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**Aligning manufacturing strategy content with heterogeneous
requirements**

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by

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Aligning manufacturing strategy content with heterogeneous requirements

Abstract

Purpose - The purpose of this paper is to show how companies can address multiple competitive priorities simultaneously and how this affects manufacturing strategy content.

Design/Methodology/Approach - The research is build upon a cross-case analysis of four successful Swiss manufacturers, carefully chosen from a broader questionnaire based survey.

Findings - While the competition on multiple competitive priorities can involve trade-offs, concerted actions help to minimize the negative effects and can lead to a strong market position. However, the concerted actions must be aligned to contextual factors in order to ensure the success of the action programs. Therefore, contextual factors influence not only the requirement to compete on multiple competitive priorities, but also define the actions needed to gain a strong market position.

Research limitations/Implications - The preliminary results of the analyzed case studies need to be tested on a larger data set in different industries and regions to determine if any patterns can be identified. Another limitation concerns the lack of quantitative key performance indicators.

Practical implications - The findings implicate that a suitable combination of action programs and structure allows to achieve strong market performance on multiple performance dimensions. Furthermore, the importance of aligning project goals and project portfolios with the broader strategic imperative is emphasized.

Originality/Value - This article expands the existing body of knowledge regarding manufacturing strategy research and highlights the influence of contextual factors on manufacturing strategy content.

Keywords Manufacturing strategy content, Context, Trade-offs, Case study research

Paper type Research paper

Introduction

Many researchers have illustrated, based on manufacturing strategy configurations, that companies must fulfill various customer needs in order to be successful (Corbett and Van Wassenhove, 1993; Ferdows and De Meyer, 1990; Kathuria, 2000; Noble, 1995; Noble, 1997; Roth and Miller, 1992). Following the assumption that multiple customer needs must be addressed simultaneously, the identified needs are then included in the company's manufacturing strategy through a set of competitive priorities. Competitive priorities mirror customer needs.

Fulfillment of the competitive priorities often requires a change of processes, achieved through the implementation of action programs (e.g. TQM or JIT). Unfortunately, there is no single action program which influences multiple competitive priorities simultaneously (Ketokivi and Schroeder,

2004b). Depending on contextual factors, different action programs influence different sets of competitive priorities. However, there is a lack of research focusing on the interdependencies of the dimensions of manufacturing strategy content. The interdependences of the actions and their potential to achieve competitive priorities need more research attention (Christiansen et al., 2003; Ketokivi and Schroeder, 2004a). Figure 1 highlights the dimensions of manufacturing strategy content and exemplifies the for this research important relationships.

- Take in Figure 1 -

The competition on multiple competitive priorities can be difficult due to the involvement of trade-offs. Considering the work of Da Silveira et al.(2001), Mapes (1997), Noble (1995), Schroeder et al. (1994) and White (1996), trade-offs exist. Further research is needed to cover the question regarding how the process of overcoming the trade-offs should be approached (Da Silveira and Slack, 2001). Furthermore, Christiansen et al. (2003) suggest that more research should be focused on understanding the combined factors of manufacturing strategy rather than investigating the influence of only one or two priorities on performance and/or competitiveness.

Next, Ketokivi and Schroeder (2004a) suggest that goals are often excluded from program analysis and empirical analysis addresses only the practice-performance relationship. We study the different dimensions of manufacturing strategy content and analyze how the competition on multiple priorities influences the dimensions and their relationships. We add to the existing body of literature of manufacturing strategy as we link competitive priorities to the actions needed in order to demonstrate how trade-offs are minimized. We further show how contextual factors influence the actions needed to manage multiple competitive priorities. We expand upon the frequent a-contextual studies which often fail to consider influence factors such as company size, infrastructure and network. Based on a cross-case analysis, we answer the following question:

RQ: How to align manufacturing strategy content in order to successful address multiple competitive priorities simultaneously?

Beginning with an overview on manufacturing strategy, we examine the notes of researchers championing the trade-off arguments and those cheering the cumulative model. The next section presents the design of the study. Based on an in-depth cross-case analysis, we illustrate how four manufacturing companies manage the complexity of multiple strategic goals. We highlight the difficulties and show which actions and structural decisions help to minimize or eliminate trade-offs between strategic goals. We conclude by discussing implications for manufacturing strategy theory and for manufacturing decision makers.

Overview of literature

Manufacturing strategy framework

Since the well known work of Skinner (1969) on the role of manufacturing in corporate strategy, a growing number of authors have made significant contributions to the understanding of the components of manufacturing strategy. Dangayach and Deshmukh (2001) give a good overview of the different definitions of manufacturing strategy. The overview reveals three common dimensions. First, manufacturing strategy includes the definition of a goal. These goals are often described as competitive priorities. The second dimension consists of actions which aim at achieving the defined goals. Third, the definitions cover structural and infrastructural decisions which aim at achieving the set goals.

Research regarding competitive priorities is widely applied, although different terms can be found describing the dimension in which the companies compete in the marketplace. Existing literature reveals that three competitive priorities are the lowest common denominators: cost, quality and dependability (Dangayach and Deshmukh, 2001). Another widely applied goal is flexibility (Anand and Ward, 2004; Gerwin, 1993; Swink and Hegarty, 1998). The increasing importance of flexibility is explained along with the increase of globalization, the market dynamic and changing customer needs (e.g., Groessler, 2007). A more commonly discussed factor is innovation, as it is mainly influenced by the research and development department. On the other hand, the manufacturing department is more often seen as an important idea generator and, therefore, a close link between R&D and manufacturing is desirable (He and Wong, 2004). We conclude that, based on the literature on manufacturing strategy content, five aggregated competitive priorities must be considered: cost, quality, dependability, flexibility and innovation.

