A MODIFIED WORK PROCESS FOR MANUFACTURING STRATEGY FORMULATION: A CASE STUDY OF A SMALL INDUSTRIAL COMPANY IN SWEDEN

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Abstract: Manufacturing is a crucial part to organisational success in an industrial SME, and therefore manufacturing strategy formulation is of great importance for small businesses. Recent research suggests that there is a need to adapt frameworks and procedures for manufacturing strategy formulation to small- and medium sized companies. This study describes a modified work process, which was also tested for formulation of manufacturing strategy formulation in a small industrial company in Sweden.

Keywords: Small- and medium-sized companies, SME, production, framework

1. INTRODUCTION

The potential contribution of small- and medium-sized enterprises is enhanced through new technologies and globalisation. According to the Organisation for Economic Co-operation and Development (OECD, 2000), smaller companies need to upgrade their management skills, their capacity to gather information and their technology base. Small- and medium-sized companies (SMEs) are different than larger companies when comparing key characteristics (Hudson *et al.*, 2001). Key characteristics for small- and medium sized companies according to Hudson *et al.* (2001):

- personalised management
- flat, flexible structures,
- severe resource limitations,
- reactive, fire-fighting mentality
- informal, dynamic strategies
- high innovatory potential
- reliance on a small number of customers.

The more dynamic, emergent, strategy styles in SMEs and the limited resources contribute to substantial barriers to strategy development (Hudson *et al.*, 2001). Strategy development as well as manufacturing strategy development is important to any type of enterprise (Slack and Lewis, 2011). As manufacturing operations are crucial to organisational success in an SME (Barnes, 2002), manufacturing strategy formulation is of great importance for a small business. However, most studies of manufacturing strategy focus on large organisations and manfaturing strategy research on SMEs is thus a neglected area (Barnes, 2002). Manufacturing strategy formulation is in many contributions viewed as frameworks, but also as procedures (Lindström, 2008). Additionally, most manufacturing strategy formulation processes are prescriptive and they are mostly adapted for larger companies (Löfving *et al.*, 2014). However, there is one prescriptive study of small- and medium sized company that suggests a modified framwork for formulation of manufacturing strategies (Säfsten and Winroth, 2002). The recent study by Löfving *et al.*, 2014, suggests that there still is a need to adapt frameworks for manufacturing strategy to better fit the characteristics of SMEs. In line with this suggestion, the case study presented in this paper was conducted to study the application of the prescriptive framework developed by Miltenburg (2005) for the formulation of manufacturing strategy. The reasons for choosing the framework

developed by Miltenburg (2005) are that it is well known and based on knowledge within the area of manufacturing strategy, and that the work process begins with the current situation of a specific company. Thus, the framework by Miltenburg (2005) is applicable to case studies.

The case company needed to formulate a manufacturing strategy for the company's production. Because the plant was bought and restarted in year 2010 and parts of the business being new to the company, the topic was considered extra relevant. The overall project goal was to deliver a manufacturing strategy containing guidelines for how the production unit should change. However, in order to deliver a manufacturing strategy unique for the specific case company, a tool was needed to guide the formulation. This paper presents the modified work process for formulation of manufacturing strategy in the case company. Similar to the framework of Miltenburg (2005), the overall formulation process or methodology consists of three questions or steps:

1. Where am I?
2. Where do I want to be?
3. How do I get from where I am to where I want to be?

After the introduction, the chapter methodology and case description comes next, followed by literature review on manufacturing strategy, presentation of the modified work process, outcomes of the application of the modified work process, conclusion, and finally references.

2. METHODOLOGY AND CASE DESCRIPTION

The study presented in this paper is part of a larger study that includes the application of the modified work process, i.e. formulation of manufacturing strategy for some product families in the case company. The larger study comprises of the steps: 1) Planning and pre-study, 2) Literature review, 3) Development of a framework or work process for formulation of manufacturing strategy, and 4) Application. The study presented in this paper corresponds to step 3, Development of a framework or work process for formulation of manufacturing strategy.

