Do personal traits influence inventory management performance?—The case of intelligence, personality, interest and knowledge

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ABSTRACT

The purpose of this study is to investigate the influence of four personal traits (intelligence, knowledge, personality and interests) on performance in a structurally simple, yet dynamically complex inventory management task. We base our model on PPIK theory from cognitive psychology and ground the experiment we conduct on the tradition of dynamic decision making research. Findings are that intelligence is the strongest predictor of inventory management performance, while the analysis shows weaker but significant relations between the other traits and performance. Regarding interests, we find that a strong interest for social issues leads to higher cost and, thus, worse performance. A similar detrimental impact on performance has a personality that is open for new experiences. Implications for research comprise investigating the relationship between the four traits and accounting for different task complexities. While obviously intelligence or personality of inventory managers cannot easily be changed, this research can help identifying favorable combinations of psychological traits that can be used in personnel selection. The value of this paper lies in contributing to behavioral theory building in operations management by describing and interpreting the psychological foundations for one of the most notorious tasks: controlling a stock of finished products and adapting its inflow to its outflow.

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1. Introduction—the inventory management challenge and its personal foundation

Anecdotal evidence of poor inventory management (IM) performance can easily be found in everyday life, for instance, empty shelves in supermarkets or long waiting times till delivery for a fashionable good. Such shortages can severely damage earnings and raise costs. Excess inventories are, however, just as bad as stock-outs. Large inventories increase the working capital and the inventory risk. In consideration of a vast body of normative research that provides policies, models, and concepts to support decision making of inventory and purchasing managers (see, e.g., Williams and Tokar (2008), for a review), persisting poor inventory management performance (IMP) needs explanation. Behavioral research has identified people as one of the important reasons for IMP shortfalls. Although still relatively scarce (Bendoly et al., 2006), behavioral inventory and supply chain management (SCM) research has collected robust evidence of biases and heuristics that result in performance figures falling short of normative predictions. Contributions have been made from various research streams with different foci and methodologies (Bendoly et al., 2010).

Research employing a cognitive psychology perspective mainly uses inventory models with purely exogenous demand as, for instance, the newsvendor model and a repeated measurement experimental design. Schweitzer and Cachon's (2000) seminal work reports suboptimal order quantities, which are explained with anchoring and insufficient adjustment and preferences to reduce ex-post inventory errors. Benzion et al. (2008) extend these findings by varying the demand distribution and Lurie and Swaminathan (2009) by showing that more frequent feedback does not necessarily increase performance. Croson et al. (2008) add to the literature by investigating the overconfidence bias in a newsvendor setting.

System dynamics based research "investigates the system level effects of behavioral regularities" (Bendoly et al., 2010) and uses dynamically complex experimental devices as, for instance, the Beer Game (Croson and Donohue, 2006; Sterman, 1989a,b) or feedback rich management flight simulators (e.g., Diehl and Sterman (1995)). This research shows that participants' IMP suffers systematically from both misperceptions of feedback structure and dynamics (Bendoly et al., 2010). Sterman (1989a,b) suggests that deficient dynamic mental models that people use to guide their decisions are at the root of this type of misperceptions. Such deficient mental models include an event-based

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perspective, open-loop view of causality, insensitivity to non-linearities, inappropriate anchoring heuristics and misperceptions of time lags. More recent studies have extended this research stream to informational aspects (Croson and Donohue, 2003, 2005, 2006) and single echelon supply chains (Bloomfield et al., 2007), where inter-echelon coordination problems are absent.

Despite rather striking regularities in decision patterns and shortcomings observed across many studies, there is still considerable variability at the individual subject level. This individual heterogeneity has received scant attention from both system dynamics and cognitive psychology based IM research. Recent exceptions are Bolton et al. (2010) who investigate, how out-of-task experience matters, Moritz (2010) who reports a statistically significant relation from cognitive reflection to IMP, and De Vericourt et al. (2011) who report a significant gender effect. These studies indicate a growing research interest in the investigation of personality traits in an IM context. Our research pursues similar goals, but follows more closely a stream of behavioral research that has long considered personal traits of decision makers—that is psychological research on complex dynamic decision making (Ackerman and Kanfer, 1993; Brehmer, 1992; Dörner, 1980, 1996; Dörner et al., 1994; Wittmann and Hattrup, 2004). This research stream has produced relevant findings regarding the linkages between personal characteristics and performance in complex situations. Focusing on dynamic systems, it suggests that human beings have severe difficulties understanding and managing systems which are dynamically complex, that is, which are characterized by feedback, time delays, nonlinearities, and accumulation. For these dynamically complex tasks, elaborate and corroborated theories exist that relate intelligence, personality, interests and knowledge to decision making performance. Especially Ackerman's (1996) PPIK theory has been bolstered by many empirical studies (see, e.g., Wittmann and Hattrup (2004)). However, none of these psychological studies have addressed IM as such.