The second (infrastructural and structural decisions) and third dimension (action programs) of the manufacturing strategy content have led to some discussion. Both dimensions involve decisions how to achieve the set goals. The first group of authors conveys the idea that the infrastructural and structural decisions such as layout, production planning, and quality control must be carefully matched with the organization's competitive priorities (Boyer and Lewis, 2002; Hayes and Wheelwright, 1984; Vickery, 1991). Others prefer the inclusion of actions rather than structural and infrastructural decisions (Christiansen et al., 2003; Frohlich and Dixon, 2001). Action programs are systematized activities, conceived for the accomplishment of objectives (Christiansen et al., 2003). The analysis of action programs as content of manufacturing strategy has received growing interest among researchers (Christiansen et al., 2003; Laugen et al., 2005; Narasimhan et al., 2005). The inclusion of action programs into the manufacturing framework can assist companies in improving their environmental fit, which should lead, based on the assumptions of contingency theory, to better performance (Bozarth and Mc Dermott, 1998; Christiansen et al., 2003). Kim and Arnold (1996) state that competitive priorities need to be linked explicitly to action programs, giving manufacturing executives

an array of alternatives from which to choose how to achieve competitive priorities.

Manufacturing strategy is embedded into contextual factors. Contextual factors can be divided into external and internal factors. External factors influence the composition of a manufacturing strategy. For instance, in a stable environment, new product introduction is not as important as in dynamic markets (Godener and Söderquist, 2004). Given the chosen strategic goals, internal factors influence the actions needed to fulfil the chosen priorities. For instance, plants with high automation levels need different actions to improve flexibility than craft related companies. External and internal contextual factors have to be considered while analyzing manufacturing strategy and its effect on performance.

The implementation of the competitive priorities through action programs influences performance (Ketokivi and Schroeder, 2004a). The chosen strategy and its success of implementation leads to the final result - performance. Therefore, the existence of negative effects between the chosen competitive priorities, if not solved through suitable initiatives, negatively influences market performance. Selecting the appropriate measures of performance is challenging. While some researchers favor financial performance indicators (Chen and Paulraj, 2004), others have described the limitations of relying solely on financial measures of performance (Flynn et al., 2009). Ketokivi and Schroeder (2004a) argue that aggregated financial measurements such as ROI or ROA do not reflect the multidimensionality of the manufacturing actions. Similar to the strategic priorities, performance is a multidimensional construct. We therefore define performance as the perceived success on the strategic goals compared to competitors.

Summarizing, we focus our analysis on an manufacturing strategy framework consisting of competitive priorities, the actions to achieve the set goals and the influence on performance. The following section highlights the ongoing debate about the interaction of competitive priorities. It captures the key statements of researchers championing the trade-off assumptions, as well as those assuming that competitive priorities are cumulative in nature.

Companies struggle with multiple competitive priorities

Looking more deeply into how companies compete on multiple competitive priorities shows that this effort leads to difficulties. Skinner (1969 and 1974) argues that companies have to focus on one priority at a time as the priorities cost, quality, dependability, flexibility and innovation require different organizational structures and infrastructures. He further argues that companies must prioritize goals in order to be able to distribute scarce resources accordingly. Given resource constraints, companies cannot afford to improve everything at the same time; they have to set priorities. Skinner argues that improvements in one goal lead to a decline in other factors (Skinner, 1969; Skinner, 1974). Trade-off studies examine the need for plants to prioritize their strategic objectives and corresponding resources (Da Silveira and Slack, 2001; Mapes et al., 1997; Noble, 1995; Schroeder and Pesch, 1994; White, 1996). In contrast to these trade-off studies, advocates of cumulative competitive priorities

claim that global competition leads to pressure to compete on multiple competitive priorities (Boyer and Lewis, 2002). Different studies show that competitive priorities reinforce each other, meaning that companies can compete on multiple competitive priorities simultaneously (Christiansen et al., 2003; Corbett and Van Wassenhove, 1993; Deflorin, 2009; Ferdows and De Meyer, 1990; Frohlich and Dixon, 2001; Kathuria, 2000; Noble, 1995; Noble, 1997; Roth and Morrison, 1992). Ferdows et al. (1986) even suggest a pre-specified order for building manufacturing capabilities, known as the sand cone model. These studies suggest that a company is able to compete on multiple competitive priorities simultaneously, however, it is not clear how companies are to achieve this goal. Based on Christiansen et al. (2003) and Dixon and Frohlich (2001), the competition on multiple competitive priorities requires the implementation of a bundle of programs. In order to understand the joint effect of the implementation of a bundle of programs and its potential to minimize trade-offs, each bundle of programs and its effect on the achievement of multiple competitive priorities must be analyzed in depth. A bundle of programs is necessary, as no single practice appears universally applicable in demonstrating competitive value in all performance dimensions (Ketokivi and Schroeder, 2004a).

Methodology

Research setting

The goal of our analysis is to gain new insights into how multiple competitive priorities can be addressed. We have chosen a qualitative, case-based approach for two main reasons. First, the study investigates “why” manufacturing trade-offs exist and “how” companies deal with them. To date, research has been mainly driven by the “what” approach, demonstrating that companies compete on multiple competitive priorities simultaneously. Our case study research is particularly appropriate for explanatory studies, focusing on the “how” and “why” questions (Meredith et al., 1989; Yin, 1994). The goal of this research is to move beyond testing and to begin the process of building theory. Our emphasis on developing constructs, measures and testable theoretical propositions makes the multiple case studies approach an ideal method for theory development (Eisenhardt and Graebner, 2007). A cross-case analysis was conducted to identify within-group similarities as well as inter-group differences (Eisenhardt, 1989).

The research focuses on four manufacturing companies, selected through a questionnaire based survey. Based on self-judgment, the companies compared their market performance with relevant competitors. The four most successful companies addressing multiple competitive priorities were selected for our detailed research. *Cable Inc.* is a machine manufacturer with headquarters in Switzerland. It has 1000 employees and a production network with 5 plants. We focused on the Swiss plant, although the interfaces with the other plants are considered. The second analyzed company is a manufacturer of plastic equipment with 5000 employees. The company, with headquarters in Switzerland, consists of 16 production plants. The research focuses on the Swiss production plant of the business unit which is responsible for the pipe systems. The business unit employs 1500

employees, and our analysis is focused on this individual, independently managed business unit. We refer to it as *Pipe Systems* in our study. *Printer Board Ltd.*, a manufacturer of electrical machinery and apparatus employing 2200 worldwide, is our third research subject. The company's headquarters is located in northern Europe. Their production network spans seven plants in six countries. The fourth company selected is *Tool Ltd.*, with 450 employees and four plants. The company, with headquarters in Switzerland, produces fabricated metal products.

