Management and Production Engineering Review
Volume 11 • Number 2 • June 2020 • pp. 11–25
DOI: 10.24425/mper.2020.133725

QUALITATIVE STUDY ON THE VALUE STREAM-BASED ORGANIZATION: LESSONS FROM HUNGARIAN PRODUCTION PLANTS

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Received: 19 February 2020
Accepted: 19 May 2020

Abstract
Lean management has become a much-researched topic in operations management. Beyond its technical aspects, nowadays the analysis of soft factors (corporate culture, organization, management, human resource management, knowledge transfer practices) have come to the fore. However, there are few sources available to the lean organization to find out what organizational changes are taking place alongside the lean application, and what organizational structures are being developed. In our study first we deal with the literature-based concepts of lean organizational structure and with the international examples, and then through five Hungarian corporate solutions and with help of the literature of organizational theories we synthesize the lean organizational forms.

Keywords
Lean organization, value stream-based organization, matrix organization, horizontal organization.

Introduction

For decades, the study of production systems has been one of the central subjects of operations management literature. By today, the concepts of production systems and lean management have become closely linked – starting with the Toyota Production System created by Toyota, which applies continuous improvement at many manufacturing and non-manufacturing companies to "systematically improve people and permanently improve processes by minimizing the resources used, to create value and prosperity" [1]. Today, there is no doubt that the lean concept in operations management has become a so-called best practice and a new paradigm [2, 3]. However, the organizational aspects of lean management, coming to the fore only in the early 2000s, were initially one of the less researched fields of this popular subject. From this time on, an increasing shift took place from the use of lean tools and practices to the specific corporate culture, organizational structure, leadership, human resource management and knowledge transfer practices supporting efficient lean operation [4]. However, value stream-based changes in organizational structure from a lean aspect have only been documented at the international level in only a few cases, although an extensive Hungarian research project has demonstrated that in half of the cases studied, the application of lean concepts has also resulted in organizational change [5].

Our study examines the organizational form developed during lean transformation, the so-called value stream-based organization, through the example of five production sites in Hungary. Our objective is to learn about the specifically generated form of a value stream-based organization structure fre-

quently proposed by lean management literature by examining the internal structure of individual production plants, i.e. by studying the micro-level of their organizational structures. Our study seeks to elucidate the specific organizational forms of organizations applying the lean approach and whether these structures can be identified by relying on the literature of organizational theory. To be able to explore this subject, we first adapt the theoretical ideas concerning lean organizational structure in lean literature, then move on to concepts regarding organizational forms most relevant to our study, based on literature pertaining to organizations. Finally, we describe and synthesize the value stream-based organizational structures of the five Hungarian companies we have studied, identifying the organizational forms introduced during the application of lean concepts.

The role of the value stream concept in lean management, value stream based organizations as viewed by lean management

The most spectacular result of Toyota's pursuit of excellence is the production philosophy known as the Toyota Production System (TPS). Outside Toyota, TPS has often become known as "lean" or "lean production" [6]. The process of how lean management was created and its conceptual elements have been summarized by numerous researchers [4, 7–20]. Even today, lean management has no generally accepted definition; among the many proposed, the description by Shah and Ward [19] is one of the most accepted: "lean manufacturing is an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing supplier, customer and internal variability". Today, the lean approach is used by numerous companies operating a company-specific production system, all of which rely on TPS at a level of 50–93% [21].

Conclusions of lean management regarding value stream-based organizations

The core element of lean management is customer value: the objective is customer value creation and increasing its proportion. Thus, in TPS, the main activity is to eliminate waste, or if this is not possible in the short term, to reduce it to the minimum. Based on their large-scale Toyota research, Womack and Jones [22] have arrived at the conclusion that successful implementation of the lean approach is based on the following five principles: 1. Definition of value, 2. *Identification of the value process (in other words: value stream)*, 3. *Creation of flow along the value creation steps*, 4. Achieving a pull principle backwards from the customer (buyer process), 5. Sustaining continuous perfection.

De Toni and Tonchia [23] as well as Jenner [24] studied the work of self-managing teams and process-based management even in the mid-1990s. The value stream concept identified by Womack and Jones [22] and assigned by Hines et al. [4] to the strategic level of lean is of special significance in terms of our study. The value stream is according to Rother and Shook [25] "the sum of the value-creating and non-value-creating activities currently needed to guide products through two main indispensable processes: 1) the production process, from the raw material to the consumer, 2) the design process, from the idea to the introduction of the product" [25].

Womack and Jones [22] have pointed out that after successful kaizen actions, one of the important next steps is for the company to consciously and actively create an organization properly channeling and maintaining the value stream. Tiwari and Tiwari [26] find as well, that the inability to form proper cross functional team to integrate different functionality of lean implementation was cited often as an important lean barrier. Koch et al. [27] state, that instead of optimization on individual department level the employees need to be evaluated from a broader perspective, on the basis of how their work contributes to the improvement of the whole company, not just its parts. Liker [6] gives a series of 13 points of advice, referred by him as "tips", that can be used to turn a company into a lean organization. Point 6 of his suggestions refers to the fact that *organization around value streams is necessary* – it can be concluded that he refers to creating an organizational structure along value streams. The authors also provide practical advice to companies on how to conduct their lean transformation, assigning a time frame to each step [22]. Of the lean transformation steps proposed by Womack and Jones [22], the second main block, "Creating a new organization" includes the creation of a lean support function within the organization ("Creating a lean function") and refers to the beginning of a restructuring of the organizational structure without fully referring to it by name (*"Reorganization by product family").* All this is considered an important task during the early stage of lean transformation (within the first two years). It should be pointed out that after presenting the relevant steps, Womack and Jones conclude their train of thought by stating that introduction of the lean approach in operational areas reveals the problems and losses concealed so far and application of the

