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ESCUELA TÉCNICA SUPERIOR DE INGENIEROS INDUSTRIALES

HOSHIN KANRI FOREST

Lean Strategic Organizational Design

by

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DEPARTMENT OF ORGANIZATIONAL ENGINEERING, BUSINESS ADMINISTRATION AND STATISTICS

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ABSTRACT

Strategic Lean Management (LM) efforts almost always fail because Leaders often lack a map of their own organization. The reason for this might be that scholars have so far mostly provided qualitative or rigid one-size-fits-all frameworks for strategically designing organizations. The purpose of this work is to provide a comprehensive quantifiable framework for strategically designing organizations for LM. Combining knowledge about Strategic Organizational Design and LM, we introduce a novel theory called HOSHIN KANRI FOREST that considers organizations as networks with organizational structure, functional connectivity and effective dynamic patterns in the quest of attaining an optimal Strategic Organizational Design towards the strategic goal of LM. This work presents the future of Lean organizations relying on strategically designing its structure, function and effective dynamics so as to emulate nature.

RESUMEN

Los esfuerzos estratégicos de Lean Management (LM) casi siempre fracasan porque los Leaders carecen de un mapa de su propia organización. La razón de esto puede estar en que los estudiosos de la materia han aportado hasta ahora esquemas muy rígidos para configurar el diseño de organizaciones. La intención de esta tesis doctoral es proponer un nuevo paradigma para diseñar estrategicamente organizaciones hacia LM. Combinando conocimiento de diseño organizacional estratégico y LM, introducimos una nueva teoría llamada BOSQUE de HOSHIN KANRI que considera a las organizaciones como redes con estructura organizacional, connectividad funcional y una dinámica efectiva regida por patrones para así describir una estrategia de diseño organizacional hacia el objetivo de LM. Esta tesis presenta el futuro de las organizaciones Lean basándose así en diseños estructurales, funcionales y dinámicas efectivas para así emular a la naturaleza.

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PREFACE AND ACKNOWLEDGMENTS

As I write, the field of organizational design is undergoing its most profound change in more than a century. I believe that this change represents a major shift that will impact our lives significantly, as well as those of generations to come.

Of what concern is this shift in paradigm? Why should anyone, except organizational leaders and scholars, care? Most of us understand accept our social structures as given and develop traits and techniques to navigate through them - more or less successfully.

Organizational design matters because organizations form the very fabric of society. From a family to a corporation, organizations influence our individual choices. The paradigm shift that is underway is one of awareness – an increasing realization- that we have choices.

The dramatic drop in the cost of exchanging information has rapidly brought connectivity between individuals that is re-shaping not only events, but also the very fabric of our social nature.

This tide has turned firmly in the direction of increasing complexity. It cannot be managed, but led responsibly.

WHOM THIS RESEARCH IS FOR

I have written this research with two audiences in mind.

The first consists of business leaders who are interested in how ideas from fields like psychology or biology can be combined to create powerful concepts that will be applicable to one of the most difficult and complex problems that executives face - Strategic Organizational Design. These ideas are rooted in many years of work, but are at the cutting edge. Some companies may have experimented with them, but not applied them widely yet. So, the purpose of this research is to make possible their wider application and replicability.

The second audience consists of scholars and students. For this group, my intention was to leave a trail that others can continue. Profound knowledge is complex. Thus, a full bibliography is provided at the end for readers who wish to find answers to their questions in the original source material.

ACKNOWLEDGMENTS

None of these ideas are solely mine. Many other persons inspired these ideas, whether intentionally or unintentionally. Their generous support and intellectual contributions made this research possible and, for this, I am deeply grateful.

I should begin by thanking the ETSII as an institution and its staff. I wish to thank Joaquin Ordieres for his patient guidance and endless ideas. Eva Sánchez Mañes and José-María de la Cruz, who teach at ETSII and whose classes in differential equations and classical mechanics ignited my interest in describing the world mathematically. The language of nature is written in mathematical terms and Eva and José-María taught me to read that book. I also thank Carlos Vera (R.I.P.) for teaching me how organizational politics functions. The perceptive Carlos taught me the nature of formal power. Jesús Misas was the first organizational leader to teach me how to lead without formal power.

On a personal level, I want to thank my mother for teaching me the art of cultivating human nature and my father for teaching me to be decisive and to think clearly. I thank my brother, José, for showing me how to never give up. Thank you Paloma, my love, for awakening my empathy and my son, Manuel, for making me a man.

Foreword.

"All you need to know to understand the world is in this garden.

This is my advice to you: Take care of your garden."

Víctor Díez Valderrama

Picture taken by María Ángeles Díez-Rubio and José Manuel Villalba-Sánchez in Parque de El Capricho. Madrid. Winter 2016.

INTRODUCTION.

CEOs and Leaders of a wide range of service and manufacturing industries set as strategic goal to implement Lean Management in the organizations they serve hoping to achieve a competitive advantage (Demeter et al., 2009). Methods and practices for implementing Lean Management in organizations are well documented (Shah and Ward, 2003) (Womack and Jones, 2003), however a considerable number of studies show that many of these efforts fail to deliver expected results (Burnes, 2004).

The problem is not that lean theory is wrong, the problem is that probably organizational leaders are asking the wrong questions. The question CEOs and Leaders should be asking is “How should an organization be strategically (re-)designed in order to implement and sustain LM?”. This pressing urgent challenge is all about a holistic understanding of organizations as systems and here is where Strategic Organizational Design kicks in.

Scholars define Strategic Organizational Design as a “deliberate process of configuring structures, processes, reward systems and people practices to create an effective organization capable of achieving the business strategy” (Galbraith, 2014). An important part of Strategic Organizational Design´s body of knowledge (Stanford, 2007) (Burton et al., 2011) emphasizes the importance of choosing a particular multi-dimensional structural and functional context for organizational design (Burton and Obel, 2004).

(Burton et al., 2011) state that organizational design starts with a goal. Others (Kesler and Kates, 2011) propose to start the Strategic Organizational Design process with a clear picture of the problem to solve in order to subsequently then define a strategy to achieve that goal or solve that problem (Kates and Galbraith, 2007). The sequence GOAL/PROBLEM-STRATEGY-DESIGN seems to be generalized for what can be called the neoclassic organizational architects. Other scholars, add evolutional circularity (or spirality) to such thought (Nonaka and Zhu, 2012) by stating that the awareness of a goal/problem that leads to the formulation of a strategy and the subsequent Strategic Organizational Design changes that follow, will have again a dynamical impact upon the goal/problem. This interdependence is made tangible through a network ´s perspective towards organizations (Cross et al., 2010).

Scholars (Sporns, 2011) define three types of network connectivity for complex systems: (1) structural connectivity representing the information exchange connections between organizational agents, (2) functional connectivity capturing the spatiotemporal patterns of connectivity between organizational agents and (3) effective connectivity describing the effect of organizational clusters over another. These three connectivity types are close related to the provided definition of Strategic Organizational Design because it tackles structure, process and effective organizational dynamics

Based upon this frame the purpose of this work is to answer two main research questions

- RQ1. How should an Organization be strategically (re-) designed in order to implement and sustain LM?
- RQ2. Can mathematical models for information flow and connectivity be suggested that help organizations steer successful Strategic Organizational Design process under the dynamic effect of evolutional forces towards sustainable implementation of LM?

The structure of the work hereinafter follows a clear roadmap in eight chapters.

Chapter 1 introduces the concept of standardized inter-process communication and sets the basic element for building lean structural networks.

A number of environmental forces such as increasing value chain network complexity, decreasing product life-cycle cost and time-to-market requirements or increasing product complexity act upon organizations enhancing the acute need for organizational routines that foster efficient and effective communication between processes. Such organizational routines erode quickly in the absence of common standards for knowledge sharing, that is why successful LM systems benefit from inter-process standardization. The purpose of this chapter is to offer a standardization model of inter-process communication that increases organizational operational performance. Firstly, we propose a novel holistic model called (CPD)nA that makes standardized inter-process communication possible in organizations. Secondly, we propose a model for quantifying the implications of standardizing inter-process communication. Finally, as a matter of application, we show the results of its successful implementation in one japanese manufacturing organization.

Chapter 2 introduces the functional connectivity dimension and links both lean functional and structural networks by introducing the concept of organizational motifs.

Organizations face strong international competition in the global market arena in achieving strategic goals, such as high quality of product or service at lower cost while increasing their ability to respond quickly to requirements of the market. These challenges concern strategically designing organizations that can meet global challenges and specialize locally to meet performance constraints. In this chapter we introduce the concept of organizational functional and structural motifs as small organizational building block. Based on this, our findings suggest the hypothesis that a Strategic Organizational Design approach to meet these challenges involves maximizing the number and diversity of functional motifs, while minimizing the repertoire of structural motifs. By detecting characteristic structural motifs, we provide organizational leaders with specific Lean Strategic Organizational Design solutions with which to meet local and global challenges simultaneously. As a matter of application, we show the implementation of such an Strategic Organizational Design approach in nine U.S. hospitals that form one large health care holding.

Chapter 3 goes ahead and describes the consensus dynamics of effective organizational networks shown by structural network clusters towards strategic goals.

In the process of value creation, organizations perform an intense intra-organizational dialog through which internal VALUE STREAM (VS) (Womack and Jones, 2003) alignment is achieved towards certain strategic objectives. Within the context of complex organizational networks, were goal conflicts are preprogrammed through incentive structures, VS alignment as legitimation of action towards strategic goals has special interest. On the one hand it facilitates the access to necessary resources for goal achievement and on the other it increases the sustainability and supports commonly agreed upon decisions leading to success. This chapter provides a winnerless process (WLP) differential equations model for quantifying intra-organizational VS alignment effective network dynamics that can help design sustainable LM solutions. This chapter presents relevant research results that show how the model was implemented in one german industrial facility.

Chapter 4 is shorter than the rest, however stands alone as a powerful implication of the described effective WLP dynamics on LM and its associated learning process. Evolving the organizational means that developing new capabilities, identifying early and retaining talent are some of the major organizational challenges in the 21st century. Individual learning in organizations is not homogeneous and depends on a number of individual and environmental factors. (CPD)nA is compared from a psychological and managerial perspective to other Lean Learning Pattern in other to show the advantages of implementing it when creating the conditions that are necessary for organizational alignment.

This chapter builds on this organizational dynamic concept to validate (CPD)nA as lean learning pattern by comparing it with other learning patterns currently used in the industry.

Chapter 5 offers a method to operationalize lean structural networks at a process management level. Process Management (PM) empowerment methodologies have traditionally focused on two aspects: goal achievement following rigid structures, such as SQDCME (Security, Quality, Delivery, Cost, Morale, Energy), or evolutional aspects of empowerment factors away from strategic goal achievement. Furthermore, GM Methodologies have been organized almost solely around the hierarchical structure of the organization, failing systematically to cope with the challenges that 21st century organizations are facing. The latter include the growing complexity of value-stream networks, sustainable empowerment of the workforce (Learning Organization), an autonomous and intelligent process management (Smart Organization), the need to cope with the increasing complexity of VALUE STREAM NETWORKs (VSNs) and the leadership paradigm shift to strategic alignment. This chapter presents a novel Lean organizational PM Method called "HOSHIN KANRI TREE", which is based on standardization of the communication patterns among POs through (CPD)nA. The standardization of communication patterns by HOSHIN KANRI TREE technology should bring enormous benefits in VS performance, speed of standardization and learning rates to 21st century organizations. A practical case study of a German manufacturing facility is presented as a way of showing how the HOSHIN KANRI TREE model works and can be implemented in practice.

Chapter 6 bonds everything together by explaining how to expand this method to service and manufacturing industries at an intra-organizational as well as inter-organizational level involving customers and suppliers. This chapter proposes an analytical description of how to design a universal reconfigurable lean service and manufacturing systems (RLSMS). This chapter proposes an information exchange network, the HOSHIN KANRI FOREST, which permits the implementation of an evolutional scale-free RLSMS. Several structural and functional characteristics of HOSHIN KANRI FOREST are quantified to enable leaders steer their organizations towards desired topologies. This chapter also proposes a method to operationalize such RLSMS. In order to show its practical implementation potential, the theoretical framework and its practical implications appear in a Health Care corporate case study that can be replicated.

Chapter 7 presents several general conclusions of the work.

Chapter 8 closes the work with an epilogue.

In order to make reading comprehensive and accessible each chapter is organised following a similar structure. First, the introduction frames the chapter by explaining the problematic and why it is relevant to discuss it. Second, the background or literature review succinctly describes typically who has performed research on the topic before and from what perspectives, what are the relationships between those different approaches and what needs to be done. Third, the body of the chapter presents the main concept and shows its contribution. This contribution is remarked with a practical case study that follows the recommendations of (Eisenhardt,1989) who offer a clear case study roadmap. This roadmap has usually following phases: (1) Scope Establishment (2) Specification of population and sampling (3) Data collection (4) Case implementation (5) Case Summary and Limitations. Each chapter closes with a further steps section that serves as a bridge for the next chapter by following a logic sequence of thought and sketching how the concept ought to be further developed.

1.(CPD)nA. STANDARDIZATION OF INTER-PROCESS COMMUNICATION

1.1. Chapter Introduction

Increasing structural VSN complexity (Schuh et al., 2013), pressing product life cycle cost and time-to-market requirements (Cocco et al., 2014) or rising product complexity (Schuh et al., 2014) are some of the environmental forces acting upon organizations. When structural complexity increases, organizations tend to develop interfaces between processes (Hanisch and Wald, 2014) in order to make information readily available for process owners (POs) (Durugbo et al., 2013). Those forces applied upon these new interfaces enhance the acute need of integrating and coordinating complex systems and this brings with it the challenge of attaining more efficient and effective communication between processes. These challenges can be successfully accomplished through the standardization of a common language to connect processes within an organizational network. Such a language can be understood as an inter-process standard.

Although existing research emphasizes the need to standardize intra-process management (Münstermann et al., 2010) capabilities, it faintly identifies the need to standardize inter-process communication. The standardization of inter-process communication is important because, as both theoretical (Fujimoto, 2001) and empirical (Sharapov, 2012) research suggests, an organization´s competitive advantage can erode quickly in the absence of common standards for knowledge sharing. Knowledge sharing "is the fundamental means through which employees can contribute to knowledge application, innovation, and ultimately the competitive advantage of the organization" (Wang and Noe, 2010).

The current chapter addresses this gap in research by asking the following two questions. First, can a communication process that aligns inter-process communication in one single standard be found? Second, in order to be shown worth implementing, can a quantitative relationship between the implementation of such standard and organizational operational performance be suggested?

The literature on process standardization serves as a framework for this research because it allows to analyze how inter-process communication was developed as well as its evolution. The review on knowledge sharing in organizations narrows the scope upon the conditions for this standard to emerge. The literature review on PDCA (Plan Do Check Act) serves as platform for the fundamental paradigm shift and first contribution proposed in this chapter: from the classical Deming´s PDCA as problem solving method towards PDCA as inter-process communication standard. An examination of inter-process organizational relationships together with the identification of the nature of the knowledge sharing channels will enable the desired standardized inter-process to be achieved. The second contribution of this chapter focusses upon proposing a mathematical model that quantifies the link between inter-process network structure and organizational operational performance.

The structure of the chapter hereinafter continues with a section devoted to the literature review in which we present a brief review on process standardization from an inter-process communication perspective within an organizational network paradigm and its impact upon organizational operational performance. The current understanding of PDCA is explained. Secondly, based upon new perspectives on PDCA as inter-process standard, we present a framework that allows for standardized inter-process organizational information exchange. Thirdly, within this framework, we propose a theoretical model that facilitates the quantification of the effect of inter-process standardization routines upon organizational operational performance. Fourthly, we present the results of our field research with one case study in a Japanese manufacturing facility. Afterwards, we discuss and interpret the field results and discuss the alignment of the field results with the theoretical model. Finally, the last section presents the conclusions from the research and encourage further research in the field.

1.2. Chapter Literature Review

1.2.1. Inter-process Standardization

Process standardization is performed on an international level by international standards bodies such as ISO, IEC and IEEE (Schoechle, 1999). Extensive and intensive research defines process standardization from several angles. In table 1-1 we summarize a literature review of process standardization from an inter-process point of view and its impact upon organizational operational performance from the perspectives of different scholars, as well as the shortcoming related to these perspectives. We also propose necessary actions to be taken and explain how this chapter will tackle these research gaps.

Reference	Key Findings in Process Standardization	Inter-process Interpretation in Manufacturing Environments	Impact upon organizational operational performance	What needs to be done?
(Münstermann et al., 2010)	Process Standardization is understood as "the unification of variants of a given business process by aligning the variants against an archetype process"	The inter-process standardization is implicitly operationalized so as to simplify and reduce the typology of interfaces between processes, avoiding hence variants and maintaining a unified communication mechanism. This is desirable in a manufacturing context for instance when several facilities perform the same or similar processes and management aims to foster **benchmarking** as shown in this example (Vojak and Hatakeyama, 2006).	(Münstermann et al., 2010) show the positive influence of standardization on process performance. Evidence of the importance of cooperative benchmarking upon organizational performance and the relevance of the human factor within it has been shown by scholars (Ramabadran et al., 2004).	The human factor is hardly analyzed in these approaches. The conditions for knowledge sharing in order to unify and align processes are not discussed by these scholars..
(Kauffman and Tsai, 2010)	Process Standardization focuses upon interchangeability of processes so as to ensure the functionality of the outcomes.	The inter-process standardization is subordinated to the product standardization in order to attain the ultimate **interchangeability** of products as shown in (Ustun et al., 2013).	Product interchangeability is operationalized for instance through product modularity allowing to "introduce many successive versions of the same product line with increased organizational operational performance levels" in manufacturing facilities (Mikkola and Gassmann, 2003)	
(Schäfermeyer et al., 2010) (Schäfermeyer et al., 2012)	Process Standardization is understood as unification process and identifies the need to manage inter-process information	Inter-process standardization management is acknowledged as a management task. The solution proposed passes through a process taxonomy that clusters processes depending on several factors such as uncertainty or repeatability following (Lillrank, 2003).	The definition of standards upon shopfloor activities with high repeatability is regarded as a key method to improve organizational performance (de Leeuw and van der Berg, 2011).	The need for a **holistic inter-process communication standard**, independent of the process nature becomes explicit. **One of the contributions of this chapter aims to fill this research gap**.
(Ping, 2011)	Process Standardization is defined as "the activities in which people develop bases or rules for measuring such processes and so develop codes of conduct by establishing regularity from disorder".	From an inter-process standardization this perspective focuses upon the behavioral aspects of standardization. Ping´s definition has the same goal as the aim (Shah and Ward, 2007) see in LM: "Lean production is an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability."	According to (Shah and Ward, 2003) The impact of LM has proven highly efficient when increasing organizational operational performance.	(Shah and Ward, 2003) propose a multifaceted view upon LM and hence upon the effort of reducing process variability. These multiple factors, explained in a number of tools/methods, need and can be standardized with the help of a holistic inter-process standard that is presented in this chapter.

Reference	Key Findings in Process Standardization	Inter-process Interpretation in Manufacturing Environments	Impact upon organizational operational performance	What needs to be done?
(Wakamatsu, 2013)	Toyota´s usage of PDCA cycle process standardization is described as "basis for continuous improvement" and as one of its strategic competitive advantages.	From an inter-process standardization perspective, Toyota implicitly performs inter-process communication as an "**evolutionary learning capability**" of capability development, better known and operationalized as 底展開 or Yokotenkai (Fujimoto, 2001).	The benefits that such evolutionary learning capabilities upon organizational operational performance have extensively and intensively been studied by scholars (Nakanishi, 2013).	PDCA is understood as problem solving technique. The current focus of PDCA will be presented later in the literature review. N**ext section will expand this view**.

Table 1-1. Process Management from an Inter-Process Perspective

1.2.2. Conditions for knowledge sharing

The knowledge management guru Ikujiro Nonaka introduces the concept of 場 "ba" in Japanese to explain the context for knowledge sharing (Nonaka et al., 2008). "Ba" is a shared context that enables the emergence of knowledge sharing out of interaction between people (Nonaka et al., 2006). We list the conditions proposed by these scholars and concretize them for a manufacturing operations special case.

- The first condition is that "ba" must be "self-organized and possess its own intention, objective, direction, and mission".
- The second condition is that "ba" requires 'participants with different types of knowledge'.
- The third condition is that "ba" needs 'open boundaries'.

In an organizational context, the first condition (1) can be jointly achieved through the powerful paradigm of holonic systems: an organizational framework that describes organizations as robust and evolvable networks of autonomous holons that interact as a system. Tharumarajah in (Tharumarajah et al., 1996) proposed for the first time the use of the concept of holon as an autonomous cooperating agent. A group of holons that act together is called a holarchy. Holonic systems have the advantage of robustness against disturbances derived from the hierarchical organizational topology (van Brussel et al., 1999) and the global performance evolutionary functionality derived from the heterarchical process oriented dynamic connectivity patterns (Kelso, 1995).

Regarding the second condition (2) , holarchies ought to share knowledge along the VS allowing for different departmental/hierarchical holons to exchange their different perspectives on a shared issue.

The third condition (3) suggests that in order for knowledge sharing to thrive we need a holonic context focused in a certain VS oriented direction towards certain goals that leaves room for individual self-fulfillment. (Nonaka et al., 2008) do not provide any practical model to foster such conditions. We believe that PDCA can provide such context: therefore the following PDCA literature review discusses the current understanding of PDCA in order to later examine it in more depth.

1.2.3.PDCA

Our research has identified four currents schools of thought that have the PDCA cycle as central unit: (1) PDCA as problem solving pattern, (2) PDCA as empowerment behavioral pattern, (3) PDCA as project management pattern (Kobayashi and Osada, 2012) (Miyauchi, 2014) (Azuma, 2014) and (4) PDCA as strategic leadership pattern (Akao, 2004) (Osada, 1998) (Hino, 2006) (Osada, 2013). Our literature-review focuses upon the first two approaches.

(1) PDCA as problem solving pattern. Edward Deming (Deming, 1964) popularized PDCA as the “Shewart Circle” in Japan as an iterative problem solving method based upon Bacon´s (Novum Organum, 1620) scientific method of “hypothesis-experiment-evaluation” or plan: developing an hypothesis-do: conducting the experiment-check: evaluating the results. Toyota developed Deming´s ideas (Hiiragi, 2013) and added the Act Phase as interpreting the results. Other companies (FUJITSU, 2010) have made use of PDCA as a problem-solving pattern as well and have developed IT cloud-based solutions to speed up the problem solving performance by enhancing cooperation between its users. (Sobek II. and Smalley, 2008) understands PDCA mainly as a problem solving technique to develop critical thinking.

(2) PDCA as empowerment behavioral pattern. The development of critical thinking through PDCA has given Toyota a strategic competitive advantage because it has fostered an organizational capability of

capability development (Fujimoto, 2001). (Rother, 2010) describes Toyota´s capability development behavioral pattern with the concept of KATA. For Rother skill comes from repetition and although the concept of KATA is not new to the business environment (DeMente, 2003), he was the first to link it to an industrial environment. This concept is based on continuous improvement towards a “target condition”, and so the PDCA should lead from the process´s current condition to the desired target condition. Chapter 4 will deepen the discussion regarding KATA and PDCA.

Both previous approaches have an inextricable connection: problem solving is used by organizations to empower its people to achieve certain goals. However, these understandings of PDCA do not consider the fact that organizations are complex adaptive systems (Schneider and Somers, 2006), and their ever-increasing structural, functional, and organizational complexity (Salado and Nilchiani, 2014), makes any attempt to describe “future states” or “goals“ on an organizational basis futile. The reason for this is simple: actions upon processes can potentially influence all other processes simultaneously. Therefore the PDCA will serve to the empowerment when it is understood as the previous mentioned scholars. At an organizational level complexity will take over and this PDCA approach solely might not be enough to explain organizational success.

In the light of these shortcomings, we propose a novel inter-process communication holon based upon PDCA.

1.3.(CPD)nA. Standardization model

1.3.1.(CPD)nA. Standardization model

We propose following interpretation of the PDCA cycle as inter-process directed communication standard between POs that enables a process oriented integrated communication from the PO sender to the PO receiver. This communication enables feedback from the PO receiver.

(1) **Check or Commitment**. In the Check Phase there are three sub-phases. First, examine the process at Gemba (Womack and Shook, 2013). Next, set a direction for improvement by agreeing that continuous improvement is a common need and by achieving consensus how to achieve success. This is done by establishing a process KPI (Key Performance Indicator) in the HOSHIN KANRI process (Jolayemi, 2008) that the sender PO owns to measures process performance. Finally, the current state of this KPI is measured.

(2) **Plan or Process-Priority Analysis**. There are three sub-phases in the Plan Phase. First , understand the current state of the process using a process mapping tool (Wagner and Lindner, 2013). Next, prioritize the main sources of MUDA, MURA and MURI (3M) (Ohno, 2014). Finally, analyze the main source of the 3Ms within the process boundaries.

(3) **Do or Action**. In the Do Phase, we work on the process. After deciding why 3M are occurring, the PO defines an action to improve the process by sustainably reducing internal process variability. It is important here to enhance the interdependent nature of processes.

(4) Repeat numbers 1 to 3 “n” times.

(5) **Act or Anchor Learning or Standardization**. The Act Phase is where anchoring and transforming the active learning into organizational learning occurs. After reaching a plateau in the KPI, the knowledge that was developed in process management becomes a Standard (understood as the best known way to perform the process).

Hence, the method we are proposing is not PDCA but C-P-D-C-P-D-C-…-A, therefore it will be designated by (CPD)nA. This process management procedure is aligned with the Theory of Constraints (TOC) (Gupta, 2008) where the current state of processes are first understood, in order to systematically eradicate the biggest constraint that hinders the process achieve better performance.

(CPD)nA is a inter-process communication framework that is able to steer and guide the continuous improvement of the process through the communication upon process performance to the (CPD)nA receiver. This autonomous communication process owned by the (CPD)nA sender is performed in cooperation with the (CPD)nA receiver and is the nucleus of the continuous learning process. Is based upon the empowerment of each PO within each individual value creating context. As a part of the empowerment process, each (CPD)nA sender, with the support given by the (CPD)nA receiver, requests to the organization the necessary resources for the process management from the organization.

The idea of PO is central in our proposal, because it defines the role of each person in the organization as a capable individual that has the response-ability of increasing value by managing the assets that have been put by the organization to his/her disposal. The (CPD)nA sender is response-able for the process and owns the (CPD)nA. The (CPD)nA receiver is response-able for providing sufficient resources for the (CPD)nA sender to review the Plan Phase. The feedback given by (CPD)nA receiver should be taken into consideration in order to prioritise potential sources of misalignment and select those that should be acted upon in the Do Phase.

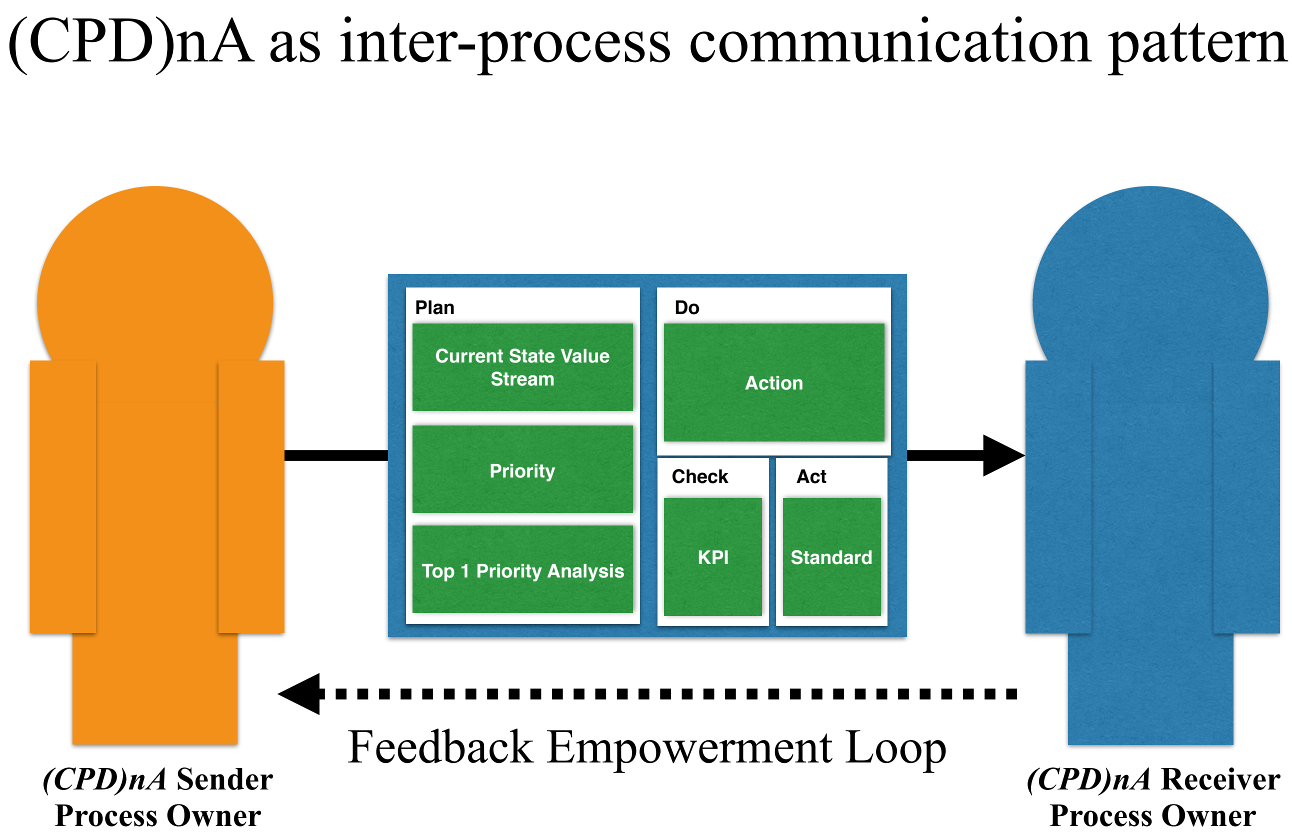

Figure 1-1. (CPD)nA as inter-process communication pattern.

The only pillars we propose within the (CPD)nA model are

(1) A common will to continually improve the process towards process variability reduction and

(2) A consensual understanding of the current state of the processes at stake.

These make this algorithm more robust and evolvable than those presented before. We will later discuss the management implications in terms of this (CPD)nA standard provides.

After describing (CPD)nA as an inter-process communication standard, we define the structural network that emerges when linking POs with (CPD)nAs.

1.3.2.Inter-process information exchange structural network

Organizations can be understood as networks under the “organizational network” paradigm (Cross et al., 2010). A network is a set of objects (called nodes or vertices) that are connected together. The connections between the nodes are called edges or links. In mathematics, networks are often referred to as graphs. One can formally define a graph as G=(N,E), consisting of the set N of nodes and edges of set E, which are ordered if the graph is directed.

We define an inter-process information exchange network as organizational structural directed graph as a set of nodes formed by the processes, represented by their related POs, of the organization and a set of edges formed by (CPD)nAs that are reported from several POs to others.

Dynamically evolving networks are the subject of intensive research (Boccaletti et al., 2006). The growth of such a network and the increasing linkage of POs with each other is expected to happen following a hierarchical or VS oriented preferential attachment rule (Barabási and Albert, 1999). This happens when the probability of (CPD)nA connection of a given PO is higher with that of other POs with whom a person exchanges vital information to support the value creation.

The (CPD)nA standard allows for inter-process connections inside or outside the organizational boundaries such as relationships with co-workers, management, suppliers, customers and practically any stakeholder. However, given that the PO as responsible for a certain process and given that this responsibility is univocal (i.e. 1 PO is responsible for one process), topologically speaking, each (CPD)nA has only one source and one sink: one sender and one receiver. This system allows for several (CPD)nA from one Sender to the same or different receivers, denoting that the performance of one PO can be measured from different KPI perspectives.

After describing the structural network we propose a mathematical model that quantifies topological properties of this network and links it to organizational operational performance.

