Continuous improvement processes in manufacturing enterprises as an enabler of process innovation

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Abstract: This paper focuses on the concept of continuous improvement processes (CIP) as one type of non-technical, procedural organisational innovation. In particular, the diffusion of this organisational concept among German manufacturing firms will be analysed. The analysis is based on data from the German Manufacturing Survey 2006 which is carried out every two years by Fraunhofer ISI. The underlying sample comprises data of 1,663 firms. Besides the diffusion of this concept in different sectors and different firm sizes, effects of continuous improvement on the process innovation capability of enterprises will be analysed.

Keywords: continuous improvement processes; CIP; non-technical innovation; process innovation.


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1 Introduction

Enterprises can achieve and maintain their competitiveness and economic success in different ways. One of these ways can be to put emphasis on the improvement of their business processes. Through the implementation of continuous improvement processes (CIP), existing barriers and problems can be identified and the workflow can be successively optimised, resulting in more efficient overall business processes. Hereby, existing ways of ‘doing things’ are critically analysed and can become subject to change, if they are found to be inefficient. CIP as an organisational practice can be regarded as a form of procedural process innovation which is directed towards the continuous inspection of existing processes in search for possible incremental improvements. CIP therefore contributes to improving the quality of the products and the flexibility in firms. In the light of increased competition among firms, introducing process innovations can be one way to fully exploit existing efficiency potentials within the firm in order to achieve a better overall business performance.

2 Holistic concept of innovation

In the past, empirical innovation research has mainly focused on product and technical process innovations. However, the latest edition of the OECD Oslo Manual which represents the methodological basis for major innovation studies, such as the European Community Survey, has taken up Schumpeter’s broad understanding of innovation and proposes an enlarged understanding of innovation (OECD, 2005). Following this broad understanding, innovation comprises many different aspects. Furthermore, the ability to innovate cannot be determined without its context, as innovation is not an end in itself, but a means to reach, maintain and increase competitiveness and economic success (Schumpeter, 1931; Tidd et al., 2005; Vahs and Burmester, 2002). Thus, economic success distinguishes an innovation from an invention. Besides new products, also new services, production methods, markets or new sources of supply and new types of organisation structures can be regarded as innovations if they contribute to increasing competitiveness and economic success (Schumpeter, 1961; Tidd et al., 2005; Kirner et
By analysing the diffusion and the effects of CIP in industry, this paper focuses on the intangible process dimension of innovation. Starting with the publication of the *Lean Production Study* by Womack et al. (1990), the impact of organisational innovations on firms’ economic success has been increasingly acknowledged. The contribution of organisational innovations to increase the efficiency and competitiveness of enterprises is nowadays no longer in doubt. Thus, organisational innovations can be regarded as an important means to economic success.

**3 Theoretical overview of organisational innovation**

Similar to Schumpeter’s initial theoretical work on innovation, important developments in organisation theory led to the further development of the concept of organisational innovation, by drawing attention to intangible factors which account for the economic performance of enterprises (March and Simon, 1958; Penrose, 1959; Chandler, 1992). In this context, the crucial importance of specific organisational capabilities has been revealed. The ‘resource-based view of the firm’ (Wenerfeld, 1984; Conner and Prahalad, 1996; Foss, 1997a, 1997b), which has evolved in close relation to the behavioural theory of organisations (Cyert and March, 1963) reflects this conceptual development.

The underlying assumptions of these organisational theories are shared by the evolutionary approach, which turned out to serve as a fruitful basis for the analysis of organisational change and organisational innovation. The evolutionary theory recognises
firms as complex learning organisations that develop different ways and strategies to solve problems and challenges evoked by their specific environments. Therefore, the paradigm of a ‘one best way’ of structuring and developing an organisation has been abandoned. According to the evolutionary view, those firms which are not able to fit the requirements adequately and do not gain economic success will be eliminated by their environment and its competition mechanisms (see e.g., Nelson and Winter, 1982; Nelson, 1991; Chandler, 1992; Dosi and Marengo, 1994; Dosi and Teece, 1998; Prahalad and Hamel, 1990; Dosi et al., 2000).

This heterogeneity in firms’ problem-solving and in their various strategies to match environmental challenges leads to the development and ongoing adjustment of firm-specific organisation structures, sets of capabilities, competencies and rules of action. Therefore, organisational innovations can be understood as a result of the firm’s adaptation process by developing and implementing two different types of organisational innovations: structural or procedural organisation practices. While structural organisational innovations influence, change and improve responsibilities, accountability, command lines or the number of hierarchical levels of an enterprise, procedural organisational innovations affect the processes, routines and behaviour within the firm (Armbruster et al., 2007).

