

Design of a Conceptual Model for Improving Company Performance Based on Lean Management Applying the Viable System Model (VSM)

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Abstract

Designing, changing and adapting organizations to secure viability is challenging for companies. Researchers often fail to holistically design or transform organizations. Thus, the aim of this study is to propose a holistic approach how organizations can be designed, changed or managed considering also its implications to production management following lean management principles. Hereby the Viable System Model was applied. This structure can be applied to any kind of structured organization and for its management with goals to be achieved in modern society; however focus of the research is the cluster of manufacturing and assembly companies. Goal of the developed organizational model is to be able to react to all potential company environments by taking decisions regarding organization and production management functions correctly and in the right moment based on the needed information. To ensure this, standardized communication channels were defined. In conclusion this proposed approach enables companies to have internal mechanisms to secure viability and also in production to reduce necessary stocks, lead times, manpower allocation and leads to an increase of the service level to the final customer.

Keywords: Cybernetics, Company performance, Lean management, Organizational Model, Production management, Viable System Model

Introduction

Developing organizations capable to deal with the present and future competitiveness needs is a challenge (Schuh & Stich, 2013, p. 2). Achieving sustainable long-term advantages will no longer ensure the competitiveness of companies. This fact also increases the complexity of manufacturing and assembly planning and control processes. This situation results in a significant increase of information and communication flows which the company has to manage in order to secure its viability.

Moreover, it can be said that information is the interconnection element in organizations. It is needed for policy definition, decision-making, management, control, coordination, etc. Problems with information flows lead to negativ impact in the organization.

Furthermore, global logistics flows have increased drastically in recent years due to a globalized world economy that introduces inherent challenges for establishing international businesses (Frazelle, 2002, p. 10). In this international competition the compliance of the service level is adding more pressure on supply flexibility (Siller, 2011, p. 1). In addition, demand volatility in almost every industry sector seems to be higher than it was in the past due to shortened product and technology life cycles, sales promotions, reorder quantities and unplanned disruptions (Christopher, 2005, p. 233). As a result, many producers are confronted with intransparent and volatile demand behaviors that cause large deviations in sales forecasts (Wildemann, 2008, pp. 168-169). As a consequence, failures in forecasts have grown steadily in recent years despite the use of information systems for that purpose (Christopher, 2011, p. 153).

Across all industries, companies are in an environment with increasing competitive pressure (Schuh et al., 2011, p. 843). The main factors that favor this situation are the increasing globalization and the resulting competition situation that causes an intense reduction of product life cycles as well as a growing individualization of the final products according to specific customer criteria (Abele & Reinhart, 2011, p. 1). This evolution is combined with the demands of customers who want to be served with shorter delivery times (Tu & Dean, 2011, p.1) as well as with the increasing product variants in manufacturing and assembly processes that expose planning and control logistics to new challenges (Auerbach et al., 2011, p.797).

The consequences for trade between companies after the financial and economic crisis are observable today which cause an increasing demand for flexibility and adaptability (Schuh, 2009, p.2). The reduction of international trade barriers requires intense global cooperation as well as an increase in business complexity (Schulte, 2008, p.457). In addition, due to climate change, the proliferation of natural disasters and their consequences are an additional source of uncertainty for logistics and production of some industries (Wöhrle, 2012, pp. 22-23). As a result, the

sustainability and energy efficiency aspects have gained importance as a cause of the energy transition and the increase of energy prices. In this context, companies are increasingly obliged to carry out individualized and flexible logistics planning and control (Schuh & Roesgen, 2006, p.7).

The trends shown take us in their sum to an increase in the complexity of relationships and processes (Placzek, 2007, p.2). As a result many companies lose competitiveness due to a slow adaptation to their environment. Therefore the capability to deal with changing customer requirements, demand volatility and new product launches is acquiring more and more importance for winning competitive advantage (Cappgemini, 2010, p. 5). This moves the prioritization of the supply chain goals to customer service, delivery performance and flexibility, instead of being based only on costs (McKinsey, 2011, p. 11). In this context, lean management defines the methods, concepts and principles how to reach these goals. While the economic effects of lean methods have been described in practice, there is still a demand for a scientific basis to explain how lean methods should act in companies (Herrmann et al., 2008, p. 1) and how these concepts should develop over time depending on external environment.

Many approaches have been considered in order to solve the problem of organizational alignment with the environment in manufacturing companies. However most of them have failed due to several reasons, such as lack of information, coordination or control that leads to take strategic decisions neither at an optimal point in time nor in an optimal way. In addition, how to deal with it is a great challenge and in a highly competitive world it is essential to adapt quickly to changes to be successful. Therefore the main research objective is to make companies more flexible, so that the company can face any kind of environment because its internal structure and communication enables a fast decision-making to align the company with market conditions. The paper will be based on the Viable System Model (VSM). By applying the Viable System Model, the organization is transformed into an autonomous system capable of adapting to constant environment changes (Beer, 1959, p. 17). For a company it is fundamental to meet customers' requirements. Although minimization of costs is always a priority, a global trend advocates following lean management principles in order to improve our customers' satisfaction and company revenues.

