The current issue and full text archive of this journal is available at
www.emeraldinsight.com/0960-0035.htm

Converting knowledge into value

Gaining insights from service dominant logic and neuroeconomics

Wesley S. Randall
Department of Marketing & Logistics, College of Business, University of North Texas, Denton, Texas, USA
David R. Nowicki
Department of Marketing & Logistics, College of Business and Department of Engineering Technology, College of Engineering, University of North Texas, Denton, Texas, USA
Gopikrishna Deshpande
MRI Research Center, Department of Electrical and Computer Engineering, Department of Psychology, Auburn University, Auburn, Alabama, USA
Robert F. Lusch
James and Pamela Muzzy Chair in Entrepreneurship, Eller College of Management, University of Arizona, Tucson, Arizona, USA

Abstract

Purpose – The purpose of this paper is to describe the conversion of knowledge into value by examining the confluence of service-dominant logic (S-D logic), supply chain management (SCM), human resource management (HRM), and neuroeconomics. S-D logic suggests that knowledge is the raw material of value creation. SCM provides an organized foundation to study the conversion of raw materials into value. HRM recognizes the centrality of human decisions in the process of converting knowledge into value. Neuroscience gives insight into the efficiency and effectiveness of the human decisions processes. Global SCM provides more than markets and raw materials – global SCM provides the human resources central to value creation.

Design/methodology/approach – This paper combines literature review with interviews from members of supply chain teams engaged in performance-based logistics (PBL) to develop a model of the S-D logic knowledge conversion process.

Findings – The model describes individual-based decision constructs managers can expect to face as they convert knowledge, from a global supply chain team, into value. The model relates the decision maker mindset, based in neuroscience principals, to the efficiency of the knowledge conversion process. These principals are extended to suggest how managers can modulate human resource processes to improve the efficiency of economic exchange and increase supply chain resiliency.

Research limitations/implications – This paper provides theoretical and practical insight into how differences in culture, neuronal predisposition, and genetics may influence managerial decisions. These findings provide a mechanism that researchers and managers may take to expand the boundaries of HRM in a global supply chain.

Originality/value – This work uses a foundation of SCM research to explain efficient conversion in a knowledge-based economy. This perspective demonstrates the criticality of global HRM mindsets and decision processes necessary to achieve competitive advantage in a knowledge-based economy. This provides a context for the study and improvement of neuroeconomic efficiency of firms.

This material is based upon work supported by the Naval Postgraduate School Acquisition Research Program under Grant No. 00244-12-1-0059.

International Journal of Physical Distribution & Logistics Management
Vol. 44 No. 8/9, 2014
pp. 655-670

0960-0035
DOI 10.1108/IJPDLM-08-2013-0223

Keywords Performance, Supply chain management, Human resource management, Knowledge, Service-dominant logic, Resiliency, Magnetic resonance, Neuroeconomics
Paper type Research paper

Introduction

Human resources, material goods and information move quickly around the world. Technology enables globally separated workers to co-create value in what can be thought of as a 24-hour knowledge factory (Gupta *et al.*, 2007). At the same time researchers have developed a new framework for exchange, known as service-dominant logic (S-D logic), that explains the economic underpinnings of "knowledge conversion factories." In S-D logic knowledge is the primary resource of competitive advantage and service is the primary basis of economic exchange (Vargo and Lusch, 2004). S-D logic articulates the way value is created through direct service application or through goods which serve as an appliance to perform a service. Similarly human resource management (HRM) provides a research framework to understand how humans exchange knowledge (Bassi and Mcmurrer, 2007).

S-D logic's focus on knowledge and integration provides a robust framework to explain how firms leverage supply chain competencies to improve value (Brodie *et al.*, 2006; Vargo and Lusch, 2004; Woodruff and Flint, 2006). HRM recognizes the centrality of human decisions in the process of converting knowledge into value (Wang *et al.*, 2009). Supply chain management (SCM) research provides a foundation to understand how managerial decisions improve the efficiencies through which raw materials are converted into value (Lambert *et al.*, 2005). Taken together S-D logic, HRM, and SCM provide a backdrop to advance the understanding of how global supply chain teams leverage human resources to create value.

This paper provides a conceptual model, based in neuroeconomics, that depicts the decision processes associated with converting knowledge into value. The unit of analysis in the model is the individual manager, and the context is global supply chain teams. The paper begins with a review of the literature on S-D logic and SCM. Second, we discuss performance-based logistics (PBL) an emerging supply chain strategy found to be consistent with S-D logic. The PBL strategy (also called performance-based contracting) has provided researchers a context for S-D logic, supply chain innovation, and investment (Kim *et al.*, 2010; Randall *et al.*, 2011). Third, we describe key aspects of neuroscience related to managerial decisions. Fourth, we develop a testable, outcome-based, HRM conceptual model for the S-D logic knowledge conversion process. Fifth, we formulate propositions based upon this conceptual model. Lastly, we provide discussions and conclusions.

Literature review

S-D logic provides a framework for understanding the process where entities achieve sustainable competitive advantage by more efficiently converting knowledge into value (Vargo and Lusch, 2011). The focus of S-D logic on knowledge provides a strong link between exchange research and HRM. Human resources use knowledge and skill to act on things and create value – things in and off themselves do not possess knowledge and skill. Thus in an S-D logic view of exchange HRM is critical to the success of global enterprises (Michel *et al.*, 2008).

The rise of S-D logic

S-D logic illustrates competition based upon the application of knowledge, skill, and ability to create service-based value (Vargo and Lusch, 2004). There are two elemental

approaches to creation of service-based value. First, value is created by direct application of knowledge and skill to create a service. Second, knowledge and skill are embedded in products and those product act as an appliance to transmit service value (Lusch *et al.*, 2010). Exchange then occurs through come combination of direct or embedded application of knowledge and skill.

Value in a supply chain exchange requires structures that convert knowledge into value (Knudsen, 2006). S-D logic provides a lens that illuminates the human resources necessary for the achievement of competitive success (Lusch, 2011). Thus S-D logic and HRM, with their focus on using knowledge to create value, are tightly intertwined.