1.3.3.Mathematical argumentation of model quantification

Complex networks and their properties are almost always quantified by the combination of two key parameters: clustering coefficient (CC) and the average path length (APL) (Strogatz, 2001). CC is a measure of the degree to which nodes in a graph tend to form clusters or cliques of "all-connected-with-all" groups. It seems self evident that in networks, people tend to exchange information with those other agents they are explicitly or implicitly connected with, therefore, given a set of nodes Ni, our aim is to increase the CC of this set to increase the information exchange in the network. APL is the average number of steps along the shortest paths for all possible pairs of network nodes. If the APL is high, then information will take many steps, and more time, to get from one node to another reducing the network´s ability to exchange knowledge. We seek then for configurations with a high network CC and a small APL. These networks are dubbed "small-world" (SW) networks (Watts and Strogatz, 1998). The diameter of a network D is defined as the average distance between any two sites on the graph. The scaling of such diameter with the network size N is highly relevant to phenomena such as diffusion, conduction, and transport, in this case of information, throughout the organizational network (Cohen and Havlin, 2003). The diameter D of a SW network scales with the network size N as $D \approx \ln(N)$ (Cohen and Havlin, 2003).

SW NETWORKs are a class of networks that are highly clustered, like regular lattices, yet have small average path lengths, like random graphs. CC and APL are combined in the novel measure of "small-worldness" w given by (Telesford et al., 2011) who propose a small-world metric, w.

$w = (APL_{rand}/APL)-(CC/CC_{latt})$ (1–1)

This metric w compares network clustering (CC) to an equivalent lattice network (CClatt) and path length (APL) to a random network (APLrand). That is why values of w close to 0 denote high "small-worldness", values of w close to 1 denote high randomness and values of w close to -1 denote high regularity. We will find this metric useful for representing the dynamic implications of inter-process communication standardization upon operational performance measured by the internationally accepted performance indicator HPV (hours per vehicle) (HARBOUR Consulting, 2007).

The proposed model advocates for a correlation between the evolution of w with changing inter-process (CPD)nA connectivity and the manufacturing operational performance of the overall facility.

When complex networks learn tasks, the learning process is mathematically modeled by a sigmoidal "S-curve" (Han and Moraga, 1995). We expect therefore a sigmoidal "S-curve" relationship between performance and network small-worldness. The generalized mathematical expression of the sigmodial curve or Richard´s curve (Richards, 1959) allows for flexible S-shaped curves as represented by equation (1-2).

$$HPV(w) = A_1 + \frac{K_1}{(1 + Q_1 \cdot e^{-B_1 \cdot (w - M_1)})^{\frac{1}{Q_1}}} \qquad (1\text{-}2)$$

The interpretation of the parameters is as follows:

- A_1: represents the lower asymptote of HPV (best performance) after optimization.
- K_1: represents the variation of w throughout the optimization.

- B_1: represents the performance optimization rate of HPV in terms of 1/w.
- Q_1: represents a coefficient that influences the gradient of the curve.
- M_1: represents the value of w of maximum HPV optimization rate.

For sigmoidal learning curves the first derivative (optimization rate) has a bell shaped form, as supported by experimental evidence (Schmidhuber, 2009). This bell-shaped form naturally explains the presence of a learning effect that can be explained in three phases: awareness, learning and maturity.

(1) In the initial Awareness stages of process management standardization, the organizational network starts exchanging information in a standardized form and although the network´s randomness decreases (w becomes smaller than 1) there is no a major impact on performance. Therefore HPV does not reduce significantly.

(2) With increasing interconnectivity Learning occurs. As clusters increase in size and path length decreases, the network´s similarity to a small-world increases, and so w comes closer to 0. We then expect a faster reduction rate of HPV in relation to w. In other words, the second derivative of HPV(w) is expected to be closest to zero for values of w close to zero as expressed in equation (1-3).

$$\left.\frac{\partial^2 HPV(w)}{\partial w^2}\right|_{w_0 \approx 0} \approx 0 \qquad (1\text{-}3)$$

(3) The Maturity phase starts when the network´s connectivity increases further. The network´s topology becomes more similar to a lattice network (values of w closer to 1) and the network performance variation is expected to become flat again: the harvest has grown to maturity and is starting to die out.

In the same line, resembling the cited learning process happening in complex networks, we expect a sigmoidal relationship between the connectedness of the network C and manufacturing performance HPV given by the mathematical equation (1-4):

$$HPV(C) = A_2 + \frac{K_2}{(1+Q_2 \cdot e^{-B_2 \cdot (w-M_2)})^{\frac{1}{Q_2}}} \qquad (1\text{-}4)$$

The interpretation of the parameters are very similar:

A_2: represents the lower asymptote of HPV (best performance) after optimization.

K_2: represents the variation of C throughout the optimization.

B_2: represents the performance optimization rate of HPV in terms of 1/C.

Q_2: represents a coefficient that influences the gradient of the curve.

M_2: represents the value of C of maximum HPV optimization rate.

Summarizing, we predict a maximum optimization rate with structures similar to SW topologies and a higher performance with more amount of explicit standardized process oriented information exchange.

1.4.Discussion and Management Implications

After having described (CPD)nA as inter-process communication holon, the resulting structural network extrapolation and proposing a mathematical quantification of its impact upon organizational operational performance, we now state the following propositions as Management Implications:

Proposition 1. (CPD)nA as an inter-process communication standard. (CPD)nA, understood as inter-process communication standard can be used to standardize all sorts of processes, avoiding the need for a process taxonomy proposed by (Lillrank, 2003). Furthermore, it fulfills all necessary conditions for knowledge sharing proposed by (Nonaka et al., 2008): firstly linking POs in a holonic network in an evolvable and robust manner; secondly combining their knowledge along the VS; and thirdly providing open boundaries for unfolding PO capabilities. Additionally it serves as an optimization pattern for solid empowerment and continuous improvement, not based upon “target states”, but upon the shared value of

KAIZEN (Ohno, 2014). Finally, it serves as an inter-process standard, reducing the variability of processes and hence establishing regularity from disorder (Ping, 2011).

Proposition 2. (CPD)nA as a holon to build structural organizational network. (CPD)nA, understood as an inter-process standard, provides the smallest unit of a network that, if extrapolated, can be used to design the structure of manufacturing organizations as holonic manufacturing systems.

Proposition 3. Structural small-worldness increases organizational learning rates. Fastest learning rates are achieved with w values close to 0 in the (CPD)nA structural network. This indicator ought to help leaders design organizations for better knowledge sharing and steer empowerment efforts towards better organizational performance.

In the next section we present a case study that will show an application of the proposed model and analyze the relationships observed.

1.5. Case Study. MotorCo.

To clarify our discussion and as a first step to evaluate the inter-process standardization and its value impact upon organizational operational performance we use a within-case study. As argued by (Byrd and Turner, 2000), a single study is only one piece of a puzzle to unlock the knowledge contained in that area. The construct proposed here can only be seen as a possible building block in the process to develop validity and reliability of the model, as well as increased generalizability.

1.5.1. Scope Establishment

We aim to study the implementation process of (CPD)nA as inter-process standard, the extrapolation to a structural network with hierarchical and value-stream oriented preferential attachment, and the implication of such a process and organizational performance measured in HPV.

The company selected for the case study is a Japan-based engine manufacturing facility that will be called MotorCo for reasons of anonymity.

1.5.2.Specification of population and sampling

The facility presented a workforce of 500 people and 34 managers distributed within three management levels E1-E2-E3 being E1 the highest in hierarchy. The inter-process standard (CPD)nA was implemented within the 34 managers and the evolving dynamics followed a hierarchical and value-stream oriented preferential attachment that ought to be described in future chapters in detail.

1.5.3.Data collection

The author was involved in MotorCo´s inter-process standardization activities which started in July 2012 and ended in June 2014. Subsequently, the case study is based on a large number of data over 24 months. On a monthly basis table 1-2 shows the KPIs measured in Gemba Walks (Womack, 2013).

KPI	Description
HPV	The overall facility HPV was measured taking into consideration all workers (blue collar and white collar).
Connectedness (***C***)	Number of ***(CPD)nA*** inter-process connections between all POs
Small Wordlness (***w***)	SWness of the ***(CPD)nA*** inter-process network

Table 1-2. KPI Description in Case Study Sampling

The actual implementation of the (CPD)nA inter-process standardization was left to the responsibility of the POs. It was observed that POs tended to (CPD)nA connect preferably other POs with whom the had either hierarchical or value-stream oriented relationships. This preferences will be discussed in the next chapters in detail.

1.5.4.Standardization procedure

In order to implement the inter-process standard (CPD)nA in all POs relationships, MotorCo conducted an ongoing empowerment effort. This empowerment process went through different phases: awareness, learning and maturity as described in the theoretical model.

- In the awareness phase all POs involved (34 managers) were made aware of the intention of senior management of standardizing inter-process management communication and were acquainted with the new (CPD)nA procedure. This was made through a series of two-day workshops. This process took about 3 months and a performance increase was still not visible.

- In the learning phase all POs were supported by experts in the implementation of (CPD)nA. The focus here was upon making sure that all POs strictly followed the procedure. Senior management needed to be explained about of the need to support the inter-process standardization with discipline and not increase the pressure for results that would hinder the learning process. This process took about 14 months and a performance increase was sustained. In the awareness and learning phases, the necessary conditions for knowledge sharing are created. In the maturity phase, these conditions are sustained.

(4) Once empowered in the usage of (CPD)nA, in the maturity phase all POs performed the inter-process standard as described. The difficulty in this phase was to maintain the homogeneity of the standard. For this reason, on quarterly basis, all POs were gathered and best practice (CPD)nA were presented for feedback-bashing purposes. This useful feedback kept the standardization process vigorous.

1.5.5.Data Analysis

The gathered data are represented in figure 1-2.

These results confirm the proposed model in this particular case.

(1) Not only have the values of HPV, C and w a remarkably high correlation as shown in the previous figure, HPV(w) and HPV(C) empirical values can also be regressed with equations (1-5) and (1-6), respectively, to Richard´s sigmoidal curve, which resemble the learning process through increased explicit connectivity. Both regression equations present a fairly high level of confidence, represented by R-squared > 0.9.

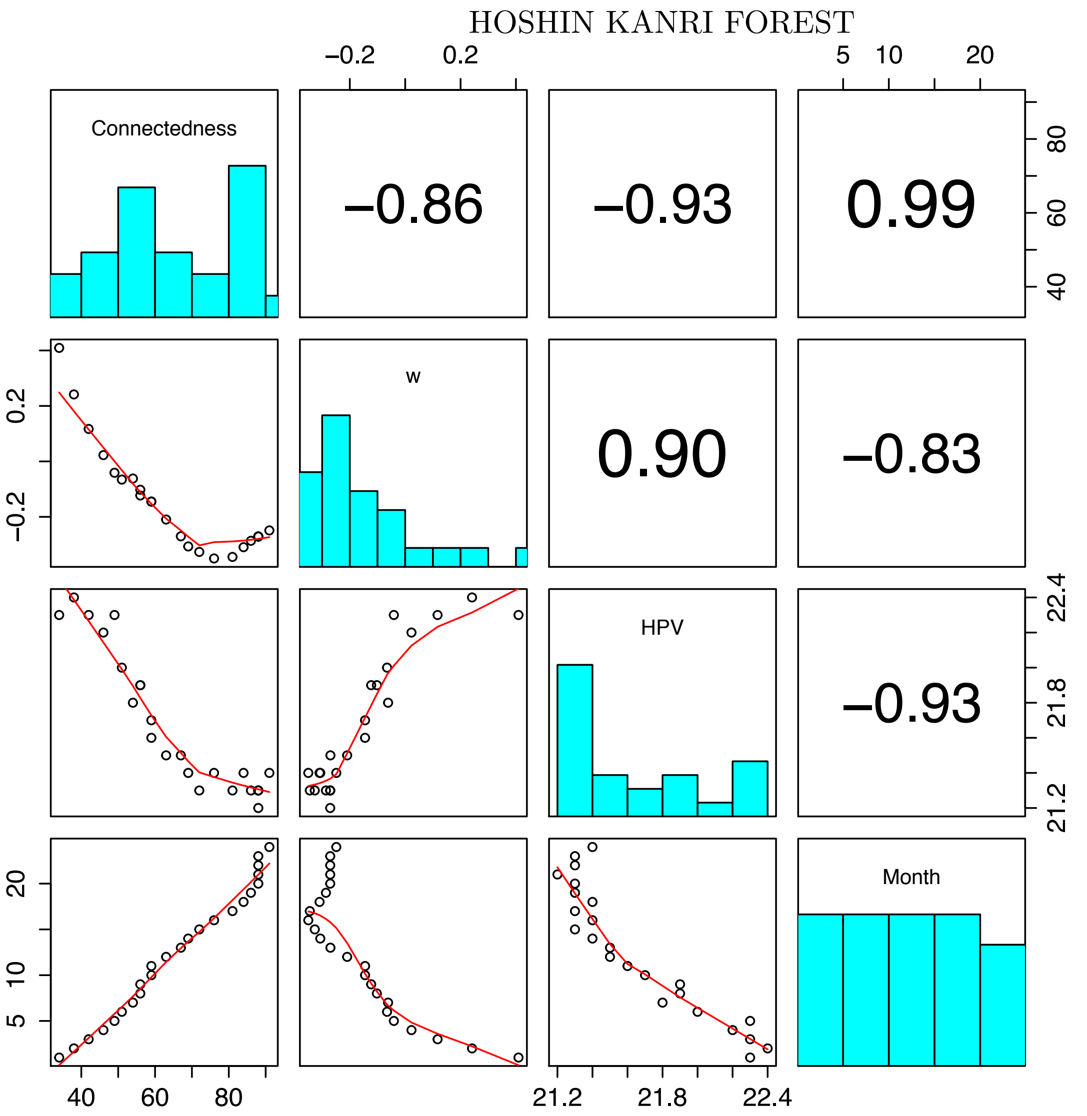

Figure 1-2. Results of Case Study

$$HPV(w) = 21.1896 + \frac{1.1104}{(1 + 239.86 \cdot e^{-1750 \cdot (w + 2.88 \cdot 10^{-2})})^{\frac{1}{239.86}}} \quad (1\text{-}5)$$

$R^2 = 0.94$

$$HPV(C) = 21.2738 + \frac{106.0477}{(1 - 0.5502 \cdot e^{1.59 \cdot 10^{-3} \cdot (C - 288.9)})^{\frac{1}{0.5502}}} \quad (1\text{-}6)$$

$R^2 = 0.92$

(2) Maximum optimization rate in HPV(w) is achieved when the structural inter-process network is very close to a SW NETWORK with w0=-0.0288 as expected and shown in equation (1-7).

$$\left.\frac{\partial^2 HPV(w)}{\partial w^2}\right|_{w_0 \approx -0.0288} \approx 0 \tag{1-7}$$

1.5.6. Case Summary and Limitations

1.5.6.1. Case Summary

MotorCo achieved two very important goals with the standardization of its inter-process communication:

- First, comparing the actual results MotorCo achieved an optimization in HPV of 4% in 24 months which is a tremendous improvement considering the high level of standards given in the facility at the beginning of the study.
- Second, and even more important than the actual degree of optimization, was the fact that the optimization was sustainable as shown intuitively in the "S-curve". Both curves HPV(w) and HPV(C) curves show that the manufacturing operational performance optimization endures and is sustainable. The model is hence robust in ensuring lasting performance benefits through the standardization of process oriented communication.

These results are in agreement with previous research performed in the manufacturing industry (Hao et al., 2012) that show that knowledge management has a positive correlation with operating performance. The results are in line with previous research that demonstrates the importance of manufacturing practices in predicting manufacturing performance (Khanchanapong et al., 2014) (Shah et al., 2008) (Sunder, 2013) (Vinodh and Joy, 2012).

These results suggest that the case covers two important inter-process standardization effects, organizational performance optimization and sustainability, and indicate that the model can indeed be sufficiently relevant to pursue further research.

1.5.6.2. Case Limitations

One single case study is not enough to claim general validity of a model. At its best, it can provide practical insights that would be otherwise difficult to present from a theoretical perspective. In particular, two limiting aspects are worth mentioning in order to temper the results.

Firstly, the time frame of 24 months used in the study was relevant in this particular case given the size of the structural (CPD)nA network created, the product complexity presented high technological challenges throughout the inter-process improvement and the Japanese culture of consensus seeking decision making. The author expects replicable dynamics but different time frames could be used in other circumstances.

Secondly, the correlations shown in the case study are robust, but correlation does not imply causation. It cannot be inferred from one single case-study that the inter-process standardization alone causes HPV optimization; the high correlation only explains a large part of the variance. Therefore, every possible causative relationship such as organizational size, product complexity, people empowerment level, or company culture should be analyzed.

1.6. Further steps

In the next chapters, the lean structural network model based on (CPD)nA will serve as a platform to define lean functional and effective organizational networks. These concepts ought to aid in the Lean Strategic Organizational Design of organizations.

Implementations of the model in other non-manufacturing environments in process intensive industries such as services and health-care will be shown in the next chapters. Because the (CPD)nA standard is an inter-process standard it can be universally implemented regardless of the business. Other applications could be in IT, finance, and many other business models.

2.LEAN STRATEGIC ORGANIZATIONAL DESIGN. ORGANIZATIONAL MOTIFS.

2.1.Chapter Introduction

Organizations face several strategic challenges in a global market arena such as demand for increasing product or service quality at lower costs with an ever increasing agility (Cegarra-Navarro et al., 2015). Under the multi-contingency theory framework (Burton et al., 2011) where organizational structure follows strategy, these challenges act as forces upon organizations that counterreact by shaping their organizational configuration through strategic organizational design.

In the spirit of proposing practice oriented Strategic Organizational Design solutions (Liedtka and Parmar, 2012), the high level goal of this chapter is to provide leaders with specific organizational structural building blocks or “motifs” (Milo et al., 2002) that allow for simultaneous achievement of these challenges. Cutting edge state-of-the art in disciplines such as neuroscience (Gollo and Breakspear, 2014) (Papo et al., 2014), biology (Kinjo and Nakamura, 2012) or industrial management (Shi and Shi, 2014) make use of motifs to explain macroscopic characteristics of complex system´s configuration.

State-of-the-art Strategic Organizational Design theory distinguish two fundamental dimensions when discussing organizational configuration (Burton et al., 2011): (1) product/service/customer oriented with a strong outward orientation and (2) functional specialization with a strong inward orientation, dividing the organization by spezialized activities. Depending on the focus, these scholars derivate qualitatively four basic organizational configuations: simple, functional, divisional, and matrix. These scholars however, do not provide quantifiable metrics to dynamically steer the Strategic Organizational Design process.

Organizational success can be made quantifiable through LM metrics (Shah and Ward, 2007). Same scholars suggest that in order to follow the Lean imperative of systematic variability reduction, organizational structure should adapt a cross-functional VS and customer oriented configuration. However, with ever-changing functional requirements, the cost of structural reconfiguration might eventually be too high, it may increase the organizational resilience to change and the acceptance to Lean might ultimately sink (Levchuk et al., 2006).

The existence of other organizational dimensions within Strategic Organizational Design is recognized (Burton et al., 2011), however the author focusses on this chapter upon the coexistence of structural and functional organizational dimensions. In order to provide a quantifiable structural and functional Strategic Organizational Design frame that allows for a less costly and risky structure-function coexistence within the Lean transformation, this chapter proposes Lean Strategic Organizational Design: an organizational structural and functional configuration strategy that allows for achievement of the Lean imperative and provides leaders with quantifiable metrics for its management.

The sequence for the chapter hereinafter continues with five phases: main contribution, management implications, case study, discussion and conclusion. The contribution follows a clear roadmap: firstly Lean Strategic Organizational Design structural and functional networks within organizations are defined. Secondly, few structural motifs that ought to provide organizational leaders with concrete Lean Strategic Organizational Design solutions for achieving organizational challenges are characterized. Thirdly, several management implications of the author´s findings are enunciated. Afterwards, the effects of the implementation of such an Lean Strategic Organizational Design approach are shown in a case-study performed within 9 US hospitals that form a health care corporation. Finally, the last section presents the conclusions from the research and its limitations and encourage further research in the field.

2.2.Lean Strategic Organizational Design.

To find a balance between local efficiency and global effectiveness is crucial for organizations (Carneiro et al., 2015). SW structural organizational configuration allows for both advatages simultaneously. SW configuration is desirable in organizational networks in terms of Strategic Organizational Design because this design characteristic allows for long range global connections between highly connected locally specialized clusters. Under the information exchange paradigm in a complex system such as the brain, the CC measures “the efficiency of the local information transmission of every node” (Di and Biswal, 2013). Similarly, in the brain a short APL “high global efficiency compared with the maximum efficiency of a random graph” (Papo et al., 2014). It is therefore extrapolated that under the information exchange organizational paradigm a high CC increases local specialization hence fostering higher quality at lower cost and a short APL counts for an increased standardization speed and best practice sharing which potentially increases speed to market. For this reason the author defines that Lean Strategic Organizational Design has been achieved when such a SW organizational structural configuration has been achieved.

In line with (Mintzberg, 1979), we emphasize the importance of patterning to produce topologies in organizations. The author intends to gain insights into Strategic Organizational Design rules by investigating the organization´s composition from smaller building blocks called “motifs” as the previously mentioned scholars have shown. The findings show that a large number of functional motifs is desirable in order to achieve organizational flexible and dynamic processing and that a small number of structural motifs ought to reduce Strategic Organizational Design cost by promoting efficient encoding and assembly. By proposing fundamental structural motifs, Lean Strategic Organizational Design approach could avoid organizational leaders enormous change management costs due to reduced reconfiguration needs (Levchuk et al., 2006). Furthermore, scholars (Sporns and Koetter, 2004) have shown that configuring networks for a small number of structural motifs and a high number of functional motifs simultaneously derives in SW structural configurations hence creating Lean Strategic Organizational Design. Therefore, the main contribution of this chapter is the characterization of these structural motifs that provide organizational leaders with clear structural building blocks so as to perform Lean Strategic Organizational Design and attain SW in the organizational configuration.

2.2.1. Lean Structural and Functional Networks

The most fundamental distinction between structural connectivity as physical "wiring diagram" and functional connectivity as web of "dynamic interactions" is borrowed from neuroscience (Sporns, 2011) and adapted to the organizational Strategic Organizational Design context. The physical information exchange wiring diagram that guides behavior is defined by how success is measured through KPIs at an organizational and individual level through VS performance indicators. The dynamic interaction between organizational agents is defined by their actions upon the VS. Therefore the two definitions depicted in figure 2-1 of structural and functional networks follow:

- We define lean structural networks (LSNs) as a set of nodes formed by POs and edges formed by the KPI in the Check phase of an inter-process communication standard (CPD)nA connecting the PO (CPD)nA Sender (Source) and the PO (CPD)nA Receiver (Sink). LSN are hence per definition directed networks. This definition contextualizes the one given in previous chapter and allows for a differentiation of LSN to its functional pair.

- We define lean functional networks (LFNs) as a set of nodes formed by POs and edges formed by the actions defined in the Do phase of the (CPD)nA that connect the PO responsible for the action (Source) and the PO (CPD)nA Sender (Sink).

These definitions have several Strategic Organizational Design implications:

- Because there is a one-on-one relationship between (CPD)nA and the structural edge (KPI), and this relationship does not exist between (CPD)nA and the functional edge (action), it implies that the LSN provides the substrate for LFN to exist. Therefore we focus on LSN when designing for SW structure.

- It implies that the organizational goal-achievement system is embedded within the LSN. The reason for this is the nature of the LSN edges (the KPIs).

- It implies that the proper dimensioning of goals and reward systems lies within a balanced and "perceived as fair" LSN configuration and that this will impact organizational "tension" or organizational climate (Burton et al., 2011).

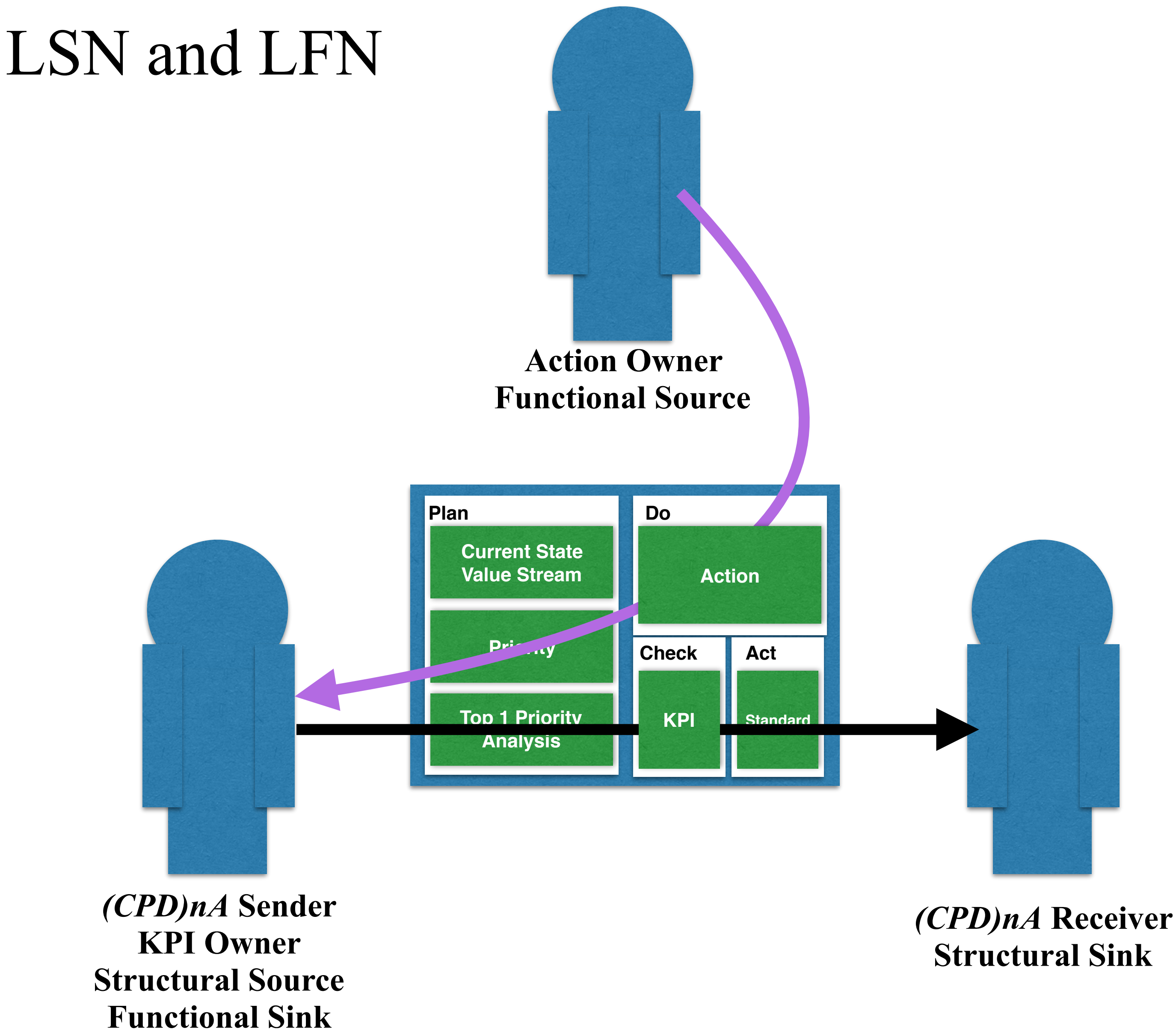

Figure 2-1. LSN and LFN.

Once LSN and LFN have been defined, we aim to characterize organizational functional and structural motifs and identify core organizational structural motifs in order to provide organizational leaders with clear building blocks so as to perform Lean Strategic Organizational Design.

2.2.2. Structural and Functional Motifs

Motifs were originally introduced to denote “patterns of interconnections occurring in complex networks at numbers that are significantly higher than those in randomized networks” (Milo et al., 2002). The size of a motif is given by the number of nodes it comprehends. Following Sporns and Koetter´s argumentation (Sporns and Koetter, 2004) our contribution will differentiate structural and functional network motifs:

- Organizational structural motifs (OSM) are the building blocks of LSNs and consist on a subgraph of LSNs of size NS.
- Organizational functional motifs (OFM) are the building blocks of LFNs and consist on a subgraph of LFNs of size NF.

2.2.3. Implementing Lean Strategic Organizational Design through OSM characterization

One of the main advantages of Lean Strategic Organizational Design is that it reduces structural reconfiguration costs towards strategic goals while keeping organizational functionality flexible. This is achieved by reducing the number of OSMs while simultaneuosly increasing the number of OFMs. Therefore we continue by characterizing Lean Strategic Organizational Design OSMs: on the one hand, one of the fundamental principles of Lean is that organizations ought to “align value creating activities along the VS” (Womack and Jones, 2003), on the other hand Lean Strategic Organizational Design seeks SW in structural configuration. Therefore, we propose certain OSMs that support VS oriented SW configuration and suggest they have certain structural characteristics:

- the nodes in the OSMs form a chain of feed-forward interconnections along the VSs where the majority of nodes are highly integrated with their neighbours forming VS oriented clusters.

- in order to achieve SW in the structural configuration some nodes must have sparse long range connectivity. Therefore, we propose that the connections linking the end of the motifs are sparse and remain hence segregated while presenting long range connections with other clusters.

The combination of these two characteristics allow for a VS oriented SW, and will derive in a Lean Strategic Organizational Design configuration.

(Davis and Leinhardt, 1972) provide a motif taxonomy for N=3 and N=4. Under this taxonomy and considering previous characteristics, the most frequent structural Lean Strategic Organizational Design motifs are represented in figure 2-2.

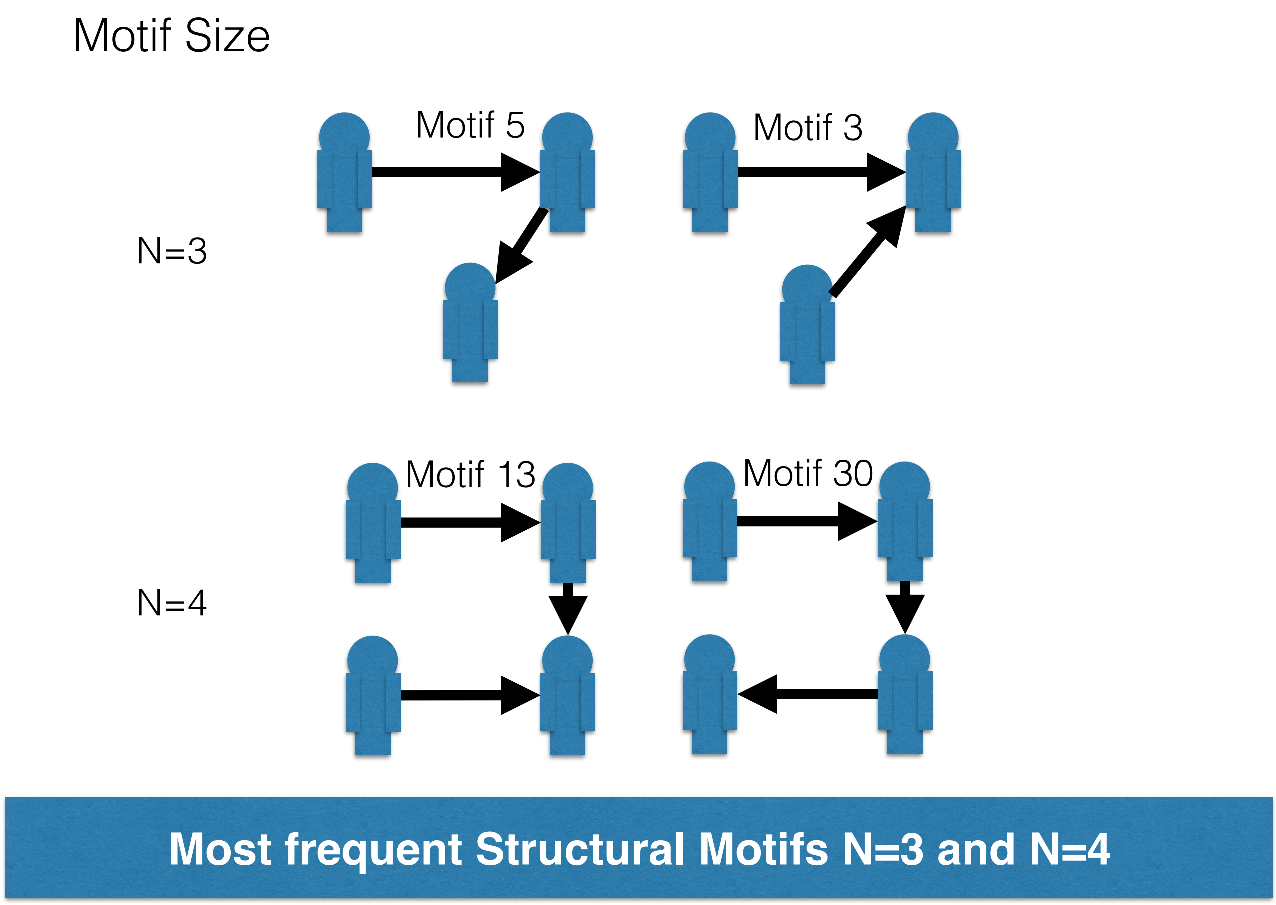

Figure 2-2. Most frequent Structural Motifs N=3 and N=4.

