Risk Management in Worldwide Supply Chain: A Six Sigma Approach

by

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Abstract

Supplying goods and services on a worldwide scale is not a new phenomenon: In the early 20th century vehicles (Ford), sewing machines (Singer) or chemicals (Du Pont) are only some examples for goods being exchanged between the continents. Continuing until the 1970s the shipping of all these goods was a very complex process consisting of many interfaces with the related documents as for example customs declarations, bill of lading or hazardous material declarations. But with integrating all these processes via IT-technology the many partners are now bundled together. By linking all these different partners the orchestrating of these ones has become the major challenge: Due to the limits of gaining a sole legal ownership along the complete global supply chain a 3PL approach shows constraints for an orchestrating pattern. The quest for a 4PL service provider is one of the answers to overcome this hurdle: The content to maneuver the supply chain by this service provider is mainly consisting of an integrated IT solution as well as time- and quality based measurements both serving as a key performance indicators for a supply chain controlling. Focusing on time – since time is a globally accepted metric across any culture, country or political constraint – the example of a kit supply of automotive parts to Thailand explains the different supply chain elements and the needed cycle time for this logistical chain. The main process elements consist of buffering, set creating, transporting and sequencing of parts resulting in a lead time of two months for the whole physical operation, and six months including also the information flow chain. Along this informational/physical chain certain risks are appearing to influence the logistical quality performance: non-achieved due dates, missing or damaged as well as lost in transit goods or services and wrongly delivered ones are three examples showing the kinds of failure in a supply chain. Hence quality tools need to be implemented avoiding these performance failures. These tools are coupled with the logistics pipeline before, in-process and after carrying out the logistical task. Especially in-process quality tools like automated identification-orientated 100% checks or the four-eye principle are supporting the goal of a zero defect logistics supply chain in terms of delivery time. With mapping all relevant time related key performance indicators a series of values allows statistical analysis with the 6 Sigma philosophy. After introducing these 6 Sigma tools and techniques the supply chain to the automotive manufacturing plant in Thailand got a significant lower amount of logistical faults.

Keywords: Risk, Quality, Supply Chain, Logistics Service Providers

1. Introduction

Supplying goods on a worldwide scale is not a new phenomenon: Even in former times trade between the known parts of the world was carried out as for example for spices, silk or fruits. By having this limited globalization in place the goods supply chain along certain routes has shaped a very first logistical network. After exploring the world in its possible land-, air- and especially seaways the international trade has emerged up to the stage as we know it today: A trade between all worldwide regions for the mutual benefit with less trade barriers as promoted by the World Trade Organization (van den Bossche 2005). To shape such worldwide supply chains the logistics function faces a great challenge: Coming from a regional focus with some links to other dispersed regions this function has to form a worldwide flow for goods and/or services within defined networks.

Due to this increasing networking logistics service providers play an essential part to manage the long-distance flow of goods and services in an efficient and systematic manner (Pfohl 2004). But the traditional regional focus with few international links will not be a competitive base for a worldwide supply chain management.

After exploring various service provider categories the paper concentrates on risk areas along the logistics pipeline and how a Six Sigma structured quality-based approach is helping to minimize this risk. The findings are based on empirical research with a particular focus on automotive manufacturing since the car industry is quite established in forming worldwide networks for more than 100 years. The empirical data are retrieved from benchmarking results in the automotive sector and literature review.

2. Logistics Service Providers and Risk

Not only globalisation but also a constant cost pressure to improve delivery processes has led to the evolution of service providers for logistics on international scale. By focusing on the automotive business one of the key terms related to logistical processes is core competence: As an Original Equipment Manufacturer (=OEM) a plant's main purpose in the automotive sector is to manufacture vehicles. As part of this manufacturing the logistics function is embedded into the OEM processes only to a defined degree. Beyond this degree it depends on economical feasibility and political-social constraints to outsource logistics (Kuhn 1998). Only some processes are left within the OEM-responsibility as for example planning, scheduling and performance controlling. Many traditional outsourcing objects in automotive logistics are linked to physical operations like transporting, sequencing, storing or line feeding. Hence the expectation for a modern service provider is not only to be a transport company but also to coordinate and partly plan a logistics pipeline. Figure 1 explains the logistical core functions in the automotive sector and the possibility to share these with service providers.

By opening the operation "International Supply & Customs" in figure 1 the logistics pipeline is described in more detail with a value stream analysis as for example the kit supply to a foreign plant as shown in figure 2 for the Knocked Down (=KD)-delivered Mercedes-Benz plant in Thailand.

