DNA ANALYSIS OF LARG_SCM CONCEPTS THAT ARE APPLIED UNDER CURRENT MARKET CONDITIONS

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Abstract

The aim of this article is to identify the differences between SCM concepts, particularly LeanSCM, AgileSCM, ResilientSCM and GreenSCM. These concepts are commonly considered as SCM paradigms by many SCM academics and professionals. Features of above mentioned concepts are mutually confronted and compared with initial concept mass Logistics- MassSCM, which dominated in the 2nd half of the 20th century. Unfortunately, MassSCM attributes have been inherited and passed on to the current SCM concepts. Particular SCM concepts are analysed and assessed by means of 4 fundamental principles: Management, Productivity, Added value, Cost appraisal. Moreover, the 4 fundamental principles enable not only definition differences between MassSCM, LesanSCM, AgileSCM, ResilientSCM and GreenSCM but also identification of DNA of the 5 SCM paradigms. The importance of transition from MassSCM to other SCM concepts, especially to LeanSCM, is tested by models inspired by Dr. Licker, built in simulation software Witness. The model enables verification of impact of paradigm SCM change on SCM productivity appraise. Without undergoing of proper transition from MassSCM to LeanSCM any tuning of SCM concept regarding turbulent and volatile market since the beginning of 21st century will lead to short term temporary insular outcomes. Hence, such approach contradicts with system theory and holistic view of SCM concept. Moreover, it also hampers achievement of competitive advantage of supply chain in current market conditions.

Keywords: lean supply chain management, transition MassSCM>LeanSCM, productivity

1. INTRODUCTION

The purpose of this article is to clarify the fundamental SCM transitions caused by change of market conditions which happened at the end of the 20th century and especially at the beginning of 21st century. Hence, the MassSCM is considered to be an initial state which is compared to the follow-up SCM particularly LARGSCM. The significance of the transition is likened to the change in DNA typical for living organisms. Changes in surrounded environment lead to evolution of living organisms and is an elementary precondition to their survival. Thus, DNA as key attributes forming behaviour and life of a biological system has to be inevitably changed and adopted to them. If DNA is not changed then living organisms cannot completely adapt and only tempts to improve cosmetically but it cannot enable them to survive in a midterm or long-term perspective. Therefore, structural and radical change of DNA represents fundamental pillar and principle based on which not only living organism but also corporate systems have to build their existence including SCM. DNA change is here verified by means of productivity as one of the four fundamental principles (management, productivity, added value, cost appraise). The verification is carried out by simulation of MassSCM and LeanSCM models by using simulation and modelling software Witness.

2. COMPARISON OF SCM CONCEPTS

Significant changes of market conditions result in radical modification of company behavior, particularly in searching for and application of new SCM concepts [1]. However, there has not been any evidence of corporate DNA evolution especially in the area of SCM. Efforts have been given to cosmetic changes such as implementation and/or improvements of new tools and principles. The idea of using the analogy between SCM and living organism is to emphasize the real benefits of easily visible and realized cosmetic improvements noticed by different behavior and usually hidden but radical changes of which scope directly embraces modification of living organism DNA. The consequence of DNA modification lies in different life patterns and acts of the living organism. The parallel of living organism is given here not only individual corporations but to their total supply chains.

MLARGSCM are confronted based on 4 fundamental DNA attributes defined by author of this papers (management, productivity, added value, cost appraise). Their change is inevitable within transition from one to another SCM [2]. Each attribute is divided into detail characteristic signs that firstly help to describe essential features of each SCM concept. Then it helps to identify differences and commons of the concepts.

The market conditions have changed throughout the recent 50 years. It starts with unsaturated markets that are characterized by stable demand. Such conditions enable companies accurate forecasting of market situation e.g. customer demand. Moreover, customers could be satisfied by quite narrow assortment and unified products targeted for mass customers. Accurate forecasting of corporate environment enables accurate planning in short and midterm horizon and also stabilization of processes and management including logistics. Furthermore, there is stable and long term demand growth. Customers are satisfied through stocks thanks to stable demand as only then short delivery time is provided, economies of scope gained and both achieved under low risk of stock obsolescence. Processes are managed by push principle [3], [4], [5]. Above described features are typical for Mass logistics system called **MassSCM.**

Market conditions are changed throughout the time and markets become saturated with quantity of goods. Competition is extended from national and regional to a global one. Market domination is shifted from supply side to demand side. Long term past stable demand grow is discontinued in USA and European countries because of oil price spikes and penetration of Japanese companies on these markets. Moreover, Japanese companies manage to deliver goods of better quality, lower price and in unbelievably shorter innovative cycle.