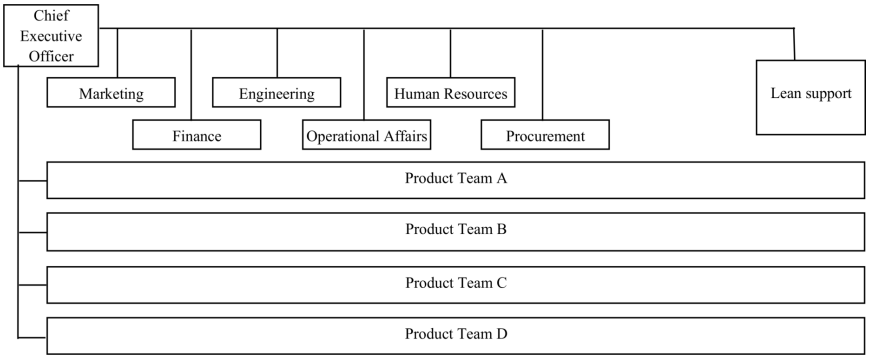


Fig. 1. Prototype of a lean organization [22].

principles inevitably reveals organizational problems, as well (restructurings, narrowing career paths). The authors believe that for this reason, there is a need for a final step (beyond the periods depicted in their tables) that even Toyota had not yet taken by the time their book was written: the purpose of this step would be the creation of a so-called lean organization. According to the authors, an organizational chart similar to Fig. 1 will evolve after organizational transformation, in which customer value creation will be achieved in an organizational structure subordinate to individual value streams.

The authors also stipulate that they themselves experienced the difficulty of transitioning to this new organizational structure (prompting the reconsideration of employee career paths and the future of traditional corporate functions) even in the case of a company that approaches the task with serious commitment, though the transformation involves extraordinary benefits for both the organization on the whole and the customers [22].

Liker [6] outlined Toyota's product development matrix organization, which, similarly to a lean organization illustrated by Womack and Jones [22], adopted an organizational structure established along value creation processes. Rother and Shook [25] refer to lean organization only as regards its position in value stream managers in the organization to the extent that value stream managers report directly to senior management just like a lean support organization, and individual value stream managers (and organizational units managed by them) have an auxiliary function.

References to a value stream-based organization from the literature of organization theory

Spector [28] discusses horizontally linked structures focusing on supply chains. In this type of organization, the main question is how to coordinate activities for the company to create maximum value for its customers. According to Spector, organizations in this form can facilitate the linking of their numerous, possibly mutually independent activities along their supply chain by using cross-functional teams.

Similarly to Spector, Daft [29] also refers to an organizational structure serving the value chain and (presumably the so-called internal) supply chain under the name of horizontal organization. As an example, the development process of a new product and the procurement and logistics process are depicted in a value chain-based horizontal structure where individual processes are implemented in an interlinked way flowing towards the customer under the supervision of process managers.

Like Womack and Jones, Haug [30] also believes that over time, companies using lean tools will reach a point where they have to face organizational limits while becoming real lean organizations. Therefore, sooner or later, they will have to reorganize their operations on the basis of value streams, and dedicate so-called value stream managers, reorganize functional responsibilities, performance indicators and their process development activities along the value stream. As a result of the latter, the author states that focused factories or business units will be created within larger companies, which requires systematic coordination and cooperation between value streams. From this time on, business decisions will no longer be taken vertically between various levels of management, but the lean organization will horizontally integrate activities along the entire value stream. According to Haug, larger companies can change the functional organizational structure in multiple steps (e.g. by inserting a matrix organization), whereas small or medium-sized companies can even create a lean organization in a single step.

A value stream organization proposal is included in Raghunathan's [31] research, which investigated productivity enhancement options in EPC (engineering, procurement and construction) projects by introducing a value stream-based organization. Raghu-

nathan also discussed how difficult it was to identify value streams, which was ultimately achieved on the basis of customers, product flow and value stream characteristics. However, due to its project organization nature, Raghunathan's model, referred to as a value stream organization, is difficult to correlate with models discussed so far because it interprets the above organizational structures in a specific industry and for tasks organized on a project basis.

In addition to the studies by Haug and Raghunathan, Marchwinski's [32] publication also describes a value stream-based organizational change and reports that a new organizational configuration was introduced in a Tennessee production unit based on the factory manager's plan, in which value stream managers were assigned full responsibility over manufacturing and the service activities that crossed over departmental boundaries. According to this description, the organizational change was induced by the necessity to demolish organizational frameworks and functional walls before developments after many improvements and "reaping low-hanging fruits", and products and customers had to become the focus of every employee. This resulted in a value stream-based organizational structure where value stream managers were assigned responsibility for the products along cross-department activities.

To quote Hungarian examples, Aradi's [33] article describes the organizational change at a Hungarian pharmaceutical production location, where the objective was to reorganize a chemical plant on a value stream basis. According to Aradi [33], "the role of innovation, acquiring new products, continuous loss hunting, continuous improvement, unique solutions and outstanding teamwork has increased in value", as a result of which "traditional hierarchical organizational structures need to be converted to a constantly improving organization flexibly adaptable to market demands". We will discuss the new value stream-based organizational structure introduced at this pharmaceutical manufacturer in detail later in this article.