To analyse this challenge a conceptual model is designed for an organization following lean management principles summarized in the literature in terms of the seven "zeros". In 1983 Edwards (1983) introduced the "seven zeros" – zero defects, zero lot size, zero set-ups, zero breakdowns, zero handling, zero lead time, zero surging – as JIT goals, which pursue the goal of avoiding all forms of waste, especially inventories (Edwards, 1983). Later Hopp and Spearman described the seven zeros corresponding to the different types of waste (Hopp & Spearman, 2008). These "zeros" are unachievable in practice, but the goals inspire an environment of continual improvement (Sheikh-Sajadieh et al., 2013, p. 263):

Zero defects
Zero inventory
Zero accidents
Zero delays
Zero breakdowns
Zero changeovers or setup times
Zero waste

The methodology can be applied to any kind of organization; however producing organizations are the main research focus. All these organizations have a target system defined by the following parameters: performance, delivery service and costs (Schuh & Stich, 2013, p. 22).

The initial hypothesis is that an organization built on the basis of lean management principles using the structure of the VSM will be able to react faster to environment changes and therefore its application will have a positive impact on the achievement of short, medium and long-term goals of every producing company. The VSM approach increase the adaptability of companies to face all future potential scenarios because the company is able to take strategic decisions that will influence later the tactical and operative levels. Therefore it is capable of implementing measures to reduce the impact of environment uncertainty and also to see developments in the environment to prepare strategies and internal configurations for the future.

In the area of productive systems of the department of Construction and Fabrication Engineering at the National Distance Education University (UNED) an approach has been developed to solve the problem of organizations and production systems with the help of the Viable System Model. The aim of the research is to propose a self-regulating approach how to design organizations and production systems.

2. Methodological approach and literature review

In this project the objective is the development of an organizational and production management model under the principles of lean management using the Viable System Model (VSM). The method used to reach this goal was the following:

Definition of methodological approach:

Comparison of the VSM with other approaches

Application cases of VSM

Literatura review for:

Cybernetics, system theory and Viable System Model

Organizational functions

Production management tasks

Lean management principles

Conceptual model development:

Development of a target system for an organization and for a production system

Production management tasks according to planning horizon levels

Definition of recursion levels and operative units

Association of tasks to recursion levels & operative units

Identification of the needed information flows between operative units and recursion levels

After having described the methodology, a comparison of the VSM, a cybernetic model, with other approaches was done. As described in the literature the VSM is an unmatched conceptual and methodological tool for the modeling and design of organizations and its areas with the goal of being viable (Schwaninger et al., 2008, p. 16). Thus, the aim of the research is to propose a self-regulating approach how designing and transforming organizations based on lean management principles. For this reason, the Viable System Model is applied for this purpose. Applying the VSM means to implement the organizational structure of any viable or autonomous system in an organization of a producing company.

To validate the research methodology, research and practical applications using cybernetics, system theory and the VSM were searched. Many authors have used the VSM as basis to describe and develop models how to deal with complex challenges of social and industry. Some of the topics worked and that give an indication of the scientific value of the approach are:

Herold (1991) developed a concept for the organization of a company based on the principles of the VSM. In this approach, the general structure of the company is analyzed first by means of a questionnaire (Herold C., 1991, pp. 74-76).

Herrmann (2008) described lean methods in terms of attenuating and amplifying variety based on the findings of the VSM (Christoph Herrmann, C. et., 2008).

Brosze (2011) developed a reference model for the management of production systems with adaptability. As a target group, it is focused on "make-to-order" manufacturing (Brosze, 2011).

Erbsen (2012) pursued the objective of optimizing patient care in disease-oriented centers in university hospitals (Erbsen, 2012).

Kompa (2014) research was dedicated to the problem of the order booking process in situations of overload in mass production companies (Kompa, 2014).

Schürmeyer (2014) pursued the objective of developing a reference model for production program planning during launch processes (Schürmeyer, 2014).

Hering (2014) designed an inter-business design concept for a coordinated production planning in real time in the consumer goods industry (Hering, 2014).

Groten (2017) described how to design integrated distribution networks based on the Viable System Model and validated the results with a simulation model comparing the VSM approach versus classical distribution planning concepts (Groten, 2017).

Basics of the Viable System Model, organization & production management and lean management principles

From cybernetics and system theory to the Viable System Model (VSM)

Cybernetics has its origin in the 40s of the last century and is often related to the work of the mathematician Norbert Wiener who studied the regulatory mechanisms and information structures existing in living organisms in order to make them understandable and possible to use (Strina, 2005, pp. 11-13). From the point of view of historical development, cybernetics can be considered part of systems theory. However, system theory focuses on the development of systems, while cybernetics explores the control and operation of systems (Schwaninger, 2004, p.4). Cybernetics deals with all forms of behavior insofar as they are regular, determined or reproducible. As a result, it takes care about what a system does (Ashby, 1957, p.1).

