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**IMPACT OF DIFFUSION AND VARIABILITY ON VENDOR
PERFORMANCE EVALUATION**

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by

Ken Doerr, RADM Don Eaton and Ira Lewis

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Impact of Diffusion and Variability on Vendor Performance Evaluation

Presenter: Ken Doerr, BS Indiana University, 1984; PhD University of Washington, 1994. Prior to joining the faculty at the Naval Postgraduate School, he taught at the University of Miami, the University of Washington and Santa Clara University, and also held research fellowships at the University of Waterloo and the University of Cincinnati. He has worked for Shell Oil, Monsanto Corporation and Peoplesoft in manufacturing and supply-chain systems. His research has appeared in several leading journals, including *Management Science*, *The Academy of Management Review*, *IIE Transactions* and *The Journal of Applied Psychology*. His research interests are in process design, work design, and information technology to facilitate operations. Dr. Doerr is originally from St. Louis, Missouri.

Kenneth Doerr, PhD
Associate Professor
Mail Code GB/ND
Naval Postgraduate School
Monterey, CA 93943-5197
(831) 656-3625
Fax (831) 656-3407
khdoerr@nps.edu

Presenter: RADM Don Eaton, USN (retired) is the Admiral Stanley Arthur Chair of Logistics and a Senior Lecturer at the Naval Postgraduate School. His interests include enabling the Future Logistics Enterprise and the increased effectiveness of reliability management in the acquisition logistics process.

RADM Donald R. Eaton, USN (ret.)
Senior Lecturer and Arthur Chair of Logistics
Mail Code GB/Et
Naval Postgraduate School
Monterey, CA 93943-5197
(831) 656-3616
Fax (831) 656-3407
deaton@nps.edu

Presenter: Ira Lewis, is Associate Professor of Logistics and Associate Dean for Faculty Affairs at the Graduate School of Business and Public Policy, Naval Postgraduate School, where he has been a faculty member since 1998. He holds a PhD in Logistics and Operations Management from Arizona State University. Prof. Lewis worked in a variety of logistics and acquisition-related positions in Canada's Department of National Defense from 1982 to 1998.

Ira Lewis, PhD
Associate Professor
Mail Code GB/LE
Naval Postgraduate School
Monterey, CA 93943-5197
(831) 656-2464



Abstract

Performance-Based Logistics (PBL) is an initiative that the Department of Defense (DoD) has targeted for "aggressive implementation" in FY 2006-2009 (Wolfowitz, 2004). It is an initiative intended to improve weapon-system logistics outcomes, and to reduce weapon system life-cycle costs. Provider evaluation in PBL is intended to center on clearly specified outcome metrics, and mutually-agreed upon goals on those metrics (DUSD-LMR, 2001)—with the idea that the DoD knows best what it wants in terms of logistic services, but the vendor may know best how to provide those services. PBL can be seen as an extension of the principle of "commander's intent" in which leadership presents goals, but subordinates are encouraged to choose methods and processes (Apgar & Keane, 2004).

Within the field of behavioral decision making, there is a substantial literature which shows that decision makers use sub-optimal heuristics to value and negotiate agreements such as PBL contracts for services; these are subject to systematic biases in judgment when evaluating performance (Kahneman, Slovic et al., 1982). In this paper, we draw a connection between the intent of PBL on the one hand, and the literature on biases and heuristics on the other. Specifically, we review the literature on PBL and logistics service measurement as it relates to: 1) the distinction between process and outcome measures and 2) the significance of risk. We then review the literature on behavioral decision making and performance evaluation that relates to those same two topics, and develop hypotheses regarding: 1) the potential impact of process measurement *on* outcome measurement, and 2) the absence of stated metrics and goals for the variance (risk) of outcomes. We develop specific, testable hypotheses from this review of the literature, report on a test of these hypotheses in a laboratory experiment, and discuss the implications of our findings in practice.

PBL is an evolving concept within the DoD, and clarification on the metrics which should be used to assess weapon-system logistics outcomes has been recently issued which emphasizes that system-level outcomes such as operational availability should be used to evaluate PBL candidates and the performance of PBL providers (Wynne, 2004). The system-level emphasis of this clarification is significant and proper, as warfighting outcomes are clearly only impacted by system-level (as opposed to component-level) performance.

But PBL is still being applied at the component level, and there is no clear guidance (to our knowledge) on how to link component-level variables like time-to-failure to system level outcomes like operational availability. Indeed, a recent Government Accountability Office (GAO) report found that most of the 185 PBL contracts they were able to identify in the DoD were written at the component or subsystem level, and they suggested that contracting at the component level should continue to be preferred to contracting at the system level (GAO, 2004).

