SYSTEM SOLUTION OF SCM IN AUTOMOTIVE IMPROVES PRODUCTIVITY IN METALLURGICAL INDUSTRY

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Abstract

The aim of the article is to apply system thinking as the actual source of best practice innovation solution from automotive industry to increase the competitiveness of metallurgic industry. Systems thinking and system theory are currently widely used in a variety of subjects in fields such as computing, engineering, information science, manufacturing, management, sustainable development and the environment. The key assumptions of system thinking are improving mutual interactions between the particular parts of the system and understanding the essential properties of the systems, which derive properties of the parts and interactions. They are quite opposite to the former assumption, which prioritize applying innovations to particular parts and summing them up to an innovative whole, without taking into consideration the essential properties of the whole.

Keywords: Supply chain management, system thinking, productivity

1. INTRODUCTION

The actual situation in the worldwide metallurgical market conditions is described in [1]. Several mega-trends in macroeconomics are driving the globalization of the steel business. The industry must transform itself for success. There are four main areas of transformation:

- Rationalize excess capacity
- Increase market and product concentration
- Increase market competitiveness
- Embrace the digital

All these mega-trends need to be organized based on the best practices available in the current industrial world. The automotive industry is one of the biggest customer of the metallurgic sphere. One of its best practices, system thinking, needs to be applied to withdraw the maximum potential from this transformation.

2. SYSTEM THINKING IN SUPPLY CHAIN MANAGEMENT

Self-centered orientation of businesses and academic research should be replaced by customer-centered orientation, properties derived outside the system. The second attitude and its impact and implications have stood so far aside the mainstream academic and practical attention. Particularly mentioned by Ackoff's: Systems thinking definition, the essential properties of the system, are properties which none of its parts have; the essential properties are derived outside the system and could be seen only in the containing system [2], and Bertalanffy: Systems thinking is recognized as general science of wholeness [3]. The first indication of the full environmental system thinking attitude could be seen in practical use in companies like Toyota creating the Toyota production system (TPS) [4].

3. METHODOLOGY PROPOSAL AND ITS METHODOLOGICAL BASIS

The combination of Value stream analysis [5], Lead time and proportion of value added activities [6] have serious impact to the profit margin. These methods are capable to measure the influence and advantages of system thinking on the Supply chain management and increase its profitability. Simulation is one the most important analytical tools to find the relevant patterns of the system processes and their interactions [7]. eVSM tool was used for value strem map design and experiments.

4. SIMULATION

The experimental part was made in the virtual simulation software eVSM. The simulation contains 3 simple production processes (body production, painting and wheel assembly). There were two options: the batch production version and the one piece flow version. The simulation consists of 1 month of production and the goal was to efficiently measure either system or particular innovation's performance. The results of the simulation were tested in 1 experiment in the Batch production and the OPF version. In Batch production, the experiment aimed at the optimization of just the 2nd process, painting and the improvement was a 50% reduction of cycle time, which means a faster production. The same experiment was done for the One piece flow version of production. The results of value added activity measurement of batch production are listed in **Table 1**.

Table 1 Batch production experiental part results

	Batch production of 1 piece	1. exp. 50% reduction of cycle time painting	1. exp. 50% reduction of cycle time painting	Batch production of 10 pieces	1. exp. 50% reduction of cycle time painting	1. exp. 50% reduction of cycle time painting
BODY PRODUCTION	1	1	1	10	10	10
Stock 1, min	9	9	10	90	90	100
PAINTING, min	1	0.5	0.5	10	5	5
Stock 2, min	9	9	10	90	90	100
ASSEMBLY, min	1	1	1	10	10	10
LEAD TIME, min	21	20.5	22.5	210	205	225
VALUE ADDED SHARE	14.3%	12.2%	11.1%	14.0%	12.2%	11.1%

	Lead time	Value added share	Influence to lead time change
Sum of performance with particular optimization	20.5	12.2	2.4%
Total real efect - influence to interactions with other parts of the systém	22.5	11.1	7.1%

The results of the experiment could be seen in **Table 1**. The particular optimization could positively influence the total lead time and value added share - the yellow parts. But more important than the mathematical calculation, concretely the sum of the new cycle times, is the real effect on the whole production system. These consequences could not be seen from the calculating just the value added activities, which is a common practice these days. These consequences need to be analyzed from the point of view of cooperation and interaction of these value added activities. In case of batch production, it means the level of stock. Total lead time needs to be counted after implementation of improvement. Total real efect (green) could be seen in **Table 1**. Instead of reduction of total lead by 2.4 % we could see the opposite results, increasing total lead time by 7.1 %.

