The learning way to production performance

An evolutionary perspective on company-specific production systems (XPS)

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Acknowledgements

Ever since childhood, I have had a significant interest in how individuals, teams and organizations manage to create performance and implement change (Hekneby et al., 2007). At the age of 16, I started my working life experience by attending a summer job at Tinfoss Iron factory in my hometown of Notodden. I quickly came to realize that some shifts were more productive, had more focus on quality, and were more fun than others. This experience became the starting point of a long journey of exploring high performance environments and organizational change in many contexts and at several organizational levels, first as an officer in the Norwegian army, then by working with top athletes and national teams in the Norwegian Olympic Committee and Confederation of Sports, and finally, over the last 15 years, as a consultant in organizational development and management training. It was while working as a consultant that I was first introduced to Lean. I was immediately fascinated by the concept, and its clarity, precise tools, documented effect, and ease of understanding. This was "high performance sport in organizational thinking", as we used to refer to it at Storform AS.

Later, I was introduced to academia and organizational studies at NTNU through the national Lean Forum Norge. My interest in Lean grew as I read the literature on it, and I was able to develop my academic interest further when I registered as a PhD student in 2017.

My experience as a PhD student was somewhat different from my expectations. Things were not as simple as first anticipated, which affected both my academic understanding and my role as a consultant at Storform AS. Under my initial project title ("Opening the black box of change management in Lean implementation"), I had a distinct idea that (1) Lean is an adaptable concept for organizational performance, and (2) certain behavioral components are crucial for managers when implementing Lean. Gradually, I developed a quite different view, which fundamentally changed my perspective on Lean. As I will try to demonstrate, enhanced production performance might relate to change processes that are more complex than just copying Lean and developing management skills.

By developing new insights, frustration follows. To quote Edgar Schein (2010, p. 22): “re-examination of basic assumptions temporarily destabilizes our cognitive and interpersonal world, releasing large quantities of basic anxiety”. I recognize this frustration in my PhD project. This did not so much impact the academic process; rather, it affected my work as a consultant. Facing my customers, I had to develop a more nuanced language for explaining how to use Lean in the processes of organizational performance. This journey has been challenging, but it has also been important in my industrial PhD program, because it has given me new insights that are useful to my customers and colleagues at Storform AS.

Some acknowledgements must be made. First, I find myself extremely lucky to benefit from Norwegian social democracy, which has allowed a 55-year-old man to develop academic knowledge through funding from taxpayers. Second, I must thank my supervisors, Jan Inge Jensen at UIA, and Jonas Ingvaldsen and Jos Benders at NTNU, for their excellent guidance and support. A special thanks is due to Jonas for putting up with my emails and questions day and night for four years. And thanks to Marte Holmemo for great support with my text in this kappa.

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Oppsummering

Produksjonsbedrifter implementerer 'beste praksis' konsepter som Lean og Toyota Production System (TPS) for økt produksjonsforbedring. 30 års forskning har imidlertid vist at det er svært få som lykkes, ofte relatert til utfordringen med å kopiere Lean og TPS til ulike teknologiske, politiske og sosiale kontekster.
Som en reaksjon på dette har produksjonsbedrifter de siste årene utforsket nye strategier. I stedet for å kopiere et konsept, skreddersyr selskapet sitt eget 'selvjusterte' konsept, bygd på ett eller flere standardkonsepter. Fenomenet går under navnet: 'Selskaps-Spesifikke Produksjonssystemer' (Company-Specific Production System, XPS) og synes å være en viktig trend bland (globale) produksjonsbedrifter. Et sentralt poeng med et XPS er dets strategiske betydning for selskapet. Utvelgelsen av konsepter, tilpasningen og justeringen til selskapets egenart finner sted på et overordnet nivå, sterkt støttet av toppledelsen i selskapet. Deretter blir konseptet forsøkt distribuert til selskapets (globale) nettverk. Den innledende tilpasningen skal bidra til å sikre bedre forankring og standardisering i selskapets nettverk.
Til tross for XPS fenomenets økte interesse og strategiske betydning, er kunnskapen om hvordan et XPS blir utviklet og implementert svært begrenset. Eksempelvis vet vi lite om hvordan standardkonsepter konkret blir tilpasset bedriftens egenart. Videre vet vi lite om hvorvidt et XPS bidrar til å sikre standardisering i et (globalt) nettverk. Og vi har lite kunnskap om hvordan et XPS blir institusjonalisert og etablert som en varig tilstand i en nettverk. XPS fenomenet har således både teoretisk og praktisk interesse.

Jeg har fulgt Elkem ASA, en av Norges eldste produksjonsbedrifter. Elkem utviklet sitt eget XPS, 'Elkem Business System' (EBS) som bidro sterkt til økt fokus på prosess forbedring i Elkems `s globale nettverk. Utviklingen av EBS var en integrerte og sammenhengende læringsprosess. EBS ble opprettet uten en 'master plan'. Ulike og til dels motstridende konsepter ble justert og tilpasset selskapets egenart gjennom omfattende eksperimentering på ulike nivåer. Eksempelvis ble skiftledere på produksjonsgulvet fjernet for å sikre større medvirkning hos operatørene. Læringen, som fant sted over 15 år ble samlet opp i et overordnet XPS.

Videre finner jeg at Elkem klarte å standardisere sitt EBS på tvers av geografiske lokasjoner ved å bygge en sterk internkultur, på grensen til en religiøs tro. Dette ble gjort ved å institusjonalisere grunnleggende antagelser på alle nivåer i selskapet knyttet til læring og kontinuerlig forbedring. Det ble også utviklet en kultur som sterkt anerkjente involvering av medarbeidere som grunnprinsipp i prosessforbedringen.

Mine funn utfordrer den klassiske forståelsen av hvordan standard konsepter som Lean og TPS blir brukt til prosessforbedring. XPS-prosessen i Elkem kan beskrives som en integrert læringsprosess, hvor standardkonsepter representerer et utgangspunkt for organisatorisk læring som igjen skaper økt produksjonsforbedring. Mine funn har således teoretisk og praktiske implikasjoner for selskaper som ønsker å utvikle sine egne selskaps-spesifikke forbedrings programmer. Sentralt er forståelsen for hvordan skape lærende organisasjoner forankret i etablerte organisasjonskonsepter.

Summary

Manufacturing companies (MCs) implement "best-practice" concepts such as Lean and the Toyota Production System (TPS) for enhanced production improvement. However, 30 years of research have shown that very few succeed in this implementation, which is often related to the challenge of copying Lean and TPS in various technological, political, and social contexts.

As a reaction to this, MCs have explored new strategies for implementing best-practice concepts. Instead of copying a concept, the company tailors its own "self-adjusted" concept that is built on one or more standard concepts. This phenomenon goes by the name of "company-specific production systems" (XPS) and seems to be an important trend among (global) MCs. A key point of an XPS is its strategic importance to the company. The selection of concepts and the adaptation and adjustment to the company's uniqueness take place at a corporate level, and they are strongly supported by the top management of the company. After the creation phase, the XPS is distributed to the MC's (global) network. Hence, the initial adjustment and tailoring process is supposed to secure adoption and standardization across the company's network.

Despite the increased interest and strategic importance of the XPS phenomenon, knowledge of how an XPS is developed and implemented is limited. For example, we know little about how standard concepts are adapted to the company's uniqueness, or about whether an XPS helps to ensure standardization in a (global) network. Furthermore, we have little knowledge about how an XPS is institutionalized and established as continuous improvement in a network. Understanding the XPS phenomenon is, therefore, of both theoretical and practical interest.

I have followed Elkem ASA, one of Norway's oldest MCs. Elkem developed its own XPS, the Elkem Business System (EBS), which has strongly contributed to increasing the company's focus on process improvement across its global network. The development of the XPS must be seen as an integrated and developing learning process. The XPS was created without a master plan. Different concepts were adjusted and adapted to the company's uniqueness through extensive experimentation at different levels in the company. For

example, shift managers on the production floor were removed to ensure more participation on the shopfloor level. The learning process, which took place over 15 years, was finally consolidated in an overall XPS.

I have also found that Elkem managed to standardize their XPS across geographical locations by building a strong internal culture, resembling a religious belief. This was done by institutionalizing basic assumptions relating to learning and continuous improvement at all levels of the company. The Elkem culture also developed norms, strongly recognizing involvement and participation at the shopfloor level in production performance.

My findings challenge the classic understanding of how standard concepts such as Lean and TPS are used for production performance. The XPS process in Elkem can be described as an integrated learning process, where standard concepts represent a starting point for organizational learning, which in turn creates increased production improvement. My findings have theoretical and practical implications for companies that want to develop their own company-specific improvement programs. Central to this is the understanding of how to create learning organizations.

Contents

1 Introduction

Manufacturing companies (MCs) are constantly seeking enhanced efficiency and business performance through technological and organizational development. This "race for efficiency" has been a driving force for MCs since the birth of industrial capitalism, with different best-practice organizational concepts (Bodrožić & Adler, 2018; Sturdy et al., 2019) becoming roadmaps for organizational implementation.

Lean was first presented as a global management concept in 1990 (Womack, Jones, & Roos, 1990) and is one of the most popular organizational concepts. It builds on the knowledge of the Toyota Motor Company's production system (TPS). Since the late 1980s, several companies from different industries and organizations have made significant attempts to implement TPS and Lean as models for best practice. However, it turned out that copying TPS and Lean was more challenging than initially expected (Hines, Taylor, & Walsh, 2020). Facing different contextual environments, MCs found that the Lean statement of "universal applicability anywhere by anyone" (Womack et al., 1990, p. 9) did not fulfill its promise. A significant number of studies in the last 30 years have documented the gap between the promised universality and practical reality. Some researchers have even suggested that only 10% of attempted implementations have succeeded (Bhasin, 2012; Holmemo & Ingvaldsen, 2016; Hopp, 2018; McLean, Antony, & Dahlgaard, 2017).

In response to this, MCs started to develop new strategies to secure business performance in their network, with a focus on adjusting and tailoring TPS (and other concepts) to fit the company's uniqueness (Netland, 2013). This "own-best-way" approach to the "one-best-way" phenomenon suggests that companies should adjust and tailor the principles and concept of TPS to their contextual environment. Such adjustment is supposed to be made at the corporate level, with the new concept being implemented in the corporate network to ensure standardization and homogeneity among its subsidiaries. This company-specific production system (XPS) carries the company name, where the "X" represents the name of the company (Netland, 2014).

An XPS is also portrayed as a "multi-plant improvement program" (Netland et al., 2014) and a "corporate Lean programs" (Netland, 2016; Powell & Coughlan, 2020b). The main resemblance is to the "own-best-way" approach, according to which the corporate level uses different concepts to create their own improvement program. This distinguishes it from other (global) Lean programs by referring to a coordinated initiative at the corporate level whereby a tailored program is created and implemented among the company's subsidiaries.

The XPS phenomenon seems to be a growing trend among MCs (Netland, 2013). Hence, adjusting organizational concepts at a corporate level with the aim of network standardization implies a significant strategic initiative followed by a vital change process for an MC (Netland, 2014). Consequently, the phenomenon has academic and practical relevance.

Despite the growing interest and strategic impact, research on XPS is very limited. Except for the work of Netland (2013, 2014; Netland & Aspelund, 2014) and Ostermann and Fundin (2018, 2020), and studies on corporate Lean programs (Powell & Coughlan, 2020a, 2020b), I have discovered no other empirical material describing either the creation of an XPS or the implementation process at the intra-organizational level. This claim is based on a search of the literature, conducted in January 2020, where all citations of Netland's articles on XPS and corporate Lean programs from 2013 until the present were investigated. Thus, there is a need for more empirical data to contribute both to an academic understanding of the XPS phenomenon and to the practical task of considering the strategic impact when creating an XPS.

My research question is:

> *How is an XPS successfully created, implemented, and institutionalized in an MC?*

Given that creating, implementing, and institutionalizing an XPS is a socially complex phenomenon that involves decisions and different events occurring at different levels of an organization, I selected a research design that allowed me to investigate the complexity of the variables within this broad social context (Yin, 2011). My aim was to explain the social phenomenon by understanding the processes taking place when an XPS is created, implemented, and institutionalized. I therefore selected a case study research design (Eisenhardt & Graebner, 2007), which best enabled me to understand and theorize a social phenomenon occurring in an organizational context. I used a reflexive methodology, which is an approach emphasizing careful interpretation and reflection anchored in the knowledge that the relationship between "reality", "empirical fact", and research results can only be revealed by the researcher's constant integration and interpretation of the social phenomenon (Alvesson & Skjøldberg, 2018).

The case selected for my study was Elkem ASA, one of Norway's oldest industrial companies with nearly a century of experience within the electrochemical industry. In 1990, Elkem was on the brink of bankruptcy: net income had dropped to an annual loss of 700 million NOK and the company's debt was more than 6 billion NOK. Elkem also struggled with safety and workplace conditions, due to outdated production facilities and a lack of strategy for future growth and investments (Aslaksen, 1999). However, Elkem is today (in 2020) a world-leading MC within the electrochemical industry and is considered one of the most fully integrated silicone manufacturers in the world. Elkem currently has 6,370 employees worldwide and its revenues amount to more than 25 billion NOK (2019). Workplace conditions are considered to be of world-class standard, with a rate of only 2.1 injuries per million working hours in 2019.

The history of Elkem is not only about the survival of an MC. Over the last 30 years, Elkem has significantly strengthened its strategic position globally and has managed to offer secure employment to more than 6,000 employees (Sogner, 2014). The company has created a work environment characterized by good work conditions and a safe environment, and it has constantly innovated and developed its production portfolio (Hekneby, Ingvaldsen, & Benders, 2020). In addition, I show in this study that Elkem seems to have exported their organizational ideas, which are rooted in the Scandinavian democratic working life tradition, with the result that factories in countries like China and Brazil now have work conditions built on trust and cooperation between management and employees.

These successes might be traced back to the strategic initiative in the period from 1991 to 2006 when Elkem developed its own tailor-made and holistic business system. This XPS was named the Elkem Business System (EBS) and was formally implemented in all plants in Elkem's global network in 1999. The EBS was heavily influenced by the TPS and by Scandinavian participatory working life traditions, which were adjusted and aligned to Elkem's production environment.

> *We are confident that it was the right choice to develop and implement EBS because we have seen the results of our improvement in the company's KPIs [key performance indicators]. Increased production volume, uptime, silicone quality, sales volume, and, of course, safety.* (Top managers, Elkem top-management team, 2017)

This statement demonstrates that Elkem's top-management team consider their creation and implementation of the XPS as an important contribution to the company's development over the last 30 years. This makes Elkem a good case study for investigating the XPS phenomenon.

My thesis is structured as follows:

1. Introduction

2. Theoretical positioning
   The historical development from TPS to XPS
   Defining the XPS phenomenon and academic shortcomings

3. Scientific approach and research design
   Research question
   Research design
   Research case
   Data collection and data analysis
   Research limitations

4. Short summaries of my papers
   Paper 1: Creating a successful XPS?
   Paper 2: How the creation of an XPS affects the shopfloor organization in the processing industry and how the concept of Lean production is adjusted to the company's uniqueness.
   Paper 3: How is a successful XPS adopted in a global network and how can its institutionalization be secured?

5. Paper presentation

6. Discussion.
   Establishing the "learning perspective" on the XPS phenomenon

7. Conclusion and practical implications

2. Theoretical positioning

> *We had to understand that cost reduction was not enough to save the company. We had to improve the production. And we learned from Toyota, through our collaboration with Alcoa. But we developed [the business system] by ourselves. These ideas did not at all come from TPS and Alcoa.*
> (Ole Enger, Elkem CEO, 1991–2006)

This statement by the former CEO of Elkem might signify a significant shift in the organizational paradigm initiated in the 1980s. It is to some extent important to understand the search by MCs for global competitiveness and their development of the XPS as a management concept. In the following, I explain my theoretical positioning by addressing how the shift in the paradigm had its roots in the TPS, and how the TPS evolved to become the company-specific production systems (XPS).

Taking an extended look at the past, the rise of the industrial capitalism, which is normally traced back to Manchester in England in the mid-18th century, initiated the “race for efficiency” and the constant attempt to create the most profitable means of production. Technology became the main driving force, with a notable historical example being the spinning jenny, the multiple-spindle machine invented by James Hargreaves in 1764 that revolutionized the spinning industry by enabling one worker to produce 120 spools at one time.

Further development of the consumer market at the beginning of the 20th century provided managerial opportunities to make more profit with the use of new technology and to develop different aspects of labor activity and work organization (Ingvaldsen, 2013).

Distribution and coordination of work tasks, skills and authority, as well as the labor structure and new work design, became important for how industrial resources were structured in the race for efficiency (Perrow, 1972). A classic example was the mass production manifested in Henry Ford’s car factories, which became the “best practice” of industrial work organization. Combining the technological assembly line, Weber's bureaucracy and Fredric Taylor's "scientific management" (Taylor, 1911), Ford created a new work organization that was to influence production across most of the world over the rest of the century.

The race for efficiency also laid the ground for a new and prosperous global industry initiated by industrial managers' consumption of management concepts (Abrahamson, 1996; Sturdy et al., 2019). As competition intensified in the market, best-practice work designs were constantly distributed to and consumed by a growing audience of managers and industrial capitalists in order to secure global competitiveness. This "market for management ideas" (Abrahamson, 1996; Benders & Van Veen, 2001) involved diffusion and consumption of different work designs, tools, techniques (Womack et al., 1990), power structures (Liker, 2004), use of technology (Bodrožić & Adler, 2018), and work task coordination (Sturdy et al., 2019). This industry would later become important for the distribution of ideas related to the TPS, and it would be synthesized in the management concept of Lean (Womack et al., 1990). As I will explain further, this is of great importance for understanding the XPS phenomenon.

The period after the Second World War had some significant developments in understanding human relations due to the Hawthorne experiments (Wickström & Bendix, 2000), and it also marked a shift in focus away from production performance. Technology was still a main driver of efficiency, but the manufacturing industry in particular started to develop a more market- and strategy-oriented focus that addressed more external factors relating to market segments, operational structure, price and cost reduction, and market strategy (Voss, 1995). Central to this was the focus on creating a shared vision within the company in order to reduce inconsistency between internal needs and market demands (Voss, 1995). There was also a significant focus on outsourcing and cost reduction programs, which were the main drivers of increasing globalization and tighter competition (Voss, 2005).

The oil crisis that hit the Western market in 1973 was especially important for MCs in two ways. First, it initiated a long period of economic stagnation in the US and European markets, forcing global networks to seek more advanced competitive strategies. Secondly, it commenced a significant interest in Japanese management and production strategies, especially those related to the automobile industry, one of the most important industries in the US (Holweg, 2007). It had long been clear to US car manufacturers that Japan had outmaneuvered their home market both in price and quality. However, the explanations for this in the 1970s and early 1980s were mostly based on misperceptions, such as about cost advantage, luck, mysterious Japanese culture, large-scale industrial policy advantage, and technology advantage (Holweg, 2007). The fundamental answer was provided during the 1980s when the TPS was scientifically documented and presented to the Western market (Fujimoto, 1999; Krafcik, 1988; Womack et al., 1990) and became subject to experiments as a management concept outside Japan (Adler, 1993; Holweg, 2007; Liker, 2004).

Before describing the distribution of TPS (and later Lean production), I will discuss the content and development of the TPS, which is important for understanding how production performance become the new paradigm that was later to evolve into Lean and XPS.

2.1 The rise of the Toyota Production System

There are several ways to define a production system depending on the perspective within organizational studies (Osterman, 2020). It can be described as the "interrelating principles and methods used to organize or create an efficient and effective process" (Osterman, 2020, p. vi). Furthermore, these principles, routines, and tools needs to exist in a comprehensive system that explains how they work together (Fujimoto, 1999). They also need to be visualized in some format to allow for distribution and knowledge transfer (Jensen & Szulanski, 2007; Jonsson & Foss, 2011).

When describing the TPS and its content, it might seem that, despite being a great design, it was a single innovation confined to Japan and, more specifically, to Toyota. To fully understand the evolution of TPS, it is important to realize that it drew from various sources across different Japanese industries, as well as from industrial traditions in US and European companies. Secondly, TPS was developed over several decades and through extensive experimentation and organizational learning processes within the Toyota company. An important component in the evolution of TPS is claimed to be the ability to learn and experiment, which allowed the organization to make mistakes and to create an extensive learning organization across all the company's levels (Fujimoto, 1999). This "manufacturing learning capability" is promoted as the core concept of the TPS (Fujimoto, 1999). As I will clarify, this knowledge seems to be important for understanding the XPS phenomenon.

To fully understand the evolutionary dimension of TPS, it is necessary to explain the basic elements of the system and how experimentation led to extensive learning and enhanced manufacturing capability for Toyota. Two important pillars evolved in the production system and are crucial to understanding the TPS: the *jidoka* and the *just-in-time* (JIT) system. *Jidoka* can be translated as "automation" and traced back to Sakichi Toyoda (1867–1930) and his invention of the automated loom. The loom stopped automatically when a failure occurred during the looming process. This revolutionized the looming industry because it reduced both the waste of raw material and the number of workers required to control several looms at the same time. Sakichi's son, Kiichiro Toyoda (1894–1952), established Toyota Motors in 1937, but it was not until the new chief engineer, Taiichi Ohno, started experimenting with these ideas after the Second World War that *jidoka* became part of the production system. Ohno began his engineering career in the looming industry and had no experience with automobile production prior to joining Toyota. Bringing ideas from the looming industry, he had the strong intention to organize future car production based on product flow rather than on functions (small not large batches), and to solve the underlying problems in the production line.

The first experiment was related to production of parts and to the functional layout, and it involved placing similar machines together and transporting the "parts in process" from one group to the next to undergo different processes. Inspired by Ford's conveyor belt in the assembly line, Ohno decided to use a similar approach in parts' production, which had never previously been done. He established the U-shape production line (also known as the "horseshoe cell" production line), which allows for uninterrupted production. There is a second vital benefit in this set-up: it allows workers to operate several machines at the same time, significantly reducing the workload. Using the *jidoka* principle, a machine stops automatically when a problem occurs, which means that parts' production can be handled with fewer resources and is no longer dependent on the machines (Benders, 1998; Fujimoto, 1999). The new layout also paved the way to the vital *shojinka* principle in the TPS, namely, how to adjust the workload to the production plan. By letting one worker operate several machines, the workload required to meet a certain production volume can be predicted and adjusted accordingly. In this way, the *jidoka* principle from the looming industry became a pillar in the TPS system, and it was later to be of great importance for MCs when focusing on production performance.

The second pillar developed in the TPS is the JIT system. This, too, drew from several sources and was formed through experimentation and organizational learning.

Producing cars for the Japanese market in the 1930s was problematic due to the American dominance (Ford and General Motors [GM]). The first products manufactured by Kiichiro Toyoda relied heavily on assembling imported parts (Holweg, 2007). Already by 1937, Kiichiro Toyoda had established a basic production rule of rejecting unnecessary parts from the assembly line. When the production volume accelerated, the rule was removed, with the result that the work-in-process piled up. This became one of the main challenges for Ohno, since he realized that coordination between the workstations had to be fundamentally changed. The solution came from a Japanese newspaper article that reported how US supermarkets refilled their inventories to meet customer demand by using a visual system to inform them when a product needed to be ordered. This led to the idea of reversing the flow of information in the production line, so that, instead of "pushing" the products through the production, the next station along the line would precisely describe the exact content and time of delivery. This would create a constant "pull" throughout the whole production, significantly reducing stocks and eliminating waste (*muda*).

In addition, Ohno discovered how US supermarkets visualized the "pull system" by using cards to flag up when new products needed restocking. This is also known as the *kanban* system. Ohno started experimenting with the JIT system in 1948, and in 1953 the main JIT communication system was introduced in the form of a card that would be sent to the previous workstation to order parts. In 1959, *kanban* was implemented, and in 1962 it was expanded to all Toyota factories (Benders, 1998). Three years later, the *kanban* system was rolled out to Toyota suppliers.

The JIT system has one demanding consequence for an organization: “there is no place to hide”. Ford’s mass production had buffers, leaving the shopfloor worker able to remove a broken or defective product and replace it with a new one. In the JIT system developed by Toyota, there are no buffers, so any defects, quality problems, or mistakes are instantly brought to the surface. As Ohno had learned in the looming industry, when problems reach the surface it is necessary to look for the root cause of the problem and solve it permanently. The *andon* system supported this by allowing the shopfloor worker to pull a string that would stop the production line. The *andon*, which was invented by Sakichi Toyoda and first implemented in the looming industry, was used by Ohno to constantly solve problems detected in the JIT system. Therefore, being exposed to a JIT system in an assembly line requires a worker constantly to be alert to any problems that arise during the working hours.

Ohno also experimented with other work structures that were drawn from a variety of sources. One important structure was standardization of work tasks. From his experience in the looming industry, Ohno found that new and unskilled workers constantly had to replace permanent workers who signed up for the Japanese military. Thus, it was necessary to define the work task precisely, so that new and unskilled workers could perform it with less training. Ohno began implementing the standard operational procedure (SOP) in 1943 in order to standardize and simplify job tasks at Toyota. An important consequence of the SOP was its enabling of continuous improvement in the production line. As soon as a standard is established, it is always possible to further develop and improve the standard. This was well known from the principles of scientific management (Taylor, 1911), where time and motion studies were a vital part of the improvement work. In the Ford production line, however, it was normally the technical personnel or managers who conducted the measurements and decided which changes to be made to the SOP. Ohno insisted that this had to be done by the workers themselves, because they knew the job best and had the best qualifications to change and improve the SOP. Therefore, continuous improvement became institutionalized and was initiated by the shopfloor workers as the TPS evolved.

Ohno also experimented with the management structure of the production line. Toyota was one of the earliest companies to adopt the American concept of training within industries (TWI). Created by the United States Department of War during the Second World War, TWI was developed so that training could be performed as rationally as possible, enabling the unskilled worker to perform precise work task as quickly as possible (Huntzinger, 2006). A key TWI principle was to "train the trainer" to establish the SOP and conduct continuous improvement with the shopfloor workers. In 1955, continuous improvement was incorporated in the job description of Toyota foremen (Benders, 1998). Subsequently, an important management task has been to ensure continuous improvement throughout the entire organization, fundamentally involving and supporting the shopfloor workers by giving them the opportunity to constantly make suggestions for improvement based on the SOP (Spear, 2004).

Developing the TPS over three decades, Toyota managed to create the fastest car production system in the world: their cars were produced in "half the time, at half the price, and with half the staff" compared to Toyota's competitors (Liker, 2004. When Toyota started their production after 1945, the total annual of production was approximately 300 cars. However, 45 years later, Toyota had a higher turnover than Ford, Chrysler, and GM combined, and had total profits in excess of $8 billion (Liker, 2004). In addition, Toyota is ranked as one of the world's leading car manufactories for quality (Liker, 2004), which can be traced back to the adoption of the Total Quality Management tradition within the TPS in 1961 (Shimokawa, 2012).