As a result of this argumentation we propose three Lean Strategic Organizational Design propositions and discuss its management implications.

2.3. Discussion and Management Implications.

Proposition 1. In order to reduce Lean Strategic Organizational Design reconfiguration cost, the number of structural motifs ought to remain low. Therefore, the author suggests that managers could simplify Organizational Structural connectivity by implementing the Lean Strategic Organizational Design VS oriented motifs. The reduced number of the described Lean structural motif types will allow for reduced structural reconfiguration costs as well as for a VS oriented configuration.

Proposition 2. In order to increase functional flexibility increases the number of functional motifs should be maximized. We suggest that managers could increase the complexity of the organizational functional connectivity by allowing for a cross-functional diversification of functional motifs. The increased number of functional motifs within the structural substrate will allow for an increased computational and performance agility. This is in line with Ashby´s "law of requisite variety" (Galbraith, 2012) as the variety of interactions in the stakeholder environment must increase with increasing environmental complexity.

Proposition 3. Lean Strategic Organizational Design Structural SW configuration is achieved when $DS \approx \ln(NS)$. As shown by (Sporns and Koetter, 2004), structural SW can be attained by implementing Proposition 1 and 2. Therefore, we suggest that managers steer the organizational structural configuration towards this mathematical equality by implementing propositions 1 and 2.

2.4. Case Study.

In order to illustrate a Lean Strategic Organizational Design organization, a complete LFN and LSN of 9 hospitals conforming a US health care corporation has been mapped in this case study.

2.4.1. Scope Establishment.

We aim to study topological characteristics such as number and type of OSM and OFM as well as SW networks of a US health care holding formed by 9 hospitals and one central head quarter. This study does not represent the dynamic evolution of the LSN and LFN network but intends to represent the structural and functional characteristics of a given state, and the consequences that can be derived from it.

The health care holding under study presents a management population of 171 managers distributed in 9 hospitals and one central corporate head-quarters department. These managers represent the nodes of the LSN and LFN under study.

The edges of the LSN are the KPIs that the managers report to each other and the edges of the LFN are the actions that are taken by the managers to serve certain processes. The LSN presents 346 edges and the LFN presents 975 edges at the moment of study.

2.4.2.Data Collection.

The health care holding implements (CPD)nA as described in the previous chapter for 2 years in the moment of the data collection.

Due to the ratio of edges to nodes in both LSN and LFN, following the criteria given by (Shi and Shi, 2014), it can be assured that the motif configuration of the LSN and LFN presented in this case can be considered mature for analysis. This means that the motif configuration has surpassed the initial growth evolutional phase and can be considered stable.

AS shown in figure 2-3, The LSN and LFN was mapped by analyzing an internal database where all (CPD)nA were stored. In order to avoid volatility in the data, this research only considered relevant connections that endured for more than two months in the LSN and more than two weeks in the LFN.

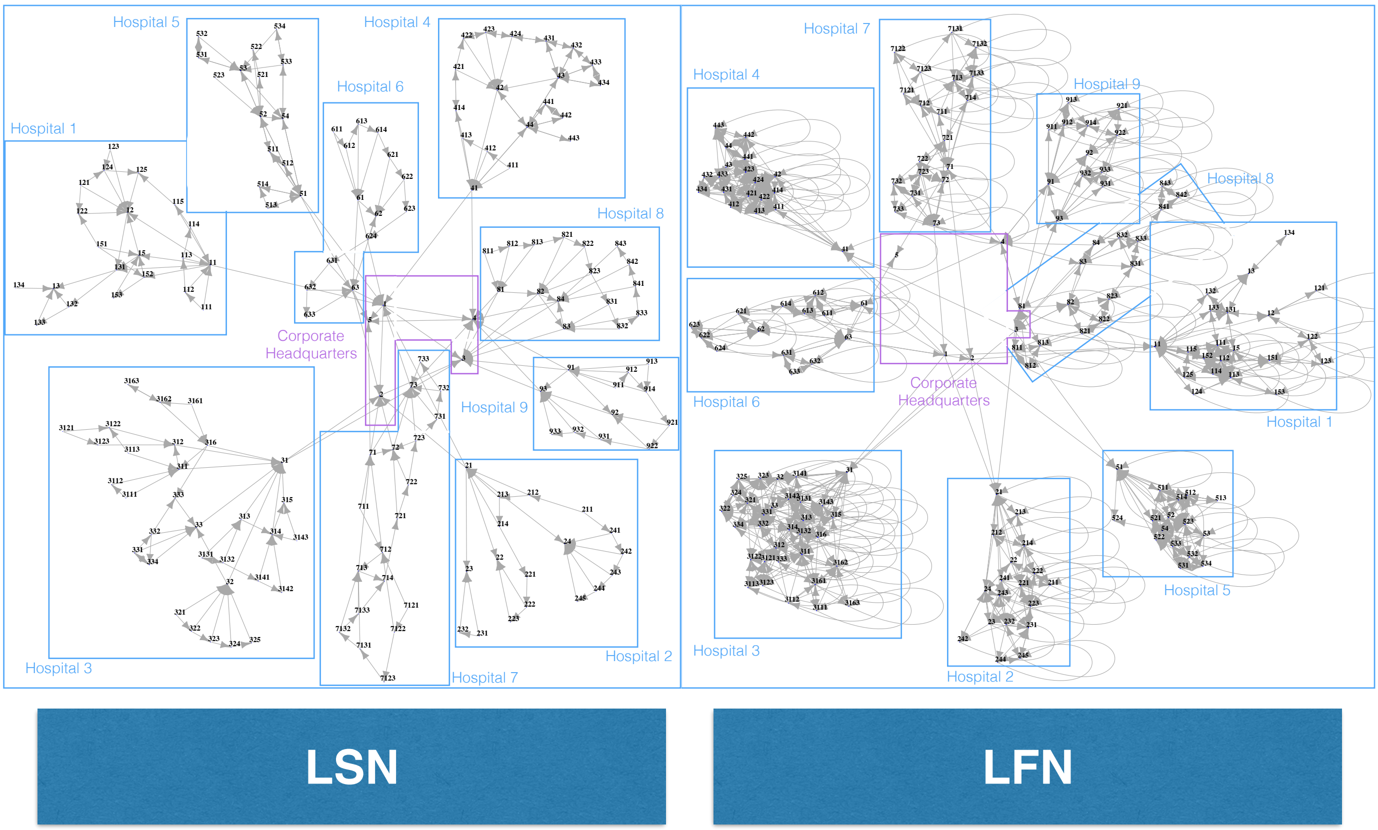

Figure 2-3. LSN and LFN. Case Study

2.4.3.Data Analysis.

As shown in figure 2-4, the most frequent motifs of M=3 in the LSN are as expected Motif 5 and Motif 3. The presence of M=3 Motif 5 in the LSN indicates a high VS oriented Lean component. The most frequent motif of M=4 in the LSN are Motif 13 and Motif 30. The presence of M=4 Motif 30 accounts for a high VS oriented Lean component. By reducing the number of structural motifs, structural reconfiguration cost remain low. Proposition 1 is therefore fulfilled.

As shown in the figure 2-5, while the diversity of OSM has remained low, as shown in figure 5 the frequency of appearance of OFM is very much distributed. By maximizing the number of functional motifs, the organization allowed for cross-functional diversification of knowledge, increasing computational performance and so following proposition 2.

Following (Sporns and Koetter, 2004) if proposition 1 and 2 are fulfilled, the author expects an organizational structural network with SW characteristics. This is confirmed by the empirical data as

D≈ln(N) with an R-squared attachement of 0.977 for the structural networks of all hospitals and for the full network as shown in figure 2-6. This confirms proposition 3.

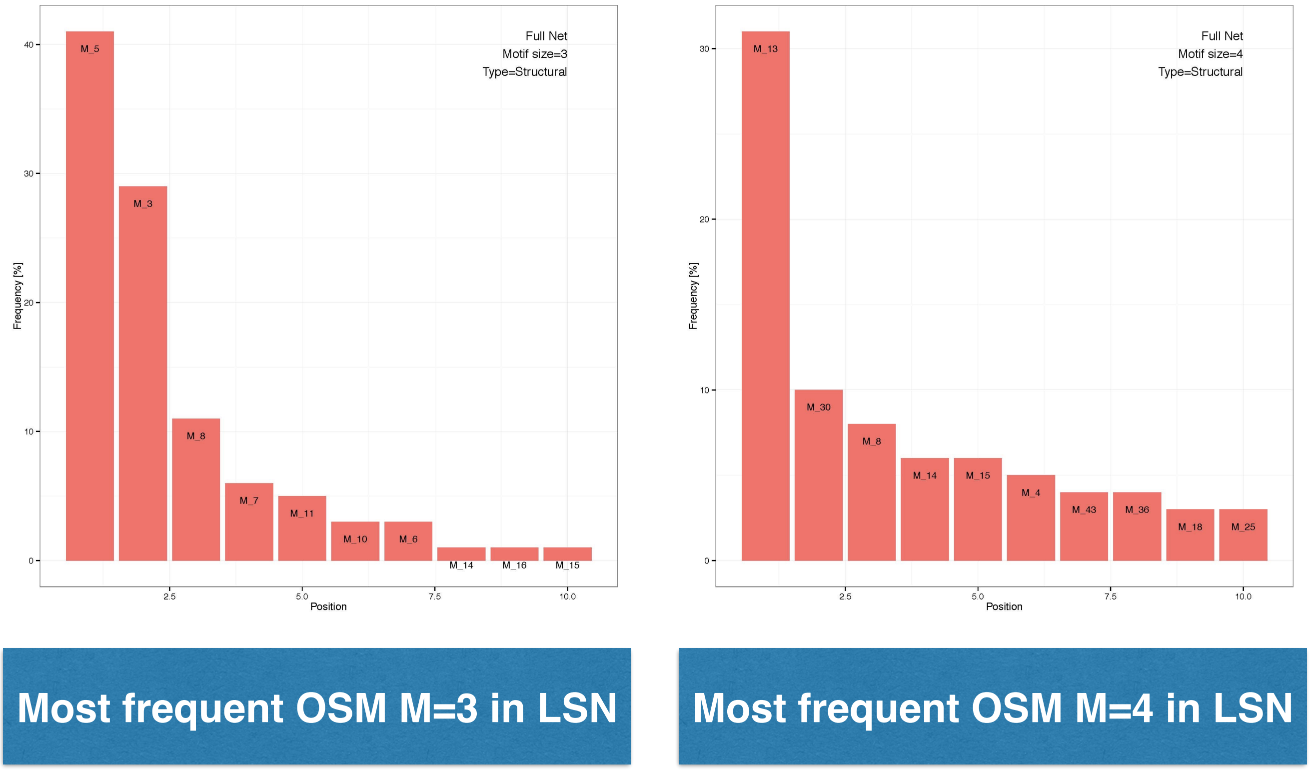

Figure 2-4. OSM Motif Distribution M=3 and M=4 in LSN

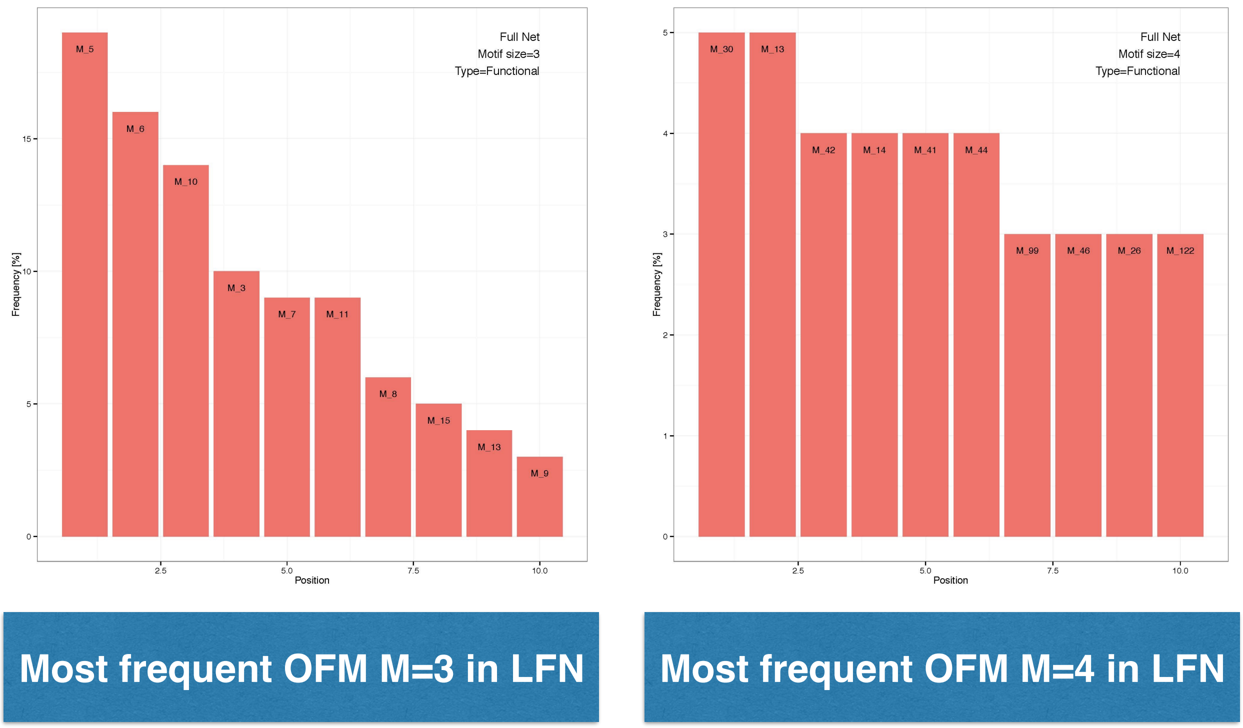

Figure 2-5. OFM Motif Distribution M=3 and M=4 in LFN

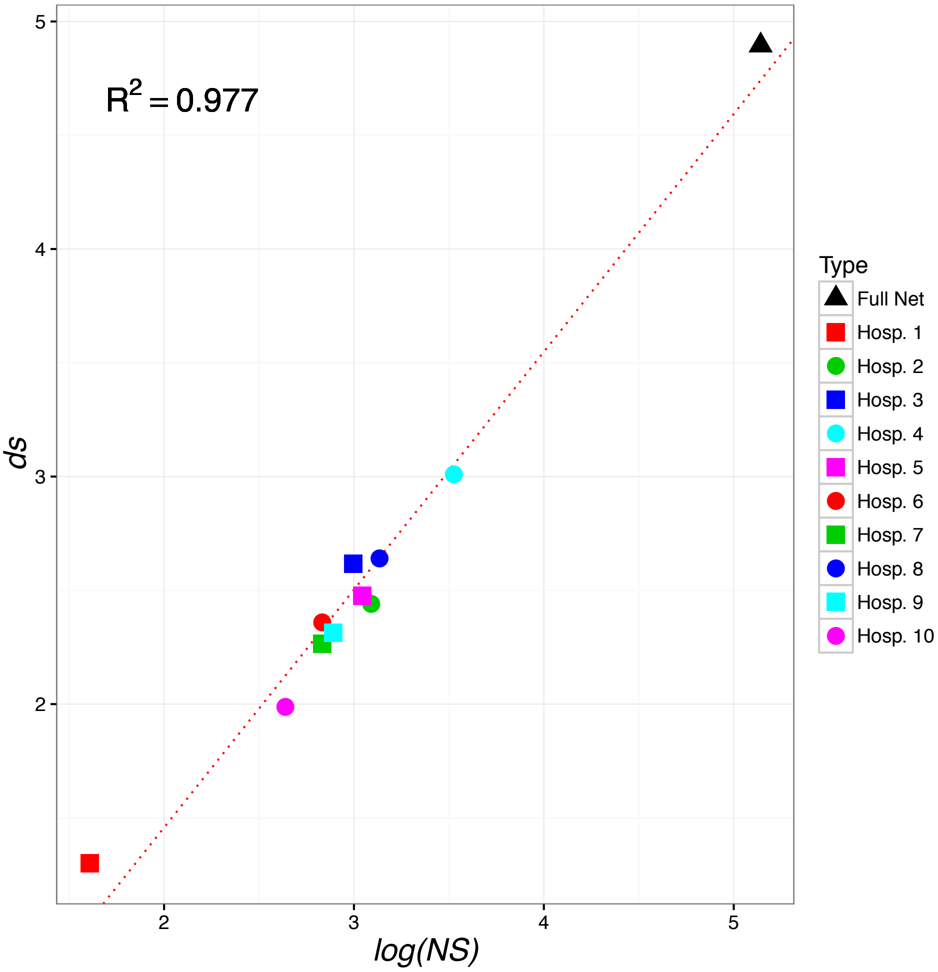

Figure 2-6. SW architechture of LSN.

2.4.4.Case Study Summary and Limitations

2.4.4.1.Case Summary

The case study has shown how by reducing frequency of OSM and simultaneously increasing frequency of OFM, the configuration of LSN presents SW characteristics. This has potentially several benefits for organizational performance.

By designing organizations with VS oriented structural motifs such as M5 and M3 (N=3) and M13 and M30 (N=4) Lean Strategic Organizational Design allows for less costly structural costs. By designing organizations with a wide range of functional motifs Lean Strategic Organizational Design allows for high computational agility.

2.4.4.2.Case Limitations

The single case study of a single company presented is not enough to derive general conclusions that can be universally extrapolated. On the other hand, the sample size is big enough to enhance the statistical relevance of the case study presented. It could be argued that these results are related to the health care industry, however the inter-process universal nature of the structural (CPD)nA network suggests this might be unlikely. The implementation time frame could be considered a constraint for achievement of certain LSN and LFN characteristics such as SW. Within other organizational settings the author expects similar results with different time frames.

2.5.Further steps

In this chapter we have shown that motifs can provide a theoretical framework to bridge the communication gap between elementary components and macro properties of networks. Through the formulation of three management propositions, a novel way to link structural and functional motif configuration with potentially benefitial macro network properties such as SWness has been proposed.

Organizational motifs and its presented properties represent a configuration set that ought to provide organizational leaders with useful structural and functional Lean SOD characteristics that are expected to reduce organizational design related costs while increasing organizational performance.

Further research ought to expand this view by proposing Lean SOD that integrate such motifs in effective dynamic ways that support organizational alignment of all organizational constituents.

3.EFFECTIVE NETWORK DYNAMICS. NEMAWASHI 根回し.

CONSENSUS MANAGEMENT

3.1.Chapter Introduction

The most important aspect of strategic planning is, according to (Grant, 2010), the strategy process: "a dialog through which knowledge is shared and consensus is achieved and commitment towards action and results is built". As shown in (Cattani et al., 2008), consensus in organizations as legitimation of action towards certain strategic goals have attracted increasing levels of attention for legitimation facilitates the access to necessary resources to achieve such goals. These consensus can and should occur in different organizational settings, although in this chapter the author focusses on those consensus related to the management of VS.

As shown in previous chapters, organizations are complex systems that, from an information exchange perspective, can be considered as networks under the "organizational network" paradigm. Typically the proper VS management comprehends the coordination of organizational clusters within such networks: different departments such as sales, engineering, production or logistics can be considered such clusters of highly interconnected hubs that are compelled to deliver coordinated solutions to ensure maximum VS performance. In this dynamics either they are all successful together or they will be unsuccessful individually.

The process of consensus building or NEMAWASHI can be described therefore as one in which all agents acting, at different levels; upon VS will reach a desired state after a finite time throughout a WLP where no agent wins in the sense described in (González-Díaz et al., 2013). We hypothesize that the achievement of VS consensus depends dynamically on the performance of all related PO and, without loss of generality, that these interaction are linear within a discrete period of time.

The effective VS goal achievement sought by different organizational clusters may be however many times conflicting thus increasing the uncertainty of the task. (Galbraith, 1974) assertively conjectured that the principal managerial task is to reduce uncertainty by processing information: "A basic proposition is that the greater the uncertainty of the task, the greater the amount of information that has to be processed between decision makers during the execution of the task”. Individual behavior of rational people trying to achieve a local optimum may lead to organizational disasters as shown in (Schuster and Kesler, 2011) referencing to (Kates and Galbraith, 2007). From an organizational network´s perspective, it is therefore crucial to understand the organizational dynamics towards a consensus on the quest towards VS goals.

In order to achieve this, the chapter is structured in five phases: Firstly, a background on complex organizational networks. Secondly, a model that describes the NEMAWASHI process and conditions for VS alignment is provided. Thridly, a NEMAWASHI management roadmap for implementation as well as several management implications are presented. Fourthly, one case study is presented so as to show the application of the model and make it replicable. Finally, we discuss the conclusions and limitations of the model and present possible further research.

3.2. Chapter Literature Review

Organizational complexity measures the level of interdependence between organizational units as shown in (Salado and Nilchiani, 2014). Neuroscientists as Friston introduces the concept of effective connectivity as the influence one neural system exerts over another (Friston, 1994).

In previous chapters the concepts of organizational structural and functional connectivity were introduced. The concept of Lean Effective Network (LEN) is now presented as a way to understand organizational networks in which

- nodes are structural network clusters around hubs of high cluster coefficient,

- edges dynamically describe the underlying causal influences between them measured through certain VS related time-dependent KPIs.

Following the hypothesis formulated in the introduction, VS can be described by n KPIs x_i i=1…n that represent the VS performance. For obvious computation reasons, in order make the KPIs comparable, these x_i need to be normalized and bounded.

Normalization occurs when

$x_i^*=(x_i-x_{imin})/(x_{imax}-x_{imin})$ (3-1)

being $x_{imax}-x_{imin}$ the maximum and minimum value of $x_i(t)$ and therefore $0\leqq x_i^*\leqq 1$.

Boundaries are set if $x_i^{**}=x_i^*\cdot(100/\sum_i x_i^*)$ (3-2)

The dynamic variation of this normalized performance x_i^{**} owned by one of these clusters can be described by the differential equation system described in (3-3)

$dx_i^{**}/dt=fi(x_1^{**},x_2^{**},\ldots,x_n^{**},t)$; i=1,…,n (3-3)

This set of equations describes a trajectory, the NEMAWASHI consensus curve, in an euclidean n-dimensional space given. The author considers VS alignment is attained if in this n-dimensional state euclidean space the trajectory described by the NEMAWASHI curve presents asymptotic stability as shown in (Linnea, 2009).

As indicated by (Freedman, 1980), this set of differential equations can describe several types of interactions that can be modelled by deterministic mathematical models in population ecology such as the Kolmogorov model. The NEMAWASHI WLP is a consensus seeking process with linear interactions between the POs. Therefore it can be potentially modelled by the particular Kolmogorov case formulated by the generalized Lotka-Volterra equations shown in (Hofbauer and Sigmund, 1988).

This chapter presents three main contributions:

(1) A system of differential equations to describe the NEMAWASHI process is proposed

(2) The necessary conditions for VS asymptotic stability are described.

(3) A NEMAWASHI management roadmap for implementation as well as several management implications are presented.

3.3.NEMAWASHI process and Conditions for VS alignment

In the process of value creation, organizational clusters consume resources that are limited and ought to be distributed among all. All structural clusters seek to maximize the value they generate out of the consumed resources. Simultaneously, poled by the aligning force of the strategy, all VS agents are compelled to strive for solutions that best serve whole system´s performance. Both centrifugal, cluster interest, and centripetal forces, strategic interest, are brought in equilibrium by the incentive structure given in the organization. This incentive structure is operationalized by the KPI.

A model that describes the consensus problem within this KPI structure consists on n structural clusters, whose performance can be measured through certain KPIs.

As shown by (Page and Nowak, 2002), different descriptions of evolutionary dynamics such as replicator-mutator equation, price equation or generalized lotka-volterra equation can be transformed into each other. Understanding these relationships is important because different problems can be expressed in one framework than another. The present work considers a generalized Lotka-Volterra set of differential equations to describe the WLP model given by (3-4):

$$dx_i^{**}/dt=x_i^{**}\cdot(r_i-\sum_j a_{ij}\cdot x_j^{**}) \; ; \; i,j=1,\ldots,n \qquad (3\text{-}4)$$

- where $r_i \geq 0$ represent the growth rate of the i^{th} VS related KPI,

- and a_{ij} represent a constant interaction between the i^{th} and j^{th} KPI. The matrix $A=(a_{ij})$ is called the interaction matrix.

Therefore the conditions of WLP are described by (3-5)

$0<x_i^{**}<1 \ \forall t$ for $i=1,\ldots,n$ (3-5)

The state euclidean space is the nonnegative orthant

$\Omega^n_+=\{x^{**}=(x_1^{**},\ldots,x_n^{**}),\ 0<x_i^{**}<1 \text{ for } i=1,\ldots,n\}$

As this set KPI_j will be reported per period of time, according to its agreed frequency, it will be possible to produce a linear projection into a smaller space and it will be possible to identify main directions explaining highest part of the variations. This can be carried out by using the PCA technique (Niyogi, 2004). As the involved KPI for the PCA can belong to different layer of processes and sub-processes, the sampling frequency can be different. Therefore, the used approach adjusts the potentially variable sampling rate to the current time.

Because of the properties of the PCA projection the eigenvalues can be understood as relevance in terms of variance for each of the eigenvectors $\{v_k\}$. Transformation between old coordinates and new ones based on those new and special axes are possible because of the rotation matrix provided by the method. Based on this property, it will be possible to consider not only the existing connection but those considered as potentially relevant for the current process and, throughout the PCA analysis, the relevance for all of them can be derived.

After performing the PCA analysis, the three most relevant projections will configure a space in which most of the VS´s variation is explained. These three KPI groups x_i^{***} i+1,…,3 help us describe the system as described in (3-6):

$dx_i^{***}/dt=x_i^{***}\cdot(r_i-\sum_j a_{ij}\cdot x_j^{***})$; i,j=1,2,3 (3-6)

The conditions for asymptotic stability of every possible equilibrium are given if (3-7), (3-8) and (3-9) are true (Linnea, 2009):

$$\left.\begin{aligned} m_{11} &= a_{22}\bullet a_{33} - a_{23}\bullet a_{32} > 0 \\ m_{22} &= a_{11}\bullet a_{33} - a_{13}\bullet a_{31} > 0 \\ m_{33} &= a_{11}\bullet a_{22} - a_{12}\bullet a_{21} > 0 \end{aligned}\right\} \qquad (3\text{-}7)$$

$$\det[A]>0 \qquad (3\text{-}8)$$

$$\begin{aligned} &a_{13}\bullet a_{21}\bullet a_{32} + a_{12}\bullet a_{23}\bullet a_{31} - 2\bullet\left(a_{11}\bullet a_{22}\bullet a_{33}\right) < \qquad (3-9) \\ &2\left[\sqrt{a_{11}\bullet a_{22}\bullet m_{11}\bullet m_{22}} + \sqrt{a_{22}\bullet a_{33}\bullet m_{22}\bullet m_{33}} + \sqrt{a_{11}\bullet a_{33}\bullet m_{11}\bullet m_{33}}\right] \end{aligned}$$

In other words, (3-4) and (3-5) describe the NEMAWASHI consensus process and the inequalities (3-7), (3-8) and (3-9) describe the conditions for VS alignment.

The inequality (3-7) has a VS related interpretation. In the first inequality describing m_{11}, the term $a_{22}\cdot a_{33}$ is a measure of competition and represent the competing effect on the growth of KPI x_2^{***} due to KPI x_3^{***}. The term $a_{23}\cdot a_{32}$ is a measure of inhibition and represent the damping effect between KPI x_2^{***} over KPI x_3^{***}. If the measure of competition, $a_{22}\cdot a_{33}$, is less than the measure of inhibition, $a_{23}\cdot a_{32}$, then an asymptotically stable coexistence may exist. The other inequalities in (3-7) have a similar VS related interpretation.

Inequalities (3-8) and (3-9) determine a lower and upper bound respectively for the difference between the measure of competition and the measure of inhibition for all three KPIs simultaneously.

3.4. NEMAWASHI Management Roadmap to VS alignment

The NEMAWASHI management roadmap proposes a five step computational process, based on genetic optimization algorithm.

- First, a VS where VS alignment is strategically needed is mapped following any process mapping method. The author recommends cross-functional process map or swim lane method proposed in (Damelio, 2011).
- Second, dimensional reduction of KPI through PCA technique. The variability of the VS remains mostly explained through the new KPI system while computation´s complexity is reduced.
- Third, three relevant KPI combinations are measured throughout a period of time, to be then normalized and bounded following expressions (3-1) and (3-2).
- Fourth, the coefficients $A=(a_{ij})$ of the interaction matrix and r_i are inferred. As there are 8 parameters for each tern of KPIs there is a cost function defined $J(p_1,..,p_8,T)$ as the euclidean distance between the real position and the iterated solution for intervals i=1,…,T. A genetic optimization algorithm is applied to this cost function J in order to infer the optimal $A^*=(a_{ij}^*)$ and r_i^* as described in (Henry and Stevens, 2009).
- Fifth, through (3-5) the WLP nature of the dynamical system is tested. If the parameters allow for a WLP dynamics, then a NEMAWASHI process can be found.
- Finally, in the case that NEMAWASHI process can be found with this set of KPIs, the necessary conditions for VS alignment (3-7), (3-8) and (3-9) are tested with these inferred $A^*=(a_{ij}*)$ parameters. The asymptotic point of VS alignment is represented in a ternary diagram.

At this point several management implications can be presented.

3.5. NEMAWASHI Management Implications

There are several managerial implications that can be derived from the implementation of this NEMAWASHI Managerial Roadmap.

- First, this method is able to provide managers with insights regarding the VS alignment potential of any number of KPIs related to VS. With a relatively limited amount of data, managers are able to discern if the coefficients describing (3-6) allow for VS alignment. This allows for a strategic re-adjustment of KPIs. How this can be performed will be explained in the next chapters.
- Second, once the coefficients of the interaction matrix are iterated, this method allows for discovering attractors within the VS. These attractors would be represented by KPI POs that have a higher specific weight and play a more important role in the NEMAWASHI process than others.
- Third, this method allows for a dynamic description of the NEMAWASHI process. Being the coefficients of the VS r_i and a_{ij} known, equation (3-6) is fully described. As a result, managers are able to foresee the dynamic properties and of the KPI system.

3.6. Case Study SpiralCo

In this chapter we present a case study from the author's professional activities that aim to illustrate the implementation of the proposed NEMAWASHI Roadmap to VS alignment in the case of a german manufacturer named SpiralCo for confidentiality reasons.

3.6.1. Research Setting

In the Spiral Manufacturing VS (figure 3-1) under consideration there are 35 team production members involved. The Spiral Manufacturing is a part of a more extensive two-geared electrical steering manufacturing in the Schwäbisch-Gmünd factory in which it is assembled. The first management level is responsible for several KPIs, shown by Table 3-1, that describe this VS. Data were gathered over a period of 49 weeks.

KPI	Metric
Average Change Over Time	hours
Overall Equipment Efficiency (OEE)	%
Throughput	parts/week
Least Time	days
Delivery Rate	%

Table 3-1. Relevant KPIs Case Study SpiralCo

3.6.2.NEMAWASHI Roadmap

- First, the VS was mapped. As proposed by (Womack, 2013), this was performed with all relevant POs following a standard Gemba Walk. Figure 3-1 qualitatively displays the result of such mapping. For confidentiality reasons such VS cannot be shown in more detail.

- Second, the PCA technique was applied and the main three principal components represent most of the variability of the VS through three KPIs: KPI1, KPI2 and KPI3.

