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# Why and How to Implement Strategic Competence Management in Manufacturing SMEs?

Djerdj Horvat<sup>a\*</sup>, Cornelius Moll<sup>a</sup>, Nadia Weidner<sup>a</sup>

<sup>a</sup>*Fraunhofer Institute for Systems and Innovation Research ISI, Breslauer Strasse 48, 76139 Karlsruhe, Germany*

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## Abstract

To become and remain competitive, manufacturing companies need to be highly flexible and offer a high quality/price ratio. One of the crucial prerequisites for achieving this goal is the adoption and effective usage of advanced technologies in manufacturing processes. This calls for strategic competence management, which characterizes the company's capability to adjust organizational and employees' competences to new requirements. However, only very few German small and medium-sized enterprises (SMEs) in the manufacturing sector currently use systematic and strategic competence management in their processes. Our paper addresses this issue by providing empirical evidence on the awareness and current usage of strategic competence management tools in German manufacturing SMEs based on recent data from the German Manufacturing Survey, which is conducted by the Fraunhofer Institute for Systems and Innovation Research ISI. Following this, we introduce a conceptual, process-based approach for managing competencies in manufacturing SMEs strategically and systematically. This approach was developed and tested over the course of a three-year research project. In addition, we present a case study of a company that successfully implemented this approach.

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\* Corresponding author. Tel.: +0-000-000-0000 ; fax: +0-000-000-0000 .

E-mail address: [djerdj.horvat@isi.fraunhofer.de](mailto:djerdj.horvat@isi.fraunhofer.de)

## 1. Introduction

The competitive environment of manufacturing companies is characterized by rapid changes. Small and medium-sized enterprises (SMEs) in the manufacturing sector are facing challenges like individualized customer requirements, digital transformation, new technologies with partly disruptive potential (e.g. 3D printing), competition intensification due to new players (especially from Asia), demographic changes, and the lack of skilled labor. Due to the scarcity of financial and personnel resources, it is much harder for SMEs to deal with these challenges than it is for large companies. The competitiveness of manufacturing SMEs depends mainly on their ability to adapt quickly to such dynamics. One of the main prerequisites is their ability to manage effectively employees' competences [1,2]. The current demographic changes and the increasing shortage of skilled workers mean that it is decisive for these companies to succeed in preparing their production employees to meet the changing competence requirements with suitable concepts of qualification and competence development, and thus to preserve, develop and use their experience and knowledge more intensively [3,4].

Managing employees' competences is particularly an issue for those SMEs that base their adaptability to environmental dynamics mainly on technological process innovations. These companies tend to spend less on research and development (R&D) activities (less than 2.5% of turnover) and are thus commonly known as non-R&D-intensive firms (or firms with low R&D-intensity) [5]. They represent an important group of manufacturing SMEs in Germany, account for more than 40 percent of value creation and employ about 50 percent of the total workforce [5]. Despite their lower R&D expenditure, they are present not only in low-tech but also in medium-tech and high-tech sectors [6]. Quality assurance and process flexibility combined with resource efficiency are their main factors of competitiveness and thus their core competences [7]. As these competences are closely related to the tacit process knowledge of individual employees in production, effectively managing them requires a special approach.

Competence management must consider the interests of all involved stakeholders and be supported by a broad range of people in the company in the sense of organizational anchoring [4]. As our previous studies showed, in contrast to larger manufacturing companies, many manufacturing SMEs have neither institutionalized structures for innovation processes nor systematic human resource and competence development [8,9]. Both strategic tasks often fall within the responsibility of upper management, where they are mostly neglected due to the pressure of day-to-day business operations. The lack of systematic and professional competence management hinders the sustainable identification and exploitation of the competences and skills relevant to innovation. Here, the organizational integration of a systematic, strategic competence management approach could help SMEs to integrate suitable routines in their strategic planning processes and thus to implement a permanent and transparent, strategically targeted competence development, in order to be faster and better prepared for changes in the environment.

Against this background, we investigated how intensively German manufacturing SMEs are currently implementing strategic competence management. Moreover, we conceptualized a practical approach as a guideline for how to organize competence management activities systematically and in line with company strategy. This research was conducted as part of a three-year project "StraKosphere", which was funded by the German Ministry of Education and Research [9].