I have considered some of the most vital components in the TPS in this chapter in order to show how the components in TPS were developed through *experimentation* and the combining of ideas and concepts from a wide range of sources. Hence, the central figures at Toyota in this period (i.e., Taiichi Ohno and Kikuo Suzumura) never considered the experimentation process as a path to a final production system. For them, the path was about solving daily problems and using different knowledge to enhance productivity in the production line (Shimokawa, 2012). It was not until later that the knowledge derived from the experimentation was framed as a holistic production system. It is also worth mentioning that this *manufacturing learning capability* (Fujimoto, 1999) implied continuous improvement and experimentation not only in the assembly line but also in other areas of the Toyota company. By including the supplier system and product development, TPS established *learning capability* at all levels of the organization (Fujimoto, 1999).

2.2 Distributing the TPS to the Western world

The impact of TPS on the Western world has been significant, and it has heavily influenced the strategic focus of global companies (Voss, 1995). At a time of regression and increased competition in Western markets, the discovery of a new production system fundamentally challenged scientific management as the dominant work design (Voss, 1995, 2005). TPS became the new paradigm in the race for efficiency.

Literature on the TPS was scarce in the West before 1980. There were some English publications on the JIT system (Schonberger & Schonberger, 1982), and Toyota suppliers had been introduced to TPS training (Holweg, 2007). In general, however, the "Japanese phenomenon" was explained on the basis of various misperceptions, best captured by Henry Ford II's description of Japanese industry as "an economic Pearl Harbor" (Holweg, 2007, p. 423).

Two significant events changed this view. First, the Massachusetts Institute of Technology (MIT) and the International Motor Vehicle Program initiated the "benchmarking methodology" to scientifically document and describe the TPS to the Western automobile industry. Second, experimentation and implementation of TPS outside Japan began with a joint venture between GM and Toyota at the Freemont plant in California, which convinced global companies that the TPS was transferable to a global network (Holweg, 2007).

The benchmarking methodology was used at more than 70 assembly plants worldwide between 1986 and 1989, and it involved three different visits to each plant (Holweg, 2007). Data was presented first in 1988 in Italy, describing the performance of TPS compared to the Western automobile industry. The data was overwhelming, although the sponsors did not initially believe it. Therefore, the scientists were sent home to verify the data, and the second presentation was made in 1989. As a result of the overwhelming performance, several scientists from MIT decided to publish the data to a broader audience, and in 1990 *The Machine that Changed the World* introduced the concept of Lean to the global management industry (Womack et al., 1990). Lean, introduced in *The Machine* and later in *Lean Thinking* (Womack & Jones, 1996), helped to extend the implementation of TPS to become a holistic business system that could be applied not simply to the production line but across all parts of the organization, including procurement, supply change, logistics, and sales (Holweg, 2007; Marodin & Saurin, 2013). With the introduction of Lean, the TPS became a global management concept that promised universal application and global competitiveness.

> We believe that the basic ideas of Lean production are universal – applicable anywhere by anyone – and that many non-Japanese companies have already learned this. (Womack et al., 1990, p. 9)

The second event came from the experience of the GM plant in Freemont, California, which showed that Japanese production systems were transferable to the US and opened up a whole new perspective of concept distribution. In this joint venture between GM and Toyota (named New United Motor Manufacturing Inc. [NUMMI]), Toyota used TPS to transform, in less than two years, GM's most unproductive plant so that it became the most productive of all GM's global factories (Adler, 1993; Holweg, 2007). The NUMMI project managed to solve a major conflict between management and the local union by creating a work condition built on trust and respect between management and employees (Adler, 1993).

The results of the NUMMI project demonstrated that culture and borders did not necessarily prevent the spread of best-practice production programs in general. This marked the beginning of a new approach by MCs. By the end of 1980, MCs started extensively to implement TPS principles in their production lines, later extending this to become a more holistic business system covering all parts of an organization (Holweg, 2007; Marodin & Saurin, 2013).

2.3 Introducing the XPS phenomenon

Since the late 1980s, attempts to implement TPS and Lean as best-practice models have been made by several companies from various industries worldwide (Netland & Powell, 2017; Netland & Aspelund, 2014: Samuel, Found, & Williams, 2015). However, a significant body of research in the last 30 years has demonstrated that implementing TPS and Lean has been more challenging than initially expected (Hines et al., 2020; Holmemo & Ingvaldsen, 2016; Hopp, 2018; McLean et al., 2017; Netland, 2016a; Osterman, 2020; Osterman & Fundin, 2020). Some researchers claim that only 10% of all Lean initiatives succeed (Bhasin, 2012; Netland, 2016a), leading to the view that Lean implementation is problematic (Osterman & Fundin, 2020).

My analysis of this literature indicates that the problems of Lean implementation are attributed to three main organizational challenges: (1) conceptual interpretation; (2) handling the change process; and (3) institutionalization. In the following, I elaborate on these three challenges to establish the knowledge behind the XPS phenomenon and why it has become an alternative to the Lean and TPS concepts.

Popular organizational concepts such as Lean have two key characteristics: room for interpretation, and the promise of performance improvement (Benders, Van Grinsven, & Ingvaldsen, 2019; Røvik, 2007). An organizational concept is usually presented with a set of principles, methods, and tools. These principles are easy to understand, but also ambiguous and imprecise, which allows for different interpretations. Such "interpretive viability" (Benders & Van Veen, 2001) makes it possible for different consumers (e.g., managers, consultants) to adapt the concept to different local conditions in their own organizations (Benders & Van Veen, 2001). This in turn gives the concept more applicability and increases the field of distribution, because consumers use the elements that are most beneficial to their own interests. A prerequisite for popularity is thus the concept of "ambiguity", and it is this possibility of providing one's "own interpretation" that defines the "interpretative space" (Benders & Van Veen, 2001; Hines, Holweg, & Rich, 2004).

Arguably, Lean is a good example of a concept with high ambiguity. As suggested by Womack and Jones (1996), Lean can be defined according to five main principles:

1. Define the customer's need
2. Create the value-stream for each customer
3. Create flow in the value-stream
4. Secure pull in the process
5. Conduct continuous improvement (*kaizen*) to reduce waste.

With such a level of abstraction, Lean has significant scope for interpretation, which, in turn, allows consumers, whether intentionally or not, to choose components that they find appropriate for their own context. This explains the long and ongoing discussion about Lean and the content of the concept (Osterman, 2020). Lean might be viewed as a system (Osterman & Fundin, 2020), as a philosophy (Shah & Ward, 2007), as a set of tools and practices (Dennis, 2017), as a 'soft Lean' version (Holmemo, Rolfsen, & Ingvaldsen, 2018), as a start-up program for new businesses (Reis, 2011), as a management concept (Liker, 2004), as an organizational learning system (Powell & Coughlan, 2020b), or as a concept for cost cutting termed "hard lean" (Holmemo, 2017). Hence, without a common understanding of the content, any attempt to measure the success of implementation relies on how the concept is interpreted. Consequently, the discussion of successful implementation is based on how the concept is defined.

The second challenge relates to the area of change management and specifically to the implementation of concepts in an organization (Beer & Nohria, 2000; Kotter, 1995). Regardless of the interpretation of the concept, Lean is often viewed as a "best practice" concept "applicable anywhere by anyone" (Womack et al., 1990, p. 9), implying that it is adaptable regardless of political, social, and technological differences. Contingency theory, however, rejects the idea of universality by holding that different contextual environments require different implementation strategies (Sousa & Voss, 2008). Moreover, contingency theory suggests that there is no best way to handle a change process; instead, the best solution is contingent on the situation in which the concept is implemented (Netland, 2016a). Several studies over the last years have discussed this challenge and suggested that different contextual environments hamper the promise of universality (Bhasin, 2012; Holmemo & Ingvaldsen, 2016; Pardi, 2005). For example, when implementing Lean, visual management and report systems are often established on the shopfloor to systematically measure, visualize, and distribute performance indicators for quality, time, safety, and so on. Such "daily layered accountability" (Netland, Powell, & Hines, 2019, p. 13) exposes individual performance and might be accepted if there is established and significant *trust* regarding the intention behind exposing performance. If not, shopfloor workers might resist, refuse to report, or try to manipulate the input, thereby creating a fundamental challenge to quality improvement (Hopp, 2018; Neirotti, 2018).

A related topic is the impact of management support and the ability to handle the change process (Holmemo & Ingvaldsen, 2018; Marodin & Saurin, 2013; Netland, 2016a). Management support has been regarded as vitally important for successful Lean implementation (Liker, 2004; Spear, 2004). Moreover, Netland et al. (2019) recommended six "Lean leadership practices" as novel management support for a successful Lean implementation process.

Linked to the implementation challenge are the internationalization of concepts and the trade-offs between standardization and adaptation when the concept is transferred across geographical locations. Companies with a network of subsidiaries (often global networks) seek to standardize their improvement programs with the goal of increased efficiency. Such standardization of improvement programs follows the same logic as standardization of marketing programs, purchasing systems, accounting services, and so on (Netland et al., 2014), with the aim being adoption and standardization introduced by the corporate level. However, studies have revealed major challenges associated with attempts by (global) companies to standardize improvement programs. Different technological, cultural, and political differences challenge the standardization. For the concept to be implemented, the subsidiaries must adapt or "hybridize" the concept (Wallace, 2004). Several studies have documented this in practice (Ansari, Fiss, & Zajac, 2010; Kostova, 1999; Netland, 2014; Rolfsen, 2014; Wallace, 2004), with standardization being described as "the exception and not the rule" (Ansari, Reinecke, & Spaan, 2014, p. 1314). Consequently, (global) companies are often forced to develop local variants of their improvement programs, and the ability to adjust and adapt to the local context is a fundamental capability for MCs when implementing Lean in their network. This might also explain why Lean implementation is still debated in the literature (Osterman & Fundin, 2020).

The third main challenge in Lean implementation relates to institutionalization (Holmemo, Powell, & Ingvaldsen, 2018). Within conceptual organizational theory, institutionalization involves the long-term persistence of change, indicating the sustainability of new practices in an organization (Buchanan et al., 2005). This stage in the organizational change process relates to Kurt Lewin's notion of "refreeze" in his systemic change model, which indicates that the change process has resulted in a common consensus within the entire organization. In this stage of the change process, new practices and concepts become shared norms, values, and knowledge, and a normative consensus has been reached (Cummings & Worley, 2014).

There is a distinct notion that continuous improvement brings evidence of Lean being institutionalized in an organization (Besser, 1996; Bhasin, 2012; Holmemo et al., 2018; Liker et al., 2008; Marodin & Saurin, 2013; Spear, 2004; Powell & Coughlan, 2020a). Continuous improvement has its roots in the evolution of TPS and the formalization of improvement work during the 1950s and 1960s (see chapter 2 on TPS evolution). Institutionalized practice became one of the main experiences that the NUMMI project distributed to the Western world (Adler, 1993; Holweg, 2007). In the NUMMI project, continuous improvement was claimed to be institutionalized among the operators, creating constantly developing performance in the production line (Adler, 1993). This was later re-established and documented by Fujimoto (1999) who explained the logic behind Toyota's "manufacturing learning capability" and how this "institutionalized learning ability" explained the success of the company. Womack and Jones (1996) further emphasized this in the fifth principle of Lean: conducting "continuous *kaizen*" by improving the standards in the flow. Many companies deciding to implement Lean have, therefore, considered Lean means to establish continuous improvement and create a learning organization.

A significant number of studies have reported problems with institutionalizing continuous improvement in an organization (Lagrosen & Lagrosen, 2019;

McLean et al., 2017). One possible explanation is that poor implementation process creates problems for long-term institutionalization. Studies have shown that organizations tend to establish short-term projects with external or internal consultants responsible for the implementation process (Holmemo et al., 2016; Holmemo, Powell, and Ingvaldsen 2018). Such 'outsourcing' of the implementation process often results in short-term effects, leaving the organization with no shared assumptions or consensus about the deeper principles of the concept (Asif, 2019; Holmemo et al., 2016; Lagrosen & Lagrosen, 2019; McLean et al., 2017).

2.4 XPS and the research challenge

In response to the challenge of interpreting, implementing, and institutionalizing Lean and TPS, MCs have developed new strategies to use the concepts for business performance (Netland, 2016b). Netland (2013) introduced the concept of XPS to describe how MCs create standardized improvement programs based on existing organizational concepts, but adapted to the MC's strategies and environments. These concepts are mostly selected from the same "well" from which TPS and Lean drew, although different aspects of the concept are emphasized, such as Total Quality Management (TQM) and JIT (Netland, 2013, Netland, 2016b). An XPS is portrayed as an "own-best-way approach to the one-best-way paradigm" of operations management: it is a strategic and long-term program shared within the global production network and creating a common platform for improvement (Netland, 2013). The central idea of an XPS is to handle the challenge of implementation and institutionalization by creating a tailor-made business system in which the principles and concept of TPS and Lean are adjusted to the company's contextual environment. This adjustment is supposed to be made at the corporate level, where the new concept is first created and later implemented, in order to ensure standardization and homogeneity throughout the company (Netland, 2013, 2014).

As mentioned in the introduction, the XPS phenomenon seems to be a growing trend among MCs (Netland, 2013, 2014, 2016b). The processing, food, and aerospace industries, among others, have explored this new approach (Netland, 2013); examples are the Electrolux Manufacturing System, Hydro Aluminium Metal Production System, Siemens Production System, Nestlé's Continuous

Excellence program, and the Jotun Production System. Furthermore, the XPS phenomenon implies a significant strategic initiative for an MC. Adjusting organizational concepts at a corporate level with the aim of network standardization followed by a vital change process is an important initiative that involves several levels of the MC (Sousa & Voss, 2008).

As noted earlier, there is limited literature on XPS despite the growing interest in it; moreover, there is a lack of empirical evidence about it. Thus, research on XPS presents several research challenges.

Research challenge I: The creation process

The XPS phenomenon requires an important creation process that is conducted at the corporate level and is intended to be applied across the operational network (Netland, 2013; Netland, 2016b).

Creating a tailor-made concept to enhance production performance is a distinctive and new strategy in using a standardized concept such as Lean or TPS. The following topics are presented in the literature as vital to the creation process:

1. Creating an XPS implies a long-term strategy, created at the corporate level, to "sustain the emphasis and focus across the global operations networks over a long time" (Netland, 2014, p. 131). The strategic focus also requires significant support from top management (Netland, 2014).
2. In creating an XPS, the company selects different concepts, indicating that specific concepts are chosen based on an assessment process (Netland, 2014).
3. To create an XPS, the company must tailor the chosen concepts to the unique circumstances and nature of the company uniqueness, which implies that a process of adjustment is required when the XPS is created (Netland, 2014).

First, the XPS is supposed to be supported by top management to bring consistency and sustainability to improvements in all plants within the company. However, the XPS literature does not offer any analysis of the content of the top-management support, despite it being considered crucial to the program's success (Netland, 2013, 2014). Similarly, studies of Lean-inspired transformation recognize top-management support as a vital factor for its success, but they have rarely detailed the content of this support (Holmemo & Ingvaldsen, 2016; Marodin & Saurin, 2013; Netland et al., 2019). Therefore, top-management support for the creation of an XPS needs to be examined empirically in order to develop practical recommendations for managers initiating or taking part in complex, strategic change.

Secondly, concepts chosen for an XPS are suggested to be some variants of the TPS and Lean (Netland, 2013, Netland, 2016b), and few XPS are supposed to contain unique, non-Lean principles (Netland, 2014). Hence, an XPS is supposed to emphasize technical aspects, such as JIT logistics. However, recent studies have indicated a different development, claiming that the success of such programs rests on organizations' ability to develop people and organizational learning (Powell & Coughlan, 2020a, 2020b).

Third, the chosen concepts are tailored to fit the company's uniqueness. The argument is that not all principles suit all companies due to differences in production set-up, plant size, technology, organizational culture, and other contingent factors (Sousa & Voss, 2008; Hekneby et al., 2021). The question is: how is this process managed? I have suggested that *adjusting concepts* is the fundamental explanation for the success of TPS, and that this was due to Toyota's ability to *experiment* with different ideas and concepts. Thus, it can also be asked: to what extent does the process of adjusting concepts relate to experimentation in the XPS phenomenon?

One hypothesis is that this process is based on a "master plan" in which the company first evaluates its contextual uniqueness, then uses several concepts to design interventions, and finally implements and adjusts the plan to fit the specific context. Such an approach is often recommended in the literature relating to deductive change and strategy deployment (Mintzberg & Westley, 1992). Another hypothesis is that the XPS is not created by a master plan but by experimentation following the same path as TPS. In this "inductive change process" (Mintzberg & Westley, 1992), the extent of such a process implies significant resource allocation and must be seen as a strategically important decision for an MC. A third hypothesis is that the XPS phenomenon mostly involves changing the company's name while continuing to use standard concepts without any actual adjustment. This "hypocrisy" hypothesis (Brunsson,

2002) suggests that the XPS phenomenon is not new; rather, it is a fancy way to keep up with the latest trends and to signal efficiency and innovation (Røvik, 2007). The first part of my research question (RC) addresses this in order to document how a successful XPS is created (see Table 1).

Research challenge II: The implementation process

The second topic relates to the XPS implementation process; here, too, there are empirical gaps. The XPS is supposed to "ease the transfer" of the concept and sustain a company's pressure on its subsidiaries Netland (2014). Hence, this ease of transfer enhances the possibility for successful adoption and standardization of the concept in the MC's network.

As demonstrated earlier in this chapter and by three decades of academic research, implementing concepts like Lean and TPS have been highly problematic. How can a tailor-made concept overcome this challenge? One hypothesis is that the creation process manages to reduce the interpretative space among the subsidiaries by clarifying the exact use of the concept and its principles. This explanation assumes that the XPS is implemented in similar contextual environments, or that the concept is adjusted to all the different environments of the network. Another hypothesis is that the XPS is made for adaptation and that the ease of transfer is related to how flexibly the concept copes with variation in a network (Ansari et al., 2014). This question needs empirical clarification. The second part of my RC addresses these questions (see Table 1).

Research challenge III: The institutionalization process

The third topic relates to the institutionalization and sustainability of the concept. The literature has identified two elements to the institutionalization process:

1. The XPS is supposed to be "infinite—meant to sustain the emphasis and focus across the global operations networks over a long time" (Netland, 2014, p. 129).
2. Leadership from top management is vital for successful institutionalization of the XPS (Netland, 2014).

The process of institutionalizing an XPS needs several empirical clarifications. How is the emphasis and focus sustained and which instruments are used to institutionalize an XPS and ensure continuous improvement? One hypothesis is that the creation process involves and educates the subsidiaries to such a level that a normative consensus is established during the creation process. Another hypothesis is that special resources (e.g., training programs, management programs) are established in the process, and that these organizational initiatives create a normative consensus that leads to institutionalization (Besser, 1996). This requires top management to play a central role in the process. It might be assumed that top-management support relates to how the organization absorbs new knowledge, establishes common values, and creates a normative consensus about the XPS content. However, as discussed earlier in this chapter, the problem is that few studies have provided a precise description of the actual content of this management support. Therefore, we need more empirical evidence of the process of institutionalization of an XPS in general and of the role of top management in particular. The third RC addresses these questions (see Table 1).

Table 1. XPS empirical clarifications

XPS stages	Creation	Implementation	Institutionalization
XPS empirical clarifications	A long-term strategic program created at the corporate level. Choosing different concepts? Adjusting to a company's uniqueness?	Ease the transfer of the program? Sustain company pressure on subsidiaries?	Infinite and a long-lasting program? Sustain emphasis over a long period? Strong management support?

Based on this my research question is:

How is an XPS successfully created, implemented, and institutionalized in an MC?

Finally, by *successfully* I mean that XPS should be (Fujimoto, 1999; Osterman 2020):

- A specified concept for production improvement with a precise description of routines, principles, and tools
- It exists in a visual format for distribution and knowledge transfer
- It represents a comprehensive system that explains how routines, tools, and principles work together
- It meets with compliance in all factories in the MC's network.

3. Research design

Based on the theoretical chapter, my research question is:

> *How is an XPS successfully created, implemented, and institutionalized in a MC?*

A vital part of a PhD thesis is its research design. Here, I outline my scientific and strategic approach to answering my research question.

The word "science" derives from the Latin word *scientia*, meaning "knowledge". I could be described as the systematic quest for "objective knowledge" about a phenomenon (Ponterotto, 2005). Central to the creation of objective knowledge is the research design, which represents the strategy adopted to produce new knowledge using scientific methods. The latter represent rules and procedures (the "rules of the game") for providing objectivity in the search for knowledge (Bougie & Sekaran, 2016).

The phenomenon forming the subject of this thesis developed from approximately the 1930s until the present. It concerns organizational development in general and industrial engineering in particular. It can be visually presented as three main stages, which are illustrated in Figure 1 and have been discussed in more detail in Chapter 2.

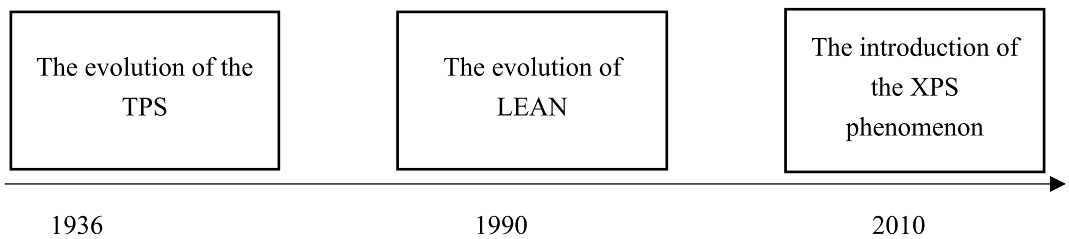

Figure 1. Historical development from TPS to XPS

Significant to my research design are Netland's (2013, 2014) inductively established theoretical constructions of the XPS phenomenon. These were based on two main data collections. In the first, 30 global companies were invited to respond on a survey to provide data about the content and main principles of their XPS (Netland, 2013). The second set of data was collected by inviting five companies to a workshop to gather more in-depth knowledge about the XPS content (Netland, 2014). This inductive approach provided me with the first theoretical understanding of the XPS phenomenon. As I have previously mentioned, XPS theory lacks empirical support. My research is therefore intended to help reduce this gap by establishing more theoretical and practical knowledge about the XPS phenomenon.

Rather than trying to test any hypothesis, I am instead looking to extend a theoretical construction on a social phenomenon. This implies following the inductive path laid out by Netland (2013, 2014) in order to establish more knowledge about an existing theoretical concept. Importantly, to follow the inductive path, it is vital that there is a critical examination of the data to ensure objectivity in building new knowledge.

Creating, implementing, and institutionalizing an XPS might construct an endless number of variables affecting the process, and hence must be viewed as a complex social process, the outcome of which can be affected by a vast number of events and variables. These events and variables appear at different times, on different levels of the organization, and among a wide range of people. To address my research question, therefore, I used a research design that allowed me to generate objective knowledge about a socially complex phenomenon.

I chose a case study methodology (Eisenhardt & Graebner, 2007; Yin, 2011), aiming to connect and understand the context of this complex social process by using a qualitative approach. Central to a qualitative approach is the critical analysis of data. To secure validity and reliability, I used a reflexive methodology (Alvesson & Skjøldberg, 2018) as the main strategy for collecting, sampling, analyzing, and interpreting the data. I will later describe this method of analysis in more detail in order to emphasize the importance of a clear methodology for questioning the data when using an inductive approach.

3.1 The case: Elkem ASA

Why use Elkem ASA as a case study to answer my research question?

The first argument relates to Elkem's experience with an XPS. As mentioned in the introduction, over a period of 30 years Elkem went from being almost bankrupt to becoming a world-leading company within the electrochemical industry. An explanation for a company's success always involves several factors in the external and internal environments. Some of these factors will be beyond management's control. However, both the company's employees and external assessments (Sogner, 2014; Hekneby et al., 2020) point to the importance of creating, implementing, and institutionalizing an XPS. Elkem's long-lasting experience with the XPS phenomenon and their success makes the company a good case study for investigating my research question.

Secondly, Elkem is a good case because it provides good access to data. As a researcher, I have been given access to all parts of the organization. I was able to book meetings with the CEO and other top managers any time I wanted (if the schedule allowed it). I was given free access to all factories globally, being met with open arms by plant managers and operators. I could participate on the shopfloor level, without supervision, contributing to day and night shifts and getting close to the environment of the production line. I was invited as an observer to the company's assessment program, the global XPS University, and the Toyota Lexington Training Program, and I formed good relationships with present and former managers of the XPS department, the HR department, and the finance department. All of this gave me the opportunity to constantly validate and cross-check my data, thereby helping me to develop scientific knowledge about the case study. I was also given the opportunity to meet former and retired managers who had initiated the development of the XPS in Elkem, including a CEO, the HR manager, the XPS department manager, and plant managers. Again, I was met with open arms and a willingness to share data with me, which was critical for my understanding of the creation and implementation process of the company's XPS over the last 30 years. This close interaction with personnel and extremely good access to data were key to making Elkem a good case study for answering my research question. Later in this chapter, I elaborate on the challenges of this close interaction.

3.2 Data collection

Data was collected from the following components in my qualitative research design:

- Observations
- Interviews
- Archive data
- Group meetings and workshops.

Some of the data collection could be categorized as formal because it was used directly in the papers and had a formal structure of transcription and coding (e.g., interviews and observations in the Elkem plants). Other data was collected in a more informal way, including data that was important for a contextual understanding (e.g., visiting the Toyota plants in the US and Japan).

From 2017 to 2020, I visited four plants in Norway, one plant in Brazil, and one plant in China. Each visit lasted for approximately one week. I also visited the Toyota plants in Lexington in the US and in Tsutsumi in Japan; each of these visits lasted for half a day. In these visits, I collected data by observations, pictures, interviews, group meetings, and archival research. I also visited the Boeing plant in Kentucky, where Lean has been implemented on the production line.

In total, I interviewed 11 top managers, representing the top-management group in Elkem and plant managers from Elkem's global network. Several of these managers were interviewed more than once. I also conducted 12 additional interviews with a former CEO of Elkem and former middle managers. These latter interviews were important for understanding the XPS creation process since 1991.

I interviewed 32 middle managers, including technical managers and operational managers in the global network. Several of these managers were interviewed more than once.

In total, I conducted 30 interviews at the shopfloor level in the global network. For the interviews in the Chinese and Brazilian plants, I used translators. I also participated in day and night shifts on my visit to the plants, and I attended several meetings about continuous improvement at different levels of the organization.

I followed the XPS team on one assessment session, during which they assessed two plants in Norway. The assessment lasted for one week. I also attended Elkem's XPS University for one week.