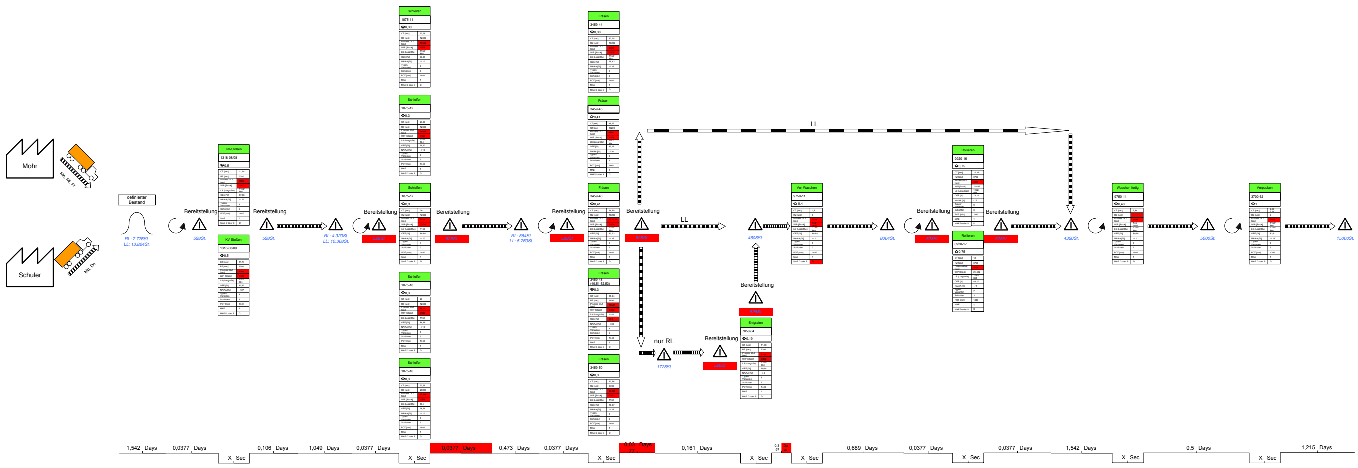

Figure 3-1. SpiralCo VS.

- Third, the three mentioned relevant VS KPIs were measured on a weekly basis. The study intends to show if this given set of KPIs is suitable for a NEMAWASHI WLP given the gathered data. These KPIs are to be normalized and bounded following expressions (3-1) and (3-2) to the KPIs as shown in figure 3-2.

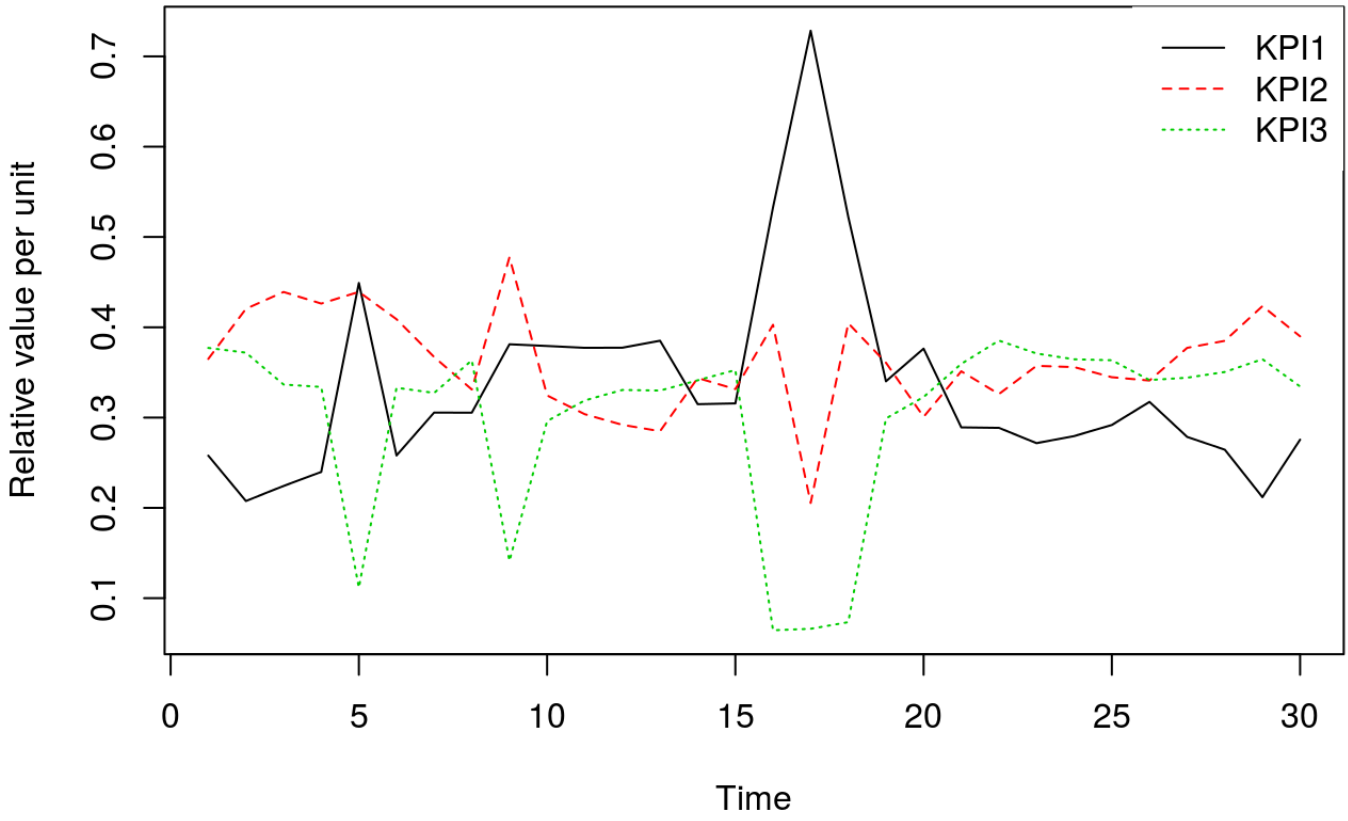

Figure 3-2. Normalized and Bounded KPIs. Spiral Manufacturing VS.

- Fourth, a genetic algorithm was implemented to infer the coefficients of the WLP differential equation system introduced in (3-4). In our particular case the selected chromosome has 12 real numbers between 0 and 1 (3 r_i and 9 a_{ij}), and we have used real value crossover and mutation with probabilities of 60% and 7% respectively. The population was built over 8000 individuals and it ran over 1000 generations. After that, the best configuration found propose the following coefficients: $A = \begin{bmatrix} 0.97 & 0.28 & 0.32 \\ 0.48 & 0.54 & 0.46 \\ 0.46 & 0.54 & 0.80 \end{bmatrix}$. As a result, conditions (3-7), (3-8) and (3-9) are fulfilled.

- Fifth, through (3-5) the WLP nature of the dynamical system is tested. We conclude that the parameters allow for a WLP dynamics and a NEMAWASHI process can be found.

- Finally, because the conditions for NEMAWASHI are given and the process presents WLP dynamics, we are able to represent the expected asymptotic point of VS alignment in a ternary diagram as shown in figure 3-3.

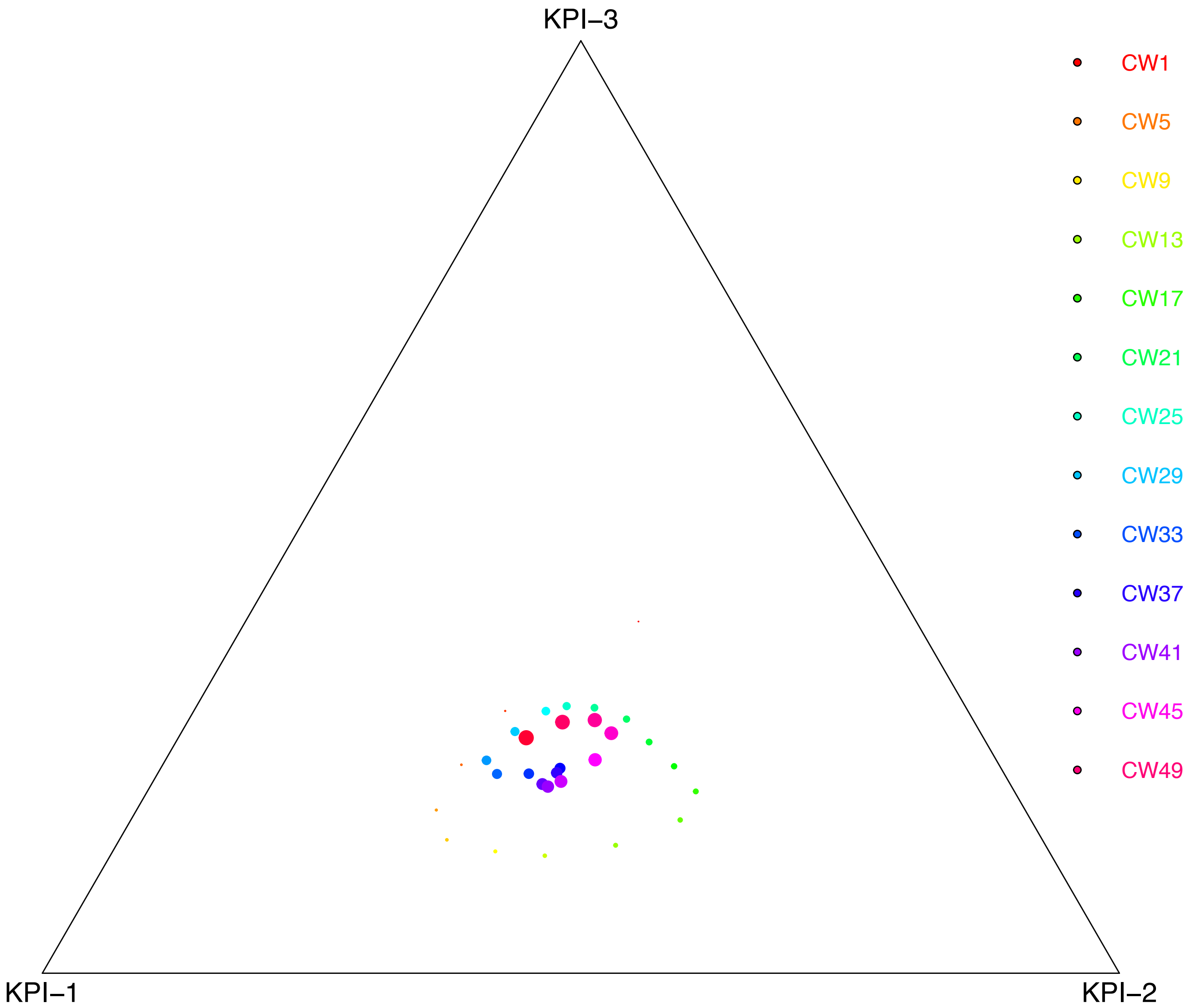

Figure 3-3. Normalized and Bounded KPIs. Spiral Manufacturing VS.

3.6.3.Interpretation and Case Study Closure

We can conclude that given this VS, the set of KPIs provided can attain a state of WLP. Therefore the NEMAWASHI Process is possible.

The dynamics show that, under these VS conditions, the system can attain asymptotic stability through a NEMAWASHI process and therefore alignment is possible. The point of equilibrium is given in the ternary diagram when the KPIs have a relation shown by Table 3-2.

When this point of equilibrium has ben reached, the VS agents have achieved alignment. This state of alignment provides a quantifiable direction worth guiding the continuous improvement.

KPI	Relative KPI Relationship
KPI1	28 %
KPI2	29 %
KPI3	33 %

Table 3-2. Asymptotic Equilibrium Point of NEMAWASHI KPIs Case Study SpiralCo.

3.7.Management Implications and Limitations

In this chapter, the author has proposed a plausible mathematical population dynamics WLP model to explain consensus seeking dynamics towards organizational alignment.

The author enunciates several conclusions through following propositions as well as its related benefits which may help VS managers better manage the process:

- **Proposition 1**. Not all KPIs help attain alignment. The model shows if the KPIs chosen are eligible for alignment. If with a certain set of KPIs chosen VS managers cannot attain alignment, the author recommends rethinking the choice.
- **Proposition 2**. The time spent in attaining alignment can be quantified. The model can help VS managers quantify how much time - and resources - will it take to attain alignment. Because alignment is a desired organizational state to be at when dealing with complex VS, it is worth working strategically towards it. This model can help better design strategic alignment seeking policies.
- **Proposition 3**. VS effective goal achievement is a complex task and absolute goals might not be strategically advisable. VS effective goal achievement might be more complex than a formulation of

absolute corporate goals such as “Zero defects”, “Unit cost reduction” or “Market share growth”. The model makes implicit dynamic KPI relationships explicit. By quantifying the dynamic relationships between KPIs, this model helps VS managers better align their strategic efforts towards realistic equilibrium points, rather than trying to achieve unrealistic goals that might bring the overall system out of control.

The limitations of this model and related further steps for future research are mainly three:

- **Limitation 1**. Restriction of NEMAWASHI to WLP. The WLP model is a co-existence model without a winner. In fact there are many other types of interaction models such as exclusion in which some PO excludes others or mutual extinction in which all POs lose. However, exclusion and mutual extinction are not a proper VS management because they might less likely lead to win-win situations and therefore this chapter considers solely the WLP model.

- **Limitation 2**. Only three PCA are analytically considered. These PCAs describe most but not all the VS variabiliry. The model only shows the interaction of three PCAs and is therefore incomplete when attaining to describe whole KPI ecological dynamics. Theoretically, the model does not establish any limitation to the number of VS related KPI under consideration. The reason why the PO try to identify and prioritize the most relevant PCAis that it still seems reasonable that the significant number of relevant KPIs are bounded as it happens with the 80/20 Pareto rule. Anyhow, there are two different aspects under consideration when dealing with scalability due to VS complexity increase:

  - The first one is the necessary conditions for asymptotic stability. These require specific conditions as shown in (3-7), (3-8) and (3-9). These conditions can be analytically hard to define as the number of KPIs increases and it is easier to compute with only three PCAs.

  - The second aspect is related to the computational capability for adjusting the A coefficients so that the trajectories become closer to the ones identified during the initial steps. The decision will be based on minimizing a function cost defined as the additive squared of absolute differences between each trajectory based on solving the Ordinary Differential Equation (ODE) and the one estimated from the empirical observation period. The number of parameters to be determined is n^2+n, where n is the number of involved KPIs. The computational complexity is expected therefore to remain manageable, being the suggested number of individuals in the population (500log (n^2)) with 35-45% of crossover, 1-3% of mutation and 10-15% of elitism. The expected computation time scales as logarithmic rule. It is necessary to accentuate however that the genetic algorithm is a heuristic technique. This means that there is no guarantee about the exact solution found. Because of this some strategies repeat the evolution by starting randomly in order to increase solution´s resilience.

- **Limitation 3**. The model describes how the NEMAWASHI process works towards alignment, but does not describe why are NEMAWASHI and alignment desirable and what happens when the VS is optimized. In this ongoing research, the author has purposely not deepen the analysis on why VS ought to be managed with a NEMAWASHI process and what happens when the continuous improvement process algorithm changes the process variables. The importance of these dynamic properties of the NEMAWASHI process shall be discussed by the author in the next chapter.

4.LEAN LEARNING PATTERNS

4.1.Chapter Introduction

Organizations have no means other than individual PO to interact with the environment and process information. When "learning," the one, who seeks to acquire knowledge, interacts with the environment to gather data that is used, together with any prior experience to form an internal representation or model of the environment for various purposes (Kulkarni et al., 1998). Therefore, organizations can be considered to be interpretation systems (Daft and Weick, 1984) in which a categorization is proposed. The latter depends on the leader's beliefs about the environment (analyzable -or unanalyzable) and the organization's degree of intrusiveness (high or low) into it. Lean Manufacturing System are characterized by a high intrusiveness into the environment. Therefore, this chapter focuses on categorization, which depends on management's view of the environment. Individual learning in an organization will be determined by the predominant leader´s belief about the environment. In a "discovering organization," leaders assume that the environment can be predicted and analyzed. As a result, leaders attempt to adapt and learn by actively setting predictable performance goals for continuous improvement efforts. Conversely, leaders in an "enacting organization" assume that the environment is unpredictable and malleable. Therefore, they innovate and learn by trial and error experimentation (Daft and Weick, 1984).

Reputed lean scholar Fujimoto (Fujimoto, 1999) coined the concept of organizational evolutionary learning capabilities by which he meant "an organization's overall ability to evolve competitive routines" when analyzing the emergence of a highly complex and competitive Lean Manufacturing System by creating certain Lean Learning Patterns: lean oriented learning routines for systematic variability reduction at an individual level.

Organizational learning might be just a myth: those that learn in organizations are people (Friedman et al., 2005). However, it continues to be a powerful metaphor. Peter Senge defines organizational learning as a process in which people are “continually learning how to learn together” (Senge, 2006). What characterizes an organization is the ability of its members to reach convergence (Weick, 1979) in order to achieve organizational goals together. This process of achieving consensus can only be realized if the organization as a whole interprets its environment coherently.

The complexity of such an environment is increasing exponentially and organizations in the 21st century should respond to this challenge with increasing organizational complexity (Salado and Nilchiani, 2014). In an environment of increasing complexity, Lean Manufacturing System should support the most important aspect of strategic planning, namely “a dialog through which knowledge is shared and consensus is achieved and commitment towards action and results is built” (Grant, 2010) to achieve fulfillment of the Lean Manufacturing System paradigm of continuous process variability reduction. Such an organizational strategic consensus-seeking NEMAWASHI process and the conditions for it have been defined and quantified in the previous chapter. This means that the prerequisite for an individual Lean Learning Pattern that seeks to successfully evolve organizational learning capability and, thus, to enable complex and competitive Lean Manufacturing System to emerge is to fulfill the NEMAWASHI conditions.

Therefore, two of the main challenges when designing such an Lean Manufacturing System are to design and implement properly an Lean Learning Pattern that enable individual learning and to ensure that this Lean Learning Pattern supports organizational alignment.

In order to illustrate this, we have chosen two main exponents of Lean Learning Patterns that depend on the leader´s view of the environment:

- KATA (Rother, 2010) as an example of a Lean Learning Pattern applied within a discovering management view of the environment.
- (CPD)nA as an example of an enacting management view of the environment.

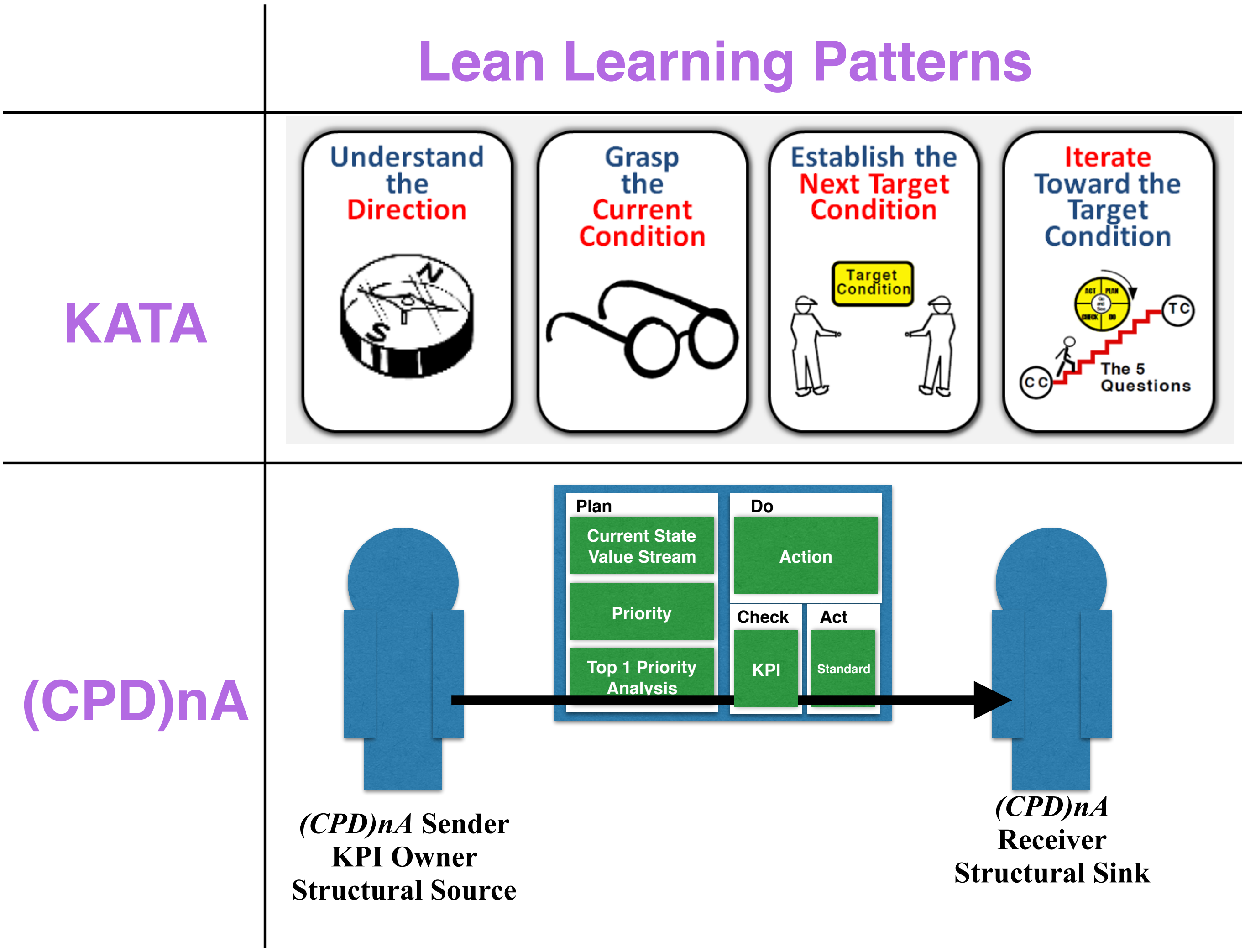

Figure 4-1. KATA and (CPD)nA

The structure of this research chapter now focuses on its contribution. First, by comparing two Lean Learning Patterns that are currently used widely in the industry, KATA and (CPD)nA, the chapter shows why and how KATA is intrinsically unable to fulfill NEMAWASHI and, therefore, to operate on an organizational complex level, as well as why and how (CPD)nA can. Finally, the chapter offers several propositions that have management implications for lean leaders who seek to develop organizational learning capabilities towards organizational alignment. The chapter ends by showing avenues for further research and related limitations.

4.2.(CPD)nA vs. KATA

Our review of Lean Learning Pattern begins by showing in Table 4-1 what Lean Learning Pattern, (CPD)nA and KATA, have in common and how they differ from a psychological and a managerial perspective. Figure 1 illustrate both Lean Learning Patterns graphically.

	Lean Learning Pattern (See Figure 1)	What (CPD)nA and KATA have in common	Differences from a psychological perspective	Differences from a managerial perspective
KATA (Rother, 2010)	1. Set direction for Challenge 2. Understand the current condition. Typically, one does so by going to Gemba (Womack and Shook, 2013). 3. Establish the next target condition. This "typically represents a step closer to the vision and a challenge that goes somewhat beyond current capability." 4. Conduct Experiments to get there through PDCA. Here, PDCA is perceived as a problem solving process.	Both (CPD)nA and KATA begin by setting a direction or challenge: * KATA defines it as a "vague," far-away vision. * (CPD)nA understands this direction-giving premise as a common understanding by all PO involved that the process needs to be continuously improved towards process variability reduction. Both (CPD)nA and KATA continue by grasping the current condition of the process by going to Gemba (Womack and Shook, 2013).	There is much psychological evidence (Huffman and Houston, 1993) that setting "target conditions" or active goals as the information used during the chosen action: information that is relevant to a goal is used, but information that seems irrelevant to goal achievement is neglected. This might have undesired consequences when attempting to achieve consensual solutions between different POs within complex dynamic environments. The "goal compatibility" framework (Markman and Brendl, 2000) suggests that POs evaluate objects relative to active goals and so "the value of an object is a function of its compatibility with that of the active goal." Thus, these objects, which can be any assets such as people, cash or equipment, are means by which to achieve the goals. These might be some of the reasons why scholars (Ordóñez et al., 2009) have reported that the systematic harm caused by goal-setting, including a "narrow focus that neglects non-goal areas, lead to a rise of unethical behavior, distorted risk preferences, corrosion of organizational culture, and reduction of intrinsic motivation" among others.	The assumption that target conditions can be set means that organizational leaders assume that the environment is predictable and can be analyzed. This is typical in "discovering organizations." With increasing complexity, "target conditions" will increasingly and dynamically depend on other dynamically changing "target conditions" that are a priori unrelated to the challenge. As a result, it is not always possible to achieve the NEMAWASHI conditions with KATA. This invalidates KATA as an Lean Learning Pattern that supports successful evolution of organizational learning capabilities. This is shown in the next section by an example of a real case.

	Lean Learning Pattern (See Figure 1)	What (CPD)nA and KATA have in common	Differences from a psychological perspective	Differences from a managerial perspective
(CPD)nA as described in chapter 1	1. Check or Commitment. In the Check Phase there are three sub-phases. First, examine the process at Gemba (Womack and Shook, 2013). Next, set a direction for improvement by agreeing that continuous improvement is a common need and by achieving consensus how to achieve success. This is done by establishing a process KPI (Key Performance Indicator) in the HOSHIN KANRI process (Jolayemi, 2008) that the sender PO owns to measures process performance. Finally, the current state of this KPI is measured. 2. Plan or Process-Priority Analysis. There are three sub-phases in the Plan Phase. First , understand the current state of the process using a process mapping tool (Wagner and Lindner, 2013). Next, prioritize the main sources of MUDA, MURA and MURI (3M) (Ohno, 2014). Finally, analyze the main source of the 3Ms within the process boundaries. 3. Do or Action. In the Do Phase, we work on the process. After deciding why 3M are occurring, the PO defines an action to improve the process by sustainably reducing internal process variability. It is important here to enhance the interdependent nature of processes. 1. Repeat numbers 1 to 3 "n" times. 5. Act or Anchor Learning or Standardization. The Act Phase is where anchoring and transforming the active learning into organizational learning occurs. After reaching a plateau in the KPI, the knowledge that was developed in process management becomes a Standard (understood as the best known way to perform the process).		It is important for creating psychological empowerment that the receiver PO explains why such KPI is important for success in order to create meaningfulness for (CPD)nA in the sender PO. Although the sender PO decides ultimately what the KPI is to be optimized with (CPD)nA, it is important for creating a sense of fairness in the PO that there is agreement on the KPI. The direction that is set with (CPD)nA is on the systematic reduction of 3M. This is not an active goal, but a "prevention goal" (Markman and Brendl, 2000). In contrast to active goals, such as "target conditions," preventive goals trigger motivational responses that are associated with responsibility and security and that regulate behavior by minimizing the presence of negative outcomes (Higgins, 1997).	Because of the awareness of organizational leaders that processes are interdependent systemic complex realities, the environment in this case is malleable and unpredictable. This is typical of "enacting organizations." The continuous improvement of the process is based solely on two pillars: (1) a common understanding of the current state of the process and (2) an agreement that the process should be continually improved towards variability reduction (this is the only strategic direction required). With increasing complexity, the (CPD)nA logic remains untouched, because it is based solely on agreement on the need for continuous improvement and an understanding of the current state. The NEMAWASHI conditions may or may not be attained depending on the organizational decision on different KPIs. The latter should take place at a higher organizational level and this will be discussed in the next chapter.

Table 4-1. (CPD)nA vs. KATA

Based on the KATA algorithm, it cannot be concluded that the NEMAWASHI conditions are fulfilled on an organizational level. The reason is that setting target states for individual KPIs does not guarantee that there will be equilibrium between competition and inhibition for KPIs, which is essential for organizational consensus.

In order to be mathematically precise, in the previous chapter, equation (3-6) expresses the NEMAWASHI dynamics and equation (3-7) expresses the first condition for asymptotic stability.

Nothing in KATA´s algorithm implies that a target state of KPI $x_2^{**}(t+1)$ is defined independently as the target state of KPI $x_3^{**}(t+1)$, both of which are understood to be active goals. Since this is the general case, condition (2) is intrinsically not fulfilled. The reason is that there is no guarantee that the measure of competition between KPI x_2^{**} and KPI x_3^{**}, as expressed by $a_{22}{\cdot}a_{33}$ is not always less than the potential inhibition effect that has KPI x_2^{**} provoked by changes on KPI x_3^{**}, as expressed by $a_{23}{\cdot}a_{32}$.

In propositional logic terms, the truth-functional tautology or theorem of propositional logic can be formulated like (P→Q)→(¬Q→¬P) (Whitehead and Russell, 2011), because:

- (P) the proposition "KATA is implemented"
- (Q) the proposition "the conditions for alignment are not always fulfilled"
- (¬P), as well as (¬Q), are respectively the opposite propositions.

Because the implementation of KATA implies that the conditions for organizational alignment are not always fulfilled, (P→Q) is true. Thus, we can conclude that, when the conditions for organizational alignment are always fulfilled, (¬Q) implies that KATA is not implemented (¬P).

The following real example shows this in practical terms. Imagine a factory whose factory manager is under cost pressure and decides to implement KATA as an empowerment program for all factory leaders. The following steps indicate how this happens:

- The strategic target state set by the factory manager is to reduce the overall product cost by 10%.
- The HR Manager, reporting to the factory manager, in order to support the strategic goal, sets a target condition of increasing the temporary production workforce by 20%.
- The Production Manager implements this action together with HR.
- Six weeks later, the quality costs have increased by 50%. This can be interpreted as being a direct consequence of the active target state that the HR Manager announced, because temporary workers don't control the process as well as experienced workers do.

- Subsequently, the Quality Manager implements KATA to reduce quality cost. This is done by increasing end product control to 100%.

- This action increases the overall cost of the product. So, the factory manager increases the overall cost reduction target state to 20% six months after having begun the KATA program.

However, because the (CPD)nA seeks the systematic reduction of the variability of the related KPI, the (CPD)nA algorithm enables the PO to adapt the actions to the passive goal of process variability reduction in order to balance, if detected, the effects of competition or inhibition from other related POs that that are implementing (CPD)nAs.

In propositional logic terms again, $(P'\rightarrow Q')\rightarrow(\neg Q'\rightarrow\neg P')$ since:

- (P') proposition "(CPD)nA was implemented correctly"

- (Q') proposition "the conditions for alignment can be fulfilled"

- $(\neg P')$, as well as $(\neg Q')$ are respectively the opposite propositions.

Since $(P'\rightarrow Q')$ is true, the implication is that, if the conditions for alignment cannot be fulfilled, (CPD)nA was implemented incorrectly. In other words, if the nature of strategic KPIs do not support a consensual VS alignment, the successful individual implementation of (CPD)nA will not be possible because the variability of the related KPIs will not decrease.

The previous example could have been solved with (CPD)nA as follows:

- The strategic target state that the factory manager sets was to reduce overall product cost by 10% and he decides to achieve this by (CPD)nA with KPI product cost.

- The factory manager measures the KPI (Check). Then, he maps the VS (Plan). Next, he prioritizes the main sources of 3M on the KPI and discovers that the cost of personnel is impacting his product cost greatly (Plan). Subsequently, he conducts an analysis of the cost of personnel finishing the (Plan). Then, an action to reduce personnel expense is outlined for the HR Manager.

- The HR Manager implements (CPD)nA after measuring the KPI (Check). Then, he maps the process (Plan). Next, he prioritizes the sources of 3M in the personnel cost (Plan). He discovers that production and quality management are not working together. His action (Do) is to appoint a group of operational leaders who will work together to reduce personnel expense by a consensual elimination of waste in the process by (CPD)nA.

Subsequently, the Production Manager and Quality Manager must work together to support the VS. If the cost of quality rises because of an action of the production manager, this action will not be performed in production. In this way, (CPD)nA reduces misalignment in a process of continuous improvement.

4.3.Propositions and Management Implications

After having described the differences between both LLP KATA and (CPD)nA theoretically and in a practical case, we state the following propositions and related management implications:

Proposition 1. KATA is a valid LLP for managerial individual empowerment within discovering organizations. However, it cannot create the conditions that are necessary for NEMAWASHI.

Management Implication 1. The fact that KATA is easy to understand and to explain is typically used by KATA consultants to generate enormous revenue from individual coaching and empowerment sessions.

Leaders should be aware that empowerment KATA programs may become a huge waste of time and PO illusion, even if using other organizational approaches to alignment, such as HOSHIN KANRI, because KATA does not create the conditions that are necessary for NEMAWASHI.

Proposition 2. (CPD)nA is a valid LLP for managerial individual empowerment within enacting organizations. Furthermore, it is able to create the conditions that are necessary for NEMAWASHI.

Management Implication 2. (CPD)nA is a more complex LLP than KATA and takes the inexperienced PO more time and effort to learn. However, it delivers a crucial competitive advantage. It prepares the organization to follow a solid path towards organizational alignment. As the next chapter will show, this can be achieved by expanding the LM effort by company-wide shop floor management efforts, such as

HOSHIN KANRI TREE.

5.HOSHIN KANRI TREE. 方針管理木. LEAN ORGANIZATIONAL PROCESS MANAGEMENT

5.1.Chapter Introduction

Some of the major challenges faced by organizational leaders in the 21st century are:

(1) the need to sustainably empower the workforce (Learning Organization) as indicated by (Narkhede et al., 2012),

(2) the need to develop an autonomous and intelligent PM (Smart Organization) as presented by (Lee et al., 2014),

(3) recent research by (Schuh et al., 2013) shows a need to cope with the increasing complexity of VSN,

(4) the necessary paradigm shift to strategic alignment pointed out by (Covey, 2004).