Knowledge alone does not assure sustained competitive success. Businesses with similar knowledge-based resources often achieve different outcomes (Fawcet *et al.*, 2010; Hunt, 2000). Business history is littered with firms who have lost ground due to inefficient conversion of knowledge into value (Levitt, 1960). Global supply chains provide greatest value when knowledge is in use by the right supply chain partner at the right time – knowledge is only valuable in use (Randall *et al.*, 2010).

S-D logic describes the distinction between knowledge and knowledge in use – referred to as applied knowledge (Druskat, 2005; Vargo and Lusch, 2004). Applied knowledge represents the conversion of knowledge into compelling value propositions (Vargo and Lusch, 2004). Applied knowledge is inherently dynamic and evolutionary (Teece and Pisano, 1994), contextual to a specific time and place, and customer-supplier dyad (Prahalad and Ramaswamy, 2004). Knowledge alone has potential, but only in use is this potential realized.

S-D logic, coupled with HRM, provides a framework for determining the efficiency of the conversion of knowledge into value – called applied knowledge (Lusch *et al.*, 2010). Applied knowledge efficiency is influenced by a firm's ability to convert training, development, and retention – all of which are elements of HRM. The efficiency of this conversion process ties together HR concepts (e.g. the impact of personnel turnover), S-D logic concepts (e.g. knowledge-based exchange), and SCM concepts (e.g. supply chain structures supportive of converting knowledge into applied knowledge).

The rise of SCM

Studies show that as much as 70 percent of the cost of goods sold is spent on purchased goods and services (Rudzki *et al.*, 2006; Trent, 2007). This means when a company like Apple sells a product for $500 as much as $350 goes to pay for purchased goods and services, leaving $150 dollars to be split up between Apple and its retailers. Improved global connectivity, proliferation of quality, and availability of complementary competencies are a few of the factors moving more transactions from the firm to the supply chain (Kaipia, 2009; Prahalad and Hamel, 1990; Rindfleisch and Heide, 1997; Williamson, 2008).

SCM has provided effective process frameworks explaining sourcing, physical distribution, operations, and manufacturing (Lambert *et al.*, 2005) More recently SCM has been used to described the acquisition and dissemination of applied knowledge (Isenberg, 2008; Paton and McLaughlin, 2008; Stank *et al.*, 2011). Blending those frameworks provides foundation for knowledge conversion that guides a firm's effort to develop its own human resources, or go to the market to acquire them.

Supply chain networks provide complementary core competencies (e.g. sourcing, engineering, design, and logistics) that improve a firm's ability to create value (Lusch, 2011). The same global collaboration structures that allow supply chain teams to solve complex supply and logistics problems provides firms new opportunities and improves

decision making (Zacharia *et al.*, 2011). More often than not, innovation is achieved through supply chain-based collaboration (Craighead *et al.*, 2009; Fawcett *et al.*, 2011). Collaboration is a competitive reality: "frequently, supply chain partners focus too much on their own share of the benefits pie, forgetting that unless knowledge resources are shared, no one benefits" (Myers and Cheung, 2008, p. 72). Firm success requires supply chain governance structures that facilitate flexible and adaptable response based upon the introduction of new knowledge. One strategy that has been shown to be consistent with knowledge conversion and S-D logic is known as PBL.

PBL: a governance context for knowledge conversion

PBL is part of a group of outcome-based strategies known also as "performance-based contracting" in aftermarket sales, Rolls Royce's "power by the hour" in the commercial sector, and PBL in defense contracting (Fowler, 2008; Kim *et al.*, 2007; Pagonis, 2004; Randall *et al.*, 2010). Performance-based strategies are all forms of a principal agent model (Kim *et al.*, 2010). The classical model involves an agent (supplier) who is responsible for producing an output on behalf of the principal (customer) who owns the output. The principal and the agent sign a contract where the agent receives compensation for delivering system performance instead of products. This structure provides the agent highest profits when investments result in least total cost over the life of the contract (Randall *et al.*, 2011). In this structure better decisions require a supplier ecosystem that shares knowledge and applies that knowledge in a dynamic fashion (Randall *et al.*, forthcoming). The economic theory of incentives provides the foundation for the compensation, and governance structure, at the center of the PBL relationship (Kim *et al.*, 2007; Nowicki *et al.*, 2008; Plambeck and Zenios, 2000).

What is novel in PBL is the manner in which knowledge-decision-incentive structures overcome the information asymmetry and moral hazards that typically characterize principal agent models (Guajardo *et al.*, 2012). PBL ties compensation to performance outcomes, instead of individual transactions – spare, repair, and overhaul (Randall *et al.*, 2011). Contracting for outcomes aligns and rewards smart bundling of supplier and customer core competencies (e.g. engineering, design, and logistics) that result in performance at ever decreasing costs (Randall *et al.*, 2010). The multi-year structure of PBL shifts from return on sales (e.g. selling spare parts) to a return on investment (ROI) (e.g. investing in redesign to drive out demand for spare parts). Competitive position is determined by the supplier ecosystem's ability to make decisions that convert new knowledge into value. The knowledge and outcome basis of PBL provides a supply chain governance structure that illuminates S-D logic in practice.

Neuroeconomics to investigate the conversion of knowledge to value

Typically human resource processes are studied by subjective analysis. In that approach the mechanistic underpinnings of human decision making have been treated as a black box. Human circumstances were treated as inputs and decisions as outputs with little insight given to the specific workings of the black box (Kim and Ugurbil, 1997). Advances in non-invasive imaging of human brain function (Bandettini *et al.*, 1992; Ogawa *et al.*, 1992) have revealed the mechanistic underpinnings of decision making. Scholars have synthesized research from neuroscience and economics in a new field called neuroeconomics (Levallois *et al.*, 2012):

> The decision of whether to purchase a product is the fundamental unit of economic analysis. From the bazaar to the Internet, people typically consider characteristics of available

> products, determine their cost, and then decide whether or not to purchase. The success of economic theory rests on its ability to characterize this repeated and elementary decision process. Neuroeconomic methods offer the hope of separating and characterizing distinct components of the purchase decision process in individual consumers (Knutson *et al.*, 2007, p. 147).