Written materials and performance indicators were provided (e.g., assessment results and XPS documentation), which were vital archival material for documenting the XPS content. Table 2 summarizes the data used in my thesis.

Table 2. Summary of data used in the research

Plant visits	Observations	Interviews	Archival data
Toyota plant, US	EBS University, 1 week	Top managers 11 interviews	EBS written material
Toyota plant, Japan	EBS assessment program, 1 week	Managers 32 interviews	Assessment written material
Boeing plant, US	Plant visits (10)	Shopfloor interviews 30 interviews	Elkem performance data
Four Elkem plants, Norway		Other 12 interviews with former CEO/managers	Company results
Elkem plant, Brazil			Company presentation
Elkem plant, China			Company history presentation

3.3 Systematizing the data

All collected data was sorted and systematized into categories, and it was stored in the file system on my computer. Interviews were first recorded and later transcribed into Word files, each of which was stored in the relevant category. I used a grounded theory coding approach (Charmaz, 2006), which involved categorizing segments of data with a short name that summarized key elements in the data. The key elements always related to the XPS literature or to the TPS literature, depending on which part of the RCs was being investigated. For example, with the retrospective data regarding the creation process of the XPS, "experimentation" become a key element since it was important to describing the second phase of the creation process. The key elements represented the link between the collected data and the development of findings in the three papers.

I used only the Word file system for this categorization, because I prefer to handle Word documents by establishing columns for the initial coding (Charmaz, 2006), extracting key elements, and later using the documents to manually cluster the elements during the analysis.

I made notes about all my observations, mostly by writing down my reflections at the end of a program or observation (e.g., my visit to the Elkem EBS University). This helped me to summarize my observational findings and abstract the emergent elements, which were later used when analyzing the data.

Archive data was stored on my file system according to categories. It was marked with name and time, and I made comments on some of the data where I discovered emergent elements (e.g., assessment data showing similarities between global plants).

3.4 Analyzing the data

Data was then analyzed systematically in order to recognize a "pattern of relationships" (Eisenhardt & Graebner, 2007, p. 25) and address my RCs in the three papers. I began by analyzing the creation process of the XPS, then the implementation and institutionalization process, before finally returning to an analysis of the creation process. The final data analyzed was the retrospective data regarding the creation process of the XPS from 1991 to 2006. Finally, I used the findings from all three papers to answer my overall research question.

In a classical quantitative research design, analyzing and interpreting data would be conducted by using statistical methods and mathematical techniques. However, my research used qualitative data. Central to the process of analysis was the use of reflexive methodology to interpret the collected data and ensure its validity and reliability (Alvesson & Skjøldberg, 2018). Reflexive methodology is based on two main characteristics: interpretation and reflection (Alvesson & Skjøldberg, 2018). The former implies that all data used for establishing scientific knowledge relies on how it is interpreted. It rejects the idea that there is an objective relationship between the subject studied and the methods used to establish scientific knowledge. As a result, “interpretation comes to the forefront of the research world” (Alvesson & Skjøldberg, 2018, p. 11), fundamentally rejecting the view that any collected data provides an objective reality. In other words, the researcher’s mind is the “statistical instrument” that analyzes the collected data. Importantly, when the researcher analyzes data, it is necessary to find a way to challenge their own interpretation in order to secure validity and reliability.

Reflection refers to the process used by the researcher to challenge the interpretation. It involves examining and consciously acknowledging the assumptions and preconceptions the researcher brings to the research and that shape the outcome. It applies an inward focus, whereby the researcher constantly challenges his or her basic assumptions, values, theoretical knowledge, and emotions. Systematic reflection helps the researcher to increase the value of empirical research because the reflection forces the researcher to constantly reflect and adjust data to avoid their own biases. Such “interpretation of interpretation” can then extract knowledge by “constantly consider[ing] various basic dimensions behind and in the work of interpretation” (Alvesson & Skjøldberg, 2018, p. 11). In other words, reflection is the method for challenging the researcher’s own interpretation.

One obvious strength in my research design is my personal knowledge and experience with organizational development, which stems from my experience as a consultant in organizational change for 20 years. The ability to understand various aspects, theoretical knowledge, and variations, to reflect on the change process, and to interact with people is important for the researcher who uses reflexive methodology (Alvesson & Skjøldberg, 2018). This “breadth and variation” (Alvesson & Skjøldberg, 2018, p. 331) increased my ability to collect fine-grained data, and, by using reflection and interpretation, I was able to extract more valid and reliable findings than would a researcher with less experience.

The counterargument is that this experience, which includes my dominant ideas, values, emotions, and basic assumptions, might have biased my reflection and interpretation, since “pre-structured understanding dominates seeing” (Alvesson & Skjøldberg, 2018, p. 331). Thus, my “experience” also represented a challenge to interpreting the data.

Four main potential areas of bias were detected in the process: (1) my pre-structured interpretation based on my former experience as a consultant; (2) my relationship to Elkem and the challenge of maintaining the necessary distance; (3) failure to capture hidden elements that are difficult to detect in the data collection; and (4) influencing the object by misguiding it to provide data that I have “forced” upon it.

3.5 Avoiding bias

To avoid bias, I created several strategies to help me in the process of collecting, structuring, and analyzing my data. Table 3 provides an overview of these strategies, later to be explained more detailed.

Table 3. Bias settings, strategies, and examples

Possible bias settings	Strategy to prevent bias	Examples
Pre-structured understanding of the received data due to my experience as a consultant and management trainer for 20 years.	Extensive use of opponent to constantly challenge my reflections and interpretations, forcing me to shift between my data and the literature.	Seeking of scientific confirmation to back up my experience as a consultant. Main challenge: handling the data without trying to *adjust it* to my own experiences.
The challenge of maintaining the necessary distance from my case due to *expressed* and *implicit* expectations.	Extensive use of opponent constantly challenged my distance to the object observed.	The “power role” explaining the creation of the XPS. I was concerned that I would establish findings that might contribute negatively to the process.
Failure to capture the “hidden” elements in the data collection due to tight schedule and new experiences.	Importance of reflecting on the situation due to tight schedule by making notes and summarizing my experience during my observations and interviews. Reflect: “What happened today?”.	Realizing that the XPS audit was not about giving scores; it was about learning, involving the organization, and understanding the content of the XPS.

Influencing the object in the data collection process.	Using open-ended questions without any “hidden guidance” or pressure. Feeding data back to several people at different levels of the organization.	Realizing the possibility that the presented data was embraced not because it was accurate but because it was desired.

The main bias problem related to my pre-structured understanding of the collected data. Having worked as a consultant and management trainer for 15 years, I might have experienced some successful interventions in the past, leading me to develop a self-image as competent at implementing Lean and organizational change. This pre-structure might then have led me to seek scientific confirmation of my experiences as a consultant; in other words, I might have tried to fit the information to my pre-structures. An example was my visit to the Chinese plant, which was part of my investigation of differences and similarities between the Norwegian, Brazilian, and Chinese plants. When interviewing managers from different levels of the organization, I struggled to avoid confirming their information with my own pre-structured understanding of the similarities between the three plants. The main challenge was handling the data without trying to *adjust it* to my own expectations.

My strategy involved hiring an “opponent” to constantly challenge how I collected, organized, reflected on, and interpreted my data. This opponent (a professor in organizational theory from NTNU Trondheim) followed my project from the very beginning, constantly challenging me on my methodological approach. The opponent also challenged me to explore alternative explanatory models from the literature, such as management fashion (Abrahamson, 1996) or power structure in an organization (Crozier, 2009). I extensively interacted with the opponent. In November 2020, we exchanged 186 emails, and we had approximately two Skype conversations per month. Not all emails directly related to the reflection, but in general approximately 150 email exchanges were conducted each year from the beginning of the project (i.e., about three emails per week since beginning the project in 2017).

There might also be some indication of a maturation process relating to this potential bias. When I started my PhD program, I was especially interested in transformative leadership (and leadership more generally), but gradually I have developed a more systemic understanding of organizations, where leadership is only one of *several* components. I have also managed to see the ambiguity in Lean (and other concepts) more clearly. This might indicate a maturation process that enabled me to be less trapped by previous experiences.

The opponent also became important in relation to the second bias setting: the challenge of maintaining the necessary distance from my case study. In my data collection, I developed a strong relationship with many Elkem employees, which impacted on my feelings of being accepted and respected as a scientist. Secondly, as a consultant there might always be a small part of my subconsciousness that looks for possibilities of new assignments and future missions. Such *expressed* and *implicit* expectations might challenge my ability as a researcher to maintain the necessary distance when collecting and analyzing the data. For example, in the final phase of my data collection, several managers showed increased interest in and recognition of my findings about the creation of the Elkem XPS. At the same time, a new CEO had joined the company (winter, 2020) and the XPS department expressed some concern about future sponsorship. Therefore, my findings represented a potentially vital asset supporting the XPS department in the future. In the data collection, I then felt worried about establishing findings that could contribute negatively to the process. I therefore used my opponent to help me reflect on whether my work was part of a possible "power play" in the organization. The reflection helped me to realize my emotional attachment and the importance of distancing myself in the process.

Third, in my interviews and observations, I always tried to make a summary of the day, which included reflecting on the possibility that I had missed "hidden elements" in the data collection. The field work was always on a tight schedule, resulting in an endless amount of exciting new experiences during the day. "What happened today" became a label I used to reflect on the "underlying understanding" of the social interaction taking place in the data collection. For example, when following the XPS team on a plant audit, I reflected on one particular event on the final day that involved the XPS team presenting their results to the plant. The classroom contained a mix of managers and operators from the entire organization. Although it initially appeared to be an audit presentation of the results, I came to realize that this presentation, as well as the whole audit, was not about giving scores; rather, it was about learning, involving the organization, and understanding the content of the XPS.

Finally, I had to be very careful not to influence the object when collecting data. I carefully reflected on my questions in the interviews, using open-ended questions without any "hidden guidance" or pressure on the interviewees. I also had to be careful when bringing my data back to Elkem for confirmation. All the papers were fed back to managers in Elkem before being submitted. In this process, I had to ensure that this feedback of data was challenged, and that it was not adopted simply because it was desirable. For example, after discovering an almost "religious dedication" to the XPS among global plant managers, I took the data back to one top manager, who was highly involved in the XPS department, for confirmation. He responded enthusiastically, stating "this is spot on, but we have never seen it before" and "you have discovered something unique and important". Reflecting on this, I had to realize the possibility that this data was embraced not because it was right, but because it was desired. I therefore selected several managers from different levels of the organization to read and comment on my paper. I selectively picked managers outside the XPS department to gather different views on the data.

After completing my interpretation and submitting my three papers, I began to interpret all the data in order to answer my overall research question. This process lasted from spring 2020 to November 2020 and involved establishing my "learning perspective" (see Figure 3) on the XPS process. In this process, my opponent helped me to reflect on my data in the three papers and go back to the literature, and the opponent also challenged me on my arguments in the emerging process. One particular event became important. Reading the literature from Fujimoto (1999) for the second time, the perspective of *organizational learning* took on greater significance. As a result, Fujimoto's description of the evolution of TPS contributed strongly to the development of the learning perspective in Elkem's XPS process.

To sum up my research design, I am studying a social complex phenomenon that has developed over several decades. I used an inductive approach that involved adding knowledge to the existing theory of the XPS phenomenon. I adopted a case study design that used Elkem ASA as the case, and I collected and analyzed qualitative data with the use of reflexive methodology. I developed several strategies in the analysis to prevent bias affecting my data interpretation. Finally, I interpreted the data from my three papers to answer my overall research question. In the paper presentation, I briefly describe the research design for each paper.

4. Paper short presentation

I wrote three papers in order to address my RC. Paper 1 addresses the first part related to how a company-specific production system (XPS) is successfully created. Papers 2 and 3 address the last part of the RC, related to implementation and institutionalization (see table 4).

4.1 Paper 1
Creating a Company-Specific Production System

Title:
Orchestrated Learning: Creating a Company-Specific Production System (XPS)

Purpose:
The aim of this paper is to increase empirical knowledge of how an XPS is created. How was the concept selected and adjusted to the company's uniqueness? How was the company evaluated for its uniqueness, and which decisions were made to initiate this strategically important topic? Which ideas were vital in shaping the content of the XPS, and how was the XPS creation supported by top management?

> *Research question:*
> *How was a company-specific production system (XPS) created?*

Method:
A retrospective case study design was selected based on the complexity of the phenomenon and the associated change process (Yin, 2014). The case study was conducted in 2019 and 2020, and it involved capturing data on how the Elkem Business System was created. Purposive sampling was used to identify the central people involved in the XPS creation process.

Findings:

The findings indicate that the multinational company managed to create a long-lasting improvement program "meant to sustain the emphasis and focus across the global operations networks over a long time" (Netland, 2014, p. 131). The creation process did not follow a master plan. There was no systematic evaluation of the company's uniqueness, and most concepts were tried out based on emerging, mostly unrelated, initiatives in the organization. The creation process had four main phases: crises; inspiration and experimentation; consolidation; and institutionalization (see Figure 2). The XPS content was created based on several (and, to some extent, controversial) ideas that combined TPS principles with socio-technological system (STS) theory and the Norwegian democratic working life tradition. (Levin et al., 2012; Thorsrud & Emery, 1970). To incorporate and adapt the concepts, different stakeholders used experimentation. Organizational experimentation led to a widespread learning process in different parts and levels of the company, lasting for 15 years.

The creation process was *orchestrated* by the CEO, enabling the organization to experiment with and adjust the concepts, and ultimately to integrate a final XPS. The CEO created faith in the concept by allocating resources and convincing the organization through persistence. Finally, the CEO allocated resources to secure the institutionalization of the XPS across the global network.

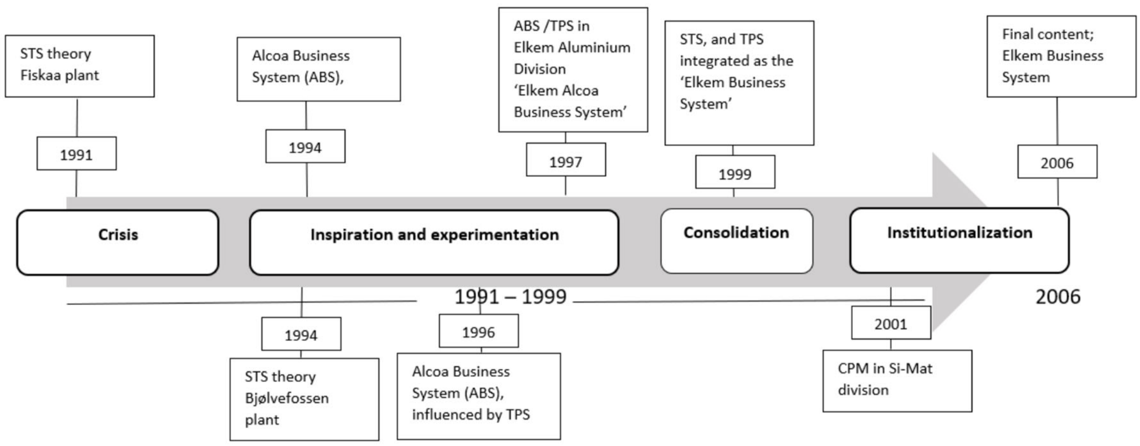

Figure 2. Creation phases of Elkem Business System

4.2 Paper 2.

Adjusting Lean to the Processing Industry: The Contingency Perspective

Title:
"Not so Different Altogether":
Putting Lean and Sociotechnical Design into Practice in the Processing Industry

Purpose:
This paper investigates how the creation of an XPS affects the shopfloor organization in the processing industry and how the concept of Lean production is adjusted to the company's uniqueness.

> *Research question:*
> *How is Lean adjusted to the shopfloor level in the processing industry?*

Method:
Data were collected in spring and autumn 2017 and winter 2018. The observations and interviews from two Norwegian plants were supplemented by interviews with top managers and other managers responsible for the creation and implementation of Elkem's Business System. Data was also collected from a management audit in one plant, which assessed the plant's overall implementation of the company's business system.

Findings:
In the process of creating an XPS, Lean production was adjusted to the shopfloor level by two important contingency factors:

1. The organizational context (especially the technological set-up)
2. Users' interpretations of Lean.

Our findings suggest the need for a situated and contingent understanding of Lean-inspired changes. Different organizational forms will emerge depending on how Lean is implemented. We demonstrate that Lean-inspired adjustment could develop a shopfloor organization typically associated with sociotechnical design, including extensive choice, autonomy, and control for employees. Our findings question the widely held notion that there is a trade-off between swift material flows and workers' choice and autonomy. While this certainly holds historically in the case of repetitive convergent manufacturing, it hardly applies to the context of the processing industry.

Our findings contribute to the overall research question. The creation process contributed to reducing the interpretative space of the XPS among the plants participating in the creation process. Hence, the reduction of interpretative space contributed to easing the transfer (Netland, 2014) of the concept within Elkem's network. Secondly, the XPS was adjusted to the shopfloor level in the processing industry by combining the principles of TPS with those of sociotechnical design, which created choice autonomy and wide span of control at the shopfloor level.

4.3 Paper 3
Implementing and Institutionalizing an XPS in a Global Network

Title:
"Managing Adoption by Cultural Development":
Exploring the Plant-level Effect of a Company-Specific Production System (XPS) in a Norwegian Multinational Company

Purpose:
The paper examines how an XPS is adopted in a global network and how the XPS contributes to easing the transfer (Netland, 2014) of the adoption process to a company's subsidiaries. Secondly, the paper explores how the XPS is institutionalized in a global network.

> *Research question:*
> *To what extent and how does the implementation of an XPS lead to homogeneous practices at a company's subsidiaries?*

Method:
A multiple case study using the methodology of Eisenhardt and Graebner (2007) was conducted at a Norwegian multinational electrochemical company producing carbon materials for the global market. Non-participating observation was conducted by studying one Norwegian, one Brazilian, and one Chinese plant of

the multinational company. This approach allowed us to investigate the process and level of XPS adoption and institutionalization at each plant, and to systematically compare the three plants in a search for patterns and explanations.

Findings:

The original intention of the case studies was to investigate the variation in XPS use between the plants. However, when analyzing the empirical data, we found that the variations were strikingly low, which led us to shift focus toward explaining the extensive adoption that had taken place.

Our findings suggest that the multinational company managed, to a significant extent, to implement and institutionalize its XPS at the three plants. The Chinese and Brazilian plants, which were contextually very different from the Norwegian plant, significantly developed their organization in a direction where empowerment substantially influenced the workplace.

The XPS brought "consistency and durability" (Netland, 2013) to the subsidiaries' improvement efforts and managed to institutionalize the XPS by cultural development and re-examination of basic assumptions (Schein, 2010). Our findings also indicate that creating an XPS is necessary yet not sufficient for institutionalization. In our case, several corporate initiatives were taken to distribute and maintain the values supporting the content of the XPS. The XPS Centre appears to have played a vital part in this. For more than 20 years, managers and operators have been trained and challenged by the idea that performance relies on the level of employee involvement and the use of scientific tools.

For some managers, especially the plant managers, this re-examination of basic assumptions resulted in an almost religious belief in the XPS. This belief then released a "religious energy" in the organization, encouraging all levels to adopt the XPS and make organizational choices relating to decentralization and investment in training and competence at the shopfloor level. Our findings indicate that it is this global and strategic investment in people, supporting the content in the XPS, that leads to the adoption process and creates homogeneity at the intra-organizational level.

5. Paper presentation

Paper 1

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Orchestrated Learning: Creating a Company-Specific Production System (XPS)

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Manuscript Type:	Research Paper
Keywords:	Company-specific production systems (XPS), Toyota Production System (TPS), Organisational learning, Socio-Technological Systems (STS)

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Orchestrated Learning: Creating a Company-Specific Production System (XPS)

Abstract

Purpose – Companies create company-specific production systems (XPS) by tailoring generic concepts to fit their unique situation. However, little is known about how an XPS is created. This paper aims to provide insights into the creation of an XPS.

Design/methodology/approach – A retrospective case study was conducted in a Norwegian multinational company over the period 1991–2006, using archival data and interviews.

Findings – The development of the XPS did not start with a master plan. Instead, dispersed existing initiatives were built upon, along with an external search for novel ideas. Widespread experimentation took place, only later to be combined into a coherent approach. Once established, the XPS was disseminated internally and further refined. The CEO orchestrated the experimentation by facilitating the adaptation and combination of different concepts and by allocating resources to institutionalize the XPS in the global network.

Originality – This paper is the first to study how an XPS is created. Our study contributes with novel empirical insights, and it highlights the role of top management in facilitating experimentation and step-by-step organizational learning.

Keywords Company-specific production systems (XPS), Toyota Production System (TPS) Sociotechnical systems (STS), Organizational learning.

Introduction

Netland (2013) introduced the term "company-specific production system" (XPS) to describe how companies create standardized improvement programmes that are adapted to their own strategies and environments. An XPS is described as an "own-best-way approach to the one-best-way paradigm" of operations management: a strategic and long-term programme, shared within the global production network, creating a common platform for improvement. The central idea of an XPS is to combine and adapt existing organization concepts to fit the unique situation of the company. However, neither Netland (2013; 2014; 2017; Netland and Aspelund, 2014) nor subsequent empirical research on XPS (Boscari *et al.*, 2016; Osterman and Fundin, 2018; 2020) offer any analysis of how an XPS comes into being. The same holds for the closely related notion of "corporate lean programmes" (Powell and Coughlan, 2020a). Hence, the extant literature offers little managerial advice on how to create an XPS, limiting the practical applicability of the XPS approach.

This article responds to these shortcomings by asking:

How is a company-specific production system (XPS) created?

A retrospective case study was conducted in a Norwegian multinational, covering the XPS development from the initial phase when the company realized a need to focus on production performance, to the final implementation and institutionalization of the XPS in the company's global network.

The findings indicate that the company managed to create a long-lasting improvement programme "meant to sustain the emphasis and focus […] over a long time" (Netland, 2014, p. 131). The creation process did not follow a master plan. There was no systematic evaluation of the company's uniqueness, and most concepts were tried out based on emerging, mostly unrelated, initiatives in the organization. Furthermore, incorporating and adapting the concepts were done through experimentation by different stakeholders. Experimentation led to a widespread learning process in different parts and levels of the company, lasting for 14 years. After the incubation phase, the learning was orchestrated by the CEO, enabling the organization to adapt and combine the concepts, and ultimately to integrate a final XPS.

This paper is, to the best of our knowledge, the first to study how an XPS is created. Our study contributes novel empirical insights, and it highlights how the process of creating an XPS is one of experimentation and step-by-step organizational learning. Correspondingly, the role of the top manager is one of orchestrating learning by facilitating local experimentation and ensuring that lessons learned are codified and disseminated.

Creating an XPS

Within the existing literature, an XPS is thought to have three main characteristics. However, beyond some general assessments in Netland's work, how these characteristics matter for the creation process has barely been addressed.

First, an XPS is a long-term, strategic programme (Netland and Aspelund, 2014). In contrast to temporary improvement projects, an XPS is supposed to be *infinite* – that is, it is intended to "sustain the emphasis and focus across the global operations networks over a long time" (Netland, 2014, p. 131). Therefore, the creation of the XPS is done centrally in the organization, where the "headquarters offer a shared system for the global production network" (Netland, 2014, p. 128). The XPS is also supposed to be supported by top management and to bring consistency and durability to improvements in all plants within the company. However, the XPS literature does not offer any analysis of the content of the top-management support, although it is considered crucial for the programme's success (Netland, 2013; 2014). Similarly, studies of lean-inspired transformation recognize top-management support as a vital factor for the success of such transformations, but they have rarely detailed the content of this support (Holmemo and Ingvaldsen, 2016; Marodin and Saurin, 2013; Netland *et al.*, 2019). Therefore, top-management support for the creation of an XPS needs to be examined empirically.

Second, an XPS combines proven principles from different organizational concepts. Although "lean" appears to be the dominant source of inspiration for XPS design, Netland pointed out that industry-specific characteristics mean that particular lean elements may not be appropriate in a certain industry, whereas "non-lean principles" may be suitable (2013, pp. 1092–1093). Despite this conceptual understanding, Netland (2014) empirically found that few XPS contain unique, non-lean principles.

Third, in an XPS, concepts are adapted to a company's strategies and environments. Not all principles suit all companies due to differences in production set-up, plant size, technology, organizational culture, and other contingency factors (Hekneby *et al.*, 2021; Sousa and Voss, 2008). Netland (2014, p. 129) addressed the issue by giving an example of a batch producer of aluminium selecting a production principle of "optimized flow" instead of "just-in-time", because the former is more suitable for a process industry. The adaptation of the concept is here related to the production set-up (Hayes and Wheelwright, 1979). Moreover, with reference to Sousa and Voss (2008), Netland implied that a more extensive contingency view should be taken when analysing uniqueness. However, the XPS literature gives no precise description either of which variables should be examined or of how the tailoring process proceeds.

The creation of an XPS might resemble how the original Toyota Production System (TPS) concept was created, even though the latter often serves as the main inspiration for the former. The TPS was also built on pre-existing concepts, primarily those associated with US mass production and with unique Japanese influences, which were combined and adapted to fit challenges facing Toyota from the 1930s onwards (Benders, 1998; Fujimoto, 1999; Holweg, 2007). The evolution of TPS reveals an extensive and prolonged process of experimentation and organizational learning. Its results and insights were synthesized into a "production system" only at a relatively late stage of development.

Research Design

Presentation of case company

Our study examines Elkem ASA, a Norwegian multinational company. Elkem is one of Norway's oldest industrial companies, with over 100 years of experience within the electrochemical process industry. Elkem started out as an engineering company selling the Söderberg electrode to the global market. From 1950, Elkem gradually became a producer of aluminium, ferroalloys, and later silicon materials, changing the company's focus from technology and engineering to running large-scale production (Sogner, 2014). Today (2020), Elkem consists of three business divisions – silicones, silicon products, and carbon solutions – and has 31 plants around the world. Elkem's main production can be classified as a highly automated process production with large volumes of standardized products. Most of the plants are organized around a single main material flow, which diverges mostly in the final phases of the value stream.

With its origins in Norway, Elkem has adopted values from the Scandinavian working life tradition, which is characterized by extensive worker participation and collaborative industrial relations (Ingvaldsen, 2013). With its global expansion, including factories in China, Brazil and South Africa, the company is exposed to a wide array of national cultures and social institutions.

In 1990, Elkem was on the brink of bankruptcy. Net income had dropped to an annual deficit of 700 million NOK and the company's debt was more than 6 billion NOK. Elkem also struggled with safety and workplace conditions, due to outdated production facilities and a lack of strategy for future growth and investments. Indeed, the consensus among central Norwegian officials in 1990 was that Elkem belonged to a dying industry and that its prospects of survival were poor.

