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The development of a lean, agile and leagile supply network taxonomy based on differing types of flexibility

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ABSTRACT

The paper explores the meaning of flexibility in the context of lean, agile and leagile supply networks and articulates a supply network flexibility framework. Two key 'sources' of flexibility are investigated: vendor flexibility and sourcing flexibility. The paper introduces an extension of the 'leagility' concept beyond the simple material flow decoupling point concept. Two new types of leagility are put forward: (1) leagile with vendor flexibility systems, which combine the use of agile vendors with lean sourcing practices and (2) leagile with sourcing flexibility systems, which combine the use of lean vendors with agile sourcing practices. Case studies of two UK based specialist fashion retailers' supply networks are presented in order to gain insights into the sourcing strategies used and the sources of flexibility employed by retailers at supply network level. A new taxonomy that dynamically links vendor and sourcing flexibility with lean, agile and leagile supply network strategies is proposed. We suggest that the proposed taxonomy can be used as a guideline for firms designing and managing parallel supply pipelines that match different operating environments. The findings add to the understanding of the ways in which the two sources of supply network flexibility (vendor and sourcing) interact in practice and provide evidence of the ways in which companies can strike balances between these sources, as well as the effects that can be achieved and some of the trade-offs involved.

1. Introduction

Since the advent of agility (Iacocca Institute, 1991) an academic debate has taken place in order to define it both as a manufacturing paradigm (Gunasekaran, 1999; Yusuf et al., 2003) and as a performance capability (Sharifi and Zhang, 2001; Prince and Kay, 2003), to distinguish it from the lean philosophy (Shah and Ward, 2003; Chase et al., 2004; Narasimhan et al., 2006) and to determine its applicability (Naylor et al., 1999; Vonderembse et al., 2006). In the broader supply chain context, two key concepts are consistently linked to agility: flexibility and speed (Goldman et al., 1995; Yusuf et al., 2003), while lean supply systems are often associated with cost effectiveness and level scheduling (Naylor et al., 1999; Christopher, 2000).

There is little consensus regarding the relationship between agility and flexibility in the literature. Agility, it has been argued, finds its roots in flexible manufacturing systems (Christopher, 2000; Sanchez and Nagi, 2001). Some researchers, however, have suggested that equating agility with flexibility is too narrow an understanding of agility (Goldman et al., 1995; Yusuf et al., 1999). As a result, Swafford et al. (2006) characterise agility as a capability and flexibility as a competence, where capabilities are derived from lower level competencies. Flexibility tends to be used at a lower, more operational level, whereas agility tends to be used at a more encompassing, business wide level (Baker, 2006). This particularly raises issues relating to the fit of a competence with the needs of an organization facing fast-changing demands in the marketplace (Chiang et al., 2012).

The postulation in this paper is that a fundamental difference between lean, agile and leagile supply networks is the fact that they have different requirements for different types and levels of flexibility. As argued by Naylor et al. (1999), agile systems must be flexible, and hence robust to changes or disturbances, whereas lean systems aim to minimize internal and external variation as much as possible, placing more rigid controls on flexibility types. The main objective of this paper is to investigate how different flexibility types, and the degree of flexibility required, relate to different supply chain strategies. This is supported by two aims:

- to add to the understanding of the ways in which different sources of supply network flexibility interact in practice;

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- to provide evidence of the ways in which companies can strike various balances between the sources of flexibility employed and the effects that can be achieved.

In addressing these aims, a number of important contributions to the literature are made. First, a framework for supply network flexibility is proposed, that is then used to develop a lean, agile and leagile supply network taxonomy. Two key sources of supply network flexibility are considered: vendor flexibility and sourcing flexibility. The lean, agile and leagile supply network taxonomy put forward highlights the fact that parallel value streams with different requirements for service levels will have different requirements for different types and levels of flexibility. As a result, different supply network strategies need to be employed. Second, we extend the leagility concept beyond the simple material flow decoupling point concept put forward by Naylor et al. (1999). Two new types of leagility are proposed: leagile with vendor flexibility systems and leagile with sourcing flexibility systems. By doing this, the paper integrates the leagility concept with an existing framework for supply chain flexibility. Third, the paper provides practical evidence with regards to the sourcing strategies used and the sources of flexibility employed by UK fashion retailers at supply network level. The literature on supply chain flexibility is still in its infancy, and most of the previous studies of flexibility in the wider context of inter-company collaboration have aimed to build conceptual frameworks and have lacked empirical validation (for a notable exception see Stevenson and Spring (2009)).

