences of trivial process lapses.
- Quality is defined by the voice of the customers; it drives the total supply chain process

In conclusion, we have now arrived at the time in history where Six Sigma methodology needs to be widely adapted and adopted for supply chain management. A very detailed and rigorous approach is required for this purpose. However, the benefits for end-to-end supply chains are immense. This, after all, defines the major difference between the supply chain winners (with overall supply chain costs ranging between 5% to 8% of total revenues) and the supply chain followers (with overall supply chain costs ranging between 8% to 20% of the total revenues). With potential savings of 3% to 12% of the total revenues – the effort will prove to be highly rewarding and well worth the investment.