With the KD approach the logistics processes are centred to deliver a complete kit in a lot size of six or multiples of it to certain destinations. The main operation for a foreign KD-supplied plant is to build up the car only: Technical alterations, material stock control, material requirements planning (MRP I) and further planning and control activities are co-ordinated by central departments of the OEM.

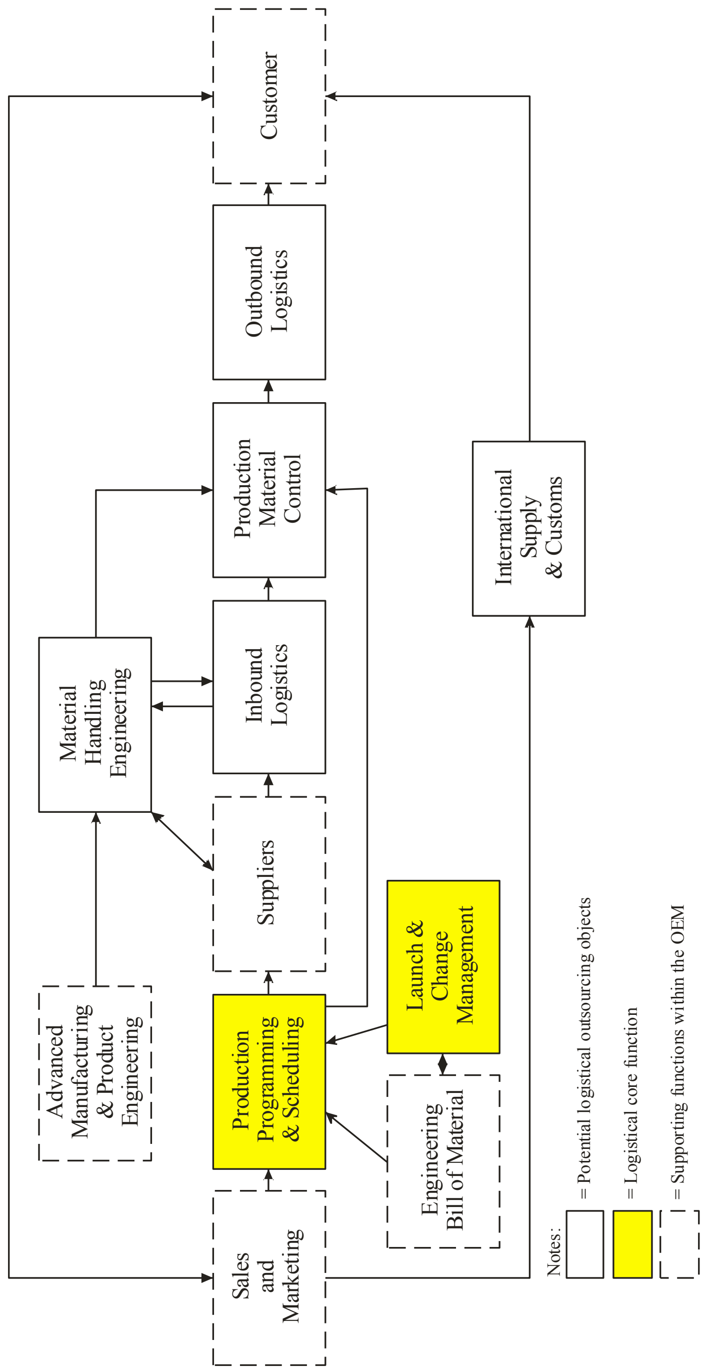

Figure 1 Logistical Outsourcing Potentials in the Automotive Sector

Looking at the value adding stream the different values are accumulated in the product cost calculation. These cost values are either processed in manufacturing (e.g. labour cost) or materialized within the product itself (e.g. material cost). These values are the most apparent ones for the final customer and many companies focus on these for optimization purposes to give the best value for money. Supporting operations like quality or logistics are having a facilitating impact on the primary activity to produce goods and services (Porter 1985). Therefore logistical value adding is helping the company to perform its core competence as streamlined as possible. With the help of the logistics function (Pfohl 2004) the logistical value is encapsulated in bridging the distance in timing and location between all suppliers (=point of origin) to the manufacturing line (=point of use) until the final customer (=point of product use) being the last element of the value stream. Bridging is also defined by having the right product at the right place in the right quality as well as the right time with the help of a continuous flow of material and/or information (Pfohl 2004, Kuhn 1998). Hence any kind of information/goods flow is evaluated as logistical value adding: Analysing the five basic process patterns (transporting, sequencing, packaging, buffering and cross-docking; Pfohl 2004) only buffering gives evidence as a non-value adding process whereas all other process categories are presenting logistical values. However, buffering is necessary to a certain limit to balance any deviations along the international logistics pipeline: Therefore a short storing is reckoned as quasi-value adding. These logistics value processes are the basis for the further discussion in this paper.

