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Strategy and Innovation for the Production Systems of SME

David Jentsch, Ralph Riedel, Egon Mueller
Chemnitz University of Technology, Department of Factory Planning and Factory Management
D-09107 Chemnitz, Germany

Abstract

The purpose of the paper is to show how corporate strategy can be aligned with the production system of an enterprise to derive an operations strategy and how strategy shapes a framework for sustainable process innovation. The research methodology builds upon action research that is realized in a long-term and participatory approach with two joint manufacturing companies. Both can be classified as small and medium sized enterprises (SME). The preliminary findings underline the importance of a holistic view towards strategy integrating the four perspectives people, technology, organization, and surrounding. Due to the action oriented research design, the paper provides practical implications for strategy development and implementation in SME. Furthermore, it highlights the utilization of analytical as well as playful intervention methods, which are combined to enhance creativity and commitment of stakeholders. On the one hand, the originality of the paper may be attributed to the context of manufacturing SME since these enterprises are oftentimes characterized by a lack of strategic management. On the other hand, the joint consideration of operations strategy and innovation has not attracted much attention before.

Keywords
Small and medium sized enterprises, operations strategy, innovation, production system

1. Introduction
Small and medium sized enterprises (SME) have a major share in the European economy: They account for over 99% of all European companies, 67% of employment, and they are the almost exclusive source of a growing enterprise population [1, 2]. The characteristics of SMEs are regarded as significantly different from larger organizations [3] and may be attributed to limited resources, a fire-fighting mentality, informal strategies, owner centrism, as well as reliance on few customers [4, 5]. Consequently, these characteristics are reported to inhibit the long-term success of the enterprises and the implementation of innovation in SME [6-9]. It may be inferred from these practical challenges that there is a need for suitable models and intervention methods to utilize the limited resources of SMEs effectively in order to develop strategies and innovation plans enabling them to outperform competition due to superior operations [10].

The focus of this paper will be on manufacturing SME and primarily on their production system. This unit of analysis still lacks action oriented research [11] and a joint consideration of manufacturing operations strategy as well as process innovation [12]. The proposed intervention includes the development of corporate / business strategies as well as the formulation of functional strategies, i.e. the derivation of a long-term perspective for enterprise functions supporting the overall goals on a corporate level [13].

The remainder of the paper is structured as follows: First, we review selected theoretical concepts concerning production systems, their long-term perspective with the lens of manufacturing operations strategy and their improvements as innovation. Building upon the theoretical insights, the research methodology is outlined in chapter three. The fourth section provides a description of the empirical context for this study and selected results due to an intervention. We conclude with the discussion of the implications of our findings and the limitations of the research design.

2. Theoretical Background

2.1 Production Systems

The term production system tends to be used with different connotations [14]. However, there seems to be a consensus that production systems transform inputs into value added outputs and consist of the elements people, technology, and organization [15] that form the manufacturing system and the assembly system as major subsystems [16-18]. Recent publications [e.g. 19] showed that the term production system might be applied to a network of factories as well.

Consequently, it appears imperative to consider this system in the context of the entire enterprise and especially from a strategic perspective since more than 50 % of the capital of a manufacturing company is related to their production system [20].

2.2 Strategic Management and Manufacturing Operations Strategy

Teece defined strategic management as "[…] the major decisions and investments needed to achieve the goals of the enterprise […]. These decisions are the most complex and the most important facing the enterprise. Complexity enters not just because of interdependencies, but also because of uncertainty about customer reaction, competitor response, and market and technological change." [21]. In the light of this broad definition it becomes necessary to introduce a hierarchical view on enterprise strategy that helps to break the goals of the enterprise into manageable sub-goals for all enterprise functions that are pursued by functional strategies (e.g. research and development strategy, manufacturing strategy, etc.) [22].

As this paper's focus is on production it is noteworthy that the strategic importance of manufacturing was highlighted by Skinner in 1969 [23] already. Rooted in Skinner's line of thought scientific interest formed as manufacturing strategy respectively operations strategy. Strategy research is usually differentiated into *content* and *process* related questions [24]. This differentiation can be applied to manufacturing operations strategy as well.