3.1 CIP as a procedural organisational innovation aiming at improving firm-specific organisational routines

According to evolutionary theorists, intra-organisational procedures and patterns of behaviour are the key resources of an enterprise. As these intangible resources are created individually inside each firm, they cannot be acquired in markets (Teece et al., 1997) like tangible assets (buildings, plant, equipment, etc.) and consequently cannot be easily copied by other competitors. They are highly firm-specific and therefore provide a strong potential to gain competitive advantage (Bessant et al., 2001). Following this line of reasoning, a firm’s economic success is supposed to rely essentially on an internal and endogenous creation of specific resources, such as organisational capabilities and competencies or behavioural patterns.

As the evolutionary approaches point out, these intra-organisational resources become efficient only when they are turned into repeated actions (Burr, 2004). Such stable patterns of behaviour are often labelled as ‘organisational routines’ (Burr, 2004; Felin and Foss, 2005; Tidd et al., 2005). As Nelson and Winter (1982, p.73) put it: “individual skills are the analogue of organisational routines”. Once they have been fully adopted and internalised, they may be applied smoothly and easily, without delay and at no additional cost. Following Nelson and Winter (1982) routines can be summarised as clusters of behaviour which have become embedded in the organisation and which represent the way things are done in a firm. Routines are often assumed to represent a dichotomous split either having or not having them. But being equal to individual skills, the introduction of new organisational skills – changing or adapting new organisational routines – needs to be a cyclic process of articulation and reinforcement of the behaviour. It has to be repeated frequently over a certain period of time to take root in the enterprise and become effective (Bessant et al., 2001). Thus, when empirically measuring the diffusion of organisational procedures or routines, there is a methodological imperative to consider different stages or levels of intensity.
The organisational concept of CIP can be regarded as a procedural organisational innovation. From the resource-based view of the firm, such organisational procedures encompass firm-specific behavioural patterns and capabilities which can manifest themselves as organisational routines. By analysing the diffusion and the effects of CIP in firms, this paper focuses on a specific type of procedural organisational innovation and on the ways it can contribute to gaining competitive advantage.

4 The organisational concept of CIP

The concept of CIP is based on a participative and open paradigm of innovation processes. Thereby, it is the antithesis of the Tayloristic way of work organisation of the late 19th century, which relied on a strict separation of ‘head’ and ‘hand’. With the increasing uncertainty of markets, rapidly changing technological threats and opportunities, regulatory pressures, shifting customer and competitive requirements, participative and open innovation processes have turned out to be a more powerful mechanism to enhance the innovative capacity of an organisation (Bessant and Caffyn, 1997). This participative paradigm of innovation processes underlies a number of different organisational concepts (i.e., total quality management, learning organisations, Japanese manufacturing techniques, etc.), all of which are grouped around the assumption that high levels of employee participation represent a competitive advantage.

CIP as an organisational concept has its origins in the Japanese management idea of lean production, widely known as ‘kaizen’. The aim of CIP as a management concept is to improve the quality of both the products and the technical and organisational processes of an enterprise in small yet continuous steps. It is understood as an organisation-wide, ongoing learning process of focused and sustained incremental innovation (Bessant and Caffyn, 1997; Bessant et al., 2001). Another central aspect of CIP is the direct individual or team-based participation of employees in the improvement process. Ideally, employees are not only involved in the identification of possible improvement areas, but also in the implementation process of their own proposals and suggestions (Bösenberg and Metzen, 1993; Witt and Witt, 2006). Thus, an organisational culture that encourages and promotes the employees’ contribution to improvement of the work process is essential.

Originally, CIP was deployed in the manufacturing and assembly process of large automotive manufacturers with large batch sizes. Today, CIP is an essential part of the implementation of a quality management system (ISO 9001) and can be applied in almost every department of an enterprise. Thus this concept has meanwhile diffused to other sectors as well as to small and medium-sized enterprises (SMEs) with small or medium batch sizes. SMEs can also benefit from CIP and enhance their competitiveness by constantly improving the quality of their work processes and products. However, reliable data regarding the use of CIP in industry have been scarce in the past. This paper addresses this shortcoming and empirically analyses the diffusion and effects of CIP in the German manufacturing industry.

In this context, the following questions will be considered:

- To what degree is CIP diffused in large enterprises and in SMEs in the German manufacturing industry?
- Do sector-specific differences exist in the implementation of CIP?
Can unexplored potentials of CIP be identified?
What are the effects of CIP on labour productivity, quality and flexibility?

