

Quantification in manufacturing strategy: A methodology and illustration

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Abstract

Strategic decision-making is often based on conceptual and qualitative models. Considering the vast amount of quantitative models in the literature, it is most interesting and important to explore the possibilities to expand the modelling base for decision-making with quantitative models that can provide deeper analysis, new insights and allow for finer sensitivity analysis. The purpose of this paper is to explore various aspects of quantification in manufacturing strategy-related issues. We review current approaches to quantitative modelling and study how quantitative models are being used and can be used for strategic decision-making in manufacturing. We create a framework and methodology for quantitative modelling for manufacturing strategy, based on market requirements, manufacturing capabilities, manufacturing actions within decision categories, and quantitative modelling approach. The framework methodology includes seven stages of quantification, for the purpose of measuring, linking, comparing, and modelling. The aim of the paper is to provide a structure that can aid in the modelling of strategic manufacturing decisions to improve the capabilities to meet market requirements.

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1. Introduction

The competitive position of manufacturing firms is based on the ability to create strategic alignment between market opportunities and manufacturing capabilities. This is the foundation for manufacturing strategy. In order to support analyses and decision-making in manufacturing, the use of quantitative modelling can help understanding the current structure and to assess the consequences of proposed actions, and even to identify manufactur-

ing-based sources of competitiveness. The manufacturing strategy domain has been and is dominated by conceptual models. On the other hand, quantitative modelling has a long history in operational research to solve real-life problems in operations management. In general, quantitative models are based on a set of variables that vary over a specific domain, while quantitative and causal relationships have been defined between these variables (Bertrand and Fransoo, 2002). In manufacturing strategy, causal relationships would be concerned with control variables relative performance variables related to market requirements such as quality, price, delivery speed and reliability,

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product range, customisation, and innovativeness. However, the area of manufacturing strategy is not without examples of quantitative modelling.

In this paper we review various approaches to modelling manufacturing strategy structure and interactions, in search of general principles for quantitative modelling in this application area. This forms the foundation for a quantitative modelling framework and methodology that can guide manufacturing strategists in the quest to understand, control and improve manufacturing operations. This paper is organised as follows. First, we give an overview of manufacturing strategy in terms of manufacturing capabilities and decision categories. Then, we review quantitative modelling approaches in general and provide some examples for strategic manufacturing decision-making. Finally, we present the proposed framework for quantitative modelling for manufacturing strategy that provides a structural methodology for developing models.

2. Manufacturing strategy

Manufacturing strategy as a concept was first recognised by Skinner (1969), referring to a manufacturing strategy as to exploit certain properties of the manufacturing function to achieve competitive advantages. Hayes and Wheelwright (1984) define manufacturing strategy as a consistent pattern of decision-making in the manufacturing function linked to the business strategy. Swamidass and Newell (1987) describe manufacturing strategy as a tool for effective use of manufacturing strengths as a competitive weapon for achievement

of business and corporate goals. Platts et al. (1998, p. 517) develop a working definition: “...a pattern of decisions, both structural and infrastructural, which determine the capability of a manufacturing system and specify how it will operate, in order to meet a set of manufacturing objectives which are consistent with the overall business objectives.” Leong et al. (1990) identify one major difference between manufacturing strategy research and the business strategy ditto. Within business strategy research a clear distinction between research on the content of strategy and research on the process of strategy has been present for a long time. In their literature review Dangayach and Deshmukh (2001) classify a total of 260 articles on manufacturing strategy from 31 refereed international journals and conferences into content and process-related issues finding that content-related articles accounts for almost 91 percent, indicating that research on manufacturing strategy formulation is limited. First we will discuss a content model and then a strategy development process model will be presented.

2.1. Manufacturing strategy content

Manufacturing strategy content is here viewed as consisting of market requirements and manufacturing decision categories and capabilities, as illustrated in Fig. 1. Leong et al. (1990) describe manufacturing strategy content as consisting of two elements: decision areas that are of long-term importance in the manufacturing function, and competitive priorities based on corporate and/or business unit goals. Similar structures are used by

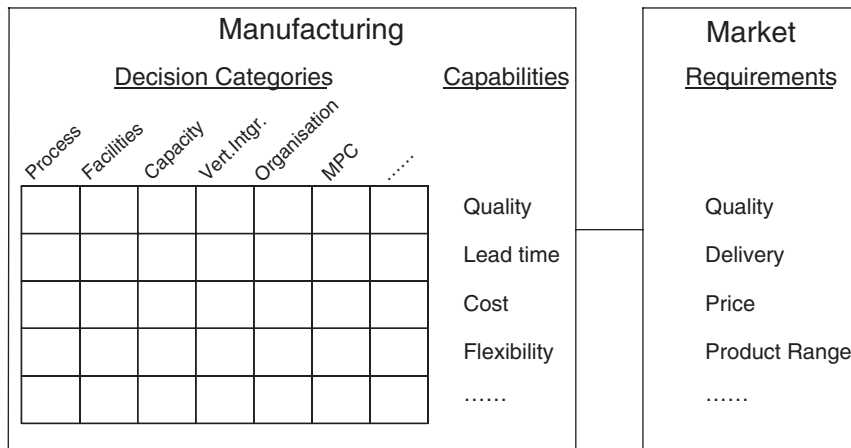


Fig. 1. Manufacturing strategy content view: integrated patterns of actions in decision categories to achieve manufacturing capabilities supporting market requirements.

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