Thus, fall of demand on European and American companies led to massive dismiss, decline of safety for employees significantly affecting their purchasing power. Hence, customer segment highly sensitive to price is established and since that grow. Above mentioned trends force companies to launch wider assortment in shorter time, individualize products and services on their markets. Furthermore, cost consideration is more and more urgent. It is vital to focus on cost reduction and flexibility through elimination of waste across the supply chain [6]. Logistic system corresponding to such market condition is called **LeanSCM**.

This is followed by the period of global competition on markets saturated either with quantities or assortment. Market dominance is completely on the side of demand and the pressure is even more intensified to extend the offered product portfolio, reduce product and also their component innovative cycle [7]. Hence, a part of the market games become extremely high variability of demand [8], high stocks obsolescence and stockout at the same time caused by significant gap between plans, forecasts and market reality. Logistics system that is able to adapt to such conditions is called **AgileSCM**.

Further evolutionary state is characterized by similar features as AgileSCM at last in some aspects [9]**.** Besides that, supply chains are more and more frequently disturbed by natural disasters, terrorist attacks, maritime piracy hitting main global goods flow roots, cyber attacks, economic, financial and political crises. Apart from symptoms of AgileSCM the demand variability is also influenced by ability of companies to deal with market disturbance in B2B relationships and transactions. [10] Thus, vulnerability of supply chains become a key aspect as the frequency of such disturbances has been recently intensified [11]. Multi scenario planning and contingency plans are essential weapon. Thus, it is inevitable to plan and monitor not only of direct contract partners´ situation but also at least one step further upstream and downstream in a supply chain, so their suppliers and customers. Such logistic system is called **ResilientSCM**.

So far, the last change of market condition is based on intensively growing concern about ecological aspect of supply chain operations. Such change is associated with attempt of companies to reduce their costs, differentiate themselves on the market by image of the company that reflects in their strategy externalities being produced by their supply chains throughout the whole product life cycle. Lower costs could be achieved by higher productivity of supply chains including reverse flows. This logistic system is called **GreenSCM.**

All SCM concepts are analyzed and confronted regarding the following scale:

1. **Radical** (structural change of DNA) = change which is not usually visible for the first sight but is highly critical (analogy to DNA change is rightful as the changes are not visible and commonly needs long term to be accomplished. However, they significantly affect the behavior of living organism.) It is considered to be paradigmatic change modifying fundamental system pillars. They highly change the perception and view on internal and external process climate, application of particular principles and tools and also performance appraisal.
2. **Cosmetic change** (change of behavior within current DNA) = available tools are partially modified to better adhere to market changes, such changes are easily visible. Tools and procedures are enriched by new appraisal criteria. Cosmetic changes are impressive, quickly implemented but usually have only short term impacts.
3. **No change** = not only principles are not changed but also tools and appraisal criteria are without any modification.

Table 1 Comparison of MassSCM with LARGSCM concepts based on 4 fundamental principles of DNA change

DNA	DNA atributes	Mass > Lean	Lean > Agile	Agile > Resilient	Resilient > Green	Mass > Lean	Mass > Agile	Mass > Resilient	Mass > Green
Management	People	Radical change	Cosmetic change	Cosmetic change	Cosmetic change	Radical change	Radical change	Radical change	Radical change
	Subjects	Radical change	Cosmetic change	Cosmetic change	Cosmetic change	Radical change	Radical change	Radical change	Radical change
	Processes	Radical change	Cosmetic change	Cosmetic change	Cosmetic change	Radical change	Radical change	Radical change	Radical change
Productivity	Productivity calculation	Radical change	No change	No change	No change	Radical change	Radical change	Radical change	Radical change
	Tools	Radical change	Cosmetic change	Cosmetic change	Cosmetic change	Radical change	Radical change	Radical change	Radical change
Added value	Identification of added value	Radical change	Cosmetic change	Cosmetic change	Cosmetic change	Radical change	Radical change	Radical change	Radical change
	Increase of added value	Radical change	No change	No change	No change	Radical change	Radical change	Radical change	Radical change
Cost appraisal	Cost reduction orientation	Radical change	No change	Cosmetic change	No change	Radical change	Radical change	Radical change	Radical change
	Cost reduction achievment	Radical change	No change	No change	No change	Radical change	Radical change	Radical change	Radical change
	External costs	Radical change	No change	No change	No change	Radical change	Radical change	Radical change	Radical change

