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Journal of Transportation Management

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Global Supply Chain Management

Objectives

Editorial Policy. The primary purpose of the JTM is to publish managerial and policy articles that are relevant to academics, policymakers, and practitioners in the transportation, logistics and supply chain fields. Acceptable articles could include conceptual, theoretical, legal, case, and applied research that contributes to better understanding and management of transportation and logistics. Saying that, our policy requires that articles be of interest to both academics and practitioners, and that they specifically address the managerial or policy implications of the subject matter. Articles that are strictly theoretical in nature, with no direct application to the management of transportation and logistics activities, or to related policy matters, would be inappropriate for the JTM. Articles related to any and all types of organizations, and of local to global scope, will be considered for publication.

Acceptable topics for submission include, but are not limited to, broad logistics topics, logistics and transportation related legal issues, carrier management, shipper management of transportation functions, modal and intermodal transportation, international transportation issues, transportation safety, marketing of transportation services, transportation operations, domestic and international transportation policy, transportation economics, customer service, and the changing technology of transportation. Articles from related areas, such as third party logistics, purchasing and materials management, and supply chain management, are acceptable as long as they are related to transportation and logistics activities.

Submissions from practitioners, attorneys or policymakers, co-authoring with academicians, are particularly encouraged in order to increase the interaction between groups. Authors considering the submission of an article to the *JTM* are encouraged to contact the editor for help in determining relevance of the topic and material.

The Editor information is: Dr. John C. Taylor, Associate Professor of Supply Chain Management, Department of Marketing and Supply Chain Management, School of Business, Wayne State University, Detroit, MI 48202. Office Phone: 313 577-4525. Cell Phone: 517 719-075. Fax: 313 577-5486. Email: taylorjohn@wayne.edu

The opinions expressed in published articles are those of the authors and do not necessarily reflect the opinions of the Editor, the Editorial Review Board, Delta Nu Alpha Transportation Fraternity, or Wayne State University.

Publishing Data

Manuscripts. Submit manuscripts to the editor by email attachment at taylorjohn@wayne.edu. Manuscripts should be no longer than 30 double-spaced pages and 7000 words. Guidelines for manuscript submission and publication can be found in the back of this issue.

Subscriptions. The Journal of Transportation Management is published twice yearly. The current annual subscription rate is $50 domestic and $65 international in U.S. currency. Payments are to be sent to Delta Nu Alpha at 1720 Manistique Avenue, South Milwaukee, WI 53172.

From the Editor...

I am honored that DNA selected Wayne State University and me to serve as the new Publisher and Editor of the *Journal of Transportation Management*. The *Journal* has made great progress since its founding in 1989 and with the help of the Editorial Review Board we hope to continue to enhance the reputation of the *Journal* for both academic and practitioner audiences.

Delta Nu Alpha and I would like to thank Georgia Southern University and its team for the tremendous job they did with the Journal for some 15 years. Dr. Karl Manrodt served as Editor the last two years and was an Associate Editor from 2000 to 2007. Prior to Karl's service Dr. Jerry Wilson served some 13 years as Editor, and then two years as Senior Editor, and he has been the guiding force of the Journal for many years. Thank you so much to Georgia Southern for their great efforts and best of luck as they begin their new Ph.D. program in Logistics/SCM.

Going forward the *Journal* will be published by Wayne State University's School of Business in Detroit, Michigan. Dr. George C. Jackson, recently retired from the Wayne State faculty, will be assisting as Associate Editor. I have also been in contact with our Editorial Review Board and look forward to them continuing their work on behalf of the *Journal*. Welcome to Editorial Board newcomers Tom Goldsby of the University of Kentucky, Stan Griffis of Michigan State University, Bob Cook of Central Michigan University, Scott Keller of the University of Western Florida, Anthony Roath of the University of Oklahoma, and Dan Lynch of Dalhousie University.

We have begun a series of changes that are intended to make the Journal more visible and attractive to readers and authors. These include registering and updating Journal information with several publishing guides, placing the Journal content with the EBSCO and Gale databases faculty have access to, registering the Journal with Google Scholar, and placing abstracts of all past journal articles on an open area of the DNA Journal web page. Full Journal article PDF's continue to be available to subscribers on the webpage at www.deltanualpha.org - email admin@deltanualpha for the password if you are interested. We also have updated Submission Guidelines on the web page.

In this issue of the *Journal* we have some great articles that I hope you will find interesting. The review process has begun on a number of articles for the Fall Issue and I encourage all to submit articles to me as soon as possible. I look forward to serving you as the Editor of the *Journal*, and hope to hear from you our readers; with questions, comments and article submissions.

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DEVELOPING REVERSE LOGISTICS PROGRAMS: A RESOURCE BASED VIEW

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ABSTRACT

Previous research proposes a six-process model for reverse logistics (RL) program design and execution. This manuscript advances RL related knowledge by incorporating the previous model into a broader theoretical framework, namely, the Resource Based View (RBV) of the firm. The current research employs exploratory techniques to investigate the applicability of RBV and its main tenants within the RL context. Based on in-depth interviews with 16 executives from seven different companies, the relationships among resources, RL capabilities, and RL competencies are explored.

INTRODUCTION

Delivering product to the customer does not always end the business cycle. Products are often returned and must be reclaimed from downstream trading partners. Historically, the sheer volume of returns has been staggering. For example, in the magazine publishing industry, half of all products are returned, and return figures of 30% are not unusual in the book publishing, greeting cards, and retail catalog industries (Rogers and Tibben-Lembke, 1999). More recent examples are almost as extreme. L.L. Bean reports that out of 48 million products shipped out to customers, 6 million were returned (Bodenburg, 2007).

Return rates of 11 to 20% are reported in the consumer electronics industry (Arar, 2008). Recalls of products as disparate as toothpaste, pet food, laptop batteries, spinach, and contact lens solution are becoming everyday news (Kator, 2007).

Returns negatively impact the bottom line. Across all industries, returns can reduce profits by as much as 30 to 35% (Rodriguez, 2007). Lost sales, transportation, handling, processing, and disposal expenses directly attributable to returns are estimated at $100 billion per year (Blanchard 2009). Added to the actual costs of handling returns are mounting pressures from different government entities and the society as a whole toward environmentally-friendly, "green" organizational practices. Rodriguez (2008) illustrates the strategic role of reverse logistics (RL) under the growing corporate ecological responsibility drive:

> As companies launch new environmental initiatives to mitigate their impact on the world's climate, they are finding that mishandling reverse logistics may leave them open to fines from regulatory agencies, and to a potentially negative reaction from customers that could affect future business. (p. 4)

Hence, designing efficient and effective reverse logistics (RL) is critical, and substantial resource commitments may be required to ensure organizational competitiveness and survival in the long run (Jayaraman and Luo, 2007).

A Resource-Based View (RBV) of firm competencies (see Barney, 1991; Wernerfelt, 1984), suggests that focused resource commitments are associated with successful organizational performance outcomes. At the same time, insufficient resource commitment to reverse logistics is cited as one of the biggest problems in developing successful returns programs (Walsh, 2006). Moreover, as managers of reverse logistics programs are well aware, resource commitments alone do not guarantee success. Indeed, critics claim that attributing success to the allocation of resources is too often made retroactively, i.e. *after* the investments have proven worthwhile. A better understanding of *how* resource commitments translate into performance outcomes seems important to both theory and practice. Framed differently, it is vital to understand how reverse logistics capabilities arise. It is argued that only *in combination* with the development of processes will dedicated resources result in maximizing reverse logistics performance. Processes can be used to form a reverse logistics competency that enhances the resources' contribution to the creation of reverse logistics capabilities.

The current research utilizes case studies to explore the relationships among resources, competencies, and capabilities applied in the context of RL operations. RL program development and implementation has not been incorporated into a broader theoretical perspective (such as RBV). The framework introduced represents our attempt to address this gap.

The manuscript begins with a literature review that is presented to help convey the theoretical grounding of the study's qualitative insights. The second section then focuses on the method of collecting qualitative information. Third, a conceptual framework is presented illustrating the

relationship between resource commitments, reverse logistics processes, and the reverse logistics capabilities of firms. Finally, implications for practitioners and academics are discussed, and future research directions are suggested.

BACKGROUND
Overview of Reverse Logistics

Reverse logistics is often defined as a set of operational processes aimed at "... planning, implementing and controlling the efficient, cost-effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing or creating value or for proper disposal" (Rogers and Tibben-Lembke, 1999). The focus of the current research is first, to provide a better understanding of what is involved in these processes and second, to explain their role in the overall reverse logistics program development and implementation. Operational processes are "structured sets of work activity that lead to specified business outcomes for customers and the firm" (Davenport and Beers, 1995). A process approach is necessary in order to fully understand and manage the complex activities and interactions involved in returns management (Cooper and Stephan, 1994). Rogers et al. (2002) identified the following processes involved in returns management: return initiation, determining routing, receiving returns, selecting disposition, crediting customers, and measuring performance. The processes actually encompass more than reverse logistics activities as they extend to the activities associated with gatekeeping and avoidance, i.e., taking steps to eliminate or minimize the causes of returns.

While both forward and reverse logistics involve handling the physical flow of goods and services, substantial differences exist. Stock and Lambert (2001) note that "most logistics systems are ill equipped to handle product movement in a reverse channel." The differences in resources, the processes involved, and the capabilities needed for handling returns, can influence logistics strategy and operations. Previous academic studies

recognize the unique nature of RL and have focused on the collection of used products, their pricing, after-market use through resale and/or re-manufacturing, and recycling options including "green" and conservation initiatives (Pokharel and Mutha, 2009; Stock, 1992). At the same time, these authors acknowledge that little theory-based research has been conducted providing a more holistic view of reverse logistics and its impact on firms' overall performance.

METHODOLOGY

Qualitative research is often used to gain understanding of how specific theoretical perspectives (such as RBV) can be applied in a particular context (Yin, 2003). The current research utilizes the qualitative method of scientific discovery to explore the relationships among

resources, competencies/processes, and capabilities within the specific context of RL.

Theory describing RL is less mature than logistics and supply chain management conceptualizations (Dowlatshahi, 2000). Thus, a purposive sampling was applied in selecting the cases of interest (Davis and Mentzer, 2006). Due to the specific nature of reverse logistics within the broader context of firms' supply chain operations, efforts were made to select participants at two levels in each company: 1) Senior supply chain/logistics executives with knowledge of the role and place of RL within the company, and 2) RL operations executives, responsible for day-to-day RL program development and implementation. After identifying the main criteria for inclusion, the next step was to develop a list of potential candidates. A referral system (Davis and Mentzer, 2006),

TABLE 1
FIRMS' CHARACTERISTICS*

Firm	Industry	Participant's Titles
I.**	3PL – Retail Business Solutions	**A**, Vice President
II.	Dedicated Returns Center for Computers and Peripherals	**B**, GM Global Operations **C**, Distribution Manager
III.	Catalog/Brick and Mortar Retailer for Furniture and Apparel	**D**, VP of Distribution **E**, Inbound Manager **F**, Returns Supervisor
IV.	Consumer Electronics	**G**, Director, Returns Management
V.	Manufacturer of Self-Service Technology and Equipment	**H**, Manager, Distribution Operations **I**, Area Logistics Manager **J**, Logistics Analyst
VI.	3PL – Cross-industry Logistics Service Provider	**K**, Executive VP, Business Development **L**, Manager, Customer Performance Team **M**, Warehouse Manager
VII.	Wholesale Distributor of Technology Products	**N**, Logistics Center Director **O**, Returns Manager **P**, Logistics Supervisor

* Adapted from Flint, Woodruff, and Gardial (2002)

** Due to guarantees of anonymity, participants were not identified by company affiliation.

where three experts in the field of RL, two from industry and one academic, was used to identify companies with extensive returns management involvement. The sampling process was constrained by limitations regarding geography and time; only companies within a day's driving distance from the researchers' location were included. A convenience sampling is considered acceptable with a case study approach (Pagell, 2004). The final sample consisted of 16 participants from seven different companies. The sampling process was deemed completed when theoretical saturation was reached. In addition, the number of interviews conducted exceeds the minimum number (8) established as a guideline in qualitative research (Davis-Sramek and Fugate, 2007). The participants were initially approached through expert referrals and provided with solicitation letters following the guidelines of Yin (2003). The initial contact subsequently identified other(s) within the firm that also had knowledge about the RL program. Industry affiliation and job positions of the participants are provided in Table 1.

According to Yin (2003), the "unique tools" of case study research, compared to other research methods, are direct observation and personal interviews. Depth interviews were employed utilizing a semi-structured interview technique. This allows the interviewer discretion to follow leads while still insuring questions and topics are covered in roughly the same order. Semi-structured interviews yield more reliable and comparable qualitative data than do unstructured or informal interviews (Bernard, 1994). Sequence of analysis (Spiggle, 1994) was employed as a means of interpreting and organizing the results. This particular method allows for use of *a priori* categorizations, based on the literature, as well as emerging themes, and then allows exploration of the themes' interrelationships. The Interview Guide is included in Appendix 1.

TABLE 2
TRUSTWORTHINESS OF STUDY AND FINDINGS*

Trustworthiness Criteria	Method of Addressing in this Study
Credibility (Extent to which the results appear to be acceptable representations of data)	- 12 months conducting interviews- two independent coders analyzed the codes and the transcripts - 1-page summary was provided to three of the participants for feedback- the initial framework was altered and expanded
Confirmability(Extent to which interpretations are the result of participants' information and the phenomenon as opposed to researcher bias)	- More than 100 pages of transcripts were independently analyzed by a co- researcher - Summary of preliminary findings to three other team members who acted as auditors - Interpretations were expanded and refined
Control (Extent to which organizations can influence aspects of theory)	- Participants do have control over securing adequate resources, developing RL-related capabilities, and enhancing their RL competencies - Participants can influence our framework
Transferability (Extent to which findings from one study in one context will apply to other contexts)	- The sample reflected a high degree of diversity in terms of industry and participant involvement - Theoretical concepts were represented by data from all participants

* Adapted from Flint, Woodruff, and Gardial (2002)

Interviews were audio taped. In each instance, initial impressions and notes from the visits were immediately shared with another researcher. The audiotapes were professionally transcribed and verbatim scripts provided to the research team. Data were qualitatively analyzed by two more academics not directly involved with the project ensuring increased trustworthiness of findings. Table 2 illustrates specific criteria associated with the reliability of the qualitative research.

RBV REVERSE LOGISTICS FRAMEWORK AND PROPOSITIONS

In its most generic form, the RBV argues that a firm's resources can be a potential source of competitive advantage (Barney, 1991) leading to differentiated performance outcomes (Aaker, 1989; Day and Wensley, 1988) and above normal economic rents (Rumelt, 1987). Firm resources, however, must be organized and carefully managed. Competency in developing, combining, and deploying resources is necessary for achieving better performance (Teece, Pisano, and Shuen, 1997). Thus, qualitative analyses focused on identification of both resources and processes which in combination appeared to bolster performance. The next section describes several types of resource commitments that appeared across interviews to be related to RL and firm performance.

Resource Commitments

Barney (1991) includes, "all assets ... controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness," as organizational resources. Guidance is needed, however, on how to best categorize resources—to help direct managerial thinking about critical inputs into RL capabilities. The data allowed for ready assignment of resources into hard (e.g., returns facilities, salvage stores, factory outlets, warehouse equipment, software and hardware systems, refurbishing equipment, etc.) or soft (e.g., managerial and employee skill with handling returns, technological expertise, vendor

relationships) categories. However, review of Miller and Shamsie's work (1996) suggested a better categorization. Two resource classifications appeared to be particularly germane to RL: 1) knowledge-based resources and 2) property-based resources.

The researchers have selected quotes from the interviews that provide support for our proposed reverse logistics framework. The following quotes relate to resource commitment.

Our (reverse logistics system) must involve the right returns authorization personnel - they are responsible to record the right information, credit the right account with the right amount, be able to codify the reasons for returns, and also has to be able to identify trends in the returns.
VP of Distribution, Catalog Retailer Company

They (salespeople) also work with our planning people, because they are going to say, 'this is how much money we get for this contract, this is how much returns will cost.
Returns Manager, Wholesale Distribution Company

Knowledge-based resources include the firm's know-how and skills—i.e., its technological, managerial, and human resources. Knowledge-based resources are difficult to transfer or imitate, at least in the short run, due to firm-specific paths of developing and/or acquiring know-how, skills, and experience among employees (Amit and Schoemaker, 1993; Barney, 1991). Knowledge-based resources are viewed as critical as illustrated in the following quote from an informant in the computer and peripherals wholesale industry, "We also go out and hire the best as it relates to strategic and key positions in returns. We pay above market wages for that kind of competitive differentiator position." While differences between industries are likely to exist regarding which resources serve as critical inputs to RL capability, the interviews clearly revealed that mangers should focus on both human and technological sources of "knowledge."

Property-based resources are defined as "legal properties owned by firms" (Das and Teng, 2000). Examples include materials handling equipment, facilities, and transportation equipment. Across the companies involved in the research, assignment of financial capital to RL is considered critical. However, they also acknowledged that reverse logistics often receives lower prioritization than other supply chain functions and is allocated fewer property-based resources. To illustrate, the general manager of an apparel and furniture catalog retailer reported, "We are at a point now where the returns project is not competing well with other programs. Other departments have projects that are keeping the returns project from getting done. Returns-related investments are just not as great as some other projects." Another anecdote revealed one firm's struggle with inadequate property-based resources: "We had so many capacity constraints... it literally looked like one of your hall closets at home just packed with stuff." While numerous property-based resources were identified, perhaps the most interesting theoretical insight pertained to the idea that, across types, resources alone did not necessarily relate to better performance:

> *After years of heated discussions with senior management, finally, the reverse logistics operation received the much needed increase in dedicated budgeted funds. The investment predominantly focused on human resources, additional space, and equipment allocations dedicated to returns handling. Surprisingly, the following evaluation revealed that the increase in resources per se worsened the situation in terms of reverse logistics program performance.*
> Returns Manager, Wholesale
> Distribution Company

> *Not that long ago, it was just 'trying to survive', and we weren't spending too much time thinking about how to make the process better. We were just trying to figure out how to get inside the (new) building, and how to open the door without things falling out.*

Distribution Manager, Returns
Center for Computers and Peripherals

While property-based and unique knowledge-based resources *potentially* strengthen reverse logistics performance (as each were consistently mentioned as important to successful reverse logistics), there is evidence to suggest that the application of resources alone may not directly impact performance. This expands upon the most stringent view of RBV and is in keeping with a "dynamic capabilities" extension of the theory (e.g., Eisenhardt and Martin, 2000; Teece, Pisano, and Shuen, 1997). At the same time, these authors acknowledge that even though resources alone may not be enough to ensure competitiveness, they are the necessary foundation. Thus, the following proposition is offered.

> *P1: In order to develop viable reverse logistics capabilities to support a reverse logistics program, it is necessary to dedicate and commit both property-based and knowledge-based resources.*

Reverse Logistics Capabilities

Capabilities represent the organization's ability to develop ways to respond to changing customer requirements. Capabilities, here, refer to organizational abilities arising from reverse logistics programs that potentially create sources of competitive advantage, differentiation, and enhanced firm performance (Daugherty et al., 2005; Eisenhardt and Martin, 2000). The qualitative data revealed three reverse logistics capabilities with parallels in extant RL research: 1) Information Management rooted in Information Technology; 2) Innovation, and 3) Responsiveness (e.g., Richey, Genchev, and Daugherty, 2005). These three categories are explored in the following sections.

RL Information Management Capability

The need for developing reverse logistics information management capabilities is recognized as a top priority among the companies involved in

the research. The following quotes are illustrative:

Processing returns, receiving, locating, pulling inventory, cycle counts of physical inventory, all those things must be done automatically. (Technology) is pretty cool, takes a lot of the possibility of human error out—and it's much easier to train than employees. It just works more efficiently.

> VP of Distribution, Catalog Retailer

> *Our client... has all the travel agents around the country utilizing a specific information network. If we don't have the ability to synchronize our information systems, we lose that customer.*
>
> VP Business Development, 3PL
> Cross-Industry Service Provider

Establishing a reverse logistics information management capability, defined as the organizational ability to seamlessly integrate reverse logistics into the complete technological and informational network of the firm, should be a top priority (Daugherty et al., 2005). When the necessary resources are focused on building information management capabilities, the impact on companies' competitive positioning can be substantial (Closs and Xu, 2000). Developing firm-specific information management capabilities to support logistics is often the differentiating factor between industry leaders and average firms (Bowersox et al., 1989).

Although increased resources have been dedicated to technology systems related to forward flows of products and services, information technology solutions for reverse flows have received little attention (Norek, 2002). This was evident through several informants' comments including, "Because of the way our returns process program is programmed into our system, it's really tied to call entry systems and it uses some of the same screens. Management realizes that returns should be handled differently but... it's a very complicated process to reprogram returns the way we want it." One apparent challenge in developing this

capability is the fact that *standardized* technological solutions for reverse logistics programs have often been unsuccessful (Stock and Lambert, 2001).

RL Innovation Capability

Because of the complexities involved, companies continually look for better ways to handle reverse logistics.

> *We are constantly evolving, coming up with new ways when it comes to handling returned product... from damaged in transit, customer wasn't there, refused by customer, to stock balancing, defective products, vendor errors, vendor quality defect, damaged goods...*
>
> Returns Manager, Wholesale
> Distribution Company

> *Reverse logistics is a funny industry in that everybody is a hobbyist to some degree or another. So, we are constantly evolving—coming up with new ways to process returned product.*
> General Manager, Global Operations,
> Computers and Peripherals 3PL

Reverse logistics innovation capability refers to the ability of the firm to apply new ideas to a set of reverse logistics processes (cf. Van de Ven, 1986). While these ideas could include information technologies, they may be independent or applied in combination with technology. Prior research on returns management has addressed innovation capabilities and found that they represent an important mediator of the link between resources and firm performance (Richey, Genchev, and Daugherty, 2005). Increased cost savings through efficient reverse logistics operations and value recovery require differentiated, innovative approaches (Guide and Wassenhove, 2002).