Data collection

Data were collected based on the following process:

- (1) questionnaire, filled out from the CEO or manufacturing manager;
- (2) phone interviews to verify the questionnaire;
- (3) selection of successful companies addressing multiple competitive priorities simultaneously
- (4) interview with CEO and manufacturing manager;
- (5) observation of shop floor activities;
- (6) analysis of corporate documents;
- (7) follow-up interviews to verify the researcher's interpretation.

These steps were completed in a similar sequence within each company. Responses to the questionnaire, submitted by the CEO or the manufacturing manager, provided a first impression of each company and were a valuable source of information in preparing for the interviews. Each company was interviewed twice by two researchers from the field of manufacturing management. Each interview was semi-structured and recorded. The first interview (each interview was scheduled to last 3 to 4 hours) was complemented with a site visit. To substantiate the information submitted in the questionnaire, top management provided additional documentation such as strategic plans and project descriptions. These internal documents constituted a valuable secondary source of data and provided a way to cross-check the information from the recorded interviews and to control for retrospective bias. Finally, the follow-up interviews were conducted to test the researcher's interpretation of the data provided by the management.

Data analysis

The data analysis began with traditional methods of inductive fieldwork (e.g., Miles and Huberman, 1994). One of the researchers wrote detailed case studies based on the recorded transcripts and archival data. Data analysis included multiple readings of the data collected. The second researcher cross-checked the case studies with the available data and suggestions for revisions were discussed. In order to minimize interviewee's bias, the data collected from the interviews were carefully compared to the shop-floor observations, the questionnaire and the documents given to the

researchers by the investigated companies. The finalized case studies were then provided to interviewees for review with the goal of minimizing any bias potentially associated with retrospective interviews.

Basic findings

Contextual factors

The four analyzed companies range from machine manufacturer to manufacturer of plastic equipment and fabricated metal products. The product portfolio of the machine manufacturer Cable Ltd. is fairly standardized with modularization possibilities. Pipe Systems, as a manufacturer of plastic equipment, offers standardized products with a low product mix. Printer Board Ltd. produces electrical machinery and apparatus which are build to order and, therefore, highly individualized. Tool Ltd., on the other hand, has a standardized product portfolio which consists of a large variety of products. The company offers 15,000 different tools.

The company size ranges from 450 to 2200 employees. The size difference is also reflected in the network structure. Pipe Systems is embedded in a global network, with plants in eight countries on three continents and a strong R&D department. The company targets a high vertical integration and is, therefore, highly independent. Tool Ltd., by contrast, is a medium sized company with limited resources. The company relies more heavily on suppliers than Pipe Systems, Cable Ltd. or Printer Board Ltd.

In comparing the four companies, there are differences on the plant level, especially the automation level. Pipe Systems operates at a high automation level, with not only highly automated machines, but also highly automated processes. One of the goals of Tool Ltd. was to invest in the automation level of the machines. The production manager highlights that the company has invested heavily over the last three years in the automation level of the machines, but that the processes are still mainly manual. Cable Ltd. and Printer Board Ltd. have a lower level of automation due to various manual process steps.

All four companies compete internationally. They have globally distributed sales networks and strong reputations in their market places. However, the structure of the distribution networks differ. In the case of Pipe Systems, product stock is owned and stored by the sales representatives, whereas Tool Ltd. manages and stores its own inventory to serve the end-customers. Printer Board Ltd. has a build to order production and, therefore, has no end product inventory. Cable Ltd. implemented pull-system and, according to its philosophy, has no end product inventory, but pulls the machine based on the customer's order.

- Take in Table 1 -

Competitive priorities

Companies have to fulfill customer needs in order to be successful. Based on their manufacturing strategy, managers rated ten competitive priorities from 1 = “not important” to 5 = “very important”. The competitive factors analyzed (see Table 2) cover a broad range of possible factors and are widely used in various studies (e.g., Christiansen et al., 2003; Frohlich and Dixon, 2001).

- Take in Table 2 -

Table 2 shows that all companies are competing simultaneously on multiple competitive priorities. Row A indicates the degree of importance to fulfill this priority in order to be successful. However, each company still has to decide if an important factor is included in the manufacturing strategy. We, therefore, asked the managers to pinpoint the factors which the company tries to implement (row B). Finally, based on self-judgment, the managers indicated in which dimension the company has a stronger market position than their relevant competitors.

The priority price is defined from a customer perspective. Each of the companies indicated that they do not compete on a low price. However, the managers explained that it is still an important goal to have low manufacturing costs in order to improve profit. The following analysis, therefore, includes the goal of producing at low costs despite the fact that none of the companies targets a cost-leadership strategy in order to offer the lowest price.

Action programs

Action programs help to achieve a desired end, and provide structure regarding how activities must be conducted within a company to achieve a defined goal. In order to capitalize upon the full potential of the programs, they have to be implemented for the right reason (Ketokivi and Schroeder, 2004a). The following section provides an excerpt of the programs implemented by the four companies studied. Each of the programs reported is considered strategically important because they directly influence the achievement of the competitive priorities. In addition, each of the companies analyzed has installed additional programs such as a supplier management program. Although this program is important, it does not directly impact the strategic direction chosen and is, therefore, not listed.

- Take in Table 3 -

Just-in-time (JIT) initiatives are widely applied within industrial companies and are often seen as best practice. Many Western companies often implement a variety of JIT elements rather than applying the whole philosophy (Mc Lachlin, 1997). The four analyzed companies have particularly focused on the flow element, utilizing the pull-system. In contrast to the push-system, in a pull-system a preceding machine produces parts only after it receives a request from the succeeding machine (Bonney et al., 1999; Venkatesh et al., 1996).