Content research scrutinizes competitive priorities (quality, flexibility, cost, and delivery [25, 26]) and decision categories. Decision categories fall into the structural category that refers to process technology, capacity, facilities, and vertical integration [27] and infrastructural categories that cover human resources, organization, quality, production planning and control, new product development, and performance measurement systems [27]. Especially the competitive priorities had induced a heated debate over decades. On the one hand, proponents of the trade-off theory argued that a production system could not compete on every yardstick; hence it should select only one up to two priorities (e.g. cost) [28, 29]. On the other hand, the theory of cumulative capabilities [30] provided the notion that quality is the basis for any priority and further priorities always build upon a sufficient level of the lower level priority, which is often visualized with the sand cone image. Cost efficiency is according to the theory of cumulative capabilities the very last priority at the peak of the sand cone. However, both theories have received only limited empirical support (trade off: e.g. [31, 32] and sand cone: e.g. [33]) calling for a contingency oriented approach when dealing with competitive priorities.

Research on the *process* is concerned with the formulation and implementation of strategy [14]. Process research provides two major streams: the planning school and the learning school [34]. The planning school sees the process of defining a strategy in a central unit that collects all necessary information and creates strategic plans that are rolled out in the enterprise in a top down approach. Contrary to this view on strategy is the learning school that emphasizes learning and decentralized decision making, which forms a specific pattern of decisions known as emergent strategy [35]. Recent research has shown that both schools of thought co-exist in successful enterprises and that they can complement each other [36]. Nonetheless, research on the process of manufacturing operations strategy is still lacking behind the content research [11, 12].

2.3 Innovation

Innovation is an important driver of business growth and it is decisive for sustainable success as well as competitiveness [37]. Simply defined, innovation is the adoption of a novelty in an organization, which is intended to improve efficiency or effectiveness [38]. Innovation can be applied to products or processes in a radical or incremental manner [38] and despite the long tradition of the term innovation (Schumpeter coined the "new combinations" in 1934 already) there is a remarkable subjective perception of innovation in the industry [6].

Investigations of the linkages between innovation and strategy seem rather sparse in the literature. Utterback and Abernathy [39] suggested in 1975 a model that promotes process innovation to arrive at a production system that is suitable for mass production. This takes place while the product innovation becomes mature and the competitive priority shifts to cost. However, the development of a production system may not be as foreseeable as in the seventies anymore. This raises the question how innovation can be stimulated while ensuring that limited resources are spent on the most important aspects, i.e. on strategically important areas. Some prior findings suggest that strategic analysis of a company may trigger innovation [40]. Inherent to this idea is that the results of a strategic analysis direct into a future state requiring change in a present system. Consequently, the realized changes are reframed as innovation. However, this concept falls short to acknowledge that innovation may be triggered in a different manner as well.

2.4 Research Questions

The main research question that shall be addressed in this paper is: How are strategy and innovation linked in a production system? This question should be traced by concrete incidents in a real life setting since production systems have a complex nature that do not allow for immediate answers since most interventions have side-effects that are not easy to be foreseen.

3. Methodology

Based on [41] the proposed research question calls for a joint systems and actors approach. The production system provides a systemic view that needs to be considered as a subsystem of the enterprise. Additionally, the specific characteristics of SME and the individual views on innovation require the consideration of the actors in the research process. Based on these requirements, action research provides a suitable research method [42]. The action research process follows the steps *data gathering and analysis -> action planning and implementation -> evaluation* in a recurrent and circular manner [43].

The first step of our intervention is the analysis of the enterprise (including all enterprise functions and processes) and its' surrounding (markets, customers, suppliers, competitors, and cooperation partners) as a mean of data gathering and analysis. Although a general framework for the analysis of the enterprise can be seen in the St. Gallen Management model [44], aspects of manufacturing operations strategy and innovation are covered as well. The enterprise analysis is realized in structured workshops with participation of various stakeholders from different corporate functions in order to access a wide spectrum of knowledge [45]. Building upon the results of the enterprise analysis, the enterprise strategy is formulated and innovation plans are derived, which are utilized to implement the strategy. The final step addresses an impact analysis of the intervention and its refinement.