Based on the data, customized solutions often seemed to be needed for returns processing, in part, since returned product flow runs counter to

standard operations. In keeping with Zieger's (2003) descriptions of firms with RL competitive advantage, the study revealed a number of firms utilizing customer-specific and industry-specific management techniques and technologies. One informant from a technology-products wholesale company revealed, "Our rules for returns are based on each individual customer - the sales system 'decides' what the rules are, based on who the customer is - the main differentiator being sales volume." Such RL programs are clearly adhering to the cutting-edge notions of one-to-one marketing or customer-specific CRM practices. Innovation is thus considered vital to the success of a reverse logistics program and an important managerial consideration when exploring how and where resources should be committed.

RL Responsiveness Capability

The complexity of the returns process, compared with outbound logistics, presents challenges for firms. The need to quickly respond to changing market expectations about returns and fluctuating return flows, was mentioned by many as making reverse logistics particularly challenging. Informants that seemed most pleased with their systems also acknowledged that their reverse logistics programs were very capable of handling these complexities. It appears that a focused effort is necessary to keep reverse logistics programs responsive to changes and competitive pressures. For instance, one respondent said:

> *The biggest problem we face is lack of visibility of what will be returned today, tomorrow, next week, next month, next quarter, next year; it's very, very limited. In the worst case scenario, we are dealing with few minutes – the truck backs up hitting the dock – that's your visibility of this incoming volume of product. So, the ability to become responsive becomes very important. So, it's the ability to optimize and plan labor to get flexible in how you staff your operation ...within that unknown volume of returns.*

Distribution Manager, Returns Center for Computers and Peripherals

Several examples of firms *being* responsive help to illustrate this point. A returns manager at a major manufacturer of consumer electronics revealed, "Speed/turnover is of utmost importance since you have credited the customers already." Another informant, involved in managing computer and peripherals returns, discussed how his firm possessed the ability to, "make some decisions right off the bat... if it's in warranty, or out of warranty, if it's an obsolete part, or if it's a part the customer doesn't want us to work on, so we can pull those out before we actually go through the testing process."

Reverse logistics responsiveness, defined as the firm's ability to respond to changing returns-related customer requirements, has been shown to enhance the competitive positioning of the firm (Richey et al., 2004). Since a return often signals a problem in the system, the ability of the firm to quickly address that problem can be an important differentiating factor (Malone, 2004). Processing orders "within 36 hours of when it's received" was critical for the wholesale distributor of technology products, creating a competitive advantage while wrestling with the unknown volume of product returns. Therefore, it is proposed that: ·

> *P2: The level of resource commitment to reverse logistics is associated with the following specific reverse logistics capabilities: IT, Innovation, and Responsiveness.*

Reverse Logistics Competency

With grounding in RVB, reverse logistics competency can be defined as mastery of the necessary processes for transferring firm-specific resources into reverse logistics capabilities. These processes should be organized by firm management in an effort to provide a source of competitive differentiation (Teece, Pisano, and Shuen, 1997). To accomplish this, Marien (1998) recommended that firms should look at new

approaches and consider reengineering of how their businesses are conducted with respect to reverse logistics. He suggested that "firms step back and take a hard look at what values reverse logistics processes can add for consumers specifically and society in general" (p. 44). Stock, Speh, and Shear (2002) cautioned that RL "shouldn't be viewed as a costly side-show to normal operations . . . Rather (it) should be seen as an opportunity to build competitive advantage" (p. 16). Other researchers have recognized the potential "powerful impact" of RL on costs, revenues, and customer goodwill (Mollenkopf and Closs, 2005). Stock and Mulki (2009) noted, "Organizations with excellent product returns processing capabilities (defined as those having processes that are both efficient and effective) can

have a potential competitive advantage, which gets larger as the magnitude of product returns increases" (p. 52).

The way logistics operational processes are organized and executed can be crucial. What a firm is capable of achieving is not just a function of the available resources; it also depends on the firm's resource transformation. To illustrate, a sheer increase in the number of RL employees would not utomatically boost performance. A clear understanding of what makes a firm competent in reverse logistics is necessary. Table 3 provides definitions of reverse logistics processes.

TABLE 3
REVERSE LOGISTICS RELATED PROCESSES*

RL Processes	Definitions
1. Return Initiation	Seeking a return approval from the firm by the customer or sending the return direct to the returns center.
2. Route Determination	Determining the mode of transportation and destination for the returned product.
3. Return Receipt	Receiving returns includes verifying, inspecting, and processing the returned product with emphasis on assigning pre-disposition codes.
4. Select Disposition	Selecting a disposition option for the returned product.
5. Credit Customer	Charging-back the customer's account.
6. Performance Analysis	Analyzing returns and measuring returns-related performance criteria aimed at improving the whole reverse logistics operation.

* Adapted from Rogers et al. (2002)

Return Initiation

Return initiation is the process by which the customer seeks return approval (Return Material Authorization or RMA) or sends the return directly to a designated returns center. The ease of returning items and how quickly return authorization is received can mean the difference between satisfied customers and those who never come back (Norek,

2003). One key issue in developing a returns initiation process was being "proactive." This theme was often tied to the returns initiation concept. Moreover, firms struggling with their reverse logistics programs seemed to acknowledge a *problem* or difficulty associated with being proactive. Consider the following quote from an employee of a consumer electronics manufacturing

firm, "When it comes to returns, we do very little proactive resolution with our customers."

Another problem appears to be the difficulty in predicting the amount of returns at any given time, which clearly effects the front-end of the reverse logistics process. Uncertainty is then compounded at the detail level—which customer/firm will initiate returns, and how? This concern is illustrated by the following quotes, "We have discrepancies on a daily basis between what was declared through return initiation and what actually was received in the returns center." Working with downstream partners is important. "Few discrepancies are found between 'actual' and 'described by dealers' when a proactive approach exists between customers and the company and we try to get them to fill in the right info." (*Distribution Manager, Returns Center for Computers and Peripherals*)

The respondents realized the need for returns policies dealing with return authorizations. At the most basic level, without structured procedures across the distribution channel, significant problems with returns are likely: "If they (customers) ship the return back without calling in and reporting it, here, we'll scan it and nothing will come up, we wouldn't even know what it is." Developing and enforcing a structured return initiation process increases returns visibility and should help companies become more responsive (Sciarrotta, 2003).

Every time we have discrepancies we try to walk with them (the customer) through the process to identify where the problem is.
   Distribution Manager, Returns Center for Computers and Peripherals

All customers have different SLEs (service level agreements effecting returns authorization).
   Logistics Analyst, Manufacturer and Distributor - Self-Service Equipment and Technology Products

Route Determination

The second reverse logistics process involves the physical movement of the returned product to a returns-processing facility. In a typical reverse channel, end users or retailers initiate the return and wholesalers or manufacturers receive and process the returned product. In this stage, strict responsibilities are assigned for sending the return back, following a return authorization. A formal agreement among the parties involved can streamline returns routing (Rogers et al., 2002). Firms seek to create competitive advantages through this particular process by recognizing what should or should not be expected within an industry.

We put a US postal service label in each order that goes out. When the product gets to customers, and if they don't like it, all they have to do is put it back in the packaging, put that label on it and leave it at their mailbox or take it to the Post Office and it comes back priority mail.
   Inbound Manager, Catalog Retailer Company

Stores are not even used to shipping returns, and so we cannot hold (that type of customer) liable to do it. We take care of ALL returns transportation. It's our responsibility.
   Area Logistics Manager, Manufacturer and Distributor - Self-Service Equipment and Technology Products

Most firms seemed to utilize some method of pre-printing shipping labels for returns that specify the contracted carrier(s) and the exact location where the return should be sent. The routing, however, often varied by business partner in terms of destination, timing, carrier selection, and returned product condition (usually as agreed upon in advance with the business partners) with multiple modes being surprisingly commonplace because of the complexities involved.

Return Receipt

This process involves physical receipt of the product. Although the returns managers interviewed represent different industries and different types of businesses, wholesalers, retailers, and manufacturers, they each identified the following activities as crucial to receiving returns: 1) verifying the documentation accompanying each return; 2) inspecting the condition and packaging of each return; 3) informing the customer of any discrepancies/ exceptions not in accordance with the return policy; and 4) assigning pre-disposition codes for the processed return. Automation, in order to streamline subsequent handling of returns, appeared to be of paramount importance to this RL process:

These (returns) are going through one single receiving area that has customer returns coming in from all over the place. Could be coming in from actual end customers, from service technicians, from engineers. We put a license plate on the product, that's a unique identifier for a specific product and we use that through the system to track what we are doing...

A lot of these will have bar codes already on them, so we can use that to load the information directly into our system. Once we get everything recorded and loaded into the system we can trace it through and make it easier to move from place to place...

We have these automated machines here, we turn on the program and it tests out the module. If it's good, it will put a green dot on it and shoot it out to the 'green dot place' and if it's bad it will shoot it to the 'red dot place'. And it's just totally automated. Pretty simple process!

We create a bar code that goes on the order number that it was sent in, the date that it got here, the pallet number that it came in, what the weight of the pallet was, and a

commodity code. We can sort things out by the commodity codes now; hey, I need bunch of speakers and know that's commodity code 35, and pull out all the 35's in the warehouse and it'll tell us where those things are...
Distribution Manager, Returns Center for Computers and Peripherals

Clearly this processes success is dependent upon adequate resource commitment. While, at first glance it may appear that information technologies are the key resources, human capital was described as vital as well as evidenced in the following quotes:

It is one of the most complicated jobs here, Returns Processor, because they are handling cash transactions, they are really handing money, giving peoples' money back, determining whether they get their shipping charges back, or whether we charge them shipping charges. They are making a whole lot of decisions about how to treat this customer from a financial standpoint and they are making a lot of decisions about the quality of merchandise - is it good enough to go back in stock, should it go to a liquidator, should it get to refurb and they are also capturing data like different returns reasons codes so we can get different reports to know why we're getting high return levels on some of the products.
VP of Distribution, Catalog Retailer Company

Returns processing position is a pretty complicated position, probably the most complicated hourly position in the DC.
Logistics Center Director, Wholesale Distribution Company

Since returns involve a number of unknowns such as the time of return, volume, and physical/ operational condition, receiving returns typically involves a physical check of the returned product. Inspection is necessary to verify whether what the customer indicated is what actually arrived in the returns facility. An RMA "check" typically

involves a step-by-step comparison between the information on the screen and the returned product itself in addition to the accompanying documentation. A more detailed receiving system also allows for fast and accurate feedback to customers in case of discrepancies and a better estimation of the timing required for returns processing (e.g., refurbishment, replacement). Perhaps most importantly, the dominant theme associated with this particular RL process, i.e., the "automation" of the returns, helps to set the stage for the next process, selecting disposition. The success of this process in yielding responsiveness, as a capability, depends on adequate commitments of knowledge-based resources.

Select Disposition

"Disposition" refers to the determination of ultimate outcome for the product. Disposition options include the choice to, "refurbish, remanufacture, recycle, resell as is, resell through a secondary market, or send the product to landfill" (Rogers et al., 2002). Interviews emphasized the importance of "getting product back in the customer's hands by giving them a new product." A PC and computer peripherals wholesaler, for example, described pushing a return straight back to the manufacturer without costly re-stocking as an operational priority. In a similar effort, a manufacturer of electronic equipment applies a type of "cross-dock" operation getting overstock returns out the door, to other customers, without placing the product back in stock. This would clearly not be the case, however, within many other industries.

Across industries it was found that alternative channels for resale and refurbishment were quite commonly uncovered during the development of reverse logistics programs. While disposal might indeed be a logical choice (i.e., "waste" was a common theme related to disposition in the analysis), many firms considered disposition not in terms of cost-savings but in terms of untapped potential revenue.

Nobody buys the CRT monitors any more. At some point, we're going to send them to a recycler. They're going to take the gas out of the monitor and take the pieces apart and recycle it the way it's supposed to be. They are the experts... So, instead of liquidating into a land-dump, better someone else take some value out of the scrap first.
Warehouse Manager, 3PL Cross-Industry Service Provider

A few companies are contracting the liquidation function - those companies want to buy truck-loads.
Distribution Manager, Returns Center for Computers and Peripherals

That the theme (of recycling) was repeated across industries bears further scrutiny. Innovative RL programs seemed to have incorporated recycling into their disposition processes. However, determining whether this was due to cultural pressure, revenue generation, or simply that more established programs had longer to find (or be found by) recycling alternatives, was beyond the scope of the data. What was clear was that revenue recovery required forethought and planning, i.e., knowledge-based resources, and that innovative RL programs tended to be proactive by seeking out (sometimes multiple) options for recycling (see Guide and Wassenhove, 2002).

Customer Credit

There were substantial differences in how firms handled crediting their downstream business partners for returns. For many, the highest priority was a fast charge-back. Themes such as "relationship maintenance" were common to this reverse logistics process. The consensus for firms, who tended to be dealing with smaller, specialized orders, was that relationships could be compromised if the customer does not receive a refund/credit promptly.

When the product hits the receiving dock in ..., it's a 'done deal' in terms of money transfer...Corporate is responsible for the

returns authorization and crediting dealers overnight without actually seeing the returned product.

> Returns Manager, Manufacturer - Consumer Electronics

Other firms, perhaps because of lower profit margins, were adamant about the importance of policies specifying not only who is "responsible" for the return and whether credit would be issued but who should pay for return-related shipping and other expenses. Even punitive remedies for customers' violations of important policies were well articulated by these firms. To illustrate, as the VP of Distribution at the catalog retailing company discussed, "the way we get the customer to pay for it, is by not refunding all their money, by withholding the freight charge from a refund, or by charging them extra for transportation." Ongoing financial commitments are critical for supporting the crediting process and handling.

The extent to which a firm establishes knowledge systems, in particular information technologies, allows quick and error-free crediting and promotes RL program responsiveness. In theory, there would be an interaction between detailed crediting processes and the commitment of knowledge-based resources in their effects on RL capability.

Performance Analysis

The process of analyzing returns-related performance is aimed at improving reverse logistics quality and identifying potential problem areas (Rogers et al., 2002). The following metrics were identified by returns managers: 1) volume of returns; 2) type/condition of returned product; 3) dollar value; 4) percent of sales; and 5) resources, including human resources, dedicated to returns. In-depth analysis of these measures can help to identify problem areas. Importantly, some reverse logistics programs' competencies even extended to real-time monitoring of the returns process by downstream channel partners.

It's online real-time, so (the business partner) can look at us any time and know exactly where we are at how many modules we processed. We have all kinds of metrics that are in the system. (They) can look at them any time they want to... We are (also) getting our certification ISO-14000 right now.

> Distribution Manager, Returns Center for Computers and Peripherals

Analyzing the volume, type/condition of returns, and dollar values associated can provide a comprehensive list of reasons for returns and identify trends. For example, if a particular customer is constantly abusing the returns policy, this will be apparent when volume of returns and percent of sales data are examined. Conversely, analysis helps to identify problems attributable to the firm. For example, by describing the type and condition of returned products, one firm uncovered damage-related problems with specific outbound carriers for particular products shipments.

The following proposition is offered relative to the development of RL competencies.

> *P3: The positive relationship between the level of resource commitments in terms of a) property-based resources and b) knowledge-based resources to reverse logistics capabilities will be stronger when RL "competencies" have been developed.*

The framework presented in Figure 1 covers the three elements of interest – RL resources, RL competency/processes and RL capabilities. The framework illustrates the importance of jointly considering *resource allocation* with *key operational processes* in the development of state-of-art reverse logistics capabilities.

IMPLICATIONS

The research highlights the importance of resources and how resources can be focused to greatest advantage within a reverse logistics

FIGURE 1
FRAMEWORK FOR DEVELOPING REVERSE LOGISTICS CAPABILITIES

RL Resources

- Knowledge-based

- Property-based

RL Cababilities

- Information
  Management

- Innovation

- Responsiveness

**RL Competencies/
Processes:**

- Return Initiation

- Route Determination

- Return Receipt

- Select Disposition

- Customer credit

- Performance Analysis
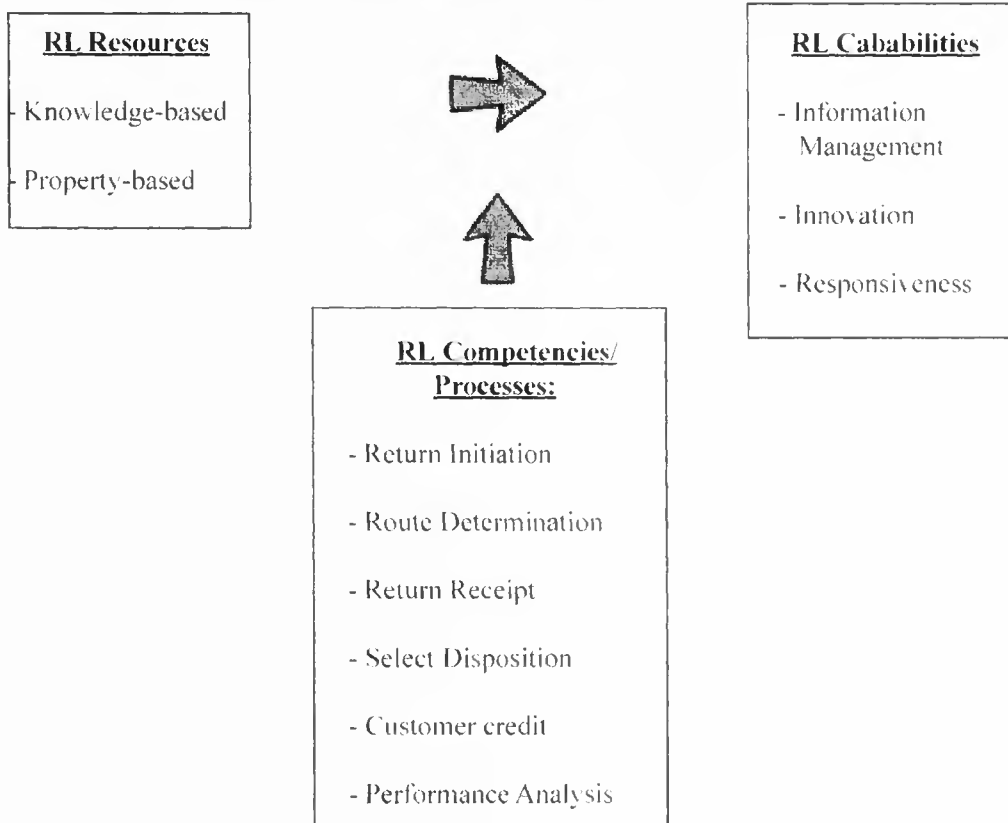
context. In the typical organization, everyone fights for resources to be able to carry out their responsibilities. Adequate resource support has always been an issue – and even more so given recent economic conditions. Reverse logistics is further hindered in that it's not "top of the mind" or "priority one" at most firms. The priority is usually getting the product *out* to the customers. Somebody else can worry about it if it has to "come back." Our research makes the argument that resources must be allocated to developing reverse logistics programs to avoid the potential negative impact on the bottom line. Conversely, if adequate resources (tangible/intangible or property-based/ knowledge-based) are targeted to reverse logistics programs, it can have tremendous positive financial impact as well as important relational implications.

Prompt handling of returns can influence customer satisfaction and repurchase intentions or loyalty.

We have argued that firms should build competencies in the form of formal processes. The reverse logistics process competencies are proposed as necessary activities to create reverse logistics capabilities and, subsequently, improve performance. Unless a transformational mechanism is present, the argument that resources will enhance performance becomes circular since better performance will, in turn, result in accumulating more resources. There is no existing research linking the major elements of the RBV and the related Dynamic Capabilities extension in a concise theoretical framework that avoids the tautology criticism. The current research presents competencies as the necessary

link between resources, capabilities, and differentiated performance.

The six processes identified by Rogers et al. (2002) represent competencies and can provide the framework for organizing or formalizing a RL program that is customer-friendly. Their six steps provide the ordering of the tasks necessary to smoothly move product back through the system and to re-claim as much value as possible from the return. Too often, reverse logistics is an afterthought. Product gets back "some way," but no one knows what to do with it. The six processes provide a way to direct company efforts in an organized way.

The research has important theoretical implications as well. The RBV is often critiqued for the tautological nature of the main argument, for lack of empirical support, and questionable applicability in practice (Makadok 2001). The current research addresses the purported shortcomings in the following ways:

First, as discussed, reverse logistics process competencies are proposed as necessary activities to create reverse logistics capability and, subsequently, improve performance.

Second, the conceptual framework presented here sets the stage for extended empirical work on RBV. For example, the current research identifies RL processes as a construct that may change the dynamics of the relationship between resources and performance. In the RL context, spending more does not always mean having a competitive program. This leads to the third point.

Third, in an environment where supply chain and logistics managers are struggling to squeeze out every possible cost-saving penny in their distribution operations, the finding that detailing the RL processes may, in fact, be more important than spending more money to improve operations, is worth managerial consideration. Theoretically, the argument being made is for *how* reverse logistics capabilities arise given resource availability. The contribution to RBV in this paper

is addressing the *how* through competencies. Managers understand a need in the market environment, assess their resources and recognize that certain competencies are necessary to enhance particular capabilities. Further, the combination of these processes can form reverse logistics competencies which help to create dynamic capabilities. This is because the competencies are rooted in the structure (i.e., IT) and the knowledge-based resources of the firm. If these resources are developed and targeted appropriately through applicable and relevant competencies (the management of the *how*), then they enhance capabilities while providing some dynamism to the firm's capabilities. Dynamism is addressed because management recognizes and can adjust through the manipulation of the competencies. Ultimately, this will differentiate performance.

LIMITATIONS AND FUTURE RESEARCH

Although information from interviews at seven companies was used, the current research was exploratory in nature. A quantitative empirical study is needed to test the proposed relationships among resources, reverse logistics competencies/ processes, reverse logistics capabilities, and reverse logistics program performance. The RBV of the firm is a general theory related to strategic intent and competitiveness. Focusing on one aspect of a firm's operations, i.e., reverse logistics, limits the generalizability of the frameworks's applications.

An interesting possibility for enhancing generalizability is to study the effects of specific processes in terms of industry specificity and/or timing of introduction. Industries are impacted differentially by returns, i.e., some industries must contend with a high volume, continual flow of returns. Intuitively it would seem that these industries would develop the best practices and most efficient returns programs. But is that true? Benchmarking leading firms with established reputations for reverse logistics efficiency and effectiveness may offer important insights that can be "borrowed" or modified to fit other companies/ industries.