Conclusions on the literature of value stream-based organizations

Considering lean or, more precisely, value stream-based organizational solutions learned from lean literature as well as the articles and case studies found, we think that none of them are sufficiently detailed in terms of organizational structure. At the same time, models found in international literature focus on different areas in the organizing process. Thus, we consider it necessary to provide a more accurate picture of the organizational structure as well, taking into account lean principles and value stream considerations, helping companies to reconsider their organizational configuration during their path to lean management, if necessary. However, it should also be kept in mind that there is probably no single, generally applicable value stream-based organizational concept (even a functional organizational structure can be customer-oriented and effective if cooperation between "silos" can be strengthened), but recommendations can most certainly be made. In order to get closer to organizational structure(s) suitable for practical implementation, we have conducted a qualitative research involving five Hungarian production sites in 2017–2018 and examined the relevant concepts of organizational theories, detailed in the next section of our article.

The most common forms of value stream-based organizations: matrix and horizontal organizations

As Dobák et al. [34] wrote in their book: "The efficiency of organizations depends largely on the characteristics of their structure, how their operating processes fit together, their management principles and methods applied, and the supportive nature of their organizational culture. However, to a large degree these depend on environmental conditions and company characteristics, considered relatively stable in the long term". The basis of this system of interrelationships is furnished by the contingency theory of organizations, focusing on the mutual relationship between environment-strategy-structure, behavior and performance, and concentrates on organizational structure, in light of the fact that formal organizational structure significantly influences the efficiency of an organization [35].

According to the interpretation of Dobák and Antal [36], organizational structure is understood as a formal organization envisioned and designed by managers. To separate various organizational structures, Dobák et al. [34] describe the structural characteristics of organizations along the division of labor, the division of power, coordination tools and configuration. Based on the latter, they distinguish the following fundamental organizational forms: functional, divisional, matrix, tensor and dual organizations. Daft [29] divides organizational dimensions into two categories: structural and contextual. As regards the structural dimensions of organizations, the author defines six categories: level of formalization, level of specialization, hierarchy of powers, centralization, professionalization and staff distribution ratios. Then along these structural char-

acteristics, Daft distinguishes between the following options for classifying staff: functional, divisional, multifocal, horizontal, and virtual grouping.

Literature examples show that while shifting to value stream-based organizations, companies typically move from functional grouping to organizational forms grouped in a multifocal (matrix) or horizontal manner. Since even some of the companies investigated by us subsequently introduced a matrix or horizontal type value stream-based organizational structure, it is necessary to explore the deeper aspects of their literature.

Main characteristics of matrix and horizontal organizations

While a functional organization is applicable in a stable environment and means a highly centralized configuration, a *matrix organization* is a more flexibly adaptable, decentralized form. According to Osterloh [37] a matrix organization is in the middle between functional specialization and the pure process model where the functional manager and the manager responsible for the process have joint decision-making powers. Davis and Lawrence [38] describe the matrix organization "where some managers report to two supervisors as opposed to the traditional structure where reporting is done to one supervisor, so the chain of command is dual rather than singular". According to them, companies turn to a matrix structure when it is absolutely necessary to be able to respond to two sectors simultaneously, if they have to face high uncertainty and this generates high information processing needs, or if they have to face serious financial or human resource limits. Burns [39] defines a matrix organization as a superimposition of one or more types of organizational forms on the existing organizational structure. As this new departmental structure solidifies, a matrix configuration is created. According to Daft [29] "a matrix organization formalizes horizontal teams along a traditionally vertical functional hierarchy and tries to give equal weight to both". In practice, however, total balance is difficult to achieve and authority moves towards one dimension. To solve uncertainties and unclarities in matrix organizations, researchers have provided several "recipes" over the past decades (in terms of clarifying tasks and responsibilities) [40].

In addition to the matrix organizational structure, we take a closer look at the so-called *horizontal structure.* According to Ostroff [41] process-oriented or process-based organizations are usually referred to as horizontal organizations. Anand and Daft [42] consider the 1980s as the time of emergence of so-called horizontal organizations, where the main organizing principle was assigned to teams and processes, the relevant structure being redesigned along processes and organizational capabilities linked from suppliers to customers. The authors likened traditional (hierarchical, control-based, functionally specialized) organizations to a pyramid and horizontal organizations to a pizza: "flat, but with all the necessary ingredients". According to Anand and Daft [42], before the emergence of horizontal organizations, organizations tried to ensure passage between functional silos by introducing certain horizontal coordination principles: with product managers, project managers, and brand managers coordinating across departments. Organizations where the demand for even stronger horizontal coordination emerged have developed in the direction of a matrix form combining a vertical structure with a similarly strong horizontal dimension. According to the authors, the actual point of horizontal organizations is to break down internal boundaries and vertical silos to keep the organization continuously active in horizontal subunits.

Similarly to the results of Anand and Daft [42], Hernaus [43] also considers that as a result of increasing complexity, organizations are trying to find new forms in the course of which process orientation has appeared as a new management paradigm. Hernaus refers to that structure as a process-based organization in which processes receive priority, which focuses on the horizontal viewpoint of business activities and in which the organization's systems are mutually linked towards business processes. According to the Hernaus [43], in the course of focusing on processes, organizations typically go through various phases of maturity: functional structure → functional structure with overarching processes → matrix structure → process structure with functional overlaps → pure process structure. Hernaus [43] adds that a process cannot be the only ordering principle of an organizational structure because functional capabilities and product management can also play a role, and certain activities cannot even be organized along processes so integration between processes will also be needed in a purely process-based organization. Thus, even in organizations becoming almost completely horizontal, some functional competence areas (such as strategic planning, finance, personnel) will remain necessary – they must keep their integrating role in addition to horizontally operating processes. Hernaus [43] gives a sample configuration of a horizontal organization (referred by them as process-based), shown in Fig. 2.

