COMPETITIVENESS OF SUSTAINABLE LOGISTICS MANAGEMENT IN THE 21ST CENTURY REQUIRES INNOVATION OF EFFECTIVENESS, NOT ONLY EFFICIENCY

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Abstract

The 21st century is characterised by the unprecedented speed and scope of changes, creating a new external environment, where the logistics systems are managed. The crucial role of external environment for the optimal performance of logistics systems in economic, environmental and social aspects of sustainability has been identified. Methodical consideration of external environment requires innovation in systems thinking, represented by the Wholeness Systems Thinking (WST). The wholeness considering of system´s purpose represents the innovation in studied system effectiveness assuring significantly higher benefits for the performance of the whole studied system than previous innovations in efficiency, managed by reductionism considering of system´s purpose, represented by the Reductionism Systems Thinking (RST). The new role of a system´s purpose implementing directly the changing external environment into the performance of studied system´s parts and interactions is tested in an automotive case study, including the automotive producer (OEM) and its supplier.

Keywords: Wholeness Systems Thinking, Sustainable Logistics Management, Efficiency, Effectiveness

1. INTRODUCTION

In order to increase the competitiveness of the logistics systems, it is necessary that the whole studied logistics processes proceed effectively, not only efficiently. More effective logistics management is possible through the application of the new systems thinking approach. The systems thinking understands the logistics system as the whole, the value of which is higher than the sum of the values of each logistics system parts and interactions. Another criterion for improving the performance of the logistics management is currently focusing on sustainable development consisting of economical, natural environmental and social aspects.

The article´s aim is to present the comparative case study results from automotive logistics systems. The case study compares two approaches, management of efficiency and management of effectiveness in studied logistics system.

2. LITERATURE REVIEW

After the introduction of GST in 1950s, the main focus of systems thinking development was oriented on cybernetics or technical systems [1], [2]. The sociological part of the systems thinking development has become relevant starting with the 1990s [3]. Interactions between the parts creating the whole systems are the corner stone of the systemic thinking used in social sciences that understands synthesis as a tool to create the whole, after taking the system apart through analysis. The original systemic thinking describes the analysis as the disassembly of the whole into individual parts, and the synthesis as the composition of the individual parts into the functional whole [4].

There are two of the most frequently mentioned concepts that form the basis of SSCM (see e.g. [5, 6]). Firstly, SD was introduced in ”Our Common Future“ report (Brundtland report) by the World Commission on Environment and Development (Brundtland Commission) in 1987 [7]. Secondly, the triple bottom line (TBL) concept was developed by Elkington in 1998 [8]. Brundtland report defined SD as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” and presented three dimensions of sustainability: economic growth, environmental protection and social equality. TBL attempts to treat all three dimensions of sustainability with equal importance and thus could be considered an integrative theory of sustainability [9].

3. METHODOLOGY

3.1. Systems thinking development (efficiency and effectiveness resolution)

Clear distinction between efficiency and effectiveness is required and is characterised by Wholeness Systems Thinking (WST) approach. WST approach is the innovative way evaluating the role of studied systems elements (parts, interactions and purpose) in reaching the desired purpose of the studied system (see **Figure 1**).

