# LEAD TIME REDUCTION AS ONE OF THE KEY FACTOR INCREASING THE SUPPLY CHAIN RESILIENCE

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**Abstract**

At the present time, products are no longer the only decisive factor when it comes to a company's success - what is no less crucial is the efficiency of the entire supply chain which allows smooth running of production as well as accurate delivery of products to customers. SCM capabilities are thus of the utmost importance. Following up on our previous industrial supply chain resilience assessment survey (conducted among one hundred key managers of the leading automotive and aerospace enterprises) whose results affirm the significance of the supply chain resilience issues, we now intend to focus on lead time reduction as one of the key factors of supply chain resilience while examining its impact on customer services. Lead time, which is defined as the latency between the placement of an order and item delivery, largely depends on cycle time, a more mechanical measure of process capability measuring the completion rate. One of the strategies to influence lead time is managing cycle time. In our approach we consider cycle time as a business enabler to increase competitiveness on the one hand and the potential for improving supply chain resilience on the other. Our objective is to put together a set of the major tools for minimizing both lead and cycle time and to indicates a measurable impact of their reduction on supply chain resilience in the automotive and aerospace industries.

**Keywords:** resilience, lead time, cycle time, supply chain management, SCM capabilities

## 1. INTRODUCTION

One of the few certainties that we can rely upon in today's world is the knowledge that nothing is absolutely perfect. This is perhaps one of the basic principles of modern management and the principle of continuous improvement [1]. In our time, products have ceased to be the only determinative factor when it comes to a company's success - what is no less important is the efficiency of the entire supply chain which allows smooth running of production as well as accurate delivery of products to customers.

## 2. DEFINITIONS

As understanding basic terminology is of the utmost importance terms such as 'supply chain lead time reduction' are explained and followed by the definition of Cycle, Lead and Value added Time. In addition to that SIOP is defined as a key enabler of the balance between demand and supply.

### 2.1. Definition of Supply Chain

In order to facilitate a deeper comprehension we can agree upon the following simplified explanation: The term 'logistics' encompasses Materials Management & Distribution. Supply Chain comprises Suppliers & Logistics & Customers [4]. A supply chain is "a sequence of processes to add value to the product during its flow and processing of raw materials, through all the intermediate forms, to form in line with end customer requirements" [7].

### 2.2. Cycle Time (C/T)

C/T informs us about how many times a particular component is treated within the production process and during a given observation time. C/T also refers to the time it takes an operator to go through all of their work elements before repeating them [3]. The clock starts when work begins on the request and ends when the item is ready for delivery. Cycle time is a more mechanical measure of process capability.

### 2.3. Lead Time (L/T)

Lead Time is defined as the amount of time it takes one piece to move all the way through the process or the value stream, from start to finish. Envision a marked component as it moves from the beginning to the very end of the production process [3]. Lead Time clock starts when the request is made and ends at delivery. In a more general sense, Lead Time is defined as what the customer sees.

### 2.4. Value Added Time (V/A)

Value Added Time refers to the actual time needed to add value to a raw material or a part. It is defined as the duration of all those work elements and process phases that actually transform the product in a way that the customer is willing to pay for [3].

### 2.5. Sales Inventory and Operations Planning (SIOP)

SIOP is a set of business decision making processes and an efficient planning technique. The main purpose of SIOP is to establish a balance between demand and supply.

### 2.6. Resilience

Resilience is defined as the capacity of a system to survive, adapt and grow in the face of change and uncertainty [10]. As shown in **Fig. 2**, optimal resilience is defined as the balance between vulnerabilities and capabilities.

## 3. SURVEY RESULTS AS FOUNDATION FOR FURTHER RESEARCH

In order to map industrial supply chain resilience we carried out an assessment survey (conducted among one hundred key managers of the leading automotive and aerospace enterprises) whose results affirm the significance of the supply chain resilience issues, we now intend to focus on lead time reduction as one of the key factors of supply chain resilience while examining its impact on customer services. As shown in **Fig. 1** the majority of our respondents perceive Supply Chain Resilience within their industrial field as highly important whereas only a minority of them found it important [1].