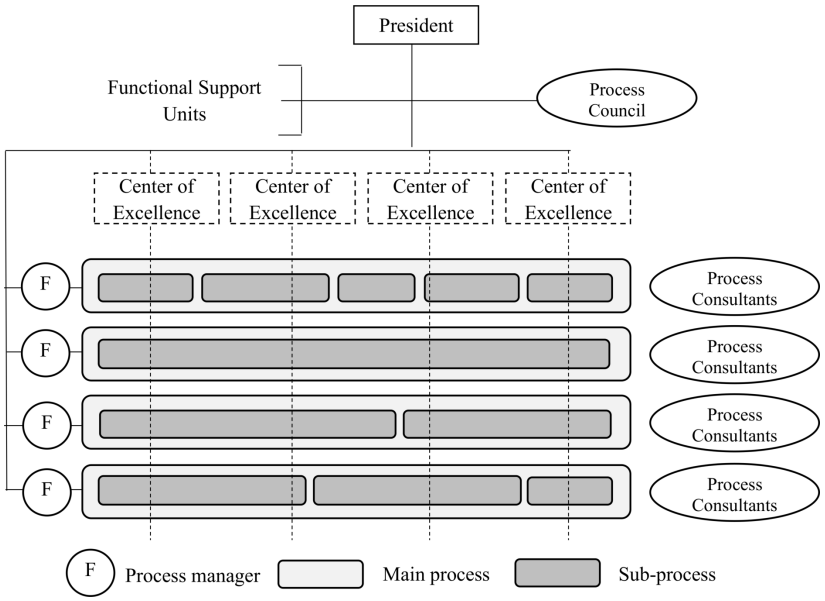


Fig. 2. Configuration of a process-based organization [43].

Hernaus [43] emphasizes that the creation of this horizontal organization is a great challenge, because its correct design can be difficult. One important basic requirement is to appoint managers with a high degree of acceptance to process management roles, thus giving importance and attention to the process dimension. Another important aspect is that there may be conflicts between the process manager and the functional manager (especially if they are not subordinated under the same organizational unit manager) so it is important for all parties to be cooperative. To exploit the benefits of a horizontal organization, companies have been trying to implement this organizational form since the 1990s [44].

Qualitative study of the value stream-based organization based on the examples of five Hungarian plants

To expand the theoretical sources previously described in our study and to understand the relevant organizational model, we have examined Hungarian companies that have started to change their organizational structures along their value streams. The theoretical concepts presented in our study provide a proper basis, but we still consider that these theoretical building blocks do not provide a sufficient foundation for stating with full certainty what we can consider to be a value stream-based organization in lean management. In addition, it is worth considering the picture of a value stream-based organizational structure on the basis of more than one practical implementation. However, it is necessary to point out that the organizational structures we have examined do not depict the macro-level organizational form of the entire company but describe secondary/tertiary/quaternary levels of division labor within said structure and the units performing production activities. Our objective is to understand more precisely the lean microstructure evolving within specific production plants and to identify the applied organizational form.

During our qualitative research of value stream-based organizations, we typically used interviews to obtain information on the organizational structures of companies involved in the study and we also conducted data collection and data analysis in a parallel, iterative manner (in a way typical of qualitative case study-based research projects). During our research, we conducted and documented thirteen interviews altogether. As regards the pharmaceutical and the medical equipment companies, our interviews were with plant managers, whereas at the plant of automation technology and the power tools factory they involved lean managers. In the case of the automotive electronics plant, we used the interviews to complement the direct information available to us.

In an interview, Szabolcs Molnár, President of the Hungarian Association of LEI (Lean Enterprise Institute), stated that shifting to a value stream-based organization is a major challenge for companies even if they claim to be well versed in the lean concept. Strong lean basics are needed to make an enterprise successful, so he knew only very few practical imple-

mentation in Hungary. The relevant organizational concept can bring benefits to everyone, but creating a successful application is a longer process. Maybe this is why we saw during the on-site discussions and continuous consultations that we were facing several versions of a value stream-based organization. In the current subsection, we list the organizational solutions discovered while learning about the abovementioned companies. The sequence of our description of these organizations below does not mean a degree of bad or good implementation of the concept nor does it represent an order of quality. However, we established a subjective sequential order of how much we find the structure similar to the image, defined by literature, of a lean organization and value-based organization, and how close the structure discussed is to an organization operating along value streams with horizontally designed teams. We discuss individual cases one by one along the lines of motivation behind the change and new organizational characteristics so that we can compare them later based on the categories of Dobák et al. [34].

The organizational change of a pharmaceutical company

On the basis of Aradi's [33] article, a pharmaceutical company's case can be found in Hungarian literature, in which the plant manager of the production site reports the introduction of a value stream organization in early 2015. This plant manufactures pharmaceutical active substances and intermediate products for internal and external customers. This Hungarian site of the company group faced a situation where the manufacturing of their products progressed along separate interests physically, territorially and from a managerial aspect, the entire value process was in multiple hands, interests did not coincide or were even mutually contrary, and elimination of losses was a local interest without increasing the efficiency of the entire process. As we learned on site from our interview with the plant manager, development of and transition to a new organizational structure was based on necessity: they wanted to replace a building-based management aimed at local optima with an organizational structure focusing on processes.

