

THE IMPLEMENTATION OF THE CONCEPT OF LEAN IN THE PROCESS OF SUPPLY CHAIN MANAGEMENT

Anna Wronka

Department of Logistics, Faculty of Management, Lodz Univeristy,
Email: akraw@uni.lodz.pl

Abstract: On the basis of a thorough analysis of the subject literature combined with empirical research, the article shows that contemporary Lean-based supply management is not only a matter of cutting costs or improving lead times. In business practice, the efficiency of Lean transformation against the whole supply chain, to a greater extent, depends on the quality of relationships with suppliers, which must, above all, be based on a mutually beneficial collaboration. In order to improve the flows between the manufacturer and his supplier, and to observe the principle of the Lean Concept, entities use a series of support tools and methods. In large companies, which are active on the global B2B market, it is an increasingly more common practice to develop the so-called Lean Matrix, which is a basis for Lean audit at the supplier's. It is also a good practice to develop Lean supplier development programmes in order to support continuous and sustainable development, in accordance with the principles of the Lean Concept.

Paper type: Research Paper

Published online: 31 December 2016
Vol. 6, No. 6, pp. 537–549
DOI: 10.21008/j.2083-4950.2016.6.6.5

ISSN 2083-4942 (Print)
ISSN 2083-4950 (Online)

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Keywords: *Lean, Lean Chain Supply, Lean in supply chain management*

1. INTRODUCTION

Constantly gaining in popularity, the concept of Lean is ceasing to be associated exclusively with tools applied in the process of production optimisation. Lean-based guidelines are, after all, more and more willingly implemented in various types of services, which can be proved by such sub-concepts as Lean Healthcare, the Lean Office and even Lean Government. This is not, however, where the application of Lean-based guidelines ends as far as business practice is concerned. The ever-growing pressure of the market to guarantee effectiveness and efficiency in the management of a company and its products has impacted the necessity of taking a holistic approach to various processes, including those which occur within an organisation and external ones, which greatly influence any given company's results. This is primarily connected with a skilful diagnosis of the context related to key flows and the relationships with other links which constitute any given chain. A crucial meaning for the volume of added value delivered to the end-customer is attributed to the quality of relationships with suppliers, and particularly with the so-called first row suppliers. It is they who have a decisive influence on the competitiveness of the whole chain supply and, thus, contribute to its profitability. A growing awareness of this correlation has translated into the dissemination of Lean practices to the suppliers of these entities which have undergone a transformation, following the dogmas of the Japanese-born philosophy. Managing cooperation in the spirit of Lean culture is a multi-phase task, to a substantial extent determined by the specific nature of business relationships between the supplier and the manufacturer. This article presents an illustrative method of implementing and verifying Lean-based guidelines at suppliers of international manufacturing corporations.

2. LEAN – WASTE REDUCTION OR SOMETHING MORE?

The subject literature provides numerous definitions of such terms as 'Lean', 'Lean Management' and 'Lean Manufacturing'. Nevertheless, the majority of available entries offer a narrow definition of the idea, limiting it merely to the minimisation of waste, cost and employment reduction, and the application of a set of tools that standardise labour (Trent, 2008, p. 18). Such an approach, however, renders it impossible to fully exploit the potential of Lean, since the Lean initiative is a resultant of numerous factors. These are, first of all, people, their awareness, behaviour, involvement and mutual trust. Lean constitutes an integral component of corporate culture, oriented for constant self-improvement and the provision of the value that customers expect, i.e. that is a benchmark for all actions shaping the multidisciplinary value stream. A Lean enterprise is characterised by its flat and flexible structure and a strategy focused on recognising and implementing gradual

changes, which are perceived as a potential source of continuous competitive advantage (Sayer & Bruce, 2015, p. 28). Being 'Lean' demands the ability to maintain stable flows of an optimum pace and quality. A permanent reduction of waste – understood not only as Muda (transportation, waiting, over-production, defects, inventory, motion, over-processing), but also as Mura (the so-called changeability) and Muri (interpreted as excessive burdening of resources) – is conducted on the basis of the fundamental principles of Lean, such as: focus on the customer, respect for people, constant self-improvement, visualisation, and measurement of processes. The observance of the aforementioned principles is facilitated by means of several tools, which could be divided in terms of the range and purpose of their application. For instance, these can be tools related to the customer and the value stream, resource flow and Pull strategy, an improvement of processes and the management of the company. Table 1 presents the most commonly applied Lean tools, divided into the aforementioned categories.

