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Spillover Effects of Learning for Production Ramp-ups

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Abstract

In today's rapidly changing market environments with heterogeneous consumer needs, short product life cycles, and global competition, organizations must perform production ramp-ups more often and react quickly to external changes. This is only possible if the required knowledge is available at the respective organizational units and workplaces. Thus, a central question to answer is: How can spillover effects of learning improve future production ramp-ups?

This paper provides an overview over the existing literature on spillover effects of learning for production ramp-ups. Specifically, the antecedents, control mechanisms and performance effects of these spillover effects are considered. While learning and knowledge management in general have received attention for quite some time, there is only little research on the specific means, tools, and methods of spillover learning that are useful for seemingly unrelated processes such as production ramp-ups in different time periods. The literature on spillover learning as well as on organizational learning in production ramp-up is extensive, but the combination of the two is still under-researched. For these reasons, further research in this area can generate insights in how to better ensure transfer of tacit and explicit knowledge in the context of production ramp-ups. In this paper, we first present the state of the art of spillover learning in production ramp-ups by reviewing the existing academic literature. After that, opportunities for future research are outlined. Identified research gaps include that little is known about the process and effectiveness of knowledge transfer between consecutive ramp-ups. Especially, an unanswered question is how deliberate learning as compared to learning by doing influences knowledge spillovers to subsequent ramp-ups. In terms of scientific methods, laboratory experiments have not yet been employed in the context of spillover learning for production ramp-ups. This opens up another interesting and promising direction.

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1. Introduction

Production ramp-up, defined as the “period between completion of development and full capacity utilization”, is of utter importance for the success of manufacturing companies [1]. During ramp-up periods, companies have to cope with high degrees of uncertainty, instability, and complexity. Since product life cycles are decreasing in their duration and the number of products and product variants increases, ramp-ups become more frequent which puts an even higher importance on a company's ability to cope with the associated difficulties (see e.g. [2]).

In this context, organizational learning is a central concept which can reduce uncertainty and instability through a better understanding of the production process and as a consequence may improve production outcomes with regard to cost, time, and quality. The goal of many firms is to achieve a learning curve as steep as possible to reach higher quality and efficiency as early as possible. For companies, it is beneficial to make use of the knowledge generated through learning effects for current and future production ramp-ups.

This paper focuses on a specific form of organizational learning, namely spillover learning. The concept of spillover learning can be defined as organizational learning through knowledge spillovers, where organizational learning refers to

“the process of improving actions through better knowledge and understanding” [3] and knowledge spillover is defined as the “external benefits from the creation of knowledge that accrue to parties other than the creator” [4].

Usually, the term knowledge spillover refers to knowledge which spills over from the organization where it was created to another organization, which benefits from it. For example, Agarwal et al. explain that knowledge, which is created within an organization, is not perfectly kept within its boundaries [4]. Thus, building on the work by Arrow they conclude that knowledge becomes, at least partly, a public good meaning that it possesses the characteristics of non-rivalness and non-excludability [4][5]. In contrast, we here regard the question how spillover learning can improve future production ramp-ups within the same organization. This means, we do not investigate spillovers of knowledge from one organization to another, but instead look at the spillover from one point in time to another. Note that this form of spillover may, nevertheless, concern different parties: One party creating the knowledge and others benefitting from it, just within the same organization. Here, the specific focus lies on different ramp-up teams. This paper reviews the existing literature on the question how organizational learning during production ramp-up can benefit future ramp-ups by the means of spillover learning. For this purpose, the spillover learning literature and the literature on organizational learning in production ramp-up are reviewed separately in Chapter 2 and 3. Chapter 4 then combines these two topics into spillover learning between production ramp-ups. Chapter 5 concludes and identifies research gaps and provides directions for future research.

2. Spillover learning in general

Before diving into the topic of spillover learning, gaining an understanding of the concept of organizational learning in order to assess the importance of spillover learning in production ramp-ups is important. The huge body of literature on organizational learning is reviewed in, for example [3][6][7] and [8]. While there is some disagreement about the exact definition of the term organizational learning, Fiol and Lyles find areas of consensus and thereby broadly define organizational learning as described in the introduction: “Organizational learning means the process of improving actions through better knowledge and understanding” [3]. Within this broad definition, multiple different ways of organizational learning can be distinguished which are very well presented in [6].

Spillover learning in general, and not necessarily spillovers from one production ramp-up to future ones, has received substantial attention (e.g. [4][5][9][10][11][12]). Even the OECD noted that learning spillovers from the global frontier of innovation to other companies and less innovative countries is an important topic in order to stimulate global innovativeness and efficiency [13].

In the existing literature on spillover learning, there is a strong focus on interorganizational spillovers, but little is researched about spillover effects to a later point in time. Due to the high number of publications in this field, we will only consider articles, which we view as either central to the field

or helpful for the topic of spillover learning from one production ramp-up to the next.

Arrow was assumably the first to describe spillover effects of knowledge between organizations in his conceptual work in 1962 by emphasizing the public good nature of knowledge [5]. Knowledge becomes available for everyone, not only the creator, as soon as it is employed in some way. While Arrow takes a microeconomic view and puts his focus on the efficiency of a market for trading knowledge, the side-note of knowledge being available for parties outside the creating organization laid the foundation of spillover learning in the academic literature [5].

Following the ideas of Arrow [5], Ghemawat and Spence [9] elaborate on the effects of knowledge spillovers on the performance of markets. They conceptually explain how the existence of spillovers has two contrary effects on an industry; an industry-wide cost reduction on the one hand and a decrease in incentives to reduce costs by expanding output on the other hand. Compared to a situation with no knowledge spillovers, costs are reduced more quickly due to higher experience. However, for each individual company the incentive to expand production in order to drive down costs is reduced since the company might as well rely on other firms to produce more. While the net effect of these two implications is ambiguous, the authors find anecdotal evidence for the former to outweigh the latter.

Spence draws the same conclusion from his model of spillover learning and competition, but also does not test this empirically [12].

Agarwal et al. take a slightly different approach to analyzing spillover learning [4][10]. They investigate knowledge spillovers in the context of strategic entrepreneurship, namely how knowledge spills over when a firm’s employee leaves the company to form her own venture. While this topic is very different from the production ramp-up context, some of the insights are transferable to, or at least helpful in, ramp-up management. Interestingly, they draw – among others – the conclusion that the originator of a knowledge spillover, and not only the recipient, can as well profit from this spillover [4][10]. The underlying mechanism is that the originator can observe how the recipient combines the received knowledge with other knowledge and by this foster additional learning. While this idea should lead organizations to more openness towards knowledge spillovers out of their own boundaries, this concept could be transferred to the setting of multiple ramp-ups within one organization. Insights, which have been generated by one ramp-up team, can spill over to another team, which exploits these insights. In turn, the first team will then be able to apply the additional knowledge, which has been created by the second team, and combine it differently for the next ramp-up.

Also in the area of entrepreneurship, Ko and Liu study the elements of knowledge spillovers in social enterprises [11]. By conducting elite interviews, they arrive at the conclusion that knowledge spillovers consist of three core elements – knowledge access, knowledge collection, and knowledge implementation. These elements lay the basis for their framework where social enterprises first access leaked entrepreneurial knowledge from their network, then

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