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A Holistic View On Production Systems Management

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Abstract

Almost every large corporation nowadays operates some sort of Production System (PS), usually built as a derivative from leading examples like the Toyota Production System. Production Systems (PSs) are introduced to increase operational performance and to eventually instill a culture of continuous improvement across the mostly globally dispersed production networks. The main question is not any longer if PSs are helpful but how to manage them. So far there is neither an answer to this question in practice nor in literature. That is, how to design and develop the *content*, the *process* and the organizational support *structure* of a PS, and thus providing a corporate perspective to managing PSs, is heavily under researched.

The methodological approach in this paper is twofold. First, a systematic literature review was conducted to identify appropriate papers dealing with this topic. Second, we draw on interviews with corporate representatives being accountable for the PS at 11 respective companies from the Pharmaceutical industry. The companies have been selected based on their maturity of production system implementation. Interviews were transcribed and coded.

We found various activities related to the three dimensions of *content*, *process*, and *structure* of PSs. Thereby, we provide an overview of activities for managing PSs. We add to the literature of PSs from a corporate perspective and derive several future research opportunities, such as if there are multiple ways in combining the identified activities to be successful with a PS. Our limitation is that interviewees are from the pharmaceutical industry only, yet the level of sophistication of PSs in this industry and the twofold approach mitigate the limitation.

Keywords

Production Systems; Continuous Improvement; Corporate; Lean; Pharma Industry

1. Introduction

Since the industrial revolution, manufacturing companies have deployed programs to improve their operations. The pioneering approach of Toyota and the creation of the world-famous Toyota Production System set the basis for lean production [1]. Automobile manufacturers started copying and developing their company specific Production Systems (PSs). Over time, PSs have become popular beyond the automotive industry and manufacturing departments [2]. The main goal of deploying PSs remains the same across all industries. Companies aim at improving effectiveness and efficiency in their operations and developing a culture of continuous improvement [3].

However, reaping the promises is not as easy as it sounds [4]. Several companies eventually fail with their Production System (PS) [5–7]. At others, the PS is only superficially integrated and/or only seen as a “toolbox”, and hence limited in driving continuous improvement systematically [8,9]. Hence, companies are faced with the question of how to manage their PS [3].

This paper aims at examining *what are activities to manage a PS*. Firstly, we performed a systematic literature analysis to identify the relevant papers dealing with Production System management. Secondly, we conducted interviews with representatives from 11 pharmaceutical companies. Finally, we present our findings and show future research potentials.

2. State of Research

Many companies have adopted or even copied some parts of the Toyota Production System [10,11] and adjusted the design and structure [12], thereby generating their own interpretation of a PS [13]. There is no coherent definition of a PS, a PS is e.g. seen as a framework consisting of strategic goals, principles, and tools to manage production processes [14,15] or as an improvement program [16]. Since programs need to be managed [17] and this article aims at identifying activities to manage PSs, the definition used by Netland [16] and subsequently other researchers [18,19] of an “improvement program” is being followed in this article. Additionally, this article takes a perspective from the headquarter as PSs are often initiated by the headquarter and deployed to sites [20,21].

By creating their PS, companies aim at a structured implementation of common practices and the creation of a culture of continuous improvement within their manufacturing network [3,20]. In case of a successful implementation, companies will benefit from improved operational performance [22], achieve a continuous improvement capability [21], and therefore experience a competitive advantage [11]. Although companies use different names to refer to their own PS, they all are in essence a “*process improvement program*” [16]. Netland recognizes three dimensions that describe a PS [16]: the *content* comprises the principles included in the PS and clearly stated in the respective visualization model. The *process* dimension summarizes the mechanism how the PS and its content is implemented. Finally, the *structure* defines the dedicated teams on corporate and site level that are needed to support the process and content dimensions [16]. Literature provides little guidance on how to manage a PS. Academics [2,10,23] point out that companies must align strategy and *content* of PSs, as well as integrate isolated initiatives into the *content* of the PS. In the *process* dimension, Saunders et al. highlight the importance of soft management skills to deploy strategic initiatives [24]. Hekneby et al. focus on the role of managerial attention to sustain the global adoption of PSs [18]. Stalberg and Funding perform a case study with a company and derive several managerial implications for the *process* and *content* dimensions, ignoring the *structure* dimension [23]. Still only few publications discuss a more holistic approach to manage PSs. Albeit Netland [16] specified guidelines for action for a PS in the dimensions *content*, *structure* and *process*, they are neither systematically derived nor collectively exhaustive.