Today, Elkem is a world-leading company within the electrochemical industry and is considered one of the most successful fully integrated silicone manufacturers in the world. It has become a global leader in silicon and micro silica, a leading manufacturer of special alloys for the steel industry, and a world-leading supplier of carbon materials and specialized carbon products. Elkem currently has 6,370 employees worldwide and its revenues amount to more than 25 billion NOK (2019). Workplace conditions are considered to be of world-class standard, with a rate of only 2.1 injuries per million working hours in 2019.

Within Elkem's top-management team, the evolution and success of Elkem are often traced back to the company's strategic initiative in the 1990s that involved developing the Elkem Business System (EBS), the company's own XPS (Sogner, 2014):

> *We are confident that it was the right choice to develop and implement EBS because we have seen the results of our improvement in the company's KPIs [key performance indicators]. Increased production volume, uptime, silicon quality, sales volume and, of course, safety.* (Top managers, Elkem top-management team, 2017)

Hence, according to Elkem, the creation of the XPS was an important contribution to the company's turnaround and business success in the period 1990–2020.

Data collection

A retrospective case study (Yin, 2014) was conducted in 2019 and 2020 to capture data on how the EBS was created. We used purposive sampling to identify the most central people involved in the XPS creation process. Data were collected from four main sources:

- Interviews with the top managers working in Elkem from 1991 to 2006, including the CEO, HR director, the EBS director, and several other managers involved in the creation process.
- Interviews with today's top-management team at Elkem, including the CEO, HR director, division directors, EBS director, and central actors related to the EBS. The interviews were followed up with several emails to further investigate the themes emerging from our analysis.
- Four workshops with central actors related to the creation of the EBS.
- Archival data from EBS educational material from 1990 to 2020, combined with observations and participation at the EBS University in September 2017.

In total, 21 interviews were conducted, using a semi-structured approach. Each interview lasted between 1.5 and 2 hours. Interviews were structured around seven main topics (see Table I). Questions were developed based on the main topics in the XPS literature: (1) the strategic dimension, including support from top management; (2) concepts in use; (3) how concepts were selected, adjusted, and tailored to the company.

Table I. Interview guide

Main topic and question	**Elaborative questions**
Introduction Describe your background and relation to Elkem and Elkem Business System.	Background? Formal position? Experiences with EBS?
Creation Overall, describe how the EBS was created in Elkem.	Time frame? Main events?

Concepts Which concepts were used in the creation process?	Origin of the concepts? History of introduction?
Tailoring process How were the concepts adapted to the company?	Evaluating company needs? How concepts were implemented? Impact on the organization?
Top management Describe the role of top management in the process.	Precise description of top management support? Importance for the creation process?
Important events or persons Are there any important events or persons in the creation process that should be mentioned?	Concepts? Events? Persons?
Closure Is there something important information regarding the creation process not addressed?	What is forgotten? Who should be contacted for further information?

Data analysis

All interviews were transcribed and, together with the archival data, sorted according to the timeline. Elkem created its XPS over a period of 14 years, with different individuals bringing in different ideas and concepts. The data were analysed based on Langley's (1999) suggestion to use "temporal bracketing" to understand organizational change processes. If there is a certain continuity in activities within a period, temporal bracketing might be used to facilitate the examination of how actions in one period change the context of action in subsequent periods (Langley, 1999, p. 703). This strategy led us to cluster our data in four main, successive phases (see Figure 1). We then analysed the data within each phase with respect to three main themes from the literature on XPS:

- Which concepts contributed to the XPS?
- How were concepts combined and adapted to company-specific conditions and needs?
- How did top managers support the creation of the XPS?

This strategy of data analysis allowed us to build a "process model" (Cloutier and Langley, 2020) of XPS creation – that is, a reconstruction highlighting the main events and activities, and how they relate. Hence, we could understand how concepts were selected, combined, and adapted, as well as top management's role in the overall process. The findings were brought back to and validated by key respondents (Yin, 2014).

Findings

Introduction and time phases

To describe the creation process, it seems reasonable to set the starting point as 1991, because it was then that a new CEO entered the company, later to become the main sponsor of the business system. The XPS emerged in a series of new ideas and experimentation over a 14-year period. In 1999, the experimentation ended in consolidation and a formal decision to establish the EBS. The final content of the EBS was established in 2006, bringing a vital concept of critical process management to the final principles and the written material that contributed to the institutionalization of the XPS.

The creation process can be structured into four main phases. Even if there is some overlap, each phase represents a different stage in the development (see Figure 1). We have labelled these four phases as:

1) *Crisis*: the first period mostly stemmed from desperation and a strong focus on survival.
2) *Inspiration and experimentation*: in this period, Elkem was introduced to several new ideas and concepts, inspiring and changing the focus of top management. Elkem started to experiment with the different concepts in the different plants and divisions, resulting in significant, yet distributed, organizational learning.

3) *Consolidation*: in 1999, Elkem integrated and combined the different concepts, and formally established the EBS.

4) *Institutionalization*: the final content of the XPS was implemented, and a plan for institutionalization was developed.

In the following subsections, we present each phase in detail. Table II presents an overview of the main findings.

Figure 1. Creation phases of Elkem Business System

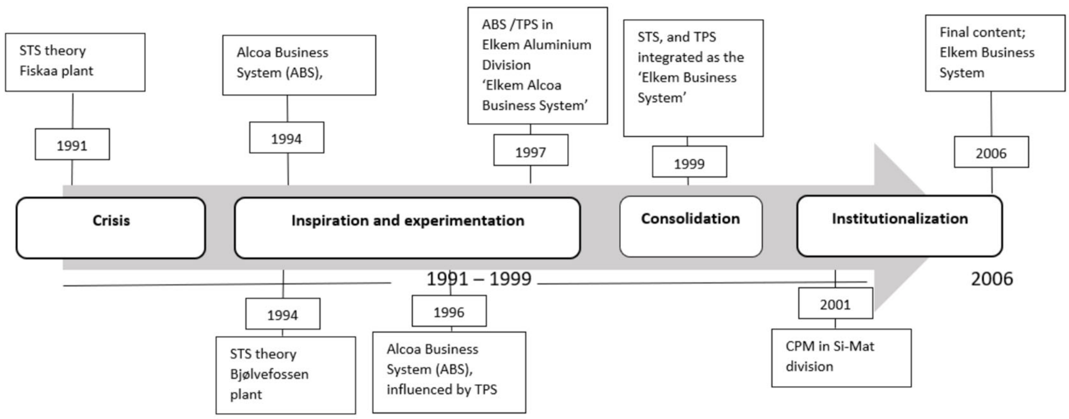


Table II. Key findings

XPS variables	Phase 1: Crisis	Phase 2: Inspiration and experimentation	Phase 3: Consolidation	Phase 4: Institutionalisation
Concepts used	STS at Fiskaa plant, 1991	Alcoa Business System (ABS), influenced by TPS, 1994 STS at Bjølvefossen plant, 1994 ABS/TPS in Elkem Aluminium Division, 1997 STS on management team in 14 Elkem plants, named the Elkem Management Forum, 1996	STS and TPS combined in the Elkem Business System, 1999	Critical Process Management (CPM) integrated into Elkem Business System, 2006

How were the concepts adjusted and combined to meet the company's unique needs?	STS was introduced through a national action-research program. No explicit adjustment, pragmatic use.	The inspiration to learn more about TPS was based on a strong belief in ABS as a "rescue package". TPS was neither tailored due to an extensive analysis of contextual variables nor picked accordingly. But initiated by several stakeholders, allowing different parts of the organisation to experiment with the concepts	Converting written material from Elkem Alcoa Business System to Elkem Business System	The CPM concept was selected based on an evaluation of the environment in the upstream process in the electrochemical industry, and it was implemented accordingly
How did top managers support the creation of the XPS?	No role. Unaware of the ongoing STS process in Fiskaa plant	Sponsor – creating belief in ABS as a rescue package; allocating resources for experimentation. Orchestrator – handling the process of experimentation and learning, adjusting concepts to the company`s needs; handling resistance.	Orchestrator – combining the different concepts, making a formal decision to create the Elkem Business System (EBS).	Allocating resources for institutionalisation

Phase 1: Crisis

The first phase of the XPS creation process mostly related to handling a fundamental crisis in the company. There was no formal decision to create an overall production system; rather, a cost reduction programme was the management's focus. However, one plant began experimenting with a totally different concept, which became a pillar for the XPS.

<u>Concepts in use</u>

In 1991, Elkem consisted of 25 wholly and partially owned production units in Norway, Iceland and North America, with approximately 5,000 employees, of whom two thirds were in Norway (Aslaksen, 1999). The globalized economic market had developed significantly, with newcomers (China and Russia) flooding the western European market with low-price products of acceptable quality (Aslaksen, 1999). In the home market, the

Norwegian government introduced new power regulations, which forced Elkem to pay more for hydroelectric power and led the company to realize that it was unable to utilize its production equipment and human resources to the standards required to be globally competitive (Aslaksen, 1999). These contextual elements were to become decisive in the emergence of the XPS over the following years.

When a new CEO was appointed in 1991, the company was on the verge of bankruptcy. The company had to cut costs, and extensive staffing reduction programme was implemented in the early 1990s. The firm relied heavily on consultancies to implement cost reduction programmes, to initiate employee reduction, and to sell off assets.

In parallel, a quite different concept had already been introduced to Elkem in 1990 by an action researcher. Working for the Norwegian government to promote modern organizational design, she was the first to introduce the sociotechnical systems approach (STS) (Trist, 1981), which was combined with Norwegian work-life norms of broad worker participation in organizational development (Emery and Thorsrud, 1976; Ingvaldsen, 2013). The "Fiskaa plant project" in Kristiansand marked the start of a long-term collaboration that was to have a decisive impact on the development of Elkem's final XPS. This project was not part of the ongoing cost reduction programme; rather, it aimed to develop a participatory work organization and to enhance the internal capacity for organic change in order to increase productivity and improve the quality of work-life (Aslaksen, 1999). The project required employees to participate in all activities, and there was a clear link between the project and the factory's long-term strategy. The project started with a gap analysis and the broad involvement of the organization. Trade union representatives, operators, chairmen, representatives from operations and maintenance, top management, and various staff members participated. Several groups (task forces) were established, and they were given responsibility for coordinating the improvement work between the meetings to ensure active participation throughout the organization.

Two significant lessons emerged from the project. First, the project demonstrated that an alternative work design might be superior. Changes involved using semi-autonomous teams and decentralized decision-making for operators (Aslaksen, 1999). This contributed to internal discussion and configuration, which related to empowerment in the EBS. Several organizational alternatives were constantly discussed and tested throughout the 1990s. Second, the project showed that when developing an organization and implementing a participatory work design, the set of principles or fixed solutions is not sufficient on its own. Because they challenge the plants' existing power structures, the ideas had to be made operational and tested in practice, and arenas for learning (i.e., cross-functional teams) across the organization had to be created (Aslaksen, 1999). This knowledge of empowerment and practical experimentation was later used to tailor different concepts to suit the company's uniqueness, ultimately becoming the EBS.

Tailoring concepts to meet the company's needs

The cost-cutting programme was based on the fundamental need for company survival, whereas the STS project was initiated with funding from the Norwegian government. In fact, the Fiskaa project was not on the radar of the top manager until 1994.

Data indicate that the STS concept was not initially tailored to suit the company's needs. The concept was introduced by the Norwegian government as part of its Industrial Sector Programme. Responding to the main challenges facing the processing industries in Norway, the programme aimed to create a more flexible work organizations, utilize the competence of the workforce, and improve the work environment (Aslaksen, 1999). Instead of deploying cost reduction actions directed by top management, all parts of the plant's organization were involved in establishing targets and actions (Aslaksen, 1999).

An important task within this process was to involve the shop floor in using new sensor technology in the production line (Aslaksen, 1999). The knowledge of empowerment was later used to tailor the concept of TPS in Elkem's aluminium division.

The Fiskaa plant was invited to participate in the programme in 1990. In return, the plant had to demonstrate interest among both the employers and the employees in working towards increased participation and sharing of their experience with other plants in the Industrial Sector Programme. Therefore, the STS concept was selected on the recommendation of an external programme rather than as a result of an evaluation of whether it was a "perfect fit".

Top-manager support

The CEO of Elkem seemed to have little knowledge of the STS initiative at the Fiskaa plant until 1994, when he met the action researcher.

Phase 2: Inspiration and experimentation

In this phase, new concepts inspired the main stakeholders in Elkem to change the focus from cost reduction to product quality in order to re-establish trust in Elkem as a profitable company. In addition, widespread experimentation with different concepts for improving production performance was initiated across the global network. This fuelled significant learning within the company.

Concepts used

In the 1990s, Elkem jointly owned two plants with Alcoa (Lista and Mosjøen). In 1994, through collaboration with Alcoa, Elkem's recently appointed CEO was introduced to Alcoa's XPS, the Alcoa Business System (ABS) (Kolesar, 1993). As early as 1980, Alcoa had begun sending managers and other technical personnel to Japan to learn how improvement work should be carried out. The new CEO received direct information from Alcoa about their exploration of TPS principles in the process industry, and in 1994 Elkem sent its first manager to Alcoa to be trained. He returned with a training programme and a clear concept of improvement work in the processing industry. The training programme created considerable enthusiasm and faith among the managers in Elkem. In retrospect, the CEO acknowledges that an important reason why the ideas from Alcoa became inspirational was that Elkem's stakeholders at the time felt a strong sense of urgency. Even top management was not convinced that the company could be rescued, and there was a lot of negative publicity about Elkem and the wider industry in which it operated:

> *To be completely honest, the reason that [EBS] became a success was that it came out of desperation. Even top management was not convinced that the company could be salvaged.* (Former CEO of Elkem interviewed in 2019)

The training programme was, therefore, considered a "rescue package", and, in 1995, Elkem started the process of creating its own training programme, in addition to sending more people over to Alcoa to learn about TPS and the basic principles of ABS.

<u>Tailoring concepts to meet the company's needs</u>

In the ABS, Alcoa had already begun adapting TPS principles to processing industries. Elkem's decision to adopt the TPS principles was not based on a precise description of contextual variables or an assessment of a "perfect fit" between these variables and the company. Rather, the TPS principles were introduced based on a strong belief that the ABS could work as a "rescue package" at a time of urgent need.

The inspiration provided by this new concept might have been related to a broader shift in focus that was taking place among manufacturers in this period (Voss, 1995). Shifting away from cost-cutting activities, the new focus was on *production performance*. Taking inspiration from the CEO in Alcoa, Elkem adopted the slogan "it's all about getting the processes under control". This slogan (and its variants) captured the new focus in Elkem and its move away from a fundamental low-cost strategy and towards a strategy of high-quality products:

> *It should be understood that this was not about cost and downsizing, but to get the process under control. That was the real breakthrough and it had much more economic effect than cost reduction.* (Former CEO of Elkem interviewed in 2019)

Alongside the new interest in applying the TPS, further experiments with the STS concept were initiated. Here, we discuss three important experiments that took place in this phase.

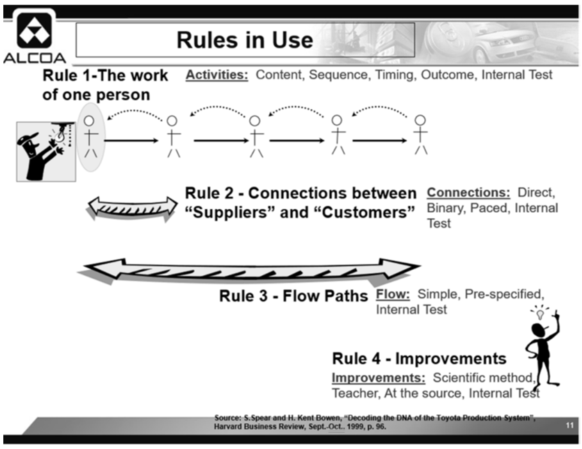
Experiment 1. In 1994, the action researcher was commissioned for a new project at the Bjølvefossen plant by the plant manager. Following the same structure as the Fiskaa project, Bjølvefossen began by establishing an innovation team, representing a vertical structure of the plant and called the extended management team (EMT). Top management, middle managers, division managers, engineers, operators, and the four unions were represented in the EMT. First, a gap analysis was conducted, which involved analysing external and internal contextual elements, and this was followed by the development of a long-term vision for the plant: "becoming a competitive and profitable melting plant for strategic customers" (Aslaksen, 1999, p. 100). Four task forces were then established, each being responsible for actions and competence development in the plant in relation to four areas: market situation, production, technology, and organizational aspects. For example, the technology task force introduced the use of new monitoring technology by production operators. Plans for new technological solutions were developed, training was integrated into day-to-day operations, and the strategic choices were made with broad involvement by the entire organization. The task forces reported back to follow-up conferences, at which actions and results were shared and discussed in relation to the next integration phase.

An interesting adjustment was made in the Bjølvefossen project that related to the political context of the plant. Between the second and the third follow-up conferences, the heads of the four unions had a strong sense of being held as "hostages" in the process by Elkem's management (Aslaksen, 1999). They wanted to discuss this with their members and shop stewards. The third conference was then used to bring all the unions together, and the plant manager presented the project in detail, thereby involving the unions by enabling them to contribute to further development. The outcome was that the union heads received a reinforced mandate to continue participating in the project, and the shop stewards were given more information about and involvement in the project (Aslaksen, 1999).

Experiment 2. Alongside the Bjølvefossen project, TPS principles were tried out in Elkem's aluminium division. Led by the division manager, this project had its own trajectory parallel with the rest of Elkem's organization. Together with several highly skilled operators in the two Norwegian plants, the aluminium division became a key arena for experimenting with TPS knowledge from Alcoa and adapting the concept to Norwegian conditions by removing supervisors from the shop floor and creating semi-autonomous teams. This was not part of the programme at Alcoa, where a more traditional work structure on the shop floor was preferred. This adaptation was made during the experimentation, leading to important organizational changes that appear similar to those associated with the STS concept. Notably, in this division STS had never been introduced as a concept in itself. Rather ideas of “flat hierarchies” and “semi-autonomous teams” entered the division via their broad acceptance as good practices in the Norwegian work-life culture (Ingvaldsen, 2013) and due to the influence of the parallel projects taking place in the Fiskaa and Bjølvefossen plants.

Elkem’s aluminium division produced raw aluminium, mainly electrochemically and often referred to as the “upstream process”; in addition, it also completed and processed raw material for specific customer products (the “downstream process”). Alcoa, in its collaboration with Toyota, developed two types of improvement programmes for its main processes: (1) critical process management, which focused mainly on the upstream process; and (2) ABS, which was based on TPS approaches to creating flow efficiency and waste reduction in the downstream processes. In 1998, the aluminium division established an internal training group consisting of local operators and specialists from Alcoa’s headquarters. They became responsible for the experimentation and developed the first written material and training programme, which was based on Alcoa’s principles. This training programme was named the Elkem Aluminium Business System (EABS) and was the precursor to the EBS. The materials described some basic principles that were eventually to constitute the basis for all improvement work in the two Norwegian plants. The training programme, in its “Rules in Use”, described the relationship between an operator’s standardized work process and the rest of the value chain (see Figure 2). Operator activity was to be defined in standard operational processes (SOP). The Rules in Use then defined how this operation was integrated in the value stream, creating flow between all the work processes and finally executing continuous improvement at every stage. Rules in Use, originally developed in the aluminium division in 1998, remain part of the training in Elkem’s global university programmes today.

Figure 2. Alcoa's 'Rules in Use'



Initiated by the training group, the principles were implemented in the two Norwegian factories and combined with STS ideas. Central to these experiments was a young and talented operator, later to become the first head of the global XPS Centre in Elkem. For many years, he had been a full-time union representative for the Norwegian Chemical Workers' Association and had been heavily exposed to the STS concept and ideas of industrial democracy in the 1960s and 1970s (Emery and Thorsrud, 1976). He had also worked with team-based improvement work and Total Quality Management projects in other organizations and was able to use many similar methods in the new context. In 1998, he and his team started to train production operators to establish self-managed work teams. An important task in combining TPS and STS was to prepare the organization to eliminate the position of the shift supervisor. The company had found that when TPS principles were introduced, operators started to suggest improvements; however, there were significant variations in the rate of actual improvements between the different shifts. This could, according to the training group, be traced back to the shift managers. As one former shift manager explained:

> *We were used as a communication channel to communicate the problems in the system. Several managers did not take the problems further and then nothing was*

done about the problems. We then realized that the problem was the managers. (Former shift manager Elkem plant, 2018)

Distributing the supervisors' responsibilities and tasks down to the teams required considerable effort to develop team roles and standardize the work processes (i.e., the SOPs). The ambition was to create semi-autonomous teams, guided by clear plans, defined roles, and standardized operations. In addition, the support chain and assistance functions were reshaped to meet the needs of the teams, operating only during the day. In parallel, the company implemented tools, such as 5S, Standardized Work, Visual Workplace, and Morning Meeting, which were combined with improvement teams led by shop-floor operators. During 1998 and 1999, the team-based organization was consolidated at the plants. All shift supervisors were removed, and the production line formally shifted to a team-based operating mode.

The results of the improvement initiative in Elkem's aluminium division from 1997 to 1999 is presented as a formidable production performance success by Elkem's top management today. It is argued that the processes led to significant increases in product quality and a doubling of production in the same period, resulting in significantly higher profits. This also contributed to the factories in Alcoa having, for the first time, no absences due to injuries over the course of a year; furthermore, the number of employees was reduced from 1,700 to 750 across the two factories. Perhaps the most important message was that new business areas were created in the downstream processes, securing jobs for those who had become redundant during the improvement phase.

Experiment 3. The STS concept was also tested in a third project led by the action researcher and directed at the global network. In 1996, the local plants in the global network had limited interrelated cooperation, there was a significant "top-down" relationship between the corporate management team (CMT) and local plants, and the relationship between the main union and the CMT was strained because of the cost-cutting programme, resulting in a law suit in 1994 related to the downsizing process in one plant (Aslaksen, 1999). Given this situation, the Elkem Management Forum (EMF) was established with two main goals:

1. To create arenas for dialogue, reflection, and learning between the CMT and the plant management teams.
2. To initiate plant improvement processes to enhance global production performance.

The EMF's participants were all top managers at the plants, in total numbering 100 people in 17 management teams spread over 14 locations. The EMT project followed the same structure as the projects at Fiskaa and Bjølvefossen. It started by addressing the company vision, then the STS methodology was introduced as a tool to analyse and develop the organization, after which Elkem's approach to strategic plant development was introduced. This was probably the first time that the STS concept was introduced to all Elkem's managers. The first session ended with the preparation of development activities that were to be conducted at each plant and presented in the next session. As at Bjølvefossen and Fiskaa, several actions were initiated across the global network between the sessions, contributing to enhanced production performance using TPS and STS practices. The EMF was evaluated and, in 1998, Elkem's CMT decided to continue the project, initiating a third module of the EMT.

The experimentation phase primarily dealt with tailoring the ideas from earlier phases. We discovered no formal decisions or discussion about evaluating different concepts that could best fit the company at that time. On the contrary, decisions were made by different stakeholders, based on the *belief* that Alcoa's concept could realize the idea of getting the processes under control and create arenas for dialogue and learning. For example, a team of Alcoa specialists was brought in to the aluminium division to conduct an initial analysis of the performance of the Norwegian plants. This “plant ABS performance audit” resulted in a presentation to the Elkem aluminium plant managers, who were immediately impressed with the analysis and the action plans for the production lines. This demonstration enhanced the willingness to implement the TPS concept, but there was no understanding or decision that the concept should be tailored to Norwegian conditions or combined with STS.

Top-manager support

Based on the data relating to the CEO in this and the following phases, he can be characterized as a strong “sponsor”, a description used in Alcoa to address top managers’ necessary support in the development of the ABS (Kolesar, 1993). As mentioned above, there was a significant amount of desperation among the managers in Elkem in this period. The CEO played an important role in creating faith and optimism, gradually managing to change the perspective from short-term costs to long-term improved plant performance (Aslaksen, 1999). This sponsor approach became important for internal stakeholders as well as for external investors and owners, allowing the CEO to create the final XPS.

The CEO can also be described as an “orchestrator” who coordinated the learning processes that were taking place. He did not have a master plan for an XPS; rather, he had a strong belief that the concepts and the new organizational structures introduced to him in this phase would save the company. Importantly, he allowed for experimentation. In an interview, the former CEO emphasized that he was himself immersed in a learning process in this phase and that the ideas that were developed were not from him, but from many different people across Elkem’s global network.

> *We could not have developed the Elkem Business System if [CEO name] had not been there. He was the main architect and sponsor of the business system.* (Former operator and EBS coordinator in Elkem)
>
> *Without the CEO – no Elkem Business System.* (Former union leader, Norwegian Chemical Workers' Association)

One particular event seems to have been important for the CEO in this phase. He met the action researcher for the first time in 1994 at a seminar led by the HR department. After being informed about the Bjølvefossen project, his first response was:

> *If this concept is so fantastic, why isn't there a "forest of trees growing" in the entire company?* (Action researcher, quoting the CEO)

The action researcher then presented the knowledge from the two projects, emphasizing the need for a holistic organizational development in which both technological and human resources would be developed to improve production performance. The CEO gradually came to appreciate the STS concept and decided to hire the action researcher in 1998 as head of the HR department.

The CEO visited the 30 plants across the world twice each year from 1994 to 2000 (amounting to more than one visit per week to a company plant for six years). In the early years of these visits, he began with a formal presentation of the TPS principles that stressed the importance of getting the processes under control. Later, from approximately 1996, he started to join the teams on the shop floor, participating in and observing continuous improvement, and experimenting with new organizational forms. In his interview, the CEO claimed that this became important for him because it enabled him to understand how TPS and STS could be combined at the shop-floor level. Key to this was the idea of restructuring the shop-floor organization into semi-structured teams, removing the foremen from the shop floor, and defining the role of middle managers and technical personnel as a "help chain" whose aim was to support the value-creating process at the shop-floor level (Lean Forum, 2012).

> *The ideas [about self-managed teams] did not come from TPS and Alcoa. We developed them entirely on our own. This was brand new in our industry and we developed this completely ourselves.* (Former CEO of Elkem)

To support the new ideas that were redefining management in the company, the CEO decided to shut down administration buildings located outside the plant's production areas. From 1996, plants were instructed to move central administration into the factory area, to further strengthen the understanding of managers as being a "help chain". Plant managers and indirect staff were integrated into the production environment, forcing the managers to directly participate in the "quest for process stabilisation" (Lean Forum, 2012). The CEO also decided to relocate all plant board meetings to the factories. The first meeting took place in a meeting room, while all others occurred on the production floor.

Most interviewees claimed that the CEO was vital to creating the XPS, particularly in relation to the way he dealt with resistance from middle managers (Lean Forum, 2012). The CEO was described as persistent and firm in convincing the global management team and technical personnel that this was the only right way, and in imparting the message that "either you are with us or you are out". The CEO confirmed this and claimed that such persistence was possible because of the strong support from the workers' union.