After a short introduction to the conceptual foundation of strategic competence management, we present selected main results of our quantitative research on the awareness and usage of strategic competence management in German manufacturing SMEs. Secondly, we introduce our process-based strategic competence management approach and describe its elements. Finally, we present an example of its successful implementation in a manufacturing company.

## 2. Theoretical foundation of strategic competence management

In times of rapid technological change and dynamic competitive environments, a company's ability to develop and adapt its resource base plays a crucial role in its success [10]. Empirical studies show that the intangible and non-transferable or copyable components of the resource base, such as the knowledge of employees acquired over many years, contribute to a company's competitive advantage to a larger extent than transferable and tangible physical resources, such as equipment [1,2,11,12]. Companies build up intangible resources over a long time with company-specific (learning) processes that reduce its imitability and increase heterogeneity.

Intangible resources are often considered together with competences in both literature and practice. The term "competence" refers to the learnable abilities of an employee or an organization to combine and exploit other resources in a purposeful manner and to carry out certain tasks independently [13]. Tangible resources (e.g. machines, technical solutions) alone are practically useless in this context. A company can only achieve sustainable competitive advantages when it has "competent" personnel able to use the technical equipment properly. Moreover, a company can only achieve strategic goals [2,13], such as high flexibility, reliable delivery or short product development cycles based on an accurate **configuration of its individual employees' competences** and skills. However, to address changing requirements and remain competitive on the market, companies should not rely on existing competences, but actively adapt to those changing requirements [1]. In other words, they should implement a **dynamic competence management approach** [14,15]

The **competence requirements are derived from the company's strategy**. These requirements serve as the starting point for central human resource management processes (operational competence management) such as recruitment, evaluation, development and training, leadership, succession and career planning for employees [4]. While the requirements are derived "top-down" from the strategy in strategic competence management, operational competence management concentrates on a "bottom-up" implementation of those requirements by managing individual employees' competences [9].

So far, these two levels of competence management, the **strategic top-down** and the **operational bottom-up**, have been discussed mostly separately in the literature [9]. We argue, however, that in order to be able to deal with new challenges arising from a dynamic market environment or technological innovation, the strategic and operational perspectives of competence management should be interlinked more closely and regarded as complementary management levels within a company [3,4,16]. Therefore, we argue that implementing a **strategic competence management approach** in a manufacturing company needs to deal with both strategic requirements and operational applicability. It should ensure effective usage of existing competences on the one hand, and the promotion and development of competences in line with the company's formulated strategic objectives on the other hand. It can be understood as a proactive and strategy-oriented systematic change management approach, which ensures successful adaptation to technological, economic and social developments and therefore contributes significantly to the company's competitiveness.

### 3. Awareness and usage of strategic competence management in German manufacturing SMEs

Given the importance of strategic competence management in ensuring innovativeness and flexibility, and thus the competitiveness of manufacturing SMEs, we analyzed its current implementation in SMEs of the German manufacturing industry [6]. To analyze and compare the situation in both R&D-intensive and non-R&D-intensive SMEs, we addressed the current relevance and usage of strategic competence management in both groups of manufacturing companies.

The analysis is based on data from the German Manufacturing Survey. This survey is conducted by the Fraunhofer Institute for Systems and Innovation Research ISI and is a regular, questionnaire-based postal survey addressing firms with 20 or more employees from all manufacturing sectors. The 8-page questionnaire includes questions concerning the implementation of innovative manufacturing technologies, organizational innovations, cooperation, relocation, performance indicators, products and services, as well as general company information.

#### *Relevance of strategic competence management for manufacturing SMEs*

As table 1 shows, there are fixed responsibilities for competence development and the qualification of production staff in 63 % of non-R&D-intensive and in 71 % of R&D-intensive SMEs. These high shares of clear responsibility regarding competence development and the qualification of production staff among all the companies analyzed indicate the high awareness of manufacturing SMEs for these areas. From a financial perspective, however, our results reveal that less than a quarter of non-R&D-intensive SMEs with fixed responsibilities have a fixed, annual budget for competence development and qualification. This share is not substantially higher for R&D-intensive SMEs (34 %). This figure is low for both types of manufacturing SMEs, and shows a significant gap between organizational and financial integration.

This gap raises the question of whether German manufacturing SMEs are paying sufficient attention to competence development and qualification, considering its potential to ensure competitiveness. Defining a fixed responsibility for competence development is a good first step, but without allocating a fixed annual budget to this role, it is difficult to implement qualification measures or programs. The low availability of a fixed budget for competence development and qualification may indicate insufficient appreciation and underestimation of its strategic relevance.