Table 1. An illustrative division of selected Lean tools; Source: Author's own elaboration, based on: Sayer, Bruce, 2015, p. 28

Tool set	Examples of tools
Customer/value stream	QFD (Quality Function Deployment), Kano model, or 3P methodology (Production, Preparation, Process)
Flow/Pull strategy	DFM/DFA (Design for Manufacturing/ Design for Assembly), 5S (Seiri, Seiton, Seiso, Seiketsu, Shitsuke), SMED (Single Minute Exchange of Die), Kanban
Improvement	Kaizen, Standardisation, Visualisation, 5 Whys
Management	Hoshin, BSC (Balanced scorecard), 3GEN (Gemba, Gembutsu, Genjitsu)

As mentioned above, not only does Lean refer to manufacturing processes, but it also encompasses the whole organisation, including such supportive departments as administration and IT. Moreover, it must be emphasised that Lean, as a long-term strategy, focuses upon the improvement of value not only in the perspective of any given process or department, but in a broader sense, i.e. along the entirety of the value stream under scrutiny in any given supply chain. This objective cannot be achieved without the development, maintenance and improvement of mutually beneficial relationships with the company's key stakeholders, including, in particular, those who co-develop the key value within the chain.

3. THE LEAN SUPPLY CHAIN

The term Lean Logistics, increasingly more common in the subject literature, refers mainly to the implementation of conceptual guidelines related to the strategy of managing logistic processes, including – for the most part – the value generated by the leading chain links, which is necessary to deliver a desired product to the end customer. The optimisation of flows (of products, services, information and finances), which occur in the supply chain in order to improve the potential of competitiveness and profitability, is the main rationale behind the transformation of traditional chains into Lean ones. Numerous examples within the realm of business practice prove that the Lean supply chain boasts higher productivity, a more conscious partnership, resulting from the multi-surfaced integration, and a lower susceptibility to risk, which is gained through so-called proactive management (Bilsback, 2011, p. 32). Table 2 demonstrates some fundamental discrepancies between the two types of chains.

Table 2. Premises of conventional and Lean supply chains; source: Author's own elaboration, based on: Aherne, 2014, pp. 50–55

Area	Conventional supply chain	Lean supply chain
Production	Based on prognoses	Based on actual demand
Customer service	Scarcely flexible	Sensitive to changes and needs
Layout of factory and machinery	Functional/by department	Reflecting product flow
Planning	Limited/random	Detailed/long-term
Processing	By batches, isolation of processes	Continuous, one-piece flow
Quality	Verification through multiple sampling	Permanent quality assurance through process support
Logistics	Cost-based	Value-oriented
Supplies	Rivalry relations: winner-loser	Partnership relations: winner-winner
Retrieval/Recycling	Limited	Essential and increasing
Environment	Low awareness and significance	Integral constituent of sustainable management
IT	Slow and manual	Fast and automated

The effective implementation of Lean guidelines in the whole supply chain requires not only a skilful configuration and application of the process-based approach in the areas stipulated in Table 2, but also a change in the mentality of all employees and, therefore, new dynamics in the development of corporate culture,

chiefly based on tightening relationships between all involved parties combined with a substantial commitment of the leaders. An appropriate attitude stems from the end-to-end approach, i.e. the ability to holistically manage a supply chain, as opposed to managing only its particular links. Understood in such a manner, the consolidation of value management of the whole stream leads to effects of synergy and, at the same time, to an increase in the attractiveness of offer, and not only to the improvement of operational effectiveness of individual logistic procedures.

