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Planning and scheduling in the automotive industry: A comparison of industrial practice at German and Japanese makers ☆

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ABSTRACT

Providing customization of products is an important way of attracting customers, but it can increase the complexity of planning and scheduling processes in the order fulfilment system. Thus the question arises, how product variety, manufacturing conditions and managerial practices interact with the planning and scheduling functions of a firm. In order to improve this understanding, we compare the order fulfilment system of German and Japanese auto makers as a sample of industrial practice. From 2007 to 2012 we engaged in a total of 56 interviews related to planning and plant scheduling functions in both sales and operations activities to analyse similarities and differences between German and Japanese auto makers. As part of this research we conducted two in-depth case studies at one German and one Japanese auto maker to map planning and scheduling functions along the order fulfilment process. Additionally, we relate those findings with secondary data sources. Our sample reveals a great variation in manufacturing conditions, product variety, and managerial practices in order fulfilment at Japanese and German auto makers. However, contrary to common perception, planning and scheduling processes differ much less between auto makers even in the light of regional differences concerning order fulfilment, different levels of product variety and mixed-model line manufacturing practice. We conclude with a discussion on variations and similarities between auto makers and the possibility of merging different practices with theoretical advances.

1. Introduction

The transition at firms from forecast-driven operating systems towards more responsive ones is still on-going (Christensen et al., 2005; Tomino et al., 2009). Thus the question arises, how regional differences, product variety, manufacturing conditions and managerial practices interact with the planning and scheduling functions along the order fulfilment process of a firm (Holweg et al., 2005; Meyr, 2004; Tomino et al., 2009; Volling and Spengler, 2011). However, the current planning and scheduling landscape is a conglomerate of different activities and tasks run by various organisational departments. For example, it is not unusual to find up to 200 individual IT-systems per auto maker in a traditional assembly plant (Howard and Holweg, 2004). The age of such supportive tools ranges from the earliest introduction of computer systems for industrial planning (e.g. batch-driven MRP host systems) to modern advanced planning methods (e.g. sophisticated car sequencing procedures).

This study aims to improve the understanding of planning and scheduling along order fulfilment in the automotive industry. We provide an overall analysis of processes, activities, and tasks (we will say "functions") related to planning and scheduling at auto makers by applying a categorization method with respect to the time horizon, planning frequency and short functional description. We compare two approaches from Germany and Japan. Much of the literature claimed that there were regional and contextual differences of lean systems in Japan and build-to-order driven-systems in Germany (e.g. Womack et al., 1990; Shah and Ward, 2003; Tomino et al., 2009; Meyr, 2004). We relate the manufacturing conditions, product variety and managerial practices in Germany and Japan and investigate the effects on planning and scheduling functions. In this respect we go beyond previous contributions that are limited to a particular region in the world such as German auto makers (Meyr, 2004), the UK (Holweg and Pil, 2004), and Japanese auto makers (Tomino et al., 2009); limited to specific elements (e.g. car sequencing (Boysen et al., 2009)); or limited to certain

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order fulfilment practices (e.g. build-to-order (Volling and Spengler, 2011)).

Our research questions are:

I. Are there any differences in product variety, manufacturing conditions, and managerial practices at German and Japanese auto makers?
II. If so, what are the implications on the design and management of planning and scheduling functions along the order fulfilment process at such makers?

This paper is set out as follows: We briefly review the literature in Section 2, and provide a framework for studying planning and scheduling functions at auto makers in Section 3. Then, research methods including data collection and evidence analysis are presented in Section 4. General characteristics of order fulfilment, product variety, and planning and scheduling of five German and five Japanese auto makers are described in Section 5. In Section 6 we provide more detailed case studies of one German and one Japanese auto maker. The discussion of theoretical and managerial implications are presented in Section 7. We draw some conclusions in Section 8 and present future research areas and limitations of this paper.

2. Literature review

Different aspects linked to planning and scheduling in the automotive industry have appeared in an interdisciplinary body of literature. For example, the discussion in production economics was driven by the results of MIT's first International Automobile Assembly Plant Study conducted 1985–1990 (cf. MacDuffie et al., 1996) and extended by the debate on mass customization (Rungtusanatham and Salvador, 2008), through which product variety can be delivered to end customers at low costs and with a short order lead-time. Another stream of literature is related to the conception, implementation and the use of IT-systems for planning and scheduling functions such as Advanced Planning Systems (APS), Enterprise Resource Planning (ERP) and/or Supply Chain Management (SCM) software (Gruat La Forme et al., 2009; Stadtler, 2005).