It is therefore urgent to study such challenges holistically in order to provide leaders with comprehensive tools to cope with them.

In the context of Learning Organization and Smart Organization, empowerment can be understood as a systematic way of learning that enables continuous improvement in an autonomous, intelligent, self-organized and systematic manner. (Coleman, 2004) defines empowerment as "the act of enhancing, supporting or not obstructing another's ability to bring about outcomes that he or she seeks." An "autonomous" management method should sustainably empower all organizational individuals to align and grow in the direction from which the organization provides value.

A powerful paradigm to empower organizations which focuses on value creation has flourished in the last two decades as LM. LM can be understood as a socio-technical management system that aims, in the words of Taiichi Ohno (Ohno, 2014), "to systematically reduce non-value adding activities in organizations. It seeks to do this by first understanding their structure and then getting rid of them always, everywhere, relentlessly and unremittingly." The LM quest of eliminating or reducing waste in organizations has been mainly understood by scholars, (Staats et al., 2011), as a problem solving task. As a result, the empowerment efforts of managers, who seek to implement LM, have been focused primarily on empowering and developing people to become good problem-solvers, as described in (Sobek II. and Smalley, 2008). However, as (Weick, 1979) points out, the identification of problems suffers from a social bias. Thus, what organizations or individuals understand to be a problem is subject to a number of cultural, situational and individual dynamic circumstances. The author understands that the "problems" that LM endeavors to solve, the non-value adding activities, are embedded within processes, and therefore the response-able POs that manage them are in charge of eliminating the non-value adding activities within them. Thus, the task set by LM is mainly an organizational PM task and not a problem-solving one. Each individual of the organization is understood to be a PO, who is acting on his or her process on the shop floor.

In an organizational business context of a complex VSN with numerous interdependent POs acting simultaneously on VSs, the POs need to be aligned in a common direction (HOSHIN) given by the strategic goals of the organizations. Furthermore, researchers, (Cäker and Siverbo, 2014), recently argue that not only is support of empowerment management systems necessary, but also they must be aligned with strategic purposes. In other words, they must be in "compliance with strategic plans and targets." POs need to consider local information, as well as strategic intentions. Studies by (Frow et al., 2010) show that multiple controls are needed to balance empowerment of PO and the alignment to strategic goals. HOSHIN KANRI (management by giving direction) is a comprehensive management system that enables such alignment of complex systems as shown by (Jolayemi, 2008). This chapter proposes a novel organizational PM method that provides the tool to operationalize HOSHIN KANRI by the systematic empowerment of autonomous intelligent POs acting in a complex VSN environment towards common strategic goals.

This chapter is structured as follows: firstly, the state of the art of current organizational PM empowerment methods and a brief HOSHIN KANRI state of the art are presented. Secondly, the main contribution is presented as the HOSHIN KANRI TREE, a novel PM method to operationalize HOSHIN KANRI as a proposal of how to cope with the four presented organizational challenges of 21st century. Thirdly, a practical case study of a German manufacturing facility is presented as a way of showing how the HOSHIN KANRI TREE model works and can be implemented in practice. Finally, several management implications are discussed, as well as the model limitations and further research.

5.2. Chapter Literature Review

5.2.1. Organizational Process Management

The author's research has identified three schools of thought within organizational PM systems as empowering methods:

(1) the goal-oriented approach that focuses mainly on providing visualization of goals,

(2) the evolutional approach that acknowledges the organizational evolution of PM in a certain direction (HOSHIN) and

(3) hybrid approaches that combine goal-orientation and evolutional PM.

5.2.1.1. Goal oriented organizational PM

Scholars have integrated concepts of the Balanced Score Card with elements of LM (Otsusei, 2005). By systematically choosing independent KPIs, BSC aims to holistically describe organizations and align goals with strategy. The result obtained, however, has been KPI-centered PM systems that lead the organizational efforts on KPIs. By focusing solely on KPIs, such systems do not foster a transparent performance dialog between POs that typically empowers the PO achieve results while increasing trust (McChesney, 2012).

Other scholars have focused the empowerment efforts around the organizational hierarchical structure or around the functional business units with rigid frameworks, such as SQDCME (Security, Quality, Delivery, Cost, Morale, and Environment) (Osada, 1998) and (Osada, 2013). The standardization of such frameworks along all strategic business units (SBUs) makes the resulting LM system unvarying and less able to evolve as needed. An inability to evolve could have undesirable consequences in the quest for the LM paradigm, as pointed out by (Borches and Bonnema, 2008). Therefore, this approach lacks the capability to cope with the increasing complexity of VSNs.

5.2.1.2.1.Evolutive organizational PM

(Suzaki, 2010) presents an evolutional direction (HOSHIN) giving approach to organizational PM that is based on PDCA. Explained in four phases - Introduction, Promotion, Expansion and Stabilization - the organizational PM concept should be implemented company-wide. The flaw in Suzaki´s approach is that PDCA is understood to be a problem- solving method, rather than a process management approach.

5.2.1.3.Hybrid organizational PM Concepts. Goal-oriented and Evolutional PM.

These two main streams have also engendered hybrid concepts. For instance, the hybrid character of SM systems is described in the 2nd key of Kobayashi´s "20 Keys" for shopfloor improvement (Kobayashi, 1995). The last level of Kobayashi´s concept makes the need clear for adaptiveness or an "all-weather-system" that a management system must have. This is central to his argumentation. However, this "goal" oriented view of PM is the main weakness of any management system that attempts to cope with complex environments because, as shown in previous chapters, no goal breakdown system can be as fast as the changing environment.

5.2.2.HOSHIN KANRI. 方針管理

A hybrid SM management system that enables a comprehensive evolutional organizational PM structure is HOSHIN KANRI (Akao, 2004). (Jolayemi, 2008) gives the most complete review so far for HOSHIN KANRI. (Witcher, 2002) describes qualitatively a strategic implementation of HOSHIN KANRI as APCD, but fails to describe analytically the organizational design and management that is necessary for successful implementation. Akao (Akao, 2004) describes a holistic HOSHIN plan that combines goals, action and a review process that links circularly senior, middle management and implementation teams from vision to strategy to action. HOSHIN KANRI is a “system´s approach of improvement of the company´s management process” that is based on a continuous “negotiated dialog,” which is called a “catchball process,” between the different strategic business units (SBUs) of the organization (Tennant and Roberts, 2001). This empowerment dialog relies heavily on PDCA to build a holonic organizational design. Although means are connected with goals, still presents two main weak points: (1) HOSHIN KANRI is considered to be a project with short-term and long-term targets and (2) PDCA is considered to be a problem-solving method, rather than a process management approach. (Hutchins, 2008) again presented the HOSHIN KANRI process as an organizational macroscopic PDCA process. The frame of reference that Hutchins presented was again not process-oriented, but project- and KPI-oriented. Hutchins describes the PDCAs as “improvement projects” and that the SM is based upon KPI Score Card reporting sheets.

HOSHIN KANRI has been implemented widely in the service industry from a policy deployment and strategic perspective. (Marsden, 1998) presents a limited review from a strategic perspective. However, what seemed clear back then is still true now, namely that “the service industry appears to be behind in its understanding of management by process and alignment towards strategic business goals.” Shortly later, (Witcher and Butterworth, 1999) showed qualitatively a practical implementation of HOSHIN KANRI as a management method in a service company like Xerox. In doing so, they emphasized the importance of individual responsibility in the strategic management process in which strategic management and operationalization becomes everyone’s business. Another practical application at Hewlett Packard (Witcher and Butterworth, 2000) that connects business fundamentals and its deployment. (Pun et al., 2000) (Roberts and Tennant, 2003) again approach a top down qualitative description of HOSHIN KANRI in the service industry as a policy deployment management method. Again, at an organizational level, (Bicheno, 2008) shows HOSHIN KANRI as an organizational PDCA tool to be applied in service systems.

In his HOSHIN KANRI cornerstone work, lean Sensei (Akao, 2004) depicts a SM based upon PDCA and a BSC KPI system. Akao describes a holistic HOSHIN plan combining goals, action with a review process that circularly links senior, middle and implementation teams from vision to strategy to action. Although means are connected with goals, still presents two main weak points: (1) HOSHIN KANRI is considered a project with short term and long term targets. This approach has not detached itself from the goal oriented view of business that is unable to cope with VSN complexity; and (2) PDCA is considered again a problem solving method, rather than a process management approach. As already described, this is a less effective and efficient empowerment usage of PDCA.

5.3.HOSHIN KANRI TREE. 方針管理木

The HOSHIN KANRI TREE is a method to visualize structural (CPD)nA organizational networks. It is proposed as a Lean organizational PM method that can sustainably empower POs and create organizational learning capabilities while pursuing strategic alignment in complex VSN environments.

HOSHIN KANRI TREE is implemented in four phases. The first one pretends to grasp VS reality unbiased as it is. The second phase pretends to prepare the ground for “planting” the tree. The third phase deals with the management effort of establishing the HOSHIN KANRI TREE. The fourth phase deals with the leadership effort of taking care of the HOSHIN KANRI TREE.

5.3.1.Gemba-Genjitsu-Gembutsu (3G) 現場。現実。現物。*Current State VS*

In the 3G phase, we intend to grasp the current (Gembutsu) state of the process (Genjitsu) where value is being created (Gemba) (Ohno, 2014). This first step indicates the importance of the VS concept to this management method. Practical experience indicates that such a process should have strategic importance in the organization. However, it is important to note that, due to the fractality that is provided by (CPD)nA, any PO can start the HOSHIN KANRI TREE, regardless of her position within the organization. The goal of this first step is to understand what POs and sub-processes are involved, how they interlink by material or information flow and the main sources of waste of the process. Then, the current state of such a process is described following one of the multiple process mapping methods that are available, such as VS Mapping, Makigami or Waste-Walk diagram, some of which are described in (Wagner and Lindner, 2013).

5.3.2.NEMAWASHI. 根回し *Prepare the ground: Understand the KPI Structure*

The NEMAWASHI Phase of the HOSHIN KANRI TREE consists on two simple steps:

(1) After understanding the current state of the VS, it is important to understand the dynamic relationships between the strategic KPIs and understand if consensus in the strategic goal achievement is possible. If historical data of the strategic KPIs are known, following the steps indicated in previous chapters to implement NEMAWASHI will lead to better understanding if NEMAWASHI can be attained.

(2) After this, we need to understand what are the most relevant KPIs related to this VS. The next steps help qualitatively visualize the KPI ecosystem inherent to the process at study. This is performed in three different steps:

- Firstly we list all current and possible KPIs that are being or could be used to measure VS performance and we create a KPI influence matrix of such KPIs with this list in the columns and the same list in the rows.

- Secondly we populate such KPI influence matrix with values 2, 1 or 0 depending if the column KPI depends respectively strongly, weakly or nothing upon the row KPI. For visualization purposes, we have color coded such matrix with dark (2), light (1) and ultra-light green (0) in following interdependence matrix. Thirdly, the sum all KPI row values indicate how strongly the KPI influences others, i.e. how strong is the KPI as a process or input KPI, and the sum of all KPI-column values indicate how strongly these KPI is influenced by others, i.e. how strong is the KPI as output or feedback-loop KPI.

- Finally, for visualization purposes, we represent the main influenced and influencing KPIs in a pareto form we will focus upon.

5.3.3.UERU KANRI. 植える管理。*Planting the HOSHIN KANRI TREE*

After identifying what KPIs can create organizational consensus while supporting strategic goals in the NEMAWASHI phase, we link the POs to (CPD)nA. The goal of linking the VSN and the organizational chart is to operationalize the HOSHIN KANRI TREE as Lean organizational PM method.

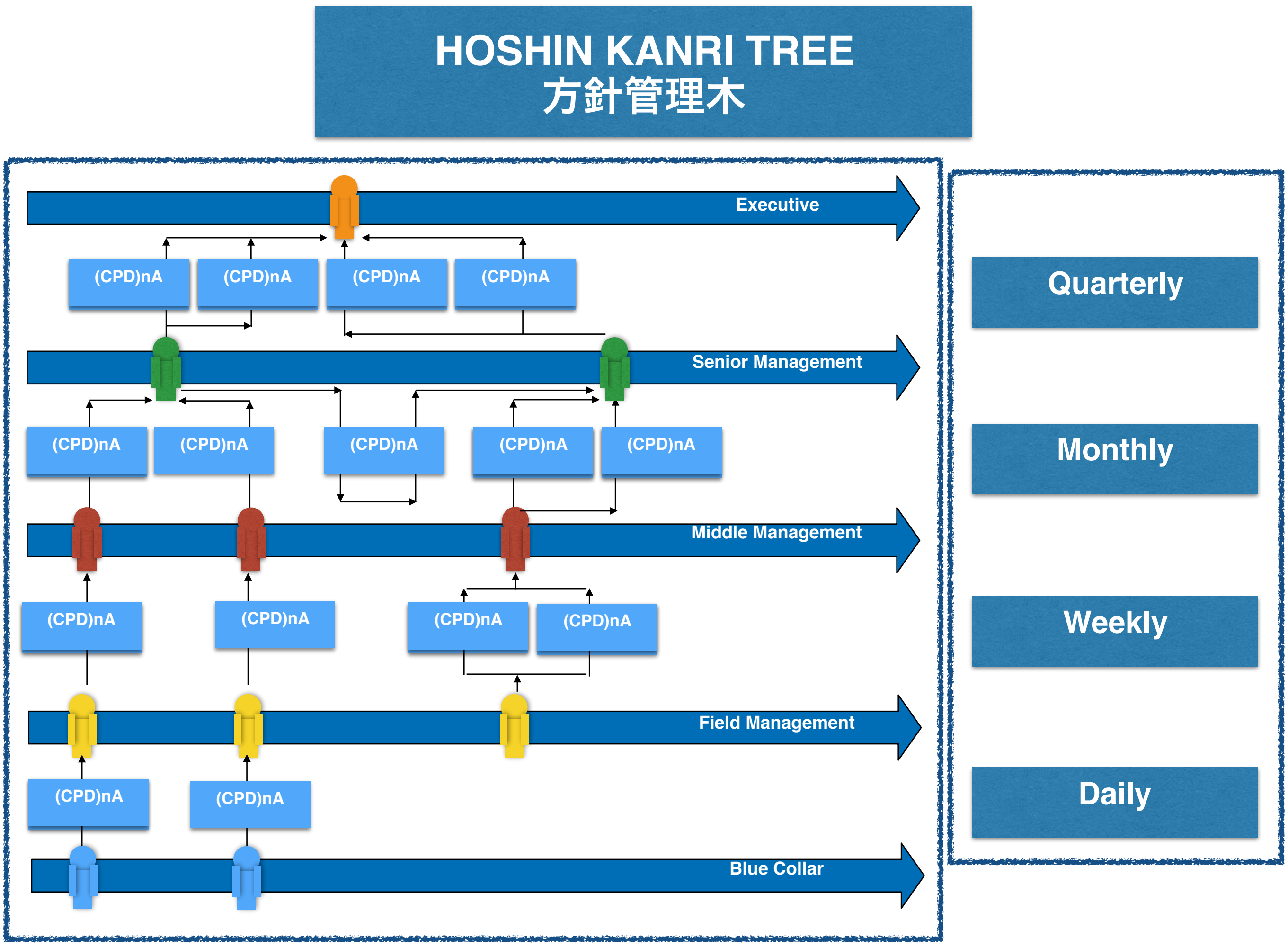

Figure 5-1. HOSHIN KANRI TREE

Initially, the links that are connected are those that make consensus possible, as shown in the NEMAWASHI process.

The structural network that conforms the HOSHIN KANRI TREE is depicted in figure 5-1.

5.3.4.UEKI-YA KANRI. 植木屋管理。*The Lean Leader as gardener: taking care of the HOSHIN KANRI TREE*

When the visualization has been completed and several PDCAs have been placed along the organizational structure, it is time to operationalize the HOSHIN KANRI TREE.

The HOSHIN KANRI TREE ought to be physically placed as close as possible to Gemba and visualized in paper form. Electronic visualizations are not desired for experience shows they lessen the involvement of the PO involved.

Taking advantage of the fractal nature of (CPD)nA, the rule to set the communication frequency towards a node i follows an allometric rule (West and Brown, 2004) expressed by equation 5-1

$d(w_i)/dt=w_0.(M_i)^{\wedge T_i}$ (5-1)

where

- $d(w_i)/dt$ represents the frequency of (CPD)nA reporting to node i
- w_0 represents a natural constant frequency of the organization
- M_i represents the number of nodes hierarchically under node i
- T_i represents the trust enjoyed by node i from other nodes.

It is practicably impossible to dynamically determine trust levels at a node level, therefore in practice this trust is considered constant throughout the organization. This has the consequence that (CPD)nAs that are reported to a given hierarchical level (similar M_i) ought to be reported at the same frequency. The recommended frequency is 1xDay, 1xWeek, 1xMonth, 1xQuarter, 1xYear, although the system allows for different variations.

5.4.Discussion and Management Implications

Following propositions are offered as discussion and management implications:

Proposition 1. Empowerment first, Alignment second. In order to implement a Lean organizational PM system such as HOSHIN KANRI TREE that holistically copes with VSN complexity and supports alignment with strategic goals, such as HOSHIN KANRI TREE, leaders must first empower POs perform (CPD)nA and then align efforts with strategic goals. Leaders should take the time and resources necessary to empower POs to perform proper (CPD)nA.

Proposition 2. HOSHIN KANRI TREE provides the necessary framework to empower POs within the organization. Because HOSHIN KANRI TREE is based on the fractal unit (CPD)nA, the HOSHIN KANRI TREE can evolve and is resilient to changes in the environment. Because of these two properties, the HOSHIN KANRI TREE is able to cope with VSN complexity.

Proposition 3. In the empowerment Phase of HOSHIN KANRI TREE, the behavioral direction (HOSHIN) deals with improving his or her process with every PDCA cycle, instead of achieving a certain numeric local "future state" or "goal."

Proposition 4. In the alignment Phase of HOSHIN KANRI TREE, the behavioral direction (HOSHIN) should be guided by strategic numerical goals.

5.5.Case Study Operational Management. Bottle Co.

In this within-case study we present the implementation process of HOSHIN KANRI TREE methodology within a german machine construction manufacturing facility dubbed BottleCo for confidentiality reasons.

5.5.1.Scope Establishment

We aim to study the effect of the application of HOSHIN KANRI TREE upon VS performance in complex VSNs. The facility under study presents a workforce of 500 people and three management levels E1-E2-E3 being E1 the highest in hierarchy.

5.5.2.Specification of population and sources

All Data were gathered on an ongoing research project for over 12 months from January 2014 to December 2014. The data came primarily from two sources: VS performance management internal reports on a monthly basis and observations of LSM methodologies applied in three gemba walks.

5.5.3.Data collection

Following again Eisenhardt´s advice, we looked at such VS performance from “many different perspectives” and so we measured on a monthly basis workforces efficiency (KPI1) customer backlog (KPI2) and cumulative VS performance (KPI3). For confidentiality reasons, we will represent the data in relative terms to the initial values.

5.5.4.Case Implementation

Throughout the within-case Analysis, we will describe the implementation of HOSHIN KANRI TREE and its effects upon VS performance.

5.5.4.1.Gemba-Genjitsu-Gembutsu (3G) 現場。現実。現物。*Current State VS*

The process of the highest level E1 manager in the hierarchy is depicted with process steps, POs, information flow, material flow, WIP and several other relevant process information that helps better understand the 3G nature of the process as indicated by (Ohno, 2014) and as exemplary shown in figure 5-2A.

A)

B)

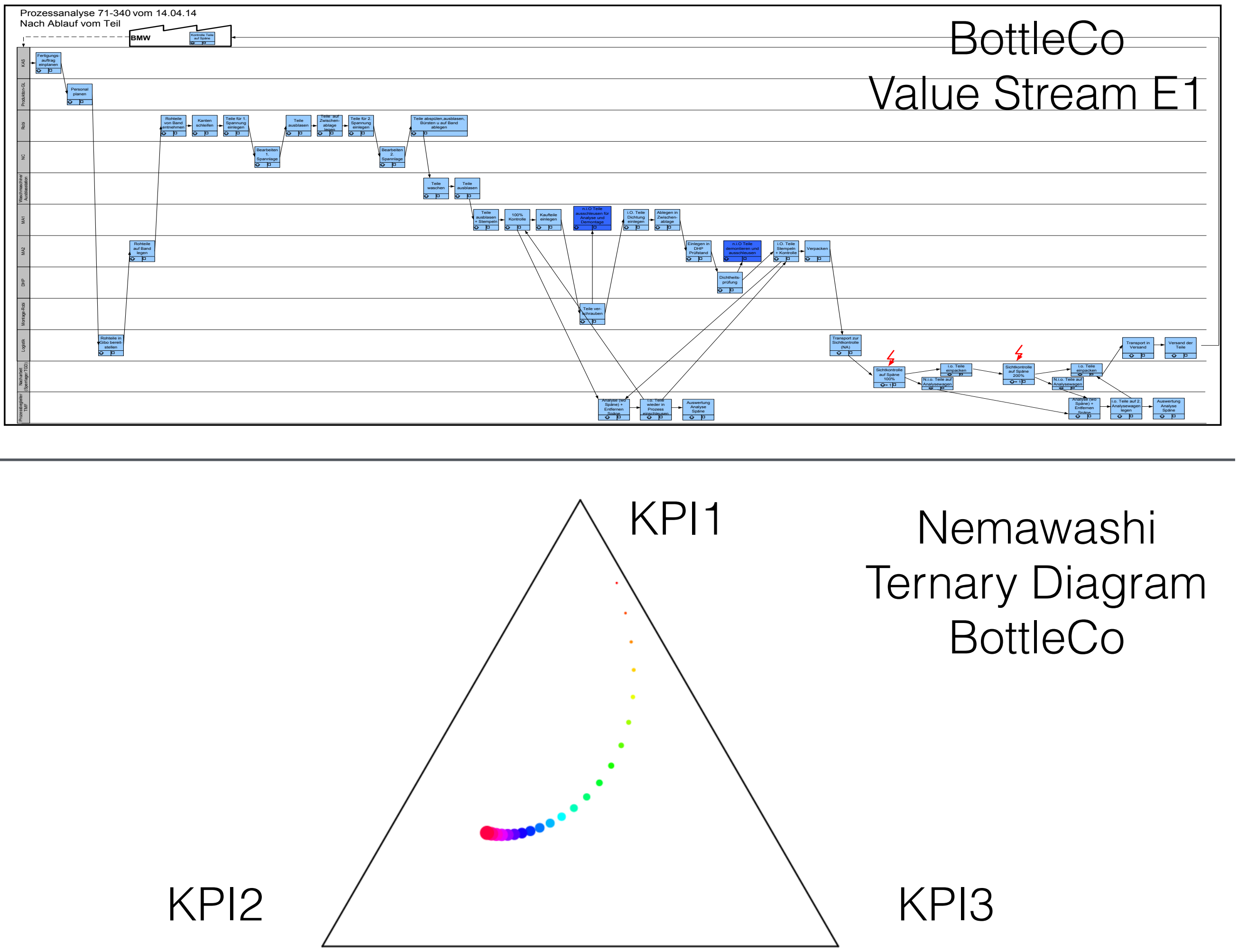

Figure 5-2. NEMAWASHI. 根回し Prepare the ground: Understand the KPI Structure

5.5.4.2.NEMAWASHI. 根回し Prepare the ground: Understand the KPI Structure

The NEMAWASHI Phase of the HOSHIN KANRI TREE consists on two simple steps:

(1) After understanding the current state of the VS, it is important to understand the dynamic relationships between the strategic KPIs and understand if consensus in the strategic goal achievement is possible. If historical data of the strategic KPIs are known, following the steps indicated in previous chapters to implement NEMAWASHI will lead to figure 5-2B that shows, through a ternary diagram, that NEMAWASHI conditions are given and an asymptotic equilibrium point can be achieved.

(2) After the proof that the strategic goals support aligned strategic goal achievement, we need to determine what KPIs are relevant for the organization. This is performed in three steps with aid of a KPI influence matrix as described previously and as exemplary shown in figure 5-3.

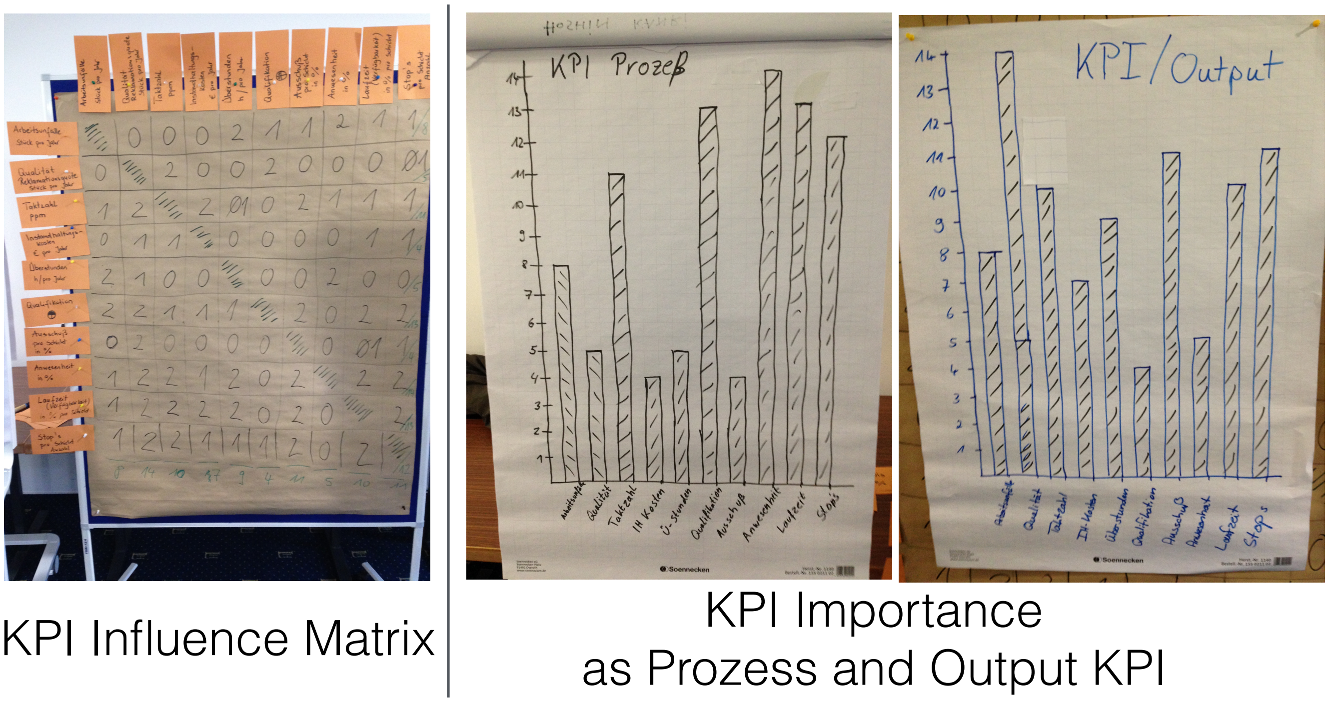

Figure 5-3. KPI Influence Matrix. Understanding the KPI Structure.

5.5.4.3.UERU KANRI. 植える管理。Planting the HOSHIN KANRI TREE

After understanding the KPI dynamics and what KPIs are potentially most important for the organization, the HOSHIN KANRI TREE was "planted" in three steps performed through a workshop. The results of the workshop are exemplary depicted in figure 5-4.

- Firstly, a linkage between all relevant POs through (CPD)nA is developed and depicted in a non hierarchical network. The reason for this is to focus on the (CPD)nA relationships and not on hierarchical ones.

- Secondly, following the hierarchical relationships in the organization, a first draft of the HOSHIN KANRI TREE for the organization is represented in a hierarchical so that all (CPD)nA being reported to a certain hierarchical level ought to be placed at the same level.

- Thirdly, the HOSHIN KANRI TREE is physically “planted” as close as possible to the Gemba with magnetic boards. It is recommended, that the (CPD)nA connections are printed in A3 format.

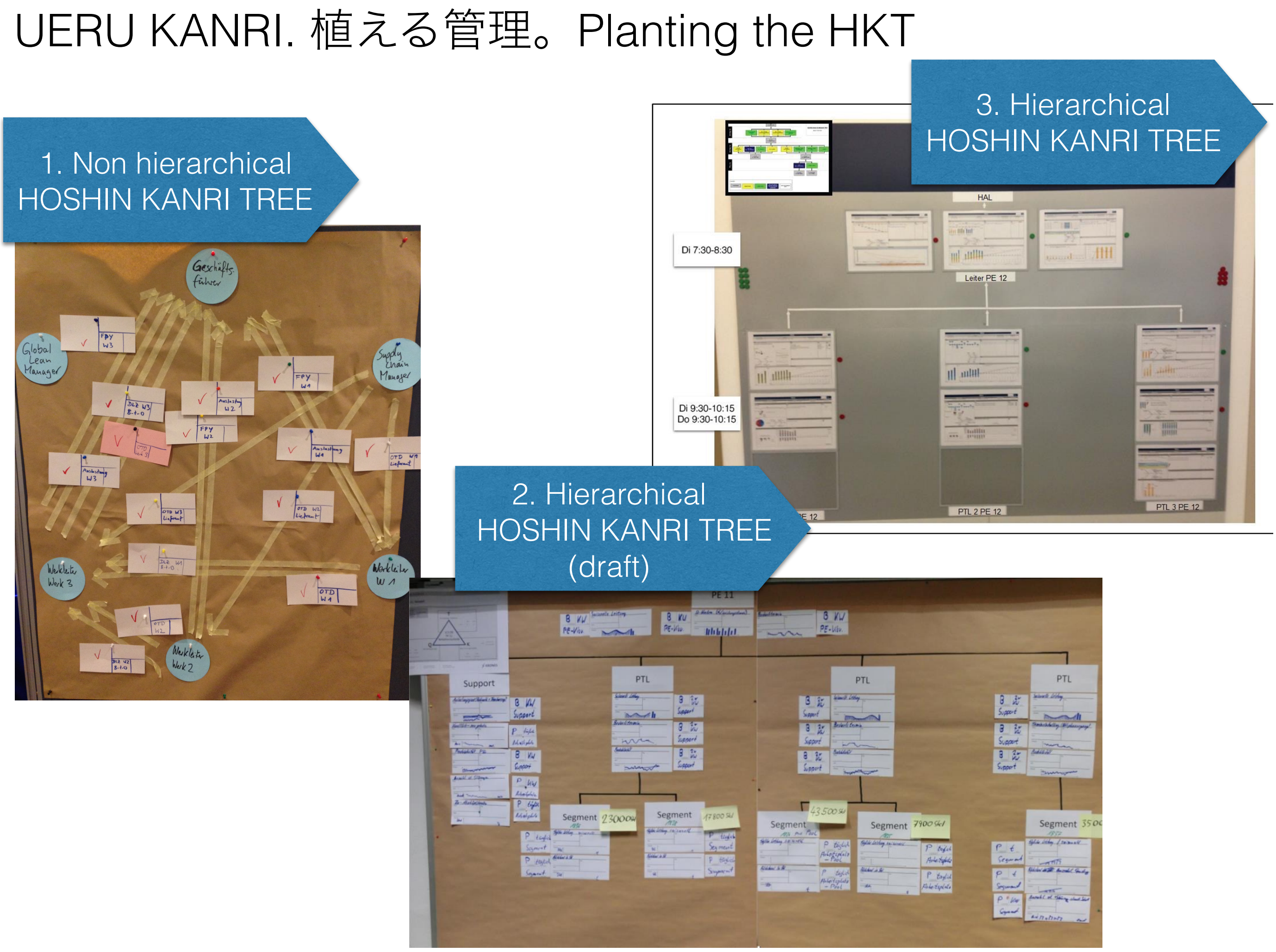

Figure 5-4. UERU KANRI. 植える管理。Planting the HOSHIN KANRI TREE

5.5.4.4.UEKI-YA KANRI. 植木屋管理。*The Lean Leader as gardener: taking care of the HOSHIN KANRI TREE*

Each Lean Leader will have a HOSHIN KANRI TREE at his or her level. The (CPD)nA sources and (CPD)nA sinks of each HOSHIN KANRI TREE will regularly visit the HOSHIN KANRI TREE following different frequencies. The (CPD)nA Routine follows a behavioral routine to facilitate the empowerment process that is supported through a colour-coded routine in the HOSHIN KANRI TREE: before the stand-up meeting at the HOSHIN KANRI TREE takes place, each (CPD)nA will be marked with a magnet. This magnet is green if the KPI of the (CPD)nA is showing better performance than the previous cycle and red otherwise. Only those (CPD)nA sources whose (CPD)nAs are red are eligible to report their (CPD)nA.