In order to achieve widespread diffusion, it must be easy and cost-effective for non-R&D-intensive as well as R&D-intensive SMEs to implement competence management, even by employees without a human resource management background. Furthermore, its value has to be communicated more distinctly, so that fixed budgets are made available.

Table 1. Responsibilities and budgets for competence development and qualification of production staff

|                                                                                      | non-R&D-intensive SMEs | R&D-intensive SMEs |
|--------------------------------------------------------------------------------------|------------------------|--------------------|
| a fixed responsibility for competence development and qualification of employees (*) | 63%                    | 71%                |
| fixed, annual budget associated with the fixed responsibility (*)                    | 23%                    | 34%                |

Source: *German Manufacturing Survey 2015*, Fraunhofer ISI; own calculations

\* = Significant differences between non-R&D- and R&D-intensive SMEs at the .05 level

### *Current state of the implementation of strategic competence management in manufacturing SMEs*

For competence management to be considered strategic, three groups of activities have to be implemented and combined in manufacturing SMEs [9]. First, following the strategic top-down approach, the fundamental activity is to **deduce individual competence requirements from the company's strategic objectives**. Following the operational bottom-up approach, the second activity is the subsequent **mapping of existing competences among the employees**. **Identifying and closing any gaps between the required and the existing competences** is the third activity. The gaps can be closed with the help of qualification measures. If none of these activities are performed or if only competences are mapped or only competence development measures are carried out, this does not represent a systematic approach in the sense of the three step procedure described above. Defining requirement profiles on its own, in combination with the mapping of employee competences or in combination with competence development measures can be regarded as initial systematic approaches and as a partial implementation.

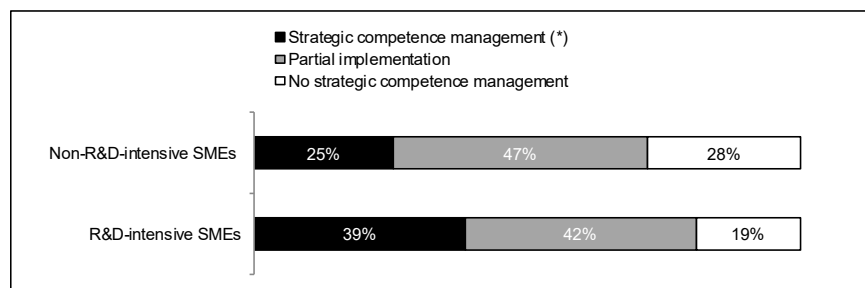


Figure 1. Strategic competence management in SMEs

Source: *German Manufacturing Survey 2015*, Fraunhofer ISI; own calculations

\* = Significant differences between non-R&D- and R&D-intensive SMEs at the .05 level

Figure 1 depicts the current implementation of these activities in SMEs. The results show that non-R&D-intensive SMEs implement strategic competence management much less frequently than R&D-intensive SMEs. Only a quarter of non-R&D-intensive SMEs but almost 40% of R&D-intensive SMEs carry out all three groups of activities, i.e. have adopted a strategic competence management approach. Furthermore, almost half of all non-

R&D-intensive SMEs have partially implemented strategic competence management. This indicates that the majority of non-R&D-intensive SMEs do not deal with competence management strategically, which coincides with findings from the previous subchapter, but tend to implement unstructured individual activities. More than a quarter of non-R&D-intensive SMEs are not active in strategic competence management at all.

Moreover, our previous in-depth analyses using the same data set showed that smaller companies are less likely to implement strategic competence management activities and that non-R&D-intensive SMEs tend to be smaller than R&D-intensive SMEs [6]. Thus, economies of scale can be observed regarding the implementation of strategic competence management. Similarly, SMEs with an increasing number of semi-skilled and unskilled employees are less likely to use strategic competence management. One reason for this might be that existing competence management solutions and instruments in the form of software tools or organizational development programs are too complex and expensive, and thus not suitable for non-R&D-intensive SMEs. There may be a lack of practicable solutions for non-R&D-intensive SMEs. Another reason might be perception; non-R&D-intensive SMEs are perhaps simply not aware of the opportunities provided by strategic competence management for these groups of employees. Our analysis shows that only half of all SMEs implement the respective measures for semi-skilled and unskilled workers. Despite their important role and high proportion in the workforce, these employees are neglected in terms of strategic competence management, especially in non-R&D-intensive SMEs. In contrast, almost all SMEs address technicians when implementing any of the above-mentioned activities. Apparently, adequate methods and programs exist for this target group and their significance for productivity is recognized by non-R&D-intensive SMEs as well.