2.1. Case as methodology

A case study is an empirical inquiry and comprises a real-life context in which the phenomenon can be studied and where the boundaries between the phenomenon and the context are not clear (Yin, 2003). Moreover, the case study allows the questions how, why, and what to be answered with a rather full understanding of complexities and exploratory investigations where variables are still unknown and the phenomenon not at all understood (Voss *et al.*, 2002). Qualitative case studies aim at insight, discovery, and interpretation (Merriam, 1994). The application of a case study can be to explain presumed causal links in real-life interventions, or to describe an intervention in a real-life context; the case study can illustrate certain topics, explore situations where the intervention occurred, and be a study of an evaluation study (Yin, 2003).

The question asked for this study was: How could the manufacturing strategy be developed? Which method / framework should be used? The case study presented here is an abductive case study where both empirical observations and interviews as well as theoretical literature review have influenced the development of the work process for manufacturing strategy formulation.

Collection of data
Data collection can be divided into two categories according to Cooper and Schindler (2008); observing study and communication study. The facts presented in this study have mainly been collected through interviews, therefore it is mainly a communicative study. The description that follows below of the case company is translated from Swedish and rewritten from the master thesis by Habib and Torstensson (2013).

2.2. The case company

The case company started its manufacturing of electrical engines in 1948 and it had as most more than 300 employees. Four years ago, the factory was closed down, but it was bought by a new owner who first started a company for stocking products. After a while, the new owner re-started the manufacturing of electrical engines. The case described in this paper studied the two businesses of manufacturing of electrical engines and contract manufacturing. The manufacturing of electrical engines started again at a small volume. The company consists today of about 30 employees and has a turnover of approximately 33 million SEK. 85 % of the turnover relates to manufacturing of electrical engines and the rest to contract manufacturing. Electrical engines can be divided into four different categories or engine families. The largest product family consists of about 200 different models. The

total number of models including spare parts is 6000. Contracts manufacturing can be divided in three categories after ordering value from customers. The facility and machines are dimensioned for a higher volume than the two businesses perform today. The company has an ambition of raising the volumes to use the machines and facilities better.

The layout of the production system is functional, like a job-shop, and divided into punching, diecasting, welding, grinding, turning, milling, cutting, winding, and assembly. The manufacturing process consists of the whole process from raw material to finished engine. From a strategic point of view, the company wants to position itself as a manufacturer of small series to avoid to compete with larger manufacturer of electrical engines. A small serie amounts up to 1000 engines per year. The larger manufacturers produce large volumes of engines and can therefore cut prices and compete on price/cost rather than flexibility. The case company also sells many of its models as spare parts. Spare parts are manufactured after customer order (Make-To-Order, MTO) and often manufactured individually. Because of high start-up costs for a sepcific engine model, a larger volume than ordered is produced. The effect is a big inventory of finished components and finished engine models. Some engine models are produced in higher volumes from known customers that order engines by forecast. The aim of the company is to increase the turnover from about 40 million SEK to 100 million SEK in three years. This goal requires a clear fomulated manufacturing strategy that supports the management of conflicts and problems.

3. LITERATURE ON MANUFACTURING STRATEGY

Manufacturing strategy consists of the two parts or subcategories *content* and *process* (Swink and Way, 1995) and it could be understood as the pattern of decisions actually made (Hayes *et al*., 2005). The decisions that are made are generally considered to be either structural or infrastructural (Slack and Lewis, 2011). Manufacturing strategy content can be specified as as *distinctive competences employed* (Swamidass and Newell, 1987) or *what is decided* (Leong *et al*., 1990) whereas manufacturing strategy process adresses *how decisions are reached* (Leong *et al.*, 1990).

3.1. Manufacturing strategy content

Slack and Lewis (2011) define structural issues as influencing physical arrangements and configuration of resources, whereas infrastructural issues influence activities that take place within the operation's structure. According to Hayes and Wheelwright (1984) there are four structural decision categories due to their long-term impact: capacity, facilities, technology, and vertical integration. Furthermore, four other decision categories form a more tactical approach: workforce, quality, production planning/materials control, and organization.

Manufacturing strategy also means developing policies that must be compatible with future requirements of customers and markets, translating these needs into the competitive priorities quality, dependability (delivery performance), flexibility, and cost (Hayes and Wheelwright, 1984), speed (Slack and Lewis, 2011), innovativeness (Leong *et al.*, 1990; Miltenburg, 2005), performance (Miltenburg, 2005), and service support (Bicheno, 2004). Competitive priorities may be defined as a set of goals for achieving the manufacturing mission (Leong *et al.*, 1990).