Even in the private sector, the measurement and performance assessment of logistic services is known to be a difficult task. Proper valuation of the outcomes of logistic services (as opposed to merely valuing inputs, such as cost) must include some assessment of difficulty to quantify factors such as customer satisfaction, and risk reduction (Lambert & Burduroglu, 2000). This outcome-measurement problem is made more difficult because so many of the traditional logistics measures are process measures (Caplice & Sheffi, 1994). Nor is this situation easier



when the services are provided to the DoD, yet, outcomes cannot be reduced to measurable quantities like profit or shareholder value (Camm, Blickstein et al., 2004).

The DoD, of course, has no simple overarching valuation metric such as profit, and it has no simple revenue surrogates. Valued outcomes have to do with military missions; thus, even if logistic services for a weapon system are provided at an aggregate level by a single provider, they are difficult to value and price. At the level of a subassembly or single logistic element, the problem is compounded. Unless decision makers have comprehensive models of weapon-systems logistics, (in which the important performance dimensions of all critical components are modeled), they cannot value a component-level contract in terms of system-level outcomes like operational availability. Such models have not been required, and we have no evidence that they are being used in the field.

In situations without clearly observable outcome measures and valuation functions, decision makers are known to place a heavy weight on surrogates (such as process measures or even input measures) (Chinander & Schweitzer, 2003). Some of these surrogates, however, may not correlate well with system-level outcomes. Under PBL, decision makers must determine relevant outcomes for component-level contracts and separate *diagnostic* measures (those that correlate well with desired system outcomes) from non-diagnostic ones. However, decision makers are known to pursue information even when it is non-diagnostic and non-instrumental (knowledge of the measure would not or should not change decisions). Unfortunately, once obtained, such non-instrumental information may be treated as if it were instrumental (Bastardi & Shafir, 1998). That is, decision makers pursue information they do not need, then act upon it. In our paper, we investigate this tendency in decision makers who were asked to evaluate provider performance under a hypothetical PBL contract.

It might be claimed that additional information could never hurt the decision process (aside perhaps from the cost of gathering it), but at least two sets of research findings indicate that such confidence would be misplaced. The *curse of knowledge* is a dysfunctional decision-making pattern that occurs when a decision maker knows information they would be better off to ignore; yet, once it is known, they cannot ignore it (Camerer, Loewenstein et al., 1989). The classic example is a wine merchant who over-prices his good wine and under-prices his bad wine; thus, he loses revenue on both sides from customers who do not know as much about wine as he does. Thus, the wine merchant is "cursed" by his superior knowledge of wine quality, and he loses revenue: he would be better off to price his wines according to market demand. In our case, the decision maker who pursues non-diagnostic process information may misestimate provider performance because of it. A related bias is the *dilution effect*: the tendency for non-diagnostic information to cause diagnostic information to be undervalued (Nisbett, Zukier et al., 1981). In the case of PBL, if a decision maker captures process metrics, he or she may not be able to place them in the proper context relative to a system-level outcome, and the impact of an important outcome metric may be diluted. In our paper, we investigate the tendency of decision makers to dilute system outcomes when given knowledge of process variables.

A special case of the misuse of non-diagnostic information is the use of information about inputs. The *input bias* is the tendency to make judgments about the quality of outcomes based on the value of inputs (Chinander & Schweitzer, 2003). For example, people tend to judge the quality of a product or service higher when they have to wait longer for it (Maister, 1985). This bias is thought to play an especially significant role in evaluation when outcomes are difficult to observe or measure. In the case of PBL contracts, the evaluation of proposals based solely on the relative cost of alternatives would be an example of an input bias. Also, a



performance evaluation that considered investments a provider made in achieving outcomes would be an example of an input bias. In our paper, we investigate the susceptibility of decision makers to an input bias when evaluating the performance of logistic service providers.

There are other reasons why decision makers may seek out component-level process measures, even when they have been directed to look for system-level outcome measures. Process measures allow a better degree of control over the internal workings of a process. They may not reduce uncertainty around outcomes, but they do give decision makers a sense that outcomes are more directly under their control. Risk preferences vary widely, but in addition to individual differences in risk aversion or risk-seeking behavior, decision makers tend to prefer controllable to uncontrollable ones even to the extent that they will maintain illusions about the degree of control they have over a situation (Langer, 1975). The preference for controllable risks is said in part to be related to a general bias decision makers have that their own abilities are better than others' (Howell, 1971). Of course, part of the logic of performance-based outsourcing is that *providers* are more capable of dealing with the internal processes of the logistics service. But, decision makers appear to maintain this preference for controllable risks, and to support their bias toward exaggerated self-assessments, even when they would be better off with less control (Klein & Kunda, 1994).