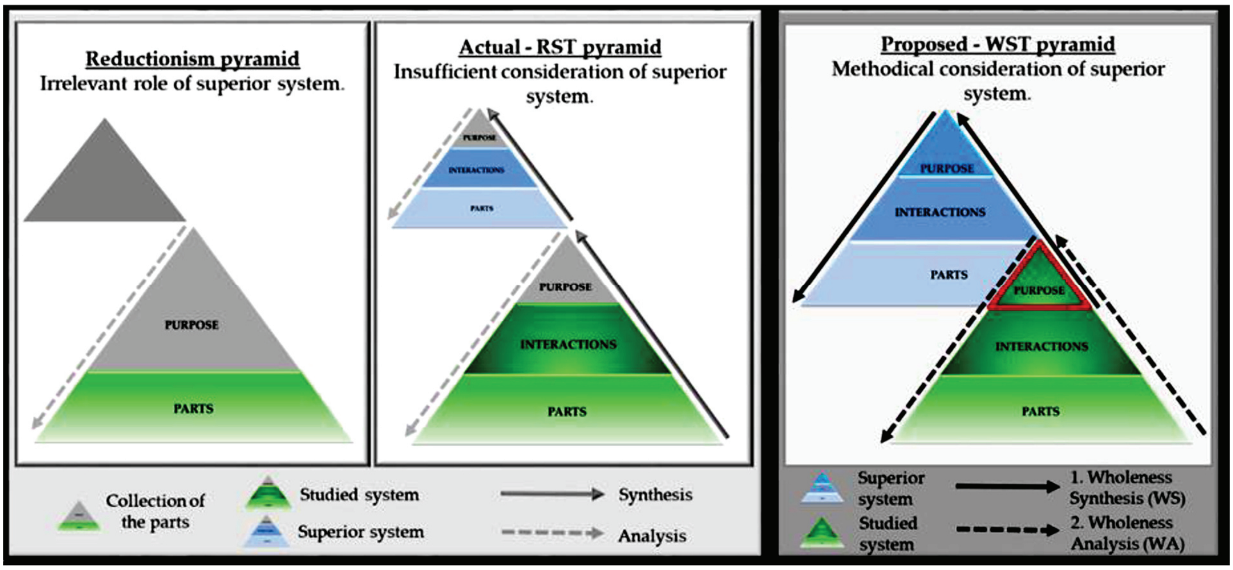


Figure 1 Systems thinking development [10]

WST approach follows actual Reductionism System Thinking approach (RST) and Reductionism. RST approach recognizes system elements, parts and interactions, which together creates bigger whole, than just collection of system parts, known as Reductionism. WST approach recognizes and defines the new role of system´s purpose, which systematically interconnects the studied system with superior system, in economical systems satisfied customers. It replaces the previous RST approach which couldn´t prevent methodically the over-performance of the studied system´s parts and interactions. In RST purpose, the studied systems parts and interactions were motivated to maximize its performance, respectively efficiency, so the over-performance was not systematically considered. The role of external environment, customer requirements was considered in the forecasted volumes. The new, WST approach integrates systematically the superior system - real customer requirements into performance of the studied systems parts and interactions. Therefore it eliminates systematically the over-performance, resulting from previous insufficient considerations of external environment, represented by forecasted volumes. The systematic interconnection of studied and superior system is possible due to the new definition of analysis - wholeness analysis (WA) and synthesis - wholeness synthesis (WS). WA consists of three steps: 1. Taking a studied system apart (parts and interactions) from the purpose perspective (as defined by WS), 2. Understanding each part taken separately, 3. Aggregating understanding of the parts and interactions into understanding of the whole system. WS consists of three steps: 1. Identifying the superior system, 2. Understanding the superior system, 3. Identifying the purpose of the studied system in the superior system [10].

The WST approach enables systematic resolution between efficiency and effectiveness. Based on the RST approach, the systems parts and interactions are motivated to maximise the performance, the system purpose, customer satisfaction is considered in terms of predicted volumes. Maximal performance is measured by efficiency formula, output is divided by input (see **Figure 2**).

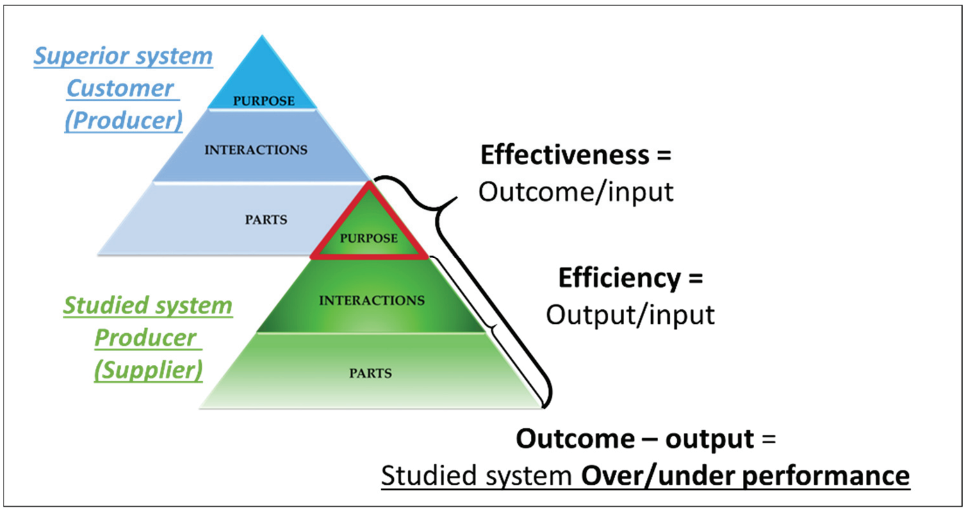


Figure 2 Efficiency and effectiveness visualisation in studied and superior system

WST approach systematically considers the superior system due to the systems purpose. The purpose of the whole system is synthesised from the superior system (representing the external environment) perspective through WS. It creates limits for the performance of studied system parts and interactions. The limits define Outcome out of Effectiveness formula (Outcome/input). In business systems like companies, parts of the logistics systems, are the system´s limits represented by customer´s orders. Therefore the difference between studied system Outcome and Output in efficiency and effectiveness formula is system over or under performance, which is not effective (but could be efficient).