4. THE APPLICATION OF LEAN IN SUPPLY PROCESSES

In view of the idea outlined in such a manner, it is an increasingly more common practice to analyse the key ingredients of any given chain with regard to the application of Lean principles, where the key ingredients are understood not only as supplies, production, storage, and transportation, but also as purchasers who expect value and an offer determined by fast pace, flexibility and quality, and who frequently provide their own customers with value in the further links of the chain.

Nevertheless, a comprehensive process of building a Lead supply chain begins with the development of a long-term relationship with suppliers, in accordance with the paradigms with the scrutinised concept. In practice, it mainly consists in redefining the architecture of the supply process, mostly through the minimisation of the number of suppliers, the optimum use of one's own strategic competences, and the application of consistent methods and tools which facilitate the integration of performed processes and which, at the same time, contribute to cost reduction combined with a simultaneous qualitative improvement of offer (Sayer & Bruce, 2015, p. 285). Furthermore, it is more common nowadays to create dedicated Lean Suppliers Networks, which are characterised by a high frequency of supervised purchases based on the pull system, by joint initiatives related to the continuous improvement of performed processes (the so-called reactive and proactive actions), and by effective communication, guaranteed, for instance, through the application of the EDI system or the so-called point-to-point communication. The identification of reciprocal relationships and common goals is meant to lead to the reduction of duplication of potential losses within the whole chain, and it can also stimulate continuous growth of operating ratios and the pressure for self-improvement. The subject literature contains a growing number of models of Lean supplies which have been developed in the context of the supplier-recipient relationship. Most commonly they refer to the factors characterising Lean supplies and contribute to a multidimensional analysis of connections between chain links. For example, in the model developed by Richard Lamming, which constitutes a foundation for all further deliberations, the following variables were taken into account: the essence of competitiveness, determinants of purchase decisions, methods of information flow, process efficiency management, supply practices, susceptibility to

price fluctuations, attitude to quality, the role of research and designing, and the level of pressure for improvement (Lamming, 1993, p. 194).

Regardless of the fact that the vast majority of theoretical and practical deliberations on Lean supplies refer to the motoring industry, the subject ought to be recognised as evolutionary and will gain in popularity following the dissemination of the Lean concept in realms other than industrial (Jasti & Kodali, 2015, p. 1051).

5. ASSESSMENT AND SELECTION OF LEAN SUPPLIER

Lean-based supply management is a multi-stage process. Most frequently, three complementary phases are distinguished: classification, selection and then development of suppliers which demonstrate operational skills that support the implementation of Lean within the chain (Trents, 2008, p. 27). A supplier's ability to eliminate losses translates into their own affordability and, in consequence, the price attractiveness of the chain in which they participate. This distinguisher, however, is not a sufficient determinant of selection of this particular link, since a Lean supplier must also guarantee appropriate efficiency and effectiveness of their processes, necessary to satisfy a demand that changes over time and in structure. Therefore, such a supplier ought to be effective and flexible in terms of the needs reported by both external and internal (within the chain) customers. In order to guarantee the aforementioned features, it is imperative to perform a reliable assessment of suppliers. The choice of verification methods is conditioned by a series of factors, among which it is the supplier's status that is considered the key value, as well as the specific nature and cycle of the delivered goods. In business practice, there are models based on both quantitative or linguistic features, which estimate suppliers (Nogalski & Niewiadomski, 2013, p. 277). As far as the detailed criteria of selection and assessment of Lean suppliers are concerned, they are usually divided into three major areas, namely: quality, costs and supplies (Xu, Tjoa & Chaudhry, 2008, p. 720). Depending on the level of integration (logistical, operational, procedural, product and partner) with any given supplier (Kshisagar, Teli & Gaikwad, 2014, p. 73), the following qualitative sub-criteria are verified: warranty and responsibility policy for the delivered product, its durability and usability, and the rate of return. At the same time, costs should be analysed through the prism of: product price, necessary logistic expenses and the offered payment terms and conditions. Delivery is chiefly impacted by: safety of the ordered goods, their appropriate packaging and such indicators as the OTD (on-time delivery), i.e. the percentage of punctual deliveries, and the LT (lead time), understood as an average amount of time required to complete a customer's order (Abdollahi, Arvan & Razami, 2015, p. 683). In practice, the analysis of individual indicators which determine the level of any given supplier's advancement within the realm of Lean practices is performed by means of various tools and techniques (Chai, Liu & Ngai,