Neuroeconomics provides a unified approach to study the confluence of economics, decision making (cognitive neuroscience), and psychology (Levallois *et al.*, 2012). The advent of functional magnetic resonance imaging (fMRI) has shown an ability to map decision structures in the brain and provide a quantitative tool for neuroeconomic research (Bandettini *et al.*, 1992; Ogawa *et al.*, 1992). To date, fMRI has been applied to study a variety of neuronal processes such as primary sensory, motor cortices, cognitive functions, and decision making (Causse *et al.*, 2013).

The use of fMRI has direct practical and theoretical application to S-D logic and PBL, "the main contribution of neuroeconomics to decision theory so far is a new picture of decision makers as adaptive and affective agents" (Alessandrini and Valeriani, 2010, p. 212). Previous studies have shown how fMRI has been used to evaluate the neural processes associated with risk and reward evaluation of value associated with food, art, humor, and music (Berns, 2004). These studies suggest that risk-aversion, or lack of it, is a complex outcome of what is considered the brain's genetically based hardware (the anatomical wiring with which people are born) and the brain's software (the working models and mnemonic representations built from experience) (Kuhnen and Knutson, 2005; Lee *et al.*, 2009; Rick, 2011). Gender is a major "hardware" or anatomical determinant of how we perceive and handle risk. Therefore gender should be treated separately in any potential study in order to develop different strategies to optimizing risk-taking behavior (Lee *et al.*, 2009). Interestingly, impulsiveness is also considered a hardware element which impacts risk-taking (Lee *et al.*, 2008). Factors such as gender and impulsiveness are a product of the anatomical wiring in the brain that is genetically influenced. Inducing anatomical plasticity in the adult brain is difficult and time-consuming, suggesting that actionable research should consider these covariates and focus more on the brain's software/functional elements (Cazzell *et al.*, 2012; Kent and Moss, 1994).

There are functional, or software, elements that relate to specific brain areas that process risk and reward, such as nucleus accumbens, striatum and insula, in conjunction with cognitive areas such as anterior cingulate, orbitofrontal, and prefrontal cortices which assess gain-loss and emotional areas of the limbic system (such as amygdala) which assess the hedonic or affective status of external stimuli (Kuhnen and Knutson, 2005). The brain does not process each risk decision on an as-is basis. Rather, the brain compares and contrasts each scenario against memory and working models built from experience (Boyer, 2006). For example, studies have shown that the short-term experience of losing or winning can affect consequent risk-taking (Xue *et al.*, 2011). In another example traders who regularly take risk become desensitized to it (Lo and Repin, 2002).

Cultural elements have also been shown to influence risk and reward structures of decision making in a global supply chain (Choudhury and Kirmayer, 2009; Zhao *et al.*, 2008). The seminal culture influence researcher Hofstede (1980, p. 43) defines culture as "the programming of the mind which distinguishes the members of one human group from another." Culture influences numerous elements of group identity such as masculinity/femininity, the power distance of societal place and birthright, the perspective of individualism and collectivism, and the tendency to avoid uncertainty (Hofstede, 1980; Sondergaard, 1994).

The area of neuroeconomics has strong potential to explore the S-D logic and PBL environment. PBL trades off the decision to continue repairs against the decision to accept risk associated with investment and innovation that drives out the demand for repairs (Randall *et al.*, 2010). In PBL the desired behavioral outcome from decision makers is closely linked to their ability to assume risk (Guajardo *et al.*, 2012; Kim and Ugurbil, 1997). Too much risk-taking may lead to risk-seeking mistakes while too much risk-aversion can also lead to risk-aversive mistakes. Thus individual predisposition to risk bias creates a consistent deviation from the "theoretically perfect" risk decision.

The soundness of the risk evaluations process of a decision maker's mindset therefore provides the foundation for the efficiency of the knowledge to value conversion process. The neuroscientific concepts underlying the brain's hardware and software, and their implications for culture suggests a rich research context for S-D logic and PBL. Understanding the neural correlates of optimal risk-taking has tremendous potential for optimizing the knowledge conversion process in a global supply chain (Rick, 2011).

Methodology – informed interview, conceptual model development

This research adopts a mixed methodological approach. The first aspect involves developing the confluences in S-D logic, SCM, PBL, and neuroeconomics literature. The second involves an archival approach to evaluate interview transcripts from the study by Randall *et al.* (2010). Lastly, we blend that literature and archival research to develop and present a testable conceptual model of outcome-based decision making.

Data set and research foundation

This research utilized the PBL data set of Randall *et al.* (2010). This data set contains over 60 practitioner interviews. That research identified the antecedents, processes, and outcomes of the PBL strategy. That research highlighted the essence of PBL to be a decision focussed knowledge conversion process that embodies S-D logic in practice.

Analysis

In the transcripts of Randall *et al.* (2010) the conversion of knowledge into value is described as a "mindset." The mindset is what governs the ROI decisions in the PBL strategy. PBL, like S-D logic, focusses on the knowledge, skills, and abilities coupled with the theoretical structure of the knowledge to value conversion process. The mindset of the decision maker influences the efficiency and effectiveness of this production conversion process, as illustrated in the following interview transcript:

> Interviewer: What is performance logistics? Is it a contract? Is it a business case? Is it a strategy? What is it?
>
> Interviewee: I believe it is a mindset. I really believe that PBL today is personality driven. If you have intuitive knowledge of what PBL can do, yes you will do well at it. But if you are just learning what PBL is you will not be very good at it.

PBL embeds a risk-reward governance structure. PBL encourages an entrepreneurial system that smartly trades off risk and reward by investing in decisions to avoid cost by improving the reliability of the system. This can be contrasted to a more compliance-oriented system focussed on a transactional system of sparing, repairing, and overhaul. One senior manager captures this contrast:

> The (post-production) managers were raised and trained in an environment of compliance, with rules as opposed to problems solving.

This entrepreneurial vs compliance mindset suggests that personality, or individual differences, impacts the outcomes of decisions. As suggested by two of the respondents who had managed a very innovative program and successful program:

> Deputy program director: A lot of the stuff that we are doing nobody told us to do it. It just made sense to us.
>
> Program director: I think there is a personality trait; it's about doing what makes sense.

