Int. J. Production Economics 131 (2011) 303–312

Contents lists available at ScienceDirect

Int. J. Production Economics

journal homepage: www.elsevier.com/locate/ijpe

Towards theory building in agile manufacturing strategies—Case studies of an agility taxonomy

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ARTICLE INFO

Article history:
Received 20 July 2008
Accepted 17 August 2010
Available online 20 August 2010

Keywords:
Agile manufacturing
Agility
Manufacturing strategy
Technology management

ABSTRACT

Agility is widely accepted in the manufacturing industry as a new competitive concept. However, how to develop a manufacturing strategy based around agility is not fully understood. A numerical taxonomy of agile manufacturing strategies was developed recently by the author, based on a large scale questionnaire study of UK industry. The taxonomy suggested the existence of three basic types of agility strategies: quick, responsive, and proactive. This paper presents a case-based investigation of the practical details of the three basic types of agility strategies. Typical cases from the basic strategy types were chosen and studied to establish why companies choose each type of the strategies, what distinctive agility drivers they are faced with and why, and whether and what typical action programs are used to implement the strategies. A cross-case analysis found that the choice of agility strategies is related to the nature of markets and competition, the characteristics of products (life cycles and degrees of maturity), and market positions of individual companies.

1. Introduction

Two elements are central to the definition of a manufacturing strategy. "Manufacturing task" (Miller and Roth, 1994), concerned with capabilities a manufacturing unit must have in order to compete given the overall business strategy, is represented by a list of competitive capabilities, ranked according to importance. "Manufacturing choices" (Flynn et al., 1999), on the other hand, are concerned with decisions made by a manufacturing unit with regard to its facilities, technology, ways of integration, capacity, organisation, workforce policies, and information systems. The theory is that good fitness between "task" and "choice" will lead to superior performance. The work of Miller and Roth (1994) is widely cited in the literature (Frohlich and Dixon, 2001). Based on 11 competitive capabilities and a taxonomical approach, it identified three types of strategies: marketeers, caretakers, and innovators, commonly used by North America manufacturers at the time. Significant changes have since taken place in the manufacturing industry. A follow-up study using the same set of capabilities (Frohlich and Dixon, 2001) found that while strategies for caretakers and innovators remained in existence the strategy for marketeers had been replaced by new forms of strategies. An important aspect that has not been considered is the emergence of agility as a new competitive concept in the 1990s. Agility recognises the significant impact of increasingly rapid changes from a dynamic business environment on manufacturing (Iacocca Institute, 1991) and argues for the emphasis of capabilities for dealing with rapid changes in a manufacturing strategy (Zhang and Sharifi, 2000; Sharifi and Zhang, 1999). Following the argument, manufacturing task and choices need to be aligned to provide companies with the capabilities of coping with and exploiting changes as opportunities, and good fitness between a manufacturing strategy and changes in the business environment is expected to lead to good performance (Sharifi and Zhang, 2001).

The last 15 years have witnessed the wide spread acceptance of agility as a new competitive concept. Despite this, the question of how to build agility in an organisation remains to be answered satisfactorily. Specifically, what are the capabilities to be developed given different sets of changes in the business environment? Are there different types of strategies that can be adopted? How are they to be chosen? What are the practices/techniques to be implemented for a chosen strategy? This paper presents a case-based investigation of three basic agility strategies, identified from a taxonomical study of UK industry (Zhang and Sharifi, 2007). Typical cases from the strategy types were studied to establish why companies choose each type of strategies, what distinctive agility drivers they are faced with and why, and whether and what typical action programs are used to implement the strategies.

2. Literature

Uncertainty has been a major topic for management research long before the term agility was introduced. Thompson (1967) suggested that the most important task for any organisation is to manage uncertainties. Drucker (1968) described the concept of

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doi:10.1016/j.ijpe.2010.08.010

entrepreneurial task as the search for changes, response to changes, and exploitation of changes as opportunities. Agility as a term reflects a comprehensive response to the business challenges of profiting from rapidly changing, continually fragmenting markets for high performance, high quality, customer configured goods/services (Goldman et al., 1995; DeVor et al., 1997). Work presented in the literature generally consists of researches that focus on manufacturing practices that could be used as enablers of agility and those that focus on integration frameworks to support the implementation. The former includes work on integrated product and manufacturing systems design (Kusiak and He, 1997; Wang et al., 2002; Zhang et al., 2007), dynamic process planning (Feng and Zhang, 1998; Lim and Zhang, 2003), responsive production scheduling (Maione and Naso, 2003; Lim and Zhang, 2004; Lim et al., 2009), flexible facility layout (Montreuil et al., 1999; Goh and Zhang, 2003; Anosike and Zhang, 2009), virtual enterprises (Cao and Dowlatshahi, 2005; Khalil and Wang, 2002), the optimisation of supply chains (Mason-Jones and Towill, 1999; Zhang et al., 2006; Akanle and Zhang 2008), the understanding of consumer dynamics (Zhang and Zhang, 2007), and the creation of empowered/flexible workforces and organisational structures (Crocitto and Youssef, 2003). The latter includes early works describing what agility is, what capabilities are relevant, and what characterises an agile enterprise (Iacocca Institute, 1991; Goldman et al., 1995; Kidd, 1995), as well as subsequent research proposing methodology to support implementations (Dove, 1996; Booth, 1996; Gehani; 1995; Gunasekaran, 1999). Recent work has placed emphasis on theory building with the support of empirical evidences. Sharifi and Zhang (2001), for instance, proposed to implement agility through the analysis of changes taking place in the business environment, the identification of agility drivers that are relevant, and the improvement of agility capabilities in response to the drivers. Yusuf and Adeleye (2002) tested hypotheses assuming linkages between different agility drivers and capabilities through a survey. Cao and Dowlatshahi (2005) examined the impact of information technology and virtual organisation on the performance of agile manufacturers. Most recently, Zhang and Sharifi (2007) discovered, through an empirical study, that there exist three distinctly different agility strategies, each emphasising a different set of capabilities.