2013, p. 3872). These could be standard statistical analyses such as the PCA (Principal Component Analysis), i.e. a factor analysis of the so-called principal components within the supply process (Zare Mehrjerdi, 2012, p. 130), tools for solving multiple-criteria issues, e.g. the AHP (Analytic Hierarchy Process), as well as questionnaires, surveys, scorecards, self-assessment results (e.g. Lean Enterprise Self-assessment Tool), actions that certify a supplier is in compliance with a set of criteria defined on the basis of the purchaser's needs and requirements, and standard reference visits. It is noteworthy to emphasise that, on the one hand, the assessment of any given supplier ought to be general enough to allow for a comprehensive verification of any given organisation and its competences, and on the other hand, it should also include the specific nature of value flow within any given chain (Berenyi & Banhegyesi, 2015, p. 32).

The audit is an example of a commonly applied process of verification of any given supplier with regard to a set of stipulated criteria. Depending on the needs (e.g. a new supplier, recently implemented procedural or product innovations, verification of corrective and preventive actions, etc.), miscellaneous types of audit are applied, e.g. self-assessment, external audit, or certification audit conducted by an authorised independent external institution.

The supplier's self-assessment related to the implementation of Lean guidelines can be performed by means of the LESAT (The Lean Enterprise Self-Assessment Tool), which is a tool that enables the assessment of the applied Lean practices and the organisation's readiness to implement further changes. The point of reference is the Maturity Matrix, which utilises a 5-step assessment of the audited organisation in the following areas: leadership, process lifecycle and infrastructure. What is more, the LESAT also defines the desired attributes of the Lean approach, diagnostic questions and potential parameters of performance (Dehdari, 2013, p. 26).

The Lean Maturity Matrix can also be the basis to prepare an auditing scenario as far as relationships with suppliers are concerned. An empirical analysis of an international manufacturer has shown that suppliers for the researched organisation are verified a/o in reference to the premises of the key matrix foundations: value stream mapping, internal logistics and quality. Table 3 presents the characteristics of all individual levels of supplier advancement, together with the desired objective evidence and illustrative auditing questions for the realm of quality.

An external audit, on the other hand, is aimed at a supplier receiving a certificate granted by an accredited institution, which constitutes a specific type of independently issued warranty and on numerous occasions eliminates the need for any other forms of verification. In practice, these are most commonly management system certificates or certificates which confirm the application of guidelines of Lean management, issued by national and international organisations.

The purpose of a systematic and scheduled review is not only to produce a measurable and objective assessment of a supplier's operational measures, but also to stimulate the supplier's integrity with the recipient, to make both parties aware of how important and crucial their co-operation is, and to ensure effective

communication between the entities (Harris, Harris & Streeter, 2011, p. 155). This dimension, however, does not guarantee a full Lean synergy between the supplier and the recipient. Nowadays, creating a value chain in accordance with idea of the Lean concept also, and more and more often above all, involves the development of a Lean corporate culture and harmony.

Table 3. Assessment matrix of a Lean supplier in terms of quality; source: Author's own elaboration, based on the internal documentation provided by company X