The need to do what makes sense is a "personality trait" one that drives managers to seek knowledge that supports innovation. Our other key finding suggests that a manager's position in the supply chain (customer, original equipment manufacturer (OEM), or supplier) also moderates risk acceptance profile. This finding appears to support the software, or environmental influences, of risk acceptance suggested by neuroeconomics. The OEM managers have a higher and more accurate risk-reward decision structure than their customers. This makes sense as the supplier ROI business model requires entrepreneurial decisions. Conversely the customers are more focussed on complying with specifications that govern the safe use of the system. PBL requires supply chain core competencies that typically reside in the OEM. Further the OEM and supply chain partners have the capital resources to act in an entrepreneurial fashion as the following interview response suggests:

> We have a number of complex issues, diminishing manufacturing source and material related challenges in all of that. You (the integrator) would have to see that, I would be skeptical that someone who hadn't demonstrated a significant body of experience could suddenly come in and say I will be the integrator. Okay show me.

Lastly we see that risk and reward are associated in a PBL environment, as the following respondent suggests:

> So, of course the risk flows down with the metric [performance outcome]. But we would not just pay a dollar per flying hour, we would be pay a dollar per usage that is surrounded by a certain number of performance metrics that the supplier has to comply with. It is almost a pass through down to that subsystem. But we hold them responsible for looking at it always from an enterprise perspective.

The PBL knowledge to value governance structure requires a culture that resists "rigid conformance" and rewards entrepreneurship. Further, this behavior appears to form more deeply within some organizations as oppose to others; consider the following response:

> So the technician picks up the part with the tag on it tells us the part is broken, and we tell them where to ship it […]. They ship it to [a repair center], and it has an unserviceable tag that has been filled out wrong. It has a wrong part number. Our people [the OEM] would like to fix a serial number, it is on the piece of equipment. Fixed the number and then fix the part. The [customer contract representative] says no you have to get the unserviceable tag fixed by the original technician.

This process for process sake is consistent with a compliance mindset. One senior manager stated he had been waiting for 20 years to be able to operate in an entrepreneurial fashion. According to this individual, he enjoyed the entrepreneurial link between achieving a clearly defined objective and reducing non-value added tasks.

In fact, in the interviews, the term risk was one of the most commonly found terms, occurring 114 times in 27 transcribed interviews. Further the use of the term risk was almost always a positive statement with regard to the OEMs management of risk, and a

negative statement with regard to the customer's ability to manage system innovation risk. According to one senior manager the propensity of the OEM to accept risk is related to their knowledge position and their ability to manage risk:

> Because ultimately you want a balance risk, and you want to transfer as much risk away from the government as possible. That's why all the guidance will tell you that migrating to a fixed-price type arrangement is the optimal contracting solution.

Findings

Creation of value requires not only an awareness of knowledge but the governance structures that enable decisions that convert knowledge into value. This process is highly influenced by the mindset of the individual. The illumination of the PBL governance process suggests that competitive advantage in S-D logic involves an ability to continuously apply knowledge in an entrepreneurial fashion. The core of this idea is not new – the ability to scan the environment, recognize opportunity, and make decisions that create competitive advantage is similar to Kohli and Jaworski's (1990) market orientation. What is new is applying these concepts to a global supply chain using a human resources lens to develop a framework for affecting the firm's ability to convert knowledge into value. The essence of this framework for PBL and S-D logic is an innovation process that shifts from a return on sales view (selling more products) to a ROI view (applying knowledge to co-create value). This framework breaks open the black box of human decision making and shows how the efficacy of this knowledge conversion process is influenced by the mindset of the human resources in the supply chain and their predisposition to engage the risk-reward decision structure.

An applied aspect our research did not address is cultural influences on knowledge. In the literature review we establish how culture influences attitudes and behaviors of people. We provide a neuroscience foundation to extend assertions of Hofstede (1980) that suggest that cultural values undoubtedly shape (e.g. the software view of neuronal processes) risk propensity. Follow-on research should seek to understand how culture influences the human resource aspects of knowledge conversion in a global supply chains.

Neuroeconomics, S-D logic, HRM, psychology, and an understanding of cultural provides a framework to explain the efficiency of global supply chains converting knowledge into applied knowledge and applied knowledge into customer and shareholder value. The essence of the S-D logic knowledge conversion process model is depicted in Figure 1.

This model describes following research propositions:

P1. Available potential applied knowledge positively influences applied knowledge awareness.

P2a. Manager genetic makeup influences applied knowledge awareness.

P2b. Manager genetic makeup influences decision response.

P3a. Manager cultural background influences applied knowledge awareness.

P3b. Manager cultural background influences decision response.

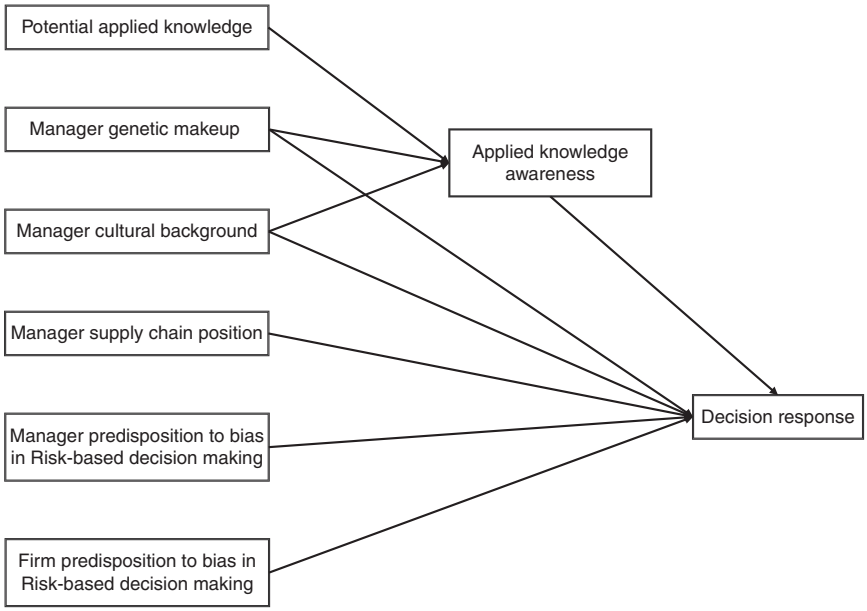

Figure 1.
The S-D logic knowledge conversion decision model

P4. Applied knowledge awareness moderates decision response.