The question of balance between benefits and drawbacks of formalizing RL processes requires more focused attention as well. Hard measures are needed in order to be able to conduct meaningful cost/benefit analyses. Focus should also be placed on better assessing the rewards associated with good reverse logistics. For example, what's the pay-off associated with providing high level customer service on returns handling? How does RL influence customer loyalty and repurchase intentions? Research could also focus on the feasibility of outsourcing reverse logistics rather than handling it in-house.

Reverse logistics has important implications relating to "green" initiatives; these issues have not been explored in depth at this point. Mishandling reverse logistics will leave companies vulnerable to regulatory retaliation and negative reactions from customers (Rodriguez, 2008). Alternately, RL activities can be handled in such a way to support sustainability and social responsibility-related corporate programs. However, greater insights are needed as to what is required to make this happen.

The "process" or competency perspective of transforming firms' resources within the RBV theoretical framework should be compared and contrasted to another theoretical perspective as a test of well-formulated theory application. The firm-specific level of analysis of the RBV may miss important implications in terms of customer relationship management and partner relationship management associated with program formalization. Considerations external to the firm are not specifically covered under the RBV of the firm.

To address these issues, the current research provides future research directions from both theoretical and practitioner perspectives. Our research can be considered an initial step in a systematic effort to test the applicability of the RBV in a particular business domain. Opportunities exist to extend the conceptual framework to other business areas within the firm

and partners outside the firm. Comparative data from a firm and its trading partners and customers can provide for a better understanding of the general effects of formalizing processes.

Broader, more inclusive, research is needed to gain greater insights into the dynamic nature of process formalization itself. For example, different reverse logistics activities may require different degrees of formalization. Their relationships with enhanced performance should be investigated both in isolation and in different combinations. The effects of formalizing processes over time represents another area of interest. It might take a certain period after the initial introduction of formal operational rules and procedures before the full effect can be assessed.

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APPENDIX 1
INTERVIEW GUIDE*

Opening
    1. Introductions of interviewer and interview participant
    2. Overview of purpose of the study
    3. Assurance of anonymity
    4. Permissions to audiotape

Demographic Data
    1. Company background
    2. Titles of interview participants

Discussion Topics
Related to your RL program development and implementation:

1. Where the returns are coming from and how?
2. What are the major reasons products are returned?
3. What is the volume of returns?
4. How their return rates compare to competitors?
5. What is happening with the returns once they hit the receiving dock?
6. What are the major disposition options once a return has been processed?
7. Do you have a dedicated area for returns?
8. How many people are dedicated to reverse logistics (salaried vs. temporary)?
9. What resources are dedicated to RL? Relative to other areas?
10. What are some of the performance indicators for your RL program?
11. How do you monitor, control, and measure your RL process?
12. Are your customers satisfied with your RL operations?
13. Do you benchmark your RL program against your competition?
14. Do you outsource any of your returns-related activities?
15. Exceptions?
16. Do you have an employee handbook?
17. How do you decide what to do?

Additional Prompts
    1. Patterns.
    2. Seasonality.
    3. Check Salvage.
    4. Close loop operation.
*Adapted from Davis-Sramek and Fugate (2007)

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FORWARD POSITIONING AND CONSOLIDATION OF STRATEGIC INVENTORIES

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ABSTRACT

The forward positioning of strategic inventory in the supply chain has an impact on transportation times and is important for sensitive demand profiles. Consolidation of stocks creates pooling effects and minimizes costs. This study analyzes a current military case where forward consolidation of equipment is considered using optimization, and payback periods are calculated for the cost of consolidating inventory at one of six locations. Results indicate that forward positioning and consolidation reduces time and cost, and also creates savings in reverse logistics flows. The study has implications for geographically diverse supply chains such as humanitarian aid and emergency response operations.

INTRODUCTION

The forward placement of inventory in the supply chain in order to save time and cost in "anticipation" of future demand is a strategic decision, which can save delivery time, and also cut transportation costs. *, ** Similarly, the consolidation of inventory creates pooling effects, improves standardization, and can increase control and visibility of key stocks. But how should this type of consolidation be made in an existing logistics network and what sort of metric should be used to measure the efficiency of such a consolidation of strategic inventory? These are questions which managers must understand as they consider forward positioning strategic inventory in the supply chain, especially in the face of uncertain demand with extremely high stockout costs, as exist in wartime, humanitarian aid operations, and other emergency response environments. This decision to forward position inventory in the supply chain may also help support critical maintenance activities necessary to sustain geographically isolated operations or to protect valuable personnel and resources when the unavailability of such inventory poses significant risk and costs.

The U.S. military faces the problem of deciding how and where to pre-position such anticipation inventory in the face of uncertain demand and is also highly sensitive to shipping time and stockout costs. In one particular problem, the U.S. Air Force at Randolph Air Force Base Texas is responsible for the management of a variety of Security Force's' War Readiness Material (WRM) equipment

packages that are shipped overseas for conflicts. This equipment is divided into several different Unit Tasking Codes (UTCs) and the packages are positioned at twelve Air Force bases in the U.S. As a result of this decentralized storage, inconsistencies in management of the assets often exist and the timeliness of their deployment to overseas locations is often lacking. How and where to best manage this inventory prior to shipment overseas is a question whose answer may provide efficiencies and increased savings for the military. Additionally, the methods used in this study and the similar forward positioning of strategic inventories in the supply chain may hold similar advantages and savings in other logistics operations where delivery time is critical.

LITERATURE REVIEW

Although the elimination of inventory has the potential to achieve significant cost savings, the need for strategic inventory buffers is still an accepted practice to account for variability in demand, even in "lean" supply chains (Womack and Jones, 1996; Christopher and Towill, 2000). The concept of advanced placement of inventory in the supply chain has been considered in a handful of previous studies (Sampson et al., 1985; Teulings and van der Vlist, 2001). More recently, the advanced or forward placement or pre-positioning of such inventories referred to as "floating stock" has been studied by Dekker et al. (2009). They showed that using intermodal rail terminals as pre-positioning points in the supply chain can result in lower inventory costs as well as shorter customer lead times. These results are similarly consistent with expected results of the forward placement or "logistics speculation" of inventory in the supply chain, as discussed by Pagh and Cooper (1998). Related research has also shown that inventory consolidation may create efficiencies and pooling effects (Zinn, Levy and Bowersox, 1989; Evers and Beier, 1998) leading to decreased logistics costs for transshipments (Evers, 1999, and Minner 2003) and as achieved by the square-root rule (Croxton and Zinn, 2005 and Shapiro& Wagner, 2009). These studies all

examine the efficiencies and inventory cost savings associated with pooling and consolidation.

This study, however, contains more of a supply chain focus that looks at the impact of transportation, inventory and other relevant costs when making decisions about where to pre-position inventory in the supply chain (Vanteddu et al, 2007, and Dekker et al, 2009). Similarly, studies of service-sensitive demand including deployable military equipment have shown there may be important cost and time savings realized from the consolidation of equipment at one or more locations in the supply chain (Ho and Perl, 1995; Amouzegar, Tripp, and Galway, 2005; and Ghanmi and Shaw, 2008). One internal Air Force study, entitled, "Evaluation of the Recent Deployments of Expeditionary Medical Assets" highlights the advantages of consolidating and forward placing military equipment prior to overseas shipments (AFLMA, 2003). Similarly, a study of humanitarian logistics by Oloruntoba and Gray (2006) looks at the need to decouple the humanitarian supply chain with strategic inventory, but does not attempt to model the decision or to look at the costs of such an effort. Additionally, no known study has looked at the payback period for forward positioning strategic inventory in an existing network while simultaneously consolidating inventory in anticipation of demand.

Given the above studies, the Air Force Institute of Technology conducted an independent analysis on the advantages and disadvantages of Security Forces' equipment consolidation in the U.S. Air Force beginning in late 2008. The problem statement for this study was "What are the costs, benefits and investment payback for consolidating U.S. Air Force Security Forces' inventories at one or more locations in the continental U.S. This paper describes the objectives, methodology, results and conclusions of the study, the theoretical implications and future planned research.

OBJECTIVE

The objective of this study is to evaluate the possible forward positioning and consolidation of security forces' equipment UTCs, at either a single location or dual locations, at or near predetermined Aerial Ports of Embarkation (APOEs) in the continental U.S. where Air Force cargo aircraft depart to overseas locations. A description of these UTCs and the typical number contained in a wartime tasking is provided in Table 1. The study aims to provide insight, including benefits and limitations, regarding whether to move forward with consolidation. A secondary objective of the study is to provide the Air Force with a decision model that can determine the minimum transportation cost of moving Security Force UTCs from the existing twelve bases to the forward consolidation point during a deployment. This will still be useful even if consolidation is not immediately implemented by the Air Force.

TABLE 1
DESCRIPTION OF A TYPICAL UTC WARTIME TASKING

UTC	Number	Description
QFE42	9	Air base defense equipment
QFE4F	4	.50 Caliber team equipment
QFE4S	2	Leadership support equipment
QFEBJ	1	MK-19, grenade launcher
QFEBR	5	Dog team equipment
QFEBX	4	Sniper equipment
QFETS	8	Tactical automation sensor

METHODOLOGY

Data about inventory quantities, transportation costs, and warehousing standards for the UTCs were compiled and collected from the Security Forces squadrons at each of the twelve Air Force Bases for the study from the period February 1st-March 30th, 2009. After the data had been collected and reviewed it was evident that significant variability existed in almost every category. This served to reinforce the Air Force's initial concern that management of this equipment at the separate bases lacked standardization. First, all UTCs should be palletized and ready for shipment though some bases reported that this was not the case. This potentially affects the square footage needed for storing the equipment, as well as the time required to deploy since pallets would need to be obtained and configured before any movement could be initiated. Second, the frequency of and time required to complete equipment inspections and the personnel doing them were noticeably different from base to base. Third, the majority of bases lacked historical data regarding the number and cost of deployments to overseas locations over the last five years. Since an accurate demand (deployment) history was not available, the research team worked with the Air Force research sponsor to develop a standard deployment package to serve as the unit of demand in the study (Table 1). According to U.S. Air Force subject matter experts, this package represents the essential equipment UTCs required to stand up a small to

medium size base overseas during a deployment. It is meant to be representative of the equipment necessary to support a base with no additional support from the Army, Navy or the host nation. This requirement would be both situation and location dependent.

Finally, two assumptions had to be made regarding movement of UTCs to different locations in order to evaluate consolidation costs. One being that the transportation costs (Table 2), obtained from the Langley AFB, Virginia and Wright-Patterson AFB, Ohio, Traffic Management Offices, are point-in-time estimates for moving a single aircraft pallet weighing approximately 7500 pounds from origin to the particular destination Air Force Base in the U.S. These costs can vary appreciably depending on when the shipment occurs, potential for a return shipment for the transportation company, and total number of pallets being shipped. Second, in a two location scenario, UTCs have to be allocated as evenly as possible among the two coasts, in a manner that minimizes the total cost of movement.

Optimization Model

In order to find the least cost consolidation point, the transportation costs for a single site location were analyzed using optimization. The problem is a classic transportation problem (Beasley, 1993; Daskin, 1995; Adlakha and Kowalski, 2009) where the cost to move equipment UTCs from the current storage locations at twelve bases to each of the potential consolidation points is determined. The study is also related to facility location problems (Efroymson and Ray, 1966; Akinc and Khumawala, 1977; Geoffrion and Powers, 1995; Drezner 1995), which have been used in previous military studies (Dawson et al. 2007, Overholts et al., 2009) since a minimum cost location is being selected from a number of alternative candidate sites. In this study, the number of consolidation points was restricted to either one single location or two locations (East Coast and West Coast of the U.S). The single-site decision model built to generate solutions for this study was created using linear programming within Microsoft Excel. The optimization model was created to determine which UTCs to ship from each of the current twelve bases to a single APOE consolidation point to minimize cost while tasking enough UTCs to meet the needs of a standard demand for a deployment as determined by the Air Force.

TABLE 2
TRANSPORTATION COSTS OF A SINGLE AIRCRAFT PALLET

	Altus	Colum	Good	Kees	Lack	Laugh	Luke	Max	Rand	Shep	Tynd	Vance
Charleston	1900	2100	1900	1200	1400	1400	2200	1400	1400	1400	1200	1500
Dover	2300	3693	2100	1500	1900	1900	2100	1900	1900	1900	1400	1900
Kelly	800	1200	800	1000	0	700	1300	1200	700	800	1200	900
McGuire	2100	2100	2100	2200	2500	2200	1500	2200	2300	2100	2500	2200
McChord	2500	1900	1400	1100	1400	1400	2100	1400	1400	1400	1400	1600
Travis	2400	2100	1900	1500	2100	1900	1100	2100	2000	1900	2100	1900

Assumptions and Limitations

Several additional assumptions were made in the model in order to determine the correct scope of the problem and to meet time and resource requirements of the study. They are:

- All currently positioned Security Forces' equipment UTCs are properly configured and meet the requirements to be deployed
- Demand for any one UTC is equally important as demand for any other UTC; therefore no weighting or preference was given to one UTC over another in the models created for the study
- Under the current policy, all UTCs deployed overseas from the twelve current bases will also be redeployed to the original bases and a return transportation cost is considered a relevant part of the analysis
- No consumption of UTCs or equipment occurs while deployed, and therefore there is no reduction in transportation costs for the returned assets or any purchasing costs for replacement assets included in the study
- Any manning and support equipment used to inspect or maintain UTCs at the current warehouse locations is available to be transferred to one or more consolidation points
- Current warehousing space will be obtainable from the owning installation of any potential consolidation point, or land will be made available on the site for the construction of a warehouse facility at an existing military installation
- No damage, loss or theft of any assets will occur during transportation, or it is assumed to be covered by the insurance of the carrier
- Transportation costs are fixed and no "time-value-of-money", inflation, or other financial adjustments have been made to the analysis of the cost of future deployments in the study and all costs are given based in 2009 dollars.

This study is limited to seven specific Security Forces' UTCs identified by codes: QFE42, QFE4F, QFE4S, QFEBJ, QFEBR, QFEBX, and QFETS; currently positioned at 12 U.S. Air Forces Bases controlled by the Headquarters at Randolph AFB, Texas. Also, the potential set of consolidation points is limited to a single site (either Charleston, Dover, Kelly, McChord, McGuire, or Travis Air Force Bases) or to two sites with one on the east coast and one on the west coast of the U.S. The two site consolidation problem does not consider Kelly, Texas; therefore, there are six combinations of east-west coast locations (Charleston/McChord, Dover/McChord, McGuire/McChord, Charleston/Travis, Dover/Travis, and McGuire/Travis).

Formulation of Problem

The problem studied in this research can be most closely associated with the traditional transportation problem which has been studied in previous operations management and logistics studies. The formulation of Daskin (1995) is used here and is modified to be a multi-item version of the formulation since there are multiple equipment UTCs in this study. The problem formulation is:

Minimize $\quad Z = \sum_{i=1}^{m} \sum_{j=1}^{n} \sum_{k=1}^{l} c_{ijk} x_{ijk}$ (1)

Subject to:

$\sum_{j=1}^{n} x_{ijk} \leq s_{ik}$ for i = 1, 2, ..., m and k = 1, 2, ..., l (2)

$\sum_{i=1}^{m} x_{ijk} = d_{jk}$ for j = 1, 2, ..., n and k = 1, 2, ..., l (3)

Where:

Z= total transportation cost

x_{ijk} =number of unit type codes (UTCs) of equipment of type k to be transported from supply location i to demand location j

c_{ijk}=cost to transport a UTC of equipment of type k from supply location i to demand location j

s_{ik} =number of UTCs of equipment of type k available at supply location i

d_{jk} =number of UTCs of equipment of type k demanded at demand location j

In addition to generating separate solutions to the transportation problem in (1) for a typical deployment tasking, this research aims to compare those optimized and therefore most efficient solutions to the cost of consolidating the entire amount of equipment one time at each of the potential consolidation locations. This can be thought of as a payback period as represented by:

$$Y= \text{Minimum of} \left[\frac{C_j}{Z_i} \right] \tag{4}$$

Where:

Y= the preferred consolidation point

Z_j= the minimum cost of potential consolidation point j from (1)

C_j= the cost to consolidate all inventory at potential consolidation point j

Since today's Air Force operations do not currently use optimization tools to select UTCs from the current twelve bases in the U.S. to support a deployment overseas, it is believed that the payback period represents a conservative lower bound for the length of time and number of deployments necessary to achieve a payback period. Future comparison of these payback periods to payback periods based on actual deployment costs would represent a more accurate estimate of the payback period and Air Force managers have started tracking those costs based on the recommendations from this study.

Generation of Solutions

The spreadsheet model used to generate solutions to the problem was built by first entering a cost matrix including the one-way transportation cost for an aircraft pallet from each of the twelve bases to each of the six potential consolidation points, Table 2. Next, a matrix of the current inventory of UTCs held at each base was entered into the model. Then a group of binary 'changing cells' were created to identify a feasible solution that would fill the requirements for a single package. These cells cannot task inventory that is not available in the inventory matrix, and they are multiplied by the cost matrix to identify a total shipping cost for the required pallets to the consolidation point, Figure 1.

In the model, the cost to ship the pallets was doubled to replicate the return of the pallets back to the original twelve bases from the APOE after the overseas deployment. As mentioned, this additional cost assumes no consumption of equipment in the overseas theater and represents a large potential savings not initially recognized by U.S. Air Force planners. The model's actual minimum cost solution is generated by solving the linear program using Excel's Solver Add-in. Finally, user inputs were added to the spreadsheet model to allow the selection of the number of required packages and the desired APOE prior to solving the model. The original Excel worksheet used to identify the current method for shipping UTCs from the twelve bases is referred to as "Baseline" in the Excel spreadsheet, and the consolidation solution for each APOE is saved in the spreadsheet as a separate worksheet. For example, "Baseline Dover", is the minimum cost solution to ship a single package of UTCs to Dover AFB from the twelve bases and then return the equipment to its origin following deployment.

In addition to the baseline solutions, the model was also solved for the consolidation aspect of the study, where the model was used to determine the one-time cost to ship the entire inventory to each of the APOE locations. A separate consolidation worksheet was created for each solution. To create the two-site spreadsheet model, several

FIGURE 1
OPTIMIZATION SPREADSHEET AND SOLVER SETTINGS

	Altus	Columbus	Goodfellow	Keesler	Lackland	Laughlin	Luke	Maxwell	Randolph	Sheppard	Tyndall	Vance		
Transportation cost matrix														
Charleston	1900	2100	1900	1200	1400	1400	2200	1400	1400	1400	1200	1500		
Dover	2300	3683	2100	1500	1900	1900	2100	1900	1900	1900	1400	1900		
Kelly	800	1200	800	1000	0	700	1300	1200	700	800	1200	900		
McChord	2100	2100	2100	2200	2500	2200	1500	2200	2300	2100	2500	2200		
McGuire	2500	1900	1400	1100	1400	1400	2100	1400	1400	1400	1400	1600		
Travis	2400	2100	1900	1500	2100	1900	1100	2100	2000	1900	2100	1900		
													Total	
QFE42	3	0	2	4	10	0	3	3	3	3	3	0	34	
QFE4F	2	0	0	0	0	0	0	0	0	0	0	2	4	
QFE4S	1	1	0	2	3	1	1	2	0	0	1	2	14	
QFEBJ	0	0	0	0	0	0	0	1	0	0	0	0	1	
QFEBR	4	4	4	5	12	4	6	5	4	4	4	2	58	
QFEBX	1	1	1	1	1	1	1	0	1	1	0	1	10	
QFETS	1	0	1	1	5	1	2	1	2	1	1	0	16	
													Total	Total Req
QFE42	0	0	0	4	0	0	0	2	0	0	3	0	9	9
QFE4F	2	0	0	0	0	0	0	0	0	0	0	2	4	4
QFE4S	0	0	0	2	0	0	0	0	0	0	1	0	3	3
QFEBJ	0	0	0	0	0	0	0	1	0	0	0	0	1	1
QFEBR	0	0	0	5	0	0	0	0	0	0	0	0	5	5
QFEBX	0	0	0	1	1	1	0	0	0	1	0	0	4	4
QFETS	0	0	0	1	5	1	0	0	0	0	1	0	8	8
Total Pallets	2	0	0	13	6	2	0	3	0	1	5	2	34	
Cost per pallet to selected APOE	$ 1,900.00	$ 2,100.00	$ 1,900.00	$ 1,200.00	$ 1,400.00	$ 1,400.00	$ 2,200.00	$ 1,400.00	$ 1,400.00	$ 1,400.00	$ 1,200.00	$ 1,500.00		
Total Cost from each location	$ 3,800.00	$ -	$ -	$ 15,600.00	$ 8,400.00	$ 2,800.00	$ -	$ 4,200.00	$ -	$ 1,400.00	$ 6,000.00	$ 3,000.00		

Selected APOE	Charleston
# deployments (standard packages)	1
time frame (years)	1
Total Outbound cost	$ 45,200.00
Total Backhaul cost	$ 45,200.00
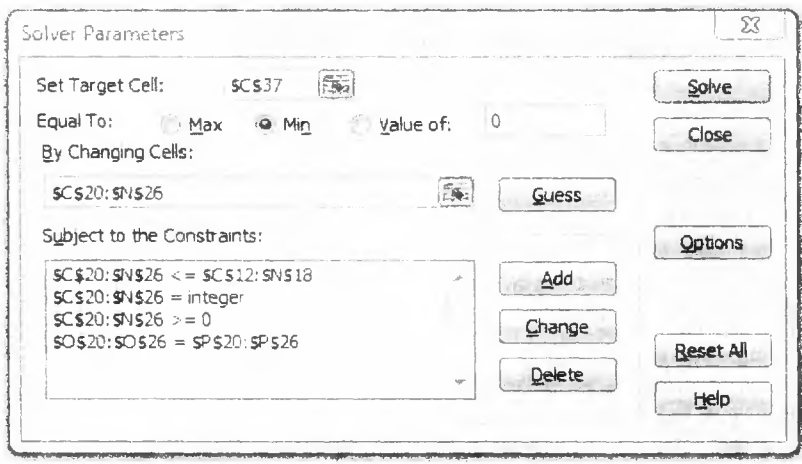
modifications had to be made to the original spreadsheet model. First, two sets of 'changing cells', one for the east coast location and one for the west coast location, had to be created. Then the model's constraints had to be modified to ensure that the total inventory being tasked to the east and west coast from each of the twelve bases does not exceed the total inventory located at the base. The baseline solutions for the model were solved similarly to the single-site model with one standard package tasked to be shipped to both the east and west coast.