Another widely applied practice is continuous improvement. Each of the companies analyzed has installed a system which gathers improvement suggestions from employees. The applied continuous improvement philosophy is based on the assumption that every process contains waste which has to be reduced or eliminated in order to achieve customer value (Imai and Heymans, 1999). Continuous improvement as implemented by the four companies covers not only the philosophy of the practice, but the active process of gathering employee suggestions. Within this study, the focus is put on the systematized process of idea gathering. This practice is present in three of the four companies. The exception is Tool Ltd. They once installed a system to enhance continuous improvement activities, but the results were of minimal help. However, Tool Ltd. has since implemented the practice of "integration between product development and manufacturing". The respective team of product developer and manufacturer are not only responsible for the development of products that are easier to produce, but are also in charge of improving processes. The team members do encourage continuous improvement, but as we look at the systematized process of idea gathering, Tool Ltd. does not have a company-wide continuous improvement practice in place.

Similar to Tool Ltd., Pipe Systems and Printer Board Ltd. have also implemented a program called "integration between product development and manufacturing" with the goal of reducing manufacturing costs and increasing the speed to introduce the products in the market (Womack et al., 1990). Cable Ltd., on the other hand, implemented the practice of project management. The practice connects the systematic process of the new product introduction with the implementation of new programs.

Each of the programs described is influencing the companies' potential for achieving their competitive priorities. Based on the interviews and the shop floor analysis, we analyzed each program with respect to its influence on the competitive priorities. Each interview partner described the relationships and explained his reasoning. Differing assessments among the interviewees were discussed and, based on the arguments, a final relationship assessment was recorded. Table 4 summarizes the identified connections. The following section shows which of the identified connections supports a reduction of a trade-off. The programs relevant for reducing a trade-off are discussed in-depth.

- Take in Table 4 -

Trade-offs and initiatives

Based on the shop-floor analysis and the management statements, potential trade-offs between the competitive priorities were discussed. The following section highlights the identified trade-offs and the company initiatives to reduce them.

- Take in Table 5 -

Table 5 shows that each of the companies analyzed faces a trade-off between the competitive

priority “order size flexibility” and “low costs”, “product design and quality”, “conformance quality”, “dependable delivery” and “fast delivery”. The management of the companies stated that order size flexibility negatively influences the process stability. Short term changes often lead to process variances due to unplanned actions. Process variances, in turn, have the potential to negatively influence the production costs and can lead to quality problems, as well as to difficulties in achieving the delivery goals.

Cable Ltd. reduces the trade-off between changing order sizes and costs through the hiring of temporary employees. In order to have the potential to react flexibly to changing volumes, companies can work with free capacity. But this results in higher costs. In order to be able to react to changing customer volumes, Cable Ltd. focuses on the hiring of temporal employees. Each process step is clearly defined, which is a precondition for allowing new employees to fulfill the process steps. The company notes that the achieved process transparency was reached through the implementation of the program pull-system. Furthermore, the program aims at combining the factors of flexibility, quality, dependability and low costs and is an important action with regard to managing the trade-off resulting from “order size flexibility” (Cua et al., 2001). Another initiative installed by Cable Ltd. to reduce the trade-off between “order size flexibility” and “product design and quality”, “conformance quality”, “dependable delivery”, “fast delivery” and “costs” is the distinction among the three different production lines. One production line is structured to efficiently produce high volumes. The respective products have a through-put time of longer than five days and the order size is higher than five. Orders with a through-put time shorter than five days are produced in the flex-shop. Products with a through-put time smaller than 48 hours are produced in the express-shop. The distinction among the three production lines allows the company to react flexibly without negatively influencing other factors such as “product design and quality”, “conformance quality”, “dependable delivery” and “fast delivery”. Furthermore, the management declared that the implementation of three different production lines has resulted in lower costs because each is running efficiently on high capacity.

Pipe Systems minimizes the trade-off resulting from the factor “order size flexibility” with process automation. The higher the automation level of each process step, the lower the effects of the variances of one process step on the subsequent one. In addition, the management of the trade-off is supported with the implementation of the program pull-system, which combines the priority “order size flexibility” with the delivery factors, as well as low costs. Although the management has undertaken some actions to avoid the trade-off, the factor “order size flexibility” is not extremely important because the distribution partners have their own inventory and orders are dispatched with a preliminary lead time to assure availability of stock.

Printer Board Ltd. and Tool Ltd. manage the “order size flexibility” trade-off using the internal production network. Both companies have the potential to outsource orders to their partner plants. This reduces the negative effect of “order size flexibility” on “low costs”, “product design and quality”, “conformance quality”, “dependable delivery” and “fast delivery”. In addition, both companies

highlight the importance of the program pull-system in combining most of the factors influenced by “order size flexibility”. In contrast to Pipe Systems, both companies use the integration of product development and production, which develops the products according to manufacturing requirements to manage the flexibility trade-off.. One of the goals is to reduce the complexity; to develop the product in a way that the necessary manufacturing processes are as simple as possible. Both companies report that employees are better able to absorb changes in the order sizes and more easily manage those changes because of this program.

A similar issue was highlighted concerning the factor “frequency of new product introduction”. The processes needed to produce an existing product portfolio are often optimized to a point where process variances are reduced to a minimal level. Low variances are the foundation necessary to achieve continuously high quality and dependability levels. The introduction of new products is bound to produce variances, because the processes have to be adapted to the new circumstances and, finally, are optimized in order to reduce process variance. The longer through-put time of new processes is the factor that influences costs. The management of the four companies stated that new product introduction negatively influences costs because the respective processes still have to be optimized in order to reach the same level of manufacturing costs. Further, as mentioned above, process variances negatively influence “product design and quality”, “conformance quality”, “dependable delivery” and “fast delivery”.

In order to overcome the negative effects of new product introduction, Cable Ltd. instituted a project management. This allows to manage the introduction of new products. It is a structured procedure which improves the repetitive processes of the new product introduction. According to the management, this lowered the negative effects of the new product introduction. The negative effects were further lowered through instituting the continuous improvement program, designed to raise the quality and speed of the new processes to the same level experienced before the new product introduction occurred.