P5. Manager supply chain position influences decision response.

P6. Manager predisposition to bias in risk-based decision making negatively influences decision response.

P7. Firm predisposition to bias in risk-based decision making negatively influences decision response.

Discussion

Our analysis integrates five main themes. First, the global supply chain is a mechanism to source both tangible and intangible (knowledge) resources. Second, the supplier network governance structure moderates the knowledge-incentive-investment-decision loop. Third individual differences (genetics, experience, culture) bias decisions from a theoretically "perfect" decision based upon given information. This bias is consistently correlated with an individual's risk acceptance/avoidance predisposition. This is an exciting thought – one that researchers and industry leaders can act on to help provide managers the necessary skill sets to recognize and compensate for this bias. Fourth, organizations as a whole may tend to have a certain bias to act in an entrepreneurial fashion (e.g. the customers are more risk adverse than the OEM). Fifth supply chain position impacts predisposition to bias in risk-based decision making. Again firm leaders can act on this to improve the efficacy of the knowledge conversion process. Taken together these themes provide a research agenda that links neuroeconomic theory, S-D logic, global SCM and HRM.

Implications for practice

We believe that the proposed model has strong practical implications. This paper shows how research and practice can use neuroeconomic principals and fMRI capabilities to provide managers an ability to account for their own neuronal processes that bias optimal risk decision making (Emonds *et al.*, 2010; Xue *et al.*, 2011). Table I provides an overview of the steps in such a study.

Ultimately fMRI can be used to understand how the cultural aspects, risk propensity, and moderators such as gender and impulsivity can be incorporated into neurofeedback-based training to optimize decision making in a global supply chain. Table II provides practical steps that utilize the idea of a risk propensity scale and training to account for predisposition to bias in risk-based decision making and ultimately improve abilities of individual decision makers and their firms.

These thoughts bring new insight into supply chain strategies such as supplier colocation (Dixon, 1999). For example, the Bose Corporation and the KIA Corporation stress supplier colocation (Ramsey, 2011; Segars *et al.*, 2001; Ward's, 2007). Typically, production colocation has emphasized inventory reductions and responsiveness (Dixon and Porter, 1994; Segars, 1998). A better explanation for colocation may lie in the value of human resources interacting together to co-create value by improving the knowledge conversion processes. Partners in a global supply chain who colocate (either geographically

Step	Task	Objective
1.	Define desired behavior	Determine the optimal risk reward behavior. This may be based upon supply chain position (buyer-supplier) or role (engineering, SCM, finance)
2.	Select managers for baseline study	Select managers whose self-description and supervisor feedback describe their predisposition to bias in risk-based decision making
3.	Identify the neuronal correlates of desired behavior	Confirm predisposition to bias in risk-based decision making and corresponding neural substrates based upon gender, culture, and propensity
4.	Design a neurofeedback-based training program that will produce changes in neuronal substrates to reduce predisposition to bias in risk-based decision making	Demonstrate the ability to reduce predisposition to bias in risk-based decision making with regard to managerial tasks
5.	Validate the training program by iterating step-3 until the desired behavioral outcome is achieved	Confirm that the neurofeedback creates desired results
6.	Create baseline training modules for organization position in the supply chain, specific work place positions, and generalized risk correlates (e.g. gender, propensity, culture)	Baseline training to efficiently influence the knowledge conversion process
7.	Develop a scale to determine predisposition to bias in risk-based decision making	Ability to accurately and efficiently determine risk propensity with our supervisor insight or fMRI. Ability to measure change in predisposition to bias in risk-based decision making

Table I.
Risk propensity scale development

Step	Task	Objective
1.	Adapt survey and training modules to current organizational requirements (e.g. gender, propensity, culture, supply chain position, work place position)	Baseline training to efficiently influence the knowledge conversion process
2.	Identification of target managers risk predisposition using survey	Baseline individual manager predisposition to bias in risk-based decision making
3.	Determine the objective risk propensity compensation based upon target manager-position requirements	Harmonize the manager risk predisposition with position requirements
4.	Create training focussed on understanding and overcoming how manager-position biases risk-based decision making	Create modules tailored to a compensate for predisposition / work position
5.	Provide a foundation for training to help supervisors compensate for bias in risk-based decision making	Establishment of supply chain/company training and mentorship guideline (e.g. based upon nature of the company in a global supply chain and the particular supervisory objective)

Table II.
Optimization of the knowledge conversion process

or virtually) create boundary spanning competencies that align culture and reduce risk bias of decision makers in the knowledge conversion process. Knowledge conversion in a global supply chain illustrates that SCM cannot be separate from HRM practices.

Implications for theory

We extend the theory of incentives as applied to PBL and S-D logic by describing the influence of mindset on decisions – incentive efficiency is influenced by bias in risk-based decision making. The proposed model suggests that competitive success involves an ability to continuously acquire and apply knowledge in an entrepreneurial fashion. Consistent with S-D logic we show that entrepreneurial decisions do not come from products but from human resources making decisions that create value. Thus HRM is central to global supply chain practices. Ultimately we suggest the essence of knowledge-based competition rest in the efficacy of individual decision making.

This implies another interesting research direction. Supply chain scholars have long been concerned with unplanned and unanticipated events that disrupt the normal flow of raw materials that support production (Craighead *et al.*, 2007; Kleindorfer and Saad, 2005; Samaddar and Nargundkar, 2010). Supply chain disruptions have significant and long term negative impact on shareholder value (Hendricks and Singhal, 2003). Researchers have suggested that resiliency provides a valid approach to ameliorate the effect of global supply chain disruptions on production (Sheffi, 2005; Sheffi *et al.*, 2005). Our work suggests that global supply chain knowledge resiliency research promises tremendous potential.