An important result of Cybernetics is that all viable systems have an invariant structure. Therefore, a system will only be viable if and only if it has this structure (Malik, 2006, p.80). A viable system is also able to adapt itself to changing scenarios of its environment. To do this, the system evaluates and learns from these situations, developing its behavior while maintaining its identity (Gomez, 1978, p.21).

An organization is no longer studied as a single company, except in the context of its relationship with the environment. Due to this, the topics such as capacity for adaptation, flexibility, ability to learn, evolution, self-regulation and self-organization are of main interests. The main problem that Cybernetics has to deal with is how to deal with environment complexity. It is concluded that the means to solve this problem is the structure or organization of a viable system. For this purpose, the Viable System Model (VSM), a cybernetic management model, was developed by Stafford Beer throughout his life (Espejo & Harnden, 1989, p.57). Beer deduced the VSM by taking the central nervous system of the human being and cybernetics as basis in order to deal with complex systems (Schuh et al., 2011, p.434). The minimum requirements that a system must meet to ensure its viability are derived when analyzing the central nervous system (Beer, 1972, p.198).

The VSM is built on three main principles: viability, recursivity and autonomy. Viability is a property of every system that is able to react to internal and external perturbations in order to maintain separate existence (Schuh et al., 2011, p.434). The cybernetic model of every viable system consist always in a structure with five necessary and sufficient subsystems that are in relation in any organism or organization that is able to conserve its identity with independency of its environment (Espejo & Harnden, 1989, pp.21-22).

System 1 consist of semi-autonomous operating units that react to the development of their environment and in which each unit coordinates itself with the other operating units, with the aim of maintaining its own stability and the stability of the entire company (Beer, 1972, pp.214-217). The plan of the operating units is to execute and control their tasks autonomously within defined limits (Brecher et al., 2011, p 434).

System 2 is the coordination system that enables the units of system 1 to solve their own problems allowing decentralized decision-making and solve conflicts between those units (Espejo & Harnden, 1989, p.287). It also carries out the coordination of the operative units regulatory centres. It is an interface between Systems 1 and 3 (Beer, 1972, p.220).

System 3 is the central control system of the operating units. It performs the control of current operations (Espejo & Harnden, 1989, p.281). It also analyzes the viability of the strategic input provided by the system of 4 and converts it into tactical operations (Brecher et al., 2011, p.435).

System 3*: performs the validation of the information that flows between system1-3 and 1-2-3 through the audit and monitoring of activities (Schwaninger, 2008, p.84). This system sends information that does not appear in the official reports, that is, informal channels (Malik, 2006, p.455).

Systems 1, 2 and 3 regulate internal stability and try to optimize performance within a given structure and criteria (Beer, 1972, p. 230). System 3 is the coordination center of all internal areas of the company condering the goals for the whole company since systems 1 and 2 can only compare deviations locally (Malik, 2006, pp.131-132).

System 4 is the strategic system that makes strategic analysis of the external environment and the internal capacity to deal with it and, based on it, takes the necessary strategic decisions (Brecher et al., 2011, p. 435). The internal stability has only sense if the external factors are considered. Reception, elaboration and transmission of information from the environment are tasks of System 4 in order to provide external stability (Malik, 2006, p.90). It is a set of activities, which feeds the highest level of decision making. It must contain a model that represents the idea of the firm in order to inform the top management about which type of firm they are running (Beer, 1972, p.233). Therefore, it considers both external and internal conditions in order to initiate changes and development. To make it possible, systems 3 and 4 maintain a continuous dialogue (Espejo & Harnden, 1989, p.281).

System 5 represents the normative level that makes the balance between current operations (System 3) against future´s needs (System 4). When there is no balance, System 5 plays the role of judge (Espejo & Harnden, 1989, p.293). It defines the rules that determine how the global system behaves. It is continuously designing the future of the system through the elaboration and choice of behavioral alternatives. Here the company policy is created, through a close interaction between the management systems, 3, 4 and 5 (Malik, 2006, p.91). System 5 is the top management and it determines policies and establishes the goals to take decisions (Beer, 1972, p 253).

Organizational functions and production management tasks

Organizational functions as described from Porter can be divided into primary and support functions, which are activities that described the value chain of an

organizarion that are related to its competitive strength. Primary activities are directly concerned with the creation or delivery of a product or service. They can be grouped into five main areas: inbound logistics, operations, outbound logistics, marketing and sales, and service. Primary activities are linked to support activities which help to improve their effectiveness or efficiency. There are four main support activities: procurement, technology development (including R&D), human resource management, and infrastructure (IT systems for planning, finance, quality, information management etc.) (Porter, 1985).