Similar to the trade-off “order size flexibility”, Pipe Systems minimizes the trade-off resulting from the factor “frequency of new product introduction” with process automation. The less each subsequent or parallel process is influenced by a new product introduction, the lower the resulting trade-offs from a new product introduction. In addition, the implementation of the program “integration of product development and production” supports these efforts by translating the production requirements into the development of the new products. The management claims that the consideration of production requirements during the development process helps to minimize the trade-off between “frequency of new product introduction” and “low cost”, “product design and quality”, “conformance quality”, “dependable delivery” and “fast delivery”.

The introduction of new products requires free production capacity, but free capacity is costly. Therefore, companies tend to produce on full capacity. Tool Ltd. has built a production plant in

Eastern Europe that allows the plant in Switzerland to have some free capacity. Together, the production costs of both plants are lower than before. The investment in the Eastern Europe plant allows the company to have a higher frequency of new product introduction due to spare capacity at the Swiss plant, without increasing the total costs. Based on this investment, the company reduces the trade-off between new product introduction and costs. The spare capacity at the Swiss plant allows introducing new products with a lower negative effect on the priorities “product design and quality”, “conformance quality”, “dependable delivery” and “fast delivery” as compared to full capacity. Similar to Pipe System, the company supports the described ambitions with the implementation of the practice “integration of product development and production”. Furthermore, all analyzed companies have implemented pull-system. The result is a shorter through-put time and a higher process transparency in general. However, only Tool Ltd. and Printer Board Ltd. highlight the importance of the pull-system for reducing the “frequency of new product introduction” trade-off. Both companies have a broad product portfolio and the introduction of new products requires more planning than in companies having a smaller product portfolio. The two companies concluded that pull-system allowed them to implement new products more easily due to transparent processes, which resulted in the potential to introduce new products more frequently.

Printer Board Ltd. accepts the trade-offs resulting from “new product introduction”. The trade-offs can be reduced with the implementation of a production line dedicated to prototypes. The reason to accept the trade-offs is the learning experience, because implementing the prototypes on the main production line is what the management considers more important than reducing the trade-off. However, in order to minimize the effect to some degree, the company has implemented the continuous improvement program. The continuous improvement program brings the new processes to the same level of quality and speed as the old ones. The management states that the program cannot avoid the trade-offs or immediately reduce them, but it helps to improve the encountered trade-offs as soon as they become visible. Similar to the companies Tool Ltd. and Pipe Systems, these ambitions are further supported through the implementation of the program “integration between product development and production”.

A special trade-off results from the priority “fast delivery” and Cable Ltd. is the only company facing it. The management reported that the customers not only asked for a short through-put time in general, but the management had to react to requests for express-deliveries, produced in between the scheduled production volume. These “in-between” requests negatively influenced the process stability and, therefore, negatively influence “low costs”, “product design and quality”, “conformance quality” and “dependable delivery”. Cable Ltd.’s response to the “fast delivery” trade-off was the implementation of two additional lines, the Flex- and Express-Shop. The distinction among the three production lines allows the company to achieve a fast delivery without negatively influencing other factors such as “low costs”, “new product introduction”, “product design and quality”, “conformance quality”, “dependable delivery” and “fast delivery”. Furthermore, a fast delivery without negative

influence on other priorities like quality and dependability was strengthened through the implementation of the pull system. The management reported that the implementation of the pull-system drastically reduced the through-put time and led to a higher transparency of the processes. Two additional programs were identified for reducing the “fast delivery” trade-off at Cable Ltd.: continuous improvement and project management.

The case of Tool Ltd. does not reveal difficulties concerning the factor “fast delivery”, with the exception of the priority “low cost”. The management reported that the customers consider fast delivery as very important and that in order to be able to fulfill this requirement the company must store the products. Although the storage of the end products is costly, the management concludes that it is more important to meet the customer’s delivery requirements. The infrastructure for storing the company’s product portfolio is expensive, but fulfills another strategic goal. Therefore we encounter a trade-off between the priorities “fast delivery” and “low costs”.

Printer Board Ltd., on the other hand, has a made-to-order production. The sequence until a new order can be produced is much shorter compared to the other companies dealing with higher volumes. The management reports that due to the transparent processes, the company can schedule orders more precisely and can fill short spare slots in the production time table with these orders. This enables Printer Board Ltd. to deliver with short lead times and no trade-off. Pipe Systems instead delivers the products to sales representatives in the respective countries. Each of the sales representatives keeps inventory of the main products. Because of this, unexpected fast delivery requests are not an issue.

Figure 2 summarizes the identified influences of the action programs and structural initiatives on the encountered trade-offs.

- Take in Figure 2 -

Performance

The four manufacturing companies studied compete on multiple competitive priorities simultaneously. Table 2 **Fehler! Verweisquelle konnte nicht gefunden werden.** shows that the four companies consider themselves more successful than their competitors in at least five out of ten factors, even though they have to fulfill multiple competitive priorities simultaneously. This result indicates that the companies are successful in implementing multiple competitive priorities and, therefore, it contradicts Skinner’s (1969; 1974) argument that a company can be successful in only one or two dimensions.

However, looking at the individual performance indicators reveals some interesting insights. Although all four companies consider the factor “dependable delivery” as strategically important, only one company, Pipe Systems, achieves a better result than the relevant competitors. A possible explanation is based on the trade-offs highlighted. All four companies aim at fulfilling the factors “order size flexibility” and “frequency of new product introduction”. It has to be recognized that, with

exception of Printer Board Ltd., the companies achieve a better market position than their relevant competitors. However, both factors have a negative effect on the factor “dependable delivery”. Although each of the companies implemented initiatives to minimize these trade-offs, we conclude that their competitors more successfully minimized the trade-off or focused on achieving the factor “dependable delivery” without fulfilling “order size flexibility” and “frequency of new product introduction”.

The factor “product design and quality” reveals a similar situation: it is considered important and is also influenced by the factors “order size flexibility” and “frequency of new product introduction”. While the initiatives of Cable Ltd. and Pipe Systems seem to have minimized the trade-off more successfully than their competitors, this is not the case at Printer Board Ltd. and Tool Ltd.