This paper adds to the growing body of research into supply chain relationships based on the delivery of performance – not products. We bring greater insight into how individual mindset elements influence principal agent models, the theory of incentives and game theory. Future research should consider how decision bias influences the incentive-feedback structures of PBL. This effort should draw on the long history of HRM research that deals with compensation and incentives.

Summary

Fundamentally, this paper suggests decision making is a global supply chain knowledge conversion process. In that view human resources are the essence of the competitive process where decisions convert knowledge, as the raw material, into applied knowledge and applied knowledge into value. Considering HRM from an S-D logic orientation provides a Rosetta stone that explains competitive advantage by conceptualizing knowledge and skills, as the fundamental economic units of exchange, using a performance-based governance structure for this exchange. In PBL governance describes economic exchange in terms of the outcome of the system – its performance – as the basis of a supply chain value proposition. Blending the practice of PBL with S-D logic affirms ideas that knowledge and skill form value propositions which satisfy service needs that transcend products.

Lastly, describing manager mindset as the basis for the efficiency and effectiveness of the knowledge conversion process may add to the transaction cost perspectives of firm valuation. Ultimately firm and supply chain value may best be understood as the ability to convert knowledge into value now and into the future. Key to this task will be gaining an understanding of the structures that support global sourcing of applicable knowledge and the conversion of that knowledge into value. In this view, production efficiency and effectiveness could be seen as factor that captures the rate at which firms (and networks of firms) become aware of applicable knowledge, understand and overcome predisposition to bias in risk-based decision making, and convert knowledge into compelling value proposition. S-D logic shows that competitive advantage is more than land, labor and capital. Competitive advantage is about the firm's (or network of firms') knowledge-based resources embodied in humans and the structures that allow a firm (and network of firms') to convert that knowledge (through decisions) into value. In brief, SCM and HRM should not be separated but managed in an integrated manner using S-D logic to form a foundational theory.

References

Alessandrini, S. and Valeriani, E. (2010), "Financial integration in the four basins: a quantitative comparison", *Theoretical & Practical Research in Economic Fields*, Vol. 1 No. 2, pp. 147-166.

Bandettini, P.A., Wong, E.C., Hinks, R.S., Tikofsky, R.S. and Hyde, J.S. (1992), "Time course epi of human brain function during task activation", *Magnetic Resonance in Medicine*, Vol. 25 No. 2, pp. 390-397.

Bassi, L. and Mcmurrer, D. (2007), "Maximizing your return on people", *Harvard Business Review*, Vol. 85 No. 3, pp. 115-123.

Berns, G.S. (2004), "Something funny happened to reward", *Trends in Cognitive Sciences*, Vol. 8 No. 5, pp. 193-194.

Boyer, T.W. (2006), "The development of risk-taking: a multi-perspective review", *Developmental Review*, Vol. 26 No. 3, pp. 291-345.

Brodie, R.J., Glynn, M.S. and Little, V. (2006), "The service brand and the service-dominant logic: missing fundamental premise or the need for stronger theory?", *Marketing Theory*, Vol. 6, pp. 363-379.

Causse, M., Péran, P., Dehais, F., Caravasso, C.F., Zeffiro, T., Sabatini, U. and Pastor, J. (2013), "Affective decision making under uncertainty during a plausible aviation task: an fmri study", *NeuroImage*, Vol. 71, pp. 19-29.

Cazzell, M., Li, L., Lin, Z.-J., Patel, S.J. and Liu, H. (2012), "Comparison of neural correlates of risk decision making between genders: an exploratory fnirs study of the balloon analogue risk task (bart)", *NeuroImage*, Vol. 62 No. 3, pp. 1896-1911.

Choudhury, S. and Kirmayer, L.J. (2009), "Cultural neuroscience and psychopathology: prospects for cultural psychiatry", in Joan, Y.C. (Ed.), *Progress in Brain Research*, Vol. 178, Elsevier.

Craighead, C.W., Hult, G.T.M. and Ketchen, D.J. Jr (2009), "The effects of innovation-cost strategy, knowledge, and action in the supply chain on firm performance", *Journal of Operations Management*, Vol. 27 No. 5, pp. 405-421.

Craighead, C.W., Blackhurst, J., Rungtusanatham, M.J. and Handfield, R.B. (2007), "The severity of supply chain disruptions: design characteristics and mitigation capabilities", *Decision Sciences*, Vol. 38 No. 1, pp. 131-156.

Dixon, L. (1999), "Jit ii: the ultimate customer-supplier partnership", *Hospital Materiel Management Quarterly*, Vol. 20 No. 3, pp. 14-20.

Dixon, L. and Porter, A.M. (1994), *Jit ii, Revolution in Buying and Selling*, Cahners Publishing Company, Newton, MA.

Druskat, V.U. (2005), "Scholarship that works", *Academy of Management Journal*, Vol. 48 No. 6, pp. 952-955.

Emonds, G., Declerck, C.H., Boone, C., Vandervliet, E.J.M. and Parizel, P.M. (2010), "Comparing the neural basis of decision making in social dilemmas of people with different social value orientations, a fmri study", *Journal of Neuroscience, Psychology, and Economics*, Vol. 4 No. 1, pp. 11-24.

Fawcet, S.E., Waller, M.A. and Fawcett, A.M. (2010), "Elaborating a dynamic systems theory to understand collaborative inventory successes and failures", *International Journal of Logistics Management*, Vol. 21 No. 3, pp. 510-537.

Fawcett, S.E., Wallin, C., Allred, C., Fawcett, A.M. and Magnan, G.M. (2011), "Information technology as an enabler of supply chain collaboration: a dynamic-capabilities perspective", *Journal of Supply Chain Management*, Vol. 47 No. 1, pp. 38-59.

Fowler, R. (2008), "Performance based life cycle product support – the new pbl", North *American Defense Logistics Conference (2008), WBR Research, Crystal City, Aelington, VA, December 3*.

Guajardo, J., Cohen, M., Kim, S. and Netessine, S. (2012), "Impact of performance based contracting on product reliability, an empirical analysis", *Management Science*, Vol. 58 No. 5, pp. 961-979.