The workshops for enterprise analysis are structured by worksheets that are filled with key insights during the workshop. Since this task is done simultaneously during the discussions in the workshop, all participants have to agree on what is written down. This is meant to limit ambiguous results in the workshops, where heated discussion may be expected. Furthermore, all workshops are audio recorded for follow up analysis and the results are fed back to the participants by means of a concluding presentation and a written report.

4. Research Cases

4.1 General Description

The context of the research cases is two enterprises (A and B) in the mechanical engineering industry, which are located in the same town in eastern Germany. Both companies have the same owner since 2009 and grew significantly during the last two years. Due to the ownership situation since 2009, both enterprises are supposed to synchronize their processes in order to act internally as one enterprise. However, the merger was not meant to resolve the two companies as entities. Together the enterprises have 65 employees in total. Most administrative tasks are realized by 15 people responsible for both companies. The remainder 50 people work in production. Production takes place at two sites that are a few hundred meters separated from each other. Company A has a strong tradition in providing maintenance service for drive technology in the heavy industry and for power generation. Company B has its roots in mechanical parts production. Hence, the companies' production system comprises a manufacturing system and an assembly system.

4.2 Data Gathering and Analysis

The data gathering and analysis phase was started in August 2010. Until October six half day workshops were realized in order to cover all topics for the analysis. Depending on the workshop topics, the participants were recruited from production, purchase and the controlling functions. The operations manager, who is also the deputy of the owner, participated in every workshop. The owner joined for two workshops. Documents as well as excerpts from the company's ERP-system were analyzed in addition to the workshop discussions.

Table 1 provides the findings for the as-is situation concerning the manufacturing operations strategy. It should be noted that the company did not have an explicit strategy (neither on the corporate level nor for enterprise functions) when the intervention started. Most strategies were implicit in the owner's and operation manager's mind and had not been discussed explicitly before.

Table 1: As-is situation for the manufacturing operations strategy

Manufacturing Operations Strategy Content		Finding
Competitive priority		Emphasis on low cost and flexibility to serve especially customer's non-standard demands
Structural decision category	Process technology	Machinery: Mainly general purpose machines with great differences in precision and level of automation Information Technology: Ramp-up of a new ERP-System, Investments in CAD software and new computers
	Capacity	Capacity chases demand, flexibility due to night shifts and an extensive network of cooperation partners
	Facilities	Two historic buildings and one new building for assembly, historically evolved layout with complex routings
	Vertical integration	Limited possibility to expand own value added due to technological restrictions
Infrastructural decision category	Human resources	Dichotomous workforce: highly experienced workers (close to their retirement) and novices, only few people in between
	Organization	flat hierarchies, communication problems at interfaces (especially between the two enterprises)
	Quality	ISO certified, high efforts to fight quality problems necessary, old technology requires very experienced workers to meet the quality requirements
	Production planning and control	Aggregate planning against infinite capacities, significant efforts necessary for coordination on the operational level
	New product development	Installation of a design department just started, fire-fighting at the design-production interface
	Performance measurement systems	almost no quantitative feedback from operations, performance evaluation based on gut feel

The results of the data gathering and analysis phase were discussed with the operations manager and the owner during a presentation in November 2010. This discussion yielded the definition of enterprise goals and a corporate strategy. Enterprise goals are directed towards growth: The turnover is expected to increase by 70% in the next 3 years, the profit share shall double, and the capital ratio is to improve by 5%. The general strategy to achieve these goals has two elements. The first element pertains to establish further the enterprise in a specific niche market of drive technologies. This builds upon an expansion in the service sector and the development of own products (respectively engineering to order). The second element of the strategy addresses operations directly. Operations are supposed to mature in a manner enabling the desired growth, i.e. processes and products need to achieve a higher quality and reliability.