The production system includes functions of inbound & outbound logistics as well as operations and their related support activities. Production is the foundation of human activity. Natural resources are transformed into useful products through production processes to meet the needs of society (Zelenović, 1982, p.319). The productive system is characterized by the process of transformation of materials into finished products including the related responsibilities of production planning and production control (Santamaría Peraza, 2012, p.42). The current understanding of production management varies widely from an authoritarian point of view of planning and production control to a global understanding of production management as management, design and development of the entire manufacturing company (Friedli & Schuh, 2012, p.28).

Production management contains the tasks of design, planning, monitoring and control of the productive system and business resources such as people, machines, material and information (Nyhuis, 2008, pp.249-273). The multi-dilemma of production planning originates discussions over and over again in the context of divergent objectives. This conflict of goals is shown in (Friedli & Schuh, 2012, p.36).

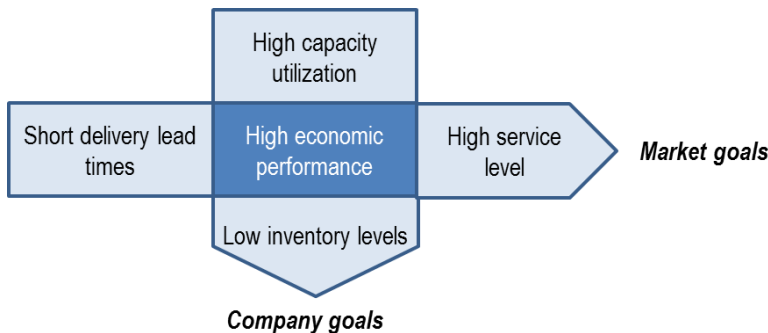


Figure 1: Multi-dilemma of production planning (Friedli & Schuh, 2012, p.36).

From customer perspective goals are short delivery times and high delivery reliability. From company point of view, the high utilization rates are indispensable due to high fixed costs. This must be achieved simultaneously with a minimum inventory to keep the working capital costs under control. Therefore, business goals

are in conflict with market objectives which increase management complexity in manufacturing companies (Friedli & Schuh, 2012, pp.36-37).

The strategic perspective of production management anticipates relevant change drivers, triggers the adjustment of the organization to be adapted to the conditions of its environment in order to give a strategic direction to the company based on the objectives, principles and standards defined at the normative level. The operational objective of production management is the supply of the products and services of a company in the quality and quantity required at a given date and at the lowest possible cost (Kämpf et al., 2007, pp.5-32). The basic tasks of the operational production management are the production program planning, the order management, the production requirements planning and the planning and control of internal production as well as external production in suppliers.

To explain the tasks of production management, the Aachener PPC (Production Planning & Control) model, which is a reference model for its analysis, evaluation and design, is used (Schuh et al., 2012, p.29).

Network tasks	Core tasks		Cross tasks		
Network configuration	Master Production Program		Order management	Inventory management	Controlling
Network sales planning	Production requirements planning				
Network requirements planning	Planning & control of outsourced production	Planning & control of own production			
Data administration					

Figure 2: Production management tasks according to the Aachener PPC model (Schuh et al., 2012, p.30)

Network tasks summarize all the planning tasks that are carried out in relation to production plant network. The core tasks are all tasks related to production management and control with focus on the individual company. The transversal or cross tasks are planning and control tasks that contains elements of the production network as well as of the core tasks and therefore have a character of coordination between both. All tasks are distinguished vertically in Error! Reference source not found. according to their strategic, tactical or operational nature. For performing these tasks, equipment and personnel resources are planned with an increasing degree of detail (Schuh et al., 2012, pp.30-32).

The tasks are assigned according to their temporal relevance at different planning levels. According to the St. Gallen management model, management levels are divided into normative, strategic and operational planning levels (Bleicher, 2004, p.80). In the past, the main focus was on operational and tactical problems, however to successfully manage logistics in the future, an active strategic planning level is also required (Schuh & Stich, 2013, p.1).

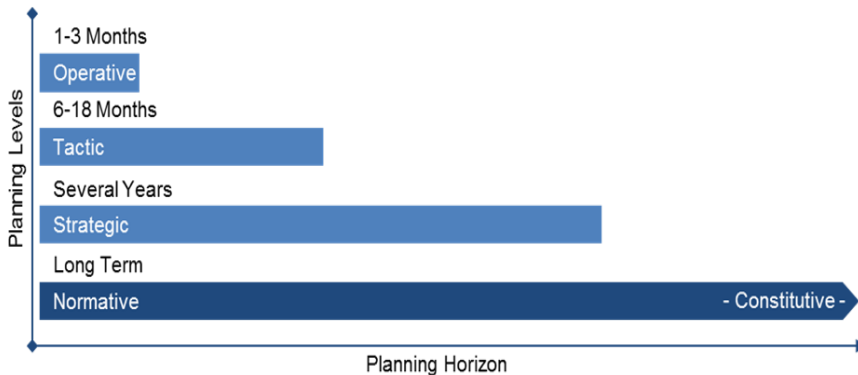


Figure 3: Planning levels and horizons in supply chain management (Bleicher, 2004, p.80).

