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Vol 11 No 1
Spring 1999

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From the Editor...

Welcome to the Spring, 1999 issue of the *Journal of Transportation Management*. The diversity of articles and topics in this issue does justice to the diversity of our industry and our culture. I am indebted to the authors in this issue for their patience, quality of research and writing and for thinking of the *JTM* as an outlet for their work. I also offer my sincere gratitude to the members of the Editorial Review Board who contributed to the success of this issue. Remember that the reviewers are volunteers - they agree to give their time and expertise and ask for nothing in return. I could not do my job without them. Speaking of dedicated and capable volunteers, my Associate Editors, Steve Rutner and Brian Gibson are a constant source of strength. A lot of people contributed to the completion of this issue. I hope that you enjoy the product!

The lead article in this issue, by Stan Fawcett, Greg Magnan, and Laura Birou, explores the application of the product life cycle concept to the logistics strategy planning process. They report the results of a study that measured applicability and usage of 43 logistics techniques across the stages of the product life cycle. The second article, by Joe Hanna, Robert Kunkel, and Greg Kuhlemeyer, looks at the impact of deregulation on the U.S. motor carrier industry in a rather unique way. They look at the stock price reaction of a sample of carriers to the passage of the ICC Termination Act of 1995. Joel Wisner and Michael Mejza, in the third article, analyze current practices in the rail industry dealing with quality assessment and improvement. Results from their empirical study demonstrate that the U.S. railroad industry is heavily invested in formal quality improvement programs. Remko van Hoek adds a truly international dimension to this issue in the fourth article. He studies the use of postponement in European supply chains across a number of different industries. His findings indicate that, as postponement increases, the need for customized logistics and transportation activities also increases. This, in turn, creates many opportunities for channel members and third party logistics providers. In the final article of this issue, Paul Murphy and James Daley empirically investigate the opinions of international freight forwarders concerning what constitutes a logistically friendly (or unfriendly) country. Important factors affecting the categorization of a nation as logistically friendly or unfriendly are identified and the implications explored. I hope that you take the time to read each of the articles in this issue. I think you will be glad that you did.

This issue of the *Journal* is the fourth under the continuing financial sponsorship of the International Intermodal EXPO - the world's largest logistics and transportation related trade show. If you missed the most recent EXPO (the 16th, April 20-22) in Atlanta, Georgia, then make plans now to attend the 17th annual EXPO April 11-13, 2000, again in Atlanta,

Georgia. See the back cover of this issue for more information. I again thank John Youngbeck, CEO of the EXPO, and his board of directors for their commitment not only to the *Journal of Transportation Management* and Delta Nu Alpha International Transportation Fraternity but also to the future of logistics and transportation education.

Speaking of commitment and financial support, remember that we cannot survive and continue to publish without reader support. Please join or renew your membership in Delta Nu Alpha International Transportation Fraternity and subscribe to the *Journal of Transportation Management*. Share this issue with a colleague and encourage him/her to subscribe today!

Jerry W. Wilson, Editor
Journal of Transportation Management
Department of Marketing and Logistics
Georgia Southern University
P.O. Box 8154
Statesboro, GA 30460-8154
(912) 681-0257
(912) 871-1523 FAX
jwwilson@gsaia2.cc.gasou.edu

Stephen M. Rutner, Associate Editor
(912) 681-0588
srutner@gsaia2.cc.gasou.edu

Brian J. Gibson, Associate Editor
(344) 844-2460
gibsobj@auburn.edu

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OBJECTIVES

Editorial Policy. The primary purpose of the *JTM* is to serve as a channel for the dissemination of information relevant to the management of transportation and logistics activities in any and all types of organizations. Articles accepted for publication will be of interest to both academicians and practitioners and will specifically address the managerial implications of the subject matter. Articles that are strictly theoretical in nature, with no direct application to the management of transportation and logistics activities, would be inappropriate for the *JTM*.

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

Submissions from industry practitioners and from practitioners co-authoring with academicians are particularly encouraged in order to increase the

interaction between the two 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 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, the International Intermodal Expo, or Georgia Southern University.

PUBLISHING DATA

Manuscripts. Four (4) copies of each manuscript are to be sent to Dr. Jerry W. Wilson, Georgia Southern University, P. O. Box 8154, Statesboro, GA 30460-8154. Manuscripts should be no longer than 25 double-spaced pages. Authors will be required to provide electronic versions of manuscripts accepted for publication. 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 \$35 in U.S. currency. Payments are to be sent to: *Journal of Transportation Management*, Delta Nu Alpha Transportation Fraternity, 530 Church Street, Suite 700, Nashville, TN 37219.

MAPPING LOGISTICS PRACTICE USING THE PRODUCT LIFE CYCLE

Stanley E. Fawcett
Brigham Young University

Greg Magnan
Univeristy of Seattle

Laura Birou
The George Washington University

The dynamic nature of today's global economy places a premium on a firm's ability to anticipate and to respond to customer needs as well as changing competitive pressures. Within this environment, developing a successful logistics strategy can be critical to the firm's long-term competitive success. This paper looks at the potential for using the product life cycle (PLC) as a strategic framework in the logistics strategy planning process. Results of an empirical study that investigated the appropriate use of 43 logistics techniques across PLC stages are reported. The implementation status of the various logistics techniques is also considered.