3.2. Manufacturing strategy process

The process of manufacturing strategy is often depicted as rational and analytical, but, as Platts and Gregory (1990) point out, the process is both deliberate and emergent because of its relation to how and when to promote change. Further, the process of manufacturing strategy is categorized into two elements; formulation and implementation (Swamidass and Newell, 1987; Leong *et al.*, 1990; Voss, 1992; Swink and Way, 1995). This view tends to be rather common in the manufacturing strategy literature, but Platts and Gregory (1990) view the process in five stages: (1) specification of manufacturing objectives, (2) formulation of manufacturing strategy, (3) detailed manufacturing systems design, (4) implementation, and (5) operation. As the main focus of this paper is on formulation of the strategy process, the following review will focus on manufacturing strategy formulation.

Manufacturing strategy formulation
Formulation of strategies is defined by Platts (1990) in this way:

> "*The strategy formulation process seeks to identify action plans which will use the organisation's strengths to exploit opportunities while minimizing its vulnerability to threats"* (Platts, 1990, p. 12).

As Lindström (2008) points out, manufacturing strategy formulation may be described by frameworks or procedures. There are several frameworks and procedures presented in the research literature, for example the Skinner process (Skinner, 1969), the Hill framework (Hill and Hill, 2009), the Platts and Gregory procedure (Platts and Gregory, 1990), the Miltenburg process (Miltenburg, 2005), the manufacturing vision process (Riis and Johansen, 2001), and the StratNav process (Baines *et al*. 2005; Baines, 2008). As the work presented in this paper is based on the framework by Miltenburg (2005), the following description is a brief presentation of the Miltenburg process.

The book by Miltenburg (2005) outlines a general process for formulation of manufacturing strategy where three issues are examined, namely (1) where manufacturing is, (2) where manufacturing needs to be, and (3) what is the best way to move manufacturing from where it is to where it needs to be. Each step interacts with every other step and the interactions can be seen in the worksheet for visualizing the process, Figure 1. The worksheet is, for example, used for analysing a factory, for generation and evaluation of alternative strategies, and to develop a manufacturing strategy. The three-step procedure uses the worksheet in the following way:

1. In step 1 (where manufacturing is), quadrants 1 and 2 in Figure 1 are used to determine the current production system in use and to assess the current level of capability for each manufacturing lever.
2. In step 2 (where I want to be), quadrants 3 and 4 in Figure 1 are used for completion of a competitive analysis for determining market-qualifying and order-winning criteria, to find the best matching manufacturing deliverables compared with manufacturing outputs, and to determine a new production system.
3. In step 3 (how I will get from where I am to where I want to be), quadrants 1, 4, 5 and 2 in Figure 1 are used for making adjustments to the manufacturing levers. These adjustments to the manufacturing levers should support changes to the desired production system, and to the required market-qualifying and order-winning outputs.