This fact has several implications: (1) at the HOSHIN KANRI TREE only the relevant issues are discussed, (2) it again focuses optimization on the understanding of the current state and on continuous improvement, and (3) no active goals or target states are defined in the management of the (CPD)nA.

5.5.5.Case Summary and Limitations

5.5.5.1.Case Summary

The results obtained in terms of workforce efficiency was increased by 22%, customer backlog was reduced by 35% and cumulative VS overall performance was increased by 3%. This results are graphically presented in figure 5-5.

5.5.5.2.Case Limitations

Although we cannot infer causation, we can definitely infer correlation between the implementation of strategic HOSHIN KANRI and HOSHIN KANRI TREE as a LSM methodology and the performance increase in the studied facility.

There were two main difficulties throughout the HOSHIN KANRI TREE implementation in this facility: first, certain important KPIs could not be measured properly and timely at first, and so the first actions of the (CPD)nA were oriented towards the creation of reliable and relevant KPI metrics. The second main limitation was the discipline of (CPD)nA owners in attending the stand-up HOSHIN KANRI TREE meetings, specially higher management played here a crucial role in leading by example.

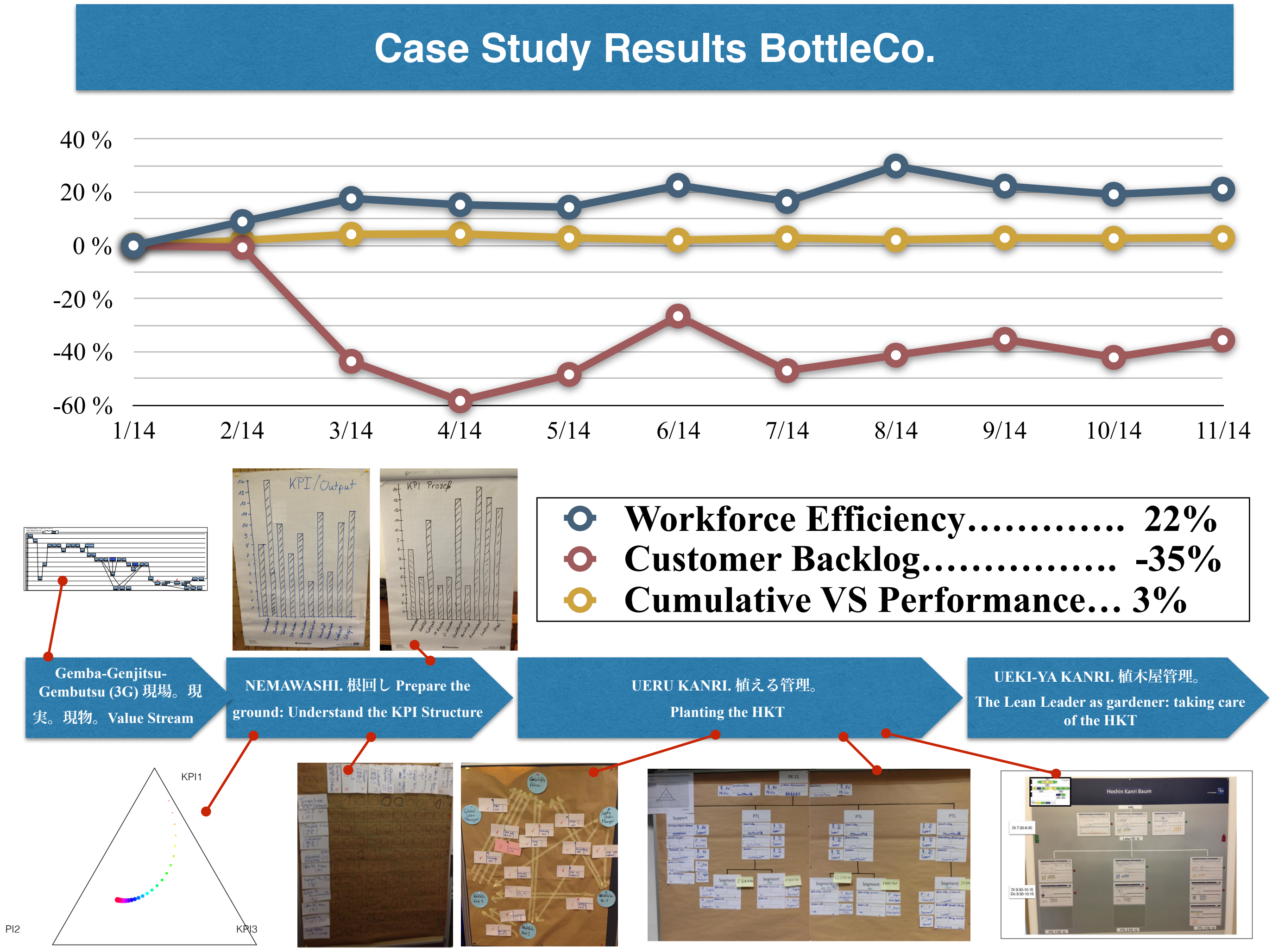

Figure 5-5. BottleCo Case Summary

5.6.Further steps

The growth process of the HOSHIN KANRI TREE, characterized by what lean structural links are created, destroyed or maintained throughout time will be described in detail in the next chapter.

The trees will become a forest when their branches touch each other and are linked together expanding the process management level to not only an intra-organizational but towards an inter-organizational dimension, involving customers and suppliers as well as other relevant related stakeholders. The organizational forest shown in the next chapter will be, in this sense universal.

It will be shown as well how to understand the evolutional process towards such forest lean design configurations and how this is crucial for a proper management of the Lean Strategic Organizational Design.

6.HOSHIN KANRI FOREST. 方針管理森. RECONFIGURABLE LEAN SERVICES AND MANUFACTURING SYSTEMS.

6.1.Chapter Introduction

Many rigorous models have been developed to support organizational service system design (Zhong et al., 2015). Some scholars have proposed that all stakeholders be integrated (Decouttere and Vandaele, 2013). Others focus on service by scaling the system on demand when and as needed (Koepp et al., 2011). Finally, some propose a modular and flexible service architecture (Jensen, 2013). It is expected that a unifying framework that encompasses these models with an analytic approach and enables the system´s ability to diagnose patients' conditions in a broader systemic manner at all times will substantially enhance the capability of these service systems to support the achievement of strategic goals. Such design features of "modularity, integrability, flexibility, scalability and diagnosability" (ElMaraghy, 2006) match those of Reconfigurable Manufacturing Systems (RMS) in the manufacturing industry (Koren and Shpitalni, 2010). Unfortunately, in the service industry, a similar framework, such as that of Reconfigurable Service Systems (RSS), has not been developed yet. This takes us to our research questions (RQ1), which is "Can we propose a universal Reconfigurable Lean Service and Manufacturing System (RLSMS) design that serves both service and manufacturing worlds?", and RQ2 "in order to be shown to be worth implementing, can we suggest a management roadmap for the design of such RLSMS?"

This chapter is organized in five major sections. First, we review RMS, while qualitatively describing its design characteristics and the benefits that they have brought to manufacturing industries. Subsequently, we seek to address the need of a transfer of these benefits to the service industry by interpreting the challenges that the latter might face when seeking to implement RSS. Then, based on previous definitions of lean structural and functional networks, we describe what needs to be done to bridge the research gap from RMS towards RSS, describing qualitatively the evolutional conditions necessary for an RLSMS. Second, we propose HOSHIN KANRI FOREST as an analytical approach to the design and management of RLSMS. Third, we show how the system bridges the gap between service and manufacturing systems by proposing several conclusions to depict potential management implications. Fourth, the proposed framework is validated by means of a case study of two hospitals that belong to a HC US corporation, worked out in close collaboration with clinicians and HC corporate management. This shows the implementation process in the HC industry and its direct impact on relevant strategic KPIs such as Patient Lead Time, Operation Success Rate and Revenue. Finally, further research steps and limitations of the research are presented.

6.2. Chapter Literature Review

6.2.1. A roadmap to RLSMS

Our literature review begins with a four-step roadmap that appears in table 6-1. First, we review an RMS that is based on the classification given by (Koren and Shpitalni, 2010). These scholars list the necessary design features of an RMS. Second, based on this classification, we provide a brief overview of the solutions and related benefits that the manufacturing industry has found to meet the design characteristics. Third, we speculate on the challenges that the service industry anticipated when designing RSS. Finally, the conditions for merging the RMS and RSS to form an RLSMS are listed.

RMS Design features	Solutions provided and benefits in Manufacturing Environments	Interpretation of potential challenges in Service Industries.	What needs to be done in order to bridge RMS and RSS? Conditions for RLSMS.
Modularity is a component-oriented design characteristic in which an RMS is physically built from modular self-similar components (Sayed and Lohse, 2013). Modules are expected to be added and removed from the manufacturing process rapidly on demand. In the context of RMS, modularity can be understood as "the compartmentalization of operational functions into units that can be manipulated between alternate production schemes for optimal arrangement" (Koren and Shpitalni, 2010).	This RMS decentralized design feature makes the use of centralized management systems obsolete because it is practically impossible to calculate all possible module configurations and capture them in one global model. This challenge has been approached by developing Holonic based Multi-Agent systems (Giret and Botti, 2009). This holon has been defined (Jovanocić et al., 2014) as an autonomous and cooperative part of a manufacturing system which has the function of transforming, transferring, storing and evaluating information and physical objects. The benefits brought by modularity design features are an enhanced adaptability to demand changes and process variability (Sayed and Lohse, 2013).	In a customer-centered service industry, the development of a modular organizational architecture (Jensen, 2013) enables organizational growth. By adopting this modular information exchange architecture, several solutions can be customized to meet customer demands through high quality service at affordable prices (Koepp et al., 2011).	If we understand each manufacturing holon as a service provider within the value creation process we can think of Service Oriented Architechture (Borangiu et al., 2012). Under the information exchange paradigm, what both worlds share is the focus on information exchange. Bridging both RMS and RSS can be then potentially achieved by the modularizaton of information exchange standards between organizational agents that serves both manufacturing and service industries.
Integrability in the context of RMS can be understood as "the ability to integrate modules rapidly and precisely by a set of mechanical, informational, and control interfaces that facilitate integration and communication" (Koren and Shpitalni, 2010).	In the context of RMS, solutions are found where machines are typically integrated through standard and flexible conveyors that allow for flexible material flow hence forming complete reconfigurable systems (Koren and Shpitalni, 2010). The benefit of integrable RMS is a higher performance that can only be achieved by a very high machine reliability (typically measured through MTBF (Mean Time Between Failures)) (Wang and Koren, 2012).	The challenge in service associated to the integrability principle are double: first ensure a standard interprocess communication and a high reliability in the processes related.	In order to fulfill the integrability principle the interacting POs ought to interchange information following a common standardized protocol. The system that integrates both RMS and RSS should facilitate this integration and communication by providing such interprocess information exchange standard. Such standard ought to support process reliability and a systematic reduction of variability as in the LM paradigm (Shah and Ward, 2007). A standard interprocess communication standard that fulfills these characteristics is (CPD)nA has been developed.
Flexibility in the context of RMS means that "the machines and operators can produce the entire part family related to the VS" (Koren and Shpitalni, 2010).	Flexible RMS demand a high automatization desgree through the combination of computer numeric control (CNC) machines connected by automated material handling systems (Godinho-Filho et al., 2014). The RMS ought to be organized around the VS and has cycle-time similar change over times between different products within the VS. To solve this issue, methods such as SMED have been developed (Shingo, 1985).	The standardization of communication improve the quality of information and in the end the resulting benefits will improve the quality of patients' life (Vida et al., 2012). Because of its information based core, organizational agents accessing this information can deploy different products throughout the VS provided that the system is organized around the VS. Lean methodology needs to be applied across the entire VS delivery systems, not just within its component functions and processes (Davies, 2014).	Beside the standardization of information, a management system that aims to achieve the integration of RMS and RSS must have a VS based backbone and be design around it in order to attain desired flexibility.
Scalability in the context of RMS means "the ability to easily modify production capacity by adding or subtracting manufacturing resources (e.g. machines) and/or changing components of the system" (Koren and Shpitalni, 2010).	This has been solved by scholars and practicioners by combining specific scalable hardware and software combinations as shown by (Putnik et al., 2013). The advantages of rapid and cost-effective reconfiguration of the RMS to the exact capacity needed to match a new market demand have been presented by scolars as two benefits of scalable RMS (Deif and E.l.Maraghy, 2006).	The service industry navigates in an environment of increasing information exchange complexity (Lipsitz, 2012). The challenge lies hence on attaining "qualitative scalability" understood as "scaling the complexity of social relationships from simple interactions to creating organizations with increasing agent complexity, i.e. improving the abilities of agents to deal with complex situations" (Fischer and Florian, 2015).	Under the organizational network paradigm the conditions for both manufacturing and service organizational evolving networks to adopt a scalable "scale-free" network structure are presented by (Albert and Barábasi, 2000): preferential attachment and continuous growth. The need to analytically describe an evolutional process of preferential attachment and continuous growth that describes both service and manufacturing systems is necessary to embed scalability in the organizational design.

RMS Design features	Solutions provided and benefits in Manufacturing Environments	Interpretation of potential challenges in Service Industries.	What needs to be done in order to bridge RMS and RSS? Conditions for RLSMS.
Diagnosability in the context of RMS means “the ability to automatically read the current state of a system to detect and diagnose the root causes of output product defects, and quickly correct operational defects” (Koren and Shpitalni, 2010)	The ability to faster diagnose process variability and find cause identification within environments of increasing complexity is a potential benefit of this design feature (Sayed and Lohse, 2013). LM scholars have developed different shopfloor management systems to allow this diagnosabilit. One holistic approach that also allows the standardization of interprocess communication has been presented in previous chapters is HOSHIN KANRI TREE.	Through a diagnosable architecture, sustainable growth challenges can be visualized and holistic system management can be performed. Such visualization should be customizable to meet the needs of different stakeholders and supported if needed by IT systems.	In the LM context, both RMS and RSS aim to reduce organizational variability. Therefore, a management system that seeks to unite both worlds ought to show process related variability on a holonic multi-agent level. The HOSHIN KANRI TREE shopfloor management method can be potentially expanded to HC and service industries.

Table 6-1. A roadmap to RLSMS

6.2.2. Evolutional Conditions for an RLSMS

Based on the definitions of lean structural and functional networks given in previous chapters, the evolutionary conditions for RLSMS can be qualitatively summarized as follows.

The evolution of such VSN can be studied under the paradigm that was discovered by (Barabási and Albert, 1999) and which states that many social, natural and real complex networks are not wired randomly, but converge to a similar SCALE FREE NETWORK structural architecture. An SCALE FREE NETWORK is a network with a degree distribution that follows a power law, such as $P(ki)\approx k_i^{-\lambda}$ where k_i represents the connectivity degree of a PO_i (Barábasi and Albert, 1999). The two most important characteristics of SCALE FREE NETWORKs are that: (1) a relatively high number of nodes exhibit a connectivity degree that exceeds the average in comparison to random networks and (2) the network structure is scale-invariant.

The evolution of the structural network can be described with three time dependent parameters (Albert and Barabási, 2000): (1) p(t) or the quote of new (CPD)nA links that were created within already activated POs in the last time period, (2) q(t) or the quote of re-wired (CPD)nA linked to already existing POs and (3) m(t) or the number of new activated nodes in VSN. (Albert and Barabási, 2000) showed that the exponent $\lambda(t)=(((2\cdot m(t)\cdot(1-q(t))+1-p(t)-q(t))/m(t))+1$ depends on time and the network´s parameters. In addition, (Cohen and Havlin, 2003) have shown that SCALE FREE NETWORK with $2<\lambda(t)<3$ has a diameter

$dt \approx \ln(\ln(N))$ where dt is the average distance between any two POs on the SCALE FREE NETWORK graph. The condition for SW network that these scholars proposed is $dt \approx \ln(N)$ was shown in previous chapters. For this reason, SCALE FREE NETWORKs are called “ultra-small” networks. Therefore we can speak of “Ultra-Lean” Organizational Structure when dealing with SCALE FREE NETWORK organizational configurations.

As mentioned earlier, in order to attain SCALE FREE NETWORK architecture, the evolutional process of such structural and functional networks must be governed by preferential attachment and continuous growth. In the next section, we will show an analytical description of these two conditions.

6.2.3. Structural and Functional Preferential Attachment

The preferential attachment of the functional network is trivial, as the actions are defined so as to reduce the (CPD)nA´s KPI variability following the LM paradigm.

The preferential attachment of the structural network is not intuitive and will be described in the following paragraphs.

The evolution of the HOSHIN KANRI TREE will be determined by how new links are created and how links are cancelled after each (CPD)nA cycle. The following operational behavior of HOSHIN KANRI TREE is, as indicated previously, based on the (CPD)nA paradigm. The evolution of the HOSHIN KANRI TREE will be driven by prioritization in the Plan step of the paradigm. In this step, each PO_i (i=1, …, N) will analyze its VSM in terms of the influence that other PO_j $j \in S(i;t)$ and their related KPI_j have over his KPIi. S(i;t) represents the set of nodes that are connected functionally (Subset S_f) or structurally (Subset S_s) with the i node by period t. Because functional and structural network have an evolutional interconnection, it is important to understand both.

Typically, the cardinality of S_f is higher than the cardinality of S_s because more actions are active in one (CPD)nA. This might imply that the growth process of the HOSHIN KANRI TREE first creates functional links by actions for improvement in the DO Phase of the (CPD)nA and then establishes them through structural (CPD)nA link that are related to KPI_j. The functional network would then create the evolutional path for the growth of the structural HOSHIN KANRI TREE.

As this set KPI_j will be reported by period of time, according to its agreed frequency, it will be possible to produce a linear projection in a smaller space and to identify main directions, explaining the greatest variations. This can be carried out by use of the PCA technique (Niyogi, 2004). As the involved KPI for the PCA may belong to a different layer of processes and sub processes, the sampling frequency may be different. Therefore, the approach that is adjusts the potentially variable sampling rate to the current time.

Because of the properties of the PCA projection, the eigenvalues can be understood as relevant in the variances of each of the eigenvectors $\{v_k\}$. Transformation between old coordinates and new ones that are based on those new and special axes are possible, because of the rotation matrix that the method provides. Based on this property, it will be possible to consider not only the existing connection, but also those that are considered to be potentially relevant for the current process. Thus, the relevance for all of them can be derived throughout the PCA analysis. Therefore, HOSHIN KANRI TREE will promote to establish new connections that are based on a probabilistic approach, according to the eigenvalue $\{\mu_k\}$ set.

From there, (CPD)nA structural connections will be created or kept with those nodes whose significance is found to exceed an upper threshold of the variance Γ. This approach can be seen as a way of preferential attachment due to the way of promoting links. In contrast, rewiring will be eliminated for those links that incorporate less than a lower threshold γ of the variance.

In formal analytical terms, the preferential attachment that is promoted by the HOSHIN KANRI TREE can be described as the probability P_{ij} of directed linking PO from j to i (i,j = 1, …, N), as shown in equation (6-1).

$$P_{ij} = \begin{cases} \dfrac{\sum_{k=1}^{Z_{M_i}} \mu_k \bullet \delta\left(\|v_k[j]\| > 0.5\right)}{\sum_{j=1}^{N}\left(\sum_{k=1}^{Z_{M_i}} \mu_k \bullet \delta\left(\|v_k[j]\| > 0.5\right)\right)} & \forall j \in \left\{u / \left(\|v_k[j]\| > 0.5\right)\right\} \ \forall v_k \in M_i \\ 0 & \forall j \notin \left\{u / \left(\|v_k[j]\| > 0.5\right)\right\} \ \forall v_k \in M_i \end{cases} \tag{6-1}$$

where:

- v_k represents the k-esime eigenvector of the covariance matrix of the S(i,t)
- μ_k represents the k-esime eigenvalue of the covariance matrix of the S(i,t)
- $M_i=\{\mu k/CumSum(\mu_k) < \Gamma$, where $k \in (1,\ldots,N)\}$
- $\delta(s)$ is a function meaning 1 when s is true and 0 is not.
- Z_{Mi} is the cardinality of the set M_i

In contrast, the connection will be re-wired or eliminated for those links that incorporate less than a lower threshold γ of the variance. In formal analytic terms, the preferential attachment that is promoted by the HOSHIN KANRI TREE can be described as the probability Q_{ij} of directed linking PO from j to i (i,j = 1, …, N), as shown in equation 6-2.

$$Q_{ij} = \begin{cases} \dfrac{\sum_{k=1}^{Z'_{M'_i}} \mu_k \bullet \delta\left(\|v_k[j]\| > 0.5\right)}{\sum_{j=1}^{N}\left(\sum_{k=1}^{Z'_{M'_i}} \mu_k \bullet \delta\left(\|v_k[j]\| > 0.5\right)\right)} & \forall j \in \left\{u / \left(\|v_k[j]\| > 0.5\right)\right\} \ \forall v_k \in M'_i \\ 0 & \forall j \notin \left\{u / \left(\|v_k[j]\| > 0.5\right)\right\} \ \forall v_k \in M'_i \end{cases} \tag{6-2}$$

Where:

- v_k represents the k-esime eigenvector of the covariance matrix of the S(i,t)

- μ_k represents the k-esime eigenvalue of the covariance matrix of the S(i,t)

- $M'_i = \{\mu k / CumSum(\mu k) < \gamma$, where $k \in (1,\ldots,N)\}$

- δ(s) is a function that means 1 when s is true and 0 is not.

- $Z_{M'i}$ is the cardinality of the set M´i

Because of the nature of PCA, this analytical approach reinforces the LM paradigm of variability reduction.

6.2.4. Continuous growth

Second, we enable continuous growth.

We do not often think intuitively of organizational networks being open or continuously growing, because systems have a specific size capacity. By definition, a LM-oriented complex VSN attempts continuously to optimize its performance. This means that the ideal upper limit to this growth is determined by a fully connected VSN in which all nodes are connected to all of the others. This upper limit is practically unreachable. There are several reasons for this, including the natural intra-organizational fluctuations of POs and the possibility of expanding VSN to suppliers. customers and all other stakeholders. Therefore, an assumption that the RLSMS information exchange network has practically unlimited room for growth appears to be realistic.

6.3. HOSHIN KANRI FOREST

As (Barabási and Albert, 1999) show, the evolution and structure of an organizational VSN complex network are inextricable. In order to understand how they intertwine, it is necessary to recognize that complex corporate VSNs require an enormous number of elements.

Given any initial VSN corporate configuration, the HOSHIN KANRI FOREST paradigm that is proposed can be understood as a continued sequence of four concatenated phases - Do-Check- Act-Plan - as described in figure 6-1. These are four phases at an organizational level, rather than a structural level, such as the (CPD)nA between POs.

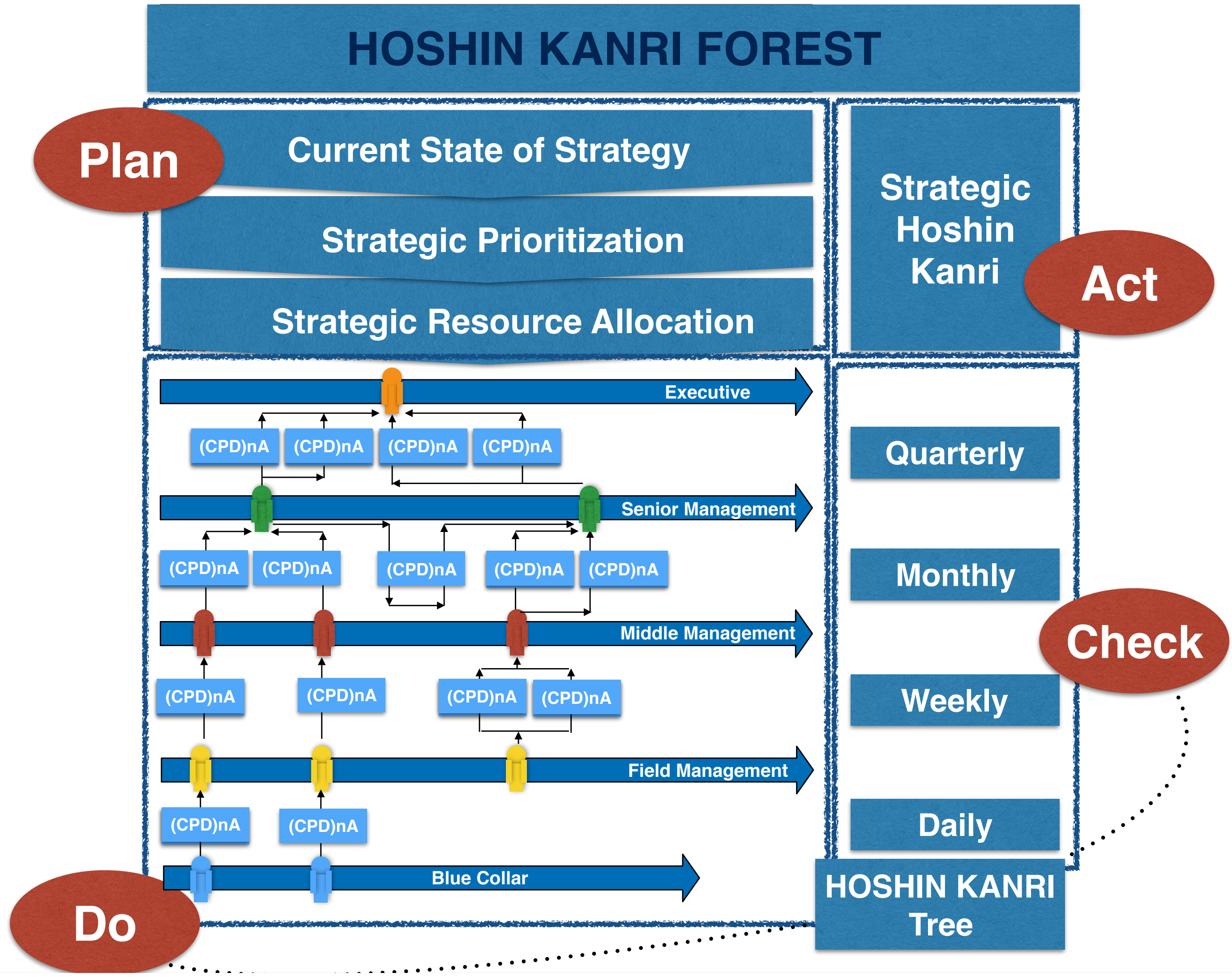

Figure 6-1. Evolutional HOSHIN KANRI FOREST phase sequence

The four phases of the HOSHIN KANRI FOREST can be described as follow:

- Do Phase. Already described in Chapter 5 it comprehends (1) Gemba-Genjitsu-Gembutsu (3G) 現場。現実。現物 phase in order to understand the current state of the process and (2) NEMAWASHI. 根回し phase in order to understand its dynamical characteristics.

- Check Phase. Already described in Chapter 5 it comprehends (1) UERU KANRI. 植える管理 phase in order to plant the HOSHIN KANRI TREE and (2) UEKI-YA KANRI. 植木屋管理 in order to provide guidelines for the lean leader to accompany the continuous growth of the process as described in this chapter through preferential attachment dynamics.
- Act Phase. This phase is well described by (Osada, 2013) and needs no further description.
- Plan Phase. In this phase, the numerous HOSHIN KANRI TREEs planted simultaneously are connected through lean structural (CPD)nA links. The branches of the HOSHIN KANRI TREEs "touch" each other hence resembling a HOSHIN KANRI FOREST.

After completing the HOSHIN KANRI TREEs, the workforce has been empowered to conduct process management following (CPD)nA. We have "planted" several HOSHIN KANRI TREEs throughout the organization, but they are not connected to each other. Hence, inter-organizational VSs might not be fully supported. Thus, we need to let us, the trees, see the forest. The overlapping branches of two trees nearly touching each other in a park offer a useful visual aid to picture that establishing contacts between HOSHIN KANRI TREEs requires their connecting through certain structural (CPD)nA links.

The HOSHIN KANRI TREE typically provides POs with useful process information that help in prioritizing future strategies and, therefore, aligning efforts. Therefore, the HOSHIN KANRI FOREST as a deals with aligning the HOSHIN KANRI TREES to the organization's strategic goals by connecting different HOSHIN KANRI TREE with strategic bondings.

In order to do this, the (CPD)nA structure is reorganized to better design a new HOSHIN KANRI TREE structure to meet future strategic challenges. First, the data that has been gathered in the HOSHIN KANRI TREE phase of all individual (CPD)nA is combined and correlated. Second, the numerical correlation of all KPIs in the form of a heat map is depicted in figure 6-2.

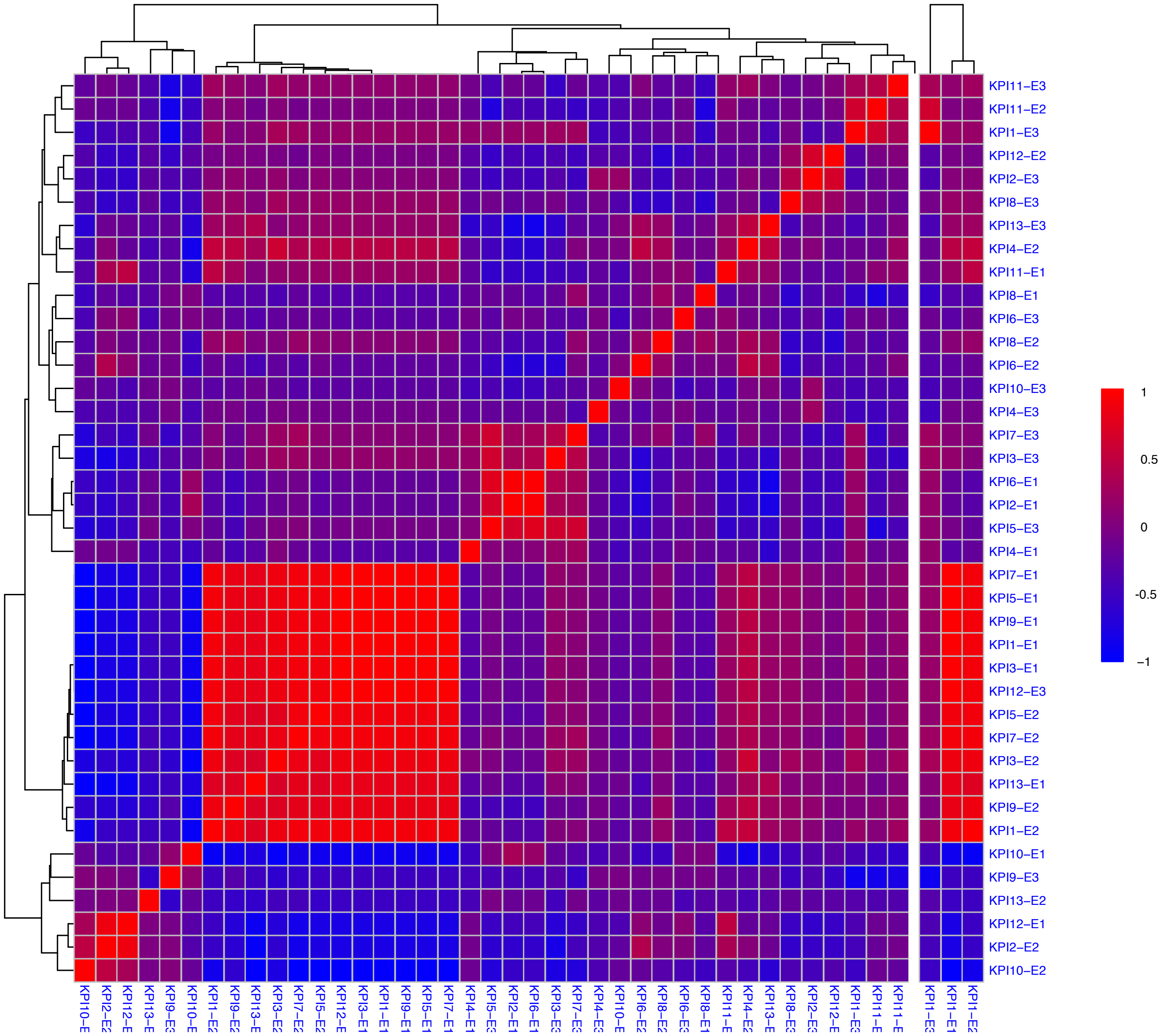

Figure 6-2. CORRELATION STRATEGIC KPI HEAT-MAP

This step is data-intensive and AI and data mining expertise is usually necessary to extract useful information. This step helps one to understand which KPIs have the greatest influence on the strategic goals by allowing important KPI correlations between previously disconnected organizational areas to be visualized. Typically, correlations that are higher than 0.8 will be considered for (CPD)nA connection. These connections have the topological effect of lowering the path length dramatically towards an SCALE FREE NETWORK.