In delegating the decisions on how to accomplish outcome goals to a provider, programs seek to use PBL to transfer some of the process and financial risk of the logistic service to the provider; in contracting to deliver outcomes while assuming responsibility for processes, providers accept that risk at a specified price. The assessment of these risks is part of a business-case analysis required for every implementation of PBL in the Navy (Young, 2003). To our knowledge, however, DoD-level PBL guidance does not require any specific measures of outcome risk, or process risk transfer.

The biases and heuristics literature make it clear that human decision makers are poor intuitive statisticians (Kahneman, Slovic, et al., 1982). Indeed, one of the early criticisms of that research was that, in part, it merely represented tests of intelligence or educational achievement (Cohen, 1982). As Cohen (1982) pointed out, if decision makers could intuitively grasp statistical concepts, what would be the point of offering classes about these concepts? However, whether it is a question of education or irrationality, it seems clear that most decision makers do not have an intuitive model that allows them to value variance in, for example, operational availability. In our paper, we investigate the tendency for decision makers, even when trained in risk assessment, to undervalue the impact of outcome variance.

The investigations in our paper are all made through laboratory experiments: questionnaires asking decision makers to evaluate PBL scenarios. The results have only limited generalizability to the actual management of extant PBL contracts, or to the valuation and pricing of PBL contracts. However, the results do have implications for the continued evolution of PBL, and the need for greater specificity in guidance. That is, if decision makers under PBL are subject to the same limitations as decision makers in our study, our research indicates the need for the DoD to develop specific guidance with regard to risk measurement and valuation, and to require comprehensive system-level models to value and price component-level contracts, and evaluate component-level logistic-service provider performance.



REFERENCES

- Apgar IV, M. & Keane, J. M. (2004). New business with the new military. *Harvard Business Review*, 82(9), 45-56.
- Bastardi, A. & Shafir, E. (1998). On the pursuit and misuse of useless information. *Journal of Personality & Social Psychology*, 75(1), 19-32.
- Camerer, C., Loewenstein, G. et al. (1989). The curse of knowledge in economic settings: An experimental analysis. *Journal of Political Economy* 97(3), 1232-1254.
- Camm, F. A., Blickstein, I. et al. (2004). *Recent large service acquisitions in the Department of Defense: Lessons for the office of the secretary of defense*. Santa Monica, CA; Rand.
- Caplice, C. & Sheffi, Y. (1994). A review and evaluation of logistics metrics. *The International Journal of Logistics Management*, 5(2), pp. 11-28.
- Chinander, K. R. & Schweitzer, M. E. (2003). The input bias: The misuse of input information in judgments of outcomes. *Organizational Behavior and Human Decision Processes*, 91(2), 243.
- Cohen, L. J. (1982). Can human Irrationality be experimentally demonstrated. *Behavioral and Brain Sciences* 4, 317-370.
- DUSD-LMR (2001). *Product support for the 21st century: A program manager's guide to buying performance*. Washington, DC: Deputy Undersecretary for Defense—Logistics and Material Readiness.
- GAO (2004). *Opportunities to Enhance the Implementation of Performance-Based Logistics*. Washington, DC: Government Accountability Office.
- Howell, W. C. (1971). Uncertainty from internal and external sources: a clear case of overconfidence. *Journal of Experimental Psychology* 89, 240-243.
- Kahneman, D., Slovic, P., et al. (1982). *Judgment under uncertainty: Heuristics and biases*. Cambridge, MA: Cambridge University Press.
- Klein, W. M. & Kunda, Z. (1994). Exaggerated self-assessments and the preference for controllable risks. *Organizational Behavior and Human Decision Processes* 59(3), 410.
- Lambert, D. M, Burduroglu, Y R. (2000). Measuring and selling the value of logistics. *The International Journal of Logistics Management* 11(1), 1-17.
- Langer, E. J. (1975). The Illusion of Control. *Journal of Personality and Social Psychology*, 32, 311-328.
- Maister, D. H. (1985). *The psychology of waiting lines: The service encounter*. J. Czepiel. Lexington, MA: Lexington Books.
- Nisbett, R. E., Zukier, H., et al. (1981). The dilution effect: Nondiagnostic information weakens the implications of diagnostic information. *Cognitive Psychology* 13, 248-277.
- Wolfowitz, P. (2004). *Implementation of the defense business practice implementation. Board recommendation of the senior executive council on continued progress on Performance-based logistics*. Washington DC: Deputy Secretary of Defense.
- Wynne, M. W. (2004). *Performance-based Logistics: Purchasing using performance-based Criteria*. Washington, DC: Office of the Undersecretary of Defense, Acquisition Technology and Logistics.



Young, J. J. (2003). *Performance-based logistics guidance document*. Washington, DC; Office of the Assistant Secretary of the Navy for Research, Development and Acquisition.



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