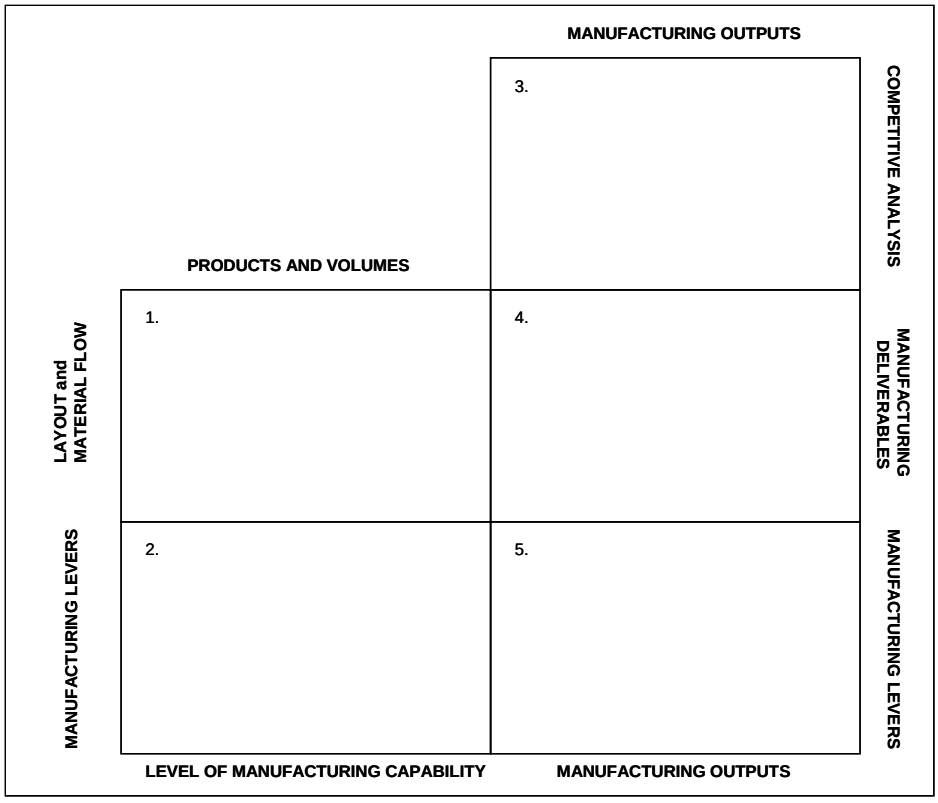

Fig. 1. The Miltenburg worksheet (adopted from Miltenburg, 2005).

Many of the examples that Miltenburg (2005) gives in his book are case studies in large companies. Frameworks or procedures for formulation of manufacturing strategies in small- and medium-sized enterprises are rare, but one example is the analysis model described and presented by Säfsten and Winroth (2002).

Manufacturing strategy formulation in small- and medium-sized companies
Based on the Miltenburg procedure, Säfsten and Winroth (2002) describe a modified analysis that consists of five steps. The first three steps is a survey of the current position:

1. The survey of the current manufacturing capability. Positioning of the capability into one of the four levels, ranging from 'infant' to 'world class'.
2. The 'five manufacturing systems' plus Flexible Manufacturing Systems, FMS, and Just-In-Time, JIT.
3. Which factors are considered important for the company's competitive ability? Where are the competitors and where does the company want to be?

The last two steps comprise an analysis of the congruence between the production system and the manufacturing strategy (Säfsten and Winroth, 2002):

4. Each manufacturing system shows different support for the competitive factors. Does the present manufacturing system support the competitive priorities of step 3?
5. Identify possible and suitable changes. Does the analysis imply that the manufacturing system should be changed or that there is a mismatch between the decision areas of the manufacturing capability study in step 1?

In the first step described above, Säfsten and Winroth (2002) use the same criteria, both for the overall level as well as for each decision area, for assessing manufacturing capability as Miltenburg (2005). In the second step of the proposed procedure, the purpose is to determine where the company is today in terms of productions system layout and flow. Also here, Säfsten and Winroth (2002) suggest the use of the PV-LF (Products and Volumes – Layout and Material flows) matrix (quadrant 1 in Figure 1) presented by Miltenburg (2005), including the productions systems FMS and JIT. In step 3, a competitive analysis is made with support of competitive priorities. The competitive priorities presented in the analysis model are *delivery, cost, quality, flexibility*, and *innovativeness*. The two presented case studies describe attributes that are derived from the chosen competitive priorities. In step 4 where the match between the current siuation and the preferred direction is analysed, Säfsten and Winroth (2002) present an evolved analysis model, which differs from the analysis model presented by Miltenburg. Säfsten and Winroth (2002) suggest an analysis model of manufacturing deliverables with two levels of support; 'supportive' and 'partly supportive'. Miltenburg (2005) on the other hand presents an analysis model of manufacturing deliverables with six levels ranging from very poor to very good. The levels of manufacturing deliverables should measure how well the current production system matches chosen competitive priorities and their attributes. The last step, step 5, identify possible and suitable changes. If there is a mismatch discovered in step 4, the company needs to investigate whether the production system or the manufacturing strategy is failing (Säfsten and Winroth, 2002). Säfsten and Winroth (2002) conclude that SMMEs (small and medium-sized manufacturing companies) have limited resources and that the ability to carry out a deeper analysis of manufacturing strategy is supported by their suggested analysis model.