3.2. Integrated Kanban System (IKS)

The IKS system enables effective integration of the entire supply chain. The chain is integrated based on a pull principle, production is customer-driven (see **Figure 3**).

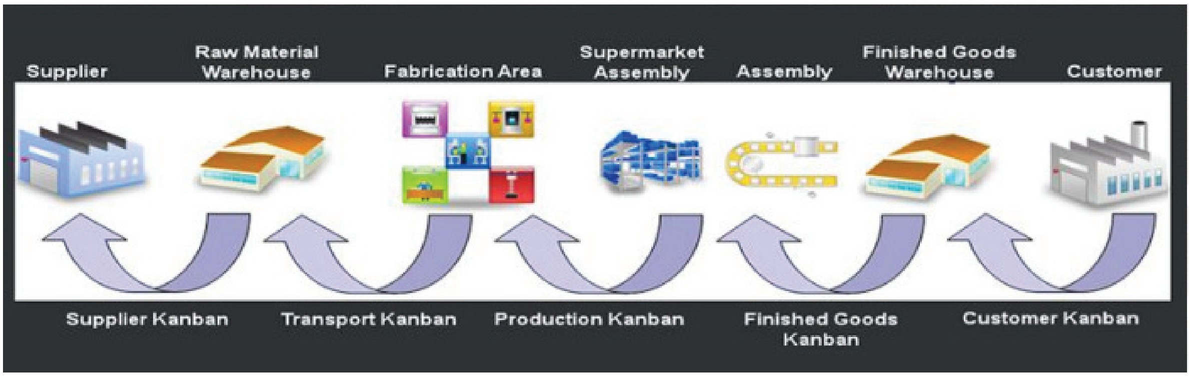


Figure 3 Pull Principle in SCM by IKS [11]

The E-Kanban system is very different from most existing systems used in companies. Frequently used solution is the use of MRP. The MRP system is not based on the pull principle but only on the anticipated prediction of customers requirements. MRP solution could be used for strategical or tactical purposes. It could be efficient, but is not effective for operational purposes. In MRP system the supplier does not have an overview of the actual consumption and condition of the customer's warehouses and therefore it could be planed efficiently but can not be planed effectively, considering the superior system, external environment. This issue is addressed by the IKS software, which enables effective communication between chains in the supply chain (see **Figure 3**).

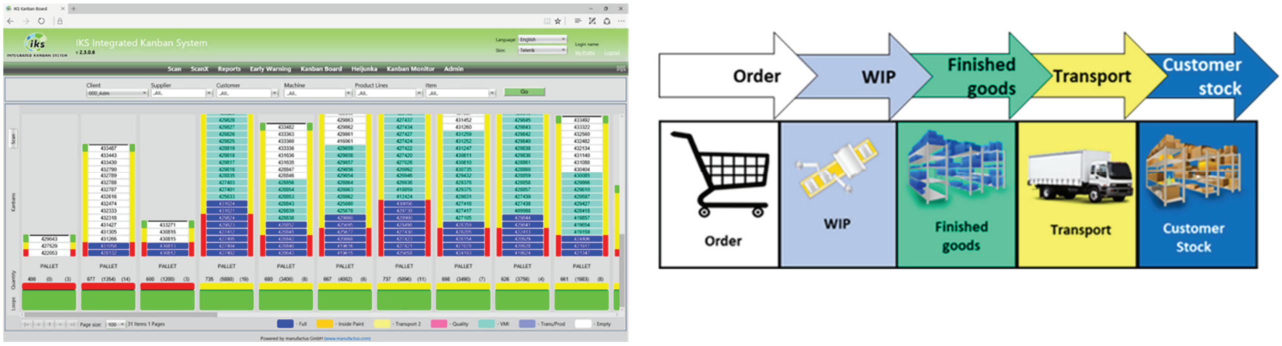


Figure 4 IKS introduction of effective, real consumption information flow

Each component studied in the logistics system, represented by concrete column on the left part of the **Figure 4** is visualised in concrete quantities in Order, WIP, Finished goods, Transport and Customer stock, visible in right part of the **Figure 4** [11]. Pull principle based on the customer production, reflected in the customer stock, is followed. The basic building block for IKS is real-time visualization of individual kanban movements. In order to achieve this, it is necessary to immediately scan all the movements using barcode readers that are directly connected to the IKS system. Once the movement of individual kanbans is recorded, it is displayed on the electronic "kanban board (left part of the **Figure 4**). This innovative report does not only show individual kanban cards, it also shows what stage they are in. Individual parties who can view this report are immediately aware of any border situations. For example, the customer does not have enough material to ensure production, the customer has too much stock material and more.