Phase 3: Consolidation

Several meetings were held in 1999 to consolidate the final XPS. One event, in particular, seems to have been vital. The results of the experimentation were presented to the management team in a meeting in Mosjøen in 1999. The meeting was part of the ongoing

Experiment 3, described in the previous section, and it gathered the entire management team from all Elkem's plants. At this meeting, the CEO, together with the other managers, formally decided that the Elkem Aluminium Business System should be renamed the Elkem Business System (EBS) and that it should be implemented not only in production but also across all parts of the global company (logistics, R&D, supply chain, etc.). This marked the formal "birth" of Elkem's global business system and the intention to implement it across the entire organization.

One organizational initiative was vital for the consolidation: the conversion of written material from the EABS to the EBS. The EABS programme had developed a substantial number of documents. These included brochures on core values, representing the principles for production performance in Alcoa (Figure 3): "Make to use", "Elimination of waste", and "Empowered people". One important change was made in this meeting, reflecting the combination and adaptation of STS and TPS: "Processes in control and capable" was added as a central value. "Empowered people" was also regarded as a strong value describing desired management behaviour, due to its fundamental recognition of employee involvement and participation as the basis for all leadership in the EBS. Today, this value is placed in the centre to further emphasize the importance of the people dimension in the EBS (Figure 4).

Figure 3. Values of the 'Elkem Aluminium Business System'

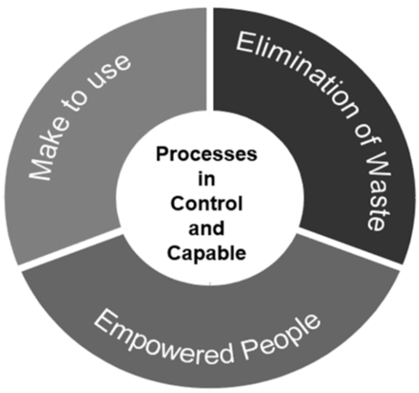


Figure 4. Values of the ‘Elkem Business System’ (revised)

Phase 4: Institutionalization

Concepts used

As mentioned above, Alcoa had an additional training programme within its global network that was to be integrated into the EBS. This was called critical process management (CPM), a programme that is highly compatible with TPS principles since it addresses the ultimate question of how processes can be stabilized and improved (Shah and Ward, 2007). What distinguished Alcoa’s second training programme was probably the level of detail of the parameters that were measured, the attempted standardization of the upstream processes, and the more extensive use of mathematics and statistical analysis to define deviations in each period. Metallurgical upstream processes have an extensive number of variables that influence the output. For example, characteristics of the raw material, such as the moisture level, the diameter, and dust density, crucially influence the process and, consequently, the final product. To ensure stable production, these variables must first be defined, then constantly measured and monitored. Central to this is the organization’s ability to ensure that the variables are identical every time (to stabilize them) and then to develop and improve the process (to make it capable).

CPM training does not seem to have received a strong focus during the early years of the EABS and EBS. But in 2001, the silicon material division in Elkem started to implement it more extensively. Despite being exposed to TPS and STS concepts over a long period, the silicon material division was still struggling to get the furnaces under control. Division managers then started hiring specialists to further develop the knowledge within the division. Finally, in 2006, both training programmes were merged into Elkem's global business system. This marked the beginning of the final concept of the EBS.

CPM knowledge, including a renewed focus on the maintenance and stability of machinery, was to have a decisive impact on Elkem's production and on the legitimacy of the final EBS. When the knowledge was established in the upstream processes, it had major consequences both for the furnaces and for production. The quality of the production increased considerably, and fewer resources were required, but, perhaps most importantly, the operators and engineers experienced the furnaces becoming more stable and less unpredictable. This directly affected working conditions on the shifts, which gradually became calmer and more controlled, with fewer "fire alarms" and other interruptions, ensuring that work could be continuous for longer periods.

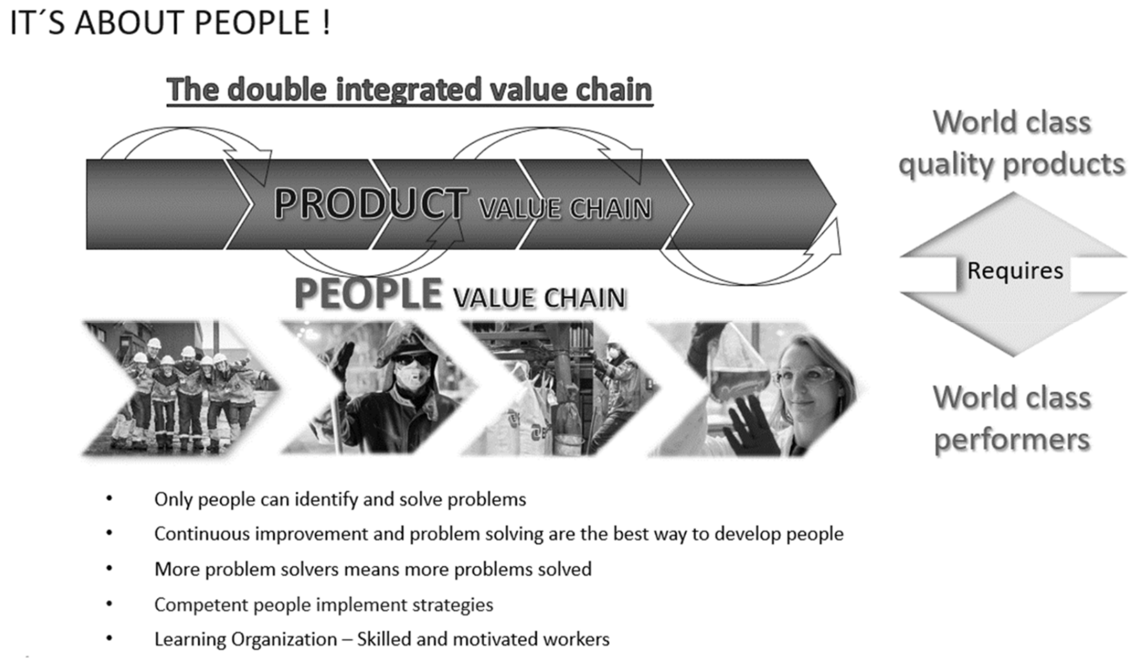
Tailoring concepts to meet the company's needs

The CPM concept was selected and implemented based on a precise evaluation of the technological environment in the upstream processes in the electrochemical industry. The silicon material division realized that the TPS and STS principles were insufficient to fulfil the ambition of getting control of the furnace processes, so they sought a complementary concept suitable for the upstream processes. This seems to have been the first time since the cost reduction programme that a concept was tailored to address a precise and identified need in Elkem.

Top-manager support

The CEO was not actively involved in implementing CPM in the silicon material division. The division manager was the main architect of this process. More importantly, however, in 1998 the CEO had appointed the former action researcher as the company's HR director. In close cooperation with her, the CEO allocated resources to institutionalize the EBS. First, a global "university" was established, securing a basic understanding of the concept in all parts of the organization. The university was based on a vital principle: it should have an equal mix of operators, managers, and technical personnel to ensure that understanding and knowledge were transferred to all organizational levels. Second, an EBS department was established, which was given the responsibility to coordinate all future activities of the EBS. Third, a global assessment programme was implemented to ensure necessary local adaptation to the concept. Fourth, a global management training programme was established. Finally, several XPS coaches were appointed to the different divisions; these coaches were responsible for international training and coordination between the XPS department and the different divisions. The institutionalization of the EBS remains a vital part of Elkem's global strategy today, and the company continues to distribute the content of the EBS to former and new plants across its global network (Authors, 2020). The 14-year learning process of integrating the STS concept with TPS is visually presented in the training material, which opens with the EBS logo: "The double integrated value chain" (Figure 5).

Figure 5. The EBS ‘Double integrated value chain’



Discussion

Apart from studies on the development of the TPS, our research is the first to document and analyse the creation process of an XPS. The TPS has become a template for other companies to follow. However, our study makes clear that creating an XPS involves much more than simply copying the TPS and replacing “Toyota” with the company name. Even if the first phase at Elkem is disregarded, it still took almost a decade to develop and refine the system, and to create mechanisms to disseminate EBS knowledge at various levels within the company. While it is beyond the scope of this paper to develop a design theory for an XPS, several observations can be made that would be relevant input for such a theory. It is particularly worth emphasizing how the design process is managed: we term this process “orchestrated learning”, by which we mean planning and structuring an extensive goal-directed experimental learning process.

The findings show that the creation of an XPS cannot be modelled as a linear process of strategic choice, in which the organization evaluates its external and internal environments, decides on a (combination of) concept(s), and then implements that. Rather, we interpret the creation of an XPS as a multi-level process of organizational learning. Framing the creation as a learning process helps us to be aware of activities and tensions that are easily overlooked when emphasis is put on selecting and implementing "best practices" (Powell and Coughlan, 2020b, p. 924).

First, we propose that creating an XPS involves combining "learning from the experience of others" with "learning from direct experience" (Levitt and March, 1988). Others' experiences enter as commodified organization concepts (Benders *et al.*, 2019), but also through direct linkages with suppliers, customers, or other actors in the same industry (dos Santos *et al.*, 2020; Powell & Coughlan, 2020b). The building blocks may be diverse: in the case of Elkem, some elements were international in origin, such as the ABS; others were national, such as the sociotechnical ideas promoted in the 1990s by the Norwegian government. We find that external knowledge was rarely simply adopted at Elkem; rather, it was tried out on a small, experimental scale, so that the company generated its own experience. As such, external knowledge seemed to trigger internal knowledge generation, rather than substituting for it.

Second, we propose that creating an XPS involves striking a balance between, on the one hand, searching out and generating new experience, and, on the other hand, consolidating experimental knowledge into a coherent approach to be further disseminated across the units (Argote *et al.*, 2020). In the case of Elkem, there was an alternation between local experiments and central efforts to revise the XPS content. Hence, the evolving XPS concept, with its associated departments, values, and practices, served as a repository for the organization's accumulated experience. By codifying the lessons learned, the XPS practices functioned analogously to how an SOP should function in a learning shop-floor environment (Adler and Cole, 1993; Spear, 2004). Furthermore, by explicating values and normative commitments, the XPS retained knowledge by infusing it with a deeper, cultural meaning (Authors, 2020). Key personnel transferred knowledge by changing positions or working through parallel organization structures like the EMF. Although a "final" XPS eventually emerged from the convergences of the learning processes, it remained flexible enough to incorporate new insights, as shown by the example of CPM.

The learning dynamics in the case company are similar to accounts of how the original TPS evolved (Benders, 1998; Fujimoto, 1999) and even to how some companies transfer and adapt their management practices when expanding internationally (Ansari *et al.*, 2014; Jonsson and Foss, 2011). It also shows a "creative accumulation" pattern of organizational learning (Ingvaldsen and Engesbak, 2020), where new concepts and new insights come to supplement the old ones, rather than replacing them.

As Netland *et al.* (2019) argued, "lean leadership" must be specified in order to be meaningful. Likewise, the role of the top manager in creating an XPS and disseminating knowledge about it should be clearly outlined. In the case of Elkem, the top manager can be considered the conductor of the orchestrated learning processes. His active role started in the second phase. He inspired staff members to experiment with ideas that originated both from within and from outside the company. New initiatives were allowed to flourish in the organization, and at one point some of these were consolidated into the final XPS. Furthermore, top management allocated significant resources to secure institutionalization, and they created units to maintain, develop, and disseminate the XPS. This indicates a key awareness of the challenges of sustaining organizational change (Buchanan *et al.*, 2005).

Finally, it is worth commenting on the terms XPS and "corporate lean programme", with the latter appearing to have superseded XPS (Netland, 2017; Netland and Ferdows, 2014; Powell and Coughlan, 2020a). Netland (2013) pointed out the importance of adapting to industry-specific conditions and, in line with that, looking to "non-lean principles" (pp. 1092–1093). In our case, the latter come to the fore. More generally, the more the production processes in an industry differ from convergent repetitive manufacturing, the more important it is to look beyond lean (Hekneby *et al.*, 2021). The term "corporate lean program" does not acknowledge this, nor does it emphasize the importance of developing one's own system. In line with our position that developing an XPS is more than simply copying another XPS, and that an XPS requires an extensive orchestrated learning process, replacing XPS by corporate lean risks throwing away the baby with the bathwater.

Limitations and future research

Netland (2013) emphasized that production processes in a processing industry differ from the convergent repetitive manufacturing used by car manufacturers, arguing that contingent factors matter for the suitability of elements of the TPS and other systems and concepts for this sector (see also Hekneby *et al.*, 2021). A possible critique of the EBS, or of our account of its development, is that the company's strategic market positioning does not appear to have played a role, and hence that it was not company specific. Therefore, the EBS may be relevant for its competitors as well. Nevertheless, the EBS may still generate a competitive advantage for Elkem: it may be relatively straightforward to imitate another company's XPS, but it is much harder to get it to work internally by instructing and educating staff at all organizational levels.

An avenue for future research would be to investigate whether XPS development in other companies follows a pattern of similar phases. In our case study, experimentation largely preceded evaluation and consolidation; in other contexts, there might be stronger elements of a grand design and less room for incorporating learning from local experiments.

Future research could also explore the role of middle managers in an orchestrated learning process and their interactions with top managers in that process. Although our study has primarily been concerned with the top management, middle managers' role must be adapted accordingly for XPS programmes to be successful (Netland *et al.*, 2019).

Conclusion and Practical Implications

Creating an XPS is a process of step-by-step organizational learning. Organizations would be wise to build on established concepts, create internal arenas for experimentation, and incorporate the lessons learned into a final production system to be disseminated and institutionalized across the company.

What are the implications of this study for managers wanting to establish an XPS? First, they should appreciate that the process requires significant time, attention, support, and dedication. The duration of the EBS development process also implies that there must be consistency in top-management support. This may be easily endangered when there are changes in top-management positions. Second, top managers should stimulate the organization to pick up new ideas and actively build a network for external learning. Third, top managers should allow the organization to experiment with different concepts before the final content of the XPS is consolidated. Furthermore, they should support interaction between key persons and transfer of experimental knowledge vertically and horizontally in the organization. Finally, top managers need to realize the importance of allocating resources for institutionalization of the XPS. The creation process is an opportunity for building shared norms in the organization.

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No potential conflict of interest is reported by the authors.

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Not so Different Altogether: Putting Lean and Sociotechnical Design into Practice in a Process Industry

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NOT SO DIFFERENT ALTOGETHER;
PUTTING LEAN AND SOCIOTECHNICAL DESIGN INTO PRACTICE IN A PROCESS INDUSTRY

Purpose: The shop-floor organization under lean production (LP) has been hotly debated for about three decades. As this organization concept leaves considerable room for interpretation, the content of lean-inspired changes can vary widely. This paper pleads for a contingency view of how LP is implemented and how the outcomes of lean-inspired changes rely on users' interpretations of the concept in particular production contexts.

Design/methodology/approach: A case study was conducted in two large Norwegian chemical plants. Data from the observations and interviews were supplemented by interviews with top managers in 2017 and 2018. The first author also followed a management audit in one plant, assessing the plant's overall implementation of the company-specific production system.

Findings: The lean-inspired changes in the company had brought about a shop-floor organization typically associated with sociotechnical design (STD), including extensive employee choice autonomy and a broad span of control.

Originality/value: Our findings demonstrate the importance of understanding how lean is interpreted in different contexts. Our contingency view may aid organizational designers in making more-informed choices by clarifying relevant issues and trade-offs in lean implementations.

Keywords: lean production, contingency theory, organization concepts, sociotechnical design

Introduction

Ever since the concept of lean production (LP) was launched in the late 1980s (Krafcik, 1988; Womack et al., 1990), researchers have debated the type of shop-floor organization that lean-inspired changes give — and should give — rise to (e.g. Delbridge et al., 2000; Mehta & Shah, 2005; Hopp, 2018). The superior performance of Japanese-owned plants was the obvious trigger for management scholars and practitioners to pay attention to LP. The crux, of course, is whether emulators of LP have succeeded in achieving performance improvements. This issue has been the subject of considerable empirical research. In a recent review, Cocca et al. (2018) even identified as many as 31 different measurements for so-called 'leanness' and associated performance outcomes.

It could be argued that the concept of lean, more than other organization concepts, leaves considerable room for interpretation. This room for interpretation means that users intentionally or unintentionally select components that they find suitable to their own context (Benders et al., 2019). The resulting shop-floor organization is thus a function of two interdependent dimensions:

3. The organizational context
4. Users' interpretations of lean

Hence, we call for situated and contingent understandings of lean-inspired changes (Marin-Garcia & Bonavia, 2015; Sousa & Voss, 2008). Different organizational forms will emerge depending on how lean is implemented, which will have either negative or positive consequences for performance (Hopp, 2018; Marin-Garcia & Bonavia, 2015). This may explain why LP has been, still is and will remain hotly debated.

To concretize these rather abstract statements, we present a case study of how LP has been implemented in two large Norwegian chemical plants. Operational processes in the process industries are markedly different from those in car manufacturing, where LP was developed and refined (Marin-Garcia & Bonavia, 2015). Whereas Toyota perfected the repetitive and convergent manufacturing of discrete products (Young, 1992), most process industries are characterized by divergent and continuous product flows, monitored by process operators. In this context, we find that lean-inspired changes may result in an organizational design that closely resembles one that might have been proposed by proponents of sociotechnical design (STD) (Achterbergh & Vriens, 2010;

Mohr & van Amelsvoort, 2016). This is remarkable, given that LP and STD are often viewed as opposing approaches (Berggren, 1992; Dabhilkar & Åhlström, 2013; Dankbaar, 1997; Pil & Fujimoto, 2007; Oudhuis & Tengblad, 2020).

This paper is structured as follows. First, we discuss lean as an organization concept and argue that it lends itself to different interpretations. Next, we discuss how scholars have dealt with the significance of different production contexts and will present a framework for assessing organizational outcomes. After presenting our methodology and the case study, we present some implications of our contingency view for the outcomes of LP, as well as under what circumstances lean-inspired changes lead to results similar to those of STD-inspired changes. We conclude by proposing implications for industrial engineers and managers.

Lean as an organization concept

An organization concept consists of prescriptive notions on how to manage or organize, which are meant for consumption by managers and are known by a particular label (Benders & Verlaar, 2003). They are characterized by what we call 'interpretative viability' (Ortmann, 1995): for ideas to be disseminated at a large scale, they must appeal to different parties, each of which can interpret the ideas in their own way. Room for interpretation is thus essential for an idea to diffuse. At the same time, this room for interpretation means that academics tend to criticize concepts as being ambiguous.

This is particularly true for lean. In order to understand how this notion has come about, we need a concise description of its evolution as an organization concept. Using comparative performance data of passenger car plants in Japan, the USA, and Europe, Krafcik (1988) showed that the Japanese-owned plants performed better, irrespective of their location. This message was popularized by Womack et al. (1990). The notion that significant performance improvements could be achieved only if LP was adopted came at the right moment, as it was introduced at the beginning of a global economic recession. Obviously, it was only possible to conduct the underlying research because many plants were 'lean prior to the launch of this label. The production system that was to become known as 'lean production' had been developed within Toyota Motors (Fujimoto, 1999; Holweg, 2007; Liker, 2004; Ohno, 1988), and many publications had appeared prior to 1988 (e.g. Schonberger, 1982; Shingo, 1981; Sugimori et al., 1977). All of these focused on convergent repetitive manufacturing: assembling many components into large numbers of discrete products, namely cars.

Womack and Jones (1996) brought the discussion to a higher level of abstraction. Whereas the authors asserted that their first book had shown how well LP worked, the aim of their next books was to focus on how those results had been attained. Observing that many practitioners struggled with the implementation of specific methods, they argued in favor of a publication on the larger system within which these methods fitted. Here, they launched the term ‘lean thinking’, which has five key principles:

1. Specify customer value by specific product
2. Identify the value stream for every product
3. Create an uninterrupted value stream per product
4. Let the customer pull value
5. Pursue perfection (by improving constantly)

This opened the door for applying these ideas well beyond the domain in which the Toyota Production System had been developed. Over the past decades, many Japanese (Nielsen et al., 1990) and lean-inspired changes have been reported in various types of manufacturing and service industries **(Leite et al., 2020**; Netland & Powell, 2017).

One specific way of disseminating lean is to develop a ‘company-specific production system’ (Hekneby et al., 2020; Netland, 2013). Companies have tried to emulate Toyota’s success by modeling their own versions of the Toyota Production System, thereby drawing on the original model while adding their own twists. This has involved adapting it to their own situations and distinctiveness, using their own interpretations of the Toyota Production System, and incorporating elements from other organization concepts.

The influence of context: types of production

A classic insight in organization studies is that the type, range, volume, and variability of manufactured products are closely related to organizational forms and production technologies (Donaldson, 2001; Hull & Collins, 1987; Woodward, 1980). This so-called contingency view holds that different output characteristics and production technologies give rise to different managerial problems and solutions and that a good fit between the production technology and organizational design leads to better performance (Mintzberg, 1980; Sorge, 1991; Sousa & Voss, 2008). Based on the contingency view, it follows that the application of prescriptive concepts such as LP results in different forms of organizations in different production contexts (Sousa & Voss, 2008).

Several typologies have been proposed for the classification of production systems. Woodward's (1980) original classification included batch, mass, and continuous-process production. Hull and Collins (1987) refined this typology by distinguishing between traditional batch production and more R&D-intensive technical batch production. A more common model for operations management is the product–process matrix of Hayes and Wheelwright (1979), which suggests that the primary technological process of a manufacturer can be classified as jumbled flow (job shop), disconnected line flow (batch), connected line flow (assembly line), or continuous flow (Safizadeh et al., 1996).

When applied to the industries in the study, it follows that automotive firms tend to be organized differently from process industries, as the nature of their output and production processes differs substantially. Lean was developed, and most intensely discussed, with respect to the final assembly lines of passenger car factories (e.g. Berggren, 1992). Its very essence is to bring together many different components into one final product. The work performed is characterized by a high degree of repetitiveness and tightly coordinated production, leaving little room for employee choice autonomy (de Treville & Antonakis, 2006). In contrast, most work in process industries consists of monitoring production processes, which take place in vessels. This generally requires a high level of formal skills, as well as practical experience with the processes at hand (Kern & Schumann, 1992). Unlike the situation in final assembly in the automotive industry, there is little manual work involved.

The lean–STD debates

To determine more precisely how lean-inspired changes may lead to the counter-intuitive result of an STD, we need a framework that lists the key differences between the organizational forms conventionally brought about by applying the two concepts. Based on the debates of the 1990s, we can identify three main contested issues for shop-floor organization (Adler & Cole, 1993; Benders & Van Hootegem, 1999; Berggren, 1992;

Dankbaar, 1997; Leite et al., 2020; Niepce & Molleman, 1998; Pil & Fujimoto, 2007). These issues are listed in Table 1.

Aspect of design	**LP**	**STD**
Strength of coupling	Sequential activities are tightly coupled and closely interdependent	Segmenting the production line into units, separated by buffers
Focus of employee autonomy	Responsible autonomy (continuous improvement by means of standard operating procedures (SOPs))	Choice autonomy (minimum critical specification)
Width of supervisory spans	Narrow	Broad

Table 1. Contested issues in the LP–STD debates

The first issue concerns how tightly sequential operations are coupled. While both lean and STD are strongly in favor of creating production flows (Christis & Soepenberg, 2016), they disagree on the internal organization of these flows. LP's just-in-time principle makes sequential activities tightly coupled and thus closely interdependent. This is thought to increase the speed of material flows, reduce work-in-process inventories, and enable the rapid detection of quality problems so that they may be resolved immediately (Ohno, 1988). The sociotechnical perspective stresses that such tight coupling causes disturbances that will be felt throughout the production system. To prevent this, the perspective prescribes segmenting a production line into units that are separated by buffers (de Sitter et al., 1997, Pil & Fujimoto, 2007).

The second issue involves employee autonomy and the role of SOPs. From an LP perspective, standards for work execution codify best practice and can—and should—be systematically refined through continuous improvement activities (Adler & Cole, 1993; Marin-Garcia & Bonavia, 2015). From an STD perspective, standardization going beyond basic coordination needs contradicts the principle of 'minimum critical specification': specifying only in detail that which needs to be specified (Cherns, 1976). When the foundations of sociotechnical theory were laid during the 1950s and 1960s, SOPs were normally written by industrial engineers at staff offices, with minor involvement and participation of the employees executing the SOPs. This 'scientific management' approach resulted in negative work conditions on the shop-floor level (Mohr & van Amelsvoort, 2016). Sociotechnical designers recommend letting the employees choose their work methods, as they knew best what worked in their own situations (Marin-Garcia et al., 2015; Mehta & Shah, 2005). De Treville and Antonakis (2006) labeled these differences 'responsible autonomy' versus 'choice autonomy', prescribed by lean and STD, respectively.

The third issue is the nature of supervision. Although lean is widely associated with flat organizational structures (e.g. Karlsson & Åhlström, 1996), empirical research on plants with detailed knowledge of the Toyota Production System has indicated that these are characterized by narrow spans of control, with work unit leaders occupying strong positions of formal and informal power (Delbridge et al., 2000; Inamizu et al., 2014; Ingvaldsen & Benders, 2016). Ingvaldsen and Benders (2016) argued that such arrangements are functional for the just-in-time production process, as supervisors handle coordination, coach workers, facilitate improvement activities, and form a buffer of manpower in the event of production disturbances. Furthermore, supervisors should act as 'benevolent fathers', educating workers but also disciplining them when necessary (Dore, 1973). In contrast, STD—at least in the more-radical and anti-hierarchical manifestations (e.g. Herbst, 1976)—prefers leaderless teams, as leaders are seen as fundamentally undemocratic and may slow down decision-making.

It is noteworthy that all three issues relate directly to the most contested topic in the LP–STD debates: LP's effects on the quality of working life (QWL) (Benders et al., 2019; Carter et al., 2017; Hasle, 2014; Marin-Garcia & Bonavia, 2015; Neirotti, 2020; Procter & Radnor, 2017). In conventional models for QWL, autonomy is seen as a predictor of worker well-being (Schouteten & Benders, 2004; De Treville & Antonakis, 2006). Just-in-time and SOPs reduce workers' discretion regarding timing and methods for task execution, respectively. A strong supervisory position may potentially limit workers' decision latitude over a wide range of aspects. Hence, workers may experience a poorer QWL than would have been the case if STD prescriptions for choice autonomy had been observed.

Data and methods

Elkem ASA is a Norwegian company with Chinese owners (from 2011) and operations worldwide. Twenty years ago, Elkem began to develop and implement its business system built on LP, heavily influenced by Scandinavian working life traditions and democratic work design (Ingvaldsen, 2013). Elkem was selected because it represents an ideal case for exploring a company's implementation of LP in a process industry context.