#### *Currently implemented qualification measures in manufacturing SMEs*

Comparing the implementation of qualification measures in non-R&D-intensive SMEs with R&D-intensive SMEs reveals some differences. What stands out in figure 2 is the higher percentage of R&D-intensive SMEs implementing qualification measures.

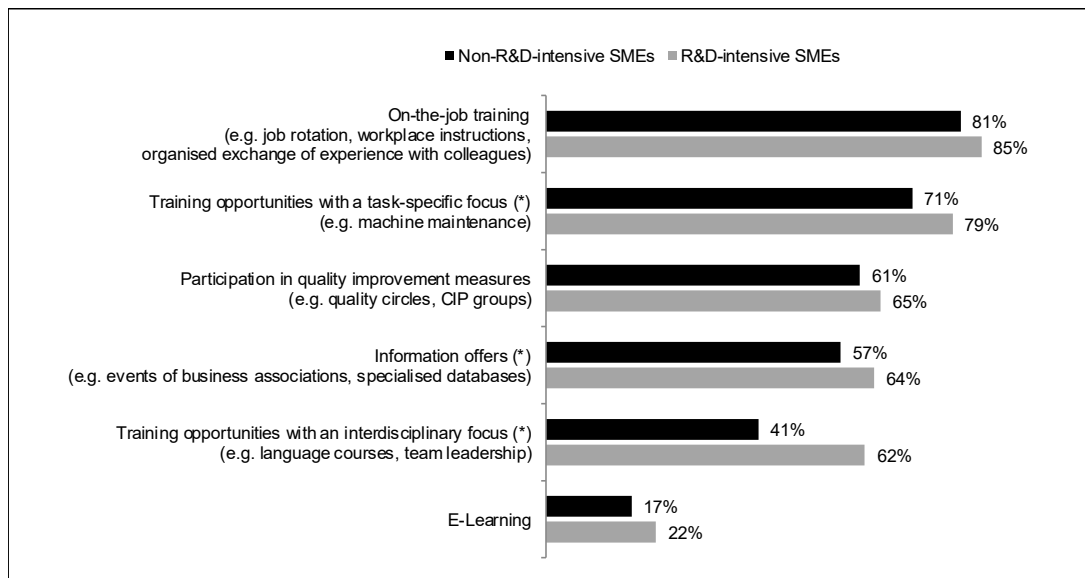


Figure 2. Training and qualification measures in SMEs

Source: *German Manufacturing Survey 2015*, Fraunhofer ISI; own calculations

\* = Significant differences between non-R&D- and R&D-intensive SMEs at the .05 level

Since non-R&D-intensive SMEs are less active in strategic competence development, this could be expected. Further, the implementation of qualification measures in non-R&D-intensive SMEs is significantly lower than in R&D-intensive SMEs for task-specific and interdisciplinary training opportunities as well as for information offers.

The figure also shows that formalized qualification measures are less widespread than on-the-job training. Finally, on-the-job training as well as quality improvement measures are more closely linked to tasks and processes, where non-R&D-intensive SMEs probably expect more specific benefits in contrast to interdisciplinary training and information offers, which foster social, self or learning competences that might only induce indirect benefits.

Finally, the figure shows that less formalized measures, such as on-the-job trainings and quality improvements measures seem to be more widespread than formalized measures. Apparently, SMEs expect more specific benefits from the measures that are more closely linked to tasks and processes in contrast to interdisciplinary training and information offers, which foster social, self or learning competences that might only induce indirect benefits.

#### 4. Development of a dynamic and systematic approach for strategic competence management

Based on the conceptual and empirical foundations described above, we developed a dynamic, **process-based strategic competence management approach** (SCMA) for manufacturing SMEs (see figure 3) [9]. This consists of two process dimensions: a strategic and an operational level. Practically, both dimensions of the SCMA should be considered iterative processes comprising various consecutive and repetitive activities (see figure 3).

The upper, strategic level focuses on the management of the company's organizational competences, often referred to as core competences in the literature. As explained in Chapter 2, these are based on tangible as well as intangible or knowledge-based resources, and play an essential role for the competitive advantage of a company.