4. COMPARATIVE CASE STUDY

Comparative case study is studying the logistics system consisting of an automotive supplier, which is considered as the studied system and an automotive producer, which is considered as the superior system (the customer of the producer of the concrete component, which is further assembled into the finished car on an assembly line). The automotive supplier is delivering 14 variants of 1 concrete component. Actual situation is characterised by RST approach, dividing the studied system into the parts and managing them according to the efficiency logic, where the studied systems parts and interactions were motivated to maximize its performance, respectively efficiency, without systematic consideration of the superior system requirements (see **Figure 5**).

The supplier is informed by the producer about the long-term production plan in order to ensure sufficient production capacity. These long-term plans are further refined by more specific information of the needed quantities in the assembly line. In order to ensure a sufficient amount of components, the means of communication between the producer and the supplier is agreed. Particular departments are evaluated by their particular KPI´s, which are focused on maximizing its performance by increasing its efficiency.

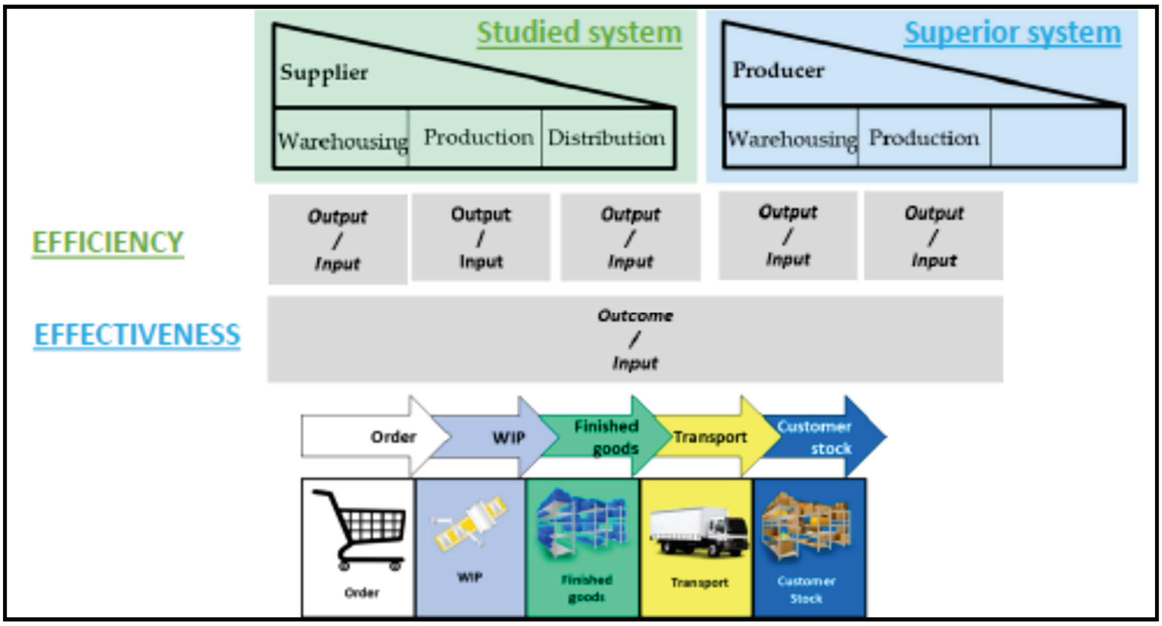
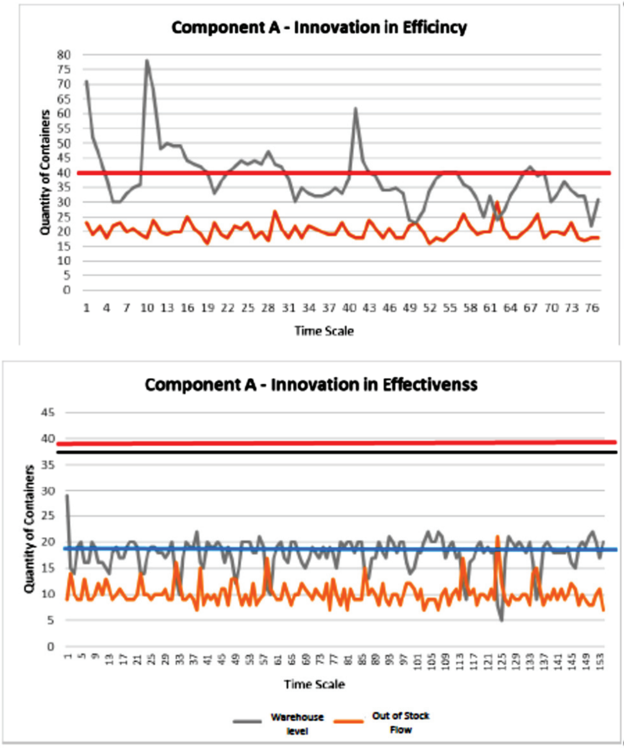