4. THE MODIFIED WORK PROCESS

Similar to the Miltenburg (2005) procedure, the suggested work process presented here should be done in the three steps:

1. Survey of the current manufacturing capability and position of the current production system.
2. Competitive analysis and determination of market qualifying and order winning criteria and attributes.
3. Analysis of chosen product families, matching capabilities and production system with manufacturing outputs.

The overall three steps can be seen in Figure 2. The overall procedure that consists of the three steps described above is described as a more detailed procedure where step 1 consists of six sub-steps, step 2 consists of three sub-steps, and finally step 3 that consists of three sub-steps (see Figure 2).

4.1. Step 1Where am I?

This first step consists of a description where the studied product families are positioned today.

Step 1A – Study the products and customers of the company
The purpose of this step is to decide the current position of the investigated product family on the PV axis in the PV-LF matrix.

Step 1B – Examine the production layout
This step focuses on the current factory layout. Through a description of the factory layout, the LF axis in the PV-LF matrix can be partly decided. See next step.

Step 1C – Study material flows of the factory
This step finishes the determination of the LF axis in the PV-LF matrix, namely to study material flows of the focused product family.

Step 1D – Describe current capabilities
To get a good idea of current capabilities, a description of the current situation of every decision category is done.

Step 1E – Identify current production system
According to Miltenburg (2005), every decision category has specific characteristics for each production system in the PV-LF matrix. In this step, a comparison of every decision category in the previous step is done and it's 'match' to a specific production system. Each decsion category gets a value, see table 1, depending of which production system it matches. If a decision category is described in more than one production system, an average value is given.

Table 1. Values of the production systems for identification of current production system.

Production system	Job shop	Batch flow	Operator-paced line flow	Equipment-paced line flow	Continuous flow
Value	1	2	3	4	5

By summing up the total score for each product family and divide with the number of decision categories (six according to Miltenburg (2005)), an average value is given which indicates the current production system in use for a specific product family.

Step 1F – Identify current position in the PV-LF matrix
The purpose of this step is to visualize the result of the steps 1A-1E as a position in the PV-LF matrix for each product family.