Radical change (change of DNA)
Cosmetic change (no change of DNA)
No change

Table 1 shows the 4 fundamental principles, DNA attributes and their change in transition throughout MLARG SCM. Green table expresses gradual transition order regarding the time and the blue one represents the comparison of LARGSCM with MassSCM and outlines critical change between MassSCM and the other concepts. The reason for that is to emphasize the significant steps that have to be done in transition from MassSCM dominated in the end of 20th century to whatever SCM out of LARG. This step has been widely neglected although it significantly determines the success or failure in transition from MassSCM to whatever SCM concept. The ignorance of that springs out from application of insular approach in implementation of new principles and tools that should adjust current SCM to new market conditions [1], [5]. In addition to that, it is still believed that implementing new tools and principles on original SCM DNA is viable and could lead to success on the market. The changes of market conditions at the end of 20th century required radical changes of SCM DNA like living organisms do. Unfortunately, corporations have since that undergone only cosmetic changes without any revision of SCM DNA. Absence of radical change in 4 fundamental principles [2], inevitably leads to failure or at least to unsatisfactory results which are far from initial expectations [12].

Different perception of productivity and added value as well as management and cost appraise leads to gap between initial goals sets before transition from Mass/Lean and actually achieved performances by implementing Lean tools e.g. implementation of Milkrun on supplies. It is due to prevalence of cosmetic changes. The successful transition cannot be accomplished if corporations fail to radically change their DNA in the 4 given areas: management (system approach applied on all supply chain parties), added value (stressing a role of waste in a supply chain), productivity (provision of what is demanded by customers and refraining from overproduction) and cost appraisal (allocation of costs to value streams rather than using insular cost silos). It is similar to adaptation of living organism to changes in their environment as without that such living organism cannot survive like a supply chain cannot be competitive and so survive without adoption to market changes.

3. PRODUCTIVITY ANALYSIS UNDER CURRENT MARKET CONDITIONS

Concerning above mentioned, it is obvious that the critical point of change in productivity appraisal lays in transition from MassSCM to LeanSCM. Thus, the main attention is here put on verification of the fundamental change in productivity in transition from MassSCM to LeanSCM. Nonetheless, the Lean features in that correspond to all LARGSCM. Verification is carried out by dynamic stochastic simulation on production-logistic models which are based on Licker´s model of computer production. Brief description of MassSCM and LeanSCM models is provided in **Fig.1** and **Fig. 2** and it depicts elementary differences between MassSCM and LeanSCM. Scope of the analyzed process is expresses by the grey area in **Fig. 1**.