Gupta, A., Seshadri, S., Mukherji, S. and Ganguly, A. (2007), "Offshoring: the transition from economic drivers toward strategic global partnership and 24-hour knoweldge factory", *Journal of Electronic Commerce*, Vol. 5 No. 2, pp. 1-23.

Hendricks, K.B. and Singhal, V.R. (2003), "The effect of supply chain glitches on shareholder wealth", *Journal of Operations Management*, Vol. 21 No. 5, pp. 501-522.

Hofstede, G. (1980), *Culture's Consequences: International Differences in Work-Related Values*, Sage, Beverly Hills, CA.

Hunt, S.D. (2000), *A General Theory of Competition*, Sage Publications, Thousand Oaks, CA.

Isenberg, D.J. (2008), "The global entrepreneur", *Harvard Business Review*, Vol. 86 No. 12, pp. 107-111.

Kaipia, R. (2009), "Coordinating material and information flows with supply chain planning", *International Journal of Logistics Management*, Vol. 20 No. 1, pp. 144-162.

Kent, R.L. and Moss, S.E. (1994), "Effects of sex and gender role on leader emergence", *Academy of Management Journal*, Vol. 37 No. 5, pp. 1335-1346.

Kim, S.-G. and Ugurbil, K. (1997), "Functional magnetic resonance imaging of the human brain", *Journal of Neuroscience Methods*, Vol. 74 No. 2, pp. 229-243.

Kim, S.H., Cohen, M.A. and Netessine, S. (2007), "Performance contracting in after-sales service supply chains", *Management Science*, Vol. 53 No. 12, pp. 1843-1858.

Kim, S., Cohen, M., Netessine, S. and Veeraraghavan, S. (2010), "Contracting for infrequent restoration and recovery of mission-critical systems", *Management Science*, Vol. 56 No. 9, pp. 1551-1567.

Kleindorfer, P.R. and Saad, G.H. (2005), "Managing disruption risks in supply chains", *Production and Operations Management*, Vol. 14 No. 1, pp. 53-68.

Knudsen, T. (2006), "An economics-based logic for marketing", in Lusch, R.F. and Vargo, S.L. (Eds), *The Service Dominant Logic of Marketing: Dialogue, Debate, and Directions*, M.E. Sharpe, Armonk, NY.

Knutson, B., Rick, S., Wimmer, G.E., Prelec, D. and Loewenstein, G. (2007), "Neural predictors of purchases", *Neuron*, Vol. 53 No. 1, pp. 147-156.

Kohli, A.K. and Jaworski, B.J. (1990), "Market orientation: the construct, research propositions, and managerial implications", *Journal of Marketing*, Vol. 54 No. 2, pp. 1-18.

Kuhnen, C.M. and Knutson, B. (2005), "The neural basis of financial risk taking", *Neuron*, Vol. 47 No. 5, pp. 763-770.

Lambert, D.M., Garcia-Dastugue, S.J. and Croxton, K.L. (2005), "An evaluation of process-oriented supply chain management frameworks", *Journal of Business Logistics*, Vol. 26 No. 1, pp. 25-51.

Lee, T.M.C., Chan, C.C.H., Han, S.-H., Leung, A.W.S., Fox, P.T. and Gao, J.-H. (2008), "An event-related fmri study on risk taking by healthy individuals of high or low impulsiveness", *Neuroscience Letters*, Vol. 438 No. 2, pp. 138-141.

Lee, T.M.C., Chan, C.C.H., Leung, A.W.S., Fox, P.T. and Gao, J.-H. (2009), "Sex-related differences in neural activity during risk taking: an fmri study", *Cerebral Cortex*, Vol. 19 No. 6, pp. 1303-1312.

Levallois, C., Clithero, J.A., Wouters, P., Smidts, A. and Huettel, S.A. (2012), "Translating upwards: linking the neural and social sciences via neuroeconomics", *Nature Reviews. Neuroscience*, Vol. 13 No. 11, pp. 789-797.

Levitt, T. (1960), "Marketing myopia", *Harvard Business Review*, Vol. 38 No. 4, pp. 45-56.

Lo, A.W. and Repin, D.V. (2002), "The psychophysiology of real-time financial risk processing", *Journal of Cognitive Neuroscience*, Vol. 14 No. 3, pp. 323-339.

Lusch, R., Vargo, S. and Tanniru, M. (2010), "Service, value networks and learning", *Academy of Marketing Science Journal*, Vol. 38 No. 1, pp. 19-31.

Lusch, R.F. (2011), "Reframing supply chain management: a service-dominant logic perspective", *Journal of Supply Chain Management*, Vol. 47 No. 1, pp. 14-18.

Michel, S., Brown, S.W. and Gallan, A.S. (2008), "An expanded and strategic view of discontinuous innovations: deploying a service-dominant logic", *Journal of the Academy of Marketing Science*, Vol. 36 No. 1, pp. 54-66.

Myers, M.B. and Cheung, M.-S. (2008), "Sharing global supply chain knowledge", *MIT Sloan Management Review*, Vol. 49 No. 4, pp. 67-73.

Nowicki, D., Kumar, U., Steudel, H. and Verma, D. (2008), "Spares provisioning under performance-based logistics contract: profit-centric approach", *The Journal of the Operational Research Society*, Vol. 59 No. 3, pp. 342-352.

Ogawa, S., Tank, D.W., Menon, R., Ellermann, J.M., Kim, S.G., Merkle, H. and Ugurbil, K. (1992), "Intrinsic signal changes accompanying sensory stimulation: functional brain mapping with magnetic resonance imaging", *Proceedings of the National Academy of Sciences of the United States of America*, Vol. 89 No. 13, pp. 5951-5955.

Pagonis, G. (2004), "Department of defense implementation of performance based logistics", in Dod (Ed.), Department of Defense, Washington, DC.

Paton, R.A. and McLaughlin, S. (2008), "Services innovation: knowledge transfer and the supply chain.", *European Management Journal*, Vol. 26 No. 2, pp. 77-83.