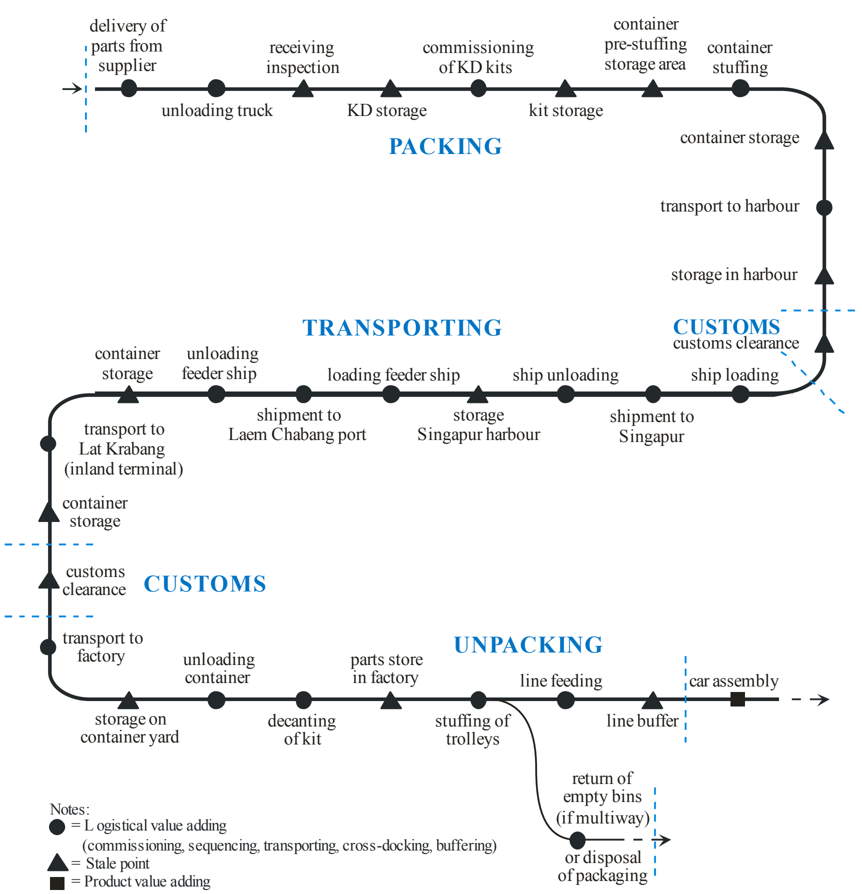

Figure 2 KD Supply Chain

Along this KD supply chain several options are conceivable to outsource certain chain elements. From the viewpoint of an automotive OEM the most preferable outsourcing option is to pass on the responsibility for the whole international delivery pipeline with its four main elements (packing, transport, customs and unpacking) to a 4PL. The car assembly will be the only remaining process within the OEM reflecting its core competence.

This solution supports to concentrate the resources on the vehicle production instead of tying up capital and manpower to master international logistics. But benchmarking results (Thonemann et al. 2003, Christopher 2005) exposed that only few service providers are existing to fit into these two requirements: To know how the automotive logistical details are carried out and how to „orchestrate" (Mueller-Stewens and Lechner 2003) a worldwide network of logistics partners. Nevertheless all major OEMs still have an own logistics area to control the pipeline and in some cases also include their own logistical operations like packaging engineering or commissioning of KD kits. Hence the current practice is defined by outsourced operations to a 3PL but the 4PL status still embedded within the automotive OEM. Figure 3 shows the different logistics provider categories and the current situation in terms of evaluating the service providers.