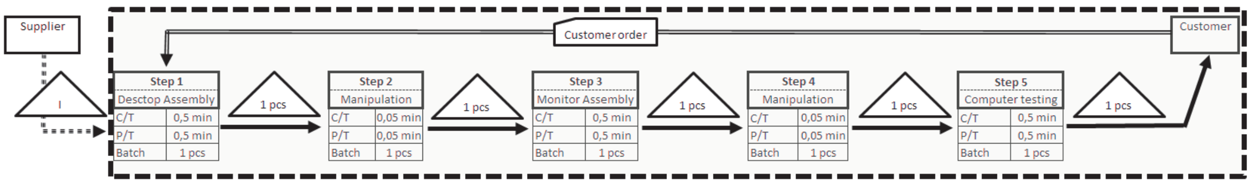

Fig. 1 LeanSCM model

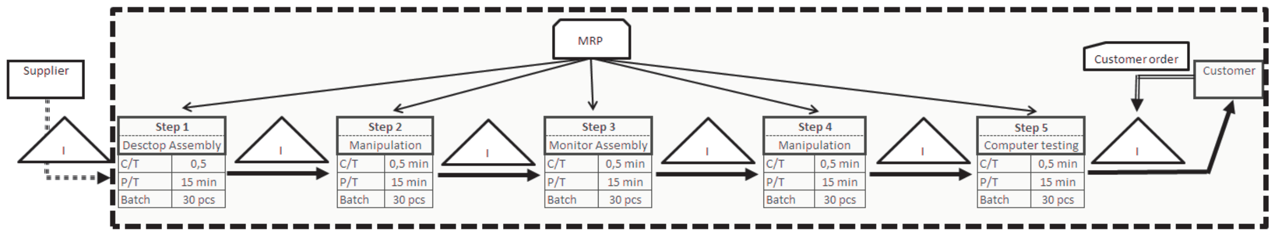

Fig. 2 MassSCM model

The length of simulation time is set to cover one month operation. Daily processes are operated in 3 shifts, each shift is 480 minutes long including 30 minutes break. Customer orders enter both models in fixed 15 minute intervals but the demanded quantity is changed based on distribution. Basic distribution is {22(1%}, {24(2%}, {26(6%}, {28(16%}, {30(50%}, {32(16%}, {34(6%}, {36(2%}, {38(1%} with the mean of 30 pieces. During demand falls the demand distribution is decreased by one piece in average per order e.g. {21(1%},{23(2%},{25(6%},{27(16%}, {29(50%},{31(16%},{33(6%},{35(2%},{37(1%} with the mean of 29 pieces, finally to 9 pieces in average. Thus, the demand is decreased by 70% in maximum. Moreover, the demanded quantity is changed, declined, to identify impacts of that on MassSCM and LeanSCM. Different demand levels are still represented by distribution. The simulation is focused on declining demand as it corresponds to current market situation, in which short term economic growth is followed by unanticipated drop including demand, with which SCM has to cope with.

MassSCM model is built up on traditional precondition of batch production which causes system rigidity and incapability of adaptation to quick changes market conditions. Parameters of the models define the capacity output at 81 000 pieces per month which meets anticipated and planed demand, including safety stocks, during the analyzed period. The set capacity is sufficient to satisfy the average customer order size of 30 pieces. The MassSCM model is confronted with the LeanSCM which is based on one piece flow. Performances of both are compared by monitoring traditional formula of productivity and the leanformula. In addition to that, it monitors number of sold pieces, lead times of operations and total process lead time defined by the grey area in **Fig. 1** and **Fig. 2**.

4. RESULTS

Results of the simulation clearly show that using traditional formula of productivity expressed by number of outputs (manufactured products) divided by consumed sources (inputs are expresses in time needed for flowing of product throughout the process) leads to hidden waste. It is caused during demand fall which make gap between forecasted demand, based on which process (production-logistics) was initially parameterized, and actual demand. Furthermore, traditional measuring of productivity shows lower productivity of LeanSCM during demand falls in comparison to MassSCM, which corresponds with many findings in practice. The reason for that lays in the fact that MasssSCM cannot react to falling demand as it follows the original plan and produce and process quantities adhering to the planes. Thus, it enables high utilization of sources. Whereas, LeanSCM is pull by demand and it produces and processes only quantities that is just demanded. Hence, at the time of unanticipated demand falls, it provides lower quantities than is originally planned. For instance, when the demand falls by 20% the LeanSCM productivity goes down by almost 20% as well. Moreover, sources are less utilized than it was planned and thus than they are in MassSCM. However, is that real picture of productivity in SCM when it is measured like that? Authors of this papers are confident that it doesn't reflect actual situation. It counts only with efficiency but not with process effectiveness. Efficiency of sources is higher in MassSCM than is in LeanSCM. But under the condition of 20% demand falls MassSCM consumes sources for production and manipulation of 20% of output that are not demanded by customers. This means that productivity appraisal needs to be changed so that effectiveness is incorporated. Hence, it significantly changes proportion between convenience of MassSCM over LeanSCM under declining customer demand. It is critical to measure performances demanded by market, not just planned by process owner, when it comes to source consumption. Only then the 20% of overproduction is reflected in decrease of productivity in MassSCM and the deviation of actual outputs from planned doesn´t reduce the productivity of LeanSCM. Thus adherence and flexibility of LeanSCM to respond to the actual market situation is not penalized.