However, a problem was encountered and for two of the UTCs (QFE4F and QFEBJ) there was initially not enough inventory to complete two standard packages. Therefore, an assumption was made to give the east coast tasking priority and a full package was filled for the east coast and a reduced package, without those two UTCs, was filled for the west coast. For allocating inventory to either the east coast or west coast for consolidation purposes, approximately half the inventory was sent to each coast with minimum transportation distance being used as the basic rule

for sending inventory from its current base to one of the two new consolidation points. Using these methods, a baseline and a consolidation solution were generated by Excel Solver for each feasible combination, and a payback analysis was conducted using equation (1) and (4) in the formulation section.

RESULTS AND ANALYSIS

The transportation cost was calculated for assembling one standard deployment package at each of the six consolidation locations by shipping the selected UTCs from the twelve Air Force bases using optimization. This cost was then doubled since any UTC shipped from a base would have to be returned to that base upon completion of the overseas deployment. This represents the state of current operations where the UTCs are stored at each base, although the Excel model used in the study optimizes which bases the UTCs should come from in order to minimize cost, which is not part of the current operating procedure. Table 3 shows the minimum transportation cost to ship a single package of UTCs to the six potential consolidation points.

In Table 3, it can be observed that each location has a cost for shipping a single package in the range of $90K-$129K with the exception of Kelly, Texas. This is due to the fact that 23 out of the 34 pallets required for a single package are already positioned at nearby Lackland AFB, Texas; therefore it is dramatically less expensive to ship a single package to Kelly at this time. This point will be discussed further in later sections. The cost for a one-time move of the entire inventory of the Security Forces' UTCs located at the twelve bases to each of the consolidation locations was also calculated. This was done in the model by multiplying the shipping cost from the base to the consolidation point by the total number of pallets being transported from each base and then

TABLE 3
SINGLE SITE PACKAGE SHIPPING COST

Charleston	$90,400.00
Dover	$114,600.00
Kelly	$17,800.00
McChord	$129,600.00
McGuire	$92,600.00
Travis	$106,400.00

summing the results. This cost represents the one-time transportation cost to consolidate the entire current inventory at a single location. The results for all six potential consolidation points are listed in Table 4.

In Table 4, it can be seen that the cost to consolidate the equipment at each of the six sites ranges from approximately $212K-$302K with the exception of Kelly which is again dramatically less due to the 31 pallets of equipment already located at nearby Lackland AFB. In general, it can be seen that the cost to consolidate at the other five bases is about double what it currently costs to ship a single package out and back to the APOE from the twelve bases. To understand this relationship further, the results were further compared by determining the payback period for each consolidation site. The cost of a one-time consolidation could be paid for over a period of time depending on the number of overseas deployments and tasked UTCs that are expected by the Air Force in the near future.

To understand this relationship, a "payback period" was calculated to understand how long it would take such a consolidation to pay for itself. For example, as shown in Table 3, the current cost to ship a single package of UTCs to Charleston and back is $90,400. The cost to do a one-time consolidation of all of the UTCs at Charleston costs $212,700 as shown in Table 4. Therefore, if consolidation occurs at Charleston, $90,400 in transportation costs could be saved each time a package is tasked for overseas shipment; and, the consolidation would pay for itself after 2.3 packages ($212,700/$90,400) are shipped

TABLE 4
SINGLE SITE ONE TIME MOVE COST

Charleston	$212,700.00
Dover	$270,358.00
Kelly	$103,700.00
McChord	$301,800.00
McGuire	$214,600.00
Travis	$262,000.00

TABLE 5
SINGLE SITE PAYBACK PERIOD

	Forward Site Transport Savings	Consolidation Cost	Payback Period (# packages)
Charleston	$90,400.00	$212,700.00	2.35
Dover	$114,600.00	$270,358.00	2.36
Kelly	$17,800.00	$103,700.00	5.83
McChord	$129,600.00	$301,800.00	2.33
McGuire	$92,600.00	$214,600.00	2.32
Travis	$106,400.00	$262,000.00	2.46

overseas. Therefore, if the Air Force expects to deploy a single package for each of the next three years, then the consolidation will pay for itself, however, since the demand for UTCs is relatively uncertain the exact payback period will only be measured by the number of packages. The payback period for each single base is calculated in Table 5.

From Table 5, it can be seen that for the current East and West Coast APOEs, an expected payback period of 2.32-2.46 packages can be expected. The results are significantly different for Kelly, since a large number of pallets are already located at nearby Lackland AFB. Assuming Kelly could be the APOE for all outbound shipments, the payback period for consolidation is 5.83 shipments. However, the initial consolidation cost for Kelly would be less than half that of any other potential location, and it is the only location in the central U.S. making it a more central location if a single consolidation location is selected.

Two-Site Consolidation

The cost for the two-site consolidation option was also calculated for assembling one standard deployment package at each of the two consolidation locations by shipping the necessary UTCs from the twelve bases. Again, this cost was doubled to account for the initial deployment and return from the consolidation locations. As previously stated, two complete packages cannot be created due to a current lack of equipment, so priority was given to the east coast and a partial package was assembled for the west coast. A modified version of the linear programming optimization model used for the single-site option was used to determine which UTCs to ship in order to minimize the transportation cost while obtaining all necessary UTCs to create a standard package at each consolidation location (minus shortages). The minimum cost for assembling one standard package at each of the two consolidation points is shown in Table 6.

TABLE 6
TWO SITE PACKAGE SHIPPING COST

	McChord	Travis
Charleston	$198,600.00	$179,400.00
Dover	$222,800.00	$206,800.00
McGuire	$200,800.00	$183,200.00

The cost for a one-time move of all UTCs to the pair of consolidation locations was also calculated. The same Excel linear programming model used for the two-site baseline was used for this, with the requirement that all UTCs be allocated evenly between the two locations by distance and that every UTC be sent to one of the two consolidation locations. The minimum cost for these one-time moves is shown in Table 7.

TABLE 7
TWO SITE ONE TIME MOVE COST

	McChord	Travis
Charleston	$229,500.00	$215,100.00
Dover	$259,200.00	$246,900.00
McGuire	$231,400.00	$218,300.00

Similar to the single-site analysis, a payback period for consolidation was calculated, as seen in Table 8.

Table 8 shows that shipping two packages (one east and one west) is almost the cost of consolidating the entire inventory of equipment at two consolidation sites. This payback period calculation is not equivalent to the single-site payback period calculation in that it compares the cost to ship two packages versus the cost to consolidate the inventory.

TABLE 8
TWO SITE PAYBACK PERIOD

	Forward Site Transport Savings	Consolidation Cost	Payback Period (# of two-package taskings)
Charleston-McChord	$198,600.00	$229,500.00	1.16
Dover-McChord	$ 222,800.00	$259,200.00	1.16
McGuire-McChord	$200,800.00	$231,400.00	1.15
Charleston-Travis	$179,400.00	$215,100.00	1.20
Dover-Travis	$206,800.00	$246,900.00	1.19
McGuire-Travis	$183,200.00	$218,300.00	1.19

Summary of Transportation Cost Findings

Costs to consolidate the security equipment at either one or two consolidation sites are not excessive in comparison to the one-time cost to ship a standard package. Overall, payback periods for the initial consolidation cost of all inventory, represent only a small number of deployments. With the current pace of military deployments, it is believed that such consolidation would pay for itself in only a few years. Also, the advantage of the reduction in transportation costs and relatively fast payback periods offer a significant advantage when compared to the potential tradeoffs with inventory and warehousing costs for the Air Force. First, it is expected that significant warehousing cost increases will not be expected since each potential consolidation point already houses military installations with available warehousing space. Also, any additional warehousing costs at the consolidation point would be offset by decreases in warehousing costs at the original twelve locations. Additionally inventory holding costs might also be reduced with expected efficiencies gained by inventory reduction from pooling effects. Overall, it is believed the potential reduction in transportation costs gained through forward positioning and consolidation offers a significant reduction in Air Force logistics costs as a whole.

Other Benefits and Issues

In addition to the transportation cost savings discussed above, there are several additional benefits to consolidating equipment. While some of these expected benefits are difficult to quantify, they can be of significant importance in the management and readiness of the equipment. The first benefit is the potential reduction in the manpower and number of hours required to inspect, maintain, and prepare the equipment for deployment. The twelve bases involved in this study report a total of 1248 hours per month required to inspect, maintain, and prepare the UTCs. Based on the estimates provided by the Air Force, at a consolidated location these same tasks could be accomplished in 402 hours, which translates into a cost savings of $416,000 per year. This savings alone would pay for consolidation at any of the potential locations. The second benefit in the consolidation options is the reaction time involved in deployment of the UTCs to overseas conflict locations. Currently, any UTC tasked requires a minimum of three days transit time, with an average of four, from the origin base to the APOE after notification of a tasking. When consolidated, this transit time is most likely reduced to half a day or less, as the equipment is already in a warehouse nearby to the APOE runway. Upon return from a deployment, the

equipment is in transit the same four days from the APOE back to the base of origin, delaying reconstitution of the UTC and increasing transportation cost. Consolidation would reduce this time to .5 days as well, for a total savings of approximately 7 days. In addition, reduction in lead time variation also leads to reduced safety stock needed at the consolidation point, further reducing costs (Evers and Beier, 1998).

The third benefit in consolidation is standardization, both in inspection and in storage of equipment. As noted earlier, the twelve bases currently used report a wide range of inconsistency in equipment inspection. The primary purpose, and underlying assumption, of standard UTC packages is that each UTC will be the same regardless of origins. This is essential in the Air Force tasking process where equipment from one base may be matched with personnel from another at the overseas destination. The same assumption must be made for the readiness and inspection of the equipment at its storage location. In this case, inspections were reported as 'quarterly', 'monthly', 'random', and 'annual', with bases reporting different standards for the same UTC. Under consolidation, the inspection, maintenance, and readiness of the UTCs could be standardized, more closely monitored and managed with fewer personnel. Finally, the fourth benefit with consolidation is that there would be a greater ability to manage the total inventory for planning purposes. For example, given the current standard package requirement, only one complete package could be fielded due to the bottleneck of having only one QFEBJ type UTC. Also, while there are only enough QFE4Fs to field one package, there are enough QFEBRs to complete eleven packages. By managing the inventory at one or two consolidation points, inventory requirements could be set at a package level. Excess inventory of one type could be eliminated and others in short supply could be augmented, thus minimizing the total inventory held and increasing the number of available packages.

CONCLUSIONS, IMPLICATIONS AND FUTURE RESEARCH

The forward positioning of strategic inventory in the supply chain has an impact on transportation times and is important for sensitive demand profiles. Consolidation of stocks has the potential to create pooling effects and minimize costs. This study analyzes the forward consolidation of security equipment and uses optimization and payback periods to analyze the cost of consolidating inventory at one of six forward locations. Although there is great uncertainty about where military operations will occur overseas, there is very little uncertainty in how equipment will be shipped in the earliest part of the supply chain. This provides the opportunity to consolidate and create what Christopher and Towill (2000) call a de-coupling point. Results of the study further indicate that forward positioning and consolidation reduces time and cost, and also creates savings in reverse logistics flows from the consolidation point back to their origin bases. Essentially the initial steps and final steps of the supply chain are shortened.

Managerial Implications

The study has implications for geographically diverse supply chains such as humanitarian aid and emergency response operations (Oloruntoba and Gray, 2006). For example, similar forward positioning and consolidation of emergency supplies for earthquakes, hurricanes and other natural disasters has the potential for similar transportation cost savings and cycle time reductions. Similar to military operations, these operations also have sensitive demand profiles and heavy stockout costs which could include the loss of many lives if the supply chain is not responsive enough. Logistics planners should consider the techniques used here to possibly consolidate and forward position critical supplies needed for humanitarian relief efforts. Additionally, stocks needed in the supply chains of the medical industry for critical medical supplies may also have high uncertainty in terms of the demand locations where

they will be needed. Forward consolidation of these stocks at shipping hubs has the potential to reduce lead times and minimize transportation costs. Similar uncertainties in rapidly changing retail goods and emergency services supply chains might also benefit greatly from consolidation and forward positioning of key stocks up to the natural decoupling points.

Based on the findings of this study, the Air Force will be able to implement the optimization model created during this study to determine the current sourcing of equipment UTCs for overseas deployments. This model will provide the minimum cost selection of UTCs to fulfill a particular tasking and can be adjusted if changes occur in shipping costs, number of UTCs available or required, or the number of standard packages required. Further, it is the recommendation of the study that the Air Force implement consolidation of security force UTCs at one or more of the consolidation locations. While there is an upfront cost associated with moving all the UTCs to a consolidation point(s), the payback period for transportation cost alone is less than three deployments in almost every case. When taking more of a total supply chain approach and considering manpower savings, reductions in shipping time, pooling effects and other benefits of consolidation, the payback is almost negligible.

Future Research

Future research should be conducted in several areas including the consequences of a natural disaster or terrorist strike at the consolidation point, since there is some risk associated with "putting all your eggs in one basket". When combining the theoretical implications of this research with those of supply chain risk studies (Manuj and Mentzer, 2008) it is thought that there may be a correct balance between forward positioning to minimize costs and cycle times, and ensuring the right amount of dispersion to avoid supply chain disruptions and costs associated with highly uncertain demand. Although in this study the reduction of transportation costs did not result in increased warehousing costs, similar research

should be careful to analyze cost tradeoffs from consolidation and identify any diseconomies of scale from making consolidation points too large. Currently, it is believed the benefits achieved by consolidation of Air Force security equipment outweigh the potential risks; however, future research should also concentrate on the site specific details of each potential location such as the availability of resources, adequacy of security measures, and specific cargo handling and loading processes.

Additionally the results of this study have led the Air Force to launch a much larger study which includes the potential consolidation of all security forces equipment UTCs at over 70 installations across the U.S. The study will also analyze the potential for transshipment of stocks in transit in order to further reduce cost, and the reconfiguration of several UTCs thought to be obsolete. Finally, the actual planned consolidation of equipment will offer the potential to study post-implementation results in order to ensure forward positioning and consolidation have achieved the desired results.

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A STUDY OF LOGISTICS STRATEGIES IN SMALL VERSUS LARGE U.S. MANUFACTURING FIRMS

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ABSTRACT

The research reported in this manuscript empirically compares the similarities and differences of logistics strategies for small and large manufacturing firms. The hypotheses focus on whether there are significant differences between logistics strategies of small and large manufacturing firms and whether logistics strategy outcomes differ. The findings indicate that there are many similarities but differences do exist. The results identify dimensions of logistics strategy and assess their impact on logistics coordination effectiveness, customer service commitment, and company/division competitive responsiveness.

INTRODUCTION

Smaller businesses frequently make an assortment of logistics-related decisions, relating to purchasing, customer service, warehousing, inventory management, order management, transportation etc. (Murphy, Daly and Dalenberg, 1995). While larger organizations make these same decisions, there are continued questions about whether there are any similarities or differences between the two (Evans, Feldman and Foster, 1990).

Larger companies generally have a variety of people who are trained in supply chain or logistics management. (Evans, Feldman and Foster, 1990). Smaller businesses, on the other hand, may have only one person who has logistics management responsibilities and other functions to perform (Harrington, 1995). As such, logistics management personnel at smaller companies may have less formal logistics training, and may be less experienced than at larger organizations. Whether this situation causes increased logistics costs and/ or less responsiveness in small firms has not been adequately addressed.

The majority of the logistics literature focuses on large companies. A review of the literature identified two articles on small company logistics. Halley and Guilhon (1997) investigated the logistics strategies of small businesses using both anecdotal and primary data. The results revealed that among small businesses there were no good or bad logistics strategies. However, two key factors associated with small business logistics strategy development were identified. They were the role of the owner-manager involvement and the company's dependency on other firms. In another study of selected logistics practices of small businesses engaged in international trade, Murphy, Daley, and Dalenberg (1995) found different types of distribution departments among the firms studied.

The idea that small and large firms have similar logistics management practices is probably something that the average manager would not expect given firm size and economies of scale (Harrington, 1995). However, Pearson and Ellram (1995) discovered that there were no statistically significant differences between small and large electronic companies in their selection and evaluation of suppliers. Similarly, Calof (1993) maintained that business size is not an obstacle to internationalization nor is it a constraint in selecting a country in which to do business.

Despite the fact that logistics strategy has been widely discussed in the literature (Clinton and Closs, 1997), the research reported in this paper focuses on a typology that has been examined over the last two decades. This typology, proposed by Bowersox and Daugherty (1987), focuses on three forms of "advanced organizational structures" comprised of "process strategy", "market strategy", and "information strategy". While support for the Bowersox and Daugherty typology has been shown empirically in large firms (Clinton and Closs, 1997; McGinnis and Kohn, 1993, 2002 and 2010; and Kohn and McGinnis, 1990 and 1997) and across industries (Autry, Zacharia, and Lamb, 2008) it is not yet clear whether the typology is relevant to small firms.

The purpose of the research presented in this manuscript is to identify similarities and differences in logistics strategies of large and small U.S. manufacturing firms. This research compares logistics strategies and assesses logistics strategy outcomes of large and small manufacturing firms. Levels of logistics strategy intensity (emphasis on process, market, and information) and outcomes (logistics coordination effectiveness, customer service commitment, and competitiveness) are compared.

Insights and implications for logistics practitioners, researchers, and teachers are provided. The remainder of the paper is organized into six sections starting with the literature review. This discussion is followed by sections on research questions variables, and hypotheses; methodology, analysis, findings, and conclusions.

LITERATURE REVIEW

The typology used to examine large and small manufacturing firms was the result of a comprehensive study of logistics integration reported by Bowersox and Daugherty (1987). Sixteen large consumer product firms were interviewed in 1986 in order to assess organizational structure. Bowersox and Daugherty identified three distinctly different organizational types based on the firm's primary strategic thrust. The first was "Process Strategy" whose primary objective was to manage flows to gain control over activities that "give rise to costs" ("cost drivers" in current terminology). The second was "Market Strategy" whose primary focus was to reduce complexity faced by its customers. Finally, "Information Strategy" was postulated as consisting of firms whose objective was to coordinate information flows throughout the channel of distribution in order to facilitate cooperation and coordination among channel members.

A literature review identified three teams of co-authors who empirically tested the Bowersox/Daugherty typology. In a series of studies McGinnis and Kohn (McGinnis and Kohn, 1993 and 2002 as well as Kohn and McGinnis, 1997a, b) sampled subjects from large U.S. manufacturing firms regarding a wide range of topics including the subject typology. They found that Process and Market strategies were emphasized when logistics strategies were intense, both strategies were present at moderate levels in balanced logistics strategies, and both strategies were present at low levels in unfocused strategies. The scale for Information Strategy was not included because of low scale reliability (McGinnis and Kohn, 1993). Later they found that Process Strategy varied with the challenge of the internal (competitive responsiveness) and external (environmental hostility) environments (Kohn and McGinnis, 1997). Emphasis on Market and Information strategies did not vary.

Finally, McGinnis and Kohn (2002) factor analyzed the nine questionnaire items (three each for Process, Market, and Information strategies) to ascertain whether the three strategies were independent. The results indicated that Process and Information loaded on one factor and Market loaded on a second factor. Regression analysis for the resulting factors indicated that the majority of variance in the dependent variable, Logistics Coordination Effectiveness, was explained by the Process & Information factor. Taken together, the results of the research by Kohn and McGinnis indicate that the three dimensions of logistics strategy (process, market, and information) are promising. However, their results suggest that logistics strategy is more likely to be a blend of the three strategies, rather than dichotomized as originally suggested by Bowersox and Daugherty (1987). Further examination of the results of this pair of researchers suggests that cost management (Process Strategy) is more likely to be a major component of logistics strategy with the roles of simplifying transactions (Market Strategy) and coordinating information flows throughout the supply chain (Information Strategy) being less influential.

Clinton and Closs (1997) studied the Bowersox/Daugherty typology using a sample of U.S. and Canadian manufacturers and merchandisers. Subjects were asked to self identify regarding their prevalent logistics strategy. Of 818 usable responses 541 (66.1%) selected Process Strategy, 146 (17.9%) selected Market Strategy, and 92 (11.3%) selected Channel (Information) Strategy. The balance, 39 (4.8%), selected "Other Strategy". Clinton and Closs found that a clear overlap exists among the three strategies. They concluded that this is to be expected since logistics must perform the same activities regardless of underlying logistics strategy. Clinton and Closs concluded that logistics strategy exists and that the Bowersox/Daugherty classification is "promising."

Finally, Autry, Zacharia, and Lamb (2008) surveyed 254 logistics managers from multiple industries. They identified two logistics strategy dimensions, Functional Logistics (FL) strategy and Externally

Oriented Logistics (FOL) strategy. The former was described as similar to Bowersox/Daugherty's Process Strategy while the latter was described as somewhat resembling Channel (Information) Strategy.

RESEARCH QUESTIONS, VARIABLES AND HYPOTHESES

Based on the literature review, the authors' concluded that the Bowersox/Daugherty typology provides a relevant framework for the study of logistics strategy. However, the earlier research focused primarily on large firms. The research reported in this manuscript examines a sample of large firms and a sample of small firms and evaluates their similarities and differences in Process (PROCSTR), Market (MKTGSTR), and Information (INFOSTR) strategies.

Three dependent variables (Logistics Coordination Effectiveness, Customer Service Commitment, and Company/Division Competitiveness) previously used in the logistics literature (Keller, et.al. 2002) were included in the study to assess outcomes of the independent variables. As shown in Exhibit 2, Logistics Coordination Effectiveness (LCE) is a scale that assesses importance of logistics coordination on internal company relationships, company strategic planning and relationships with customers, suppliers, and other channel members. This dependent variable is useful for assessing whether the Bowersox/Daugherty typology is associated with this important goal of logistics. Customer Service Commitment (CSC) is a scale that assesses customer service's level of importance (emphasis on employee development and training), value as a coordinating activity, and importance in achieving competitive goals. The third dependent variable, Company/Division Competitiveness (COMP), evaluates the firms' overall competitiveness in the areas of responsiveness and perceived overall competition. These three dependent variables provide a means of assessing whether changes in the independent variables (Process, Market, and Information strategies) result in changes of logistics outcomes.