All data were collected by the first author in spring and autumn 2017 and winter 2018. Table 2 describes the data in detail. The observations and interviews from two Norwegian plants were supplemented by interviews with top managers and managers responsible for the implementation of Elkem's business system. The first author also followed a management audit in one plant, assessing the plant's overall implementation of the company's business system. All interviews were recorded and later transcribed. The first author conducted observations during day, afternoon, and night shifts at the plants' furnaces. He also observed continuous improvement meetings and management meetings. All observations were summarized and transcribed into files. Note that data were collected via various methods in order to avoid single source bias.

The data were analyzed and interpreted by all authors in a number of consecutive discussion rounds. The starting point for the data analysis was to map and understand the logic of Elkem's business system, based on the interviews with top managers and division managers, as well as the audit program. The observations and interviews were then coded to determine how the business system was put into practice at the plants. We systematically looked for organizational and technological choices influencing the contested issues in the LP–STD debates (see Table 1) and the resulting organizational outcomes. Findings from the interviews, observations, and collected data were systematically triangulated to improve the internal validity, as recommended by Yin (2009). To further strengthen the validity, we used participant verification by encouraging groups of key informants to comment on our findings.

Unit of enquiry	Management interviews	Shop-floor interviews	Observations	Archival data
Plant 1	9 managers	8 operators	5 days on the shop floor, both day and night shifts	Plant performance
Plant 2	7 managers	7 operators	4 days on the shop floor, both day and night shifts	Plant performance
Top management	4 managers	N/A	N/A	Elkem performance
Implementation audit	4 managers	N/A	4 days following the audit	Plant implementation performance

Table 2. Data material

Findings

We present our findings in this section, beginning with the context of production in Elkem. We then proceed to the organizational outcomes.

Context of production

The plants produce silicon materials for the global market. The production environment may be classified as a highly automated process, producing large volumes of standardized products. The plants are organized around a single main material flow, which diverges only in the last phases of the value stream. Raw materials (mainly minerals and carbon-based reductants) are automatically transported to the 'furnaces', considered the 'heart of the process'. The furnaces separate the silicon through an electrochemical process. Aided by sensor technology, skilled operators monitor and control critical input, process, and output variables. Based on customer orders, silicon flakes are crunched to different sizes, sorted by quality, and packed for shipping.

A primary strategic focus at Elkem over the last 20 years has been the implementation of a comprehensive business system built on LP principles. Developed in Norway, the business system is also heavily influenced by Norwegian working life norms, reflecting the ideas of STD. The business system's main goal is to reduce variability so that processes are 'under control'. To do so, the business system prescribes the application of LP tools (5S, production leveling, Total Productive Maintenance, etc.) and employee empowerment. At Elkem, employee empowerment implies two important organizational choices: first, to show 'respect for people' and involve everyone in continuous problem-solving, and, second, to decentralize decision-making in autonomous work teams and remove the position of the team supervisor. Extensive empowerment is thought to lead to better problem-solving and higher employee motivation. In the words of the CEO:

> *I had to understand the [people] dimension and how strong it is. The enormous energy you can release through the organization when people are properly trained and are made responsible… and your decisions are decentralized.*

A dual emphasis on improving both technology and human resources is evident in Elkem's concept of 'the double integrated chain of value' (see Figure 1), indicating that technological and human development should be equally emphasized, as specified in the statement: 'To create world-class production, we need world-class operators'. To realize the double chain of value, Elkem has made several investments in technology and people.

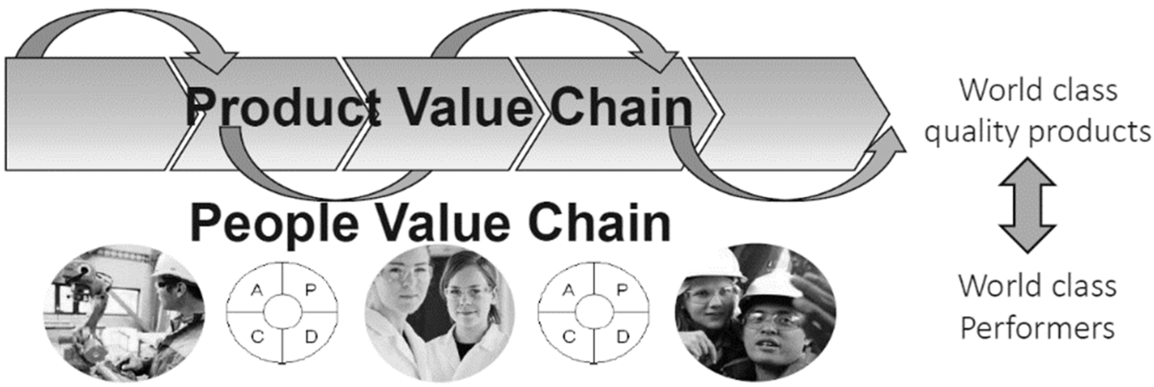

Figure 1. The double integrated chain of value (from a company presentation)

First, the upstream and downstream processes are extensively automated, and transportation of the materials (from the raw materials received at the docks to the final products) is fully integrated in a just-in-time logistics system. The furnaces, which are the production bottlenecks, signal when raw materials are needed, triggering the preparation of new raw materials. The output of the furnaces is stored in 'cooler containers' to reach the right temperature. Based on customer orders, silicon flakes are crunched to different sizes, sorted by quality, and packed for shipping.

Second, the introduction of sensor technology significantly changed the furnace operators' jobs, turning them into highly knowledgeable system controllers (cf. Kern & Schumann, 1992). When the raw materials hit the furnace, the operators at the furnace have all the input data at hand, using it to adjust the process to ensure a stable output. Temperature, weight of the raw materials, humidity in the raw materials, gas concentration, and electrode levels are all examples of process control data, and these data are shown on large TV screens in the control rooms. Computer-controlled systems are then used to manage the overall process and evaluate statistical data.

Third, Elkem launched a continuous improvement initiative, with extensive operator involvement. At one of the plants visited, 80 out of 105 of the operators had voluntarily participated in 'critical process groups', working systematically to reduce the furnaces' instability. Using the A3 tool from LP, improvement targets, analyses, and hypotheses were worked out and taken back to the operational teams for implementation. The operators reported a strong motivation for this job, stating that the continuous improvement work was one of the most important activities for improving performance at the plant.

> *Because… you know, if the furnace is good, my job is good. The group work has been very important for my daily work.* (Furnace operator)

Organizational outcomes

Table 3 summarizes the organizational outcomes with respect to the contested issues in the LP–STD debates. Although material flows were organized just-in-time, we observed that the organizational outcomes were similar to the recommendations of STD.

Aspect of design	Elkem outcome
Strength of coupling	Material flows were just-in-time, but because of extensive automation, work activities were not tightly coupled and machine paced
Focus of employee autonomy	Operators were primarily left with non-routine regulatory tasks, over which they enjoyed extensive choice autonomy
Width of supervisory spans	On the shop floor, there were no supervisors instructing or guiding the workers

Table 3. Elkem's shop-floor organization with respect to design aspects

Strength of coupling

As explained above, the material flows at the plants were designed according to the just-in-time principle. However, because of extensive automation, work activities did not become tightly coupled and machine paced, as would be the case in an assembly line. Aside from some routine tasks, task execution was generally triggered by undesirable variations in the chemical processes, not by the arrival of materials to be processed. If the 'furnace was good' (i.e. all process parameters were within the desired range), no action was required by the operators. This meant that as long as things ran smoothly, the work pace was steady and relatively slow. When asked to compare the current furnace process and the process 15 years ago, the operators' first response was often a smile and a statement regarding reduced work intensity:

> *The most important thing for us is that the furnace works well. Then, everything is more relaxed, and we will have a better shift. Fifteen years ago, the furnace was very unstable, and we had no control of the process and [it was] hard to operate.* (Melting plant operator)

Focus of employee autonomy

At Elkem, the operators' routine tasks were standardized in SOPs. Consistent with an LP work design, the operators had been organized into continuous improvement groups to establish and refine those standards. This introduced an element of responsible autonomy.

However, as routine tasks had largely been automated, operators were primarily left with non-routine regulatory tasks. Observations on the shifts indicated that the operators spent 60–70% of their time observing and controlling the furnace parameters. Parameters that influenced technical performance were related in non-linear ways, giving rise to complex feedback loops. It was impossible to impose standard regulatory actions for contingencies that might occur in the furnace. Consequently, the operators enjoyed extensive choice autonomy. For instance, the operators might adjust the level of raw material poured into the furnace, based on sensor information on the TV screens and their experience with the furnace. During a shift, some events might call for minor adjustments, and some might call for more-complicated decision-making. Bigger breakdown decisions normally require assistance from a process engineer, but operators generally have the authority to take actions on their own, based on their training and experience:

> *Twenty-five years ago, we had supervisors on the shift telling us what to do and nothing was left for us to decide. Today, I operate the furnace based on some basic SOPs, but when something happens, nobody controls me or tells me what to do.* (Furnace operator)

This logic was also applied to the pouring team in the downstream process. Observations indicated that approximately 30–40% of the pouring team's tasks were non-routine. They primarily involved observing and adjusting the pouring process when the indicators of level, quality, or pouring stream moved within the upper and lower indicator levels.

Width of supervisory spans

At Elkem, there was no direct supervision on the shop floor, instructing or guiding the workers to make the right decisions. The operators only contacted the technical specialists when it was determined that their input was needed. In fact, the operators went so far as to say they had ‘no important use for management’. They felt capable and confident that they could solve most of the operational tasks on their own.

> *It could be several days before I see my team leader. Actually, I don’t really need to see him down here, because we are running the furnace on our own.* (Furnace operator)

When asked how it worked, not having a leader to follow up their daily work, the operators did not seem to fully comprehend the question. To them, the question was irrelevant because taking necessary actions to stabilize the furnace was considered a team responsibility. The company had invested in formal and informal training to support autonomous decision-making. The relatively slow and steady pace of work meant that coordination needs were modest and less time-critical than for an assembly line. Hence, supervisors' coordination and ‘buffer of manpower’ functions were not essential for keeping production running. In the interviews with the operators, this team perspective appeared to have resulted in a strong sense of responsibility towards the work process and a high-quality working life experience. Quotes from the interviews corroborate this impression:

> *I have total responsibility for the furnace, and this gives me a very good feeling. If the furnace works well, I work well, and this is very important for my life.* (Furnace operator)

> *I have worked in the pouring room for many years, and I am still very happy with my job. We have a great social community, help each other when needed, and, yes, I love my job.* (Pouring operator)

Conclusion and discussion

In this article, we have shown how a contingency view, emphasizing users’ interpretations of lean in particular production contexts, can advance our understanding of the outcomes of lean-inspired changes. In the case of Elkem, a lean-inspired production system had brought about a shop-floor organization typically associated with STD, including extensive employee choice autonomy. The primary transformation tasks were automated to the extent where just-in-time material flows were realized without leading to repetitive, machine-paced work. SOPs remained in place for routine tasks, but as most tasks were regulatory and non-routine, the company relied on a qualified workforce to make independent decisions. Close supervision had become less important, as there was less need for coordination and the operators were skilled decision-makers.

Theoretical contributions and research implications

The contingency view proposed in this paper has major implications for understanding the outcomes of lean-inspired changes. As our case study illustrates, the operational processes in process industries differ in significant ways from those in repetitive and convergent manufacturing. As these process characteristics provide the operational context wherein lean is applied, lean can be put to work quite differently in a process industry than in a company producing large amounts of similar, discrete products. The different uses can also be related to the predominant frames of reference in the national contexts of organizations. More precisely, the way in which lean is connected to employee autonomy in our case was informed by prevailing norms in Norway. At the same time, the process context is ideally suited to this specific interpretation. Such close interdependencies between process characteristics and national characteristics have been outlined before (Lowe et al., 1997; Sorge, 1991) and illustrate some of the complexities of attributing outcomes to the umbrella concept 'lean'.

Consequently, formulating a general definition of leanness applicable across contexts and cases can only be achieved at a very high level of abstraction. This has also been done in recent attempts to formulate the essence of lean (Cocca et al., 2018; Netland & Powell, 2017). Another implication from our argument is that searching for stable statistical relationships between 'leanness' and specific outcomes will likely give inconclusive or weak results, even if there is a consensus on the general definition of lean. More reliable findings may be produced if the nature of the production context is taken into account, for instance by using the classification schema of Hayes and Wheelwright (1979) or Hull and Collins (1987). Nevertheless, selective interpretations of the concept (Benders & Slomp, 2009; Spring & Unterhitzenberger, 2020) indicate that outcomes are always situated in concrete contexts, which can only be somewhat accounted for in survey-based research.

Our contingency view may inform debates on the relationship between LP and STD (e.g. Marin-Garcia & Bonavia, 2015,). With few exceptions (e.g. Benders & Van Hootegem, 1999), prior studies on the LP–STD relationship have had little to say about technical contingencies and have implicitly assumed that the findings from a particular environment (e.g. convergent mass production) may be generalized. In convergent mass production, applications of the two concepts have led to different outcomes, as their different preferences for coupling activities, prescribing task execution, and supervision have been accentuated (Adler & Cole, 1993; Berggren, 1993; Dankbaar, 1997; Niepce & Molleman, 1998; Pil & Fujimoto, 2007). As shown in this case study, however, process production is a different story. Here, a lean-inspired production system had brought about outcomes typically associated with STD. The Elkem case study lends some support to the idea that LP and STD can be made compatible, with 'no inherent conflict' (Dabhilkar & Åhlström, 2013, p. 1019). However, the contingency view indicates that we should show great caution in drawing conceptual interferences from empirical findings, as suggested by Dabhilkar and Åhlström (2013) and Pil and Fujimoto (2007). Whether or not the concepts themselves can be seen as compatible at a conceptual level also depends on how the concepts are defined. This implies some arbitrariness, especially in terms of the fairly ambiguous concept 'lean', where multiple definitions and measures coexist in the literature (Cocca et al., 2018). Whether or not applications of the concepts bring about similar outcomes is, at an empirical level, an issue of how they are put to use in concrete contexts.

With respect to the relationship between LP and QWL, we suggest that future research should take into account the differences in production environments. Although literature on the LP–QWL relationship has shifted towards contingency models (Hasle, 2014; Huo & Boxall, 2018), the contingency factors highlighted have been social (e.g. industrial relations, process of implementation, and employee involvement) rather than technological. Situating findings within specific production environments might lead researchers to discover more robust empirical relationships.

Future research might further develop a contingency model of the LP–STD relationship by investigating production contexts that have not been discussed here, such as job shops and batch production, and testing our findings on larger samples though surveys or comparative case studies. Based on our findings, we hypothesize that applying LP and STD tends to bring about similar outcomes when 1) the level of automation is high and

2) tasks are predominantly non-routine as opposed to routine. On one hand, these two variables often go together, as routine tasks are more likely to be automated, leaving operators with non-routine tasks. On the other hand, a high ratio of non-routine tasks may also be present in less-automated environments, for instance in one-of-a-kind production.

Managerial implications

Our findings have clear managerial implications. Designing production systems means making choices, and these choices are made by managers and industrial engineers. Where our contingency view highlights key factors in the environment of these organizational designers, for the latter these are the conditions within which they make decisions. These decisions can be divided into two main categories:

1. selecting and combining relevant insights from organization concepts;
2. making them fit for the specific context to be (re)designed.

The contingency model may aid managers and industrial engineers in making more informed choices by clarifying the issues and trade-offs involved in prescribing a production system. Our model especially questions the widely held notion that there is a trade-off between swift material flows and workers' choice autonomy. This idea emerged from the LP–STD debates of the 1990s (e.g. Berggren, 1992; Dankbaar, 1997). While this certainly holds historically for the case of repetitive convergent manufacturing, it hardly applies to the context of process production, as we have demonstrated. Here, a just-in-time material flow may be realized through the design of the production technology, leaving highly skilled, largely autonomous operators with the task of regulating that technology.

In technologically advanced production environments, industrial engineers may appreciate the insights from STD when dealing with aspects that are less developed in the literature on LP: worker motivation, QWL, and how to control non-routine activities by empowering employees. Combining the two concepts may aid organizations in exploiting opportunities for lean implementations that simultaneously increase technical performance and QWL.

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Managing Adoption by Cultural Development: Exploring the Plant-Level Effect of a Company-Specific Production System in a Norwegian Multinational

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Managing adoption by cultural development'

Exploring the plant-level effect of a company-specific production system in a Norwegian multinational

Purpose: Company-specific production systems (XPS) are standardised improvement programmes, devised by and adjusted to a particular firm, generally a multinational corporation (MNC). A pertinent issue concerns the possibilities and constraints of putting them into practice in plants in different countries. This paper describes and analyses to what extent and how a Norwegian MNC succeeded in adopting an XPS in its local plants.

Design/methodology/approach: Brazilian, Chinese, and Norwegian plants of a Norwegian electro-chemical company were studied from 2017 to 2019. Our data consist of the results of the plants' assessment performance programmes, combined with interviews and observations at different organisational levels.

Findings: The MNC largely managed to adopt the XPS in these plants. This was made possible by creating a strong corporate culture, shaping the managers' basic assumptions, and persuading lower-level management and operators to adopt the improvement programme. The corporate culture was the result of several initiatives, including the deployment of different human resource management practices, supported by top management teams and using the Norwegian plant as a laboratory visited by operators and managers.

Originality/value: This paper is, to the best of our knowledge, the first to study the actual use of an XPS intra-organisationally. It highlights the role of culture development and the basic assumptions for achieving global adoption. Global improvement programmes require constant managerial attention and actions at several levels in order to be adopted globally.

Keywords: Company-specific production systems (XPS), local adoption, cultural development, basic assumptions, Toyota production system

Introduction

Netland (2013) introduced the term ‘company-specific production system’ (XPS) to describe how multinationals corporations (MNCs) create standardised improvement programmes, based on existing organisational concepts and adjusted to the MNC’s strategies and environments (Netland, 2014; Netland & Aspelund, 2014). An XPS is portrayed as an ‘own-best-way approach to the one-best-way paradigm’ of operations management (Netland, 2013, p. 1093): a strategic and long-term programme, shared within the global production network, creating a common platform for improvement.

The strength of an XPS lies in the promise of realising superior performance throughout an MNC by achieving a high degree of intra-organisational adoption of the concept in the global network (Netland & Aspelund, 2014). However, a significant body of research points to the limits of realising substantial intra-organisational standardisation due to the fundamental challenges MNCs face when implementing improvement programmes globally (Ansari, Fiss, & Zajac, 2010; Ansari, Reinecke, & Spaan, 2014; Kostova, 1999; Kostova & Roth, 2002; Netland & Aspelund, 2014; Rolfsen, 2014; Wallace, 2004). When confronted with different political, social, and technological environments, MNCs are often forced to adapt their improvement programmes to local conditions. According to Ansari et al. (2014, p. 1314), global adoption of improvement programmes is ‘an exception, not the rule’, and ‘hardly any management practice qualifies as a “one size fits all”’.

Given these tensions, more knowledge is required about subsidiaries’ actual use of an XPS in a global network (Netland, 2013). Since performance improvements can only be achieved through altered shop-floor practices, it is crucial to learn whether these are actually put into effect. To the best of our knowledge, there has been no in-depth empirical research on subsidiaries’ use of XPS. Hence, this study aims to address the following research question: *To what extent and how does the implementation of an XPS lead to homogeneous practices at subsidiaries?*

We address this question by examining how a Norwegian MNC implemented its XPS in three subsidiaries. Findings from Chinese, Brazilian, and Norwegian plants indicate that the subsidiaries adopted the XPS extensively. Adoption was made possible by creating a strong organisational culture (Schein, 2010), whereby subsidiaries developed a shared understanding of the basic assumptions and underlying values inherent in the XPS. By establishing a global XPS university, performing assessment programmes, and setting up a 'laboratory' to which visits were mandatory, the MNC actively shaped the belief systems of local managers and operators.

Our study contributes to understanding how MNCs successfully implement global improvement programmes in their networks. We highlight the importance of cultural development for achieving adoption at the subsidiary level, and our findings have practical implications for managers aiming for best practice in a global network.

1. XPS and local adoption

With his introduction of the concept XPS, Netland (2013) was referring to how manufacturers and other organisations create their own improvement programmes. These programmes are informed by one or more existing organisational concepts, typically taking inspiration from the Toyota Production System (TPS) (Fujimoto 1999). Netland (2014) found that an XPS represents a lasting strategic programme, supporting diffusion of the core ideas across the inter-organisational network. An XPS is meant to create a common strategy and language for production improvement in all parts of a global operations network, enabling transfer of 'best practices' among units. As a result, not every plant has to 'reinvent the wheel' (Netland, 2013). Intended to combine the strength of proven production improvement principles with the unique composition of the firm's characteristics and needs, an XPS is labelled with the company's name (the 'X' in the XPS) to make it the company's 'own' programme.

A fundamental challenge when adopting improvement programmes in a global network is the subsidiaries' political, social, and technological differences, which create a counterforce to the isomorphic pressure from the corporate level (Ansari et al., 2014). There is an extensive body of literature problematising the notions of local adoption (Ansari et al., 2010; Rolfsen, 2014; Wallace, 2004). According to Ansari et al. (2014), to 'adopt' is to 'adapt', and standardisation is 'the exception not the rule' since hardly any improvement programme qualifies as a 'one size fits all' solution (p. 1314). Consequently, MNCs are often forced to develop local variants or hybrids (Wallace, 2004) of its improvement programme, and the ability to adjust and adapt to the local context is a fundamental capability for MNCs when diffusing improvement programmes in their network. Ansari et al. (2014) presented the case of an MNC's corporate improvement programme that was 'made to vary', arguing that adaptation may even be a necessary condition for diffusion rather than something that only happens during diffusion or as an outcome.

According to Netland and Aspelund (2014), subsidiaries might react differently when an XPS is introduced. They claimed that 'the corporation must carefully manage any legitimacy-seeking pitfall that leads to shallow implementation of practices and the trade-off between adoption and adaptation' (p. 394). To 'adopt' is considered the ideal for an improvement programme because it entails the subsidiary embracing and implementing the transferred improvement practice in full. To 'adapt' means that, while profoundly implemented, the programme is adjusted to better fit the local contingencies (p. 395).

As with generic organisational concepts, an XPS lends itself to various interpretations. The greater the interpretive space, the greater the possibility for local adaptation (Benders, Van Grinsven & Ingvaldsen, 2019). By detailed specification of the different operational principles and practices, the XPS can narrow down the interpretive space compared to the organisational concepts on which it builds. To reduce unwanted local variation and ensure the core tenets of an XPS are put into practice, it is essential to instil the desired values and beliefs locally. Unless this happens, superficial implementation is likely to result. At a general level, this may be conceptualised as changing the organisational culture. Starting with Schein's (1990; 2010) classic definition and classification of cultural elements, the topic of organisational culture has recently gained renewed focus within operations management (e.g., Lagrosen & Lagrosen, forthcoming; Losonci, 2017; Taherimashhadi & Ribas, 2018). Besser (1996) provided strong empirical data on how Toyota developed its plant at Lexington (Kentucky, USA) and how a 'community of fate' was built into the organisational culture. This resulted in a culture where employees believed they shared common interests with management.

For an XPS to be adopted, the cultural understanding of the expressed practices is crucial. A single practice may have different meanings at different subsidiaries. For instance, the principle of problem-solving involvement at a shop-floor level could be interpreted as a method to make the blue-collar worker 'easier to handle' by implementing new work processes and methods. Another interpretation is that enhancing innovation and productivity can only be solved through shop-floor employees' participation. The basic assumptions about why to involve people therefore become vital to the way in which the practice is adopted at the subsidiary level. The example illustrates that the MNC's ability to influence cultural understandings is central to an XPS's promise of adoption and homogeneity (Taherimashhadi & Ribas, 2018). By creating a shared culture, the interpretations of the XPS become more similar and the practices become more homogeneous.

2. Research method

2.1 Methodology

A multiple case study using the methodology of Eisenhardt and Graebner (2007) was conducted at a Norwegian multinational electro-chemical company that produces carbon materials for the global market. The production processes are highly automated, producing high volumes of standardised products. Non-participating observation was conducted by the first author who studied one Norwegian, one Brazilian and one Chinese plant of the MNC. This approach allowed us to investigate the process and level of XPS adoption at each plant, and to systematically compare the three plants in a search for patterns and explanations.

The original intention of the case studies was to investigate the variation in XPS use between the plants. However, when analysing the empirical data, we found that the variations were strikingly low, implying a shift in focus towards explaining the extensive adoption that had taken place. In the interviews, references to 'values', 'beliefs', and 'culture' were often made, which made *culture* a key emergent theme that called for further elaboration.

2.2 Data collection

The first author collected data from 2017 to 2019. He started by interviewing the MNC's top management group and participating in the XPS global university and assessment programmes. This allowed us to establish the content of this XPS (see Figure 1) and address how it was intended to be diffused and implemented globally.

In the next phase, three plants were visited. We collected data from two main sources: the corporate assessment programme; and interviews and observations.

1.2.1 The corporate assessment programme

Table 1 shows an overview of the content of the corporate assessment programme.

Table 1. The XPS assessment content

Sponsorship to Achieve Change Management The objective of this category is to develop an environment that encourages and nurtures XPS. The hypothesis is that a management team who leads by example and spends much of their time at the Gemba to understand, support and challenge will create an improvement culture. a. How leadership/management understands and demonstrates EBS in developing the people value chain b. How the organisation is challenged, coached, and trained to continuously improve c. How much time and resources are dedicated to improvement activities d. How management supports and challenges processes and activities.
A3 Cascading/Strategy Deployment This category focuses on how PDCA thinking is integrated throughout the unit to reach the vision and goals. a. How the strategic plan for the unit is developed, communicated, and linked to division goals b. How the plan for the unit is broken down in order to specify the sub-goals of all underlying departments c. How the strategic plan is the main driver of the improvement work, how it is monitored and followed up, and how deviations are handled d. How the organisation is involved to ensure the necessary participation and strong ownership.
Learning and Competence Development Competence is defined as the combination of knowledge, skills and attitude/behaviour. The objective of this category is to develop employees with high levels of competence and precision in their work/discipline and in problem solving. The underlying hypothesis is that if all employees are more competent in, and more motivated to perform, problem solving, the speed of improvement will correspondingly increase. The HR department is accountable for a competence development programme to develop a learning organisation. a. Strategic goals behind basic and key competence development b. How basic and key competence is built and documented c. How training is undertaken and followed up. (The facilitation of problem solving is covered by category 7)
Daily Management The objective of this category is for teams to take responsibility for meeting expected goals, solve occurring problems, and make improvements. The hypothesis is that organising the right competence and developing communication systems and standards will enable the team members to take responsibility for meeting daily goals and to improve their daily work. a. How the workforce is organised with roles and responsibilities b. How communication between management and teams is performed c. How to ensure stable and consistent work practices.