3. Methodology

The research question is answered in a methodological twofold approach, combining a theoretical and practical perspective. The theoretical perspective is based on a systematic literature review. Due to the topic of this research, the systematic literature review follows the step-by-step approach for operations management by Thomé et al. [25]. Two databases namely *ScienceDirect* and *Web of Science* were used for the search which was carried out in June and July 2021. Search words¹ were carefully selected and discussed among the authors. Only peer-reviewed journal articles were included to ensure high-quality results. Papers should cover entire improvement programs, not isolated or single practices, at manufacturing companies. Both forward and backward searches were used to refine the final selection of papers. A total of 39 papers

¹ ("OPEX program*" OR "improvement program*" OR "CI program*" OR "JIT program*" OR "TQM program*" OR "TPM program*" OR "Lean Production System*" OR "Toyota Production System" OR "Company-specific Production System*") AND ("sustain*" OR "implement*" OR "manag*")

has been identified during the systematic literature review. Data gathering from the papers was conducted using a concept matrix according to Webster and Watson [26] in order to find activities in managing PSs.

The practical perspective uses semi-structured case interviews which provide the researcher with the opportunity to have a structure in place but also allows for enough flexibility to cope with the complexity of the topic at hand. The selection of the case interview partners was based on three criteria to guarantee the reliability of the process. First, prior engagement between the companies and the authors had to have taken place. This ensures common understanding of a PS, reducing the risk of misunderstandings [27]. Second, partners should be active in pharmaceutical companies. Even though the pharmaceutical industry was a laggard in introducing PSs compared to other industries, it is now at the forefront with regard to the applied sophistication in designing PSs [28,29]. Third, cases should embrace companies with different sizes and maturity stages to mitigate the risk of a selection bias. The semi-structured interviews were performed in 2021. The process relies on a pre-defined interview guideline and questions emerging during the interviews to increase the reliability of the research [30]. This guideline was structured according to Netland's [16] *content*, *process* and *structure* dimension of PSs and pre-tested with a practitioner from one of the case firms. A total of 12 interviews from 11 companies² with interviewees from corporate teams were conducted, ranging from 37 to 69 minutes. The size of companies ranges from 2000 to 95000 employees. Interviews were transcribed using the commercial software *trint* and codified with the software *Atlas.ti*. Data coding was structured in two cycles, according to Saldaña [31]. Initially, codes are found using the open-coding technique, which is suitable due to the explorative, open nature of the research [32]. Successively, the initial codes are aggregated in themes by removing redundancies and categorizing them with the axial coding technique [31]. Both methodological approaches were then combined afterwards to refine and structure the selection of activities and sub-activities for managing PSs. The overarching structure comprises *content*, *process*, and *structure* dimensions according to Netland [16].

4. Results & Discussion

4.1 Content

Table 1 contains the activities identified in the *content* dimension.

Table 1: Collection of activities for managing the content of PSs

Activity	Sub-Activity	Literature	Interviews
<i>PS Content Identification</i>	Copying PS Content from External	[33,34]	[A, F, J, K]
	Integration of Existing Projects & Initiatives	[35–37,23]	[A, B, C, E, F, G, H]
	Strategic Alignment of PS & Company Strategy	[5,33,38,16,11,39,40]	[A, B, C, E, F, G, H, I, J, K]
<i>PS Content Definition</i>	Definition of Lean & Fundamentals Elements	[41]	[C, D]
	Combination of Soft & Technical Elements	[10]	[D, E, G, H]
	Integration of Digitalization Elements	[42]	[D, I, J]
<i>PS Integration</i>	Operationalization of PS Elements	[43,44]	[C, H]
	PS Integration with other Improvement Programs	[45,10,46]	[B, D, E, F]
	PS Definition as an Umbrella System	[36]	[A, B, C]

² Companies 1-11 are referred to as A to K respectively in the following chapters

<i>PS Content Evolution</i>	PS Scope Expansion	[47,39]	[A, B, C, I, K]
	PS Content Adaptation	[48,47,16,39,23]	[A, C, D, E, I]
<i>Adaptation of PS at Sites</i>	Adaptation and Update of Guidelines/Standards	[16]	[A, E, H, I, J]
	Adaptation of Guidelines/Standards at Sites	[44,49]	[A, D, E, G, H, I, J]
	Adaptation of PS itself at Sites		[C, G, K]