Lean management principles

The lean concept was developed in Japan after the Second World War when Japanese manufacturers realized that they could not afford the massive investment required to rebuild facilities. Toyota produced automobiles with less inventory, human effort, investment and defects and introduced a greater variety of products. The goal of lean management is to concentrate efforts in added value and customer demand by reducing waste. Various authors have studied the quantitative and qualitative benefits of lean implementation. Quantitative are improvement in production lead time, cycle time, set up times, inventories, defects and scrap as well as overall equipment effectiveness. Qualitative benefits include improved employee morale, motivation, better communication, team decision making, etc. The modern concept of lean management is derived from the Toyota Production System (TPS) (Bhamu & Singh Sangwan, 2014, pp.876-877). Shah and Ward (2003) identified 22 lean implementation elements and classified these into four categories: just in time (JIT), total productive maintenance (TPM), total quality management (TQM), and human resource management (HRM) (Shah & Ward, 2013).

At the same time, lean production concepts make the boundaries between the departments disappear. The tasks are distributed between production, maintenance and other departments, which must be taken into account when organizing these fields of responsibility (VDI - Verein Deutscher Ingenieure, 2012, p.2). Therefore to reach all potentials of lean management in production systems the break-down of

responsibilities and communication channels should be redefined. As basis for the conceptual model the seven zeros build the basic goals for the production system.

To illustrate the methods of lean management in a current production system, the VW group principles are shown as example. These are the principles to achieve a synchronized production oriented to added value (Bozalongo Santander, 2013, pp.50-55):

- A work organization oriented towards people
- Basics: cycle, flow, pull and perfection
- The customer cycle as a guide
- Process time reduction
- "Pull" principle
- Quality with zero failures
- Standardization
- Leveled and smoothed production
- Environment protection
- Elimination of any waste

4. Basics of organization & production management, lean management principles and the Viable System Model

Development of a target system for an organization and for a production system

The final goal of each business activity is to increase the value of the company (Biedermann, 2008, p.88). The orientation to corporate value corresponds to the management approach based on added value. This approach provides the basis for corporate orientation towards increasing corporate value. The increase in the company value will be achieved mainly by increasing the performance of the company (Alexandre et al., 2004, pp.126-127). The key indicator includes, therefore, the factors of turnover, capital employed and costs (Alexandre et al., 2004, pp.126-127), which are decisive for the success of the company. These factors are included in the Return-on-Capital-Employed (ROCE) indicator. ROCE is a common feature in business practice and describes the return on a company's capital (see formula below) (Isermann, 2008, pp.876-877):

$$\text{ROCE} = \text{EBIT} / (\text{Capital-Employed}) = (\text{Volume of business-Costs}) / (\text{Capital employed})$$

However, in order to increase the ROCE, the intermediate objectives derived from it have to be improved in a certain way. Figure 4 shows the target system designed for this study based on lean principles. To achieve the highest possible value of ROCE, turnover must be as large as possible, while costs and capital employed as small as possible.