Based on the above questions the following null hypotheses were developed:

H_1: The importance of Process Strategy is equally relevant in small and large manufacturing firms;

H_2: The importance of Marketing Strategy is equally relevant in small and large manufacturing firms;

H_3: The importance of Information Strategy is equally relevant in small and large manufacturing firms;

H_4: The importance of Logistics Coordination Effectiveness is equally relevant in small and large manufacturing firms;

H_5: The importance of Customer Service Commitment is equally relevant in small and large manufacturing firms;

H_6: The importance of Company/Division Competitiveness is equally relevant in small and large manufacturing firms;

The six hypotheses provide a basis for assessing logistics strategies of small firms. If the first three hypotheses are accepted then there is insufficient evidence to conclude that the importance of Process, Market, and Information strategies of small firms are different between small and large firms. On the other hand, rejection of hypotheses 1, 2, or 3 would indicate that the logistics strategies in small firms differ from logistics strategies in large firms. In a similar manner, acceptance of the second group of three hypotheses would suggest that small and large firm logistics managers' perceptions of three outcomes (Logistics Coordination Effectiveness, Customer Service Commitment, and Company/Division Competitiveness) were equal. Conversely, rejection of hypotheses 4, 5, or 6 would then suggest that logistics managers of small and large firms perceived logistics strategy outcomes differently.

METHODOLOGY

In 2006 a four-page, 41-item questionnaire was mailed to 700 small manufacturing firms selected randomly from the Directory of Manufacturers. The focus was exclusively on firms with annual sales of $5,000,000 or less. Ninety-nine (14.1%) usable responses were received. While the response rate was low, one-way analysis of variance by order of response quartile found no significant differences at alpha = 0.05 among the six questionnaire items that related to logistics strategy. The authors concluded that the data was adequate for use in studying logistics strategies in small U.S. manufacturing firms.

In 2008 a four-page, 46-item questionnaire was electronically sent to 905 members of a large national supply chain management organization who worked for manufacturing firms in the U.S. with sales of over $5,000,000. Large firms of over $5,000,000 sales were selected in order to provide a basis for comparison with the data gathered on small firms in 2006. The members sampled typically worked for large national or multi-national organizations that have substantial manufacturing presence in the U.S. No attempt was made to control for country of ownership. One hundred and twenty-three were undeliverable for a net sample of 782 subjects. After two follow-ups a total of forty-nine (6.3%) usable responses were returned. While the response rate was low, it is understandable given the results of similar recent studies reported in the supply chain management literature (Flint, Larsson, and Gammelgaard, 2008). As a further test the 2008 results were compared to previous data sampled from the same organization in 1990, 1994, and 1999 (McGinnis, Kohn, and Spillan, 2010). Mean responses did not vary significantly using one-way ANOVA. The authors concluded that the 2008 data was adequate as a large firm control in assessing small firm responses.

ANALYSIS

As noted earlier, three independent variables and three dependent variables were selected for the

assessment of logistics strategies in small and large manufacturing firms. Each of the variables was a multi-item scale that had been developed in previous logistics strategy research and was documented in a comprehensive review of multi-item scales reported by Keller, et al. (2002). In addition, all scales exhibited stable levels of reliability over their use in several empirical studies and offered adequate face validity to warrant their continued use.

Table 1 summarizes the three independent variable scales titled Process Strategy, Market Strategy, and Information Strategy (also referred to as channel strategy). Each scale was comprised of three questionnaire items that had been previously used in several empirical studies. Further inspection of

Table 1 reveals that the average reliability coefficient (alpha) for the scale Process Strategy over three studies in 1990, 1994, and 1999 was 0.638, above the range of 0.50 to 0.60 considered adequate by Nunnaly (1967) and just below the value of 0.70 suggested by Nunnally and Bernstein (1994). Because the range of alphas was 0.579 to 0.710 in the previous three studies the authors concluded that reliability was adequate for use in the current study. Finally, the average alphas (Market Strategy = 0.730 and Information Strategy = 0.605) for three previous studies indicated that those scales would be defensible independent variables for this research. A review of results from the 2006 (small firm) and 2008 (large firm) studies further supported the relevance of the three scales as independent variables.

TABLE 1
INDEPENDENT VARIABLES

Scale 1: Process Strategy (PROCSTR)*

PS-1 In my company/division, management emphasizes achieving maximum efficiency from purchasing, manufacturing, and distribution.

PS-2 A primary objective of logistics in my company/division is to gain control over activities that result in purchasing, manufacturing, and distribution costs.

PS-3 In my company/division, logistics facilitates the implementation of cost and inventory reducing concepts such as Focused Manufacturing and Just-in-Time Materials Procurement.

Scale 2: Market Strategy (MKTGSTR)*

MS-1 In my company/division, management emphasizes achieving coordinated physical distribution to customers served by several business units.

MS-2 A primary objective of logistics in my company/division is to reduce the complexity our customers face in doing business with us.

MS-3 In my company/division, logistics facilitates the coordination of several business units in order to provide competitive customer service.

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Scale 3: Information Strategy (INFOSTR)*

IS-1 In my company/division, management emphasizes coordination and control of channel members (distributors, wholesalers, dealers, retailers) activities.

IS-2 A primary objective of logistics in my company/division is to manage information flows and inventory levels throughout the channel of distribution.

IS-3   In my company/division, logistics facilitates the management of information flows among channel members (distributors, wholesalers, dealers, retailers).

*Scales: 1 = Strongly Agree, 2 = Agree, 3 = Neither Agree nor Disagree, 4 = Disagree, 5 = Strongly Disagree.

Coefficient of Reliability - Alpha

	Process Strategy	Market Strategy	Information Strategy
1990	.626	.811	.520
1994	.710	.642	.727
1999	.579	.737	.568
2006	.726	.685	.856
2008	.609	772	.699

The three dependent variables are shown in Table 2. Two of the scales, Logistics Coordination Effectiveness and Customer Service Commitment were comprised of three items while the third scale, Company/Division Competiveness, consisted of four items. Examination of alpha averages and ranges for the three scales for 1990, 1994, and 1999 (Logistics Coordination Effectiveness average alpha = 0.632, range = 0.539 to 0.708; Customer Service Commitment alpha average = 0.708, range = 0.673 to 0.729; Company/Division Competitiveness alpha average = 0.740, range = 0.675 to 0.862) resulted in the authors' conclusion that these scales were adequate for purposes of this research. Further examination of the alphas of these three scales for the 2006 (small firm) and 2008 (large firm) did not alter that conclusion.

A second evaluation of the six scales was conducted to assess whether there was any systematic bias between the responses to the 2006 (small firm) and the 2008 (large firm) questionnaires. As shown in Table 3 means of the scale scores did not vary significantly between the two questionnaires. Mean responses of the nineteen items that comprise the six scales was conducted to further assess the 2006 and 2008 data. As shown in the Appendix, the means of six of nineteen items were significantly different, alpha <0.05, without any systematic pattern relative to the scales. Based on these results the authors concluded that there was no pattern of differences that would prohibit a comparison of logistics strategies of small and large manufacturing firms using the 2006 and 2008 data.

From the results shown in Tables 1, 2, and 3 the authors concluded that the 2006 data (from small U.S. manufacturing firms) and the 2008 data (from large U.S. manufacturing firms) provides a reasonable basis for comparing logistics strategies of small and large firms.

TABLE 2
DEPENDENT VARIABLES

Logistics Coordination Effectiveness (LCE)*

LC-1 The need for closer coordination with suppliers, vendors, and other channel members has fostered better working relationships among departments within my company.

LC-2 In my company logistics planning is well coordinated with the overall strategic planning process.

LC-3 In my company/division logistics activities are coordinated effectively with customers, suppliers, and other channel members.

CUSTOMER SERVICE COMMITMENT (CSC)*

CSC-1 Achieving increased levels of customer service has resulted in increased emphasis on employee development and training.

CSC-2 The customer service program in my company/division is effectively coordinated with other logistics activities.

CSC-3 The customer service program in my company/division gives us a competitive edge relative to our competition.

COMPANY/DIVISION COMPETITIVENES (COMP)*

COMP-1* My company/division responds quickly and effectively to changing customer or supplier needs compared to our competitors.

COMP-2* My company/division responds quickly and effectively to changing competitor strategies compared to our competitors.

COMP-3* My company/division develops and markets new products quickly and effectively compared to our competitors.

COMP-4 In most of its markets my company/division is a:

Very Strong Competitor		Moderately Strong Competitor		Weak Competitor
1	2	3	4	5

*Scales: 1 = Strongly Agree, 2 = Agree, 3 = Neither Agree nor Disagree, 4 = Disagree, 5 = Strongly Disagree.

DEPENDENT VARIABLES

Coefficient of Reliability - Alpha

	Logistics Coordination Effectiveness	Customer Service Commitment	Company/Division Competitiveness
1990	.539	.723	.684
1994	.649	.729	.862
1999	.708	.673	.675
2006	.582	.706	.740
2008	.538	.653	.701

Table 3
COMPARISON OF MEANS OF SCALE SCORES*:
2006 (SMALL U.S. MANUFACTURING FIRMS) &
2008 (LARGE U.S. MANUFACTURING FIRMS)

Scales	N/ Means**/ Standard Deviations		Mean Differences Significant
	2006	2008	<0.05?
Process Strategy (PROCSTR)	124/	50/	
	2.24/	2.19/	
	0.665	0.660	NO
Market Strategy (MKTGSTR)	117/	49/	
	2.62/	2.41/	
	0.651	0.968	NO
Information Strategy (INFOSTR)	116/	49/	
	2.74/	2.85/	
	0.719	0.758	NO
Logistics Coordination Effectiveness (LCE)	128/	50/	
	2.62/	2.58/	
	0.636	0.609	NO
Customer Service Commitment (CSC)	127/ 50/		
	2.41/	2.63/	
	0.673	0.772	NO
Company/Division Competitiveness (COMP)	119/	48/	
	2.39/	2.42/	
	0.602	0.659	NO

*Scale Scores = (Sum of item scores of items in that scale)/(Number of items)

**Scales: 1 = Strongly Agree, 2 = Agree, 3 = Neither Agree nor Disagree, 4 = Disagree, 5 = Strongly Disagree.

The balance of the analysis was conducted in two steps. First cluster analysis was conducted on the independent variables to ascertain whether logistics strategies were homogenous within (a) small firms and (b) large firms. Data was analyzed using SPSS 15.0 for Windows. The program selected was Two-step Cluster. Output included cluster frequencies, scale means and standard deviations, and the assignment of each respondent to one of the clusters. Clusters were named using a criteria based on means of the scale scores. "Intense Logistics Strategy" was defined as a cluster in which one or more scale average scores was less than 2.000, keeping in mind that low scores were

considered in agreement with item statements and high scores were associated with disagreement. "Moderate Logistics Strategy" was defined as a cluster in which none of the scales were below 2.000 or greater than 2.999. Finally, "Passive Logistics Strategy" was defined as a cluster where one or more scale averages was greater than 2.999.

In the final step of this analysis cluster membership was used to assess respondent perceived attitudes toward the three dependent variables, Logistics Coordination Effectiveness, Customer Service Commitment, and Company/Division Competitiveness.

As shown in Table 4, the 2006 (small firm) respondents were classified into three clusters. Cluster mean differences were assessed for small firms using One-way Analysis of Variance. Post hoc analysis of the ANOVA output revealed that all means were significantly different with p values <0.05. The authors concluded that the three logistics strategies for small firms were distinct with no commonality in the independent variables. Forty-four (39.3%) respondents were classified as having "Intense" logistics strategies. All three independent variables (process, market, and information strategies) had scale means that were significantly lower than the other two strategies. Average score means for these respondents were near "agree". This means that those respondents placed positive emphasis on all three independent variables.

Forty-eight (42.9%) small business respondents were grouped into "Moderate" strategies. Scale score means for all three independent variables were between "agree" and "neither agree nor disagree", indicating modest emphasis on the three independent variables. Twenty respondents (17.9%) were classified as having "Passive" logistics strategies. Scale score averages for process, market, and information strategies were 3.0 (neither agree nor disagree) or higher (tending toward disagreement).

Large firm respondents (see Table 4) were classified into two logistics strategy groups. Thirty-five respondents (71.4%) were classified as having "Intense" logistics strategies and fourteen (28.6%) were classified as having "Passive" logistics strategies.

Further analysis of means of small and large firm means for "Intense Logistics Strategy" and "Passive Logistics Strategy" provided additional insights. See the "Comparison of Differences of Mean Scale Scores" portion of Table 4. This analysis revealed that, when logistics strategies were "Intense" small firms' scale score means for Process Strategy and Information Strategy were significantly more important than large firms. Further, the scale score means for Market Strategy did not vary by an amount greater than due to chance. However, when logistics strategies were "Passive" scale score means between small and large firms for Process Strategy, Market Strategy, and Information Strategy did not vary by an amount greater than that due to chance.

The results shown in Table 4 indicate that logistics strategies in small firms group into three categories while logistics strategies in large firms group into two categories. This suggests that small firms may be able to stay closer to their markets and tailor their strategies more closely to specific needs of those markets. In addition, small firm "Intense" strategies emphasize cost (Process Strategies) and coordination information flows in the channel (Information Strategy) to a greater extent than in large firms. Again, this may be due to the ability of small firms to better focus their strategies on the needs of their markets.

This observation is further reinforced by the size of "Moderate" logistics strategies in small firms, which are less focused than "Intense" strategies but are definitely not "Passive". Finally, comparison of "Passive" strategies in small and large firms (Shown in Table 4) reveals a similar focus in small and large firms.

Overall, logistics strategies in small and large manufacturing firms differ in degree rather than type. In small firms overall logistics strategies are more finely segmented than in large firms. However, gradations in strategy from "Intense" to "Passive" are similar in both large and small firms. The following paragraphs discuss outcomes of logistics strategies in small and large firms.

TABLE 4
COMPARISON OF CLUSTER ANALYSES RESULTS OF LOGISTICS STRATEGIES: 2006 (SMALL U.S. MANUFACTURING FIRMS) & 2008 (LARGE U.S. MANUFACTURING FIRMS)

2006 – National Sample of Small U.S. Manufacturing Firms, N = 112

Cluster**	PROCSTR Mean*/Standard Deviation	MKTGSTR Mean/ Standard Deviation	INFOSTR Mean/Standard Deviation
1. Intense Logistics Strategy, N = 44	1. 674/0.397	2. 227/0.579	2.152/0.424
2. Moderate Logistics Strategy, N = 48	2. 542/0.433	2. 625/0.387	2. 813/0.329
3. Passive Logistics Strategy, N = 20	3. 000/0.405	3. 450/0.475	3.817/0.587
Significance	0.000	0.000	0.000

2008 – National Sample of Large U.S. Manufacturing Firms, N = 49

Cluster**	PROCSTR Mean**/Standard Deviation	MKTGSTR Mean/ Standard Deviation	INFOSTR Mean/Standard Deviation
1. Intense Logistics Strategy, N = 35	1.895/0.456	2.000/0.741	2.610/0.688
2. Passive Logistics Strategy N = 14	2.905/0.561	3.429/0.672	3.476/0.550
Significance	0.000	0.000	0.000

*Scales: 1 = Strongly Agree, 2 = Agree, 3 = Neither Agree nor Disagree, 4 = Disagree, 5 = Strongly Disagree.

**Cluster Classification:

Intense Logistics Strategy: One or more values of PROCSTR, MKTGSTR, or
INFOSTR <2.000.

Moderate Logistics Strategy: No values of PROSTR, MKTGSTR,
or INFOSTR <2.000 or >2.999.

Passive Logistics Strategy: One or more values of PROCSTR, MKTGSTR, or
INFOSTR >2.999 or greater.

COMPARISON OF DIFFERENCES OF MEAN SCALE SCORES

Intense Difference Between (Small - Large) Mean Scale Scores			
	Process	Market	Information
t-value (small-large)	-2.265	1.487	-3.451
p-values	0.026	0.141	0.001
Conclusion	Sig.*	Not Sig.	Sig.*

*Process strategy in small firms is more important than in larger firms.
*Information strategy in small firms is more important than in larger firms.

Passive Difference Between (Small - Large) Mean Scale Scores			
	Process	Market	Information
t-value (small-large)	0.542	0.101	1.730
p-values	0.591	0.920	0.093
Conclusion	Not Sig.	Not Sig.	Not Sig.

The logistics strategy clusters developed from the independent variables and shown in Exhibit 4 were used to assess respondent perceptions of the dependent variables. As shown in Table 5 "Logistics Coordination Effectiveness" (LCE) and "Customer Service Commitment" (CSC) are highest in importance when logistics strategies are "Intense" and lowest in importance when logistics strategies ware "Passive" for both small and large firms. However, the effect of logistics strategy on "Company/Division Competitiveness" (COMP) is less clear. As shown in Table 5, in small firms the means of COMP were not significantly different between "Intense" and "Moderate" logistics

strategies but were significant for "Passive" logistics strategies.

Further examination of Table 5 reveals that the outcome differences between small and large firms were modest. There was one significant difference at alpha = 0.05 for CSC when logistics strategies were "Intense" (CSC was more important to small firms). Overall, logistics strategy outcomes in small and large firms were similar. It was concluded that differences in logistics strategy outcomes were modest when comparing small and large manufacturing firms.

TABLE 5
COMPARISON OF OF LOGISTICS STRATEGIES AND DEPENDENT VARIALBES
2006 (SMALL U.S. MANUFACTURING FIRMS) &
2008 (LARGE U.S. MANUFACTURING FIRMS)

2006 – National Sample of Small U.S. Manufacturing Firms, N = 112

Cluster*	LCE Mean**/Standard Deviation	CSC Mean/ Standard Deviation	COMP Mean/Standard Deviation
1. Intense Logistics Strategy, N = 44	2.349/0.561	2.053/0.579	2.174/0.544
2. Moderate Logistics Strategy, N = 48	2.722/0.635	2.549/0.556	2.438/0.639
3. Passive Logistics Strategy, N = 20	3.117/0.475	3.000/0.764	2.790/0.509
Significance	0.000	0.000	0.001***

*See Exhibit 4 for criteria for cluster classification

**Scales: 1 = Strongly Agree, 2 = Agree, 3 = Neither Agree nor Disagree, 4 = Disagree,
5 = Strongly Disagree.

***Means for Clusters 1 and 2 not significantly different <0.05 with Tukey B Post Hoc Test.

2008 – National Sample of Large U.S. Manufacturing Firms, N = 49

Cluster*	LCE Mean**/Standard Deviation	CSC Mean/ Standard Deviation	COMP Mean/Standard Deviation
1. Intense Logistics Strategy, N = 44	2.371/0.497	2.400/0.695	2.324/0.644
2. Passive Logistics Strategy N = 14	3.143/0.518	3.214/0.687	2.661/0.655
Significance	0.000	0.001	0.108***

*See Exhibit 4 for criteria for cluster classification

**Scales: 1 = Strongly Agree, 2 = Agree, 3 = Neither Agree nor Disagree, 4 = Disagree,
5 = Strongly Disagree.

***Means of Clusters 1 and 2 not significantly different <0.05.

COMPARISON OF DIFFERENCES OF MEAN SCALE SCORES

Intense Difference Between Small - Large Mean Scale Scores			
	LCE	CSC	COMP
t-value (Small-Large)	-0.185	-2.371	-1.101
p-values	0.854	0.020	0.275
Conclusion	Not Sig.	Sig.**	Not Sig.

**Customer Service Commitment in small firms was greater than large firms.

Passive Difference Between Small - Large Mean Scale Scores			
	LCE	CSC	COMP
t-value (Small-Large)	-0.149	-0.853	0.618
p-values	0.882	0.400	0.541
Conclusion	Not Sig.	Not Sig.	Not Sig.

FINDINGS

Any analysis and findings must be presented as tentative but forms the basis for additional testing. However, these findings provide insights into similarities and differences in logistics strategies between small and large U.S. manufacturing firms

Similarities

The similarities of logistics strategies in small and large U.S. manufacturing firms were extensive. The coefficients (alphas) of the six scales, as shown in Tables 1 and 2, varied between small firm and large firm respondents by amounts comparable to or less than the variation among those of large firms respondents in four (1990, 1994, 1999, and 2008) empirical studies (McGinnis, Kohn, and Spillan, 2010). Mean responses to all six scales did not vary significantly between small and large firm respondents (see Table 3). This indicates that the subjects in both small and large manufacturing firms have similar perceptions of logistics strategy

and of logistics strategy outcomes. The authors concluded that the scales used in this research are applicable to U.S. manufacturing firms regardless of size. This finding is consistent with insights from Clinton and Closs (1997) that responses (on a different set of questionnaire items regarding logistics strategy) from Canadian manufacturing firms and merchandising firms did not vary substantially, which suggests that the scales used in this research may be robust in applications beyond U.S. manufacturing firms.

Examinations of Tables 3 and 4 reveal that Process Strategy is perceived as most important overall, in each logistics strategy cluster in small manufacturing firms, and each logistics strategy cluster of large manufacturing firms. This finding is consistent with the results of research discussed in the literature review and suggests that the control of costs and rationalizing complex logistics activities is a priority of logistics strategy regardless of firm size.

Additional examination of Table 4 indicates that logistics strategies of both large and small U.S. manufacturing firms can be clustered into similar categories. Further examination of Table 4 reveals that, with one exception, the values of the three logistics strategy dimensions (Process, Market, and Information) do not vary between small and large firms regardless of logistics strategy intensity. The exception is that, when logistics strategy is intense, Process Strategies are significantly more important in small firms than in large firms. Based on these results the authors concluded that perceptions of logistics strategy do not differ substantially between logistics managers in small and large manufacturing firms.

The effect of logistics cluster grouping on dependent variables, Logistics Coordination Effectiveness (LCR), Customer Service Commitment (CSC), and Company/Division Competitiveness (COMP), as shown in Table 5, is similar for small and large manufacturing firms. Further examination of Table 5 reveals that, with one exception, when strategy intensity levels are the same the values of the three outcome variables do not vary significantly between small and large firms. The exception is that, when the logistics strategy is intense, logistics managers in small firms place greater emphasis on Customer Service Commitment, apparently because of its importance as a source of competitive advantage to small firms.
.
In summary, logistics strategies and perceived logistics strategy outcomes appear to be similar in small and large firms except when the logistics strategy is "Intense". In this scenario logistics managers in small firms are more likely to place greater emphasis on cost management (Process Strategy) and have higher levels of commitment to customer service (Customer Service Commitment).