4.3 Action Planning and Implementation

The action planning and implementation stage is currently in progress and may not be reported in detail here. Nevertheless, action planning is now significantly influenced by the competitive priority on quality since an insufficient level of quality causes turbulences within the production system (rework, scrap, etc.) and negative customer feedback. Both issues were raised during the previous intervention phase. Therefore, the priority on quality provides a reference for all planned and emergent improvement activities notwithstanding if improvements are incremental or radical.

One major improvement was initiated in the infrastructural category already. In order to advance communication along the interfaces (cf. Table 1, category organization) the operations manager agreed to run a workshop based on LEGO® SERIOUS PLAY™ (LSP), which was facilitated by one of the authors of this paper. LSP is an open source method that utilizes LEGO bricks to build metaphorical representations that are linked to personal and shared stories on specific question in a business or operations context [46]. The question of our intervention was to develop a shared identity of the enterprise. This shared identity builds on the personal views of nine participants that were recruited from the administrative level of both enterprises (operations manager, production planning, design, purchasing, finance, and supervisors). The LSP-workshop took a whole Saturday and was voluntary. It was for a surprisingly high portion of participants the first time to reflect collectively on their work in the companies in a deliberate manner. Using LEGO bricks as a tool was a novel approach for all participants. Figure 1 gives an impression of the workshop results. For instance, the numerous tubes indicate the manifold connections that all functions have despite some people belong to different enterprises.