In addition to that, lead time of a material in a supply chain is not monitored and reflected by traditional way of productivity measuring. Simulation clearly catches that transition from MassSCM to LeanSCM leads to radical change of lead time, e.g. under stable demand the lead time in LeanSCM model is 42 times shorter than in MassSCM model. However, when the demand falls e.g. by early cited 20%, lead time in LeanSCM is not changed but in MassSCM is extended by 1700 times. How it is possible? Rigidity of MassSCM cannot enable adequate response to demand fall and continue on meeting initial plan so the level of stocks is increased and the total lead time is longer. Furthermore, traditional measuring of productivity neglects total lead time and usually only considers cycle time of a single process step. Decreased customer demand has almost no impact on cycle time of individual process steps and so the traditional formula of productivity cannot capture this type of wasting. From above mentioned, it seems to be obvious that rigidity of MassSCM and its incapability of responding to demand changes causes not only overproduction, so the sources are allocated to outputs that nobody require, but also leads to enlargement of total lead times that multiplicatively requires consumption of other company sources. Overproduction is the main source of all other types of waste with impact not only on additional costs but also on lower quality and above mentioned extension of lead time. Essence of this paper is not to express particular figures of waste but to emphasize its existence which has been highly neglected until now due to orientation of MassSC productivity only on production of maximum output quantities per time.

Table 2 An example of simulation results

Average order size	Traditional productivity			Lean productivity					
	Mass	Lean	Δ Productivity Mass>Lean	Mass	Lean	Δ Productivity Mass>Lean	Δlead time Mass	Δlead time Lean	Δlead time Mass>Lean
30	99,9%	100,0%	0,0%	99,7%	99,4%	-0,3%	0	0	42
24	99,9%	79,9%	-20,1%	79,8%	99,8%	20,0%	60	0	2 707
18	99,9%	59,9%	-40,1%	59,8%	99,8%	40,0%	119	0	5 419
12	99,9%	39,9%	-60,1%	39,8%	99,7%	59,8%	179	0	8 113
9	99,9%	29,9%	-70,1%	29,9%	99,6%	69,7%	228	0	10 303

CONCLUSION

Widely known change of DNA that living organism have to undergo in order to survive in long term period under ever changing environment provides precise parallel to invisible changes of market conditions with which supply chains and so even an individual corporation have to struggle with.

Changes in market conditions require adequate adaptation of SCM. However, it is highly important to distinguish between necessity for radical change of SCM DNA and cosmetic improvements that are made within the same DNA as cited in **Table 1**.

Academics and practitioners have commonly devoted their time mainly to the level of cosmetic changes in the area of SCM system. But the importance of DNA changes has been neglected. The radical changes have to be made in 4 fundamental areas SCM and other parts of economic systems, see **Table 1**. DNA changes in SCM are verified for the purpose of this paper in the area of productivity. Results of the simulation on MassSCM and LeanSCM models proves the existence and necessity of radical the change in DNA in transition from MassSCM to LeanSCM under condition of declining demand.

It is essential to point out that it is highly important to shift from traditional maximum volume oriented formula measuring productivity typically in MassSCM to the Lean one enabling reflection of actual customer demand. Leaving the volume oriented orientation of productivity and reflecting only volumes that are demanded by market and also involvement of total lead time analysis are examples of presented DNA change that have been neglected. Simulation results and comparison of MassSCM and LeanSCM models uncover waste which is considered to be added value in traditional system of measuring productivity.

Change of SCM DNA is inevitable in transition from MassSCM to any other SCM concept so that supply chain is able to adjust market changes, satisfy customers and be competitive on the today markets.

Verification of necessity to radical change in analysis of productivity of SCM, which is dictated by market changes, is the first step in verification of all 4 areas requiring radical changes in SCM DNA. The following research step will be to verify the remaining 3 fundamental principles which would lead to establishing unified theory of SCM which identifies neglected changes.

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