He summarized the company's own activities as follows: "instead of a traditional organizational hierarchy, a value stream-based matrix organization was created, which is exemplary within the chemical industry and the company group" [33]. The new organizational solution was developed by the site management with the involvement of employees. During their work, they created a new organizational configuration, in which three basic functions were developed [33]:

- value stream, which monitors and manages the entire product manufacturing process, i.e. the value stream, from a technological aspect,
- an area that provides the human and technical resources needed for manufacturing, prepares shift schedules, tracks the operability of technical equipment and tools, and the availability of necessary materials, coordinates planned maintenance, ensures audit compliance, conducts training, motivates employees, promotes innovative ideas and implements lean ideas,
- the production manager, a person responsible for manufacturing the product, whose task is to directly administer production, allocate human resources, balance load differences between shifts, inspect manufacturing documentation, report and manage deviations, promote innovative ideals and implement lean tools.

In the course of determining value streams, the company took into account the similarities between technologies, their business importance, annual volumes produced and batch numbers. The work aimed at transforming the organization determined the primary connection points of supporting areas and functions. Maintenance staff and technical area managers were assigned to individual areas, while quality assurance staff was basically assigned to value streams. A documentation group was created to issue and manage all production documentation and organize training. In addition, a new unit dealing with production projects was also created.

Value streams were mutually separated along product lines and, by introducing a way of thinking in terms of value streams, a new dimension was practically superimposed on the existing organizational structure. In the newly formed matrix organization, value stream managers managing the manufacturing of active ingredients through all the relevant processes have appeared along with the so-called area managers. Aradi's article includes the organizational chart applied in the production plant [33].

The new configuration was introduced by the company in January 2015. In the new organizational structure, value stream managers are intended to represent a process approach, while area managers are still responsible for providing resources for manufacturing: operating machines and responsibility for the staff. Manufacturing and areas closely related to the latter, such as the core of corporate operation, are now managed in a matrix structure while supporting areas have remained in their functional organizational units and some colleagues have been as-

signed to value streams (quality assurance) or area units (maintenance). It should be noted that factory's manufacturing process is typically not a series production or process system, and the site does not manufacture discrete products, so even the organizational form shows unique features with the added dimension of area management and the adaptation of supportive departments to this core organization.

Following the interview with the plant manager, we had the impression that the organization was aware of its prevailing limitations: on the one hand, not all support functions were directly or indirectly assigned to value streams (for example, for the time being, quality assurance was outside of value streams at the time of our interview); on the other hand, not even the matrix is balanced in its two dimensions as, for the time being, area and functional managers still have more extensive powers. Nevertheless, the organizational structure introduced at this pharmaceutical production site is forward-looking both in the given company and presumably within the group, as well. Adopting a process approach is a considerable challenge when manufacturing non-discrete or large-scale products in active ingredient and drug production. Thus, the introduction of a new dimension across facilities and production areas, i.e. the value stream approach, as a second organizational structure dimension is a noteworthy idea.

The organizational change of an automotive electronics manufacturing site

In Hungary is located one of the largest automotive electronics production plants, being a subsidiary of a multinational electronics manufacturer, automotive supplier company. In recent years, the plant has undergone a continuous shift to a value stream-based organizational concept in order to be able to expand their existing value stream management function and create a matrix organization in which executive processes are organized along value streams created on a product group basis in addition to traditional functional departments. According to the company group, one of the most important success criteria of their lean initiative is their operation on the basis of a value stream organization, so the relevant organizational change has been embedded in the entire lean concept. Aware the advantages and disadvantages of functional organization, the company's central governance decided to strengthen process orientation at a global, company group level. To this end, its declared intention is to create value stream organizations focusing on the order fulfillment process [45, 46].

The plant management of this production site – in cooperation with the HR manager, by appointing an internal project manager and with the involvement of top management – decided on changing the organizational structure of the factory in mid-2016. However, a value stream-based organization is not without precedent at the location, as the value stream concept was partially introduced as early as in 2012, based on the following principles at the time: a shared, dual value stream manager role shared between design logistics team leaders and manufacturing department heads was created and a total of six value streams were defined for the entire factory. The management of the factory reviewed the positive results achieved through the value stream concept since its introduction in 2012 and the limitations of the system, and started developing an improved value stream organization in 2016. For this new concept, the experiences from both this location and other sites of the company group were assessed. The transition to a value stream-based organization was scheduled by the production location for early 2017. According to the expectations of the factory managers, the organization should be able to function more efficiently after the structural change, problem solving should become faster and decision-making should take place at lower organizational levels.

By value stream, the location means the totality of all processes and activities "aimed at transforming products and services into a form required by the customer" [47]. Categories existing in this organizational form have been described by the factory as follows:

- value stream manager: responsible for the optimal use of resources (time, cost, people, equipment, etc.), takes full responsibility for value stream development and the related long-term vision,
- main group: consists of employees belonging directly to one value stream who are responsible for daily operation, deviation management and continuous improvement, managed by the value stream manager,
- front office: consists of employees working in functional areas (logistics, quality assurance, engineering, finance and controlling, etc.) belonging to one or more value streams, managed by functional managers,
- back office: a group of employees not related to or assigned to value streams, representing the functions that are uneconomic to link to value streams or are responsible for maintaining and improving standards and central processes, managed by functional managers,

- value stream office: the physical office itself where the majority of the main group and the front office staff are present together for the sake of proper and fast communication and ideal collaboration.

By this concept, the manufacturing location has essentially mapped the matrix structure proposed by the company group to its own organization.