Pillar	Quality
Element	Supplier's quality
Level 1	On-arrival, component quality control is maintained. However, it is designed for 100% check of components, regardless of their weight.
Level 2	The discrepancy between the expected and the actual quality is standardised and there is a system of its verification. However, no actual corrective action is taken whenever there is any incompatibility.
Level 3	CTQ (critical-to-quality) component quality check is defined and managed effectively.
Level 4	Specified actions are taken for components which do not meet stipulated requirements. A routine assessment of any given supplier is maintained, and so is the regular communication between the supplier and the recipient.
Level 5	A system of continuous supplier improvement has been established, on the basis of the PDCA method. The supplier has implemented a management system. There are sporadic or no quality problems. There are transparent product specifications for suppliers and a long-term strategy of process and quality integration for key suppliers.
Evidence	<p>Criteria of component inspection:</p> <ul style="list-style-type: none"> - the manner in which quality criteria are set for all identified critical components. <p>System of managing supplier quality:</p> <ul style="list-style-type: none"> - the manner in which critical component quality check is transferred to any given supplier for product quality purposes. <p>Tools for managing supplier quality.</p> <p>There is a correlation between the PDCA method and supplier assessment indicator – identification of key suppliers. The manner in which the AQP and PPAP processes are implemented.</p> <p>Application of audits in accordance with VDA 6.3. Standard in the process of supplier assessment.</p> <p>Application of ADP (Advanced Quality Planning).</p> <p>Application of PPAP (Production Part Approval Process).</p>
Questions	<p>Could you tender a list of CTQ products for supply quality?</p> <p>Could you prove the application of the PDCA method in the process of development of supplier quality?</p> <p>What examples could you use to explain the benefits of sharing a roadmap for operational excellence?</p>

6. LEAN SUPPLIER DEVELOPMENT PROGRAMME

As mentioned above, suppliers' contribution to the development of Lean practices along the whole chain is not limited exclusively to the application of standard (for the concept) tools for managing supplies. It also requires their involvement in processes which stimulate respect for the principles of the philosophy in all co-operative actions. In practice, it consists in the continuous development and improvement of partner relationships, e.g. by making suppliers committed to the development and design of products and technological processes and the completion of customer orders, by creating multidisciplinary teams, organising training sessions and workshops, and by blending complementary competences not only through the synchronisation of production systems or the integration of management systems, but also via participation in programmes which promote and consolidate good practices (McIvor, 2001, p. 227). Within the framework of propagating Lean transformation, it is an increasingly more common practice to conduct dedicated Lean Supplier Projects, the purpose of which is, above all, to increase the understanding of solidity of Lean transfer and of the application of the Lean Concept in all areas characterised by interdependency between the supplier and the recipient. These include meetings with experts, training sessions and workshops based on the idea that supports the development of internal identity within any given organisation through the so-called sense giving, constant support in the form of guidebooks containing practical hints and tips, as well as consultation programmes conducted using various channels of communication.

The effectiveness of such initiatives depends on numerous factors, among which the subject literature most frequently mentions the following: the specific nature of a collaboration with any given supplier, and the type of transferred knowledge (explicit or tacit), and thus, the possibility to share it (Boscari, Danese & Romano, 2016, p. 54). Moreover, an important role is also attributed to the Lean cultural value, since supply chains are of a more globalised nature these days, which – to a greater extent – determines the adaptive abilities and flexibility level in response to pressure on changes exerted by other links in the chain (Kull, Yan, Liu & Wacker, 2014, p. 1). A conscious application of Lean practices, apart from the measurable results in terms of the growth of operating efficiency within key processes, also leads to cultural changes in the organisation, and to the establishment of values and a consolidation of behaviour that is consistent with the Lean philosophy (Bartolotti, Romano & Martinez-Jurado, 2016, p. 182).

Table 4. The schedule of the implementation of the Lean Supplier Project; source: Author's own elaboration, based on the internal codumentation provided by company X

Phase	Time	Tasks
PREPARATION	4–8 weeks	Supplier selection: - revision of supplier database, following the applied criteria - selection of potential suppliers – programme beneficiaries - determination of scope and objective
		Project initiation: - visiting a supplier's HQ to present project assumptions - introduction to workshops at the supplier's HQ - establishment of diagnostic team, consisting of Lean experts - establishment of diagnostic team, consisting of supplier's representatives
IMPLEMENTATION	5 days	Diagnosis: - training for management - recognising losses and wastes (Muda walk) - Value Stream Mapping and Designing - establishing a long-term roadmap - determining objectives and involvement level for all parties - estimating the potential
		Transformation: - project of transformation - list of actions and observation of measurements - optimisation of interface - support for Lean experts, regular reviews
		Sustainability - Kaizen programme - training experts and board members - facilitative reviews run by customers
VALUE APPLICATION AND IMPROVEMENT	6–9 months	Identified potential: - agreed division of benefits - outcome of negotiations in reference to improvement actions
	Unlimited	Long-term stabilisation: - stipulation of further stages of Lean transformation - regular improvement meetings