We found that companies are not only concerned with how they design their PS initially but also how they adapt it over time or to their sites in the network. The identification of PS elements can be driven by copying from other renowned models, building upon existing improvement projects or initiatives, and by an alignment with corporate strategy. The integration of PSs relates to how the PS and other on-going initiatives in companies compete for resources and attention from management, thus taking an outside-in perspective from the PS. Another aspect is the PS as an umbrella system enveloping all improvement initiatives, thereby fostering the internal integration of the PS. During the definition of the PS content, that is the description and operationalization of elements, companies shape their PS. From both the practical and theoretical perspective, the content itself comprises lean and other fundamental elements but also contains softer as well as digitalization elements. The operationalization of the PS content refers to the level of detail, ranging from generic to specific. Despite the definition of the content at a company's headquarter, the PS itself and its elements in form of operationalized guidelines or "playbooks" is adapted to the company's sites. While literature shows evidence for the adaptation of guidelines, since they provide a certain degree of freedom to adhere to, it does not for the adaptation of the entire system, such that different elements are merely applicable or applied to selected sites due to their characteristics. The interviews in this case revealed that some companies design their system in a modular way in which some elements are deployed to sites with certain roles. Lastly, we identified the evolution of the PS content which is the adaptation of the PS system itself, the expansion of the scope, and the adaptation of guidelines and playbooks.

4.2 Process

Table 2 includes activities and sub-activities from the process *dimension* of PSs.

Table 2: Collection of activities for managing the process of PSs

Activity	Sub-Activity	Literature	Interviews
<i>Roll-Out Strategy Definition</i>	Roll-Out at Organizational Levels	[47,46]	[A, B, F, H, J]
	Roll-Out Responsibility Definition		[A, B, C, D, E, F, G, H, K]
	Roll-Out Strategy Definition for Network		[A, E, G, I, K]
	Roll-Out Strategy Definition at Sites	[50,36,51,27,52]	[A, C, D, E, F, G, H, I, J, K]
<i>Capability Building & Transfer Mechanisms</i>	Coaching	[53]	[B, D, I, J]
	Training (Workshops)	[50,43,33,44,36,53,54,37,27,52,40,55]	[A, B, D, E, F, J, K]
	Job Rotation	[50,43,36,7,40]	[D, I]
	Setting up Learning Platforms		[D]
	Successful Practice Sharing	[50,43,44,36,54,52,39]	[B, F, H, K]
	Establishing Teamwork (cross-functional)	[50,43,36,56,40,55]	[B, E]

	Definition of Standards, Guidelines & Playbooks	[44,36]	[B, C, E, F, H, J]
<i>Monitoring & Controlling</i>	Ensuring Resource Availability & Financial Support	[51,57,37,52,41,40,55]	[G]
	Performance Management	[50,44,36,51,53,37,41,58,39,40,55]	[A, C]
	Maturity Assessment	[50,43,44,36,53,27,52,58,39,55]	[A, C, D, E, F, G, H, I, J, K]
	Strategy Deployment	[36,51,56,53,59,39,7,40]	[A, B, C, E, F, G, H, I, K]
	Establishing Program & Project Management	[40,55]	[B]
	Daily Visual Management (Huddles)	[53,58,7]	[E, J]
	Conducting Follow-Ups	[35,51,52,55]	[A, I]
	Conducting Gemba Walks	[16]	[D, G]
<i>Management Engagement</i>	Getting Site Leadership Team Commitment	[27]	[A, I]
	Getting Top Management Commitment	[60,37,47,61,16,52,41,40,55]	[A, C, E, F, G, I, J, K]
	Establishing Management Involvement	[51,56,47,52,46]	[A]
	Creating Management Push	[5,36,51]	[A, D, E, J]
<i>Buy-In & Motivation Creation</i>	Creation of a Joint Vision	[44,37,23]	[A, E, I, J]
	Common Language Definition	[36,54]	[A, E, J]
	Raising Awareness	[48,53,54,47,52,39,40]	[B, F, G, J]
	Communication	[50,62,51,37,52,40]	[A, E, F]
	Quick Improvement Benefits Sharing	[5,60,27,11]	[B, C, E, F, G, H, J]