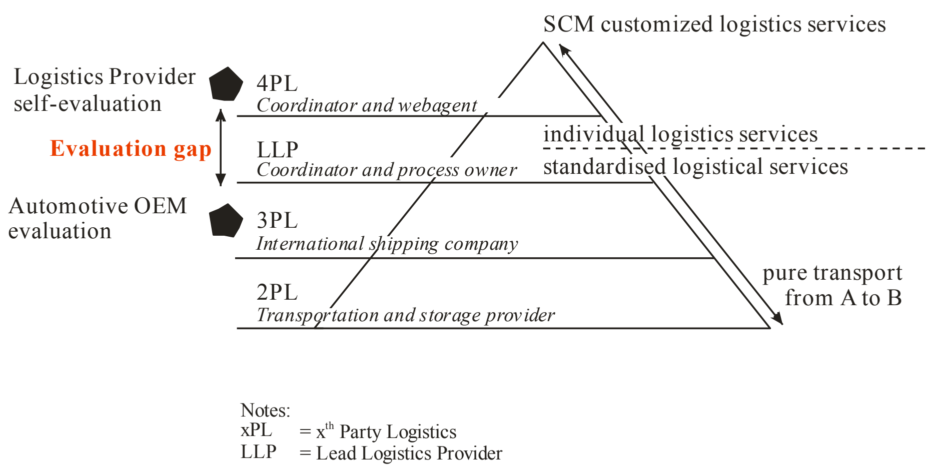

Figure 3 Logistics Service Provider Categories

To close the gap between the automotive OEM expectations and the capability of the external service provider one of the elements is risk management: Integrating risk into supply chain management ensures a smooth and stable material/information flow anywhere and anytime. Empirical examples indicate that measuring time and controlling the lead time in particular is a key performance indictor (=KPI) for a risk analysis. Comparing the ideal lead time to the actual time values the histogram shows the normal distribution of the time values and the x-chart (Tshikawa 1990) gives the range as shown in Figure 4-1 and 4-2 based on 40 empirical data sets covering app. 1 year kit supplies to an overseas KD-delivered plant.

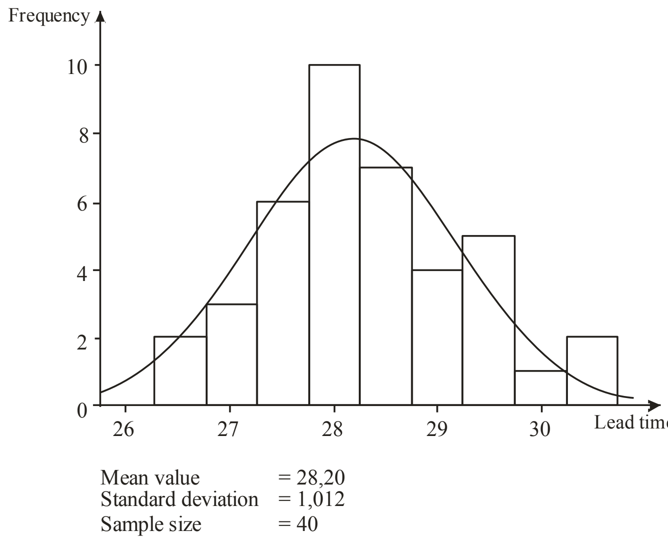

Figure 4-1 Histogram for the Lead Time for an International Supply Chain

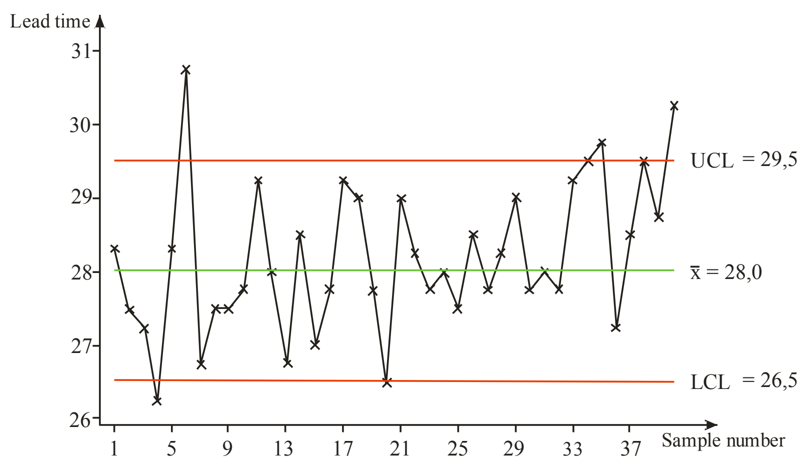

Figure 4-2 X Chart for the Lead Time for an International Supply Chain

With statistical analysis tools according to the Six Sigma methodology (Eckes 2001, Rehbehn and Yurdakul 2005) it became evident that risk in the automotive supply chain is linked to

1. damage in transport / lost in transport,
2. customs processes,
3. shipping / transportation delay and
4. OEM supplier delay in material delivery.