For the purposes of this article, an empirical analysis of a Lean supplier development programme was conducted. The programme was initiated in an international company which is a leader in the energy, electrotechnical and telecommunications industry. Within the framework of the Lead Supplier Project, a series of guidebooks was developed with guidelines for all interested parties. The main aim of the programme is to support suppliers in the process of continuous improvement of delivery process, with particular focus on quality, and the effectiveness and efficiency of the whole chain, achieved through the elimination of losses in all direct and indirect processes that contribute to the making of the production system in the

analysed company. The program is based on the following premises: partner collaboration with suppliers, atmosphere of mutual trust, focusing on value for the end customer and on continuous and sustainable improvement of the supply chain through the implementation of actions which optimise and synchronise processes, the involvement of each chain link in the perfection of performance, and sharing tried and tested operational tools, best practices and benefits with suppliers. The Lean Supplier Project is conducted in three phases, each of which has its specified time and tasks. Table 4 shows various stages of the implementation of the Lean Supplier Project in the analysed company.

Table 5. The schedule of the implementation of the Lean Supplier Project; source: Author's own elaboration, based on the internal codumentation provided by company X

Phase	Time	Exit
PREPARATION	4–8 weeks	Selection of potential suppliers Supplier's consent to: - scope of the project, financing, division of estimated benefits
IMPLEMENTATION	5 days	Objectives: - long-term implementation schedule - potential First success: - instances of successful implementations - interface Continuous improvement: - results, improvement of supplier's processes
VALUE APPLICATION AND IMPROVEMENT	6–9 months	Results for the company: - quality, delivery time, costs
	Unlimited	Results - continuous improvement of supplier's process indicators

A detailed description of each stipulated phase, together with their assigned tasks, has been prepared, including the information on responsibilities, tools and objectives. The project is fully integrated with the production system of the company that implements it and is reviewed on a regular basis, both in terms of suggestions and recommendations provided by its participants, and the possibility of further improving it. The results of the implementation of each successive stage are provided in the form of reports and are available to all interested parties.

7. CONCLUSIONS

The awareness of the fact that external and internal suppliers have a great impact on the quality delivered to the customer and the effectiveness and efficiency of the flow chain requires effective and efficient management. A supplier's Lean transformation consists in the integration of numerous functions and departments, since it is not merely limited to the optimisation of the value incorporated in the process (jidoka) or to the application of the JIT system (just-in-time), which in real life is more and more commonly substituted with the approach based on the MRI indicator (Minimum Reasonable Inventory) (Zare Mehrjerdi, 2012, p. 132). The implementation of principles of the Lean Concept for suppliers is a complex and continuous process, which takes place in numerous dimensions and demands the involvement of all resources, including, mainly but not exclusively, people who hold various positions and offices. Any actions must be performed simultaneously with cross functional classifications and boundaries between the supplier and the manufacturer.

The issue of Lean supplier development, as outlined in the article, is a new area of research within Polish subject literature, both in its theoretical and empirical representation. Nevertheless, the analysis of practices, and particularly solutions applied in international manufacturing corporations, indicates that the shaping of the supplier-recipient relationship in accordance with Lean principles is a common practice and constitutes important input data in the process of improving the chain as a whole.

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BIOGRAPHICAL NOTES

Anna Wronka, PhD, holds the position of assistant professor in the Department of Logistics, within the Faculty of Management at Lodz Univeristy, conducting lectures and classes, both in Polish and English, in quality which is related to logistics management in companies. As the author of over a dozen scientific publications, she focuses on the subject of Lean management and other concepts which contribute to the improvement of processes in various types of organisations.