The paper is organised as follows. In Section 2 we review the concept of flexibility in relation to the lean, agile and leagile paradigms, drawing mainly on the literature available in the area of manufacturing systems. In Section 3 we summarise the current literature on supply chain flexibility and put forward a conceptual framework for supply network flexibility. Section 4 illustrates how the supply network flexibility framework put forward could be used to extend the concept of leagility. Section 5 presents the methodology and the data collection procedures employed. In Section 6 we present the findings of two primary case studies, highlighting ways in which companies operating in the UK fashion sector strike various balances between the sources of flexibility employed and the effects achieved. A taxonomy that illustrates how different flexibility types, and the degree of flexibility required, relate to different supply chain strategies is proposed. Finally, in Section 7 we present our conclusions and suggest avenues for further research.

2. The role of flexibility in lean, agile and leagile systems

Though there is a vast amount of literature available dealing with manufacturing practices and performance in the context of lean and agile strategies, there is considerable confusion over these two paradigms as to their content and any temporal dependencies that there might be in their implementation (Narasimhan et al., 2006). Furthermore, as time has now become a key factor in competitiveness due to customers becoming increasingly reluctant to accept long lead-times for products and services, various authors (Bower and Hout, 1988; Stalk, 1988; Reichhart and Holweg, 2007) argue that the importance of speed and responsiveness in today's industry settings have blurred the boundaries of related concepts, such as agility (Goldman and Nagel, 1993; van Hoek et al., 2001; Yusuf et al., 2004) and lean thinking (Womack and Jones, 1996; Hines et al., 2004).

When discussed as paradigms, authors tend to treat lean manufacturing and agile manufacturing as systems of practices, also containing philosophical values and cultural elements. There also seems to be confusion, when addressing lean and agile manufacturing at paradigmatic level, of 'what' their underlying values and principles are with 'how' they should be implemented. Krishnamurthy and Yauch (2007) state that there are 3 general positions with respect to the lean and agile paradigms: those who believe that they are mutually exclusive or distinct concepts that cannot co-exist (Harrison, 1997; Goldsby et al., 2006), those who believe that they are mutually supportive strategies (Naylor et al., 1999; McCullen and Towill, 2001; Gunasekaran et al., 2008) and those who believe that leanness must be a precursor to agility (Hormozi, 2001; Jin-Hai et al., 2003). As such, while both strategies appear to address the same competitive priorities (cost, quality, service, flexibility), they each emphasize different elements (Narasimhan et al., 2006) such that clear dividing lines can be drawn between the two (Gunasekaran et al., 2008). In an attempt to further identify important differences pertaining to the 2 strategies' constituent performance dimensions, Narasimhan et al. (2006) conclude that while the pursuit of agility might presume leanness, in contrast the pursuit of leanness might not presume agility. The authors of the same study also identified that one of the greatest distinction between agile and lean performers appears to be in the flexibility performance dimensions.

From this perspective, Naylor et al. (1999) previously argued that the lean and agile paradigms differ most importantly in their emphasis on flexibility for market responsiveness (see Table 1). The authors noted that agile manufacturing calls for a high level of rapid reconfiguration and will eliminate as much waste as possible but does not emphasise the elimination of all waste as a prerequisite. Lean manufacturing states that all non-value adding activities, or muda, must be eliminated. The supply chain will be as flexible as possible but flexibility is not a prerequisite to be lean (Naylor et al., 1999). As such, out of the seven different criteria used by Naylor et al. (1999) to compare the two paradigms, the 'muda' and 'reconfiguration' characteristics are argued to be similar for both paradigms, while the issue of flexibility leads to the differentiation highlighted by the latter two characteristics, namely 'robustness' and 'smoothing demand'. Agile supply chains must be flexible, and hence robust, to the range of market changes the supply chain is expected to cope with (Stevenson and Spring, 2007) and will, in fact, exploit this capability to achieve competitive advantage. In contrast, lean systems aim to minimise internal and external variation as much as possible.

The way in which flexibility could be used to distinguish between the lean and agile paradigms is further highlighted in Fig. 1 (adapted from Naylor et al. (1999)), who refer to the two axes as demand for variability in production and demand for variety of product. In order to directly relate these two variables to the flexibility literature, we explicitly refer to them as volume flexibility (the ability to change the level of aggregated output) and mix flexibility (the ability to change the range of products made within a given time period, while maintaining the same aggregated output) (see, for example, Slack (1987)). These 2 types of flexibility (mix and volume) are identified by Oke (2005) as 'external flexibility types', as they determine the actual or perceived performance of the company and are viewed externally by

Table 1
Rating the importance of different characteristics of leanness and agility (Naylor et al., 1999).

Keyword	Lean	Agile
Use of market knowledge	❍❍❍	❍❍❍
Virtual corporation/value stream/integrated supply chain	❍❍❍	❍❍❍
Lead time compression	❍❍❍	❍❍❍
Eliminate muda	❍❍❍	❍❍
Rapid reconfiguration	❍❍	❍❍❍
Robustness	❍	❍❍❍
Smooth demand/level scheduling	❍❍❍	❍

❍❍❍=Essential, ❍❍=Desirable, ❍=Arbitrary.