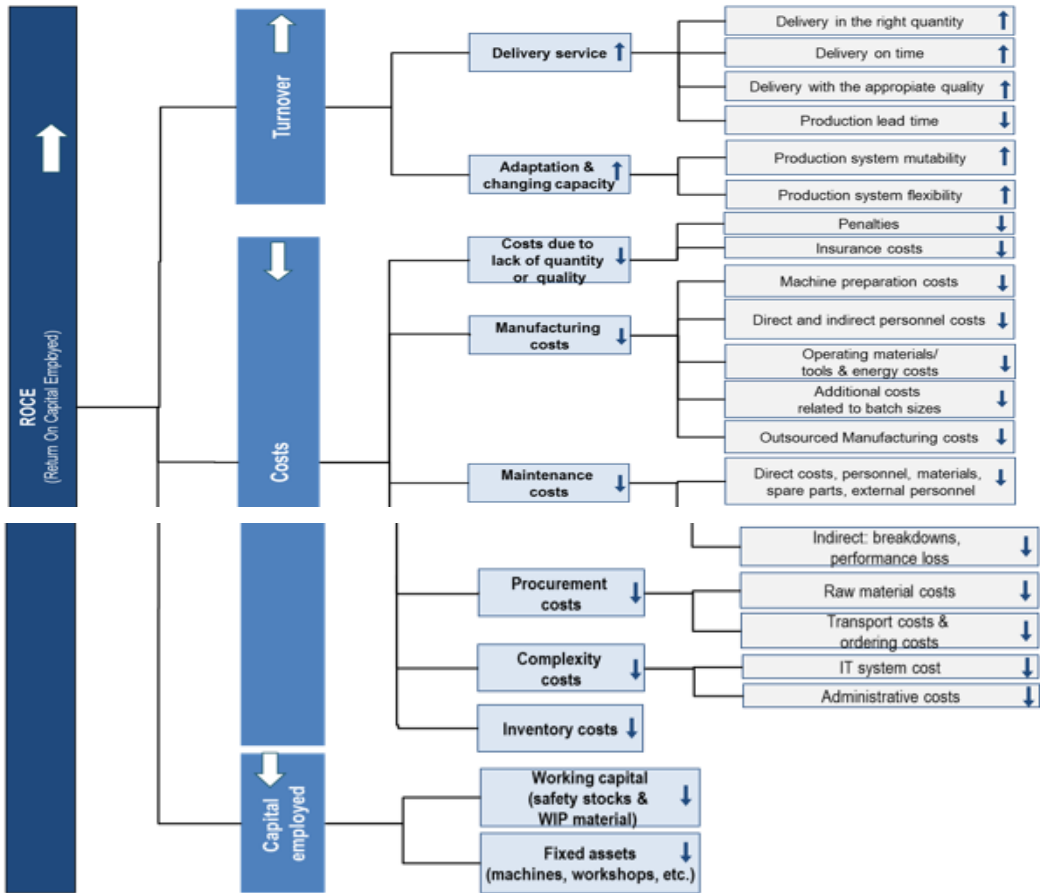


Figure 4: Corporative target system (own elaboration)

Production management tasks according to planning horizon levels

Production systems are considered important in relation to aspects of quality, time and costs (Dombrowski & Mielke, 2011, p.1). As explained before, planning tasks can be classified into strategic, tactical and operational planning depending on the respective planning horizon. Therefore this classification was performed for the conceptual model:



Figure 5: Production management & planning tasks according to time horizons (own elaboration)

Definition of recursion levels and operative units

A company is assumed as a viable system that is the first level of recursion in which the five systems necessary to ensure viability are found. Therefore, in the course of this research work can be differentiated four levels of recursion:

The highest level, company (n-1)

The production recursion level (n). In the same recursion level it can be found finance, human resources, IT, research and development, etc.

The recursion level of the plant or production workshop, for example production management activities in an automotive assembly shop ($n + 1$)

The recursion level of machine group or installation with the associated activities for the different production activities such as preparation of the machine, change of tools, operation, production control, etc. ($n + 2$)

The systems 1 of the recursion level $n + 2$ are no longer viable systems in contrast to the higher recursion levels, because they do not contain a structure like that of the VSM, since they are the elements of production execution.

Within this first level of recursion, company, the different functions of a company can be found, such as production, maintenance, commercial, finance, research and development, information systems, etc. In this research project, production tasks will be analyzed in detail, recursion level n , but also taking into account the function of system 2 at the company level, $n-1$, whose function is to coordinate the different functional areas of a company.

System 5 of the company ($n-1$) defines its legal framework, politics, corporate policy and constitution, ethos and underlying values as well as its leadership philosophy. All of this information is transferred to all functional departments inside the organization including the production system. Using these common normative values the company receives information from the environment that can be: the behavior of the competition, data from new markets, new technologies, changes in regulations, influences of globalization or changes in the company's market. Based on these inputs the company defines its strategy in system 4 of company level in continuous communication with system 3 to check if the strategy can be implemented and the internal consequences of its implementation on the stability of the company. System 2 at company level plays the role of coordinator between the functional areas of the company trying to solve conflicts between them. Moreover the systems 1 at company level are all functional areas of every company such as production.

At the recursion level of production (n) it is assumed that the different production plants or workshops will be the respective systems 1 which also contains a viable system in each of these locations. The VSM of the production system within a company is described by the tasks performed by its five necessary systems:

System 5 establishes the production objectives and communicates them to the other management systems, systems 3 and 4. System 4 observes and collects essential information from the external environment of the productive system. The environment is mainly represented by the demands of customers, but also by other factors such as information systems offered by the market for the management, planning and control of production, new manufacturing technologies and, in general, all factors affecting the production system such as market standards, delivery times, production strategies, delays, production costs in external companies for example to help in making decisions about outsourcing or to not manufacture certain parts or the

assembly of certain sets, etc. With these and other informations from the external environment and information from system 5, system 4 creates a vision of what the production area has to be and which should be the measures to be followed to reach that state. This vision is validated internally with system 3 so that system 4 makes the decision and System 3 makes the changes internally.

System 3 is responsible for maintaining the internal stability of the model by optimizing the use of internal resources using the information received from system 4 about the clients as well as the information of the different divisions of system 1 obtained through system 2. It would be related to functions such as operative production management and control, information management, quality management, operative logistics planning and control, etc. Moreover system 3* allows a quick response to possible emergencies in the manufacturing process or in the production control and monitoring by acting before information flows through system 2. It is capable to perform actions in real time if something happens outside of normal limits such as making changes in sequencing and production scheduling to avoid stopping production flow.