Five activities were identified in the process dimension. First, companies define more or less intentionally their roll-out strategy. Interviews revealed that this design of the roll-out strategy is manifold, covering not only the roll-out within sites but also across the network and organizational levels. That is, whether all sites are in scope at the same time or some might act as a starting point. Companies might also start from top management downwards or start from the bottom upwards with their roll-out. Second, the knowledge or the content of the PS needs to be transferred to the sites and capabilities need to be built at site level. In this activity, various transfer mechanisms are leveraged by companies. Usual mechanisms, such as trainings as well as guidelines and manuals, are used frequently but also other more advanced ones, such as coaching and successful practice sharing, are utilized. Interviews revealed that companies also leverage dedicated learning platforms or online academies. In some cases, a formalized job rotation program was used to systematically build capabilities at the sites. Third, the progress and effectiveness of the PS is monitored and controlled. Most of the sub-activities are conducted in a continuous manner. Ensuring sufficient resources in form of financials and time is critical. Strategy deployment includes goal setting and cascading so that objectives are clear but also well aligned. In addition, maturity assessments are regularly conducted to track the progress of PS implementation. Also, the achieved improvements and potential gaps to be closed are monitored with performance management. Daily management in form of huddles, regular follow-ups and gemba walks are used for controlling and monitoring. Fourth, creating engagement from management was

found to be decisive in both literature and practice. Especially, a dedicated push from top management at the beginning of the PS was mentioned in the interviews. Yet, a continued commitment and eventually a revitalizing push from management was also observed in both interviews and literature. Fifth, companies need to create buy-in and motivation within the organization. Frequent communication, raising awareness and a joint vision help to get employees on board for the PS. Additionally, a common language ensures the same understanding and thus further helps in engaging employees.

4.3 Structure

Table 3 summarizes the activities for managing the structure of the PS. The structure of the PS can be divided into formal and informal structures as well as the respective responsibilities. For the formal structure, a corporate PS team is usually established to initiate the PS such as designing its content while site PS teams are leveraged to deploy it. Interviews with practice additionally showed the importance of the team leader of the corporate PS team who is appointed at the beginning of the PS.

Table 3: Collection of activities for managing the structure of PSs

Activity	Sub-Activity	Literature	Interviews
<i>Formal Structures Definition</i>	Central/Corporate Team	[43,36,16,40]	[A, B, C, D, E; G, I, J, K]
	Site PS Teams	[52,49]	[A, E, K]
	Head of Corporate PS Team		[I]
	External Support (Consultancies)	[51,52,41]	[A, E, G, H, J]
<i>Informal Structures Definition</i>	PS Champions/Ambassadors	[33,44,36,51]	[A]
	Communities of Practices		[F]
<i>Responsibilities & Relations Definition</i>	Connection between Corporate & Site PS Teams		[J]
	Ownership & Responsibility of Improvements	[63,57,45,16,7,55]	[D, E, G, I, J, K]

In addition to formal structures, companies establish informal structures or let them emerge organically. These informal structures are PS champions, which are assigned facilitators of the PS but not dedicated to corporate or site PS teams, and communities of practices, which often reflect a group of people interested in a certain topic of the PS. Lastly, the definition of responsibilities for improvements and ownership is a critical activity which is an on-going task. Yet where the responsibility resides might change over time. Moreover, the connection or responsibility between corporate and site PS teams was highlighted by practitioners.

5. Conclusion and Future Research

Companies have experienced improvements with the help of PSs but some of them failed eventually. The question that emerged and that is being raised by companies is how do PSs need to be managed. Our article sheds light on this question by providing an overview of activities for managing PSs. Our twofold approach revealed various activities and sub-activities that companies can consider to manage their PS. These include how they define and adapt the PS content, how they monitor and control the progress, how they build the capabilities at their sites, how they create management engagement and organizational buy-in, and how they establish the respective organizational structure. With this, we add to the literature of PSs by integrating single activities from various papers into a holistic and structured collection. Managers of PSs at manufacturing companies can use this overview to reflect upon their existing approaches and identify

overlooked activities worth to consider. These research findings offer several future research opportunities. First, the activities should be tested quantitatively. That is, linking the activities to the success of PSs to test if certain activities are more decisive for successfully managing PSs than others. Second, different combinations of activities might yield a positive outcome, as there might be no one-best-way to manage PSs. Thus, various combinations of activities should be tested instead of just a single one. Third, not all activities might be important when a PS is being designed, deployed or sustained. This implies that activities might increase or decrease in importance depending on the stage of PS implementation. Future research should pay more attention to these dynamics in a PS. Lastly, the collection of activities should be challenged and more refined by conducting interviews with more companies also from other industries.

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Biography

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