Table 2 describes result of second experiment. The same products were made by different kind of production - OPF. Particular optimization of second process was made to improve cycle time of processes by 50%. Mathematical calculation without consideration of influence of improvement to other processes leads to reduction of total lead time by 16.7%. The more important is real efect to the whole system, because previous and after processes needs to react to the new situation. The real effect of particular optimization in OPF production increase the lead by 50%. The verification of the situation is made for production of 10 pieces, where we can see the same results.

Table 2 One piece flow production experiental part results

	OPF production of 1 piece	1. exp. 50% reduction of cycle time painting	1. exp. 50% reduction of cycle time painting	OPF production of 10 pieces	1. exp. 50% reduction of cycle time painting	1. exp. 50% reduction of cycle time painting
BODY PRODUCTION	1	1	1	10	10	10
Stock 1, min		0	1			10
PAINTING, min	1	0.5	0.5	10	5	5
Stock 2, min		0	1			10
ASSEMBLY, min	1	1	1	10	10	10
LEAD TIME, min	3	2.5	4.5	30	25	45
VALUE ADDED SHARE	100%	100%	56%	100%	100%	56%

	Lead time	Value Added Share	Influence to lead time change
Sum of performance with particular optimization	2.5	100	-16.7%
Total real efect - influence to interactions with other parts of the systém	4.5	67	50.0%

OPF principle of production was designed according to system thinking principles (focus on the interactions and the productivity of the whole system). The influence of particular optimization which improves just part of the process cause that the result of the whole system, lead time, is worse.

Both above mentioned experiments leads to the similar results. Particular optimization could seriously improve performance of particular processes either batch production or OPF. But the performance of the whole system measured by lead time and value added share is always worse. This fact should be considered during evaluation of any improvement, innovation because current business world haven´t know the influence of the particular optimization to the whole system yet.

5. INFLUENCE OF LEAD TIME AND VALUE ADDED RATIO TO PROFIT MARGIN

The profit margin formula measures the Net profit / Total revenue. An efficiency comparison of these days could not recognize the difference in improving productivity neither by increasing production number nor by increasing the productivity of processes on their own [6]. Profit margin calculation could improve this week's side of actual productivity calculation and focus on the ability to improve costs without influencing the quantity because it is contained in both parts of the formula (in Net profit and Total revenue). This means that the costs representing the level of value added activities in total lead time are easily recognized. Experiment 1 proves that particular improvement of cycle time - the speed of any process without considering the whole, is getting worse than the total lead time and the rate of value added activity. These variables are responsible for the total costs which occur in the profit margin calculation. These variables are responsible for the total costs which occur in profit margin calculation.

6. POTENTIAL BENEFITS OF SYSTEM SOLUTION IN MATALLURGICAL SCM

The transformation of the metalurgic sphere in the worldwide markets of 21st century is undeniable. Globalization, competitiveness, digitization etc. create new conditions which make an innovative playground for all participants in the whole supply chain containing metallurgic parts. The principles of the Toyota production system are managed with the system thinking principles explaining that the productivity of SCM is not the productivity of the Sums of its parts but the productivity of the whole. The application of innovation and improvements should consider this situation.

Incresing production volumes were responsible for the increased productivity in Mass production oriented systems during 20th century. Lean production introduces the ability of system thinking to increase productivity thanks to the consideration of the properties of the wholes rather than the sum of their parts. The simulation of simple production processes explainy easily the importance of the connection between individual parts and the properties of the wholes which are defined through the system theory. The same logic could be applied to the metallurgic supply chain containing millions of units of products, which are currently produced rather by batch production system, than one piece flow production system with its advantages. Improvement in system thinking is focusing on the redesign of the whole rather than improving just parts. The same logic should be applied in system of metallurgic SCM. Automotive industry as one of the biggest customer is focusing on reduction of lot sizes.

7. CONCLUSION

The automotive industry has utilized system thinking for improving its productivity. The same methodology could be applied in the metallurgic supply chain. The market conditions of 21st century are characterized by serious changes that influence the whole industrial sphere. The whole metallurgic sector is being driven to transform. The critical assumption to successful transformation is the application of system thinking. 2 main approaches are focused on improving interactions of the parts and derivation of the scale of productivity improvement from the properties of the upper system, of which the examined system is part. The simulation and the results of the experiment verify that particular optimization can improve only particular parts. The lead time and value added share could prove that real influence of such particular optimization makes lead time longer and the share of value added activities of the whole system worse, which leads to higher costs expressed by worse profit margins. Metallurgical enterprises should utilized system thinking approach to reach successful transformation securing expected profit margins and lead time. Either innovation in interaction in supply chain or the scale of innovations of these interaction should be evaluated and implemented by system point of view.

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