The organizational change of a manufacturing location producing automation technology

During our research on Hungarian value stream-based organizational solutions, we learned that a manufacturing site producing automation technology also started to implement a value stream-based structure. Upon interviewing the company's lean manager, we gained information on their organizational changes. Similarly to the pharmaceutical company described above, this automation technology site was also internally motivated to implement an organizational change because the originally available production area proved to be too small for the increased volume of one of its product lines and it thus became justified to invest in a new building. At the same time, the goal was to satisfy customer needs quickly and flexibly, and this required a new approach because of the very high level of custom-made production in this product line. During our visit, the company divided its four major product lines into 5 (and subsequently 6) value streams and continuously adapted its organization to the latter concept.

Similarly to the automotive electronics site described in the previous example, this automation technology location also started introducing a value stream-based structure in 2017 in the form of a matrix organization. The company grouped office staff indirectly involved in manufacturing as follows:

- (so-called co-located) employees in the value stream office: they belong to the value stream as well as to their functional organization; they work in the areas of disposition, material management, logistics planning, engineering, maintenance and quality assurance,
- employees in support functions, who can be further divided into two groups:
  - moving over to value stream offices at regular, fixed weekly times: like HR, EHS (Energy, Health and Safety), SQA (Supplier Quality Assurance),
  - remaining at their previous location: IT, lean.

Moreover, it was revealed during the interview that the functional managers are disciplinary managers of employees located at matrix intersections and delegated to value streams, but the same employees are managed by value chain managers during daily operation. The objectives of these colleagues are determined jointly by the two managers: the focus of individual target tasks is the value stream, but the functional manager also defines an objective – so the objectives are roughly balanced for employees.

A highly forward-looking aspect in this company's concept is that during their transition to a value stream-based organization, they integrated all necessary support functions in the value stream in a single step and physically placed them in a single office, so neither logistics, nor engineering, nor quality management could be left out. Another positive characteristic of their solution is that white collar value stream employees are sitting close to production, and plans have been drawn up for moving maintenance staff from the office to the production area.

The organization change of a power tools manufacturer plant

Our understanding of the lean organizational concept was further refined by learning the example of a power tool production location. Similarly to the medical equipment manufacturer (discussed later) and the automotive electronics manufacturer, the application of lean management looks back to a history of more than 10 years in this power tool factory, as well, in which preparatory work concerning a value stream-based organization started around 2013. This introduction was urged and facilitated by the fact that the division manager for (power tools) manufacturing pressed for the relevant change since he had extensive experience in the area from other plants at that time. At that time – as commented on by the company's lean manager – they still did not know how to create an organization around a value stream, but they wanted to try it. Since then, their value stream-based organization has undergone several evolutionary phases in roughly 1–2 cycles, and changes are always implemented according to their best knowledge.

According to the lean manager, they worked in a matrix organization with dedicated teams for a year or two after launching a value stream-based organization. Initially, the biggest problem for them was how to define value streams: they defined them on the basis of technology and not based on user/use, which proved to be a dead end. Large, unmanageable value streams were created, which, although changed in 2016, did not yield much better results. The year 2018 was the first when value streams were mutually separated from the aspect of the customer/use, and a total of approximately 30 value streams were

thus created – including similar but not completely identical ones.

As regards organizational form, the company shifted from the matrix form to defining so-called business segments from the user's perspective and thus, they organized teams related to value streams accordingly. The resulting organizational solution shows two very important aspects of this reorganization:

- One aspect is within the company. Although functional organizational units have not been abandoned by the company, they perform their activities more as so-called functional excellence teams. Their tasks include defining and perfecting processes as well as searching for and providing optimum solutions. These functional teams are delegated to value streams and are not guided by functional goals.
- The other aspect transcends corporate boundaries and even goes beyond the product implementation process. After the creation of business segments, the value stream now includes not only all processes within the plant in the view of the production location, but everything has been organized in an integrated fashion, from idea generation through introduction of the future product in the manufacturing process to implementation. The idea of a specific new product was born in the product development in Germany, but even the Hungarian factory cooperates closely with the German colleagues. After the completion of the tasks in Germany, product development and production take place in the Hungarian plant, which represent the other two parts of the entire value creation chain. Thus, all three larger blocks belong to the same value creation chain, even if they are geographically separated. Within each block, employees were moved to one office and a manager was appointed to head each of the three phases of the value creation chain: they are referred to as business owner (idea generation, Germany), execution owner (product development, Hungary) and value stream manager (order fulfillment, Hungary). Although there is currently no "main" value stream manager assigned above them, the three of them function as a "mini board" in the business segment, with the business owner (i.e. the manager based in Germany) playing the principal role.

Important achievement of this concept is that irrespective of where and at which other subsidiary they take place, all processes representing values that are key to the use and customer of the given product are organized in an integrated fashion. In addition, it should also be emphasized that despite the elimination of functional management powers, the production site in Hungary has tried to retain the relevant competencies to prevent them from being split among value streams. Therefore, the former team leader structure was replaced by a process owner structure, and senior colleagues transcending value streams are helping professional orientation.

The organizational change of a medical equipment manufacturer

At the Hungarian medical equipment manufacturer location we visited the plant manager who informed us that they had been working as a value stream-based organization since 2005. Before that, a functional organizational structure was typical in the plant in 2003–2004, but according to a proposal of the factory manager at the time, they started building a value chain-based organization and appointed the first value stream managers as early as 2005. A total of eleven value streams were managed at the production plant as of 2018, and they were mutually separated on a product line basis, while taking into account the number of employees as an important factor of manageability (at present, they employ a maximum of hundred persons that can be assigned to a value stream).