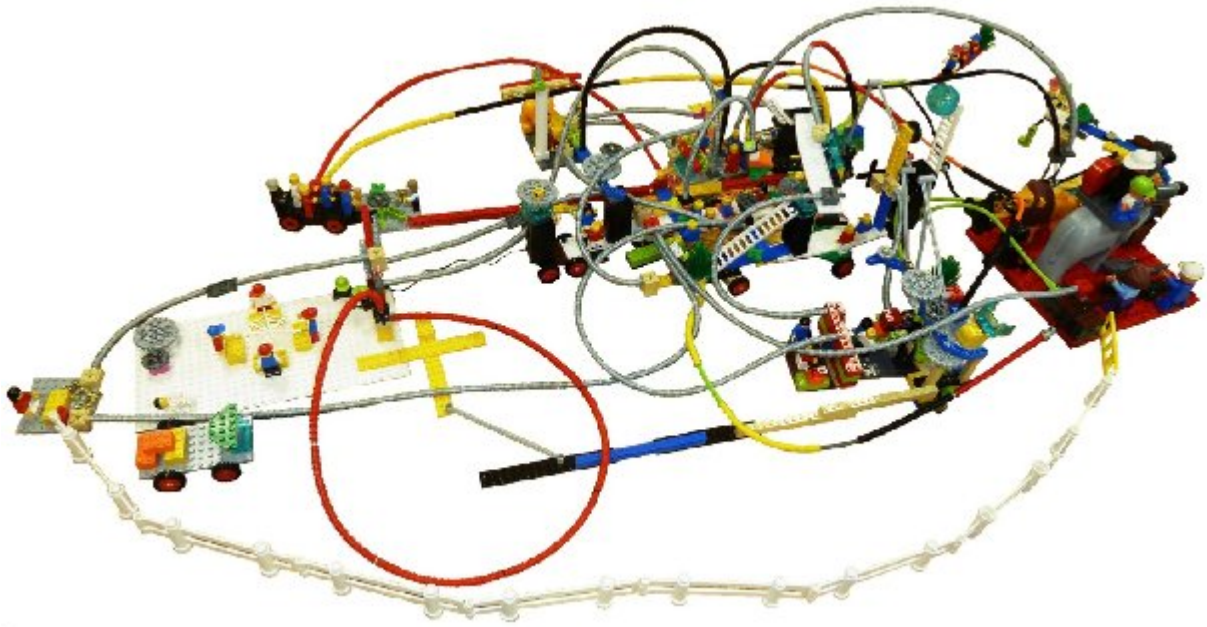

Figure 1: Shared identity of enterprise A and B

Intended with the workshop design, several prejudices related to the other enterprise and communication problems were surfaced. However, the requirement to arrive at a shared model induced a compromising atmosphere that allowed for balanced problem solutions. The intervention raised also several strategic issues (e.g. “Is parts manufacturing or service more important?”). Due to his continuous participation during the stage on enterprise analysis, the operations manager was able to answer such question in a coherent manner and share the enterprise strategy in this way. However, even seemingly simple problems like the unbalanced number of holidays in enterprise A and B were raised during the workshop. This difference was not on the agenda of the operations manager, but more frontline oriented participants saw an important signal in equalizing the amount of holidays in order to lower barriers between both enterprises. Since this suggestion was consistent with the operations strategy to integrate both enterprises more closely, the suggestion was implemented shortly after the workshop.

5. Conclusion and Outlook

The article set out to establish a connection between manufacturing operation strategy and innovation in the context of SME. As a result of the literature review, the main topics of operations strategy were identified based on the results of content research. The specific process of action research guided the intervention in the empirical context and yielded a strategic analysis for the enterprises. Therefore, the current situation of the production system requires various innovations in order to achieve the enterprise goals. Furthermore, a playful intervention was presented that was utilized to improve communication as a mean of strategy implementation. A small example from the workshop illustrated a feedback reaction that triggered further innovation. Figure 2 attempts to conceptualize the observed relationships between strategy and innovation.

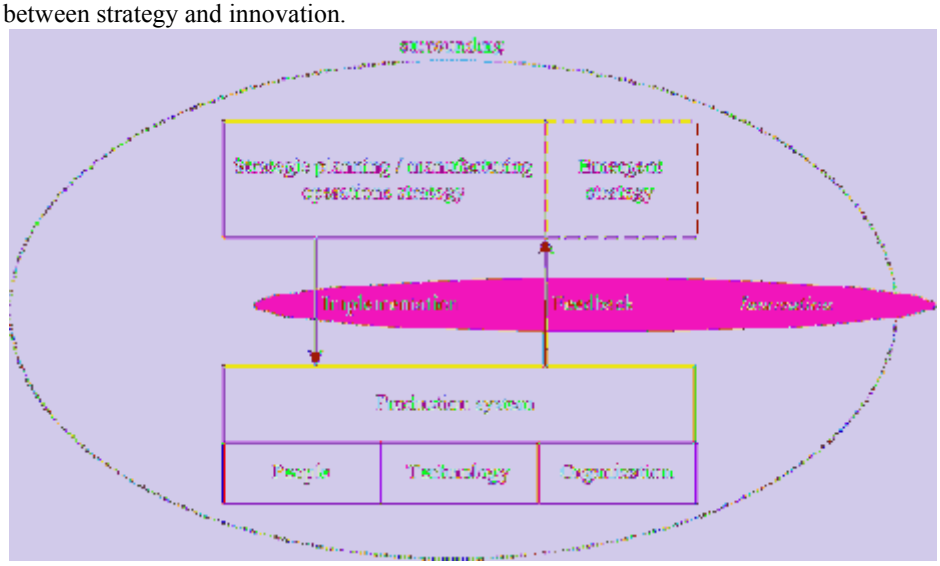

Figure 2: Relations of Strategy and Innovation

Figure 2 shows that strategic planning and the development of a manufacturing operations strategy induces innovation in a production system due to its implementation. That means that the production system (or parts of it) are not in a state supporting the strategy and need to be adjusted to meet the desired state. On the other hand and probably due to the nature of a complex system, the strategy implementation or other events trigger feedback reactions from the production system that might feed strategic planning (e.g. reconsidering the resource base) or that add to a pattern of decisions as emergent strategy. Therefore, innovations may occur also due to feedback reactions as they have a potential for improvement as well. However, these reactions may not be desirable in terms of the prevailing strategy and may not be implemented in the production system as an innovation.

Major limitations of the presented findings pertain to the missing evaluation of implemented actions. Hence, it is still a pending task to measure the impact of the intervention and to close the research cycle. Furthermore, a replication of the research process in a different context should pertain to external validity of the findings.

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