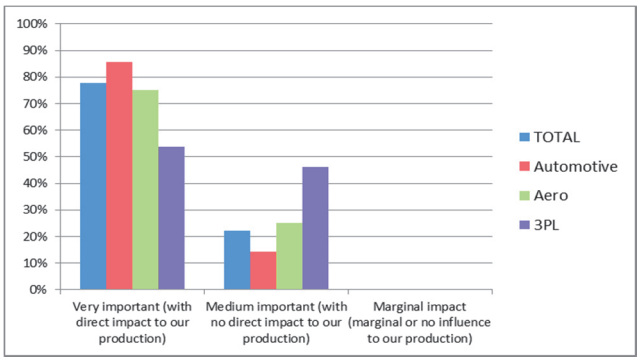


**Fig. 1** Perception of Supply Chain Resilience

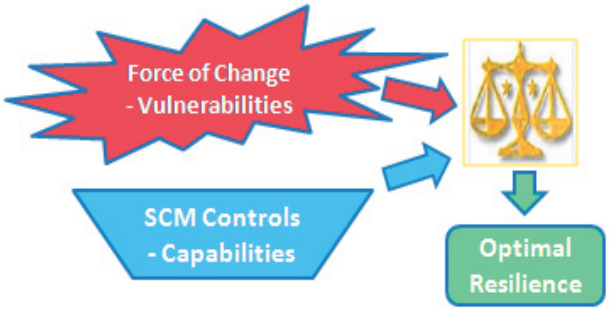


**Fig. 2** Supply Chain Resilience Framework

## 4. ACKNOWLEDGED LEAD TIME AND CYCLE TIME REDUCTION BENEFITS IN AN AEROSPACE PRODUCTION COMPANY

Benefits of right implementation and execution of SIOP processes brought to the company:

- Reduction of excess and obsolescence
- Faster product introductions and a go-to-market competitive advantage
- Inventory reduction
- Improvement of customer service
- More stability in the use of resources within the whole supply chain
- Linkage between strategy and tactics
- Silo effect elimination

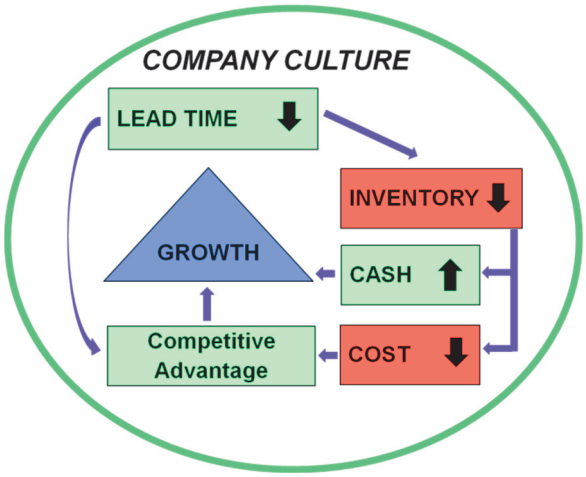


**Fig. 3** Targeting improvements related to Lead Time reduction

Reducing working capital while at the same time meeting customer needs will force the company to improve operational practices and enable it to gain competitive advantage (see **Fig. 3**).

## 5. RESULTS OF THE INVESTIGATION

Based on the research conducted among aerospace and automotive companies we can conclude that the major tools for minimizing both lead and cycle time include Value Stream Map (VSM) (see **Fig. 4**) and the process improvement methodology known as DMAIRC (Define, Measure, Analyze, Improve, Review, Control [6].

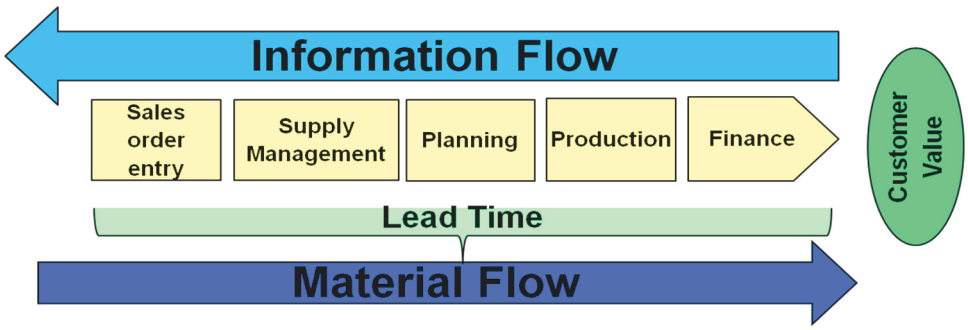


**Fig. 4** Value Stream Map process

VSM should list all value-added and non-value added process steps in order to show Cycle Time. “The point of value stream mapping is not the map itself, but understanding the flow of information and material.” [3]

The other components of an efficient VSM are waste elimination (D.O.T.W.I.M.P.), reduction of cycle time and incorporate financial benefits.

As the product makes its way through the value chain up to the customer we can observe a tendency of cycle time reduction (see **Fig. 5**) and increased pressure on it as key driver for lean management, reduction of the inventory in whole supply chain and SCM resilience increase (see **Fig. 5**).