The strategic process begins by analyzing **market and technological trends** in order to formulate the company's **short- and long-term strategic objectives**. As realizing these strategic objectives usually causes various **internal organization-, process- and work-related changes**, this may require new or adjusted competences. Therefore, in this phase, the company's management defines future **targets or required competences** derived from the company's strategy. This process should take place systematically and periodically (annually or semi-annually). In terms of participants, it should involve not only the company's upper management, but also the operational level including human resources as well as the team leaders from the relevant departments, e.g. production, engineering, sales, logistics etc. Methodologically, it should follow an accurate, valid and comprehensive approach as a part of regular strategy meetings. In order to characterize the necessary internal changes and the company's competence requirements, the derived and discussed objectives can be categorized into clearly defined managerial fields like employees, organization, management, networking, political environment, market, and technological innovations etc. This makes it easier to prioritize them and to characterize the company's internal changes.

The process conducted on the strategic level results in **competence requirements or competence target profiles**. These requirements form the interface between the organizational and the individual dimensions and function as both the output of the strategic level and the input to the operational level of the process. They play a central role in our approach to strategic competence management. Derived from the company's strategy, the competence requirements serve as the basis for human resource management to evaluate the existing competences and **identify competence gaps** among employees. There are various practical and easy to implement instruments that can be used here, e.g. competence matrix or the competence management table [9]. Once the team has identified the competence gaps, they **select and implement competence development measures** to close them, e.g. company-internal or external courses, coaching and mentoring, practical training etc. The final phase of the process is the **evaluation of the success achieved with the competence development** process using a benchmarking approach. The achieved results are compared with the previously defined competence requirements. The evaluation process should therefore involve members of the team, which defined the strategic competence requirements as well as human resource management and team leaders (operational level). The process can be repeated if necessary.

The dynamic nature of the SCMA refers to the iterativeness of the whole process at both levels. On the one hand, competence requirements have to be revised regularly in line with the company's strategic objectives, with the aim of keeping abreast with the environmental dynamics that determine competitiveness. On the other hand, it has to be checked regularly whether the existing competences match the competence requirements, with the aim of keeping the labor force "fit" and able to realize the strategic objectives. If the company does not repeat the process regularly,

it may fail to adapt quickly enough to significant environmental dynamics and thus fall into a "competency trap" with negative consequences for its innovativeness and ultimately its success.