In this research, we combine the three research lines mentioned above: behavioral IM and SCM research based upon either cognitive psychology perspective or on system dynamics, and psychological research on complex dynamic decision making. From the latter field we take the PPIK theory (Ackerman, 1996) and ask how much this theory can contribute to explaining differences in individual IMP (which have been substantiated by the first two research lines). Following experimental system dynamics and dynamic decision making research, we use a dynamically more complex inventory task—with feedback and delays—than in the newsvendor situation that is mostly used by behavioral IM research grounded in cognitive psychology. In our case, inventory managers have to review and decide periodically on production quantities that result—with some delay—in inventory inflows, which accumulate in the stock of inventory. They have to account not only for incoming orders but also for backlogged orders. And, importantly, they have to consider that customers react to bad service levels by decreasing their order rate and vice versa. We test if the PPIK theory can contribute to explaining individual IMP differences. Thus, the purpose of this paper is to address limitations mentioned by Moritz (2010) and De Vericourt et al. (2011) and find out whether intelligence, personality, interests, and knowledge determine performance in an IM task, with the ultimate goal to give recommendations what personal traits successful inventory managers should have. In order to operationalize the four personal traits, we use different standard psychological tests from the literature; we operationalize IMP by the degree of control performance participants demonstrate in a simulated inventory task in a controlled experiment.

The paper contributes to theory in behavioral operations management in two ways. From a content perspective, this study describes and interprets the psychological foundations of one of the most notorious tasks in operations management: controlling a stock (e.g., of finished products, work in progress inventory, or raw materials) and adapting its inflow to its outflow with feedback being present. The inflows in such stocks could be production from upstream production stages or purchases; the outflow of these stocks can be, for instance, deliveries to customers or to further production stages; feedback could result in inflows being affected by outflows (with a time delay) and vice versa; for instance, late delivery outflows could reduce future incoming orders. From a methodological perspective, this study contributes to behavioral operations management by its prototypical use of validated psychological tests and of a dynamically complex decision experiment. The dynamic tasks used in these form of experiments resemble actual decision making in operations management substantially, for two reasons. Firstly, they require repeated decision making, not just one singular decision. Secondly, the state of the system, which they represent, depends on earlier decisions, i.e. the task evolves over time depending on participants' actions in the past.

The paper continues in Section 2 with a more elaborated discussion of the theoretical background of this work, again focusing on behavioral operations management studies of IM and on complex problem solving from psychology. In the section after that, we present the experimental design and methods that are used; in particular, we describe the tests used to measure personal traits and which method is employed to derive IMP. In the fourth section, the results of the experiment conducted are shown, addressing the relation between personal traits and IMP. The paper concludes with a discussion of contributions and limitations of this research and outlines directions for further research.

2. Theory: on stock management failures and psychological theories of complex problem solving

In this literature review, we want to shed further light on how IM problems have been addressed in behavioral operations management research based on (i) cognitive psychology and (ii) system dynamics and (iii) what theories psychological research offers to explain differences of personal performance in complex decision making tasks; the focus of the latter part is on Ackerman's PPIK theory. Our aim is to argue further for the potential that an integration of the three research streams possesses.

Behavioral IM research that makes use of cognitive psychology is a rather recent activity starting with the Schweitzer and Cachon's (2000) seminal work. In this and in following investigations (Benzion et al., 2008; Bolton and Katok, 2008; Bolton et al., 2010; De Vericourt et al., 2011; Feng et al., 2011; Lurie and Swaminathan, 2009; Moritz, 2010; Su, 2008) the well-researched and widely-discussed newsvendor setting is used in the laboratory. While the newsvendor problem might apply in an array of settings found in practice (e.g., Schweitzer and Cachon (2000)), in even more situations its assumptions are violated. Specifically, it is assumed that a newsvendor makes a one-shot decision for one single period that does not influence succeeding periods: unsold items are returned and unfilled demand is lost (resulting in stock-out costs). In our research we focus on IM as a dynamically more complex decision making task. Based on Brehmer (Brehmer, 1992, p. 212), who grounds his definition on earlier studies by Edwards (1962) and Hogarth (1981), we understand dynamically complex decision making tasks to be characterized by four features:

1. a series of decisions has to be made, not just one that finally solves a problem;
2. the state of the system changes depending on decisions and exogenous effects;