UNDERSTANDING OF THE LEAN PRODUCTIVITY – THE SOURCE OF SCM PRODUCTIVITY GROWTH IN THE METALLURGICAL INDUSTRY

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Abstract

The productivity of the Supply chain management (SCM) system is strongly influenced by the stability of either the production or the delivery processes. Commonly, unpredictable customer demand is understood as the root cause of instability. However, this is not the only source of instability and rigid production and logistics processes and conservative production planning are responsible for it at least in a similar way. Actual competitive markets create strong pressure on productivity which is generally reached by big production lot sizes focusing on unit costs reduction. Nevertheless, the consequences of big production lot sizes create overproduction, which is the source of all kinds of waste, well-known from LEAN production, reducing productivity in the production and delivery processes as a whole. The aim of this article is to propose conceptual framework enabling the quantification of Lean productivity benefits ensuring productivity growth of the whole SCM in the metallurgical industry.

Keywords: productivity growth, production levelling, metallurgical industry

Introduction

The goal of the article is the proposal of a conceptual framework describing the so far ignored importance of perception of productivity in the frame of Supply chain management (SCM) as a whole. This fact is critical for competitive production in international markets of 21st century characterised by its dynamic changes and unpredictable development. Although market conditions have dramatically changed, manufacturers, especially the big corporations in the automotive industry, haven't been able to respond accordingly. The actual way manufacturers work is characterized by its particular non-systemic optimizations, supported principally by the automation of value added activities e.g. production of more models on one assembly line, centralization and automation of warehouse operations. In view of this we have to absolutely accept the conclusion of Christopher, who claims that the only fundamental customer centric department and activities of actual businesses and supply chains is marketing. Simply said, an excellent product is not sufficient. An excellent, customer centred developed product must be supported by an excellent customer centred supply chain [1].

1. METHODOLOGICAL BASE

1.1 System thinking

System thinking is contrary to analytical thinking. Analytical thinking describes the functionality of the reality in general and how it works. It disassembles the reality to its individual parts and examines its functions. On the contrary, system thinking explores why reality functions the way it does. This understanding results from exploring the circumstances where the surveyed reality is working. To understand it, broader consequences need to be taken into account (understanding why there is right-wheel driving in England is impossible to find out from any analysis of any automobile in the world, it is possible to discover only from functions of upper system, why is the society using automobiles in this way). Furthermore, system thinking results from the

holistic theory; that the whole is more than the sum of its parts, or simply said because of the interactions of its independent parts (how these independent parts are able to work together to reach the final effect) [2]. SCM system could be compared to the system of a car. A car is composed from thousands of parts. Imagine that we have the best cars from each worldwide brand and we will pick the best component from each of them to get the best possible car so far with the best components as motor, transmission, wheels, seats etc. If we disassemble all these chosen cars, with the help of top engineers, choose the best components and try to get the best possible car, what could we get? We surely couldn't get the car because these components wouldn't fit together. Couldn't work together [3]. The result of how these thousands of components would successfully cooperate depends on the purpose of the final car (family, sports, outdoor, etc.) The same is for SCM of automotive companies focusing on delivering the car with the highest flexibility and quality at the lowest possible price to the final customer. The goal is not the minimum costs of each individual part of SCM but the lowest costs of interacting parts of SCM as the whole (the same for quality lead time etc).

1.1.1 System solution in frame of Mass SCM – principles of interactions

Maximum output of individual parts, isolated optimization with minimum unit costs are characteristics corresponding to the markets of 20th century, especially unsaturated markets accepting any output of products by businesses at that time. SCM concept, occurring in the 80s, thanks to integration, effective planning tools as ERP (enterprise resource planning), MRP (material resource planning) is supposed to help producers to cope with the increasing saturation of the markets and competition. Customer centred marketing and developing products start to come up. Unfortunately, that is so far the most from the businesses processes that was influenced by customer centred attitude in the current supply chains. The entire system is focused on the principle of increasing productivity described as producing more instead of consuming less.