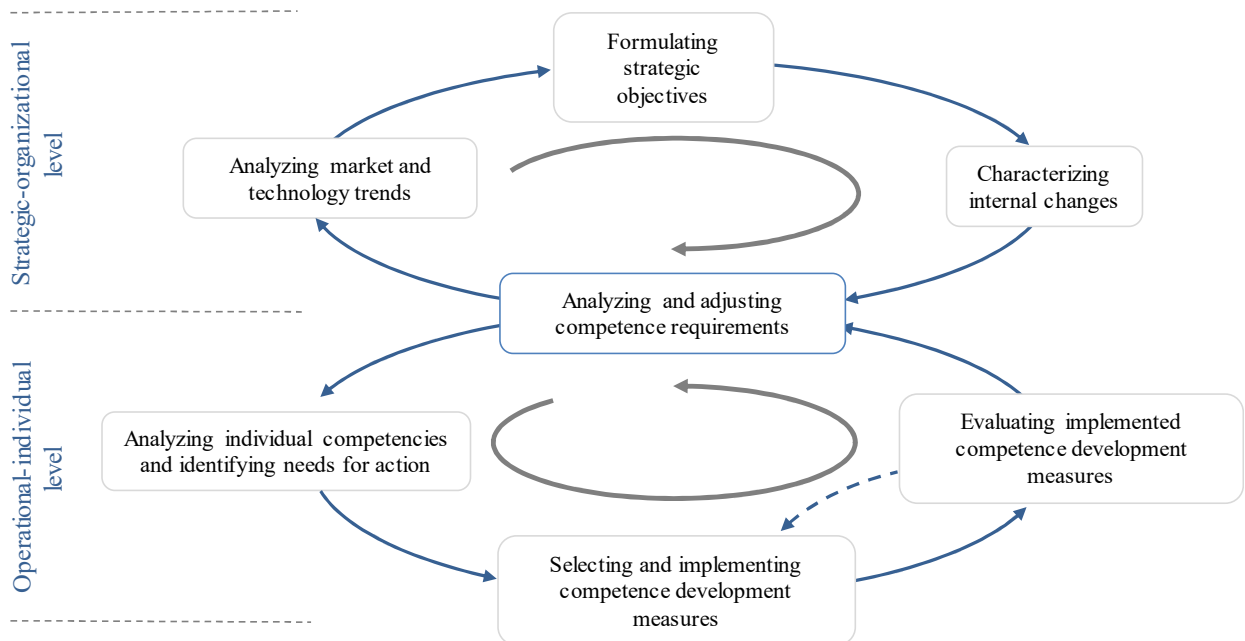


Figure 3: Dynamic process-based SCMA (own representation)

## 5. Success story of implementing the SCMA

To illustrate the successful implementation of our SCMA (see figure 3), we present the summary of a case study of a German SME from the metal and plastic processing industry, which was an industrial partner in a three-year research project funded by the German Ministry of Education and Research. The company produces metal and plastic parts for the mechanical engineering, automotive and aircraft industries. Its expertise is in processing metal using CNC machinery and plastic using injection molding. In the project, we demonstrated the practical implementation of our approach along all the process phases from strategy development and deriving competence requirements to analyzing and developing competences of individual employees as well as evaluating the results of implemented measures. Over the whole process, we worked with a selected team of employees representing different functional areas (management, human resources, production, construction, logistics, sales and marketing). Environmental dynamics such as the cyclical demand for products, new customer requirements and new production technologies, as well as internal changes like demographic developments and employee turnover are only some of the challenges significantly influencing the company's work. Addressing these challenges in a first workshop with the company's team, production flexibility was defined as one of the most important company objectives. The way to achieve greater flexibility, according to the workshop team, was a better merging of the two main production departments, injection molding (plastic) and CNC precision production (metal). In a second workshop, we characterized all the organizational, workplace-relevant and technical changes that this would trigger. The team then defined the competences required to implement the defined objectives. For example, one of the key changes defined was the need for employees who could be deployed flexibly in either department. In terms of organizational competences, this requires greater company adaptability to internal and external changes. Among other things, this requires employees with different individual competences in terms of applying digital technologies, knowledge of both metal and plastic processing etc.

In the second phase, the team selected employees who are willing and able to work in both departments. Based on an in-depth analysis of their competences and skills using the competence management table as a tool as well as discussions with their supervisors, the team defined and described in detail the competence gaps that had to be filled in order to deploy them flexibly in both departments. Subsequently, human resource management defined internal and external measures to develop the required competences and drew up individual plans with clear time schedules and milestones. For instance, all the selected employees from the molding department had to attend special external courses for metal processing using CNC machines. Furthermore, they conducted internal practical training with experienced colleagues. Finally, they took an exam which demonstrated their theoretical knowledge as well as their competence in working in both departments. Only those employees who passed the exam received a license and were promoted to a so-called "flexi team group". Other candidates were given the opportunity to take additional courses and repeat the exam.

In addition to the example presented, we demonstrated and tested our approach in three additional manufacturing companies as part of the same project [9]. Its successful implementation in different contexts and organizational settings demonstrates its validity and wide applicability.

## 6. Conclusions

There is no doubt that competence management plays a crucial role for manufacturing SMEs achieving and maintaining competitiveness in a turbulent competitive environment. However, our analyses based on recent data from the German Manufacturing Survey show that, despite manufacturing SMEs' high awareness of strategic competence management, only a few of them are using it fully and actively in their strategic processes. The results are even worse when we distinguish SMEs using R&D-intensity. Considering that the competitiveness of non-R&D-intensive manufacturing firms is based mainly on production process innovations as well as their flexibility and adaptability, it is essential that these firms employ strategic competence management. However, our empirical results clearly show that they still underestimate the importance of a strategic approach to competence development and management. We therefore conclude that manufacturing SMEs need practical and easy to implement approaches to organize their competence management activities more effectively.

To address this need, we developed a process-based strategic competence management approach (SCMA) for manufacturing SMEs. Conceptually, the approach merges two levels or dimensions of competence management: strategic-organizational and operational-individual. While the strategic level tackles the dynamic process of defining and adjusting competence requirements based on the company's strategic objectives, the operational level deals with the process of managing individual employees' competences based on previously defined competence requirements. Companies can improve their effectiveness in managing competences and thus become more agile in responding to change only by closely interlinking the strategic and operational processes.