Figure 5 Visualisation of efficiency and effectiveness difference in logistics system consisting of studied system and superior system

The same process was studied in the IKS system. The online visualisation of the studied process is considering the real customer requirements. The number of kanbans (containers) of all the 14 variants of the component in the process is managed according the Pull principle, rather than the prediction and forecasting.

The everyday flow of the 14 variants of one component from supplier to producer was studied 3 months. The concrete results of variant A of the studied components is visible on the graf, visualised on the left part of the **Figure 6**. It can be seen that the warehouse level in most cases is well above individual expenses. The warehouse level never dropped below 20 pallets in this case. The red line represents the average balance in the warehouse in pallets, in this case it is 39 pallets. The graph can therefore be inferred that the stock is too high. The innovation in efficiency means, that this is the result of recent optimization, which was motivated by particular improvement in supplier´s warehouse, without systematic consideration of the producer´s needs. The graph, which shows the use of the Pull principle via IKS, has reduced the difference between warehouse level and out of stock flows. The warehouse's status never dropped below the five-pallet inventory, so there was no threat to the flow of production. The key indicators for the comparison of individual material management systems are the red, black and blue axes. The red axis represents the current average warehouse status, black is the total number of kanbans (pallets) in circulation, and blue shows the average warehouse status when using IKS system. When comparing the current and potential average warehouse status, the effectiveness of the new material flow management can be clearly seen. The innovation in effectiveness results from systematic consideration of superior system, producer´s requirements. These two indicators, in case of wheelhouse A, differ by 21 pallets in favor of the new system. The right part of the **Figure 6** demonstrates the results of comparison of all 15 variants of component, which were processed in the same detail as presented variant A.

The quantity of containers (kanbans in IKS terminology) needed for the whole studied logistics system decreased significantly. The total warehouse level decreased by 33 %. The principle cause of presented improvement in studied system performance is systematic consideration of customer (producer) requirements, explained by WST. The effectiveness of the whole studied system is derived out of superior system, customer requirements. The effectiveness of the whole studied logistics system is not the sum of particular efficiencies of studied system parts and interactions.



Component	Efficiency Innovation	Effectiveness Innovation	Difference	% Change
A	39	18	-21	- 54 %
B	35	18	-17	- 49 %
C	15	8	-7	- 47 %
D	15	8	-7	- 47 %
E	14	8	-6	- 43 %
F	14	8	-6	- 43 %
G	21	24	3	+14 %
H	53	35	-18	- 34 %
I	24	24	0	0 %
J	54	35	-19	- 35 %
K	28	20	-8	- 29 %
L	28	19	-9	- 32 %
M	18	14	-4	- 22 %
N	20	14	-6	- 30 %
Total	378	253	-125	- 33 %

Figure 6 The comparative case study results of 1 variant in detail out of all 14 variants

5. CONCLUSION

The article´s aim is the introduction of innovation in effectiveness in studied logistics management system from automotive. The new WST approach represents the innovation in effectiveness represented by new system´s purpose. The WST introduces the new system´s purpose, which is synthesised from the superior system, representing the external environment - the customer satisfaction in economic dimension of Sustainability. The new system´s purpose creates limits for the efficient performance of studied system parts and interactions, which prevents their under or over performance and influenced significantly the resources needed for the performance of the whole system. Innovative system´s purpose, customer satisfaction, replaces the former system´s purpose, defined by RST approach (system´s purpose is the sum of system´s parts and interactions). The parts and interactions were motivated to maximize the performance, so the increase in efficiency of particular parts and interactions is required. IKS enabled to compare the effectiveness of the whole studied logistics system according RST approach and innovative WST approach. The 3 months testing period confirms that innovation in effectiveness promises significant reduction of total resources needed for the same performance of the studied logistics system. The studied logistics system is more productive considering the effectiveness of the whole system, not only efficiency of particular parts and interactions. The introduction and verification of the innovation in effectiveness was demonstrated in the economic aspect of Sustainability. The similar contributions could be expected in the natural environmental and social aspects of Sustainability. Therefore the further research in this area is proposed.

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