3. The agility taxonomy

The taxonomy (Zhang and Sharifi, 2007) was developed based on a conceptual model of agility (Zhang and Sharifi, 2000). According to the model, a manufacturing unit experiences various changes in the business environment (referred to as "agility drivers") which drive it to prioritise "agility capabilities" that need to be developed to cope with and take advantage of changes. This in turn forces the unit to search for manufacturing practices ("agility providers") to obtain the required capabilities. In the context of manufacturing strategy, drivers are the essential driving forces for the unit to rethink about its strategy. Agility capabilities represent the set of capabilities that need to be chosen and prioritised to form the "task" in the strategy. Agility providers are a specialist set of tools and practices from which "choices" in the strategy could be developed. The list of drivers, capabilities, and providers used as constructs in the development of the taxonomy are provided in Table A1 of the Appendix. The constructs were developed from a literature review and refined through exploratory case studies and iterative tests. The detailed literature and development of the constructs are reported in Zhang and Sharifi (2007).

Data used in the development of the taxonomy was obtained from a questionnaire survey, designed to establish the degree of influence each agility driver had on each surveyed company, the importance attached by the company to each agility capability, and the importance placed on each of the agility providers. The sample included 900 UK firms, randomly selected from the Department of Trade and Industry database, with 25% each from auto-parts, aerospace, and electronics sectors, and the remaining from machinery, white goods, food/drink, rubber/plastics, and textiles. It comprised firms ranging from small businesses of less than 50 people to large businesses with over 2000 employees. Annual turnover ranged from under £3 m to over £120 m. The survey, including a pilot stage targeting 200 firms and a main stage targeting 700, resulted in a total of 79 responses, or a response rate of 8.8%. In terms of respondents, 25.9% held the titles of Manufacturing/Operations Directors, 17.2% Engineering Directors, 20.7% Managing Directors, 32.8% General Managers, and 3.4% Quality/Project Managers. Details of the instrument development and data treatment can be found in (Zhang and Sharifi, 2007).

The taxonomy was developed by clustering companies according to relative importance they place on seven agility capabilities: proactiveness, responsiveness to changes, flexibility, quickness, competency, customer focus, and partnership. Three distinct clusters were discovered. Table 1 shows the three clusters in terms of cluster centroid scores and relative ranking for the 7 capabilities. The probability that one or more of the cluster means differ from another is also depicted for each capability. The clusters differed on six variables at the 0.05 level of significance or less. They were interpreted based on (a) whether there are significant differences on the cluster means of the capability variables at 0.05 level or less and (b) relative ranking of the importance of a capability within a cluster. The first cluster was interpreted as "responsive players". They are preoccupied with flexibility and responsiveness to changes. They do not emphasise proactiveness and partnerships and they attach low importance to quickness. The second was named "quick players". They are oriented towards a strong customer focus and quickness. They do not emphasise flexibility and responsiveness to changes and they give the lowest priority to proactiveness and partnership. The third was referred to as "proactive players". They are characterised by high priorities on proactiveness and customer focus, high values for all capabilities, and high importance given to partnerships.

A canonical discriminant analysis was carried out to identify what underlining dimensions actually separated the three clusters, where each cluster was used as criterion variable coded into $3-1=2$ dummies and the 7 capabilities comprised the predictor set (Miller and Roth, 1994). Standardised estimates for both canonical structure loadings and canonical coefficients were obtained, the former representing the correlations of the original variables in the predictor set with an underlying unobserved dimension while the latter being analogous to beta weights in regression that can be used to predict cluster membership. Two canonical functions were found, each corresponding to an underlining dimension. One had a larger absolute correlation with proactiveness (0.643 vs. −0.216), partnership (0.588 vs. 0.025), flexibility (0.213 vs. −0.170), responsiveness to changes (0.371 vs. −0.272), and competency (0.206, −0.075), while the other with quickness (0.561 vs. 0.325) and customer focus (0.538 vs. 0.286). The five variables that function 1 has a stronger correlation with are concerned with capabilities for dealing with changes, either reactively or proactively. It was named "change proficiency" (Dove, 1996). The large canonical coefficients with proactiveness and partnership suggest that firms placing high emphases on the two capabilities will fall at the high end of the dimension. The smaller but positive canonical coefficients with flexibility and responsiveness suggest that firms putting high emphasis on these capabilities may appear somewhere in the middle, while those placing low emphasis on all will likely appear at the lower end. Function 2 has a strong positive correlation with quickness and customer focus and a weaker negative correlation with responsiveness and flexibility. This function is labeled as the "speed to customers" dimension which emphasises