Overall, no systematic patterns of differences in means of scale score means for Process, Market, and Information strategies or Logistics Coordination Effectiveness, Customer service commitment, and Company/Division

Competitiveness were found that would lead to the conclusion that small and large U.S. manufacturing company logistics strategies are fundamentally different. This supports a conclusion that small and large U.S. manufacturing firms' logistics strategies are not fundamentally different.

Differences

The most significant difference between small and large U.S. manufacturing firms, as shown in Table 4, is the number of logistics strategy clusters. Respondents in small firms grouped into three strategies. They were "Intense" (39.3% of respondents), "Moderate" (42.9%), and "Passive" (17.9%) logistics strategies (percentages do not add to 100 due to rounding). Large firm respondents grouped into two logistics strategies, "Intense" (71.3%) and "Passive" (28.6%). Again, percentages do not add to 100 due to rounding. The greater gradation of logistics strategies of small firms may be due to (a) greater small firm awareness of market subtleness, and/or (b) greater variations of overall strategies among small firms, and/or (c) an ability of small firms to tailor logistics strategies more closely to customer requirements.

Forty four (39.3%) small firms were grouped into the "Intense Logistics Strategy" category while thirty-five (71.4%) of large firm respondents were grouped into that category. This may suggest that (a) small manufacturing firms are less sophisticated in their logistics management, and/or (b) logistics is of less overall importance in small firms, and/or (c) small firms face less supply chain complexity. The authors suspect that (c) is the reason that small firms are less likely to need an "Intense Logistics Strategy".

Examination of the results shown in Table 5 indicate that, when logistics strategies are "Intense" small firms place greater emphasis on "Customer Service Commitment" (CSC) than do large firms. This suggests that small firms may place greater emphasis on customer service than large firms because (a) high levels of customer service may

differentiate some small firms from their larger competitors, (b) of the need to focus on the needs of a limited number of important customers, and (c) of a response to the demands of their customer base.

Overall Findings

Based on an assessment of the similarities and differences of small and large manufacturing firms the following conclusions were reached regarding the six null hypotheses:

H_1: The importance of Process Strategy is equally relevant in small and large manufacturing firms. This hypothesis was partially supported by results shown in Tables 3 and 4. The means of Process Strategy were not significantly different between small and large firms overall (Table 3) nor when logistics strategies were "Passive" (Table 4). Process Strategy was significantly more important in small firms when the logistics strategy is "Intense" (Table 4).

H_2: The importance of Marketing Strategy is equally relevant in small and large manufacturing firms. This hypothesis was supported by the results shown in Tables 3 and 4.

H_3: The importance of Information Strategy is equally relevant in small and large manufacturing firms. This hypothesis was partially supported by results shown in Tables 3 and 4. Information Strategy was not significantly different between small and large firms overall (Table 3) nor when logistics strategies were "Passive" (Table 4). Information Strategy is more important in small firms when the logistics strategy is "Intense" (Table 4).

H_4: The importance of Logistics Coordination Effectiveness is equally relevant in small and large manufacturing firms. This hypothesis was supported by the results shown in Tables 3 and 5.

H_5: The importance of Customer Service Commitment is equally relevant in small and large manufacturing firms. This hypothesis is partially supported by Tables 3 and 5. The means of Customer Service Commitment were not significantly different overall (Table 3) nor when logistics strategies were "Passive" (Table 5). Customer Service Commitment was significantly more important in small firms when logistics strategy was "Intense" (Table 5).

H_6: The importance of Company/Division Competitiveness is equally relevant in small and large manufacturing firms. This hypothesis was supported by the results shown in Tables 3 and 5.

The results suggest more similarities between small and large firm logistics strategies and outcomes than differences. Two independent variables (Process Strategy and Information Strategy) were more important; one dependent variable (Customer Service Commitment) was of greater importance in small firms when strategies were "Intense" (note that in this study 1 = strongly agree, 5 = strongly disagree); the three independent and three dependent variables did not vary overall (Table 3); and nine of twelve comparisons (Tables 4 and 5) were not significant at alpha = 0.05.

When differences between logistics strategies of small and large U.S. manufacturing firms occur, they are likely to occur when logistics strategies are "Intense". According to the results when logistics strategies are "Intense" small firms are likely to place more importance on Process and Information strategies and have a better Customer Service Commitment outcome than large firms. When logistics strategies are "Passive" the levels of importance placed on Process, Market, and Information strategies and the outcomes of Logistics Coordination Effectiveness and Competitiveness are likely to be similar.

CONCLUSIONS

When considered within the context of previous research into the Bowersox/Daugherty typology the findings of this research contribute to a further understanding of logistics strategy. First, logistics

strategies in small and large U.S. manufacturing firms differ in degree rather than type. Process (control costs), Market (reduce complexity faced by competitors), and Information (facilitate coordination in the channel) strategies are evident in small and large firms. While the roles of these three dimensions are not perfectly aligned, the similarities are great enough to conclude that logistics strategies in small and large U.S. manufacturing firms are similar. Second, perceived logistics strategy outcomes of small and large manufacturing firms are similar. Increased levels of Logistics Coordination Effectiveness, Customer Service Commitment, and Company/Division Competitiveness were (with one exception) associated with greater intensity of logistics strategy in small and large firms. This suggests that outcomes of logistics strategies do not differ substantially as firm size varies. Given that logistics strategies and logistics strategy outcomes are similar between small and large U.S. manufacturing firms it was concluded that the Bowersox/Daugherty typology is applicable to manufacturing firms regardless of size.

This research implies that the focal points of logistics in small and large firms are cost management (Process Strategy), reducing complexity faced by customers (Market Strategy), and coordination within the channel (Information Strategy). While the emphasis on these three components of logistics strategy may vary due to factors such as overall strategy of the firm, the degree of competition faced, and the relative importance of the firm's competitive advantages (cost, differentiation, or both), these factors may affect logistics strategy more than firm size.

Implications for Practice

Balancing the relationship among process strategy, market strategy, and information strategy, is challenging. It will require substantial coordination of logistics/ supply chain managers with firms' management team, channel members, suppliers, and other stakeholders. It will also require that the firm's management constantly read and re-read

its environments over time to understand competitive threats and opportunities for logistics strategy innovation. Logistics/supply chain managers in firms of all sizes (small and large) can benefit from understanding the dynamics of cost management, reducing the complexity faced by customers, and using information to better coordinate channel activities when tailoring logistics strategies for their firms.

Small businesses can benefit from a greater understanding of logistics strategy's components and how they can be exploited to improve competitiveness in their markets. Overall, logistics strategy consists of managing costs (Process), simplifying complexity faced by customers (Market), and coordination of information flows (Information) to improve logistics coordination and customer service as a means of maintaining (or improving) competitiveness. This research suggests that the small firms manage the logistics strategy to maximize customer service through emphasis on Market (reduce complexity faced by customers) and Information (close coordination with customers and suppliers) strategies. While Process (cost control) is also likely to be important to small businesses, it is unlikely to be paramount, relative to Market and Information strategies.

Implications for Education, Training, and Research

Logistics/supply chain educators can use the insights from this research to focus on three dimensions of logistics/supply chain management and their relevance regardless of the firm's size. At the basic level emphasizing the three components of logistics strategy (Process, Market, and Information) provide fundamentals that should serve the student well whether or not they pursue further studies in logistics/supply chain management. At the advanced level; process, market, and information strategies can be the basis for integrating logistics/supply chain management with other areas of the firm. Finally, graduate students should benefit from the insights provided by the Bowersox/Daugherty typology in

developing research agendas and teaching strategies.

Future research opportunities include extensions of logistics decision making by including antecedents and moderating factors (such as competition, market turbulence, and differences in business environment) into the design. Future research should also examine the relevance of the Bowersox/Daugherty typology to small and large firms in nonmanufacturing industries including retailing, healthcare, financial services, transportation firms, and food service. These industries may provide different perspectives on process, market, and information strategies as well as logistics coordination, customer service, and competitiveness.

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APPENDIX 1
COMPARISON OF 2006 AND 2008 ITEM MEAN SCORES:*

INDEPENDENT VARIABLES

Items	N/Means*/Standard/Deviations 2006	2008	Mean Differences Significant <0.05?
Scale 1: Process Strategy (PROCSTR)*			
PS-1 In my company/division, management emphasizes achieving maximum efficiency from purchasing, manufacturing, and distribution.	128/1.92/0.790	50/1.94/0.818	NO
PS-2 A primary objective of logistics in my company/division is to gain control over activities that result in purchasing, manufacturing, and distribution costs.	127/2.15/0.746	50/2.12/0.824	NO
PS-3 In my company/division, logistics facilitates the implementation of cost and inventory reducing concepts such as Focused Manufacturing and Just-in-Time Materials Procurement.	124/2.61/0.969	50/2.50/0.995	NO
Scale 2: Market Strategy (MKTGSTR)*			
MS-1 In my company/division, management emphasizes achieving coordinated physical distribution to customers served by several business units.	117/2.91/0.820	49/2.53/1.209	YES
0.093			

MS-2   A primary objective of logistics in my company/division is to   126/2.22/.0838   50/2.36/1.139   NO
reduce the complexity our customers face in doing business with us.

MS-3   In my company/division, logistics facilitates the coordination   121/2.72/0.868   49/2.31/1.158   YES
of several business units in order to provide competitive customer service.

.

Scale 3: Information Strategy (INFOSTR)*

IS-1   In my company/division, management emphasizes   118/2.83/0.840   49/2.78/0.941   NO
coordination and control of channel members (distributors, wholesalers,
dealers, retailers) activities.

IS-2   A primary objective of logistics in my company/division is to   124/2.54/0.914   50/2.64/1.005   NO
manage information flows and inventory levels throughout the
channel of distribution.

IS-3   In my company/division, logistics facilitates the management   119/2.87/0.780   50/3.16.0.912   YES
of information flows among channel members (distributors, wholesalers,
dealers, retailers).

*Scales: 1 = Strongly Agree, 2 = Agree, 3 = Neither Agree nor Disagree, 4 = Disagree,
 5 = Strongly Disagree.

DEPENDENT VARIABLES

| | N/Means*/ Standard/ Deviations | | Mean Differences Significant |
Items	2006	2008	<0.05?
Logistics Coordination Effectiveness (LCE)*			
LC-1 The need for closer coordination with suppliers, vendors, and other channel members has fostered better working relationships among departments within my company.	130/2.53/0.900	50/2.30/0.647	NO
LC-2 In my company logistics planning is well coordinated with the overall strategic planning process.	130/2.76/0.852	50/2.74/0.899	NO
LC-3 In my company/division logistics activities are coordinated effectively with customers, suppliers, and other channel members.	128/2.57/0.829	50/2.70/0.974	NO
CUSTOMER SERVICE COMMITMENT (CSC)*			
CSC-1 Achieving increased levels of customer service has resulted in increased emphasis on employee development and training.	128/2.30/0.865	50/2.60/0.926	YES
CSC-2 The customer service program in my company/division is effectively coordinated with other logistics activities.	128/2.57/0.770	50/2.72/1.089	NO
CSC-3 The customer service program in my company/division gives us a competitive edge relative to our competition.	128/2.36/0.849	50/2.58/0.992	NO

COMPANY/DIVISION COMPETITIVENES (COMP)*

COMP-1 My company/division responds quickly and effectively   127/2.06/0.759   49/2.53/1.023 YES
to changing customer or supplier needs compared to our competitors.

COMP-2 My company/division responds quickly and effectively   126/2.43/0.784   49/2.67/0.851 NO
to changing competitor strategies compared to our competitors.

COMP-3 My company/division develops and markets new products   123/2.81/0.872   49/2.65/0.830 NO
quickly and effectively compared to our competitors.

COMP-4 In most of its markets my company/division is a: 123/2.34/0.848   50/1.84/0.912 YES
Very Strong   Moderately Strong   Weak Competitor
1   2   3   4   5

*Scales: 1 = Strongly Agree, 2 = Agree, 3 = Neither Agree nor Disagree, 4 = Disagree,
  5 = Strongly Disagree.

ADAPTING BAUMOL'S INVENTORY THEORETIC TO LANDED COST DECISIONS

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ABSTRACT

Major U.S. corporations have been importers for over 200 years. A significant impetus for "offshoring" has been reducing costs—usually labor costs. Often, other costs were overlooked. There has been a growing disenchantment with sourcing goods overseas, especially when there may be domestic alternatives as other costs begin to dominate. Baumol and Vinod's Inventory Theoretic model was useful in adding transportation considerations. However, Baumol leaves out several important costs that unless considered in offshoring decisions can lead to suboptimal solutions. This paper extends that model, providing a prescriptive model that could be operationalized by firms to evaluate offshore sourcing decisions.

INTRODUCTION

Major U.S. corporations have been importers for over 200 years. Initially, the colonists interests were in importing manufactured goods, but as industries developed their interests turned to importing basic raw materials such as metallic ores and manufacturing machinery. After World War II the U.S.experienced great growth in imports of manufactured goods. Recent years have seen two significant shifts: the widespread practice of securing offshore sources for manufactured goods by firms of all sizes, and the purchase of a wide range of materials and products. The three principal drivers have been and continue to be 1) securing goods at a lower cost, 2) accessing materials not available in the U.S. market, and/or 3) seeking to establish a commercial presence in order to achieve subsequent entry to the foreign market. During the past 20 years growth in imports has been so aggressive that it has on average trebled the growth of U.S. gross domestic product (U.S. Dept. of Commerce).

Securing goods at a lower cost usually means using cheaper labor by locating production offshore or by purchasing goods from foreign producers. Access to raw materials not available in the U.S. could include but is not limited to Chinese tungsten, Jamaican or Australian bauxite, African cocoa beans, Brazilian tantalite and columbite, and coffee from a range of foreign locations. Manufacturers purchase a wide range of sub-assemblies and components ranging from plastic molds, to water pumps to motors, to electrical components (Anon n.d.). Walmart and other mass merchandisers have turned to China for consumer goods that include electronics, hand tools, appliances, footwear and clothing. From a more cynical perspective some firms source overseas because their archrivals are doing so. Relocating production offshore has the strategic benefit of providing better access to foreign markets, but is more difficult to establish than just purchasing from an existing producer.
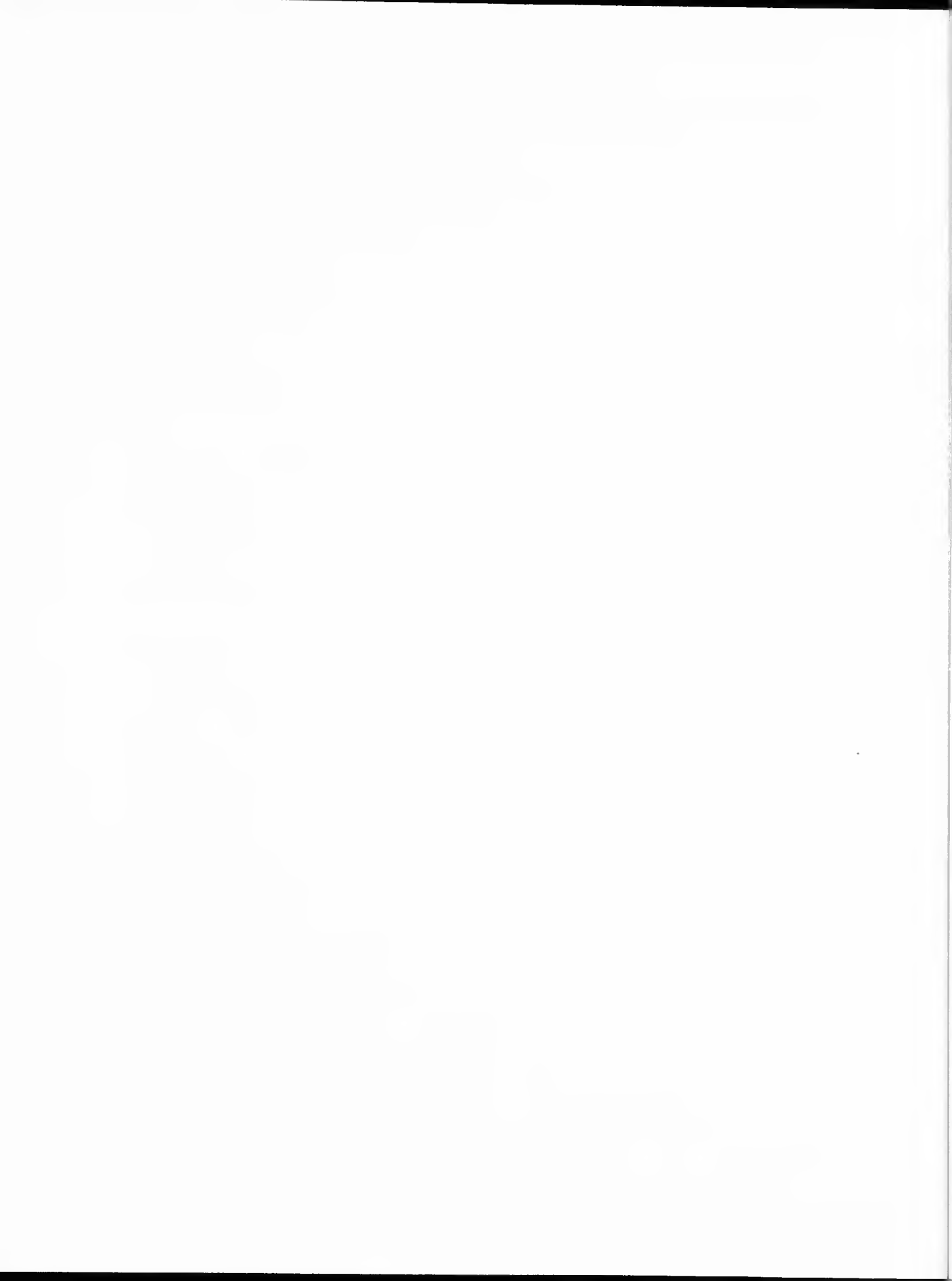
There has been a growing disenchantment with sourcing goods overseas, especially when there may be viable domestic alternatives (Ferreira and Prokopets, 2009; Goel, Moussavi, and Srivatsan, 2008; Minter, 2009; Mulani, 2002). Moreover, many firms are willing to continue with offshore sources, but want to opt for those closer to home given the myriad problems they have encountered with the complexities involved, including (Anon, 2008; Berstein, 2007; Ferreira and Prokopets, 2009; Minter, 2009; Mulani, 2008; Norek and Isbell, 2005; Smyrlis, 2010; Stalk, 2006):

· Trade regulations including duty and export taxes
· Different languages, cultures, and legal systems
· Spotty product quality
· Problems with intellectual property
· Long and capacity constrained supply chains
· Rising costs

As a result, many businesses are looking at bringing manufacturing back onshore, "nearshoring," "splitshoring," or "peak-load manufacturing" as an alternative to now more expensive offshore manufacturing (Mulani, 2002)

Business needs tools to make informed decisions on 1) whether to proceed to source offshore (or to move onshore or near-shore), or 2) selecting between two or more alternative sources of supply perhaps located in different parts of the world. The problem, as further discussed in the following literature review, is that there has been but scant coverage of this in the research within an array of business disciplines including managerial accounting, marketing, as well as logistics and supply chain management.

LITERATURE REVIEW

The term *landed cost* was investigated within a multi-disciplinary context that included accounting and logistics or supply chain management. Bowersox et al (1968) considered an extensive array of costs within distribution but disregarded offshore purchases. In reviewing total cost concepts, Baumol and Vinod (1970) developed

their inventory theoretic model that traded transportation off against inventory holding thus providing two key variables in offshore sourcing. This model was later updated by Tyworth (1991) for transportation sourcing decisions. Corey (1978) discussed sourcing decision-making processes with regard to both measurement systems and other functional areas, but provides no guidance for evaluating offshore purchases.

From an accounting perspective Carr and Ittner (1992) investigated total cost of ownership and attempted to develop conceptual models that embraced all relevant costs beginning with the identification of demand and ending with the ultimate disposition of a spent asset, but did not connect the variables necessary for effective offshore sourcing. Cavinato (1992) developed a model that differentiated costs from value obtained in order that supply chains could become the basis for competitive advantage. To achieve this, incurred costs need to be offset by some perceived value returned.

The application of landed (or total) cost models by industry varies greatly from firm to firm with Mascaritolo of NCR reporting that total cost of ownership is commonly calculated only by comparing the purchase price of a product between the new and the old source (Berstein, 2007). A "best practice" total cost model according to Ferreira and Prokopets (2009) includes four major components: supplier price and terms, delivery costs, operations quality and costs, as well as other costs. Delivery costs include origin, international, and domestic transportation as well as custom duties and value-added taxes. Operations quality and control costs include all types of inventory and quality costs. Other costs include standard costs of risk, seller qualification, and local tax incentives; situational costs of procurement staff, broker fees, infrastructure, exchange rate trend, skills training, and tooling; as well as customer specific costs (Ferreira and Prokopets, 2009).

Although many of the elements of total cost have been known for some time, many relevant costs are regularly not considered. Less than fifty percent

of surveyed manufacturers reported using relevant costs including (Ferreira and Prokopets, 2009):

- Customer service
- Packaging
- Tooling
- Material handling and warehousing
- Increased procurement staff
- Overhead and administrative
- Product qualification
- Inventory
- Costs of quality
- Country specific costs (VAT, customs)

Soft cost considerations are sometimes included in industry total cost models. NCR considers whether a prospective source country is "friendly" (Berstein, 2007). Whirlpool has found that having trained workers, an existing factory, and a large reservoir of available parts suppliers is beneficial (Uchitelle, 2005). Low labor rates have grown less important for some manufacturers like Whirlpool where labor content in top-loading washing machines has declined from 2.5 hours per machine in 2000 to 1 hour per machine in 2005 (Uchitelle, 2005). Brittan of United Technologies noted that purchasing has changed dramatically from purchasing a motor to purchasing "a motor that is in an assembly, manufactured with zero defects and delivered every four hours in the quantity you need to a particular point on your production line" (Berstein, 2005).

The principal contribution of all of these was in illustrating the diverse nature of costs with respect to how they may be incurred as well as how they may be reported within the firm. These authors showed how suboptimal behaviors brought about by firm budgeting processes that are isolated by department, business unit, division, or other organizational factors, are a natural impediment to total cost analysis.

Ellram (1993, 2000) noted that it was functional activities that needed to be linked both temporally and organizationally within the context of total cost of ownership. Perhaps one of the most significant

contributions was her segmentation of cost activities into pre-transaction, transaction, and post-transaction phases whereby the estimate of future costs and an entire range of administrative overhead costs would not be overlooked.