Conventional operations management knowledge recognizes that product variety interacts with the order fulfilment strategy of a firm and causes several challenges in ensuring process efficiency (e.g. Slack et al., 1995). But there is no consensus on the relationship of gain (e.g. profit and market share) and burden (e.g. extra operational efforts, inventory, and overhead) of product variety. Reviews of various perspectives on product variety from marketing, economics and operations are provided by Ramdas (2003) and Lancaster (1990). Future direction of discussions related to the gains and burden was recently explored by Brun and Pero (2012). Following Holweg and Pil (2004), we believe that product variety is one mediator during the order fulfilment process, but the related planning and scheduling functions depend also on other factors, for example manufacturing conditions and managerial practices of a firm.

Much of the literature on automotive operations analyse management practices and manufacturing conditions especially of Japanese makers (e.g. Womack et al., 1990; Fujimoto, 1999; Lander and Liker, 2007). Regional comparisons of performance are well established. However, we believe there is a gap in that previous studies typically include topics such as supplier management (Sako and Helper, 1998), manufacturing performance (MacDuffie et al., 1996), labour productivity and high-involvement work practices (Pil and MacDuffie, 1996) or lean manufacturing (Shah and Ward, 2003), but do not provide any detailed analysis of the related planning and scheduling functions in the order fulfilment system.

For the past fifteen years, almost all auto makers have adapted Japanese-based lean production principles (Lander and Liker, 2007). However, Toyota, the source of lean production principles, has found it difficult to make further improvements (Schonberger, 2007). As competition takes place in multiple dimensions, auto makers need to develop appealing brands and services in addition to excelling in operations and quality. Thus, central decisions lie in selecting the "optimum" or "appropriate" level of variety and how to link customer orders and other demand information to planning and scheduling functions (Pil and Holweg, 2004; Tomino et al., 2011; Volling and Spengler, 2011). While we do not seek to provide a comprehensive review of mass customization, product variety management and/or order fulfilment (Ramdas, 2003; Salvador et al., 2002), it is important to identify how planning and scheduling interact with these areas.

Two mass customization principles have been identified in the automotive industry: (1) design-based (product platforms and modularity), and (2) assembly-/distribution-based (option bundling and late-configuration) (Pil and Holweg, 2004). Benefits of design-based mass customization are closely linked to the order fulfilment principle which the firm follows (Staeblein et al., 2011). Operating in response to customer orders (e.g. demand-driven systems like "build-to-order") or decoupling manufacturing from the receipt of customer orders (e.g. forecast-driven systems like "make-to-stock") has a major impact on potential beneficial effects of design-based mass customization. Pil and Holweg (2004) show that increased flexibility to respond with short-lead times to a variety of customer requests during the manufacturing process can be enhanced by the use of product platforms and modularity. Mutable support structures (such as standardized engine mountings for passenger cars) are able to reduce complexity in operational processes, and create economy of scale advantages (Pil and Holweg, 2004). They also show that such benefits are much more limited in forecast-driven value chains, where product platforms and modularity provide economy of scale advantages only. Assembly- and distribution-based mass customization has a considerable effect on how auto makers operate their order fulfilment system (Alford et al., 2000; Brabazon et al., 2010). A continuum of order fulfilment practices from make-to-stock to build-to-order are used by auto makers (Holweg and Pil, 2001). While American auto makers typically use inventory-driven strategies (see the study of GM's inventory policies by Cachon and Olivares (2010)), European and Japanese makers are in the transition to more customer-oriented systems (Meyr, 2004; Tomino et al., 2009).

The link between order fulfilment and product variety has been subject to research studies in the automotive industry (Fredriksson and Gadde, 2005; Pil and Holweg, 2004). Studies of the order fulfilment process often focus on in-depth analysis of single elements or relationships, for example order acquisition (Forza and Salvador, 2002), car sequencing (Boysen et al., 2009) or the interaction of order fulfilment and master production planning (Volling and Spengler, 2011). Only a few studies investigate the complete order fulfilment process of a firm, e.g. Holweg et al. (2005). Product variety for passenger cars is driven by customization that typically takes place in the dimensions of body styles, engine types, transmissions, colours, trims, and other selectable options, generating an extremely large number of theoretical product variants (MacDuffie et al., 1996; Pil and Holweg, 2004). The difference between the theoretical and actual variety demonstrates that the use of mass customization is not universal, but contingent on the product variety actually requested by customers (Staeblein et al., 2011). Furthermore, Brun and Pero (2012) refer to limitations derived from the implementation of IT-systems for planning and scheduling, which sometimes cannot manage

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