Initially, only certain support functions were included in the value chains (manufacturing support, quality assurance), which were followed by logistics one year later. According to the manager of the production unit, a matrix organizational form still existed at the time of introducing the value stream-based organization, but they "managed to dismantle" this relatively quickly. Although functional organizational units still currently exist alongside the value stream teams, they have a completely different role than before:

- for example, engineering is referred to as "operations development" and they work on major development projects and machine refurbishing,
- the quality assurance department performs/assists audits, is responsible for general quality indicators and provides some degree of professional support,
- the logistics organization is responsible for ensuring the smooth supply of raw materials needed to complete the manufacturing plant and procures indirect materials.

According to the plant manager, value streams essentially function as profit centers with detailed monthly assessments. The value stream manager role is a highly complex and prestigious position within the organization.

By dissolving the initial matrix organization, this production location introduced a horizontal organi-

zation in which all support functions beyond manufacturing were classified under value streams, and functional organizational units no longer have disciplinary responsibilities (unlike in the case of the previous matrix organization) but function as centers of excellence. In the course of our research, the example of this medical equipment manufacturer has helped us understand a great deal about the organizational structure considered by Womack and Jones to be desirable as a lean organization.

Comparison of the value stream-based organizational concepts explored

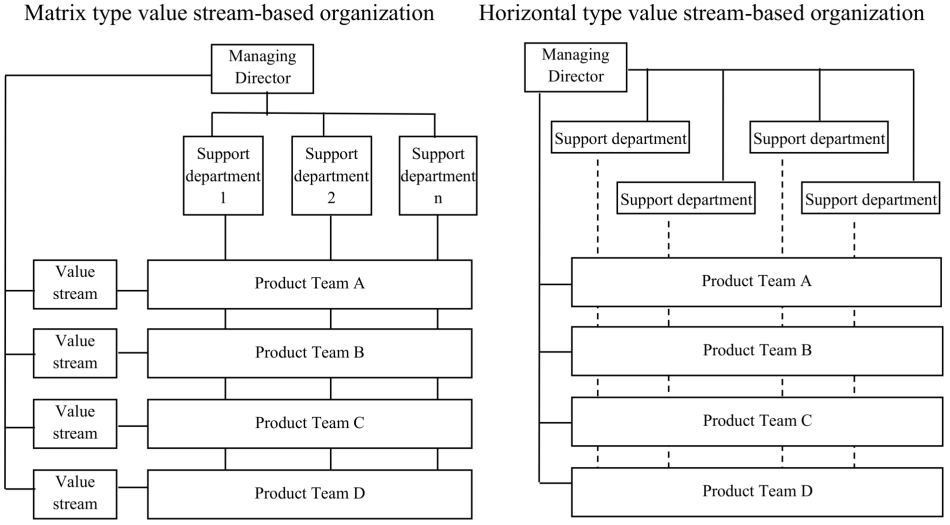
We started the analysis of Hungarian value stream-based organizations we explored with matrix organizational solutions by closely examining the above-mentioned matrix of the pharmaceutical manufacturer as well as the matrix-structured organizational solutions of the automotive electronics manufacturer and the automation technology production site. On the other hand, further examples, such as the power tools plant and the medical equipment manufacturer have presented examples of a horizontal organizational structure. The five organizational solutions studied in practice during our research project are compared in our table.

We analyzed the value stream-based organizational solutions of Hungarian production plants we had examined on the basis of structural characteristics identified by Dobák et al. [34].

- As regards the division of labor, all five companies apply the principle of the primary and secondary division of labor. In the case of the pharmaceutical company, the automotive electronics manufacturer and the automation technology production plant, these are embodied in matrix dimensions. For the time being, product (i.e. value stream) based task sharing is a secondary principle in all three organizations, and the primary principle is territorial in the case of the pharmaceutical plant and functional in the other two companies. Although the value stream approach has become an important organizing principle in these companies and they have created the value stream dimension of the matrix structure, for colleagues in the matrix intersections, disciplinary responsibility lies with the area/functional manager. In the case of the medical equipment manufacturer and the power tools factory, the division of labor is primarily based on the product, i.e. the value stream, but there are also some organizational units that have been created on a functional basis (functional excellence, central support departments/groups) in a coordinated manner.
- As regards division of power, the pharmaceutical company, the automotive electronics manufacturer and the automation technology production plant are characterized by two-line management because their employees receive instructions and decisions from both managers of the matrix. Regarding their powers, the area/functional managers have stronger authority than value stream leaders, so matrices are unbalanced. In the medical equipment manufacturer's value stream organization, the division of powers is clearly characterized by a one-line scheme, with employees having a single disciplinary manager, and value stream teams and central functional groups are independent. It is difficult to define the principle of the power tools factory's division of powers, but we think that it is basically characterized by a one-line scheme because employees basically have a single disciplinary manager (the value stream manager) and the head of the functional excellence team provides professional co-ordination over them but does not make decisions or issue instructions regarding the colleagues concerned.
- The major companies examined typically use structural and technocratic coordination tools, which is not surprising. However, as regards vertical or horizontal coordination, it can be stated that in the case of the medical equipment manufacturer and the power tools factory, coordination is highly horizontal, whereas vertical coordination also plays an important role along with the horizontal one at the other three companies.
- As regards configuration, the organizational solution applied by the pharmaceutical company, the automotive electronics manufacturer and the automation technology production plant is a matrix organization, with each unbalanced in a spatial/functional direction. The structures of the medical equipment manufacturer and the power tools factory can mainly be classified into the categories described by Daft and thus, we identify them with the horizontal organization because according to Daft [29], main processes and supporting functional areas are mutually independently situated in the latter under the managing director. This is the case in these two companies, most typically at the medical equipment manufacturer plant.

Table 1
Comparison of the five Hungarian value stream-based organizational solutions analyzed.