Although we defined the main process phases of both levels or dimensions of the SCMA, the companies themselves have to decide how to implement them based on their own organizational characteristics, e.g. organization of work, hierarchies, responsibilities, standards, formalization etc. It is up to them which activities and instruments they select for the defined process phases, and this depends on each company's own internal requirements. Hence, our conceptual approach should be considered as a guideline for how to better organize competence management activities in line with the strategy process in manufacturing SMEs and not as a general tool for achieving competitiveness.

In future research, it would be interesting to test and analyze the implementation of the SCMA in different company settings and to investigate its effects on innovativeness and competitiveness. Additional success stories could help managers decide how to implement it in their own company context. Moreover, testing it in different organizational settings would shed more light on various antecedents and prerequisites for its implementation and contribute to the organizational literature.

## References

- [1] D. Horvat, C. Dreher, O. Som, How firms absorb external knowledge - modelling and managing the absorptive capacity process, *International Journal of Innovation Management*;23(1) (2019) 1950041–1950076.
- [2] D. Horvat, O. Som, Wettbewerbsvorteile durch informationsbasierten Wissensvorsprung. In: *Industrie 4.0 für die Praxis*. Springer; (2018) 185–200.
- [3] K. North, K. Reinhardt, B. Sieber-Suter, *Kompetenzmanagement in der Praxis: Mitarbeiterkompetenzen systematisch identifizieren, nutzen und entwickeln*. Mit vielen Praxisbeispielen. Springer-Verlag; (2018).
- [4] W. Sauter, F.-P. Staudt, *Strategisches Kompetenzmanagement 20: Potenziale nutzen - Performance steigern*. 1st ed. Wiesbaden: Gabler; (2016).
- [5] O. Som, Innovation without R&D: Heterogeneous innovation patterns of non-R&D-performing firms in the German manufacturing industry. *Springer Science & Business Media*; (2012).
- [6] C. Moll, N. Weidner, *Strategisches Kompetenzmanagement in nicht-forschungsintensiven KMU*. In: D. Horvat et al. (Eds) *Gestaltung eines strategischen Kompetenzmanagements: Lösungsansätze und Instrumente für nicht-forschungsintensive, kleine und mittelständische Unternehmen* (2018) 9–28.
- [7] H. Hirsch-Kreinsen, „Lowtech“. *Innovationsmuster und Entwicklungschancen*. In: *Lowtech-Unternehmen am Hightech-Standort* (2007) 253–280.
- [8] T. Jackwerth, A. Jäger, S. Güth, *Fähigkeiten und Kompetenzen gezielt ausbauen: Strategische Kompetenzentwicklung für die Produktion, Mitteilungen aus der ISI-Erhebung" Modernisierung der Produktion"*, (No. 73.) (2018).
- [9] D. Horvat, N. Schaper, J. Decius, A. Virgillito (eds.), *Gestaltung eines strategischen Kompetenzmanagements: Lösungsansätze und Instrumente für nicht-forschungsintensive, kleine und mittelständische Unternehmen*. Stuttgart: Fraunhofer Verlag; (2018).
- [10] J. B Barney, D. J Ketchen Jr, M. Wright, The future of resource-based theory: Revitalization or decline?, *Journal of management*;37(5) (2011) 1299–1315.
- [11] H. Takeuchi, Knowledge-based view of strategy, *Universia Business Review*, (40) (2013) 68–79.
- [12] D. M Decarolis, D. L Deeds, The impact of stocks and flows of organizational knowledge on firm performance: an empirical investigation of the biotechnology industry, *Strategic Management Journal*, 1999, Vol.20;20 (1999) 953–968.
- [13] K. Reinhardt, K. North, Transparency and Transfer of Individual Competencies - A Concept of Integrative Competence Management, *J. UCS*;9(12) (2003) 1372–1380.
- [14] D. J Teece, G. Pisano, A. Shuen, Dynamic capabilities and strategic management, *Strategic management journal*;18 (1997) 509–533.
- [15] K. M Eisenhardt, J. A Martin, Dynamic capabilities: what are they?, *Strategic management journal*;21 (2000) 1105–1121.
- [16] W. Sauter, A.-K. Staudt, *Kompetenzmessung in der Praxis: Mitarbeiterpotenziale erfassen und analysieren*. Springer-Verlag; (2016).