Although Table 2 illustrates that companies can be successful in multiple performance dimensions, it also shows that some factors, such as “product design and quality” and “dependable delivery” are more difficult to combine than “wide product range” and “innovative products”, for instance. These factors are not influenced by other factors and do not influence others and are, therefore, easier to include within the manufacturing strategy.

Discussion

The identified influences between context, manufacturing strategy and performance are highlighted in this section. The case studies show that the simultaneous competition on multiple competitive priorities can lead to trade-offs. However, it is also demonstrated that suitable initiatives or actions can reduce trade-offs. We note that the existence of trade-offs is influenced from contextual factors. Contextual factors are further defined if actions are suitable for implementing a chosen range of competitive priorities. The following section details the management of trade-offs and the relevant contextual factors.

The management of trade-offs

Each of the analyzed companies has chosen a manufacturing strategy which targets the fulfillment of customer needs. The management of the respective competitive priorities leads to challenges because some of the goals negatively influence the achievement of others. The case studies show that “order size flexibility”, “frequency of new product introduction” and “fast delivery” negatively influence other competitive priorities. Table 5 summarizes the identified trade-offs.

Two ways of managing the encountered trade-offs are identified. First, to reduce trade-offs, companies make structural changes. In the case of Cable Ltd., the trade-offs resulting from the priorities “order size flexibility” and “fast delivery” are solved by installing two additional production lines: the Express- and Flex-Shop. The distinction among the three lines even reduced the overall production costs. Another structural decision can be seen at Tool Ltd. The trade-off resulting from the priority “fast delivery” is not existent because Tool Ltd. stores end-products. Therefore, based on a

good inventory management, the company can easily fulfill the priority “fast delivery” without interfering with the achievement of other priorities. However, the existence of the inventory is cost intensive and, therefore, negatively influences the priority cost. Because the company does not compete on low price, the management argues that the influence on market success is higher if the other factors are achieved. Another structural decision concerns investments in process automation. Pipe Systems reduces the negative effect of “order size flexibility” and “frequency of new product introduction” by utilizing a high level of process automation.

Another way of managing trade-offs is based on the implementation of action programs. To reduce the trade-off resulting from the competition on “frequency of new product introduction”, Cable Ltd. implemented the program project management. It is designed to combine the goals “frequency of new product introduction”, “low cost”, “dependable delivery”, “fast delivery” and “wide product range”. Similarly, Pipe Systems, Printer Board Ltd. and Tool Ltd. have implemented the program “integration of product development and production”. Two companies, Cable Ltd. and Printer Board Ltd., support the described efforts through the program continuous improvement. The trade-off resulting from the priority “fast delivery” was not only minimized through the investments in infrastructure, but also through the implementation of the programs “pull system” and “continuous improvement”.

The influence of contextual factors

The case studies reveal that the management of trade-offs requires investments concerning structural dimensions and the implementation of action programs. It is further revealed that the influence of contextual factors define the existence of trade-offs. Finally, the contextual factors identify a program’s potential to minimize a given trade-off.

The existence of a trade-off in one company but not in others requires an analysis of potential reasons. The differences in the contextual factors appear to be a potential source of explanation. In the case of Cable Inc., the trade-off resulting from the priority “delivery speed” is not evident in the other case studies. Based on the case study data of Pipe Systems, the influencing factor is the structure of the distribution network. Each of the sales representatives is responsible to carry an inventory of the products. Therefore, the orders from the sales representatives are bundled. This situation clearly reduces the importance of the priority “delivery speed”. However, from an internal perspective, a fast delivery is still an important factor because the faster the product is finished the fewer resources are used, resulting in lower production costs. Printer Board Ltd., on the other hand, is a producer of made-to-order products. The manager claims that delivery speed is an important factor, but its internal conversion does not lead to trade-offs. As mentioned, in order to avoid trade-offs from the priority “delivery speed”, the company installed a special inventory which leads to higher costs. Therefore, Printer Board Ltd. encounters the trade-off between “delivery speed” and “low costs”.

The analysis of the programs implemented reveals that although the programs were similarly

named, the relations to the competitive priorities were assessed differently. Therefore, the implementation of a certain practice does not help reduce trade-offs in every circumstance. Table VI reveals that Tool Ltd. and Printer Board Ltd. use the program pull-system to overcome the trade-offs resulting from the factor “frequency of new product introduction”. On the other hand, Cable Ltd. and Pipe Systems both implemented a pull-system, but the program was not targeted at improving the factor “frequency of new product introduction”. Comparing the four case studies demonstrates that the difference can be traced back to the variety of the product portfolio. The broader the product portfolio, the higher the complexity employees face in translating each of the product requirements into manufacturing processes. The higher the transparency of the manufacturing processes, the easier it is to translate the requirements of an additional product into manufacturing processes. Each of the companies stated that the implementation of pull-system has led to a higher process transparency. Therefore, we conclude that the implementation of pull-system helps companies with broad product portfolios reduce the trade-off from the factor “frequency of new product introduction”.

Another difference encountered concerns the program integration of product development and production, and its potential to reduce the trade-off resulting from the factor “order size flexibility”. Tool Ltd., Printer Board Ltd. and Pipe Systems have implemented the program, but in comparison to the other two companies, Pipe Systems does not address the factor “order size flexibility”. The reasoning explained is the automation level. The higher the automation level in manufacturing, the lower the influence of the employees on the processes. To be able to fulfill the flexibility requirements, Tool Ltd. and Printer Board Ltd. need skilled employees who can easily implement the changing requirements. This influence is not identical at Pipe Systems, given the high automation level where flexibility is not similarly influenced by the employees.

Finally, the potential of the program of continuous improvement to reduce the “frequency of new product introduction” reveals another difference. Printer Board Ltd. and Cable Ltd. explain that, based on process improvements, free capacity can be generated. Free capacity, in turn, is needed to implement new products. While, as described, free capacity pulls new product introduction, another situation exists at Pipe Systems. The new product introduction is managed from top down and the influence of manufacturing is low. Therefore, we suggest that the program continuous improvement does support the factor “frequency of new product introduction” if the company’s decision line is not merely top down, but influenced by manufacturing.