HOSHIN KANRI FOREST has been described as an evolutional process. The research would be incomplete without an analytical characterization of the evolutional state of the process.

6.4. Analytic characterization of RLSMS. Organizational Networks' Perspective

The following RLSMS analytic categorization is based on the strategic "punctuated equilibrium model" (Dominguez et al., 2015). It indicates that organizations develop LM capabilities in alternating periods of "convergence" and "reorientation". This refers to periods of incremental change. Those, in turn, refer to periods of rapid and discontinuous change. In the context of organizational network, our research has identified two types of such RLSMS routines in organizations. These can be described as the original Japanese concepts of KAIZEN or "gradual improvement" and KAIKAKU or "fast improvement."

- KAIZEN. This form of LM System behavior is also rooted in Japan (Imai, 2012) and can be described as gradual improvement. The purpose of Kaizen is to have every PO practice continuous improvement (CI) of its own process each day throughout the entire day. Kaizen is usually implemented in steady actions. The main problem in implementing Kaizen is the failure of management to adhere to CI behavioral patterns and instill the habit of CI in the culture. For this reason, we need a structure that allows the growth and sustainability of the LM System (Stoughton and Ludema, 2012). From the perspective of organizational networks, we define the LM System as being in a KAIZEN period if the number of POs that are communicating with others through (CPD)nA m(t) increases in time. Therefore, the analytic condition for KAIZEN is $m(t)<m(t+1)$.

- KAIKAKU. This form of LM System behavior can be defined as a radical improvement (Osada et al., 2001). Kaikaku is usually implemented in focused and intense CI actions. It designs closed focused groups that have well-defined objectives. Sufficient resources and management attention are necessary. Failure is usually not an option. The consequences of failure and success are clearly stated. Kaikaku is the preferred modus-operandi in certain forms of project management that are described in Kaikaku Project Management (Ohara and Asada, 2008), task force management and CI events. The usual consequence of a continued Kaikaku-based LM System is a fundamental lack of sustainability and a resulting, long-term rejection of CI, an undesirable result (Glover, 2010). From an organizational networks´ perspective, we define the MS as being in a KAIKAKU period if the number of POs that are communicating with others through (CPD)nA m(t) does not increase. This is the case when, during disruptive changes, resources are used to concentrate on a few specific (CPD)nAs and the VSN does not have sufficient resources to grow. Therefore, the analytic condition for KAIKAKU is $m(t) \geqslant m(t+1)$.

6.5.Health Care Case Study.

The research locations of this study are two hospitals that belong to a US-based HC Corporation (HCC). HCC reported net sales revenue in 2014 of approximately $500 million. The two hospitals under study are similar in size with about 200 employees each. In order to illustrate an HOSHIN KANRI FOREST in an organization as RLSMS, the evolution of HOSHIN KANRI FOREST in these two hospitals has been mapped in this case study.

6.5.1.Scope Establishment and Specification of Population

We sought to study topological characteristics, such as p(t), q(t), m(t) and the structural network diameter in relation to the number of activated nodes. In parallel, the hospital's strategic performance was measured in order to draw conclusions.

The population involved in the HOSHIN KANRI FOREST study consisted mainly of patients, doctors and nurses, as well as maintenance, laboratory, emergency, legal and HR department administrative personnel and practically all process-related stakeholders.

6.5.2.Data Collection

All data were gathered in an ongoing research effort that was conducted from January 2012 to December 2014 and coordinated by the HCC´s OMCD. Relevant VSN information, such as p(t), q(t) or $\lambda(t)$ can be easily calculated with this data. The HOSHIN KANRI FOREST was mapped by analyzing an internal database in which all (CPD)nA were stored. The data was delivered for each point in time on a discrete, quarterly basis to the researchers from, two sources:

- the strategic performance KPIs: KPI1 Patient Lead Time (PLT) (days), KPI2 Operation Success Rate (OSR) (ppm) and KPI3 Revenue (Million-$) were provided by the corporate control department,
- the CI-oriented information exchange structure data revealed relevant structural network information, such as: the number of (#) POs connected through (CPD)nA, # (CPD)nA active, # new (CPD)nA, # new (CPD)nA within existing POs, # new (CPD)nA with new POs, # re-wired (CPD)nA, m(t) or # new activated POs and network diameter.

6.5.3. Case Study Implementation and Data Analysis

The HCC implements HOSHIN KANRI FOREST as described in four phases that form a cycle.

6.5.3.1. Do and Check. HOSHIN KANRI TREE

The implementation begins with several seminal (CPD)nA structural connections between each Hospital Manager and his direct reports on a monthly basis. These (CPD)nA are related to one of the strategic KPIs that are mentioned above.

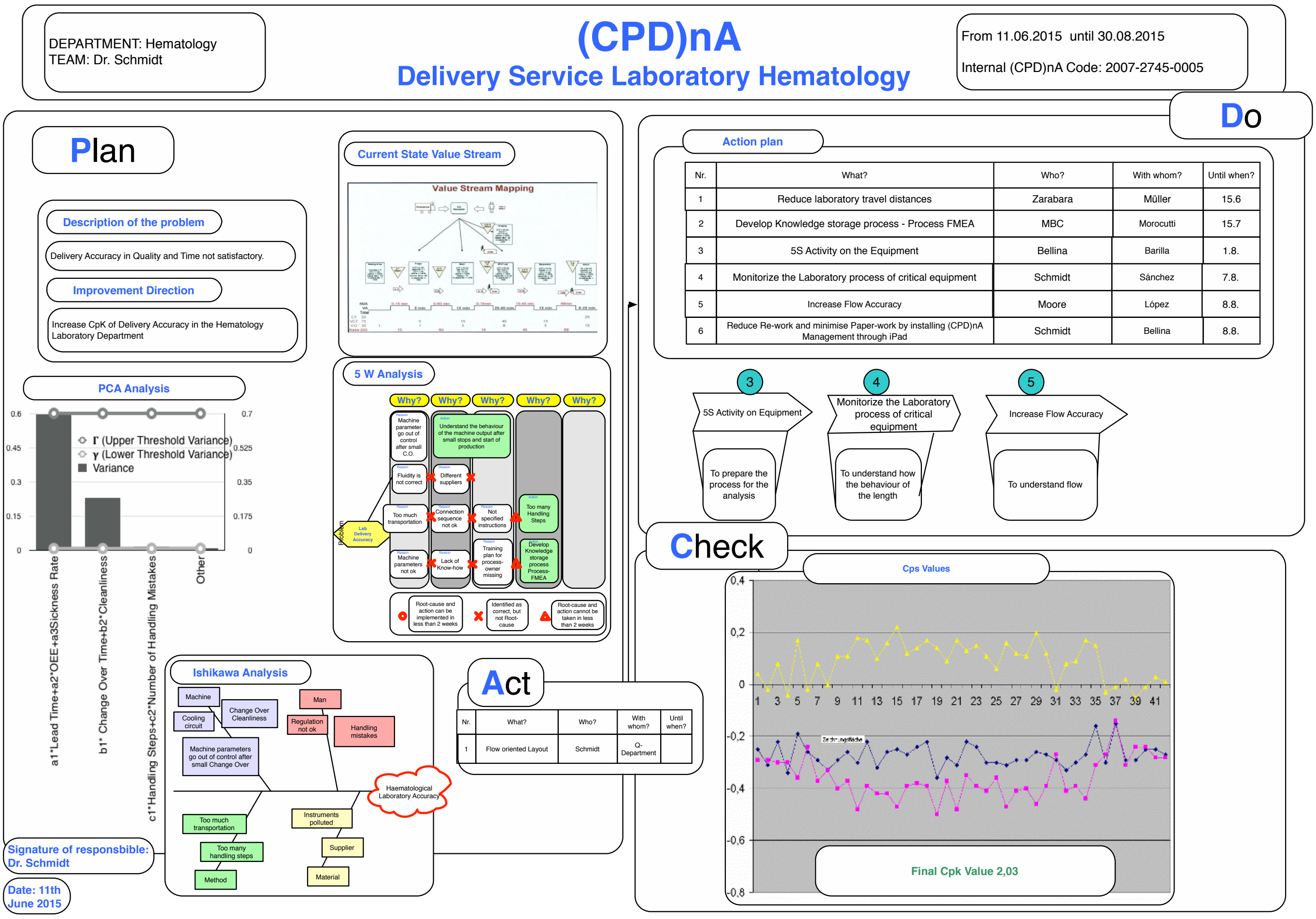

Figure 6-3. (CPD)nA. Cpk Delivery Service Laboratory Hematology

Following equation 6-1, after each (CPD)nA iteration, the (CPD)nA owners conducts a PCA analysis and decide on the most relevant (CPD)nA connections that the next iteration will need. In this study, they are Γ=70% and γ=1% of variance. As shown in Figure 6-3, the combination of Lead Time, OEE and Sickness Rate in this case has an influence of 70% of the variance. Therefore, the POs that are related to those KPIs will be connected to the PO of this (CPD)nA. Similarly, a combination of Handlings Steps and Number of Handling Mistakes have an influence of γ<1% and potential existing (CPD)nA connections of POs that are related to those KPIs will be terminated.

Figure 6-4 shows an example of how a hospital manager decided to establish new (CPD)nA connections in her structural network. It must be noted that the patient is depicted as a PO. When the HOSHIN KANRI FOREST is mature, the patient will be is involved in the communication related to her process from the very beginning, thereby increasing process transparency, improving communication and ultimately increasing trust among the doctor, nurses and patient.

In order to operationalize the shopfloor management communication, these (CPD)nA connections are visualized in a HOSHIN KANRI TREE form as shown by an example at different managerial levels and reporting frequencies in Figure 6-4.

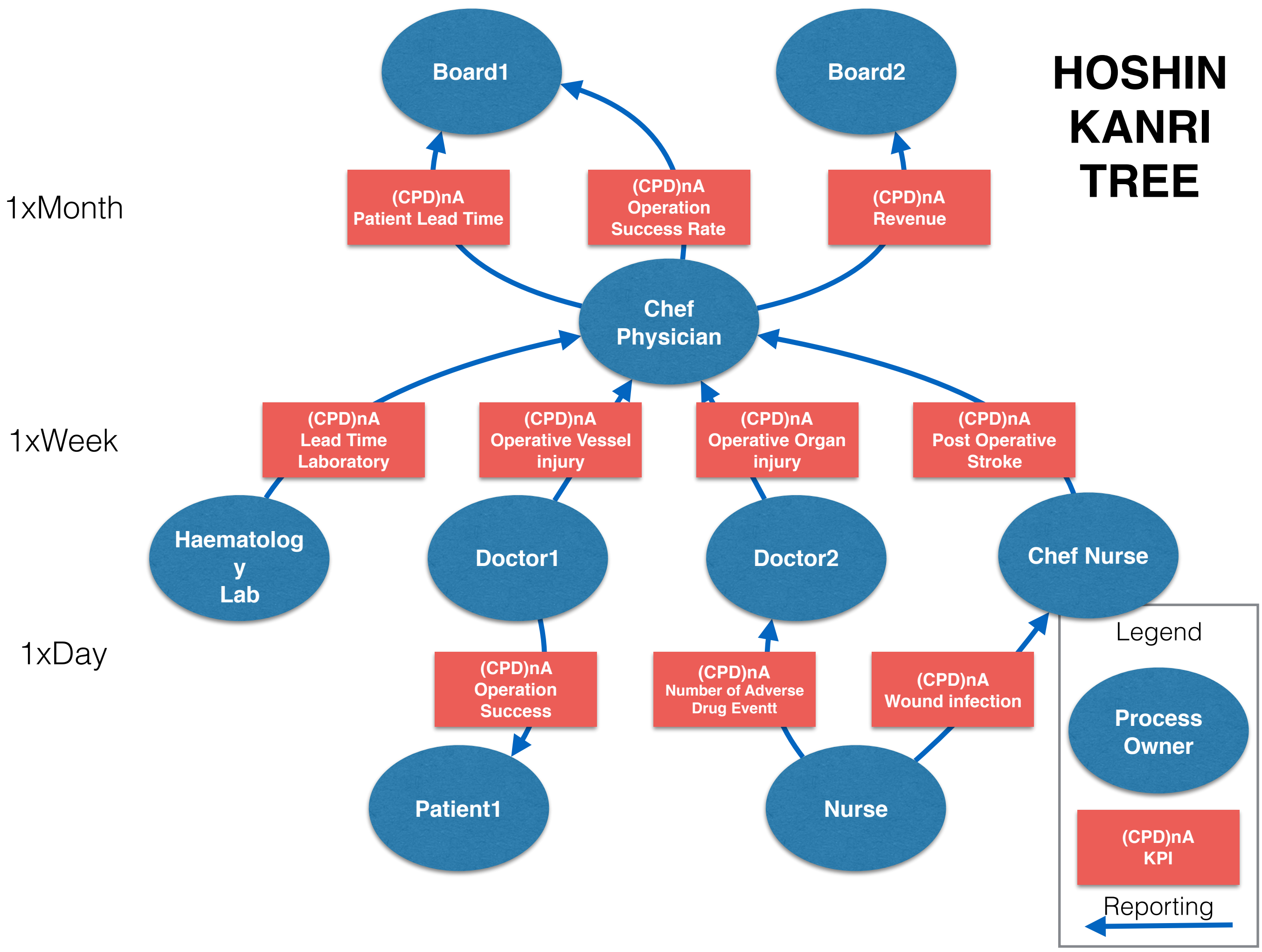

Figure 6-4. HOSHIN KANRI TREE visualization.

The HOSHIN KANRI TREE continues to grow in this manner. At the end of each quarter, each hospital manager performs a Nemawashi process in order to assess the situation and ensure that the HOSHIN KANRI TREE KPIs is capable of delivering an agreed on solution.

After applying NEMAWASHI technology to both hospital´s three strategic KPIs, the genetic algorithm showed coefficients that fulfill the conditions for asymptotic stability. The coefficients are

$$A_{Hospital1} = \begin{bmatrix} 0.46 & 0.09 & 0.96 \\ 0.56 & 0.35 & 0.73 \\ 0.21 & 0.67 & 0.46 \end{bmatrix}; \; A_{Hospital2} = \begin{bmatrix} 0.56 & 0.52 & 0.55 \\ 0.12 & 0.34 & 0.97 \\ 0.11 & 0.18 & 0.78 \end{bmatrix}.$$

Figure 6-5 shows the ternary diagrams of the evolution. This is important to ensure adjustment and sustainable common alignment.

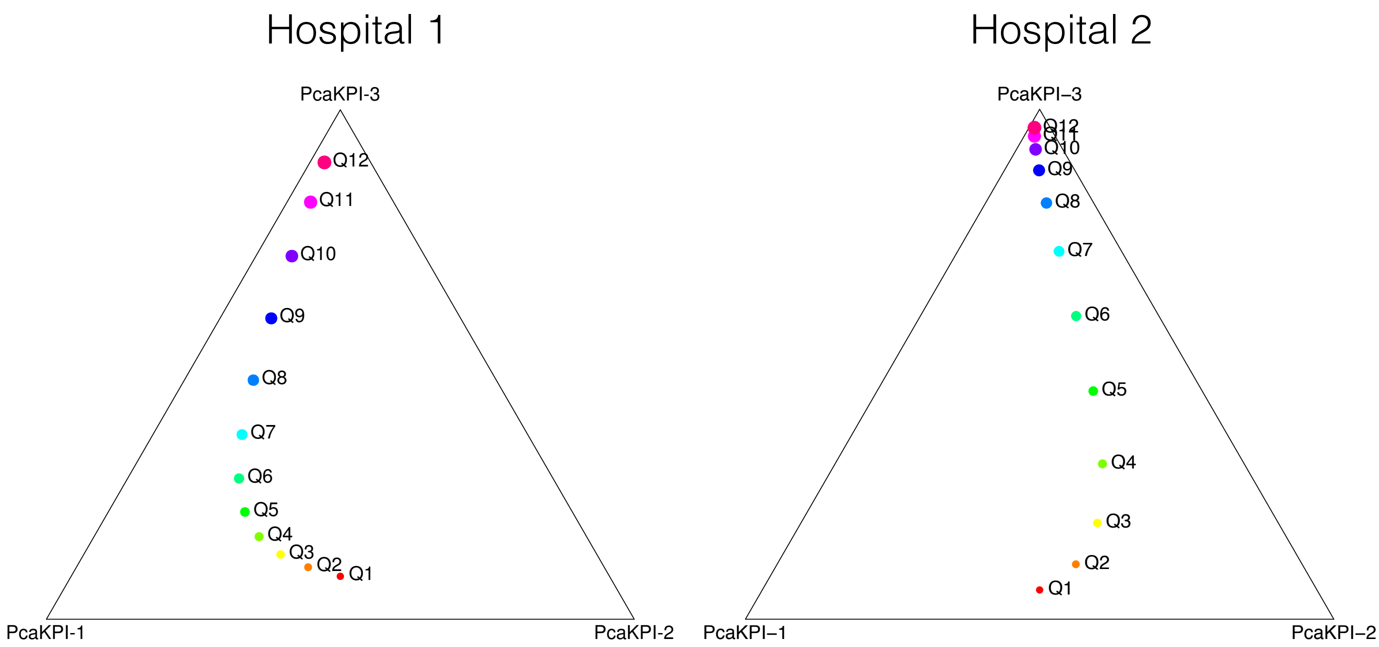

Figure 6-5. NEMAWASHI Two Hospitals.

It can be seen how the two hospitals reach asymptotic equilibrium to a sustainable revenue increase. However, for hospital 1 to achieve this, it focuses intensely on patient lead time reduction. However, the focus of hospital 2 is on increasing its operation success rate.

It can also be observed that the distance between the points in the ternary diagram of hospital 1 is shorter than the distance between the points between Q1 and Q4 in hospital 2. This indicates that there is a more dynamic NEMAWASHI initial process in hospital 2 than in hospital 1. Subsequently, the points in the ternary diagram between Q9 and Q12 are located farther apart than those in hospital 2 during the same period. This may show that hospital 1 required more time to deploy NEMAWASHI consensus dynamics in the organization than did hospital 2. Perhaps, this can be used as a signal for an organization's readiness for NEMAWASHI.

6.5.3.2.Act. STRATEGIC HOSHIN KANRI

HCC corporate leadership provides strategic new goals.

Figure 6-6 shows how the HOSHIN KANRI FOREST has evolved over the period of 12 quarters. A systematic strategic analysis of the network parameters is conducted each year to better understand the HOSHIN KANRI FOREST dynamics. Because of the standardize HOSHIN KANRI FOREST management structure, it is easy to compare the two hospitals in strategic terms.

Some of the relevant aspects of this case are:

- In Figure 6-6A, $2<\lambda(t)\leq 3 \ \forall t$. Therefore, the conditions for SW NETWORK and SCALE FREE NETWORK are achieved in similar sequences and time between the 7th and the 11th quarter after implementation started. The condition for SW NETWORK, $d(HKF) \approx \ln(N)$ is achieved when the structural network has reached all internal stakeholders in Q7. The condition for SCALE FREE NETWORK, $d(HKF) \approx \ln(\ln(N))$ is achieved when the structural network is expanded to the patients in Q11, thereby reaching one-on-one customization in the relationship with the patient. At this stage, as soon as each patient enters, the hospital becomes a (CPD)nA that will accompany her throughout the entire hospital experience. The patient, as the customer, becomes part of the organizational structure and receives prompt standardized information about her related KPIs (Check), the treatment process, the current priorities, and the analysis (Plan), as well as the actions that the (CPD)nA sender (Doctor or Nurse typically) will undertake for her best treatment (Do). This allows for several benefits: (1) the patient feels that the process is fully transparent, (2) this transparency increases the quality of communication among doctors, nurses and patients, (3) this reduces patient lead times because no information must be sought, as every patient-related document is standardized and accessed through the

(CPD)nA and (4) the hospital becomes increasingly paper-free and lean in its administration (i.e., with the aid of iPads, doctors and nurses can access relevant patient-related (CPD)nA simply by scanning the codes on the patient's identification cards.

- In figure 6-6B, it can be seen that the maturity level of the HOSHIN KANRI FOREST increases in time as 1-p(t)-q(t) increases almost constantly. This means that the combined effect of the quota of new (CPD)nA links and the quota of re-wired (CPD)nA within existing POs decreases almost constantly. This makes sense from an evolutional perspective, in view of the oscillatory nature of (CPD)nA. For this and other reasons, continuous growth of the network is necessary to attain the desired SCALE FREE NETWORK structure in HOSHIN KANRI FOREST.

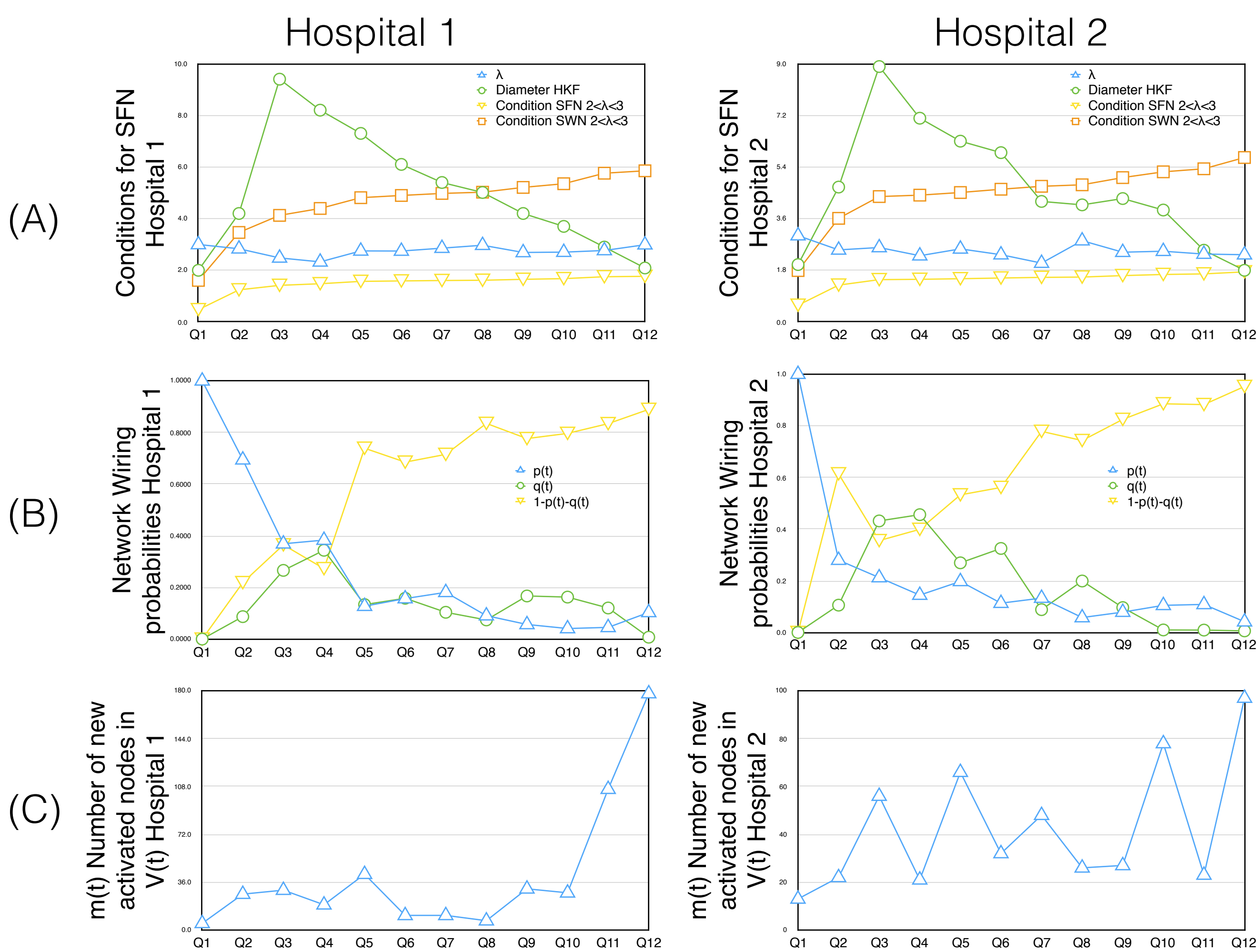

Figure 6-6. Case Study Results. HOSHIN KANRI FOREST evolution.

- In figure 6-6C it can be seen that the number of newly activated nodes, m(t), increases and decreases in alternating periods of KAIZEN and KAIKAKU. The behavior of both hospital 1 and 2 is different. In hospital 1, the variability of m(t) is less pronounced than in hospital 2. This confirms the conclusions that were drawn from observation of the NEMAWASHI process previously. A high variability of m(t) may indicate higher consensus dynamics. Hostpital 2 experiences more acute punctuated equilibrium dynamics.

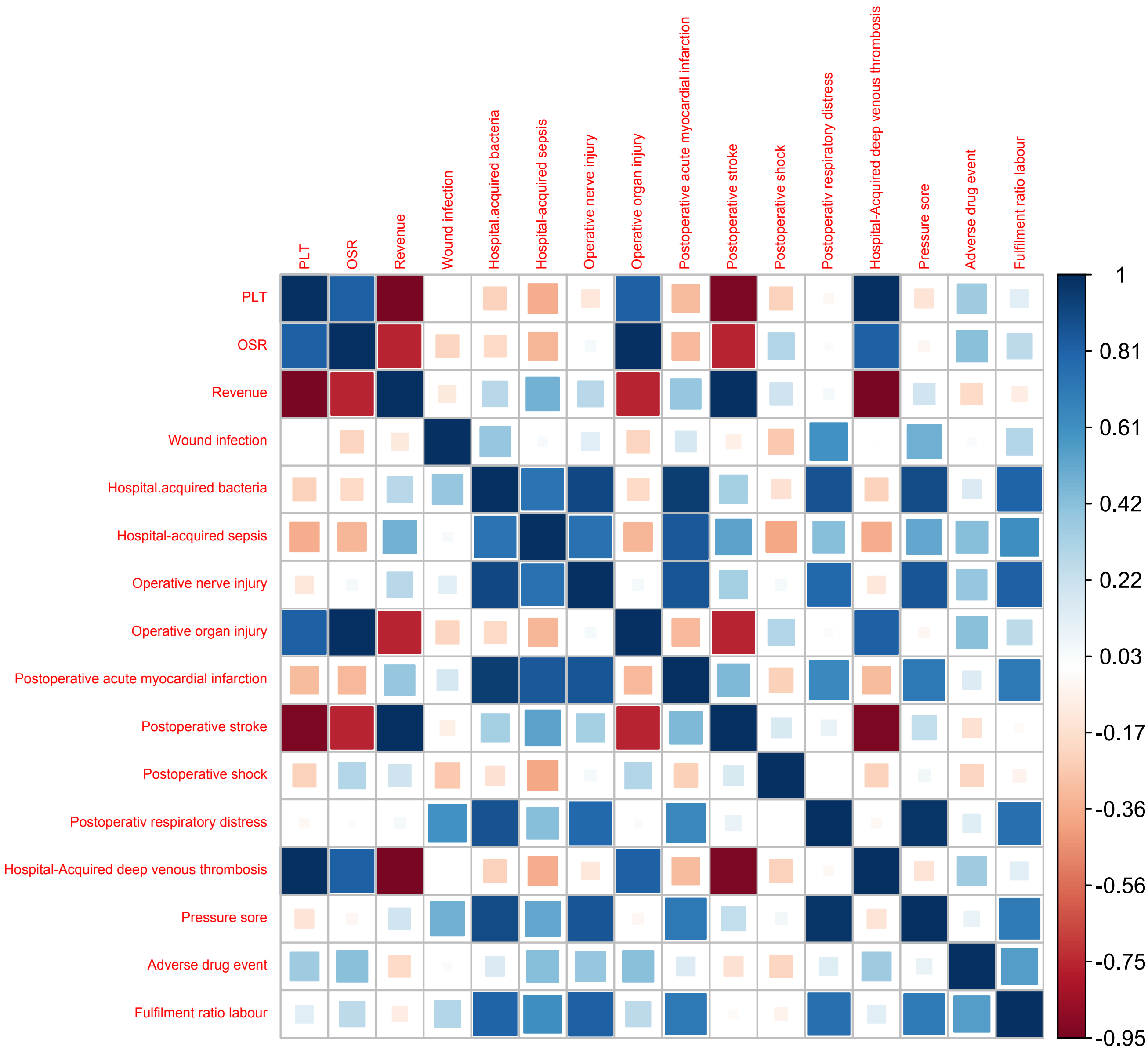

Figure 6-7. Heatmap correlation. Year 1. Hospital 1.

6.5.3.3.Plan. HOSHIN KANRI FOREST

After the first year of performing (CPD)nA and HOSHIN KANRI TREE as described, the hospital manager and all related hospital leaders attend a one-week strategic workshop at which a previously prepared KPI correlation heatmap is discussed in order to guide the hospital to the new strategic challenges that are set by the corporate leadership. By identifying relevant correlations between the strategic KPIs and other operational KPIs, new strategic (CPD)nA connections can be created.

It is seen in figure 6-7, for instance, that the strategic goal of OSR has a strong correlation with Operative Organ Injury. Therefore, a new (CPD)nA connection from the chief doctor to a related PO is needed in order to influence the strategic OSR goal. In this way, several HOSHIN KANRI TREEs are (re-)connected together to ensure alignment, thereby creating a HOSHIN KANRI FOREST.

6.5.4.Case Summary and Limitations

6.5.4.1.Case Summary

The data analysis of these two hospitals has shown the evolution of the HOSHIN KANRI FOREST information exchange to an RLSMS. The data analysis also has shown that, in order to achieve this, the HOSHIN KANRI FOREST information exchange structure undergoes alternate phases of “convergence” and “reorientation,” as described in the punctuated equilibrium model.

6.5.4.2.Case Limitations

Although the case study is extensive and has more than 800 individuals under study, one single case study is not sufficient to claim general validity of a model. Thus, causation cannot be inferred. At best, the case study can provide practical insights that would be otherwise difficult to present from a theoretical perspective. Two limiting aspects are particularly worth mentioning in order to temper the results. They are: (1) the time frame of three years that was given in the study was relevant in this particular case, in view of the size of the HKF information exchange network that was created and the corporation’s maturity level and (2) the HC-related complexity presented great challenges to communication due to the heterogeneity of the population that was involved. Effective and efficient communication among doctors, nurses, patients and many other stakeholders who participated in an inter-disciplinary exchange of information was only possible by the standardization of communication, that is, through (CPD)nA. The author expects that there will be replicable dynamics, but different time frames in other circumstances.

6.6.Management implications

Several propositions and its related benefits are shown that may help service and manufacturing leaders to better design and manage the HOSHIN KANRI FOREST as RSLSM:

Proposition 1. The HOSHIN KANRI FOREST is applicable as both a service and manufacturing system. As was shown in Section 3.1., the standardization of a VS-oriented information exchange by an inter-process exchange standard, such as (CPD)nA, enables the universal application of HOSHIN KANRI FOREST to both service and manufacturing industries.

Management Implication 1. Managers can benefit from the universal property of HOSHIN KANRI FOREST as RLSMS, because the standardization can be implemented along VSN that combine service and manufacturing processes. This enables both standardized intra-organizational and inter-organizational implementation towards customers and suppliers across organizational boundaries.

Proposition 2. HOSHIN KANRI FOREST fulfills structural, functional and evolutional conditions for RLSMS. The nature of (CPD)nA as an inter-process standard makes a modular, integrable, flexible and diagnosable organizational design possible. (CPD)nA serves as a fractal component that enables the flexible integration of organizational individual POs within complex VSN that can be diagnosed in real time with the aid of HOSHIN KANRI TREE technology. The scalability conditions of preferential attachment and continuous growth are fulfilled by HOSHIN KANRI FOREST.

Management Implication 2. The management of such a system by preferential attachment to systematic variability reduction and practically continuous network growth enables the emergence of HOSHIN KANRI FOREST as a scale-free lean-oriented organizational RLSMS.

Proposition 3. Service and Manufacturing Leaders can quantify and, therefore, direct the structure of their management system to one that best suits their needs. The topological characterization of the HOSHIN KANRI FOREST that has been shown enables leaders to quantify the structure of the RLSMS from a network´s perspective and link this to organizational performance.