4.1 Database

The analysis is based on the German Manufacturing Survey 2006 which was carried out by the Fraunhofer Institute for Systems and Innovation Research ISI. The objective of this regularly conducted, questionnaire-based written survey is to systematically observe manufacturing industries in Germany. The questionnaire comprises questions on the implementation of innovative technological and organisational concepts, on performance indicators, products and services, as well as on general company data. The survey was first launched in 1993 and is conducted every two years. In 2006, 13,426 firms from main manufacturing industries in Germany were asked to fill in the questionnaire; 1,663 companies returned a utilisable questionnaire, which results in a response rate of 12.4%. The random sample was stratified across ten industries and six size classes.

5 Empirical findings

5.1 Diffusion of CIP in the German manufacturing industry

The analysis of firm level data shows that currently nearly three quarters (72%) of the surveyed enterprises have implemented CIP. However, breaking down the firms by their manufactured batch sizes, it becomes apparent that most users of CIP are still enterprises with large batch sizes (78%). Enterprises producing in single, small or medium batch size use CIP to a lesser extent (70%). This may be due to economies of scale, leading to greater efficiency through the improvement of individual work steps in large enterprises. However, in contrast to batch size, the complexity of the manufactured goods does not seem to have any influence on the use of CIP.

CIP are particularly widely used in high-tech and advanced technological sectors such as in the electrical industry, medical engineering, or optics and automotive and suppliers industry (Figure 2). Furthermore, CIP is clearly more often implemented in large firms with more than 250 employees than in SMEs with less than 250 employees. Almost 90% of large enterprises in the manufacturing industry have already implemented CIP, compared to only about two thirds of SMEs. This greater diffusion among large enterprises can be observed in nearly all sectors. The difference in the use of CIP between large enterprises and SMEs is most striking in the automotive and suppliers industry, where CIP are used by all large enterprises, but only by 72% of SMEs. It is thus obvious that CIP is still traditionally mainly anchored in large enterprises in the automotive industry. Although SMEs in the food, textile and chemical industries as well as the machinery industry have caught up on the application of CIP, the most relevant implementation potential can be presumed for this group.

In addition, significant differences can be observed regarding the dynamics of the implementation of CIP in large firms and SMEs. Nearly 25% of SMEs have introduced CIP only in the last three years, compared to only 10% of large enterprises. This might reflect the perceived need of SMEs to catch up on the use of CIP. Should this high
prevailing dynamics of implementation be maintained, it can be expected that SMEs and large firms will soon have implemented CIP to a comparable degree.

**Figure 2** Use of CIP in the sectors of the German manufacturing industry

<table>
<thead>
<tr>
<th>Industry</th>
<th>Large firms</th>
<th>SME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>88%</td>
<td>96%</td>
</tr>
<tr>
<td>Man. of food products, beverages and tobacco</td>
<td>88%</td>
<td>90%</td>
</tr>
<tr>
<td>Man. of textiles, textile products or leather</td>
<td>90%</td>
<td>92%</td>
</tr>
<tr>
<td>Man. of paper products, publishing, or printing</td>
<td>40%</td>
<td>58%</td>
</tr>
<tr>
<td>Chemical industries</td>
<td>67%</td>
<td>76%</td>
</tr>
<tr>
<td>Man. of rubber and plastic products</td>
<td>70%</td>
<td>86%</td>
</tr>
<tr>
<td>Man. of basic metals and fabricated metal products</td>
<td>70%</td>
<td>99%</td>
</tr>
<tr>
<td>Man. of machinery and equipment</td>
<td>70%</td>
<td>92%</td>
</tr>
<tr>
<td>Man. of electrical and communication equipment excl. Nace 33)</td>
<td>79%</td>
<td>84%</td>
</tr>
<tr>
<td>Man. of medical, precision and optical instruments, etc.</td>
<td>76%</td>
<td>89%</td>
</tr>
<tr>
<td>Man. of transport equipment</td>
<td>72%</td>
<td>85%</td>
</tr>
<tr>
<td>Other sectors of manufacturing</td>
<td>55%</td>
<td>68%</td>
</tr>
</tbody>
</table>