Conclusion

Theoretical implications

The need to manage multiple competitive priorities simultaneously was demonstrated in various articles. However, the effects of these situations on manufacturing strategy content is a rather underdeveloped area. The analysis shows that the competition on multiple competitive priorities can

be successful. However, an active consideration of the influence of contextual factors and possible trade-offs is needed.

Manufacturing strategy is often treated as an a-contextual situation. However, internal and external contextual factors influence manufacturing strategy content and, therefore, must be included in manufacturing strategy theories. A trade-off between two factors is not present in every situation; it is, indeed, situation specific. In addition, the influences of action programs differ in dissimilar contexts. In some companies the implementation of an action program supports the reduction of trade-offs, in other companies different results are achieved. The study shows that companies can choose consciously which trade-offs they want to address and decrease (Clark, 1996) but have to control the indirect relationships between the different action programs to not influence other trade-offs negatively with the chosen action. Corresponding to contingency theory, external factors and internal structures must be aligned in order to be successful.

Furthermore, the analysis of trade-offs has to be holistic. The activities implemented to minimize a trade-off between two factors can still influence another factor. We exemplified how the process of overcoming trade-offs has to be approached.

In support of Da Silveira and Slack (2001), the analysis shows that trade-offs are perceived to exist and that they are a central to how managers approach the process of improvement. To reach a high performance level in multiple performance indicators simultaneously, trade-offs have to be identified and, based on an active behavior, minimized.

Competing on multiple competitive priorities simultaneously is challenging. In addition to aligning the manufacturing strategy content to contextual factors, the analysis shows that the decision categories have to embrace two dimensions: structural/infrastructural decisions and action programs. Both dimensions are needed to implement the requirements of multiple competitive priorities. We demonstrate that in order to compete on multiple competitive priorities simultaneously, a concentrated action in both decision dimensions is needed. We claim that manufacturing strategy theory has to include both equally important dimensions. The results underscore the importance of aligning project goals and project portfolios with a broader strategic imperative. Successful organizational coordination needs the alignment of contextual factors, strategic goals and coordinated actions.

Practical implications

The need for addressing multiple competitive priorities simultaneously is challenging. Companies successfully addressing the requirements must have transparent manufacturing strategies and be aware of the effects and interdependencies. First of all, contextual factors must be analyzed and their influence considered. Competitive priorities have to be aligned to customer needs and possible trade-offs accounted for. Combining factors which negatively influence each other can have a negative influence on multiple performance indicators. It is, therefore, crucial to be aware that an improvement

of a priority can be achieved through a specific investment, but that these actions may lead to a decrease in the performance of other factors. Depending on the market position, it can be more profitable to accept the level of market performance of such a priority as opposed to negatively influencing other factors.

Our study suggests that a suitable combination of action programs and structure supports achieving a strong market performance on multiple performance dimensions.

Limitations and further research

The in-depth analysis of four Swiss manufacturing companies provided insight into how multiple competitive priorities can be addressed simultaneously. We demonstrated that contextual factors influence the existence of trade-offs and the influence of action programs. These preliminary results will be tested on a larger data set to determine if any patterns can be identified between contextual factors and trade-offs, as well as the combination of contextual factors and the influence between action programs and the strategic goals. Finally, it needs to be tested if differences in geographical terms exist.

Another limitation concerns the lack of quantitative key performance indicators. However, each of the interview partners has worked more than ten years at the analyzed companies and has excellent market knowledge. In order to overcome possible employee bias, each dimension was explained and both interviewees had to come to the same conclusion. Future studies should consider the inclusion of quantitative data in measuring the changes discussed.

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Figures and Tables

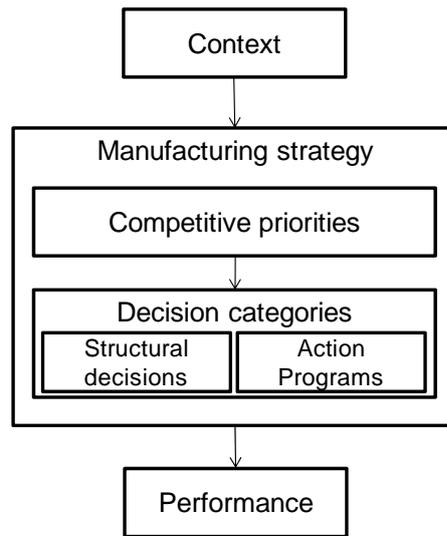


Figure 1: Manufacturing strategy framework

	Cable Ltd	Pipe Systems	Printer Board Ltd	Tool Ltd.
Company size	1000 employees, 5 plants	1500 employees, 5 plants	2200 employees, 7 plants	450 employees, 4 plants
Geographic focus	International	International	International	International
Network	Global network	Global network	Global network	Small network
Distribution network	No stock	Stock owned by sales representatives	No stock	Stock owned by Tool Ltd.
Dependence on third party	Low (strong internal network)	Low (strong internal network)	Low (strong internal network)	High (collaboration with suppliers important)
Product characteristics	Modularized	Standardized	Individualized products	Standardized
Product portfolio	Low product mix	Low product mix	High product mix	High product mix
Plant layout (automation level)	Low automation level	High automation level	Low automation level	Medium automation level

Table 1: Overview of contextual factors

		Cable Ltd			Pipe Systems			Printer Board Ltd			Tool Ltd		
Competitive priorities		A	B	C	A	B	C	A	B	C	A	B	C
Price	Low price	3	-	No	4	-	No	4	X	No	3	-	No
Quality	Conformance quality	4	X	Yes	5	X	Yes	4	X	Yes	4	X	No
	Product design and quality	4	X	Yes	5	X	Yes	4	X	No	4	X	No
Delivery	Fast delivery	4	X	Yes	3	X	Yes	5	X	Yes	5	X	Yes
	Dependable delivery	4	X	No	5	X	Yes	5	X	No	5	X	No
Flexibility	Wide product range	4	X	Yes	4	X	Yes	3	X	Yes	4	X	Yes
	Order size flexibility	4	X	Yes	3	X	Yes	5	X	No	3	X	Yes
Innovation	Innovative product	4	X	Yes	5	X	Yes	2	-	No	4	X	Yes
	Frequency of new product introduction	3	X	Yes	4	X	Yes	4	X	Yes	4	X	Yes
Sum of the competitive priorities			8	7		8	8		9	5		9	6