Plambeck, E.L. and Zenios, S.A. (2000), "Performance-based incentives in a dynamic principal-agent model", *Manufacturing & Service Operations Management*, Vol. 2 No. 3, pp. 240-263.

Prahalad, C.K. and Hamel, G. (1990), "The core competence of the corporation", *Harvard Business Review*, Vol. 68 No. 3, pp. 79-91.

Prahalad, C.K. and Ramaswamy, V. (2004), "Co-creation experiences: the next practice in value creation", *Journal of Interactive Marketing*, Vol. 18 No. 3, pp. 5-14.

Ramsey, M. (2011), "Kia looks to add workers in georgia", *Wall Street Journal*.

Randall, W.S., Nowicki, D.R. and Hawkins, T.G. (2011), "Explaining the effectiveness of performance based logistics: a quantitative examination", *International Journal of Logistics Management*, Vol. 22 No. 3, pp. 324-338.

Randall, W.S., Pohlen, T.L. and Hanna, J.B. (2010), "Evolving a theory of performance based logistics using insights from service dominant logic", *Journal of Business Logistics*, Vol. 31 No. 2, pp. 35-62.

Randall, W.S., Wittmann, C.M. and Nowick, D.R. (2014), "Service-dominant logic and supply chain management: are we there yet?", *International Journal of Physical Distribution and Logistics Management*, Vol. 44 Nos 1/2, pp. 113-131.

Randall, W.S., Wittmann, C.M., Nowick, D.R. and Pohlen, T.L. (2011), *Service-Dominant Logic and Supply Chain Management: Are We There Yet?* University of North Texas, Denton, TX.

Rick, S. (2011), "Losses, gains, and brains: neuroeconomics can help to answer open questions about loss aversion", *Journal of Consumer Psychology*, Vol. 21 No. 4, pp. 453-463.

Rindfleisch, A. and Heide, J.B. (1997), "Transaction cost analysis: past, present, and future applications", *Journal of Marketing*, Vol. 61 No. 4, pp. 30-54.

Rudzki, R.A., Smock, D.A., Katzorke, M. and Stewart, S.J. (2006), *Straight to the Bottom Line: An Executive's Roadmap to World Class Supply Management*, J. Ross Publishing, Fort Lauderdale, FL.

Samaddar, S. and Nargundkar, S. (2010), "Analyzing supply chain disruption risk: a decision analysis framework", *Operations Management Education Review*, Vol. 4, pp. 87-107.

Segars, A.H. (1998), "Strategic information systems planning success: an investigation of the construct and its measurement", *MIS Quarterly*, Vol. 22 No. 2, pp. 139-163.

Segars, A.H., Harkness, W.J. and Kettinger, W. (2001), "Process management and supply-chain integration at the bose corporation", *Interfaces*, Vol. 31 No. 3, pp. 102-114.

Sheffi, Y. (2005), "Building a resilient supply chain", *Harvard Business Review Supply Chain Strategy*, Vol. 1 No. 5, pp. 1-11.

Sheffi, Y., James, B. and Rice, J. (2005), "A supply chain view of the resilient enterprise", *MIT Sloan Management Review*, Vol. 47 No. 1, pp. 41-48.

Sondergaard, M. (1994), "Hofstede's consequences: a study of reviews, citations and replications", *Organizational Studies*, Vol. 15 No. 3, pp. 447-456.

Stank, T.P., Dittmann, J.P. and Autry, C.W. (2011), "The new supply chain agenda: a synopsis and directions for future research", *International Journal of Physical Distribution & Logistics Management*, Vol. 41 No. 10, pp. 940-955.

Teece, D. and Pisano, G. (1994), "The dynamic capabilities of firms: an introduction", *Industrial & Corporate Change*, Vol. 3 No. 3, pp. 537-556.

Trent, R.J. (2007), *Strategic Supply Chain Management: Creating the Next Source of Competitive Advantage*, J. Ross Publishing, Fort Lauderdale, FL.

Vargo, S.L. and Lusch, R.F. (2004), "Evolving to a new dominant logic for marketing", *Journal of Marketing*, Vol. 68 No. 1, pp. 1-17.

Vargo, S.L. and Lusch, R.F. (2011), "It's all b2b […] and beyond: toward a systems perspective of the market", *Industrial Marketing Management*, Vol. 40 No. 2, pp. 181-187.

Wang, H.C., He, J. and Mahoney, J.T. (2009), "Firm-specific knowledge resources and competitive advantage: the roles of economic- and relationship-based employee governance mechanisms", *Strategic Management Journal*, Vol. 30 No. 12, pp. 1265-1285.

Wards Auto World (Ed.) (2007), "Hyundai plans Alabama engine plant. Wards Auto World", Penton Media Inc., Southfield, MI, available at: http://wardsauto.com/news-amp-analysis/hyundai-plans-al-engine-plant

Williamson, O.E. (2008), "Outsourcing: Transaction cost economics and supply chain management", *Journal of Supply Chain Management*, Vol. 44 No. 2, pp. 5-16.

Woodruff, R.B. and Flint, D.J. (2006), "Marketing's service-dominant logic and customer value", in Lusch, R.F. and Vargo, S.L. (Eds), *The Service Dominant Logic of Marketing: Dialogue, Debate, and Directions*, M.E. Sharpe, Armonk, NY.

Xue, G., Lu, Z., Levin, I.P. and Bechara, A. (2011), "An fmri study of risk-taking following wins and losses: implications for the gambler's fallacy", *Human Brain Mapping*, Vol. 32 No. 2, pp. 271-281.

Zacharia, Z., Nix, N.W. and Lusch, R.F. (2011), "Capabilities that enhance outcomes of an episodic supply chain collaboration", *Journal of Operations Management*, Vol. 29, No. 6, pp. 591-603.

Zhao, X., Huo, B., Flynn, B.B. and Yeung, J.H.Y. (2008), "The impact of power and relationship commitment on the integration between manufacturers and customers in a supply chain", *Journal of Operations Management*, Vol. 26 No. 3, pp. 368-388.

Corresponding author
Dr Wesley S. Randall can be contacted at: Wesley.randall@unt.edu