5.2 **Intensity of CIP implementation**

The implementation of CIP in firms of the dataset varies more strongly if the intensity of use of this concept within the enterprise is considered (Figure 3). Organisational concepts such as CIP can be implemented to various extents, ranging from mere pilot implementation to wide internal diffusion. In order to estimate the extent of use of CIP, surveyed enterprises were asked to estimate whether CIP has been implemented and diffused within the firm to a low, medium or high degree. Almost 40% of large enterprises with 250 or more employees stated that the full potential of CIP was exploited. Interestingly, these are only 45% of all those firms which declare to have introduced CIP at all. An even more striking relativisation in the proportion of CIP users can be observed in case of SMEs. Only 18% of SMEs stated that they have exploited the full potential of CIP. This equals only one quarter of SMEs using CIP at all. Thus, a considerable gap exists between the proportion of enterprises using CIP and those which have indeed implemented CIP to its full internal potential. This is particularly the case in SMEs.
5.3 Effects of the implementation of CIP

In the light of an assumed unexploited potential of CIP implementation in SMEs in German manufacturing industry, possible economic effects of a wider exploitation may be of interest. Such an analysis is not without difficulty, as several factors like firm size or batch size influence both the use of CIP and also the value of indicators like labour productivity, process quality and process flexibility. For this reason, the effects of CIP are analysed for a specific type of enterprises with homogenous production conditions: small and medium-sized automotive manufacturers and suppliers with less than 250 employees, producing in large batch sizes. In the underlying database, 91 enterprises of this type could be identified. Ninety-one percent of them have introduced CIP and 29% of these firms stated that they have exploited the full internal potential of CIP. In order to analyse possible effects of CIP, enterprises not using CIP will be compared at first to those which have introduced CIP, and in a second step, with those using CIP intensively by exploiting the full potential of CIP within their enterprise. Figure 4 shows the results of this analysis.

The findings can be summarised as follows:

- The labour productivity does not differ in a statistically significant manner among the three types of CIP users. The average labour productivity per year varies only between 74,000 to 80,000 euro per employee, which does not indicate any big difference between CIP users and non-users.
The lowest scrap-rate of 1.1%, defined as the average percentage of products in need of reworking or scrapping, is to be found in firms which use CIP intensively and have implemented it to its full potential. This result is statistically significantly lower than the scrap-rate in enterprises which do not use CIP to its full potential (2.6%) or have not implemented CIP yet (3.1%).

The median change over time for machinery as an indicator of the flexibility of production systems is again statistically speaking significantly shorter in enterprises which are using CIP intensively (52 minutes) compared to firms which have introduced CIP, but do not exploit its full potential (81 minutes) or compared to non-users (102 minutes).

These results thus show two different aspects: on the one hand, labour productivity may not necessarily be the appropriate measure to assess the effects of organisational, respectively non-technological, process innovations. On the other hand, organisational measures can aim to improve performance indicators such as product quality and process flexibility without implying negative effects on labour productivity. This could be shown for the analysed type of enterprises (SMEs in the automotive and suppliers sector with large batch sizes) exploiting CIP to its full extent. These firms seem to be able to improve
their competitiveness through higher quality and greater variability and flexibility without suffering any losses regarding productivity.

The analysis also shows that it may not be sufficient to differentiate only between users and non-users of organisational concepts when assessing performance effects of these measures in enterprises. Rather, it is important to consider the intensity of implementation as well. Just comparing CIP users to non-users would not have led to any significant performance differences in this case. The performance effects only become transparent in case of intensive use.

6 Conclusions

The paper has discussed the relevance of CIP as a specific type of procedural organisational innovation for the performance of firms. CIP has been identified as an organisational concept which aims to improve firm-specific organisational routines which represent key resources of firms. Through continuously optimising firm-specific processes and workflows, a high degree of individual process professionalisation can be achieved, which cannot be easily copied by competitors, thus resulting in a competitive advantage for the firm. Such process innovations can be considered as a separate innovation path which in itself can constitute a competitive advantage if successfully pursued.

The presented empirical analysis of the use of CIP revealed that this organisational concept is already widely implemented in the German manufacturing industry. Primary CIP users are large enterprises with more than 250 employees as well as producers of large batch sizes. Unexploited potentials for use are mainly found among SMEs, although these are catching up which is indicated by the prevailing high dynamics of implementation. The overall relatively high diffusion of this concept in industry seems to be justified. In the example of a selected type of enterprises it could be shown that firms using CIP and exploiting its full internal potential are achieving better product quality, as well as higher flexibility without any loss of their productivity. As CIP aim at process innovation as well as improvements of competitiveness and business performance, this concept is a vital part of a holistic innovation management approach, which focuses not only on the development of new products and services, but also on the improvement of technological and non-technological processes and workflows within the firm.

References