1.1.2 System solution in terms of Lean SCM – principles of interactions

Toyota production system (TPS) very well known as Lean, created by the Japanese automotive maker Toyota Motor Corporation, has grown from 50th in the 20th century in the isolated market background of the Japanese islands. This background, with its limited market capacity and weak purchase, simulated in a certain manner the power of the actual highly competitive area of the worldwide automotive markets with its high volume and complexity of final products [4]. In such market conditions, there was no possibility to improve productivity and increase output only by increasing production volumes. The only way was to reduce the amount of consumed resources. Toyota has developed its production system for almost 70 years principally in similar conditions that current businesses have faced for almost 20 years. So there is a really serious gap between the production system improving its productivity by producing more or consuming less attitude. That's one of the core principle allowing Toyota to become number one in selling volumes in automotive in 2008 [5]. At the same time Toyota exceeds outstandingly its competitors in quality, flexibility and profitability [6]. Furthermore, the tools and principles of its production system have become the most utilized sources for optimization, so far [7]. TPS and its SCM opposing to the marketing affairs of western producers, is entirely customer centred and there is no place for MRP, ERP systems, cost accounting managing productivity and its activities and particular optimization supported by automatization or computerisation. The productivity of the whole system is oriented to consume less instead of producing more.

Maximum output vs. minimum consumption is critically dependent on the ability to identify and quantify what is the productive solution. The other important aspect is the analysis of value added and waste activities in SCM processes. In the past, where all production was bought by insatiable customers all value added activities were oriented to production. Competition and demanding customers change this understanding in a crucial way. Actually, there is a huge gap between value added activities from the producer's side and

customer's side. From the introduction of the transition from the system principle of interactions in MassSCM to LeanSCM [8] is important to understand the absolutely different influence to productivity (connection of efficiency and effectiveness) of the supply chain as a whole. Conceptual framework explaining this transition and productivity influence is based on a model example of 2 basic supply chains consisting of 3 chains. Similar benefits shown in the model situation are possible to be expected in practical supply chain optimization.

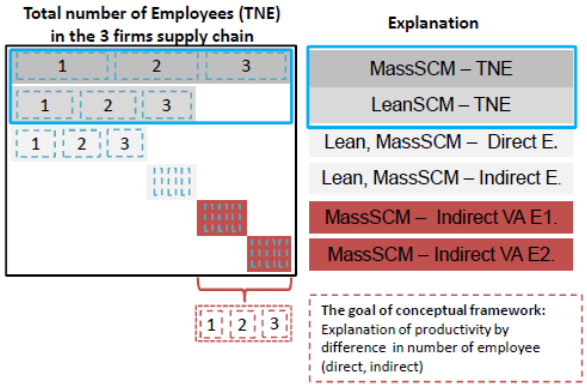

Fig. 1: Conceptual framework description

Fig. 1 describes visually the main goal of conceptual framework. There are 3 firms analysed with a total number of employees and it is distinguished between the number of employee in Mass and Lean SCM variant. The number of employees is furthermore divided into Lean and Mass Indirect E – the same for both parts (finance, marketing, HR, etc). Mass SCM – Indirect VA E1 – employee results from instability of processes and Mass SCM – Indirect VA E2 – indirect personal such a disponent (employee responsible for call-offs of material at suppliers), quality control, process engineers, capacity planners etc..

1.1.3 Levelling production in automotive supply chain of metallurgical components description

Levelling production is production planning principle developed by Toyota to be able cope with production of more models on 1 assembly line in the same level of levelling by mix and levelling by volume quantities [9]. Actual automotive practice is using only levelling by mix part [10]. One of the core reason is production more focus motivating to produce whatever, even if it is not suitable for the production plan because of quality issues or limited flexibility demanding more employees, see Picture1 - MassSCM Indirect VA E1,2.

Automotive producer (AP) from central Europe is producing around 3000 cars a day. It consumes approximately 20 000 tons of metal-plate roles a month. There is 300 different kinds of metal-plate roles. There are about 40 days of stock of these roles and the principle of deliveries from metallurgical producer to the stamping department of the automotive producer is based on VMI (Vendor management inventory). VMI means, that there is a logistics services provider who is paid by metallurgical producer and is responsible for deliveries and safety stock keeping to the customer – AP. AP is following only 50% of levelling production potential and even that part is running because of the customer satisfaction goal. There haven't been measured any efficiency benefits, so far. Proposed conceptual framework should demonstrate the benefits of levelling production to the metallurgical supply chain by reducing the quantity of warehouse level and reduction of indirect employees due to inefficiencies in production (stamping, welding, painting and assembling departments) plant.

2 EXPERIMENTAL PART

2.1 Description of the model

Conceptual framework is based on the following logic model of production which is similar for all companies in SCM. There is a company producing 100 pieces of a product a day with 10 employees, 6 direct and 4 indirect (but connected with production, production planners, industrial engineers, quality staff, maintenance etc.) employees. Based on the difference in productivity understanding Mass SCM – producing more and Lean SCM – consuming less principle, there are two possible ways of optimization. Mass SCM, increasing productivity means to invest into better equipment enabling the staff to increase efficiency and be able to produce 120 pieces a day with 10 (6/4) employees. In Lean SCM, increased productivity is reached by the JIT production principle and many others (levelling, kaizen, etc. [9]). As a result of optimization, the company is able to produce 100 pieces with only 8 employees, with a reduction of 2 indirect employees assuring activities connected with quality control, maintenance, planning etc.