System 2 is represented by the functions of coordination between the different production locations in daily activities. This system receives all the information of the different production plants and acts as a filter so that only the necessary information reaches the system 3. The difference between both is in the time horizons of action. While system 2 performs functions in daily activities, the tactical system optimizes the performance of the internal system over a longer time horizon.

System 1: each plant or workshop within the production system is an operational unit that includes the management of the unit and the division that performs the operational activities. An example could be an assembly workshop that contains production planning and control departments responsible for the equipment and personnel including team leaders together with the operators that finally perform the production tasks.

Environment: represents all the external factors that influence the production system in a company. The diagram shows the environment of the entire production area as well as of each production plant or workshop.

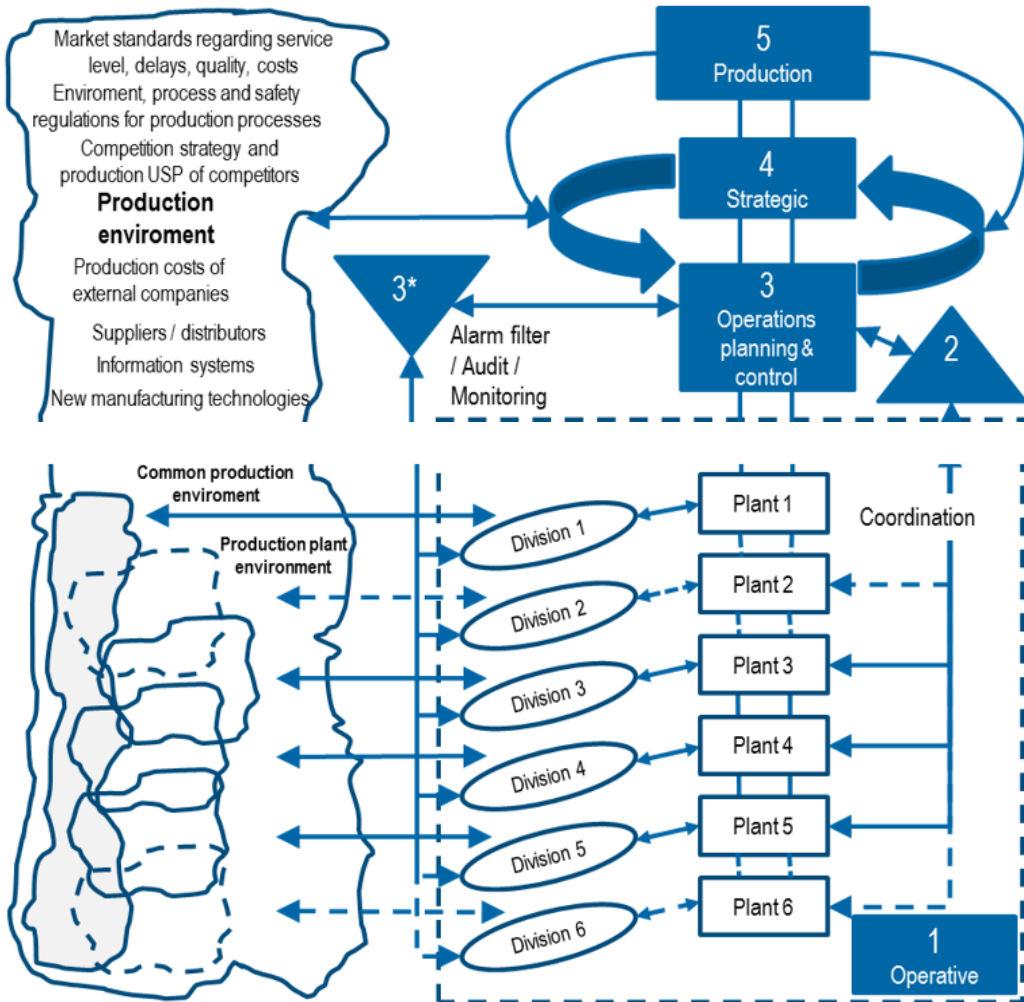


Figure 6: Analogy with the VSM: Production recursion level (own elaboration)

Association of tasks to the recursion levels & operative units

Production management tasks were assigned to the VSM systems at recursion levels n and $n + 1$. As an example in **Error! Reference source not found.** are shown the strategic production management tasks and its classification. In the same way it was done for all other tasks:

Strategic planning tasks	Production recursion level			Plant recursion level		
	S 5	S 4	S 3	S 5	S 4	S 3
Principles, guidelines (1.1)	X			X		
Definition of product programm (1.2)	X					
Organizational structure (1.3)		X				
Creation of investment programm (1.4)		X				
Production strategy planning & master data (1.5)		X				
Continuous evaluation of production environment (1.6)		X				
Target system (quality, cost, time) (1.7)		X				
Production system design, production location distribution (1.8)		X				
Production master programm: sales planning, requirements and resources planning (1.9)		X				
"Make-or-buy" decisions (1.10)		X				