5S and Visual Management The main objective is to lift work areas to a controlled and predictable state and identify and eliminate 'hidden waste'. The underlying hypothesis is that high 5S performance is a prerequisite for high standards in other processes and activities in the company. Visual management visualises system status and condition and makes it easier to achieve a shared understanding and to make fast, fact-based decisions on site. This category will assess: a. How the workplace is cleaned and organised to ensure effective processes and activities b. How a clean and organised workplace is ensured over time c. How the condition of the workplace, process, and activities are visualised and ensured.
Problem Solving and Continuous Improvement This category focuses on effective problem solving and continuous improvement. The objective is to have a continuously improving organisation that effectively identifies and solves problems. The hypothesis is that the rate of improvement will increase if all employees are involved with problem solving and continuous improvement on a daily basis. a. What competence, methods and tools there are for problem solving and continuous improvement b. Who are involved in problem solving and continuous improvement activities c. How problems are identified and reported d. What is the result of problem solving and continuous improvement?
Continuous Flow and Elimination of Waste This category focuses on one of the core elements in improvement work – reducing waste – and on continuous flow. By waste, we mean all activities that do not create value and that we, as a producer, have to pay for. Continuous flow connects the processes or activities to create a flow according to customer needs. The hypothesis is that, by reducing waste and optimising flow, we will increase cash flow, free up resources, and reach higher customer loyalty. a. How waste is identified and eliminated b. How process and activities are linked and managed. (Kanban JIT)
Critical-Process Management (CPM) The objective of this category is to ensure that processes are in control and capable to increase productivity and customer satisfaction. The hypothesis is that an organisation, structure, and a good way of working, together with collection, documentation, development, and sharing of process knowledge, will lead to stable, predictable, and capable processes. This category will assess: a. How CPM and CPM teams are sponsored and interconnected with the whole value chain b. How processes are prioritised, and how customer and business requirements are identified c. How the overall process understanding is developed and maintained to assess, ensure, and improve processes d. How process parameters are measured.

The global XPS team has conducted plant assessments since 2004, which involve classifying the level of XPS adoption at the plants. The plants are assessed according to multiple variables, as outlined in table 1. Each variable is rated on a scale from 1 to 5, and each level is described textually. Importantly for the current study, we discussed the definition of ‘adoption’ and ‘adaption’ based on Netland and Aspelund’s (2014) criteria with the XPS team manager conducting the assessment programme. We then asked the team manager to classify the level of adoption (‘embraced and fully implemented’) related to the levels in the assessment programme. The level of adoption is rated at level 3, indicating that the subsidiary has embraced the concept. Transitioning from level 2 to level 3 represents a qualitative shift from resistance to adoption, while level 3–5 is ‘more of the same’, indicating that the subsidiaries conduct the activities more frequently. Level 3 was therefore established as the baseline for adoption in the assessment programme.

> *We are looking for those who have made it their own and are developing XPS to ensure enhanced performance. Level 3 describes this, I believe. But at levels 4 and 5 the culture is more developed, and more people in the plant are conducting continuous improvement. (XPS team manager)*

2.2.2 Interviews and observations

Table 2 shows an overview of the qualitative data.

Table 2. Overview of qualitative data. Words collected refer to interview transcripts.

Unit of enquiry	Management interviews	Shop-floor interviews	Observations	Words collected	Assessment data
Norwegian plant	5 managers	6 operators	One morning meeting Three critical-process management (CPM) meetings	12,684 words in total	XPS assessment 2012 XPS assessment 2017

			Union and environment meeting Day and night shift in control room Two guided tours of the plant		
Brazilian plant	5 managers	4 operators	Three morning meetings Three CPM meetings Day and night shift in control room One guided tour of the plant	20,594 words in total	XPS assessment 2012 XPS assessment 2017
Chinese plant	6 managers	5 operators	Two morning meetings Two CPM meetings Day and night shift in control room Two guided tours of the plant	16,228 words in total	XPS assessment 2012 XPS assessment 2019
Top management	4 managers	N/A	N/A		XPS training documentation XPS assessment documentation XPS university programme
Top management	3 managers	N/A	N/A		XPS content document 1999 XPS content document 2019

At each plant, the first author started the interview process with the plant manager, proceeded with the rest of the organisation, and ended with a second interview with the plant manager. This allowed us to investigate the plant managers' interpretations of the XPS, to observe actual adoption in each plant, and then to challenge the possible variations found in the plant during our data collection. Fifteen to twenty semi-structured interviews were conducted with top managers, middle managers, and lower-level employees at each plant.

We used the content of the XPS as the main guide for the semi-structured interviews, together with the variables from the assessment programme (see table 1) to create an interview and observation guide (see Table 3).

Table 3. Interview guide

1. Sponsorship to Achieve Change Management Identify managers at all levels and their ability to lead by example and spend their time at the Gemba to understand, support, and create an improvement culture.
2. A3 Cascading/Strategy Deployment Identify how the organisation is involved to ensure necessary participation in PDCA thinking to achieve the unit's vision and goals, and how this is linked to division's goals.
3. Learning and Competence Development Identify the managers' ability to develop employees with high levels of competence and precision in their work/discipline and in problem solving.
4. Team and Daily Management Identify the organisation's use of semi-autonomous teams on shop-floor level, and how the teams take responsibility for meeting expected goals, solve occurring problems, and improve their daily work. Identify span of control and the power structure on shop-floor level.
5. 5S and Visual Management Identify if work areas are controlled and in a predictable state, and whether there is the ability to identify and eliminate 'hidden waste'.
6. Problem Solving and Continuous Improvement Identify the organisation's effective problem solving and continuous improvement capacity, in teams and at different levels. The level of employees that are involved in problem solving and continuous improvement on a daily basis.
7. Continuous Flow and Elimination of Waste

Identify the organisation's ability to secure the core elements in improvement work – reducing waste (all activities that do not create value and, as a producer, have to pay for) – and in continuous flow (connecting the processes or activities to create a flow according to customer needs).
8. Critical-Process Management (CPM) Identify the organisation's focus on getting critical processes under control and its capability to increase productivity and customer satisfaction.

In our interviews (which lasted about 1.5 hours each) we asked managers and employees to describe work tasks and workplace conditions that related to the variables. For instance, investigating variable 4, 'Team and Daily Management', we asked the operators at the furnace: 'if something unexpected happens on your shift, to what degree do you and your team make your own decision to solve the problem?' We used a designated translator from the corporate HR department to translate the interviews with operators at the Brazilian and Chinese plants. The first author also participated in various improvement meetings and observed how the XPS was used in daily operations.

2.3 Data analysis

First, data from the top management group, the XPS university, and the variables in the assessment programme were analysed. Observations, corporate documents, and interviews were coded into categories, capturing the content of the XPS. Our categories were then taken back to the top management team to validate our interpretations. Secondly, we analysed data from the company's assessment programme in 2012 and 2017/2019.

Thirdly, we analysed the qualitative data from the plant visits to confirm the level of adoption from the assessment data. Recordings, notes, and observations were transcribed and coded by the first author. We categorised the data and used Netland and Aspelund's (2014) framework for subsidiaries' responses to improvement programmes as a theoretical framework for classifying adoption vs adaption. Based on the initial findings, we noted indications of local adoption within each case and homogeneity between cases. Our material indicated cultural explanations, and we then decided to analyse the cultural dimension systematically. We analysed how the subsidiaries' organisational culture had been developed and how the actions were taken at the corporate level to secure a homogeneous culture among the subsidiaries.

3. **Findings**

3.1 The XPS content

The XPS was developed at the corporate level between 1991 and 1999, and it was based on TPS principles (Liker, 2005). It was also influenced by Norwegian working life norms (Ingvaldsen, 2013; Levin, Nilssen, Ravn, & Øyum, 2012). In 1999, a decision was made to implement the XPS in all divisions. The core idea of the XPS is to reduce variability so that processes are 'in control'. To do so, the XPS prescribes the application of lean-production tools, such as 5S, A3 problem solving, waste reduction and visual management. Furthermore, two important organisational choices were made. First, decision-making was decentralised on the shop floor by establishing a broad span of control, removing supervisors, and increasing operators' autonomy and ability to fix problems by themselves. Secondly, operators were engaged and involved in problem solving, process control management, and waste reduction. Engagement and involvement require investment in competency and training, and the XPS prescribes this clearly by addressing the 'double integrated chain of value', heavily focusing on personnel development as a fundamental part of the XPS (see Figure 1). In the words of the CEO:

> *I had to understand the [people] dimension, and how strong it is. The enormous energy you can release through the organisation when people are properly trained and are made responsible… and your decisions are decentralised. (CEO, Norwegian MNC)*

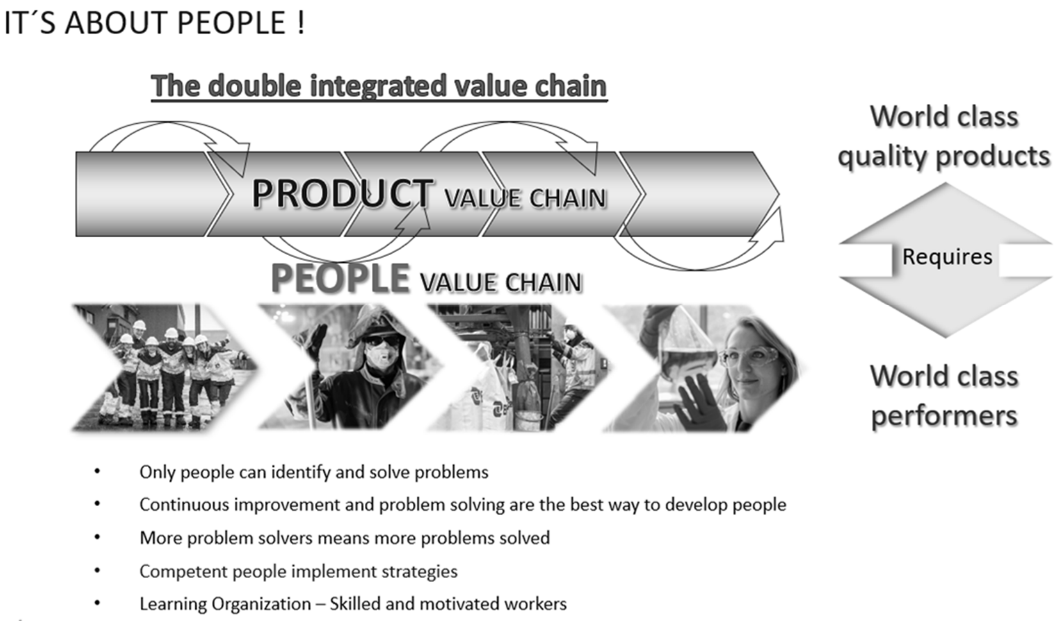

Figure 1. The corporate XPS: ‘It’s about people’

3.2 Plant-level adoption

3.2.1 Assessment findings

Table 4 shows the scores from the plant assessments.

Table 4. Assessment data for XPS adoption

		Dimension	Norway	Brazil	China
2012	1	Sponsorship	5.00	5.00	4.00
	2	Strategy, A3-hierarchy, PDCA	4.00	5.00	3.00
	3	Team Organisation	4.00	4.00	4.00
	4	Day-to-Day Team Management	4.00	5.00	3.00
	5	Learning, Practice, Competency Development	4.00	5.00	4.00
	6	Standardised Work, Routines	5.00	5.00	5.00
	7	Problem Solving, Continuous Improvement	4.00	4.00	2.00
	8	5S	4.00	4.00	4.00
	9	Controlled Critical Processes, Stability and Cap.	4.00	4.00	3.00
	10	Technical Maintenance	4.00	4.00	3.00
	11	Visual Performance Monitoring	4.00	3.00	4.00
	12	Continuous Flow, Elimination of Waste	3.00	3.00	4.00
Average			4.08	4.25	3.58
Standard deviation			0.51	0.75	0.79

Dimension			Norway	Brazil	China
2017/2019	1	Sponsorship	4.00	4.00	4.00
	2	Strategy, PDCA	4.00	3.00	4.00
	3	Learning, Competence Development	3.00	5.00	3.00
	4	Work teams, Standards and Daily Management	4.00	4.00	4.00
	5	5s and Daily Visual Management	4.00	3.00	5.00
	6	Problem solving	3.00	3.00	3.00
	7	Waste Reduction and Flow	3.00	3.00	3.00
	8	Critical-Process Management	4.00	4.00	3.00
Average			3.63	3.63	3.63
Standard deviation			0.52	0.74	0.74

Assessment data from the plants in 2012 show an average score above level 3 at all plants (Norway: 4.08; Brazil: 4.25; China: 3.58). The Chinese plant reported level 2 on the variable 'problem solving and continuous improvement' in 2012, and this was the only score lower than level 3 in the dataset. Assessment data from the plants in 2017 (Norway and Brazil) and 2019 (China) report an average score above level 3 at all plants (Norway: 3.63; Brazil: 3.63; China 3.63).

The average scores for Norway and Brazil were lower in the second assessment. This could indicate that the implementation process stagnated during this period. The XPS department, after reviewing the data, attributed these lower averages to changes in the assessment instrument between the measurements rather than to an actual digression. According to the XPS department, the empowerment dimension in the XPS was significantly more integrated in the categories in 2017/2019.

Taken together, the assessment data indicates that the XPS was adopted at the different plants. Assessment data also indicate homogeneity between the plants. All three plants reported an average score of 3.63 in 2017/2019. As explained below, plant visits and other additional data corroborated the findings from the assessment scores.

3.2.2 Plant findings

When visiting the plants in Norway, China, and Brazil, we found adoption of empowerment, expressed as the two organisational choices from the XPS, and adoption of the eight variables described in the interview guide (see Table 3). We also discovered important cultural elements that explained how managers used the XPS in daily management.

Decentralised decision-making

We found several indications of decentralisation that gave the blue-collar workers authority to make their own decisions about their daily work tasks on the production line. We found that plants managed, to a certain extent, their operations with broad spans of control, and that the operators took responsibility for daily operational decisions and continuous improvement. In two of the plants (Norway and Brazil), we found that supervisors were removed from the shop-floor level, and that there was a focus on greater responsibility for the operators, on the reduction of unnecessary information, and on greater coordination when stabilising the critical processes at the production line. At the Chinese plant, the supervisors had not yet been removed, but preparations to do so were underway in 2019. Standard Operation Procedures (SOP) were established in all areas of the production line, but, due to the large amount of non-routine tasks, the operators were given the authority to make their own decisions.

> *Yes, […] I needed to improve productivity. One way was to change the organisation and take out the layer of the supervisor. I could do it however I wanted, and I decided to do it via XPS, […] because I have seen the plants in Norway and the maturity of the employees, and I could not see it in Brazil. (Plant manager, Brazilian plant, 2018)*

> *I spend 90% of my working time by myself without any supervision of my manager. Most of my tasks I solve by myself. (Operator, Chinese plant, 2019)*

Problem-solving competencies

We found that all plants had invested in competence and skills, enabling the blue-collar workers to handle more challenging work tasks and to conduct problem solving on their own. We found that variables 3 and 4, 'Learning and Competency Development' and 'Team and Daily Management', had to a certain degree been adopted at all three plants, giving the operator the necessary competency and skills to conduct problem solving.

Competency investment included the ability to manage new technological set-ups in the production line combined with problem-solving skills, such as waste reduction, critical-process management, and 5S. This was especially visualised by variable 8, 'Critical-Process Management'. This is likely one of the most important variables relating directly to production performance in process industry. In this variable, the subsidiary is supposed to 'collect, document, develop and share process knowledge, [and this] will lead to stable, predictable, and capable processes' (see Table 1). We found that the operators were given the responsibility to collect and document the variables on their own and then report back to the technical staff and managers, and *jointly* correct and stabilise the critical processes.

> *The people are more important in the company because people are responsible for making changes and improving. The most important part about the XPS is that it involves the people, gives them training and involves them. Competency and behavioural competence are very important, and we have strong procedures about how to increase the competence. (Head of HR department, Brazilian plant, 2018)*

Continuous improvement participation

With regard to the variables in the interview guide, we found indications that all plants involved and engaged their employees in continuous improvement activities, and aimed for enhanced performance on critical output variables as well as on EHS and maintenance activities. We especially investigated the Chinese plant on variable 6, 'Continuous Improvement' (see Table 2), because it reported level 2 for this variable in 2012 (see Table 4). We found that 'all employees were involved in problem solving and continuous improvement on a daily basis' at the Chinese plant, indicating adoption of the variable. We also found indications that all plants had to a certain degree adopted variable 1, 'Sponsorship'; variable 2, 'Strategy and PDCA'; variable 5, '5S and Visual Management'; variable 7, 'Continuous Flow and Elimination of Waste'; and variable 8, 'Critical-Process Management'. We discovered minor variations between the self-assessment programme in 2017/2019 and our data from the plant visit.

> *The biggest change over the last five years in my workplace is the knowledge of how I should continuously improve my work. (Operator, Chinese plant)*

3.3 The adoption process and cultural development

3.3.1 Local managers' adoption process

When visiting the plants, we discovered that the plant managers described a very similar management approach. Their year-long training within the company appeared to have resulted in a strong dedication to the XPS. In their interviews with us, the plant managers used the term 'religion' and 'a way of thinking in all areas in life', giving the impression that the XPS was so integrated in their mindsets that it might be regarded as a religious belief. All plant managers sought to persuade middle managers and engineers to follow the XPS. This was found in several areas: morning meetings, problem-solving meetings, lunch breaks, critical-process meetings, social arrangements, and in daily follow ups. Plant managers also manifested their beliefs by wearing the same work clothing as operators at the plant, showing that 'we all share the same belief' on the shop floor. When resistance arose among middle managers, mostly during morning meetings and critical-process meetings, this was often related to the level of involvement of the operators and when discussing how to conduct problem solving. Rituals were then conducted to manifest the XPS, symbolising the use of scientific tools and deductive methods, combined with an almost spiritual belief in the involvement of the people at hand. Instead of telling them how to solve the problem, top managers encouraged them to use the Lean Production (LP) tools and experience the effect. Through this 'self-experiencing process', middle managers gained a new understanding of problem solving and the potential of the XPS, making the operators self-driven in stabilising the critical processes for output performance.

The plant managers and operators also reported to have their own 'Mecca' to visit. The Norwegian plant was described as their visual confirmation that the improvement programme was a success and that their beliefs were correct. At the Chinese plant, most middle managers and several operators reported having been sent to Norway to see and learn about the improvement programme. The Chinese plant manager even claimed to have visited 'Mecca' at least 50 times during the last 10 years to study how the organisational choices at the shop-floor level played out at the Norwegian plant.

The preliminary findings were fed back to the MNC's corporate level to validate them. There, respondents strongly recognised the description of the local managers. As one top manager said:

This is spot on, but we have never addressed it like this before. Yes, it is a religious belief, and you have described something that has been right in front of our eyes. And, yes, that's why we succeed. (Top manager, MNC corporate manager team)

The top manager even recognised this 'religious belief' in his own management practice. During the interview, he was able to precisely pinpoint when the transformation into a belief system had occurred, and when he was 'saved':

At this point in my career in the company I am saved and in line with the XPS business system. But in the beginning, when the top management group discussed finger bandage injuries, I really questioned the focus. Today, I really understand the potential in investigating small injuries to prevent big injuries. And it is this inner journey that has become the salvation. (Top manager, MNC manager team)

The findings relating to managers' understandings of the XPS and their almost religious beliefs in the concept became a central variable in the further investigation of the cultural dimension of the adoption process and how this adoption was made possible.

3.3.2 Corporate adoption process and cultural development

The findings indicated several mechanisms used at the corporate level to convey the content of and beliefs in the XPS to local plants. Following the creation of the XPS, the corporate level developed several strategic initiatives aimed at institutionalising the XPS. These initiatives, which are explained below, became important to secure the XPS adoption.

The XPS centre

When the XPS programme was established in 1999, an XPS centre was immediately set up in the global organisation. The leader of the centre became part of the top management group, and the centre was given power and resources so that it could constantly develop and deploy the core ideas across the global network. It had two main objectives. First, it became the 'corporate dynamo' where ideas, concepts, and written material of the XPS were constantly maintained and interpreted, and where the concept was kept aligned to its original and core ideas. When analysing written material from 1999 and 2019, the expressed norms and organisational choices had not changed, and this kept the concept close to its original ideas. This manual has now been translated into nine different languages. Secondly, the XPS centre has been responsible for educating the organisation and hence manifesting the core ideas of the concept to the entire network. Together with the human resource management (HRM) department, the XPS centre has been responsible for the global XPS university, the assessment programmes, and the global XPS network, and it has developed the written materials and visual concepts used at the subsidiary level, resulting in XPS centre members spending between 150 and 200 days per year in travel.

The members of the XPS centre also represented a great variety of competence. Some had worked as team leaders on the production line, some had been responsible for the company's technological division, some had been recruited from the management level, and some had been part of the global operational network. Most importantly, however, the members of the XPS centre understood the complexity of the production line and had extensive 'real-life' experience. This diverse, hands-on competence became essential to the global institutionalisation of the XPS content.

One particular task for the centre explains the framing of managers' interpretation of the concept. Each time a new CEO entered the company, the leader of the XPS centre immediately began training the new CEO on the implementation of the XPS ideas. This was regarded as a vital task, providing the 'the right interpretation' from top management to secure the necessary legitimisation of the XPS. In the XPS manager's words:

> *My colleagues and I have been responsible for training all CEOs hired after the XPS was established, to help them understand the concept. (XPS head manager, MNC)*

Global structure for improvement work

We found one vital content of the XPS within the global network: sustaining the corporate pressure at the subsidiary level. Each day, operators visualised and reported, using large whiteboards, their performance on the shift, addressing safety, quality, and efficiency. This exercise was also termed 'visual management' in the XPS. Every week, top management teams analysed all performance data that were reported from plants to division managers. Serious deviations between reported and designated performance called for an explanation from division managers at a meeting. Serious injuries were root-cause analysed and, most importantly, the gradual development of bringing main processes under control was visualised at all organisational levels, leaving no doubt that top management demanded constant development and that this search for enhanced performance would never stop. We found that the establishment of this 'push' system, combined with visual management and regular weekly meetings of the global top team, helped to establish basic assumptions (Schein, 2010) about the constant ability to enhance performance by solving problems on the shop floor. In the words of the CEO:

> *You have to create some 'push' in the organisation to achieve 'pull'. (CEO, Norwegian MNC)*

Global XPS university

A global XPS university was established in 1997. This university was meant to educate the organisation in the main ideas of the XPS. A core principle was the diversity of participants. This was named the '1/3 principle' because each programme should recruit one-third of participants from the shop floor, one-third from technical managers, and one-third from plant managers across the global network. This was a strategic decision made early during the XPS development, emphasising the importance of bringing different levels together in problem solving and discussing the core concept of the XPS. Today, approximately 1,500 people have completed the week-long programme, and some 800 to 1,000 have attended courses at local academies that are conducted by local plants.

We found that the training at the university was vital for establishing basic assumptions about the core ideas of the XPS. During the week-long training, managers and operators were trained in practical problem solving, which was combined with a constant focus on how to provide operators with the autonomy to solve their own problems. The university was located in different places globally, but it was always close to one or more plants. The plants were used as practical cases in the programme, demonstrating how the XPS had affected organisational choices at that particular plant. This further established basic assumptions and helped to convince some sceptics among participants.

> *I'd heard a lot about this programme, and everyone returning seemed brainwashed. Now I understand why. This is the best programme I have ever attended. (Operator attending the university, September 2017)*

Assessment programmes

The assessment programme began in 2001 and has developed together with the XPS. Initially, the assessment was technically focused and audit oriented. Today, the assessment is described as a learning process. We found that during the three-to-five days of the programme, the assessment team interacted with the different organisational levels, educating the plants more than assessing them. A general format was followed, based on eight principles described by five levels of degree of implementation (see table 1). However, the assessors used much of their time explaining and persuading the staff about the core ideas of the XPS, emphasising the empowerment dimension, and describing how to involve the operators in problem solving and continuous improvement.

> *We don't like to call it audit, so we renamed it assessment and reduced the number of topics. Today, the people dimension is fully integrated in the assessment document, and, yes, it's important to sell the idea of people involvement in the assessment programme, so it becomes their own. (Head of XPS department, MNC)*

We found that the assessment programme helped to establish basic assumptions about the XPS and its core ideas among managers, operators, and engineers at the subsidiaries. This was done by following an 'educational approach' when assessing, as well as by letting the managers interpret and discuss results in meetings after the evaluation had been conducted. On the last day of the assessment week, all involved personnel assembled in a group meeting. Here, the results were presented one by one, according to the standards of the assessment board, and questions and comments were anticipated. Importantly, this openness contributed to a collective discourse and further established basic assumptions by allowing sceptics to rise to the surface, and by then using the values in the concept as guidelines for the discourse.

Network organisation and cross-cultural learning

The MNC also facilitated knowledge sharing between plants. XPS coordinators and teams were used to spread knowledge between the plants and were responsible for daily training and implementation of the core ideas. Travel was used extensively to transfer practical knowledge and core ideas across the plants in the global network. As noted earlier, the Norwegian plant was used as a 'visual laboratory', and several managers and operators from the global network were sent to visit and observe the XPS in practice.

4. Conclusion and discussion

The findings suggest that the MNC managed, to a significant extent, to implement its XPS at the three plants. Plant visits supported the assessment findings, especially regarding adoption of empowerment as prescribed by the XPS. Based on this, it might be argued that the MNC is on its way to implementing the XPS in its network (cf. Marin-Garcia et al., 2008). The data suggest that the Chinese and Brazilian plants, contextually very different from the Norwegian plant, significantly developed their organisation in a direction where empowerment had substantially influenced the workplace. Nevertheless, follow-up studies at the shop-floors may lead to differences in the intensities and forms in which this move towards increasing empowerment has become lived reality.

Findings indicate that the creation of an XPS in a global network contributed to increasing homogeneity among subsidiaries. The XPS clearly brought some 'consistency and durability' (Netland, 2013) to the subsidiaries' improvement efforts. However, our findings also indicate that creating an XPS is necessary yet not sufficient. In our case, several corporate initiatives were taken to distribute and maintain the values supporting the content of the XPS. The creation of the XPS centre appears to have played a vital part in this. For more than 20 years, managers and operators have been trained and challenged by the idea that performance relies on the level of employee involvement and use of scientific tools. For some managers, especially the plant managers, this re-examination of basic assumptions, (Schein, 2010), resulted in an almost religious belief in the XPS. This belief then released a 'religious energy' in the organisation, encouraging all levels to adopt the XPS and make organisational choices relating to decentralisation and investment in training and competence at the shop-floor level. Our findings indicate that it is this strategic investment in people globally, supporting the content in the XPS, that leads to the adoption process and creates homogeneity at the intra-organisational level.