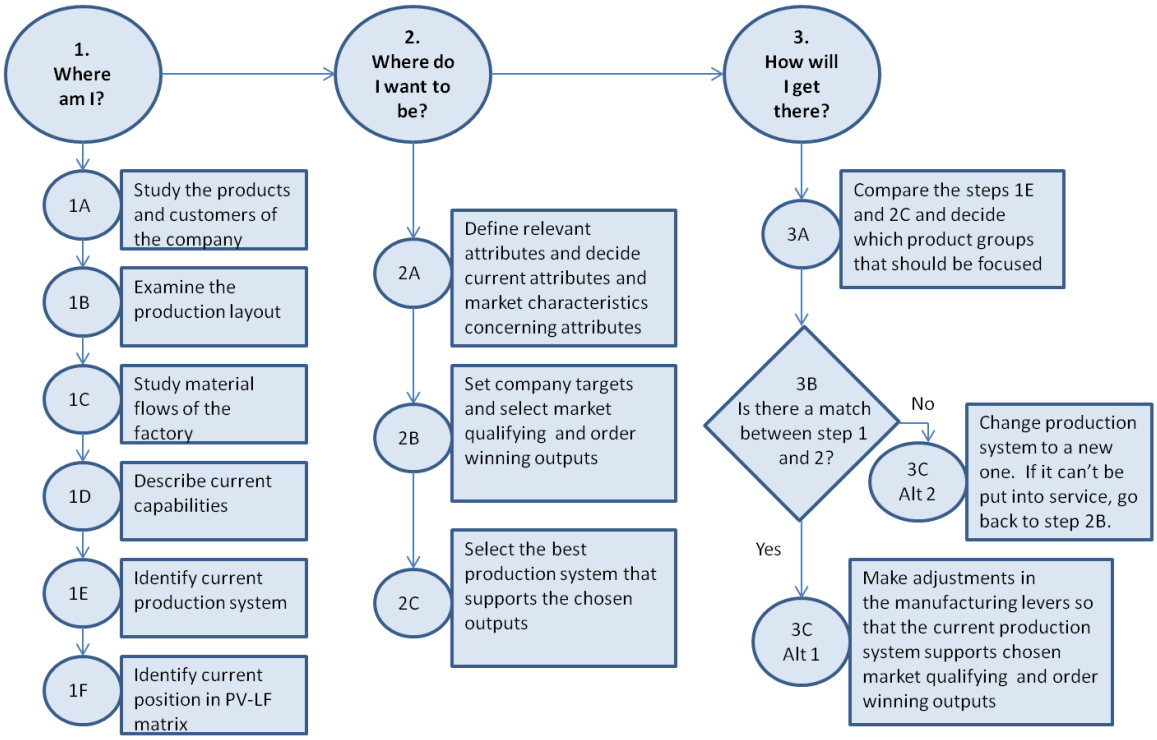

Fig. 2. The modified work process based on Miltenburg (2005) and translated from Habib and Torstensson (2013).

4.2. Step 2 Where do I want to be?

The second step of the work process is a competitive analysis including setting aims and making approriate priorities in line with the terms market qualifying criteria and order winners (see sections 3.1 and 3.2).

Step 2A – Define relevant and current attributes and market characteristics
Similar to the process described by Miltenburg (2005), the purpose of this step is to choose important competitive priorities (called manufacturing outputs by Miltenburg, 2005) and attributes. Attributes is a kind of measures related to a specific manufacturing output.

Step 2B – Set company targets and select market qualifying and order winning outputs
In this step, company targets are set. Thereafter each competitive priority is classified in either market qualifying, order winning criteria, or none.

Step 2C – Select the best production system that supports the chosen outputs
With the help of defined manufacturing deliverables (see quadrant 4 in Figure 1), a best matching production system to chosen competitive priorities can be found. However, during the described case study it was found that the manufacturing deliverables defined for the competitive priority 'quality' didn't match the definitions made by employees in the case company. Therefore, the competitive priority 'quality' was not used and instead a different competitive priority called 'conformance to a specification' was used.

4.3. Step 3 How will I get there?

Similar to the Miltenburg (2005) procedure, the purpose of this step is to find out how the company should get to where they want to be. Except the steps that Miltenburg suggests, this work process has added step 3A where priorities are made between the studied product families.

Step 3A – Decide which product groups that should be focused
Compare steps 1E with step 2C and decide which product groups that should be focused and if there are product groups that could be put together, or if a product group should be managed separately.

Step 3B – Is there a match between step 1 and 2?
If the production systems are the same in step 1E and 2C, the current production system should be kept. If the production systems differ, more major changes are needed (see alternatives 1 and 2 below).

Step 3C Alt. 1 – There is a match between steps 1E and 2C
When the production system is the same in both steps, make adjustments in the decision categories so that the match increases between the chosen production system and the manufacturing levers, so that the production system better supports order winner(s) and market qualifiers.

Step 3C Alt. 2 – There is no match between steps 1E and 2C
If the production system does not fulfil the order winner and market qualifiers, either change production system or go back to step 2B and change competitive priorities. A change of production system means that the company needs to change the way they manufacture a specific product group.

5. OUTCOMES FROM THE APPLICATION OF THE MODIFIED WORK PROCESS

The execution phase, i.e. application of the modified work process for formulation of manufacturing strategy, of the overall case study started with an analysis of the products, the manufacturing process and the current production systems. The next step was to analyze the market. The market analysis was done by interviewing the company's president. The last step was to use adapted theories to identify gaps between competitive priorities and the current state and to formulate guidelines for improvement. The result of the overall case study was a process for developing a strategy tailored for the company (presented in this paper) and specific suggestions for each product family for what to focus on long term.

6. CONCLUSION

For a SME with limited resources, there could be major barriers to overcome to formulate a manufacturing strategy. However, as manufacturing contributes to a very important part of the business of a SME, formulation of manufacturing strategy ought to be a prioritized area. Despite the limited number of cases, this study contributes to the research on adjusting prescriptive frameworks and procedures on manufacturing strategy formulation to SMEs.

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