Journal of Operations Management 32 (2014) 154–174

Contents lists available at ScienceDirect

Journal of Operations Management

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

Agent-system co-development in supply chain research: Propositions and demonstrative findings

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ARTICLE INFO

Article history:
Received 7 February 2013
Received in revised form 23 February 2014
Accepted 3 March 2014
Available online 19 March 2014

Keywords:
Behavioral operations management
Agent-system co-development
Supply chains
Adaptive complex systems
Vignette-based experiment
Survey research

ABSTRACT

In this study, we develop an agent-system co-development (ASC) theoretical framework for behavioral research in supply chains. The ASC framework aims at explaining the dynamic agent-system relationships in supply chains whereby both action-influencing properties of human agents (e.g., beliefs, personalities, attitudes) and governance-influencing properties of supply chain systems (e.g., social norms, power-dependence, partnerial/adversarial relationship forms) mutually influence each other over time. Two empirical studies are conducted to illustrate how ASC can be a useful theoretical framework in supply chain research and to partially validate the central thesis of ASC in the contexts of partnerial/adversarial supply chain relationships and cooperative/competitive attitudes of human agents in supply chains. The results of both studies support the central thesis of ASC regarding the dynamic agent-system relationships. From two replicated experiments in Study 1, the results suggest that agents' cooperative and competitive attitudes in business relationships are altered as they are exposed to different supply chain conditions of partnerial and adversarial relationships. In addition, from the multi-method research efforts in Study 2, the results from two survey studies and an experiment are largely consistent with one another, suggesting that personnel turnovers in existing supply chain systems can eventually lead to changes in supply-chain-system properties including the degrees of long-term commitment, information sharing, and joint problem-solving between supply chain partners, as well as the frequency of opportunism occurrences in the supply chains. Finally, we propound that the dynamic agent-system relationships proposed in the ASC framework can be a useful analytical lens in viewing various supply chain issues, such as supply chain evolutions and changes, supply chain designs and personnel decisions, and self-reinforcing feedback loops and decision tendencies in supply chains.

1. Introduction

Behavioral operations management (BeOps) has emerged as a major domain in the operations and supply chain literature. The extant body of BeOps research has been quite diverse, covering a broad range of inquires such as human biases, cognitions, perceptions, individual/group decisions, and negotiations in operations and supply chain systems (e.g., Bendoly et al., 2010; Croson et al., 2013; Gino and Pisano, 2008). BeOps studies, while diverse, share a central thrust in highlighting the importance of behavioral issues in operations and supply chain management, as the successes of the implementation of various operations and supply chain tools, techniques, and policies depend largely on the understanding of human behaviors (e.g., Bendoly et al., 2006; Bendoly and Speier, 2008; Gino and Pisano, 2008). In essence, BeOps has brought the human element back to the focus of operations and supply chain studies.

Supply chain research has extensively leveraged the BeOps perspective in examining supply chain phenomena such as bullwhip effect (e.g., Croson and Donohue, 2006; Nienhaus et al., 2006), newsvendor problem (e.g., Bostian et al., 2008; Cui et al., 2012), and buyer–supplier multiple-block contract (Lim and Ho, 2007). This research stream broadly examines the effects of human factors on performance outcomes of supply chain systems, and has significantly contributed to the supply chain management literature, which traditionally has been focused largely on rational decisions, optimization, and performance effects of supply chain system

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http://dx.doi.org/10.1016/j.jom.2014.03.002
0272-6963/

properties (e.g., Donohue and Siemsen, 2010; Gino and Pisano, 2008). In other words, the introduction of BeOps to supply chain research has broadened the domain of supply chain studies to cover not only the properties of supply chain systems (e.g., structure, design, social norms, etc.) but also the properties of human agents (e.g., biases, cognitions, personalities, attitudes, etc.) who operate in the systems. Recent supply chain research has also revealed that these two sets of properties can jointly affect various supply chain outcomes such as conflict resolution, innovation, and opportunism (e.g., Brown et al., 2000; Carson et al., 2006; Jap and Anderson, 2003; Lumineau and Henderson, 2012; Mooi and Frambach, 2012; Poppo and Zenger, 2002; Tangpong et al., 2010).

Supply chain management literature thus far seems to regard supply chain system properties and human agent properties as two separate sets that can independently or jointly affect supply chain outcomes. As such, the dynamic relationships between these two sets of properties have been overlooked and not been adequately studied. The understanding of the dynamic agent-system relationships in supply chains can potentially give us substantive insights into the evolution and mutation of supply chains, and can help us address the challenges faced by supply chain managers and senior executives who are tasked with the responsibility of re-designing or re-structuring supply chains and buyer–supplier relationships in the supply chain networks. The importance of the dynamic agent-system relationships to supply chain management practices is simply illustrated by the ill efforts of the U.S. automakers to form partnerial relationships with their part suppliers in the 1980s when aggressive bargaining and opportunistic behaviors among their purchasing agents indeed determined the eventual, adversarial form of their buyer–supplier relationships (Kanter, 1989; Lyons et al., 1990). Such adversarial relationships between the U.S. automakers and their suppliers persisted in the 1990s (Mudambi and Helper, 1998) and still remain today (Höhn, 2010; Ro et al., 2008).