Our study has several practical implications. First, future managers must recognise the organisational choices needed to institutionalise the XPS in the global organisation and to allocate resources to the strategic initiatives. Key questions include: How should we organise the XPS work internally? How should we secure distribution of practical and tacit knowledge in our network? How do we educate and bring our managers and employees on board? How do we visualise and report performance vertically and horizontally in our network? And how do we assess and develop the XPS within the subsidiaries? These questions are fundamental for the institutionalisation process because they constantly challenge and re-examine the basic assumptions within the organisation, and, in this way, they create the culture needed to secure adoption and homogeneity.

Finally, top managers in the MNC must support the XPS in their daily management, becoming the primary 'sponsors' of the concept. This constant 'push' from top management is of vital importance in sustaining the normative pressure and securing the institutionalisation of the XPS.

Declaration of Conflicting Interests

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6. Discussion

In this chapter I summarize my findings in order to answer my research question: How was a successful XPS created, implemented, and institutionalized in a manufacturing company? An overview is presented in Table 4. I then discuss the findings, introducing a *learning perspective* of an XPS. I have developed a model (the experimentation, experiencing and re-examining [EER] learning model; see Figure 3) to explain how Elkem used the XPS to create an integrated learning process in their organization. Finally, I discuss the theoretical implications of the learning perspective when using an XPS for future production performance.

Table 4. Main findings

Paper	Creating	Implementing	Institutionalizing
Paper 1 Red color: overlapping creation and implementation.	Created a "long-lasting" improvement program. No "master plan". Concepts tried out by emerging and unrelated initiatives.	Contributed to easing the transfer of the XPS by adjusting it to the processing industry context. Adjusted to shopfloor level in the processing industry, by (1) adjusting TPS to the technological set-up and (2) reduction of interpretative space (users' interpretations of Lean production).	Managed to implement and institutionalize its XPS at the three plants, significantly developing their organization in a direction where empowerment substantially influenced the workplace.
Paper 2 Blue color: overlapping creation and implementation.	Four phases of creation over a 15-year period.		Brought "consistency and durability" to the subsidiaries and managed to institutionalize the XPS by cultural development and re-examination of basic assumptions.
Paper 3 Green color: overlapping implementation and institutionalization	Adjustment and "tailoring" by experimentation Orchestrated by top management, with significant dedication and persistence to ensure new ideas were tried out, evaluated, and eventually consolidated to form the XPS.	Standardizing the concept using (1) assessment program for adoption and (2) vertical "push system" to visualize improvement and production performance at all levels of the organization.	Resource allocation for long-term institutionalization.

6.1 Successful creation

The XPS was successfully created according to my definition of a successful XPS "sustaining the emphasis and focus across the global operations networks over a long time" (Netland, 2014). The XPS was created without a master plan, and the creation process lasted for 15 years. Selected concepts were not implemented as standardized best-practice concepts, nor was the uniqueness of the company evaluated systematically. Concepts were tried out and experimented on by emerging and unrelated initiatives, which combined "learning from the experience of others" with "learning from direct experience" (Levitt & March, 1988).

Experimentation enabled the selected concepts to be tailored to the company's uniqueness. This was especially demonstrated in Paper 1, which documented how the experimentation with the TPS and STS theory led to the decision to remove the shift supervisors from the shopfloor level. The extensive learning process also managed to reduce the interpretive space (Benders & Van Veen, 2001), thereby ensuring a common understanding of the XPS content. This was described as the "double integrated chain og value", which emphasized the strong connection between people and product (Hekneby et al., 2021).

Orchestrated by top management, experimental knowledge was further disseminated across the units and eventually consolidated to form the final XPS content. This involved a visual presentation of the material to explain the concepts and how the XPS interrelated with a holistic production system. Hence, the experimentation process was cyclical, constantly bringing new ideas and concepts to the XPS in the creation phase. This was especially important when the concept of Critical Process Management (CPM) was implemented in the Elkem Business System (EBS) after its first content was presented in 1999.

6.2 Successful implementation

My findings demonstrate that Elkem managed, to a significant extent, to implement the XPS across its network. This finding is strongly supported by the data from the Chinese and Brazilian plants discussed in Paper 3. The implementation process started with the creation process, during which managers from different levels of the global organization were involved in the XPS process. As mentioned above, this contributed to narrowing the "interpretative space" (Benders & Van Veen, 2001) in order to arrive at a common interpretation of the XPS. Hence, the creation process provided a significant understanding of how Lean could be implemented in Elkem's shopfloor technology, which was important for the future adoption of the XPS. Paper 2 demonstrates how Lean was adapted to the shopfloor level in the processing industry by creating a shopfloor organization typically associated with STS, which included extensive employee choice and autonomy (Hekneby et al., 2021).

After the creation process, adoption was strengthened by three important actions: standardization, knowledge transfer, and visualization/vertical push system. Standardization of the XPS was made by rolling out a global assessment program. As discussed in Paper 3, this program was educational, giving the plants the opportunity to further experiment and learn how to use the XPS. Additionally, Elkem initiated an extensive knowledge transfer by establishing XPS coordinators across the global network. Finally, the implementation process was supported by a vertical "push system" that required all plants at all levels to provide the top-level group with progress reports on improvements and learning development. As demonstrated in Paper 3, the top-management team received weekly reports from each plant on safety, quality, and production performance.

6.3 Successful institutionalization

The XPS managed to institutionalize the improvement program in order "to sustain the emphasis and focus across the global operations networks over a long time" (Netland, 2014, p. 131). The main component of the institutionalization process was Elkem's ability to build a strong corporate culture by *re-examination of basic assumptions* (Schein, 2010) among managers and operators. We found that, not long after creating the XPS, Elkem allocated significant resources to building a corporate culture that would support the content of the XPS in the global network. This included leadership training, the XPS assessment program, the XPS University for managers and operators, XPS agents in all divisions, global learning activities, and so on. This initiative resulted in further re-examination of basic assumptions. We also found that this re-examination led to several managers and operators having an almost "religious belief" in the XPS. The cultural development then reinforced the organizational capability to institutionalize the XPS.

6.4 The role of top-management support

The role of top management was important to all three parts of the XPS process. We found that top management became "the main sponsor" of the XPS. This role indicated significant participation on the shopfloor level, inspiring the organization to experiment with different concepts both within and outside the company. New initiatives were allowed to flourish in the organization and eventually to be integrated into the final XPS content.

Secondly, we found that top management allocated resources to secure institutionalization and ensure that the XPS was a long-term program. This included establishing XPS assessment programs, the XPS Centre, the XPS University, management training, and so on. The experimentation and learning culture was further developed by re-establishing basic assumptions throughout the global company.

Finally, we define these top-manager behaviors as *orchestrating learning*. This refers to planning and structuring the process of learning and to ensuring that new ideas are tried out, evaluated, and, if successful, retained and transferred. It does not imply that top managers have the answer, nor that they can perfectly match company needs and available concepts. Rather, it means that they make sense of and coordinate distributed learning processes toward a common goal.

6.5 A learning perspective on XPS

As discussed in chapter 2, Netland (2013, 2014) might suggested that the XPS process follows a rational change process during which it first evaluates its contextual uniqueness, then uses several concepts to design interventions, and finally implements and adjusts the specific content of the XPS. My findings indicate an organizational *learning process* that used the XPS to establish organizational learning to improve production performance (Powell & Coughlan, 2020a, 2020b).

The different views might relate to a broader discussion in the conceptual literature about organizational change. *Episodic change* is associated with planned, intentional change (Weick & Quinn, 1999). It occurs when organizations are forced to find new ways to align themselves with changes in the external environment in order to address “a growing misalignment between an inertial deep structure and perceived environmental demands” (Weick & Quinn, 1999, p. 365). Because episodic change indicates a transition to a “newly created equilibrium”, it is intentional and planned. The “continuous change” perspective is described as more *evolutionary* because the change process is “ongoing, evolving, and cumulative” (Weick & Quinn, 1999, p. 375). A common premise, which emphasizes the long-term perspective, is that continuous change is an “evolving process” (Weick & Quinn, 1999, p. 366).

Netland (2013, 2014) might suggested that the XPS process resembles the episodic change perspective, whereas my findings might relate to the evolutionary perspective, thereby indicating a learning perspective by which XPS is used to enhance production performance (see Table 5).

Table 5. Contrasting episodic and evolutionary XPS

Dimensions of change	Episodic XPS	Evolutionary XPS
Perspective on change	Top down and planned. Systematic evaluation of company’s uniqueness. Deployed for effective coordination of production performance in the network.	Evolutionary and experimental. Actions followed by investigation. Creates evolutionary learning ability in the network. Focus on cultural development and institutionalization.
The use of organizational concepts	Strategic choice of organizational concepts to fit the company’s needs. Tailors the composition to fit the company’s needs.	Uses organizational concepts as inspiration. Tailoring by experimentation and learning.
Time perspective	Long-term program. Intended to sustain the emphasis and focus across the global operations and networks over a long time. Short creation process of XPS content.	Never-ending learning process. Long creation process of XPS content. Institutionalization of continuous improvement.
Role of top managers	Top-management attention to achieving long-term strategy. Emphasis on a more technically oriented process.	Orchestrator and main sponsor. Securing learning and institutionalization through cultural development.

Elkem created, implemented, and institutionalized its XPS by developing different learning activities; through doing this, the company enhanced its production performance. I am not rejecting Netland's (2016b) argument that a more episodic XPS process could lead to improved production performance. However, my findings indicate that there might be a *learning way* for a manufacturing company to improve production performance, namely, by using the XPS as a process to create organizational learning. Standardized concepts could be used as sources of *inspiration* and *experimentation* in this process, rather than being implemented as a "best practice concept" in the organization (Powell & Coughlan, 2020b, p. 924). The adjustment lies in the organization's ability to initiate learning. This was strongly supported by the data from the creation process of Elkem's XPS where STS and TPS were used simultaneously.

Figure 3 illustrates the EER learning model that I have developed to understand the learning perspective in Elkem.

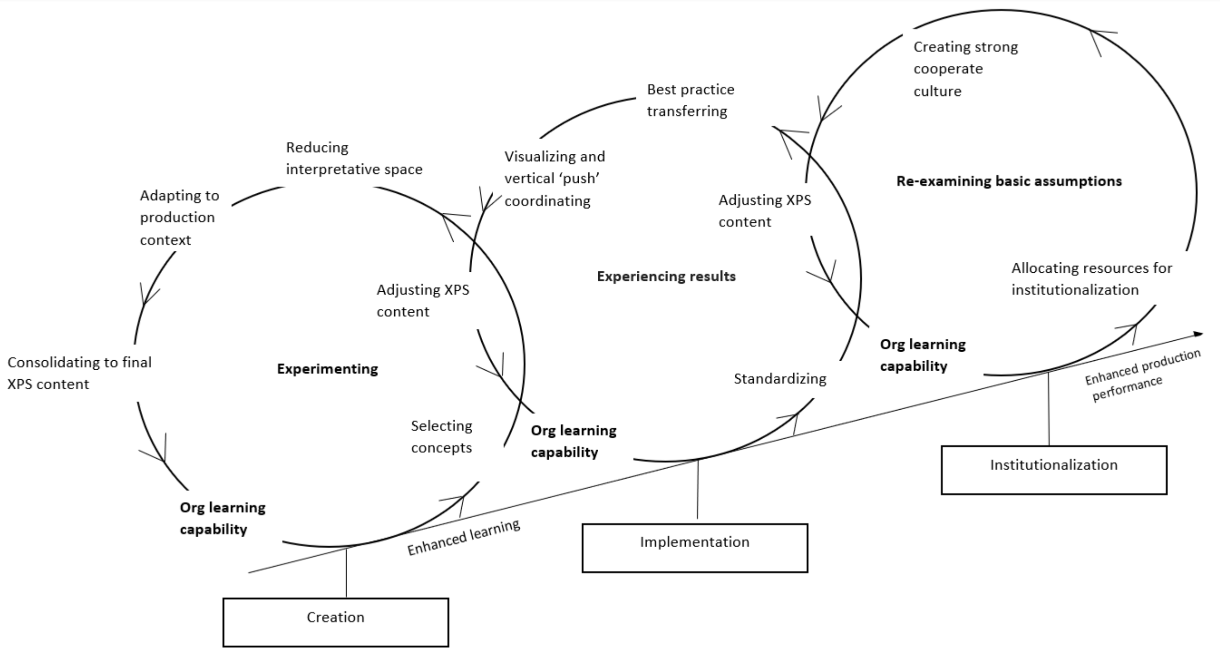

Figure 3. The experimentation, experiencing and re-examining (EER) learning model

The EER learning model is a visual description of Elkem's organizational learning processes. I have demonstrated that the XPS process in Elkem did not follow a linear change process or the predefined pattern classically described as episodic change (Weick & Quinn, 1999). The XPS process in Elkem could be described as an integrated learning process, where creation, implementation, and institutionalization of the concept overlap and evolve over a long period of time.

Each step in the process is marked by different learning activities that are highly integrated and create an enhanced learning capability and improved production performance. Learning capability and production performance are visualized by the elevation of the circles in Figure 3.

The EER learning model starts with the creation process, which is visualized as a "rotation" of learning activities infused by *experimentation* as the main force in the learning process. Elkem used standardized concepts to experiment and learn, later consolidating the learning into an XPS content. Different learning activities shaped the curve, constantly bringing impulses to the final content of the XPS. First, different concepts were selected. Hence, the concepts were selected mostly because of external impulses and a great desire to experiment with the most recent innovations in manufacturing production performance. The learning from Alcoa's business system became important, and, later, the STS concept was introduced, based on the experimentation in the Fiskaa and Bjølvefossen plants. As a result, learning was created from both external experience and "direct experience" (Levitt & March, 1988).

Experimentation also led to a better understanding of how the two concepts could be combined and used, which contributed to narrowing the interpretative space of the XPS content (Benders & Van Veen, 2001). In the creation process, the combination of TPS and STS underwent extensive experimentation at the shopfloor level, which involved constantly adjusting the XPS to the technological set-up in the processing industry. Finally, the experimentation process was consolidated to a final XPS, which resulted in the organization having improved learning capability and production performance.

The second circle in Figure 3 relates to the implementation process in Elkem. The main force is *experiencing* the results. This was strongly supported by the data from shopfloor about experiencing the furnaces as "calmer" when the CPM was implemented in the XPS. As a result of the experience of XPS improving production performance, the XPS was standardized with an assessment program for ensuring the transfer of practice and its adoption across the network. Knowledge transfer was reinforced by hiring XPS operators to work at different levels and geographical locations in the organization, with the intention of ensuring knowledge about best practice and the content of the XPS were extended throughout daily operations of the global network. The XPS operators also conducted meetings and educational activities across the global network, and they brought new ideas back to the XPS department so that the XPS content could be evaluated and, if necessary, adjusted. The *experiencing* of results was further reinforced by visual artifacts (Schein, 2010) and the vertical push system, which involved all parts of the organization reporting progress on vital key performance indicators as well as weekly meetings of the top-management team. The process then reinforced the organizational learning capability and production performance, bringing the organization to a higher level than that of the creation phase (as depicted by the second circle being more elevated than the first circle in Figure 3).

The third circle relates to the process of institutionalizing the XPS. As I have shown, Elkem managed to make the XPS and its shared norms and values sustainable and enduring (Buchanan et al., 2005). It might be argued that continuous improvement was fundamentally internalized among the members of Elkem's organization. The main force for this process was *re-examining* basic assumptions (Schein, 2010), which entailed a deeper cultural understanding of the expressed practices in the XPS. As demonstrated in Paper 3, a single practice can have different meanings at different levels of an organization. By creating a shared culture, the *interpretations* of the practice become more similar and the practices become more homogeneous (Hekneby et al., 2020). Several strategic initiatives (e.g., EBS University, the EBS department, and the assessment program) contributed to creating this deep internalization of ideas and building a strong culture for improvement. For some managers and operators, this re-examination resulted in an almost "religious belief" that regarded the XPS as "a way of thinking in all areas in life" (Hekneby et al., 2020).

Key to the model is the connection between each phase, indicating that the learning process is interrelated. When Elkem created their XPS, the company also started the process of implementation, significantly affecting the interpretive space among the plants involved. The same principle holds for the last circle. When Elkem created their XPS, they also started to institutionalize it by re-examining basic assumptions in the organization. Support from the top manager and his plan to visit the company's global plants over a six-year period were important for the re-examination of basic assumption from the outset of the XPS process. Finally, organizational learning was constantly adjusting the content of the XPS as the learning capability and production performance evolved in the organization.

The learning perspective visualized in the EER model might be thought to resemble the evolution of the TPS. As demonstrated in chapter 2, the secret behind Toyota's success was not to implement standardized concepts. Toyota established an "evolutionary learning capability" (Fujimoto, 1999, p. 26) by using different ideas and concepts to create learning at different levels of their organization. TPS did not evolve with a master plan, but with the ability to capture impulses and new concepts, to experiment and learn constantly from these impulse, and to quickly transform this learning into standards and manufacturing capability across the entire organization (Fujimoto, 1999). Important to the process was Toyota's ability to manage learning by "making good decisions, learning from mistakes and grasping the competitive benefits of unintended consequences" (Fujimoto, 1999, p. 26). This evolutionary character of the TPS is fundamental to understanding Toyota's success (Fujimoto, 1999) and to viewing the "mystery" of Toyota's production performance in its correct context.

The learning perspective in the EER model might also represent a different approach to using the XPS for production performance and company advantage. In the search for improved production performance, the XPS might be more than just an alternative to the "one-best-way" approach (Netland, 2013). The XPS could exist as a *catalyzer* for an extensive learning process in an organization (Powell & Coughlan, 2020a, 2020b). A strategic decision to create a successful XPS could be the starting point for exploring how different concepts can be used to create organizational learning that combines "learning from the experience of others" with "learning from direct experience" (Levitt & March, 1988). As shown in the case of Elkem, this happened from approximately 1994, and the company is still exploring new concepts and ideas with the aim of improving its learning and business performance. By embodying this "learning way", the XPS acts as a *catalyzer* for experimentation and organizational learning, leading to improved production performance and an enhanced learning capability.

6.6 Theoretical implications

The learning perspective has implications for research on organizational concepts (e.g., Lean and TPS) and on XPS (Dennis, 2017; Liker, 2004 Netland, 2013, Powell & Coughlan, 2020b). Scholarly publications over the past 30 years have demonstrated the fundamental challenge of using organizational concepts to standardize production performance in different contextual environments (Ansari et al., 2014; Osterman, 2020). Therefore, further investigation into the possibilities of using organizational concepts to create organizational learning capability is required. Studies should consider how the concepts are used as inspiration and as the basis for experimentation, rather than how they are standardized and implemented. The concepts of Lean and TPS, and later of XPS, originated in that manner (Fujimoto, 1999). Therefore, we need to address the use of organizational concepts differently in the future. A statement from the former CEO of Elkem exemplifies how, as a plant manager 15 years ago, he discovered the "learning way":

> *In the beginning, I could not understand why we needed to implement stupid tools for cleaning and tidying (5s). I then had to assemble my management team, fundamentally involving them in the understanding of the EBS. Today, you might experience the EBS as a religion when you meet the organization.*
> (CEO Elkem, spring 2017)

The learning perspective also challenges the notion of specific managerial behavior relating to "Lean leadership" (Liker & Convis, 2011; Netland et al., 2019; Reynders, Kumar, & Found, 2020) in two main areas: (1) the content of prescribed leadership behavior; and (2) the use of organizational concepts to create learning in an organization.

As pointed out in chapter 2, there is a distinct notion that organizational learning and continuous improvement (CI) brings evidence of lean being successfully implemented in an organisation. Hence, the organizational concept of lean should be implemented in order to create organizational learning (Liker et al., 2011; Netland et al., 2017; Powel et al., 2020a). In this perspective, Lean leadership secures the *implementation* and, consequently, *organizational learning* (Netland et al., 2019). It is remarkable how Lean leadership is presented with a significantly high level of abstraction and, at the same time, is prescribed with precise behavioral components. For example, the "essence of lean" is first described as "Learning, a long-term perspective, and leadership" (Netland et al., 2017, p. 11), yet it is simultaneously prescribed in an extremely specific way. To succeed in implementing Lean (and to ensure continuous improvement), the most important thing to do is to "observe the gemba (the shop floor), ask questions and conduct coaching" (Netland et al., 2017).

As I have demonstrated, a successful XPS is about learning, a long-term perspective, and leadership. On the other hand, describing "how to walk and how to talk" to managers seems problematic in the learning perspective. To create learning at different levels of an organization, in different contexts, and at different points of time, it would be almost impossible to pinpoint the exact behavior required of a manager. For example, when the Elkem CEO commenced the XPS creation process, he was far away from engaging in the learning process himself; however, he would later attend the plant's production line every second week for six years. For him, remembering names of the operators in the global network become crucial to building trust and mutual respect in the learning process. Precise components of leadership behavior should be re-evaluated because the behavior depends on too many contextual variables (Argote, Lee, & Park, 2020). This implies that acknowledgement of the concept of Lean at a high level of abstraction relates to organizational learning. Consequently, Lean leadership can scarcely be "demystified" by pointing out some key behavioral components (Netland et al., 2019).

Secondly, by taking a learning perspective on the XPS process, Lean (or other concepts) can be used for *inspiration* and *experimentation*, rather than as a universal concept – applicable anywhere by anyone (Womack et al., 1990). As demonstrated by the findings from Elkem, several concepts were used as sources for inspiration and experimentation, and several concepts became important for Elkem's learning capability. The concept of Lean does not create learning per se. Rather, it is how the concept is used that creates learning. In the learning perspective, leadership is about knowing how to use the various available concepts to create learning within the specific political, social, and technological context. This was demonstrated in the case of Elkem, where the top manager become an "orchestrator" of this process, allowing the organization to experiment with several concepts and later to abstract the learning to an overall business concept ready for implementation and institutionalization. The learning perspective therefore challenges the notion of a certain type of novel Lean leadership because organizational concepts are used for experimentation rather than implementation.

6.7 Limitations and further research

A limitation of my study relates to the retrospective methodological design. A longitudinal design involves repeated observations of the same variables over time (Bougie & Sekaran, 2016). By following an organization as it evolves over time, data robustness is empowered. My findings are cross-sectional (Bougie & Sekaran, 2016) and based on information from different sources who experienced the events several years ago. This might, therefore, lead to bias because the approach relies on events being interpreted and explained retrospectively. It is recommended that further investigation of the learning perspective in an XPS process captures real-time data as the process unfolds.

The learning perspective and XPS processes should also be further documented among MCs and MNCs. Surveys could be used to investigate whether their XPS processes have been episodic or related to continuous change. Such information could help to understand how an XPS evolves in (global) companies in the future.

Further research is also required on how to use the XPS as a catalyst for creating organizational learning and long-lasting production performance. The origin of TPS might still provide valuable knowledge on how concepts can be used as "fuel" for initiating and developing evolutionary learning capability.

7. Conclusion and practical implications

In my research for this thesis, I embarked on a journey to investigate MCs' use of organizational concepts and how an XPS improves production performance. By considering the historical evolution from the TPS to the XPS, I have explored how an XPS is successfully created, implemented, and institutionalized in an MC. My findings have shown that a successful XPS constitutes a "learning way" to improving production performance. By taking a "learning perspective" on the XPS process, production performance relies on the organization's ability to experiment and facilitate learning. This process is visualized in Figure 3. Hence, an XPS might be a catalyzer for an extensive learning process in an organization.

In the following subsections, I discuss the practical contribution of my thesis by considering its implications at different levels of an organization.

7.1 Top management

First and foremost, when a top manager chooses to use an XPS, he or she is the main "sponsor" of the process. The manager's dedication, attendance, and ability to involve the organization are fundamental to the success of the XPS. This is not a process where "black belt generals" can be hired to do the job. Although consultants can be used to support the process, it is the top manager who is the general in charge of the never-ending learning process.

Secondly, a top manager needs to start the process by onboarding their closest managerial colleagues in the process. There must be a critical mass within the management team who share the same assumptions regarding the content of an evolutionary perspective and what this implies for the organization.

Third, the top manager needs to (re-)establish arenas for experimentation, learning, and vertical/horizontal knowledge distribution. Meetings and report systems should be standardized, and the learning activities, conducted at every level of the organization, every day, and in every shift, should be directly linked to the company's overall strategy. Experimentation and learning are conducted for a purpose that is always linked to the overall strategy.

Fourth, and related to the role of being a sponsor, the top manager will need to travel. He or she needs to be constantly present in the process in all parts of the network. The top manager will provide the organization's members with inspiration, but, above all, he or she will capture the main essence of the intended and unintended learning experiences. This is vital for the creation of the overall business system. Traveling is also important for the constant re-examination of basic assumptions in the company, for the process of institutionalization, and for building a strong corporate culture.

Finally, the top manager will provide resources for long-term institutionalization activities. This is crucial for the cultural development and re-examination of the basic assumptions in the company. Educational programs for managers and operators, measurement systems, internal consultant programs, knowledge programs, and so on will be formalized as parts of the overall business system.

7.2 Middle-management level

Middle managers are the main dynamos in the learning process. Their main task is to involve the shopfloor in the learning process. This entails experimentation, standardization, and problem solving to enhance production performance.

Secondly, as the main dynamos, middle managers will ensure that there is vertical and horizontal knowledge transfer in the organization. Important roles of middle managers involve standardizing the reporting systems to ensure they are always connected to the company's strategic goals, providing constant learning, and revitalizing the content of the business system.

Third, middle managers are close to the shopfloor, so they are an important component in the processes of re-examining basic assumptions (Schein, 2010), creating a strong corporate culture, and institutionalizing the learning capability. Being "in the middle" means that their task is to understand the deeper values of the business system and to communicate this understanding to the shopfloor.

Their daily behavior (e.g., how they follow safety procedures) is crucial for the cultural development.

7.3 Internal and external consultants

If a consultant is given *responsibility* for implementing Lean (or a similar concept), then they are in the wrong place. From an evolutionary perspective on the XPS process, the main task of a consultant, whether internal or external, is to support the managers and operators in creating learning and enhancing production performance. Their job is to give advice, ask questions, challenge decisions, undertake educational work, ensure knowledge transfer, and so on. In performing these tasks, it is essential that they maintain a professional distance from the managers responsible for the change process in the organization.

Secondly, consultants should acknowledge their ability to inspire the organization with new ideas, new concepts, and additional knowledge for the learning process. They will also provide important external “eyes” that can view aspects of the learning process that might not be seen by those close to the process. Consultants can provide valuable information because they might discover important learning opportunities that are overlooked as being “obvious” in daily operations.

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