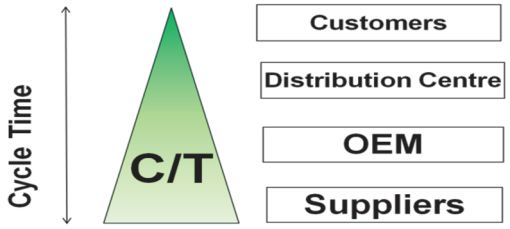


**Fig. 5** Cycle Time reduction in SCM

**Cycle time performance measurement:**

- On Time to Request - OTTR %
- Days of Supply - DOS

$$DOS = \frac{\text{Inventory on hand}}{\text{Average daily usage}} \quad [\text{days}] \tag{1}$$

- Inventory $ - safety stock reduction

**Lead time performance measurement:**

$$\text{New SS} = \text{old SS} \sqrt{\frac{LTI}{FI}} \quad [\text{units}] \tag{2}$$

The following adjustment can be made to the standard deviation or the safety stock (SS) in order to compensate for the differences between lead-time interval (LTI) and forecast interval (FI). Although not exact, the formula gives a fairly good approximation [8]:

- Lead-time reduction (Year-over-Year indicator: YOY per cent change).

When Replenishment Lead Time is greater than Demand Fulfilment Lead Time required the company needs to take into consideration procurement, production, order fulfilment, transit and customer-requested lead time. Visual management plays an important role here and can serve a tool for monitoring and controlling the process status and progress [9].

Even though cycle time reduction projects are supported by various tools, techniques and data, it is the change in the mindset that will provide sustained improvement and expected results. A usual mindset could be expressed by the “Order today, make tomorrow” motto. Yet owing to efficient lean management and optimized processes we should be able to make today what was ordered yesterday. A good example of the best practice is a Formula 1 race. Pit stop time reduced by 1 sec decreases the total race time by 0.015%. Still the pit stop crew spent months perfecting itself! When a similar mindset is implemented in a company supply chain than the company’s performance will gain momentum and achieve substantial resilience of its SC.

## CONCLUSION AND FURTHER RESEARCH

The results we have obtained confirm that the issue of Supply Chain Resilience is important for the majority of the respondent companies. They also make it evident that lead time and cycle time reduction are ones of the key factors for increasing the Supply Chain Resilience. This article proposes a number of tools and approaches to be used in order to optimal resilience focusing on lead time and cycle time reduction.

Based on our research findings we envisage the following areas for improvement to be achieved through our next project:

- Continual increase of awareness about the issue of Supply Chain Resilience especially among 3PL providers whose responses did not absolutely match with those of producers.
- Development of standardized and user-friendly management tools to turn theory into day-to-day practice.

## ACKNOWLEDGMENTS

***This work was supported by the Internal Grant Agency of ŠKODA AUTO University. No. IGA/2012/3***.

## REFERENCES

[1] NOVOTNY P., FOLTA M.: A Deep Dive Into Resilience Capabilities As a Result of Supply Chain Efficiency, [CD-ROM]. In Metal 2013: 22nd International Conference on Metallurgy and Materials. s. 2000-2005. ISBN 978-80-87294-41-3.

[2] Marousek R., NOVOTNY P., FOLTA M.: AUTOMOTIVE, AEROSPACE AND LOGISTICS 3PL INDUSTRIAL SUPPLY CHAIN RESILIENCE ASSESMENT, In CLC 2013: Carpathian Logistics Congress. 1. vyd. Cracow: TANGER, 2013, s. 1-6. ISBN 978-80-87294-46-8.

[3] ROTHER M., SHOOK J,: Learning to see Value stream mapping to create value and eliminated muda, The Lean Enterprise institute, Massachusetts 1999 ISBN 0-9667843-0-8

[4] RUSHTON A., CROUCHER P., BAKER P.; The Handbook of Logistics and Distribution Management, CILT UK, 4th edition 2011, ISBN 978 - 0 - 7494 - 5714 - 3

[5] PETTIT, TIMOTHY J; FIKSEL, JOSEPH; CROXTON, KEELY L.: Ensuring supply chain resilience: development of conceptual framework, Journal of Business Logistics 31. 1 (2010): 1-VII.

[6] Garza A., Flint A., Kumar V., Jiju A.: A DMAIRC approach to lead time reduction in an aerospace engine assembly process, Journal of Manufacturing Technology Management 25.2 (2014): 27-48.

[7] WICHER, P., LENORT, R. The Ways of Creating Resilient Supply Chains. [CD-ROM]. In CLC 2012: Carpathian Logistics Congress. Ostrava: TANGER, 2012, pp. 688-694. ISBN 978-80-87294-36-9.

[8] ARNOLD, R., CHAPMAN, S. and CLIVE, L. Introduction to Material Management, 6. edi., Upper Saddle River: Pearson Education, 2008. ISBN 978-0-13-233761-8.

[9] GOUBERGEN, D., VANDEVALLE, W.: LEAD TIME REDUCTION THROUGH CYCLIC SCHEDULING IN A JOB SHOP.INDUSTRIAL ENGINEERING RESEARCH CONFERENCE, 2011.

[10] FIKSEL, J.; Sustainability and resilience: toward a systems approach, Sustainability: Science, Practice, &

[11] Policy, 2006, Vol. 2, No. 2, pp. 1-8.