Legend:
A= Importance from 1 (low) to 5 (high)
B= Company aims at (X = yes/ - = no)
C= Better than competitor

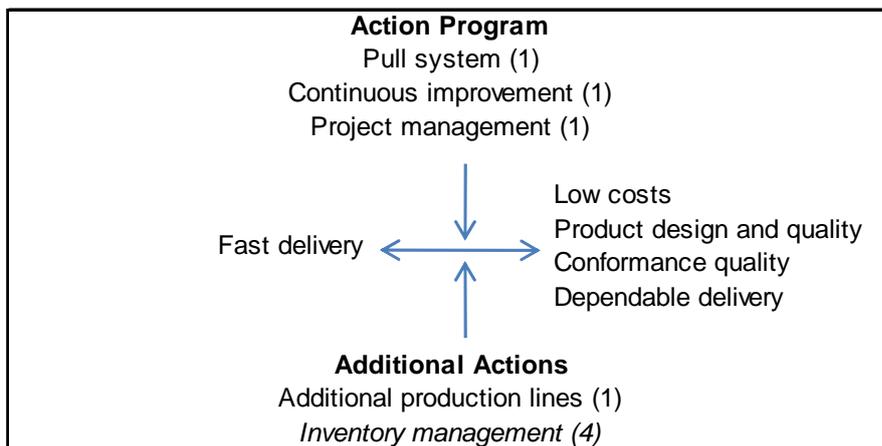
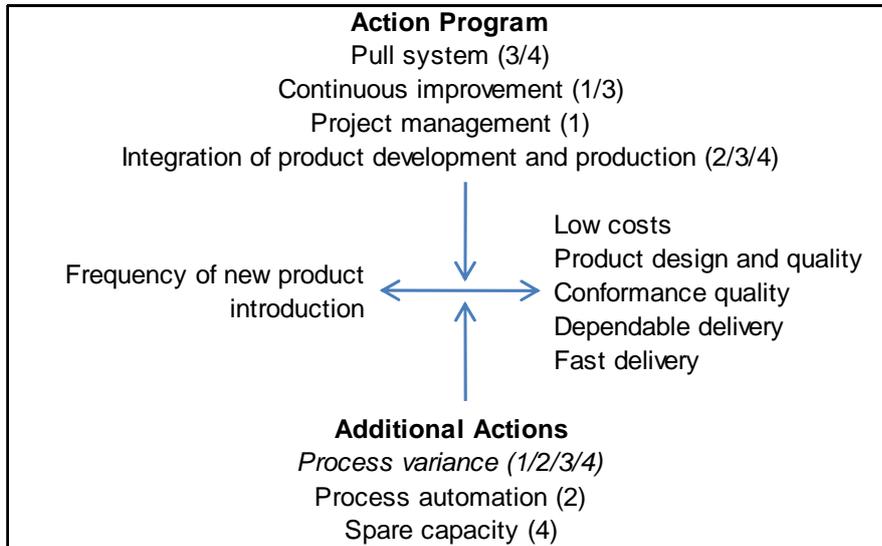
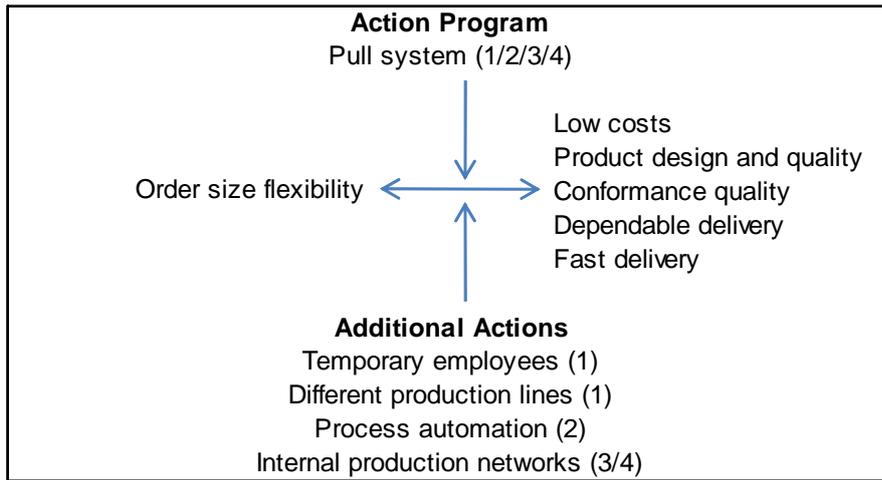
Table 2: Competitive priorities of the four companies and performance

Action Programs	Company			
	Cable Ltd	Pipe System	Printer Board Ltd	Tool Ltd
Pull-System	X	X	X	X
Continuous Improvement (Kaizen)	X	X	X	
Project Management	X			
Integration between Product Development and Manufacturing		X	X	X

Table 3: Overview of the analyzed programs

Competitive Priorities	Competitive Priorities								
	Low price	Product design and quality	Conformance quality	Dependable delivery	Fast delivery	Wide product range	Frequency of new product introduction	Innovative product	Order size flexibility
Low costs					2		4		4
Product design and quality					1		4		4
Conformance quality					1		4		4
Dependable delivery					1		4		4
Fast delivery							4		4
Wide product range									
Frequency of new product introduction									
Innovative product									
Order size flexibility									
Legend:									
Number = valid for X companies									

Table 5: Sum of the encountered trade-offs between competitive priorities



italic = negative influence on trade-off

1= Cable Inc.
2= Pipe Systems
3= Printer Boarder Ltd.
4= Tool Ltd.

Figure 2: Trade-offs and initiatives