To integrate risk into the calculations for lead time a risk factor τ is introduced. This factor is 1 as standard value in case of a smooth and non-deviating supply chain. If the supply chain is faster due to lower risk the τ-value is less than 1 until minimum of 0 which means that this process is not needed anymore. If it needs more time than average τ becomes greater than 1 with a maximum value of 2 by definition. The equation for the international lead time with integrated τ is

$$LT_{\text{Worldwide Supply Chain}} = LT_{\text{Packing}} * {}_1 + LT_{\text{Transporting}} * {}_2 + LT_{\text{Customs}} * {}_3 + LT_{\text{Unpacking}} * {}_4$$

with LT = Lead Time

τ_n = Risk factor at stage n of the worldwide supply chain

The value of τ is derived form two sources:

1.Empirical ex post data analysis

2.Failure mode and effects analysis (FMEA) for ex ante data

By combining the two calculation views both past and future perspectives are taken into consideration to determine the risk level of each supply chain element as given in the above formula. Empirical tests have proofed that the risk factor τ is country-specific: a high τ represents countries with particular high process variation of customs and inbound transport being the root cause to exceed the given tolerances as given in figure 4/2. This τ-value result in a higher tied-up capital along the logistics pipeline: A higher stock balances the time deviations in these processes to ensure a smooth production supply in the CKD-delivered plants. The calculated cost for line stoppage is justifying this extra cost burden in inventory with both cost items playing a major part in the cost-benefit trade-off for buffering parts. Especially this quasi-value adding process opens a variety of improvement potentials for a 4PL.

3. Conclusion

Many 3PL companies are seeking to get to the next level of service providers: the 4PL. For achieving this target one of the major elements is the integration of risk management to manage especially worldwide supply chains. By introducing the risk factor τ linked to lead time deviations – analysed and evaluated by Six Sigma quality tools – a first step is taken to capture risk in a measureable KPI. Further empirical research is required not only to apply this risk assessment in automotive supply chains but also in other industry sectors' logistical pipelines. Also a field of interest is given by developing quality as a second KPI for risk assessment along the supply chain. With joining time and quality into one tool a holistic approach crystallizes out to assess risk. But one of the hurdles to achieve this assessment level is the still existing predominant 3PL architecture of external service providers: Only after stepping up to 4PL structures the road ahead is free for an external service provider to manage risk along worldwide supply chains.

References

Christopher, M.: *Logistics and Supply Chain Management*, 3rd edition, FT Prentice Hall, London et al. 2005.

Eckes, G.: *The Six Sigma Revolution*, Wiley Publishing, New York et al. 2001.

Ishikawa, K.: *Introduction to Quality Control*, Chapman & Hall, London 1990.

Kuhn, J.: *Outsourcing as a Globalisation Tool*, Conference proceedings 31st International Symposium on Automotive Technology and Automation, Section: Logistics Management, pp. 211-216, Duesseldorf 1998.

Kuhn, J.: *Die Ressource Zeit im Spannungsfeld der Logistik [The Resource Time within Logistics]*, in: Zeitschrift fuer Betriebswirtschaft (ZfB) 2/1998, vol. 68, pp. 131-146, Gabler Publishing, Wiesbaden 1998.

Mueller-Stewens, G. and Lechner, Ch.: *Strategisches Management [Strategic Management]*, 2nd edition, Schaeffer Poeschel Publishing, Stuttgart 2003.

Pfohl, H.-Ch.: *Logistiksysteme*, 7th edition, Springer Publishing, Berlin et al. 2004.

Porter, M.: *Competitive Advantage*, The Free Press, New York 1985.

Rehbehn R. and Yurdakul, B.: *Mit Six Sigma zu Business Excellence [With Six Sigma to Business Excellence]*, Publicis Corporate Publishing, Erlangen 2005.

Thonemann, U., Behrenbeck, K., Diederichs, R., Großpietsch, J., Küpper, J. and Leopoldseder, M.: *Supply Chain Champions*, Gabler Publishing, Wiesbaden 2003.

van den Bossche, P.: *The Law and Policy of the World Trade Organization*, Cambridge University Press, Cambridge 2005.