2.2 Testing the hypothesis

Based on the logic of model description the Witness simulation takes 30 days of production with different customer demands from 70 – 130 pieces a day. The customer demands were put into the model based on normal distribution. As a result, to meet the customer demand the consuming less principle production needs 10% less employees than the more production optimization. The critical importance is the system point of view which takes into account during the evaluation not only the direct personnel but even indirect personnel which is critical in Mass SCM for a successful production. Even if the need of direct personnel during all the testing phases is in Mass SCM version less, meaning around 10%, the need of indirect personnel in Lean SCM is less than 20%, see Fig.2. It means that in total Lean SCM is more optimal as a whole on the number of total personnel. There have been only direct personnel comparisons so far, based on the current understanding of productivity and value added activities.

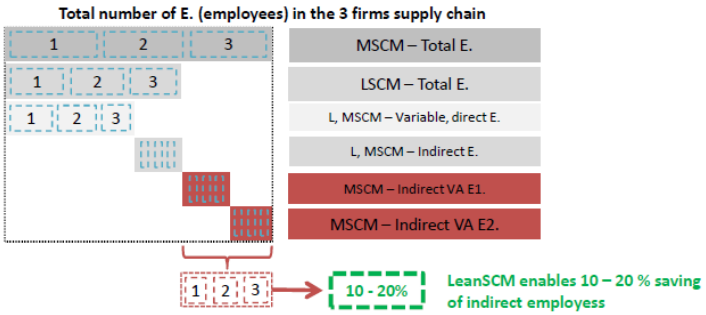

Fig. 2: Conceptual framework description results

3. RESULTS

Production oriented system – Mass SCM attitude - from 20th century, shortly called PRODUCING MORE principle, is trying to minimize the number of employees directly connected to production. This way of optimization and evaluation of productivity generates similar results in both MassSCM and LeanSCM attitude only in the number of direct employees. A side effect of PRODUCING MORE attitude is hiding indirect activities, employees, which are critically important for such a way of production, maintenance, quality control, despondent, industrial engineers, planners etc. Current calculations of productivity have not taken into account these indirect employees. Customer focused oriented system – Lean SCM attitude - from 21st century, shortly called CONSUMING LESS principle, is trying to minimize all employees direct/indirect

connected to production. All Lean tools and principles (JIT, Levelling, Kaizen, Kanban, Jidoka, SMED, etc) are focusing on the reduction of all resources needed for fulfilling the customer's wish. It could be called a self-managing system which doesn't need the army of indirect personnel (maintenance, quality control, despondent, industrial engineers, planners etc.). Current calculations of productivity couldn't show the elimination of this army of indirect employees because they are not calculated as a part of the direct sources necessary for production. The most important difference in productivity of the compared principles is in the TOTAL number of employees in the production system. Fig. 2 shows that the Lean SCM production principle needs around 10 – 20 % of indirect employees less than the Mass SCM. Both Lean and Mass SCM contain indirect activities including the official definition of SCM [11].

With the application of the proposed model to the Metallurgy Supply chain in automotive we could expect similar benefits. There is only one possible solution of deliveries of metallurgical resources leading through producing more principle either on the metallurgy producer's side or the logistics services provider's side or on the customer's AP side. Each part of the current solution of the supply chain is working optimizing and measuring the results separately. The system solution of SCM could reduce the number of employees more than 10% and reduction of fluctuations, warehouse levels etc. between 10-40%. Picture 2 describes the principal changes in SCM in metallurgy, which could bring the previously mentioned increase in productivity.