Management Implication 3. By deliberately alternating KAIZEN and KAIKAKU phases, managers can direct the process towards structures that best suit their specific organizational needs.

7.CONCLUSIONS

Describing organizational structure as trees and forests creates an extremely powerful metaphor. Consequently, much of this work has been inspired by such a botanical view. The observant reader, however, may have noticed that this image has a limitation - every plant in a garden is isolated physically. In other words, forests are not networks. Nevertheless, trees are useful in seeking to understand organizational complexity. As the organizational leader daydreams his way to the timberland, he may notice that the ground is completely shaded. When he looks up, he may see a thick tapestry of intersecting and interwoven branches, that is so complex that it is difficult to see to which tree any particular branch belongs.

This work has provided several insights into this organizational complexity that aim to answer the initially proposed research questions: RQ1. How should an Organization be strategically (re-) designed in order to implement and sustain LM? and RQ2. Can mathematical models for information flow and connectivity be suggested that help organizations steer successful Strategic Organizational Design process under the dynamic effect of evolutional forces towards sustainable implementation of LM?

In order to do so, in the following paragraphs several HOSHIN KANRI FOREST organizational propositions and its related managerial conclusions are presented.

Proposition 1. ***LSN is the organizational correlates of organizational learning capability. Organizational learning capability reaches a maximum rate with SW structural network configurations.***

Management Implication 1. Because SW configuration is achieved when $dt \approx \ln(N)$, an important implication of this is that it provides leaders with measurable KPIs to steer their Strategic Organizational Design process to such desirable SW LSN configuration. Instead of designing for matrix or other less flexible organizational configurations, SW LSN provides maximum organizational learning rates.

Proposition 2. ***SW structural network configuration is achieved when the number of VS oriented structural motifs is kept small and the number of functional motifs is maximized. This has been described as Lean Strategic Organizational Design.***

Management Implication 2. This has important organizational design implications: the first is that only a few number of structural motifs is necessary to build SW LSN configurations. This saves configuration costs and eases the organizational design effort. The second is that the number of functional motifs should not be bounded and the creativity and connectivity power of POs should be left to the responsible management of the PO involved.

Proposition 3. ***LFN paves the road for LSN to grow.***

Management Implication 3. This means that by working together (functional connections through the Do-Phase) the likelihood that POs create a structural bond between each other is more probable. This means that SW and SF structure will be first achieved on a functional level and only then will the structural network achieve such configurations.

How such an SW structural network evolves into an SF network, when expanding beyond the organizational boundaries to customers and suppliers by the applying such RLSMS systems as HKF has been shown.

This has important implications for organizational leaders because empowering their POs to engage in dynamic continuous improvement short term actions will undoubtedly have a structural impact in the organization in the long term.

Proposition 4. ***Organizational states correspond to dynamical patterns in the LEN.***

Management Implication 4. When organizational leaders try to understand the dynamics within their organization and the interactions of their organizations with other organizations, they may be overwhelmed by the complexity. For instance, leaders may wish to know how long it may take to attain organizational consensus when describing certain strategic goals. Alternatively, they may wish to know if their organization is changing smoothly (KAIZEN) or abruptly (KAIKAKU).

LEN becomes then a powerful paradigm to help discover organizational dynamic pattern formation. This has enormous implications for organizational leaders who can determine the dynamic characteristics of their organizations and direct their pursuit of a Lean Strategic Organizational Design.

Proposition 5. ***Organizational culture is what LSN, LFN and LEN combined feel like.***

Management Implication 5. It is difficult to provide a scientific measure of an elusive concept, such as organizational culture. However, any PO of an organization will answer in the affirmative, if asked if his organization has a certain "culture." How this culture "feels" is a combination of how information is processed to support the VSs (LSN), how actions on such VSs (LFN) are implemented and how organizational clusters find consensual solutions forming the coordinated entity that we understand as organization.

How the individual PO "feels" within these three networks combined acting on him can be understood as organizational culture, which can have an important impact on overall organizational performance. This is a matter that is not discussed in this work. Instead, it may be explored in the future by organizational psychology.

REFERENCES

Akao, Y., 2004. Hoshin Kanri. Policy deployment for Successful TQM. Productivity Press, Cambridge.

Albert, R., Barabási, A.-L., 2000. Topology of Evolving Networks: Local Events and Universality. PHYSICAL REVIEW LETTERS 85, 5234–5237.

Azuma, H., 2014. チームの目標を達成する!PDCA [Goal achievement with PDCA!], 1st ed. 新星出版社, Tokyo.

Barabási, A.-L., Albert, R., 1999. Emergence of Scaling in Random Networks. Science 286, 509–512.

Bicheno, J., 2008. Policy Deployment, in: The Lean Toolbox for Service Systems, Systems and Industrial Engineering Books. Picsie Books, Buckingham, pp. 282–287.

Boccaletti, S., Latora, V., Moreno, Y., Chavez, M., Hwang, D.U., 2006. Complex networks: Structure and dynamics. Physics Reports 424, 175–308.

Borangiu, T., Thomas, A., Trentesaux, D. (Eds.), 2012. Service Orientation in Holonic and Multi-Agent Manufacturing Control, 1st ed, Studies in Computational Intelligence. Springer-Verlag Berlin Heidelberg.

Borches, P.D., Bonnema, G.M., 2008. ON THE ORIGIN OF EVOLVABLE SYSTEMS. EVOLVABILITY OR EXTINCTION, in: Proceedings of the TMCE. Kusadasi, Turkey.

Burnes, B., 2004. Emergent change and planned change – competitors or allies? International Journal of Operations & Production Management 24, 886–902.

Burton, R.M., Obel, B., 2004. Strategic Organizational Diagnosis and Design: The Dynamics of Fit. Kluwer Academic Publishers, Dordrecht.

Burton, R.M., Obel, B., DeSanctis, G., 2011. Organizational Design: A Step-by-Step Approach, 2nd ed. Cambridge University Press, Cambridge, UK.

Byrd, T. A., Turner, D. E., 2000. Measuring the flexibility of information technology infrastructure: Exploratory analysis of a construct. Journal of Management Information Systems 17, 167–208.

Cäker, M., Siverbo, S., 2014. Strategic alignment in decentralized organizations — The case of Svenska Handelsbanken. Scandinavian Journal of Management 30, 149–162.

Carneiro, J., Salter, S.B., Punnett, B.J., 2015. Local responses to global challenges: Lessons from small economies. Journal of Business Research.

Cattani, G., Ferriani, S., Negro, G., Perretti, F., 2008. The Structure of Consensus: Network Ties, Legitimation, and Exit Rates of U.S. Feature Film Producer Organizations. Administrative Science Quarterly 53, 145–182.

Cegarra-Navarro, J.-G., Soto-Acosta, P., Wensley, A.K.P., 2015. Structured knowledge processes and firm performance: The role of organizational agility. Journal of Business Research.

Cocco, M., Cerri, D., Taisch, M., Terzi, S., 2014. Development and Implementation of a Product Life Cycle Optimization Model, in: Technology and Innovation (ICE), 2014. Presented at the International ICE Conference on Engineering, IEEE, Bergamo.

Cohen, R., Havlin, S., 2003. Scale-Free Networks Are Ultrasmall. Physical Review Letters 90, 058701–1:4.

Coleman, P.T., 2004. Implicit Theories of Organizational Power and Priming Effects on Managerial Power-Sharing Decisions: An Experimental Study. Journal of Applied Social Psychology 34, 297–321.

Covey, S.R., 2004. The 8th Habit. From Effectiveness to Greatness. Free Press, New York.

Cross, R.L., Singer, J., Colella, S., Thomas, R.J., Silverstone, Y. (Eds.), 2010. The Organizational Network Fieldbook: Best Practices, Techniques and Exercises to Drive Organizational Innovation and Performance, 1st ed. Jossey-Bass.

Daft, R.L., Weick, K.E., 1984. Toward a model of organizations as interpretation systems. Academy of Management Review 9, 284–295.

Damelio, R., 2011. Chapter 5. Cross-Functional Process Map (aka Swimlane Diagram), in: The Basics of Process Mapping. CRC Press, FL, USA, pp. 73–92.

Davies, M., 2014. Finding economies of scale and coordination of care along the continuum to achieve true system integration. Healthcare Management Forum 27, 158–160.

Davis, J.A., Leinhardt, S., 1972. The Structure of Positive Interpersonal Relations in Small Groups, in: Berger, J. (Ed.), Sociological Theories in Progress. Houghton Mifflin, Boston, pp. 218–251.

Decouttere, C., Vandaele, N., 2013. A Broader View on Health Care System Design and Modelling, in: Proceedings of the International Conference on Health Care Systems Engineering, Springer Proceedings in Mathematics & Statistics. Springer International Publishing, pp. 215–225.

Deif, A.M., E.l.Maraghy, W.H., 2006. A control approach to explore the dynamics of capacity scalability in reconfigurable manufacturing systems. Journal of Manufacturing Systems 25, 12–24.

de Leeuw, S., van der Berg, J.P., 2011. Improving operational performance by influencing shopfloor behavior via performance management practices. Journal of Operations Management 29, 224–235.

DeMente, B.L., 2003. Kata. The key to understanding and dealing with the japanese! Tuttle Publishing, Boston.

Demeter, K., Losonci, D., Matyusz, Z., Jenel, I., 2009. The Impact of Lean Management on Business Level Performance and Competitiveness, in: Reiner, G. (Ed.), Rapid Modeling for Incresing Competitiveness. Springer London, pp. 177–198.

Deming, E.W., 1964. Statistical Adjustment. Dover, New York.

Di, X., Biswal, B.B., 2013. Dynamic brain functional connectivity modulated by resting-state networks. Brain Struct Funct. doi:DOI 10.1007/s00429-013-0634-3

Dominguez, M.C.C., Galán-González, J.L., Barroso, C., 2015. Patterns of strategic change. Journal of Organizational Change Management 28, 411–431.

Durugbo, C., Tiwari, A., Alcock, J.R., 2013. Modelling information flow for organisations: A review of approaches and future challenges. International Journal of Information Management 33, 597–610.

Eisenhardt, K., 1989. Building theories from case study research. Academy of Management Review 14, 532–550.

ElMaraghy, H., 2006. Flexible and reconfigurable manufacturing systems paradigms. Int J Flex Manuf Syst 17, 261–276.

Fischer, K., Florian, M., 2015. Contribution of Socionics to the Scalability of Complex Social Systems, in: Socionics, Lecture Notes in Artificial Intelligence. Springer-Verlag Berlin Heidelberg, pp. 1–14.

Freedman, H.I., 1980. Deterministic Mathematical Models in Population Ecology. Marcel Dekker, INC.

Friedman, V.J., Lipshitz, R., Popper, M., 2005. The Mystification of Organizational Learning. Journal of Management Inquiry 14, 19–30.

Friston, K.J., 1994. Functional and Effective Connectivity in Neuroimaging: A Synthesis. Human Brain Mapping 2, 56–78.

Frow, N., Marginson, D., Ogden, S., 2010. Continuous" budgeting: Reconciling budget flexibility with budgetary control. Accounting, Organizations and Society 35, 444–461.

Fujimoto, T., 2001. Evolution of Manufacturing Systems at Toyota. Productivity Press, Portland.

FUJITSU, 2010. 障害を予知し事前に回避する. 新しいクラウド障害対処技術 (To avoid in advance to predict failure. New cloud troubleshooting technology). FUJITSU JOURNAL 36, 14–15.

Galbraith, J.R., 2014. Designing Organizations: Strategy, Structure, and Process at the Business Unit and Enterprise Levels, 3rd ed. Jossey-Bass, San Francisco.

Galbraith, J.R., 2012. The future of Organization Design. Journal of Organization Design 1, 3–6.

Galbraith, J.R., 1974. Organizational Design: An Information Processing View. Interfaces 4, 28–36.

Giret, A., Botti, V., 2009. Engineering Holonic Manufacturing Systems. Computers in Industry 60, 428–440.

Glover, W.J., 2010. Critical Success Factors for Sustaining Kaizen Event Outcomes (PhD Thesis). State University Virginia, Blacksburg, Virginia.

Godinho-Filho, M., Barco, C.F., Tavares-Neto, R.F., 2014. Using Genetic Algorithms to solve scheduling problems on flexible manufacturing systems (FMS): a literature survey, classification and analysis. Flexible Services and Manufacturing Journal 26, 408–431.

Gollo, L.L., Breakspear, M., 2014. The frustrated brain: from dynamics on motifs to communities and networks. Philosophical Transactions of the Royal Society of London B: Biological Sciences 369. doi: 10.1098/rstb.2013.0532

González-Díaz, L.A., Gutierrez, E.D., Varona, P., Cabrera, J.L., 2013. Winnerless competition in coupled Lotka-Volterra maps. PHYSICAL REVIEW E88, 1–6.

Grant, R.M., 2010. Organization Structure and Management Systems: The Fundamentals of Strategy Implementation, in: Contemporary Strategy Analysis. John Wiley & Sons, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, United Kingdom, pp. 174–206.

Gupta, M.C., Boyd, L.H., 2008. Theory of constraints: a theory for operations management. International Journal of Operations & Production Management 28, 991–1012.

Hanisch, B., Wald, A., 2014. Effects of complexity on the success of temporary organizations: Relationship quality and transparency as substitutes for formal coordination mechanisms. Scandinavian Journal of Management 30, 197–213.

Han, J., Moraga, C., 1995. The influence of the sigmoid function parameters on the speed of backpropagation learning, in: Mira, J., Sandoval, F. (Eds.), From Natural to Artificial Neural Computation, Lecture Notes in Computer Science. Springer Berlin Heidelberg, pp. 195–201.

Hao, Q., Kasper, H., Muehlbacher, J., 2012. How does organizational structure influence performance through learning and innovation in Austria and China. Chinese Management Studies 6, 36–52.

HARBOUR Consulting, 2007. The HARBOUR Report. HARBOUR Consulting, USA.

Henry, M., Stevens, H., 2009. 8. Multiple Basins of Attraction, in: A Primer of Ecology with R, Use R! Springer Science+Business Media, New York, pp. 227–254.

Higgins, E.T., 1997. Beyond pleasure and pain. American Psychologist 52, 1280–1300.

Hiiragi, S., 2013. 危機対応としての問題解決力 －トヨタ生産システム成立とその後の展開－ (Problem-Solving Capability for Current and Potential Business Crises Response －Creation and Continuous Development of the Toyota Production System －. Manufacturing Management Research Center 440.

Hino, S., 2006. Toyota´s System of Production Functions, in: Inside the Mind of Toyota. Productivity Press, New York, p. 241.

Hofbauer, J., Sigmund, K., 1988. Evolutionary games and population dynamics. Cambridge University Press, Cambridge.

Huffman, C., Houston, M.J., 1993. Goal-oriented experiences and the development of knowledge. Journal of Consumer Research 20, 190–207.

Hutchins, D., 2008. Chapter 10. Hoshin Policy Deployment and Control, in: Hoshin Kanri: The Strategic Approach to Continuous Improvement. Gower Publishing Limited, Hampshire, England, pp. 93–106.

Imai, M., 2012. Gemba Kaizen: A Commonsense Approach to a Continuous Improvement Strategy, 2nd ed. McGraw-Hill Professional, New York.

Jensen, T.B., 2013. Design principles for achieving integrated healthcare information systems. Health Informatics Journal 19, 29–45.

Jolayemi, J.K., 2008. Hoshin kanri and hoshin process: A review and literature survey. Total Quality Management & Business Excellence 19, 295–320.

Jovanocić, M., Zupan, S., Starbek, M., Prebil, I., 2014. Virtual approach to holonic control of the tyre-manufacturing system. Journal of Manufacturing Systems 33, 116–128.

Kates, A., Galbraith, J.R., 2007. Designing your Organization. Using the Star Model to Solve critical design challenges., 1st ed. Jossey-Bass, San Francisco.

Kauffman, R.J., Tsai, J.Y., 2010. With or without you: The countervailing forces and effects of process standardization. Electronic Commerce Research and Applications 9, 305–322.

Kelso, S.J.A., 1995. Dynamic Patterns. The Self-Organization of Brain and Behavior. MIT Press, Cambridge.

Kesler, G., Kates, A., 2011. Leading Organization Design. Jossey-Bass, San Francisco.

Khanchanapong, T.T., Prajogo, D., Sohal, A.S., Cooper, B.K., Yeung, A.C.L., Cheng, T.C.E., 2014. The unique and complementary effects of manufacturing technologies and lean practices on manufacturing operational performance. International Journal of Production Economics 153, 191–203.

Kinjo, A.R., Nakamura, H., 2012. Composite Structural Motifs of Binding Sites for Delineating Biological Functions of Proteins. PLoS ONE 7, e31437.

Kobayashi, H., Osada, H., 2012. IT ベンダーの提案型営業のプロセスモデル (Process model for proposal-based sales in the IT vendors). 日本 MOT 学会による査読論文 1, 58–67.

Kobayashi, I., 1995. Key 2. Rationalizing the System / Management by Objectives, in: 20 Keys to Workplace Improvement. Productivity Press Inc, Ney York.

Koepp, G.A., Manohar, C.U., McCrady-Spitzer, S.K., Levnie, J.A., 2011. Scalable office-based health care. Health Services Management Research 24, 69–74.

Koren, Y., Shpitalni, M., 2010. Design of reconfigurable manufacturing systems. Journal of Manufacturing Systems 29, 130–141.

Kulkarni, S.R., Lugosi, G., Venkatesh, S.S., 1998. Learning Pattern Classification—A Survey. IEEE TRANSACTIONS ON INFORMATION THEORY 44, 2178–2206.

Lee, J., Bagheri, B., Kao, H., 2014. Recent Advances and Trends of Cyber-Physical Systems and Big Data analytics in Industrial Informatics, in: IEEE International Conference on Industrial Informatics. Presented at the INDIN, Porto Alegre, Brazil.

Levchuk, G.M., Serfaty, D., Pattipati, K.R., 2006. SECTION III: ORGANIZATIONAL LEVEL ADAPTABILITY. Normative design of project-based adaptive organizations, in: Burke, C.S., Pierce, L.G., Salas, E. (Eds.), Understanding Adaptability: A Prerequisite for Effective Performance within Complex Environments, Advances in Human Performance in Cognitive Engineering Research. Elsevier Ltd., Amsterdam, pp. 276–278.

Liedtka, J.M., Parmar, B.L., 2012. Moving Design from Metaphor to Management Practice. Journal of Organization Design 1, 51–57.

Lillrank, P., 2003. The quality of standard, routine and nonroutine processes. Organization Studies 24, 215–233.

Linnea, C., 2009. Stable Coexistence of Three Species in Competition (Examensarbete). LINKöPING UNIVERSITET, LINKÖPING, SWEDEN.

Lipsitz, L.A., 2012. Understanding Health Care as a Complex System. JAMA. The Journal of the Amercian Medical Association. 308, 243–244.

Markman, A.B., Brendl, C.M., 2000. The influence of goals on value and choice. Psychology of Learning and Motivation 39, 97–128.

Marsden, N., 1998. The use of hoshin kanri planning and deployment systems in the service sector: an exploration. Total Quality Management 9, 167–171.

McChesney, C., Covey, S., Huling, J., 2012. The 4 Disciplines of Execution: Achieving Your Wildly Important Goals, 1st ed.

Mikkola, J.H., Gassmann, O., 2003. Managing Modularity of Product Architectures: Toward an Integrated Theory. IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT 50, 204–218.

Milo, R., Shen-Orr, S., Itzkovitz, S., Kashtan, N., Chklovskii, D., Alon, U., 2002. Network motifs: simple building blocks of complex networks. Science 298, 824–827.

Mintzberg, H., 1979. The Structuring of Organizations. Prentice Hall Engelwood Cliffs, New Jersey.

Miyauchi, K., 2014. A4一枚から作成できる・PDCAで達成できる 経営計画の作り方 (How to make it achievable business plan is in the can · PDCA created from the A4 one). 日本実業出版社, Tokyo.

Münstermann, B., Eckhardt, A., Weitzel, T., 2010. The performance impact of business process standardization. An empirical evaluation of the recruitment process. Business Process Management Journal 16, 29–56.

Nakanishi, T., 2013. トヨタ対VW(フォルクスワーゲン) 2020年の覇者をめざす最強企業 [Toyota vs. VW (Volkswagen) Strongest companies in 2020]. 日本経済新聞出版社, Tokyo.

Narkhede, B.E., Nehete, R.S., Mahajan, S.K., 2012. EXPLORING LINKAGES BETWEEN MANUFACTURING FUNCTIONS, OPERATIONS PRIORITIES AND PLANT PERFORMANCE IN MANUFACTURING SMES IN MUMBAI. International Journal for Quality research 6, 9–22.

Niyogi, X., 2004. Locality preserving projections, in: Neural Information Processing Systems. MIT Press, p. 153.

Nonaka, I., Toyama, R., Hirata, T., 2008. Managing flow. A process theory of the Knowledge-based firm. PALGRAVE MACMILLAN, New York.

Nonaka, I., von Krogh, G., Voelpel, S.C., 2006. Organizational knowledge creation theory: evolutionary paths and future advances. Organization Studies 27, 1179–1208.

Nonaka, I., Zhu, Z., 2012. Pragmatic Strategy. Eastern Wisdom, Global Success. Cambridge University Press, New York.

Ohara, S., Asada, T., 2008. Japanese Project Management. KPM — Innovation, Development and Improvement, 1st ed, Japanese Management and International Studies.

Ohno, T., 2014. トヨタ生産方式の原点 [The origin of the Toyota Production System]. 日本能率協会マネジメントセンター (Japan Management Association Management Center), Tokyo.

Ordóñez, L.D., Schweitzer, M.E., Galinsky, A.D., Bazerman, M.H., 2009. Goals Gone Wild: The Systematic Side Effects of Over-Prescribing Goal Setting. Harvard Business Review 09-083, 1–27.

Osada, H., 2013. 戦略的方針管理の研究と開発 (Research and Development of Strategic Management by Policy). Journal of the Japanese Society for Quality Control 44, 58–64.

Osada, H., 1998. 戦略的方針管理のコンセプトとフレームワーク (Concept and Framework of Strategic Management by Policy(SMBP)). Journal of the Japanese Society for Quality Control 28, 156–168.

Osada, T., Tsuchiya, S., Nakanishi, K., 2001. Monozukuri kaikaku no tameno TPM. Nikkan Kogyo Shinbun, Tokyo, Japan.

Otsusei, S., 2005. 方針管理とバランス・スコアカードの関係に関する研究 (Relations between Hoshin Kanri and Balanced Score Card). 環太平洋圏経営研究 6, 103–135.

Page, K.M., Nowak, M.A., 2002. Unifying Evolutionary Dynamics. Journal of Theoretical Biology 219, 93–98.

Papo, D., Buldú, J.M., Boccaletti, S., Bullmore, E.T., 2014. Complex network theory and the brain. Philosophical Transactions of the Royal Society of London B: Biological Sciences 369. doi:10.1098/rstb.2013.0520

Ping, W., 2011. A Brief History of Standards and Standardization Organizations: A Chinese Perspective. East-West Center Working Papers, Economic Series 117, 1–25.

Pun, K.F., Chin, K.S., Lau, H., 2000. A QFD/Hoshin approach for service quality deployment: A case study. Managing Service Quality 10, 156–169.

Putnik, G., Sluga, A., ElMaraghy, H., Teti, R., Koren, Y., Tolio, T., Hon, B., 2013. Scalability in manufacturing systems design and operation: State-of-the-art and future developments roadmap. CIRP Annals - Manufacturing Technology 62, 751–774.

Ramabadran, R., Dean, J.W., Evans, J.R. Jr., Raturi, A.S., 2004. Testing the Relationship Between Team and Partner Characteristics and Cooperative Benchmarking Outcomes. IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT 51, 208–225.

Richards, F.J., 1959. A Flexible Growth Function for Empirical Use. Journal of Experimental Botany 10, 290–300.

Roberts, P., Tennant, C., 2003. Application of the hoshin kanri methodology at a higher education establishment in the UK. The TQM Magazine 15, 82–87.

Rother, M., 2010. TOYOTA KATA. MANAGING PEOPLE FOR IMPROVEMENT, ADAPTIVENESS, AND SUPERIOR RESULTS. McGraw-Hill, New York.

Salado, A., Nilchiani, R., 2014. The concept of problem complexity, in: Procedia Computer Science. Presented at the Conference on Systems Engineering Research, Elsevier Inc., Redondo Beach, CA, pp. 539 – 546.

Sayed, M.S., Lohse, N., 2013. Distributed Bayesian diagnosis for modular assembly systems—A case study. Journal of Manufacturing Systems 32, 480–488.

Schäfermeyer, M., Grgecic, D., Rosenkranz, C., 2010. Factors Influencing Business Process Standardization: A Multiple Case Study. Presented at the 43rd International Conference on System Sciences, IEEE Computer Society, Hawaii.

Schäfermeyer, M., Rosenkranz, C., Holten, R., 2012. The Impact of Business Process Complexity on Business Process Standardization. Business & Information Systems Engineering 5, 261–270.

Schmidhuber, J., 2009. Simple Algorithmic Theory of Subjective Beauty, Novelty, Surprise, Interestingness, Attention, Curiosity, Creativity, Art, Science, Music, Jokes. Journal of SICE 48, 21–32.

Schneider, M., Somers, M., 2006. Organizations as complex adaptive systems: Implications of Complexity Theory for leadership research. The Leadership Quarterly 17, 351–365.

Schoechle, T., 1999. Toward a Theory of Standards, in: Proceedings of the Lst IEEE Conference on Standardization and Innovation in Infomation Technology. Presented at the SIIT'99, IEEE, Aachen, Germany.

Schuh. G., Potente, T., Thomas, C., Schmitz, S., Mayer, J., 2014. Design principles for an integrated product and process development approach for rotationally symmetric products, in: 2014 Proceedings of PICMET '14: Infrastructure and Service Integration. Presented at the Management of Engineering & Technology (PICMET), 2014 Portland International Conference on, IEEE, Kanazawa, pp. 2126 – 2148.

Schuh. G., Potente, T., Varandani, R., Schmitz, T., 2013. Methodology for the assessment of structural complexity in global production networks. Procedia CIRP, Forty Sixth CIRP Conference on Manufacturing Systems 2013 7, 67–72.

Schuster, M., Kesler, G., 2011. Aligning Reward Systems in Organization Design: How to Activate the Orphan Star Point. People & Strategy 34, 38–45.

Senge, P.M., 1990. Part 1. How our actions create our reality and how we can change it., in: The Fifth Discipline. The Art and Practice of The Learning Organization. Doubleday; Revised & Updated edition, London, p. 7.

Shah, R., Chandrasekaran, A., Lindeman, K., 2008. In pursuit of implementation patterns: the context of Lean and Six Sigma. International Journal of Production Economics 46, 6679–6699.

Shah, R., Ward, P.T., 2007. Defining and developing measures of lean production. Journal of Operations Management 25, 785–805. doi:10.1016/j.jom.2007.01.019

Shah, R., Ward, P.T., 2003. Lean Manufacturing: context, practice bundles and performance. Journal of Operations Management 21, 129–149.

Sharapov, D., 2012. Routine Structure and Knowledge Management: Impacts on Routine Attributes, Value and Imitability.

Shi, H., Shi, L., 2014. Identifying Emerging Motif in Growing Networks. PLoS ONE 9, e99634.

Shingo, S., 1985. A Revolution in Manufacturing: The SMED System, 1st ed. Productivity Press.

Sobek II., D.K., Smalley, A., 2008. Understanding A3 Thinking: A Critical Component of Toyota's PDCA Management System, 1st ed. Productivity Press.

Sporns, O., 2011. Brain Networks: Structure and Dynamics, in: Networks of the Brain. The MIT Press, Boston, pp. 31–50.

Sporns, O., Koetter, R., 2004. Motifs of the brain. PLos Biology 2, 1910–1918.

Staats, B.R., Brunner, D.J., Upton, D.M., 2011. Lean principles, learning, and knowledge work: Evidence from a software services provider. Journal of Operations Management 29, 376–390.

Stanford, N., 2007. Guide to Organisation Design. Creating high-performing and adaptable enterprises, 1st ed. The Economist is Association with Profile Books LTD.

Stoughton, A.M., Ludema, J., 2012. The driving forces of sustainability. Journal of Organizational Change Management 25, 501–517.

Strogatz, S.H., 2001. Exploring complex networks. Nature 410, 268–276.

Sunder, V.M., 2013. Synergies of Lean Six Sigma. UIP J. Oper. Manag. 12, 21–31.

Suzaki, K., 2010. New Shop Floor Management: Empowering People for Continuous Improvement. Free Press, New York.

Telesford, Q. K., Joyce, K. E., Hayasaka, S., Burdette, J. H., Laurienti, P. J., 2011. The Ubiquity of Small-World Networks. Brain Connectivity 1, 367–375.

Tennant, C., Roberts, P., 2001. Hoshin Kanri: Implementing the Catchball Process. Long Range Planning 34, 287–308.

Tharumarajah, A., Wells, A.J., Nemes, L., 1996. Comparison of the bionic, fractal and holonic manufacturing systems concepts. International Journal of Computer Integrated Manufacturing 9, 217–226.

Ustun, T.S., Hadbah, A., Kalam, A., 2013. Interoperability and interchangeability considerations in microgrids employing IEC61850 standard, in: SEGE. Presented at the IEEE International Conference on Smart Energy Grid Engineering (SEGE), 2013, IEEE, Oshawa, ON, pp. 1–5.

van Brussel, H., Bongaerts, L., Wyns, J., Valckenaers, P., van Ginderacter, T., 1999. A Conceptual Framework for Holonic Manufacturing: Identification of Manufacturing Holons. Journal of Manufacturing Systems 18, 35–52.

Vida, M.M., Lupşe, O.S., Stoicu-Tivadar, L., Bernad, E., 2012. Flexible solution for interoperable cloud healthcare systems. Studies in health technology and informatics 180, 280–284.

Vinodh, S., Joy, D., 2012. Structural equation modeling of lean manufacturing practices. Int. Jour. Prod. Res. 50, 1598–1607.

Vojak, B., Hatakeyama, T., 2006. A Comparison of American and Japanese Competitive Product and Manufacturing Process Benchmarking and Reverse Engineering in the Electron Device Industry: Frequency of Use and Perceived Value. Presented at the IEEE International Engineering Management Conference 2006, IEEE, pp. 287 – 291.

Wagner, K.W., Lindner, A.M., 2013. Kapitel 1. Wertstromdesign. Kapitel 2. Lean in Administrativen Prozessen., in: WPM - Wertstromorientiertes Prozessmanagement: - Effizienz Steigern - Verschwendung Reduzieren - Abläufe Optimieren. Carl Hanser Verlag GmbH & Co. KG, München, pp. 1–64.

Wakamatsu, Y., 2013. トヨタのすごい習慣&仕事術 [Work habits and skills of great Toyota]. PHP研究所, Tokyo.

Wang, S., Noe, R.A., 2010. Knowledge sharing: A review and directions for future research. Human Resource Management Review 20, 115–131.

Wang, W., Koren, Y., 2012. Scalability planning for reconfigurable manufacturing systems. Journal of Manufacturing Systems 31, 83–91.

Watts, D.J., Strogatz, S.H., 1998. Collective dynamics of small-world networks. Nature 393, 440–442.

Weick, K.E., 1979. The Social Psychology of Organizing, 2nd ed. Addison-Wesley, Reading, MA, USA.

West, G.B., Brown, J.H., 2004. Life´s Universal Scaling Laws. Physics Today 57, 36–42.

Whitehead, A.N., Bertrand, R., 2011. Principia Mathematica - Volume One. Rough Draft Printing.

Witcher, B.J., 2002. Hoshin Kanri: a study of practice in the UK. Managerial Auditing Journal 17, 390–396.

Witcher, B.J., Butterworth, R., 2000. Hoshin kanri at Hewlett Packard. Journal of General Management 25, 70–85.

Witcher, B.J., Butterworth, R., 1999. Hoshin kanri: how Xerox manages. Long Range Planning 32, 323–332.

Womack, J.P., 2013. Gemba Walks. Lean Enterprises Inst Inc, Cambridge, Massachusetts.

Womack, J.P., Jones, D.T., 2003. Introduction, in: Lean Thinking. Simon & Schuster, New York, p. 4.

Zhong, X., Song, J., Li, J., Ertl, S.M., Fiedler, L., 2015. Design and analysis of gastroenterology (GI) clinic in Digestive Health Center of University of Wisconsin Health. Flexible Services and Manufacturing Journal 1–30.