Total cost of ownership, however, is different from, albeit related to, landed cost. Where total cost of ownership is by design intended to encompass every conceivable cost during the period that an asset (fixed as well as current) is owned, it is the intention of the landed cost concept to embrace only those costs involved with sourcing items and ultimately putting them in the hands of the anticipated consumer or industrial end user. Logically, landed cost is embedded within the transactional phase of total cost of ownership, but a careful review of the literature for the latter suggests that it may not be present with sufficient detail to prompt effective decision-making. (Young, et al, 2009). Steve Banker (2009) comes closest to a comprehensive approach to assessing total landed costs, but while he discusses the numerous variables to consider, he stops short of developing a useful and actionable model.

Given the growth in international trade, it is instructive to find those sources where the issue of landed cost is not articulated. Citing all of the sources where landed cost was not mentioned in an actionable manner is not a practical endeavor, but some key samples of where one would have expected to find some reference include the topics of procurement, logistics and cost accounting. While Hickman and Hickman (1992) was informative with respect to identifying and negotiating with foreign sources as well as minimizing transportation and customs duty, no provision was made for bundling these costs into an effective decision support tool. Similarly, Wood et al (1995) divided the cost of international distribution into several categories, but did not establish a holistic view of landed cost management. Finally, Kaplan and Cooper (1998) addressed integrated cost systems and how they drive profitability, but also ignored the need to

integrate all costs associated with global procurement decisions.

Even in the international trade literature, one seldom finds a sufficiently encompassing approach that could guide those endeavoring to engage in foreign sourcing. Seeking to include both inventory concerns, transportation and purchase price, Fantasia (1997) sought to understand net landed cost and how it represents the true cost of bringing product to the customer. At the close of the 1990's some software firms as well as those providing international shipment services began to offer technology solutions as chronicled by Atkinson (1999). However, despite these advancements most efforts were relegated to transaction-related costs that are easily identifiable. Consistent with these findings, Coyle et al (2003) defined landed cost as "The total cost of a product delivered at a given location; the production cost plus the transportation cost to the customer." Citing the suboptimality found in most models, Van Der Hoeven (2003) stated that there was value to be found in total landed cost models.

Only recently did the work of Young et al (2009) define landed cost to include cycle inventory carrying costs, inventory in-transit ownership, administrative overhead, and transportation expenditures as major constituents that importers would need to take into consideration if their objective was to achieve strategic cost advantages from their offshore sourcing endeavors. As Coyle and others have pointed out over the years, the management of supply chains is an exercise in identifying and evaluating tradeoffs.

Facilitating the consideration of variables is best done with the aid of models; however, the extensive literature search could not provide a single model that appeared to possess all of the variables that appeared to be potentially operative with respect to offshore sourcing decisions. Nevertheless, there was one model that provided a means for trading off several of the key variables thereby suggesting that it might provide a useful base that could be logically extended—the Inventory Theoretic Model derived by Baumol and Vinod (1970).

BAUMOL'S METHODOLOGY

The most common application of the inventory theoretic has been in the selection of transportation modes based on total annual cost where transportation and inventory carrying costs are the variables most often traded off. Baumol defined total annual cost as the sum of cycle inventory holding plus ordering cost plus the cost of owning goods in transit plus transportation expense, that is:

TAC = Inventory + Ordering + in-transit + Shipping + Safety Stock holding costs carry costs costs costs

or:

$$TAC = (Q*v*W/2) + A*(D/Q) + t/365(D*v*W) + T*D + S*v*w \qquad (1)$$

where:
TAC = Total Annual Cost
Q = Order Quantity
D = Annual demand
v = Unit price of the goods
w = Holding cost expressed as a percentage
A = Unit cost of an order
t = Time in days for transport
T = Per unit transportation cost
S = Safety Stock

While Young et al (2009) identified the major variables and decomposed them into a taxonomy of their key constituents, no prescriptive model that could potentially be operationalized by firms seeking to evaluate offshore sourcing decisions was provided. The key difference is that the expanded equation is used to determine source of supply rather than choice of transportation mode. Those key variables are shown in Table 1 below:

TABLE 1
SUMMARY OF LANDED COST MODEL VARIABLES

Module 1: Price	Module 2: Transportation	Module 3: Customs	Module 4: Inventory	Module 5: Overhead
1. Supplier price	1. Foreign inland	1. Tariff rate	1. Cycle stock	1. Sourcing
2. Selling terms	2. Line haul	2. Merchandise processing fee	2. Safety stock	2. Due diligence
3. Payment terms	3. US inland	3. Harbor maintenance fee	3. Inventory in-transit	3. Compliance relationship maintenance
4. Payment processing cost	4. Accessorials	4. Custom processing cost	4. Stock-out costs	4. Supplier learning curve and supplier development
	5. Insurance			
	6. Packaging			5. Duty management

Although the model is useful for identifying the variables, the process of applying it to the inventory theoretic is threefold in that 1) some model components are fixed costs and some are variable, 2) many of the costs, especially when overhead in nature, may be extremely difficult to determine or may not be separable, and 3) some components may be variable for some import scenarios and fixed for others. Given this, it is our view that the Baumol and Vinod model should be expanded to incorporate various elements common in offshoring operations.

OFF-SHORING EXPANSION TO BAUMOL'S THEORETIC

This extension of Baumol's theoretic adds several components often ignored and yet critical in assessing the total landed costs. These include the purchase price of the item, duties and taxes, and a reconsideration of fixed administrative costs. Incorporating the components of offshoring, the conceptual model therefore becomes:

TAC = Purchase + duties + administrative + inventory + administrative + in-transit +   trans. + Safety Stock
       Price   & taxes   costs (fixed)   holding   (order) costs   carry costs costs   costs

or

$$TAC = D*v + D*v*C + R + (Q*v*W)/2 + A*(D/Q) + t/365*(D*v*W) + T*D + S*v*w \qquad (2)$$

Where the new variables are:

C = Customs Duties and Tariffs
R = Fixed Administrative Costs

The Formulation

Purchase Price (D*v): It is axiomatic that one of the variables when selecting a supplier will be the price paid for an item. The Baumol theoretic treats the purchase price as a fixed cost and thus does not consider that in the equation, since that theoretic is applied after source selection for determining the transportation modes and inventory policies. This extension of the theoretic moves the decision point earlier, considering the selection of the supplier and as such the price charged by that supplier becomes relevant, and thus variable. This is determined by multiplying the anticipated period (annual) demand by the price per unit (D*v), similar to the inclusion of purchase price when considering quantity discounts from the same supplier (Silver, et.al., 1998).

Customs, Duties and Taxes (D*v*C): This component of the extension adds the costs of customs duties and taxes as a fractional or ad valorum (percent) charge of the value of the unit purchased. Just as with the addition of the purchase price, these costs are assumed fixed when a supplier has already been selected but becomes a variable of interest, and thus a relevant cost, when selecting a supplier. There will of course be no international trade costs if a domestic supplier is chosen. When considering international supply partners, these costs (on an ad valorum basis) may vary depending on country of origin of the goods. For example, goods coming from Mexico, Canada or another nation where a free trade agreement is in place or one of the countries designated by

Congress to receive preferential treatment under the General System of Preferences (GSP) may be imported with reduced or even no duty. The Harbor Maintenance Tax applies to only ocean transport, but may be avoided by using shipping to a Canadian ocean port and then using overland transport into the United States.

"Fixed" Administrative Costs (R): This cost is the charge associated with procurement activity separate from a per unit charge. Just as with the previous two components, the costs will vary depending on the supplier chosen. Once a source is selected, these costs become fixed but the total costs of "fixed" administration must be considered as an element in selecting the supplier. Fixed costs associated with sourcing as a procurement activity includes identifying and qualifying potential sources of supply, development efforts such as co-locating engineers and designers with the supplier to assure that their output is in conformance with specifications, a vetting for compliance with such initiatives as C-TPAT, and contracting. Of significant interest when considering offshore suppliers is that the maintenance of relationships with offshore suppliers may consume more administrative overhead costs given the need to overcome differences in language, business cultures, legal systems and regulation, and time differences. Finally, the learning curve associated with new suppliers is a consideration as well as a fixed cost.

In some instances the fixed costs may be spread over short time durations of just a matter of days, while in others, for example, the cost of establishing the supplier, may be distributed over many years. With the current practice of more frequent changes in suppliers, the former rather than the latter may be the case.

While continuing to use Baumol's original variables in the inventory theoretic, there are several topics where an expanded definition and underlying understanding is nevertheless required. These are:

Variable Administrative Costs (A*D/Q): When originally considered, this was interpreted to mean ordering cost. While this may still represent a major element, the costs of the entire transactional cycle needs to be accounted for, hence the costs incurred by the customshouse broker, the fees associated with establishing and processing letters of credit, the administrative processing of receipts, and the payment of invoices are all elements.

There may be compliance cost elements that are variable. For example, goods may arrive and Customs may elect to conduct an extensive examination that requires that the ocean container be opened, the goods removed and inspected, and then subsequently reloaded. The cost of unloading, reloading, and any required blocking and bracing is done at the importer's expense.

Duty management is an activity where decisions may be made whereby an importer may put goods in a bonded warehouse or enter them into a foreign trade zone . Alternatively, goods can be imported temporarily for processing and then re-exported under several different legal provisions such as temporary import bonds. Moreover, U.S. goods may be exported for further processing and returned under "American Goods Returned" processes The net effect would be to lower the value of variable C while increasing the overhead associated with administering such efforts.

Transportation cost (T*D): International commerce consists of more than a single linehaul. This variable needs to contain all of the costs of the various transport legs as well as the accessorial charges that would include terminal receiving fees at the port of loading and terminal handling charges at the port of arrival. Insurance can be accounted for as either a premium paid to the freight forwarder or, in the case of larger and/or more sophisticated importers, as a blanket policy that may likely fall under the fixed administrative costs of the R variable. While currently represented as a single cost per unit for shipping, this component could be expanded to include the specific costs relevant to each leg of transportation.

Safety stock costs (S*v*w): Safety stock is a consideration whenever sourcing decisions are made, given the contribution to total annual costs. In an offshore decision this factor is made more critical as the time for transportation, and opportunities for delay are increased. It is acknowledged that this can be reduced through faster (but more expensive) transportation modes such as air, highlighting the trade-off between transportation and inventory costs.

Order Size, or Quantity (Q): The Baumol model determines the optimal ordering quantity balancing ordering and holding/carrying costs. The challenges posed by real-world constraints in offshoring may force a more complex solution. When comparing sourcing from domestic, or off-shore, locations, your order size may not be optimized simply as a relationship of ordering and holding costs, but may be driven by the minimum shipping sizes (containers, pallets, or truck-van loads) and frequency of the shipping routes. As such decisions may need to consider both continuous and periodic review policy approaches.

Packaging costs may be categorized as export packing and included with forwarding costs, or as charges incorporated in the selling price by the supplier.

Whereas the principal tradeoff found with the application of the EOQ model was inventory holding versus ordering cost, the Inventory Theoretic was inventory holding (both as cycle, safety, and in-transit) versus transportation cost. In extending the Inventory Theoretic to look at total landed cost, the tradeoff is the savings in the price of the goods versus all other costs combined. By applying this extension firms not only will be able to determine the optimal order size and transportation modes, but also determine the lowest total landed costs associated with each supplier.

HYPOTHETICAL SCENARIO

Atlantic Medtech (Atmed), located in Au Claire, Wisconsin, a producer of disposable surgery supplies, has begun discussions with a potential Chinese supplier of high purity polyvinyl chloride tubing that has typically been supplied to the industry by St. Gobain under the trade name Tygon© as well as others. Because of the application the tolerances and sterile properties have been the most stringent element of the specification.

A volume purchaser, Atmed's two sources were both domestic producers: one in Houston, and the other in Cleveland. Pricing on a delivered basis varied very little and averaged $5.00 per meter, delivered Au Claire. The average lead time of five days has varied little over the life of the buyer-seller relationship. Annual volume required by Atmed is 400 kilometers and while this is distributed over 15 different gauges and wall thicknesses, the overall mix has held steady over the years.

Admed's purchasing department had begun the quest for lower cost suppliers approximately 18 months prior and ultimately identified a firm in Hunan Province, China that appeared to have the capacity and the expertise even if they were not familiar with medical applications and the requirements of the Good Manufacturing Practices (GMPs) of the U.S. Food and Drug Administration. Given this information, the $3.00 per meter ex

works quoted price was sufficient cause for Atmed to send two engineers and their families to China for what was believed to be a two year stay that would involve their respective salaries of $80,000 each plus 30% fringe benefits, and $40,000 each for transportation, housing for their families, and schooling for their children. Prior to the assignment, Atmed also paid $5,000 for immersion courses in Chinese language and culture.

When the purchasing director set out to calculate the cost savings the following cost components were considered: price of the goods at $3.00 per meter, transportation of the quantity in ten 20-foot containers at $3,000 each, terminal handling charges of $700 per container, inland transportation from Los Angeles-Long Beach of $2,500 per container, $300 per entry to the customs broker, and customs duty of 3.7% ad valorum plus a Harbor Maintenance Tax of 0.125% and a Merchandise Processing Fee of 0.21%. Even with all of these extra costs, savings appeared to approach $500,000.

Once Atmed had shifted its source to the Chinese producer, total lead time became eight weeks after placing the order with six of those consisting of average transit time. Depending on whether the freight forwarder in China booked the appropriate sailing, the variance of the lead time could drive total time to 10 weeks. Atmed calculated its inventory holding costs to be approximately three times the prime lending rate or 15%. As experience with the new supplier's material continued, Atmed found quality to be erratic and this necessitated holding additional safety stock for such an eventuality, but also meant that a quality engineer would need to make a quarterly visit to the supplier—at a cost per trip of $15,000.

Expanding this analysis to include those costs that were not built into the total cost calculation resulted in the following:

TAC = purchase + duties + administrative + inventory + administrative + in-transit + trans. + Safety Stock
price & taxes costs (fixed) holding (order) costs carry costs costs costs

or

$$TAC = D^*v + D^*v^*C + R + (Q^*v^*W)/2 + A^*(D/Q) + t/365^*(D^*v^*W) + T^*D + S^*v^*w \qquad (3)$$

$1,671,973 = 1,200,000 + 45,180 + 250,000 + 4,500 + 11,000 + 27,616 + 110,000 + 23,676$

When compared against the domestic source including all of these individual cost elements, the TAC becomes:

$2,019,612 = 2,000,000 + 0 + 0 + 0 + 3,000 + 12,500 + 0 + 0 + 4,112$

The difference represents a savings of $347,639 and not the $800,000 as first seen when only comparing price. The scenario also states that there have been some subsequent quality problems requiring an engineer to make annual trips costing another $60,000 annually. There also may be some additional administrative burden that is not yet accounted for, such as Chinese inland trucking, a freight forwarder in Shanghai, and a terminal receiving charge at the port. Clearly, the savings continue to evaporate and should one also weigh the potential impact of quality rejections, as perhaps manifested in product recalls and loss of brand equity in the marketplace, the savings are insufficient to warrant the foreign sourcing decision.

CONCLUSION, MANAGERIAL IMPLICATIONS AND RECOMMENDATIONS

Baumol's inventory theoretic has as an assumption either the a-priori selection of a supplier, or alternatively that the cost differences associated between suppliers is trivial. When considering international trade these costs are non-trivial and the failure to consider them in off-shoring decisions can lead to sub-optimal solutions. This model captures many of those costs.

There are substantial fixed and variable costs associated with off-shoring that are frequently not accounted for in most landed cost models. The costs of establishing and maintaining off-shore sources and relationships are perhaps the greatest fixed and variable costs that need to be recognized.

Relationship costs take on greater importance as we seek to develop relationships that cross cultural and geo-political boundaries.

There are substantial risks associated with offshore sourcing that are rarely included in any analysis. These can include natural and political/civil disruptions at the source or en-route, volatility of exchange rates and energy prices, and changes in customs and governmental regulations and policy. These are not captured in the proposed model but need to be considered outside the model.

This model does not consider the many strategic motivations that drive offshoring. For instance, firms may choose to produce offshore as a means of entering foreign markets. This decision may fit the long-term growth plan for the firm even if it results in near-term higher landed costs. However, the decision to produce offshore does not necessarily require that onshore production cease. This model could be used as support for maintaining both on-shore production while developing off-shore production and markets.

Using this model is on the face rather simple— collect the data, input the numbers, and assess the results. Unfortunately, the challenges in operationalizing this extended model are more complex, and often are more an organizational challenge than a mathematical one. Such challenges may include that 1) many, if not most firms will not be able to readily identify their true costs of administrative overhead whether fixed or variable, 2) often the time required for making a

decision is too short to allow for the collection of relevant cost data, 3) their organizations are too frequently siloed thereby precluding any single unit from making the requisite analysis, and 4) risks may not be known until bad events occur. That said, none of these are insurmountable obstacles and the pay-off in reduced total landed costs could be substantial.

Firms could follow several approaches to operationalizing this model. Firms should first address the issue of ownership—of the data and the process. By establishing clear lines of ownership, and developing collaborative cross-functional teams, the firm can redress not only the silo nature of their processes but the problems associated with conflicting data elements, assumptions and policies. Once these barriers have been addressed the process teams can collectively document their processes, fitting their requirements for supply support with the options available, collecting the data they believe is appropriate for their particular process. At that point the introduction of the data into the model should result in a clear picture of their supply chain. Improving their visibility of actual costs should allow for better sourcing decisions based on total landed costs

The ability to comprehensively assess offshoring options may be a core competency that heretofore few firms have demonstrated. This model, along with a strategic vision for the organization, provides one step towards that end.

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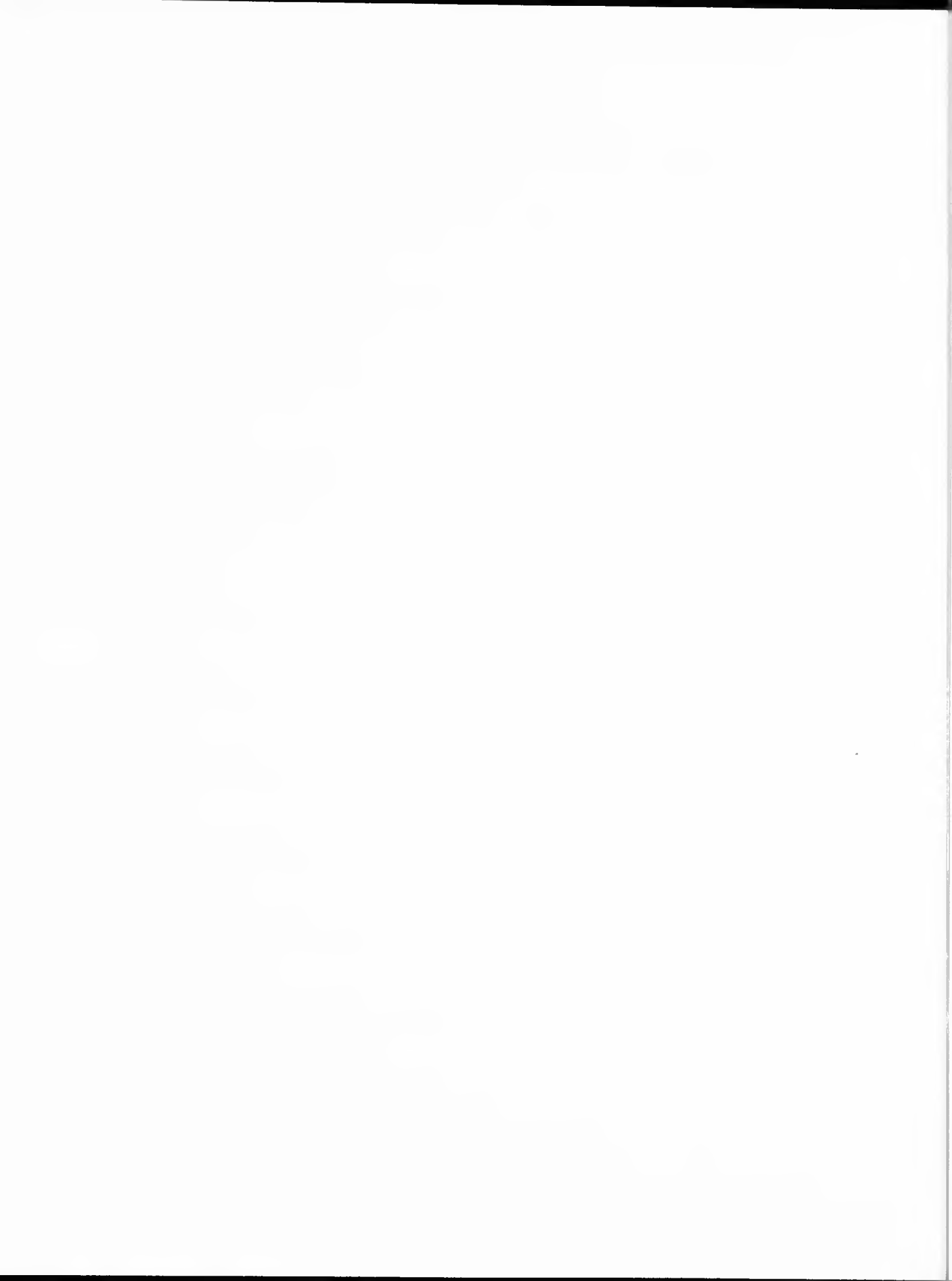
FUEL COSTS AND SUPPLY CHAIN DECISIONS

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ABSTRACT

The affect of rising fuel costs on the individual consumer is well documented in current media. Consumers are paying more for their basic necessities. Fuel surcharge, transportation cost, and logistics have become house hold words. The rising cost of crude oil creates an increase in fuel cost, and this creates an increase in the cost to transport products from one location to another. Managers, who are responsible for acquiring products and delivering them to customers, are also feeling the impact of higher fuel prices. This article will outline three significant areas where fuel prices are affecting U.S. supply chain decisions. Sourcing decisions, transportation modes, and product design and packaging practices are all currently being influenced by the cost of logistics.

INTRODUCTION

Individual consumers are well aware of the effects of rising fuel prices on their personal shopping experiences. Numerous news reports, magazine articles, and personal stories recount the sticker shock of seeing consumer goods escalate in price. Consumers, who were once oblivious to fuel surcharges, logistics, and transportation strategies, have discovered how this aspect of supply chain management affects their ability to purchase goods. Families are even struggling to purchase fuel to keep their personal automobiles operational. Gas prices, and even gas availability, has become a significant issue for many citizens.