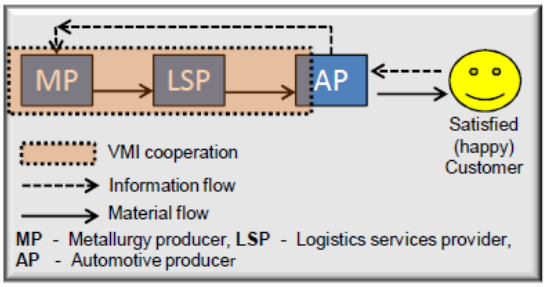

Fig.3 Actual SCM solution in metallurgy

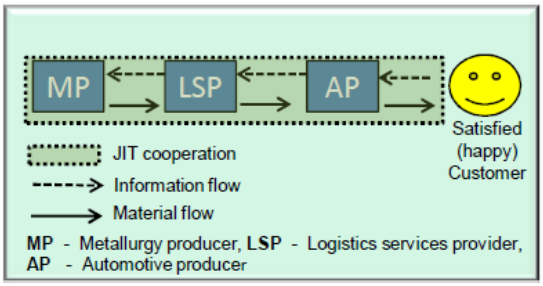

Fig. 4 Proposed SCM solution in metallurgy

2. DISCUSSION

The system solution assumes the analysis of functionality of the whole SCM, not only the sum of the productivity of its particular parts. The calculation of the whole number of employees, direct and indirect, shows an interesting difference in the compared productivity of the Mass SCM and Lean SCM principles. The conceptual framework based on the system solution and understanding of value added activities in the LEAN way (which is possible to understand only with the help of the system thinking) is able to identify the actual excess capacity of actual Mass SCM solutions and helps to understand the advantages of a better capacity utilization of Lean SCM solution. To be able to achieve a better understanding of mutual interconnections and relations of direct and indirect employees in the current industrial world, more research must be completed. The proposed conceptual framework describes and shows directions where further research activities should be focused.

3. CONCLUSION

The proposed conceptual framework describes, that increasing productivity by bigger production lot sizes/volumes or utilization of new technologies substituting human work, which we bring as a way of thinking from 20th century, hasn't been the only and the most efficient option to become competitive so far and there is a more effective alternative, which is represented by TPS. TPS has been described by countless publications and teaching programs so far. The principles are generally well-known as well as the tools JIT, kanban, kaizen, etc., as almost every company, not only in automotive, but in any branch of national industry

has tried to optimize its processes with their help. The common part of this aspiration is the analytical approach using only particular tools and principles, without considering the interconnections and system solution. There has been only a small part of attention dedicated to the explanation of why such Lean attitude hasn't brought success so far or why the results haven't become a long-term competitive advantage as in the case of Toyota Motor Corporation. The proposed conceptual framework clearly presents the reason of such failure. The explanation is not visible on a tour in Toyota or any other automotive producer plant; it is not possible to understand with a standard analytical way of thinking. Understanding the differences in transition from MassSCM to LeanSCM principle is possible thanks to system thinking which is covering a broader context of SCM activities. The PRODUCING MORE or CONSUMING LESS difference in productivity is understandable thanks to the description of an upper system of which the SCM system is a subsystem of – this is the difference between market conditions and customer needs of 20th , respectively 21st century.

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REFERENCES

[1] CHRISTOPHER, M., RYALS, L. J. The Supply Chain Becomes The Demand Chain. Journal of Business, Logistics, Vol. 35, No.1, 2014, pp. 29-35.

[2] PERNICA P. Logistika pro 21. Století Supply Chain Management. Praha: *Radix,* 2005, ISBN 80-86031-59-4

[3] ACKOFF, R. System thinking and thinking systems. System dynamics review. Vol. 10, No. 2.-3., 1994, pp. 175-178.

[4] LIKER, J.K. Tak to dělá Toyota. Praha: *Management Press,* 2007. ISBN 978-80-7261-173-7

[5] MCINTYRE, D., A. Toyota: The World's Most Profitable Car Company. *24/7 Wall St.* [online]. 4.2.2014 [cit. 2014-05-08]. Dostupné z: http://247wallst.com/autos/2014/02/04/toyota-the-worlds-most-profitable-car-company/

[6] WOMACK, J.P. JONES, D.T. ROOS, D. The Machine that change the world: The Story of Lean Production, Harper Perennial. Free Press. 2007.

[7] HOLMAN D. Cost estimation methodology of productivity LEAN utilized in supply chain in market condition of 2 nd decade of 21. century: Doctoral thesis. Prague: University of economics, 2012.139 p.

[8] HOLMAN, D. JIRSÁK, P. Unified Theory of SCM Competitiveness in 21st century (Principles of paradigmatic change MassSCM > LeanSCM). In CLC 2013: s. 1-7.

[9] OHNO,T.: Toyota Production System: Beyond Large-Scale Production. Productivity Press. 1988.

[10] HOLMAN, D., LENORT, R., STAŠ, D., WICHER, P. Levelling Production – Critical Assumption of Competitive Lean SCM. Applied Mechanics and Materials. 2015. Vol. 708, No. 13, s. 33—38.

[11] CSCMP Supply chain management a Logistics management definitions. Available at: http://cscmp.org/aboutcscmp/definitions.asp, cit. 20.5. 2015