	Pharmaceutical company	Automotive electronics manufacturer	Automation technology manufacturer	Power tools manufacturer	Medical equipment manufacturer
Division of labor	two-dimensional – primary principle: territorial – secondary principle: product (value stream)	two-dimensional – primary principle: functional – secondary principle: product (value stream)	two-dimensional – primary principle: functional – secondary principle: product (value stream)	two-dimensional – primary principle: product (value stream) – secondary principle: functional	two-dimensional – primary principle: product (value stream) – secondary principle: functional
Division of powers	two-line	two-line	two-line	one-line	one-line
Coordination tools	structural (teams), technocratic (e.g. planning systems); horizontal and vertical coordination	structural (teams), technocratic (e.g. planning systems); typically horizontal coordination, but vertical is also present	structural (teams), technocratic (e.g. planning systems); typically horizontal coordination, but vertical is also present	structural (teams), technocratic (e.g. planning systems); typically horizontal coordination	structural (teams), technocratic (e.g. planning systems); typically horizontal coordination
Configuration	area-based (unbalances) matrix organization	functional (unbalanced) matrix organization	functional (unbalanced) matrix organization	horizontal organization	horizontal organization



Source: independently created figure based on Womack-Jones [22]

Fig. 3. Typical configurations of a value stream-based organization.

It is worth noting that both the power tools factory and the medical equipment manufacturer plant stated that they initially introduced a value stream-based organization with a matrix organization, which has been eliminated by now. In our view, during the period since 2005, the medical equipment manufacturer had more time to shift from the matrix organization to the horizontal structure, and the power tools factory is also taking steps in this direction.

After learning the theoretical and practical models, we can make the following synthesizing statements regarding the value-based organization:

- The introduction of a value stream-based organization is basically typical of companies that are experienced in employing lean management. All the types of organizational solutions we have explored have occurred at companies where the approach, principles and tools of lean management are used (although to varying extents of intensity and with different priorities).
- In a value stream-based organization, horizontal coordination along value streams is important. Value streams are typically separated along products/product lines. In addition, the companies we

visited also highlighted that it was important to ensure the manageability of the dimensions of value streams.

- The managers of organizational units representing value streams are so-called value stream managers who have comprehensive (typically decision-making, objective-setting) responsibilities over the processes required to produce a given product/product line. They do not always have all the resources along the value stream – this depends on the organizational structure chosen.
- In a value stream-based organization, the division of labor is two-dimensional, one of which is typically the product and the other is the functional dimension. The division of labor can work in a two-line or one-line scheme, depending on the organizational form selected. As regards coordination, the above-mentioned horizontal coordination has significance. According to all these, a value stream-based organization typically adopts a matrix or horizontal organizational structure. Our summary figure shows a simplified configuration of the two organizational forms.

Three of the Hungarian value stream-based organizational forms we explored provide examples of a matrix-type value stream based organization whereas two are closer to the horizontal form. The matrix organizational structure includes the advantages and disadvantages of a matrix; nevertheless, it represents an important shift from companies previously operated in a functional organization scheme towards the lean form. It is worth noting that all three of the value stream-based organizations operating in a matrix form that we examined started introducing the new organizational structure using this form, whereas the other two organizations abandoned the initial matrix form over time and switched to a horizontal structure. Thus, it can be assumed (however, it could only be stated with certainty upon examination of a larger sample) that a development path can be conceived in the application of a value stream-based organization and initially, a company can more readily move from a typically functional organization to a matrix scheme rather than immediately attempting to introduce a horizontal organizational form. This assumption is also supported by Dobák et al. [34], who understand that abrupt changes are understandably not typical in the transformation of organizational structures, as companies rather tend to shift towards organizational forms not overly different from the original structure in a first step. Whether we consider Osterloh's [37] figure or Daft's [29] grouping of corporate forms, it can be assumed based on both that transition between organizational forms takes place in several steps, and a value stream-based organization typically changes into a multi-focused (matrix) organization first while starting out of a functional structure before becoming a horizontal company.

According to Daft [29], the more an organizational structure moves towards the horizontal (or even virtual) form, the more a company can achieve innovation and a transition to a learning organization. This is also supported by the opinion of Womack and Jones [22]. An interesting question, however, in connection with the current form of the companies we have examined is whether the transition from a matrix structure towards a horizontal value stream-centered organization is predetermined or not. Both the automation technology manufacturer and the automotive electronics factory are strongly technology-oriented companies and, as it has become apparent from the interviews, the preservation of functional excellence was an important aspect when choosing a matrix organizational form (this is supported by an interview with the factory manager). At the same time, the example of the power tools factory demonstrates that despite a horizontal structure, they are trying to keep functional excellence using process management and senior employee systems, and to prevent the splitting of professional knowledge among individual value streams.

Conclusions

While a value stream-based organization may be a novel phenomenon in lean literature described mainly at the (micro) level of individual plants, the organizational science approach is ahead of the game when adopting a macro approach, so we pointed out in our article the important logical relationship, according to which lean organizational forms indeed have specific ramifications in organizational theory. All in all, it can be stated that when applying the lean concept, organizations will face structural issues affecting their organizational form over time to which, in most cases, the correct response will be the introduction of a value stream-based organization. And all this means the matrix or horizontal organization in practice that is well known and thoroughly discussed in the literature of organizations, so multiple approaches may also be viable. However, organizations choosing this path should consider their own internal characteristics, including whether they are ready to completely dissolve functional limits or implement horizontal coordination in a matrix structure first, in light of their advantages and disadvantages. It should also be pointed out that no

matter which organizational change path is adopted by the given plant, support (or pressure) on behalf of top or even global management is necessary for change to make it permanent.

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