In the mid to late 1990's, the cost for a barrel of crude oil hovered around the $20 mark. However, in 2007 crude climbed to $150/barrel, and currently is priced in the $70-80 range. These crude oil prices translate to higher refined fuel prices. Not only do personal transportation vehicles rely on fuel, but also cargo jets, container ships, rail cars, and tractor trailers. These vehicles carry goods from manufacturers to the ultimate end customer. As crude oil prices escalate, fuel prices follow. As fuel costs increase, the cost to transport merchandise through the supply chain increases. Fuel surcharges, additional fees added to a standard freight charge, have become a matter of fact for many companies. Industrial buyers and consumers, who did not know or care where their products originated when transportation costs were low, are now becoming more aware of how the supply chain operates and how fuel costs affect the price of consumer goods.

Supply Chain strategies that were once optimum are being challenged as transportation costs rise and become a larger percentage of a product's total delivered cost (Tirschwell, 2008). Supply Chain decisions related to outsourcing, transportation modes, and product design and packaging are dramatically influenced by the cost to move a product from one location to another. Manufacturers are trying to become more efficient in their business decisions when dealing with options that affect transportation costs. Consequently, there is a positive side effect of the rising cost of fuel. Businesses are becoming more energy conscious and energy efficient when dealing with decisions that affect transportation costs.

Manufacturers are actively seeking strategies to become more efficient in terms of transportation costs. Three key areas being targeted for improvements are outsourcing decisions, modes of transportation, and product design and packaging techniques. Manufacturers are taking a close look at their outsourcing decisions. They

are comparing the savings associated with low cost labor in foreign countries with the transportation cost required to bring products back to the U.S. for sale. When moving products from one point to another, manufacturers consider different transportation modes, such as marine, rail, truck, and air freight. Each option has its own advantages and disadvantages in terms of speed of travel and cost of travel. Firms are also working to become more efficient with the design and packaging of products. The packaging of a product can have a significant impact on the cost to distribute it. The amount of cubic space the product and packaging consumes, and the added weight of the product and packaging materials, are two key considerations that are being addressed in hopes of reducing transportation costs.

OUTSOURCING

In recent years, the media has publicized the trend of manufacturing companies in the United States moving their production operations offshore. U.S. companies found the lure of low cost labor in foreign countries hard to resist. Moving the manufacturing operations offshore could result in major cost reductions, even when the completed products had to be shipped back to the U.S. for delivery to the final customers. Decisions were made to save on labor cost at the expense of transportation costs. As fuel costs rise, and transportation costs increase, the strategy of moving production to far away sources to acquire low cost labor has come under scrutiny. As transportation costs increase, it becomes more important to minimize the distance from original manufacturer to retailer (Semichi-Levi, et al., 2008).

Jeff Rubin, chief economist at CIBC World Markets, says "The cost of shipping a standard 40-foot container from East Asia to the U.S. eastern seaboard has already tripled since 2000 and will double again as oil prices head towards $200 per barrel." While these shipping costs have come down due to reduced oil prices and the recession, costs are still considerably higher than in the mid

2000's. Oil prices now account for a much larger portion of total freight costs (Rubin, 2008). Higher energy costs translate directly into higher transportation costs. Rubin equates transportation costs to tariff-equivalents. At $20 per barrel of oil, as seen in 2000, transportation costs were equivalent to a 3% U.S. tariff. With oil at $70-80 per barrel, the tariff-equivalent rate is 6%. At $150 per barrel, fuel costs would equate an 11% tariff, comparable to tariff levels in the 1970's.

Bo Anderson, a former GM group vice president of global sourcing and supply chain, states that "on total landed cost for North American consumption, Alabama is our lowest cost country today" (Murphy, 2008). Emerson Electric, which makes various electro-mechanical products, has moved some of their appliance motor manufacturing from Asia to Mexico (Aeppel, 2008). This approach helps to offset the transportation cost of bringing a product to North America, but does not totally sacrifice the savings associated with lower cost labor. Although wages in China are lower than those in Mexico, the wages in Mexico are still considerably lower than those of a U.S. worker.

Of course, the cube and weight of the product being shipped has an affect on how important transportation costs are for that product. Batteries are a relatively heavy item compared to their size. Consequently, shipping costs are an important consideration in making supply chain decisions. Crown Battery Manufacturing Co. recently reversed their decision to manufacture batteries destined to consumers in the U.S., from Mexico back to the US. Crown moved the production operation from a plant in Reynosa, Mexico to a plant in Ohio (Aeppel, 2008). One approach to balancing the cost of labor with the cost of transportation is to target operations in small rural communities in the Midwest or Southeastern United States. Salaries, and cost of living, are lower in these areas than in large urban cities. Labor unions are also not as well developed. Consequently, the labor costs are lower than in other more industrial developed areas of the U.S. Additionally, transportation costs are not as high

as compared to bringing products to the U.S. from foreign countries.

Should fuel costs continue to rise, distribution distance will become a greater influence on outsourcing decisions. A product that can be produced close to the consumer will require less transportation cost than one that is produced a great distance from the end consumer. Consequently, efforts to reduce the transportation distance between manufacturer and consumer are likely to continue. Onshoring, nearshoring, and insourcing are all terms to describe the business practice of keeping, or bringing operations back closer to the end consumer. Heavy or bulky products are especially affected by fuel costs due to the cost of transportation. The affect of distance is beginning to rival the affect of labor costs in many industries. Should this trend continue, outsourcing strategies will shift to a more balanced relationship between labor cost and transportation costs.

TRANSPORTATION MODES

Transportation options in a supply chain have two critical features; the speed at which a product is delivered and the cost to deliver it. Unfortunately, these two features are at work against one another. Transportation modes that allow the fastest delivery are the least efficient in fuel use. Air, rail, truck, and marine have decreasing rates of fuel consumption, but increasing rates of travel time. As transportation costs rise, more focus is placed on the efficient use of fuel. Business logistics costs in 2007 exceeded 10 percent of the U.S. Gross Domestic Product (Wilson, 2009). Consequently, the demand for more cost effective modes of transportation increases. Many manufacturers have indicated plans to shift freight from truckload carriers to rail carriers (Blanchard, 2008). Rail transportation is significantly more efficient than truck. In the first quarter of 2008, 935 trucking companies went out of business (Smith, 2008). On *www.freightrailworks.org,* the rail industry advertises that the rail system is capable of moving one ton of freight 436 miles on just one gallon of

fuel, a significant savings compared to truck (AAR, 2010).

Of course, transportation by rail alone does not give a company the ability to deliver to unlimited locations like truck transportation does. To take advantage of the fuel efficiency of rail transportation, and still possess the flexibility of truck delivery, many manufacturers are switching to intermodal transportation options. The rail system provides a fuel efficient means of moving freight over long distances and the truck and trailer system provides a means of picking up freight from the origination point and moving it to a rail terminal and moving the freight from a rail terminal to its final destination point.

In another new tactic, some truck carriers are reducing the maximum speed allowed on their trucks. In January, Con-Way Freight dropped the maximum speed on their trucks from 65 MPH to 62 MPH. Con-Way estimates that this reduction in speed will save 2/10 of a gallon of fuel for every mile traveled (Allen, 2008). At $3/gallon diesel this equates to a savings of $.60 per mile. In Ontario, long combination vehicles, consisting of a tractor and two 53-ft trailers, are being used to transfer two loads at once with a 30 percent reduction in fuel (Menzies, 2009). This tactic is especially useful when transporting voluminous, lightweight goods.

Transloading, transferring merchandise from marine containers to 53-ft trailers, is another tactic gaining popularity at U.S. west coast ports. On average, the contents of three standard 40-ft marine containers will fit in two domestic 53-ft trailers (Ruriani, 2007). This results in two inland shipments rather than three, a savings of about 30 percent. This trend is most prevalent at west coast ports rather than east coast ports, because the freight arriving in California is moved a longer distance. The transportation savings on these longer inland shipments offset the labor and overhead costs of transloading (Mongelluzzo, 2007).

Manufacturers also may choose to serve a market from a closer production facility. This approach may have the effect of reducing specialized factories in favor of more flexible factories capable of making several products. Manufacturers may also reverse the "make to order" trend in favor of "make to stock," because this approach is more conducive to large quantity shipments that reduce transport costs (Semichi-Levi, et al., 2008). Another strategy aimed at reducing transportation costs is to use more distribution centers rather than having suppliers ship direct to stores. This strategy allows larger bulk shipments, thereby reducing fuel costs. In 2006, Home Depot shipped 80 percent of their products directly from vendors to stores. Their new logistics model is to decrease that to 50 percent, sending the balance through distribution centers (Maloney, 2009). In the future, retailers may shorten their supply chain by forcing manufacturers to move their distribution centers closer (Goodwill, 2009).

Transportation modes can have a significant impact on transportation costs. In order to reduce transportation cost many companies are shifting to more economical transportation modes. This shift will often result in less delivery flexibility and a reduction in distribution speed, but will reduce delivery costs. The more fuel efficient the transportation option is, the more desirable mode it is when dealing with high fuel prices.

PRODUCT DESIGN AND PACKAGING

Product packaging and containers serve several purposes. The package may be for physical protection of the product, theft deterrent, marketing, storage, or consumer use. However, the packaging of a product consumes valuable transportation and storage space and adds weight to the overall delivered product. When fuel costs were low, retailers may have sacrificed space and weight in order to surround their products with packaging that appealed to the consumer's eye. There is now a new focus on more cost efficient packaging in terms of transportation and storage cost.

Sam's Club has recently introduced a new one gallon milk container. The new milk container is square shaped and does not have the traditional spout at the top for pouring. The new containers do not require crates or metal racks for storage. They can be stacked directly on top of one another, because of their flat tops. The square milk jug was introduced in Sam's Club stores in November of 2007 (Sustainable is Good, 2008). It is estimated that a milk truck can carry 9% more milk in the same space using the new containers compared to the traditional milk jugs. By carrying more milk in each truckload, the shipping cost for the milk is reduced. Of course, not everyone is pleased with the new design. Some customers find the new design difficult to use. It is taking some time for these consumers to adapt to the new containers. Sam's Club is offering classes on how to pour milk from the new containers. These issues point out the relationship between marketing and logistics, and the need for interaction across these management disciplines.

Wal-Mart's packaging team worked with one of their private label brands, Kid Connection, to improve the packaging of nearly 300 toys. By reducing the packaging, Wal-Mart estimates that it saved $2.4 million in freight each year (Wal-Mart, 2009). Radius, a toothbrush manufacturer in Pennsylvania, recently redesigned it's product to include lighter packaging (Radius Toothbrush, 2010). In transportation, weight equals fuel. The less a product weighs, the less it will cost to transport it from one location to another. Radius estimates that they have reduced their fuel consumption by 30% by using the light weight packaging material. Hewlett-Packard is another manufacturer that has reduced its packaging material in hopes of decreasing shipping costs. They have redesigned their print cartridge packaging with less and lighter materials. The reduction will decrease the truck and ship traffic required to distribute their products. Products can also be redesigned to reduce weight or cubic volume to lower transportation costs. Other examples of this concept are concentrated laundry

detergent, flat panel TV's rather than the larger tube versions, and knock down furniture rather than assembled units.

Wal-Mart and Hewlett Packard have teamed up to offer a laptop computer in a recycled messenger bag (Gonsalves, 2008). HP won the Wal-Mart Home Entertainment Design Competition by offering their HP Pavilion dv6929 Entertainment Notebook with no box and no Styrofoam. The messenger bag provides the padding for the notebook during shipping. When shipping from HP to Wal-Mart, HP can fit three notebooks in a shipping box. This translates to removing one out of every four trucks required to ship the laptops. HP estimates that they have removed 97% of the product packaging materials.

Retailers are also using computer software to help determine the most efficient way to pack product in cartons, pack cartons in trailers, and combine shipments. When you pay for a trailer to move from one point to another, you want the trailer as full as possible. Additionally, you want each carton as full of product as possible. Nesting is the process of packing multiple products in one box to maximize space utilization (O'Donnell, 2008). Companies like Williams-Sonoma rely on efficient nesting process to minimize the number of cartons used during shipping.

Products still need to be protected during transit. One of the roles of packaging is to provide protection to the product, but there are alternative ways to provide this protection. When a product is placed inside a box and the product does not take up all of the free space, some internal packaging material must be used to fill the void. Styrofoam and other forms of padding are typical solutions to this problem. However, these materials add cube and weight, and therefore shipping costs to the product. The Technical Development Manager for Sealed Air recommends using inflatable air cells (Armstrong, 2009). This approach consumes the excess space and protects the product, but does not add significant weight to the overall package. Shrink wrapping may also offer product stability during shipment without adding packaging material cube and weight.

As fuel costs continue to rise, product design and packaging methods will continue to be refined. Less packaging material and lighter product and packaging material reduce the overall product size and weight. Organizations will continue to optimize product design and packaging methods to minimize the fuel costs required to move products from one point to another.

SUMMARY

Rising fuel prices are making supply chain decision makers look carefully at their transportation strategies. Although most of what is reported in the news and research literature is the negative impact of the rising fuel costs, there are some positive aspects of the situation. Businesses are placing a more detailed focus on being energy efficient when establishing transportation policies. This new found focus on energy efficiency will reap benefits in years to come. More efficient strategies to conserve fuel will make a positive impact on earnings no matter what the cost of crude oil. Many of the transportation strategies to conserve fuel, will also make the supply chain more environmentally friendly. Using less fuel makes the supply chain greener.

On the other hand, there are some negative consequences of transportation demand management. Higher transportation costs effectively limit the range at which manufacturers can market their products. This distance limitation forces manufacturers to be generalists, at the expense of increasing specialization. This restriction on specialization in turn limits productivity growth. In addition, limits on the distance at which a manufacturer's goods can remain competitive, reduces the level of total competition in a given market, potentially leading to increased spatial monopoly.

In summary, three significant areas of concentration are outsourcing decisions, modes of

transportation, and product design and packaging techniques. Outsourcing decisions that chase low cost labor and ignore transportation costs are being scrutinized. Businesses are now focusing on total delivered cost and attempting to balance the cost of labor with the cost of transportation. Several U.S. companies have reversed decisions that sent manufacturing jobs to offshore operations, in favor of bringing the production work closer to the end consumer. In a world of instant gratification, consumers would like to have their goods as soon as possible, but as soon as possible can come with a hefty price. With rising fuel costs, many companies are transferring deliveries from less fuel efficient, faster modes of transportation to more fuel efficient slower modes. This may result in waiting longer for goods or the need for more advanced planning, but yields lower transportation costs.

Product packaging has also been an overlooked cost dimension for many companies. Packaging was viewed as a means of advertisement, theft deterrent, and product protection. The added weight and bulk of the packaging was not always a consideration for manufacturers. Focusing on transportation costs has driven some manufacturers to redesign their product packaging. Using lighter materials, using less material, and optimizing containers for increased space utilization has resulted in less packaging weight to transport. Similar strategies have been deployed for product design. Often the product can be redesigned to reduce its weight or cubic volume. This, in turn, lowers transportation costs.

These strategies, that reduce transportation costs, are a positive outcome of the increased fuel prices experienced by so many companies. Fuel is a limited energy resource and strategies that maximize the efficient use of that resource will help businesses be more efficient overall.
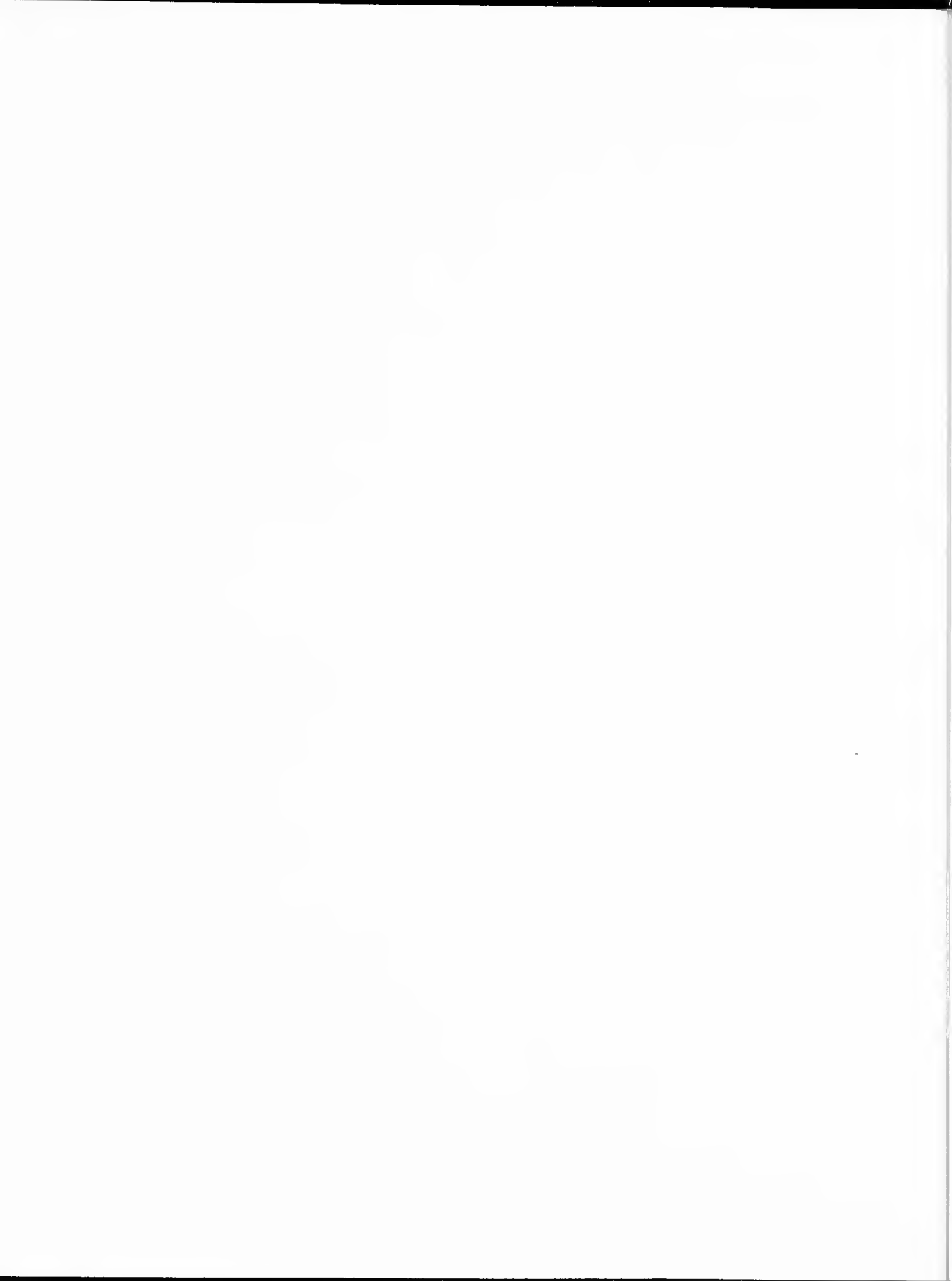
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Journal of Transportation Management

Guidelines for Submission/Publication

GENERAL

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2. Articles should be submitted electronically to Dr. Taylor at taylorjohn@wayne.edu.

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4. Article length should be in the range of 6000-7000 words including references. Tables and figures are in addition to the word count. However articles including all text, references, appendixes, tables and figures (but excluding front matter) should not exceed 30 double spaced pages in the format described below. Shorter articles are also acceptable. It will be difficult to publish articles much longer than 7000 words.

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1. First Page - Title of the paper, name and position of the author(s), author(s) complete address(es) and telephone number(s), e-mail address(es), and any acknowledgment of assistance. Times New Roman with 12 point font.

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Radius Toothbrush (2010), "New Packaging," Radius Toothbrush, [On-line]. Available: http://www.radiustoothbrush.com/radiustoothbrushnewpackaging.aspx, Accessed: 06/10.

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$y = c + ax + bx$
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Book Chapter:
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Book:
Coyle, John J., Bardi, Edward J., and Novack, RobertA. (2004), *Transportation,* 6th ed., Cincinnati, OH: South-Western College Publishing.

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Wilson, J. W. (2003), "Adapting to the Threat of Global Terrorism: Reinventing Your Supply Chain," [On-line]. Available: http//:georgiasouthern.edu/coba/centers/lit/threat.doc. Created: 11/01/02, Accessed: 11/12/03.

MANUSCRIPT SAMPLE
A FRAMEWORK FOR EVALUATING SUPPLY CHAIN PERFORMANCE

Terrance L. Pohlen, University of North Texas

ABSTRACT
Managers require measures spanning multiple enterprises to increase supply chain competitiveness and to increase the value delivered to the end-customer. Despite the need for supply chain metrics, there is little evidence that any firms are successfully measuring and evaluating inter-firm performance. Existing measures continue to capture intrafirm performance and focus on traditional measures. The lack of a framework to simultaneously measure and translate inter-firm performance into value creation has largely contributed to this situation. This article presents a framework that overcomes these shortcomings by measuring performance across multiple firms and translating supply chain performance into shareholder value.

INTRODUCTION

The ability to measure supply chain performance remains an elusive goal for managers in most companies. Few have implemented supply chain management or have visibility of performance across multiple companies (Supply Chain Solutions, 1998; Keeler et al., 1999; Simatupang and Sridharan, 2002). Supply chain management itself lacks a widely accepted definition (Akkermans, 1999), and many managers substitute the term for logistics or supplier management (Lambert and Pohlen, 2001). As a result, performance measurement tends to be functionally or internally focused and does not capture supply chain performance (Gilmour, 1999; *Supply Chain Management,* 2001). At best, existing measures only capture how immediate upstream suppliers and downstream customers drive performance within a single firm.

Table 1 about here

Developing and Costing Performance Measures

ABC is a technique for assigning the direct and indirect resources of a firm to the activities consuming the resources and subsequently tracing the cost of performing these activities to the products, customers, or supply chains consuming the activities (La Londe and Pohlen, 1996). An activity-based approach increases costing accuracy by using multiple drivers to assign costs whereas traditional cost accounting frequently relies on a very limited number of allocation bases.

$$y = a^2 - 2ax + x^2$$

REFERENCES

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Revised May 25, 2010
Dr. John C. Taylor, Editor

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