Figure 7: Strategic production management tasks and its classification to VSM systems (own elaboration)

Identification of the needed information flows between operative units and recursion levels

Current technical literature agrees that the connection interfaces between recursion levels is extremely important (Ríos, 2012, p.59). Goal is to determine basic links that can be transferred to any VSM in any company. The intensity of this connection between the levels varies according to the company (Ríos, 2012, p.59). An exchange of information within the company and between levels of recursion is necessary to control the corporate environment, which generally has more information than can be processed in the company (Herold, 1991, p.287). Between the recursion levels it can be found the following communication flows:

Between the company environment and the system 4 at the production recursion level

Between systems 5 of company and production

Between systems 4 of company and production

Between systems 3 of company and production

Between systems 2 of company and production

Between the operating units, systems 1, of company and production

Between the alarm / monitoring filter (System 3*) of the company's recursion level and system 4 of production

The company environment can not be assigned to a specific recursion level, but is a joint element for the entire structure of the VSM. System 4 collects all the information that allows the company to recognize future developments and possibly reorient its own structures (Malik, 2006, p.456).

Between the two normative systems of company and production there is a flow of information that defines the degree of freedom of decision making in which production recursion level can act. Specifically, it means that the decisions taken by the management of the company are communicated to the management of production

management defining its guidelines for autonomous decision making within the respective areas. These guidelines can be financial, on personnel, on affectation to other areas, etc. In the same way, the objective levels such as production in term, production quality and production costs and adaptation capacity are influenced by decisions from the management, defining the priorities and the limits for the coordination among production areas. An example could be: the direction of the company in its strategic plan establishes the target production volume for the following years as well as the required flexibility in percentage on the production as well as the decrease in target costs. Of course these decisions would influence the decision-making framework for the production system that should adapt their methods and tools to be able to optimize costs, times and quality based on the given flexibility.

As explained during the research work basic communication flows were defined. In total a number of 88 information connections were defined for the production recursion level specifying if the communication goes from company's recursion level to production recursion level or between systems in production recursion level. An extract is shown in **Error! Reference source not found.:**

51	Performance of the IT system for production management	From System 3 to 4
52	Processing methods of production orders	From System 3 to 1/2
53	Principles, guidelines and product program	From System 5 to 4/3
54	Decrease production lead times "zero waste" "zero inventory"	From System 5 to 4/3
55	Improvement of customer service level "zero defects" "zero delays"	From System 5 to 4/3
56	Stock minimization: "zero inventory"	From System 5 to 4/3
57	Maximize the assurance of quality in production process "zero defects"	From System 5 to 4/3
58	Minimization of working accidents "zero accidents"	From System 5 to 4/3
59	Minimization of environmental impact & energy resources consumption "zero waste"	From System 5 to 4/3
60	Maximization of orders manufactured according to planning "zero delays"	From System 5 to 4/3
61	Prioritize production orders based on delays to final customer delivery date "zero delays"	From System 5 to 4/3
62	Maximization of the use of facilities and personnel "zero waste"	From System 5 to 4/3
63	Optimization of production costs "zero waste"	From System 5 to 4/3
64	Minimization of deviations between sales forecasts and production needs "zero waste"	From System 5 to 4/3
65	Optimization of production changeovers "zero unplanned changeovers"	From System 5 to 4/4
66	Minimization of production breakdowns "zero breakdowns"	From System 5 to 4/5
67	Customer satisfaction	From System 5 to 4/3
68	Information on principles, guidelines	From company to 4/5
69	Information about company policy	From company to 4/5
70	Information on basic strategies	From company to 4/5

Figure 8: Example of information flows in the conceptual model of company and production (own elaboration)

Conclusions

The research work helped to develop a model supporting the following main hypotheses:

Thanks to a new conceptual model for organizational management and production taking into account the added value to the end-customer within a supply chain, the viability of a company can be assured.

Lean management provides the methods and tools to be applied inside any organization to improve company target system: delivery service, costs and performance.

The Viable System Model provides the necessary structure to determine the interrelationships between areas and parameters that allow them to be optimized in a recursive way, making continuous improvement possible. It enables to create regulatory mechanisms to ensure the viability of the company in the long term.

Next step of the research will be to simulate company and production performance using the conceptual model developed and to compare it with current available structures how to deal with changing environment. Final goal is to transfer this research method to real organizations and production systems applying it in particular areas or to design organizations and production models based on it.

In conclusion this proposed approach can increase the efficiency of organizations and production systems. Also it shows how a VSM approach can be used as a methodology for organizations and production systems to be successful in any kind of environment.

By using it a company can adapt itself to all future potential environment scenarios by changing its strategy and internal set-up.

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