The importance of such dynamic agent-system relationships has motivated us to shift the research inquiry toward the mutual influences between human agent properties and supply chain system properties. The first research objective of this study is therefore to propose an Agent-System Co-development (ASC) framework, which is rooted in dynamic person-situation psychology, complex systems and teleological perspectives, as a theoretical lens in examining how human agent properties and supply chain system properties mutually influence each other over time. The other objective of this study is to partially validate the ASC framework, using vignette-based experiments (e.g., Rungtusanatham et al., 2011) along with conventional surveys (Flynn et al., 1990). On the whole, this study aims to postulate theoretical propositions regarding the mutual relationships between human agent properties and supply chain system properties and to provide demonstrative empirical findings for such relationships.

In the next section, we provide the background of this study, which briefly reviews the literature regarding the application of BeOps in supply chain research. We then provide the theoretical development and the central propositions of ASC in the third section, and detail the empirical efforts to test the propositions in the fourth and fifth sections. Finally, we end the paper with the discussion and conclusion.

2. Literature background

Recent supply chain management research has applied the BeOps perspective as a behavioral analytical lens in explaining various phenomena in supply chains that might have been considered anomalies if viewed through the conventional supply chain rational decision and optimization lenses (Donohue and Siemsen, 2010). For example, in the context of inventory management, decision-makers' risk preference and biases, such as anchoring, recency, and reinforcement biases (Bostian et al., 2008; Cui et al., 2012; Schweitzer and Cachon, 2000), have been used to explain systematic deviations of decision-makers' actual order quantities from optimal order quantity for the single-period ordering decision under uncertain demands, i.e., the newsvendor problem. Bostian et al. (2008) found that the most recent demand observation is more likely to be greater than the optimal order quantity if the optimal order quantity is low. Thus, a manager's recency bias tends to result in an order quantity larger than the optimal order quantity. Similarly, when the optimal order quantity is high, a manager's recency bias tends to result in an order quantity lower than the optimal order quantity. These biases drive managerial behaviors and explain the "pull-to-center" effect (i.e., the average order quantities are too low when they should be high and vice versa) that is observed in actual managerial decisions in newsvendor problems. Cui et al. (2012) found that, while making newsvendor decisions, Chinese and American managers demonstrated significantly different decision process biases, which led to different decisions and performance outcomes.

In the context of buyer–supplier dyadic operations, Lim and Ho (2007) experimentally examined the effect of decision-makers' beliefs on the design of multiple-block contract between a manufacturer–retailer dyad under a deterministic downstream demand. A contract may price each unit the same (that is, one-block) or price incremental block of units with declining marginal prices (that is, multiple-blocks). Theoretical marketing models predict that, when the number of blocks is increased from one to two, the manufacturer's profits improve significantly because both channel efficiency and its share of channel profits increase. Increasing the number of blocks to three and beyond yields no incremental profits. Thus, the manufacturer should prefer a two-block contract to a one-block price contract. Lim and Ho (2007), however, found that the experimental outcome deviated from these theoretical predictions and the manufacturer would benefit from having more blocks (i.e., beyond two) in the price contracts. Their results suggest that the retailer was averse toward losing the counterfactual profits it would have earned if the lower marginal prices were actually applied. The manufacturer then accounted for such influence on the retailer in its contract design decisions, price setting, and the number of blocks, and derived higher channel efficiency and its share of channel profit from the dyadic relationship. Similarly, Wu (2013) investigated the performance of supply chain contracts in a laboratory setting and revealed that in the repeated interactions, individuals' behavior deviated from the economic self-interest assumption and had social preference for fairness, which in turn enhanced the supply chain performance.

Studies from behavioral operations have also examined the behavioral causes of the bullwhip effect, the phenomenon of increasing demand variability in the supply chain from downstream (retail) to upstream (manufacturer) (Cachon et al., 2007). Croson and Donohue (2002, 2006) found experimentally that bullwhip effect is explained, at least to some extent, by managers' misperception and cognitive limitations where they underestimate existing supply line inventory. Behavioral research on supply chain inventory management and bullwhip effect has also been augmented by the inclusion of system dynamics, highlighting the importance of "complexity in dynamic contexts consists of feedback processes, time delays, stocks and flows, and nonlinearities" (Bendoly et al., 2010, p. 446). Scholars have found that the perception and recognition of the feedback of inventory availability on customer demand resulted in higher inventory level/safety stock and order variability (Dana and Petruzzi, 2001; Gonçalves et al., 2005). Likewise, Ancarani et al. (2012) experimentally illustrated that order variability and bullwhip effect became amplified under supply chain uncertainty (i.e., stochastic lead times) whereas