INTRODUCTION

The competitive imperatives of a global marketplace make anticipating and responding to customer needs a challenging task (Blackwell 1997). Within today's dynamic market, an effective logistics strategy can help mitigate the competitive challenge and assist the firm in achieving high levels of customer satisfaction. Because an effective logistics strategy not only supports the firm's overall competitive efforts but can also lead directly to competitive advantage, logistics has recently gained considerable visibility as a viable competitive weapon. One senior manager at a Fortune 500 company acknowledged, "We've changed the way we develop products, manufacture, market, and advertise. The one

piece of the puzzle we haven't addressed is logistics. It's the next source of competitive advantage. The possibilities are just astounding" (Henkoff 1994).

An important aspect of competing through logistical capability is to put in place the right set of logistics practices to help the firm deliver high levels of customer value. Unfortunately, a multitude of logistics practices coupled with a complex competitive environment makes selecting appropriate logistical practices problematic. The fact that new "tools and techniques" come and go almost overnight exacerbates the challenge of managing logistics for competitive impact. As a result, many firms have implemented a set of logistics practices that absorb scarce managerial time and

financial capital only to find that they fail to deliver any real value to customers (Stock 1992). To help sort through the myriad logistics practices and identify those techniques that really yield customer value, managers should seek to carefully align the logistics strategy to the overall firm strategy. A strategic planning framework such as the product life cycle (PLC) can help managers more effectively manage logistics activities as a cohesive strategic weapon (Anderson 1991). Such a framework can help identify unique customer needs while creating a better understanding of the competitive environment. The resulting focus and alignment promises to enhance both logistics performance and customer satisfaction. Because the product life cycle is widely used and understood by managers in diverse industries and across functional areas, it is a convenient and practical vehicle to align logistics practice to the competitive needs of the firm.

This paper looks at the product life cycle as a tool for developing and implementing an effective logistics strategy. Specifically, 43 different logistics practices are considered and matched to the life cycle stage where they are used most frequently. Further, the implementation status of each logistics practice is compared across the growth and maturity stages of the life cycle. The following section defines and discusses the PLC concept and its relationship to logistics management. The subsequent section looks at the research methodology and is followed by a discussion of relevant findings. Conclusions and managerial implications are then presented.

THE PRODUCT LIFE CYCLE AS A GUIDE TO LOGISTICAL MANAGEMENT

The PLC concept depicts the sales of a product from its market introduction to its decline and withdrawal from the market; that is, over its entire "life" (Kotler 1991). Most descriptions of the PLC include five distinct stages: design, introduction, growth, maturity, and decline. Each stage of the product life cycle implies a unique set of competitive, market, and product characteristics (see Table 1) (Wasson 1978). Volume and learning efficiencies as well as market acceptance and loyalty are the primary determinants of these characteristics. Intuitive appeal combined with consistent experience have led to the widespread acceptance and historically strong influence of the PLC concept on strategy development. This positive influence on strategy development is a strong force promoting the use of the PLC as an alignment mechanism. Ayres and Steger (1985) commented on the pervasive influence of the PLC:

The influence of the product cycle concept on management strategy in the last fifteen to twenty years—along with its concomitant experience curve and market share notions—has been enormous. Perhaps it has been the single most important set of strategic beliefs held by corporate management during the decades of the 1960s and 1970s.

Over the years, substantial research has highlighted the PLC's suitability as a framework for strategy development. Studies

TABLE 1
CHARACTERISTICS OF PRODUCT LIFE CYCLE STAGES

Design	Involves the development and test marketing of some product or service the company has never attempted to sell with full-scale efforts. Other attributes of this stage include: heavy R & D expenditures, uncertainty of the success of the proposed innovation, and preparation of a marketing plan.
Introduction	Commences with the full-scale marketing of the product or service in its intended market or in a large region. This stage is also characterized by low unit sales, losses or low profits, uncertainty of length of stage, product vulnerability to attack from competing items or services, relatively few distributors, inexperienced personnel, product often manufactured in pilot plants, active product debugging, and initial promotions.
Growth	Begins when unit sales start increasing at a growing rate or at more than one percent monthly. Trial sales have been largely completed. This phase is also epitomized by substantial profits, existence of many distributors, widespread market coverage, less product vulnerability, use or development of full-scale production lines, heavy amount of manufacturing overtime, and adding new models to product line.
Maturity	Occurs when sales volume continues to increase, but at a decreasing rate. Sales typically plateau and eventually decline slightly during the maturity stage. Unit sales may fluctuate within the range of plus or minus one percent monthly. This stage is also represented by profits leveling off and then declining, existence of many aggressive competitors, declining prices, production facilities or processes in need of repair or redesign, cost-price squeeze, development of new markets or new product models and sizes, and special sales inducements or concessions to customers.
Decline	Occurs when unit sales decline at an increasing rate or at more than one percent per month. Other attributes of this stage are declining profits, product substitution by distributors, sales and profit declines cannot be curtailed except in the very short run, promotional support is withdrawn, R & D budget is canceled, and manufacturing equipment is sold.

(Fox 1977)

by Hofer (1975), Anderson and Zeithaml (1984), and Hambrick and Lei (1985) support the use of the PLC to guide the selection and implementation of different practices to enhance business unit performance over the life of a product. At the functional level, the PLC was first emphasized in manufacturing by Hayes and Wheelwright (1984; 1979) as a guide in developing the product-process matrix. They suggested that, "the product life cycle can be used to summarize the customer and product requirements that must be satisfied by the manufacturing function and its product technology." Moreover, they recognized that the PLC "highlights the need to change the priorities that govern manufacturing behavior as products and markets evolve" (Hayes 1984). Similarly, Kaminski and Rink (1984) proposed using the PLC concept to guide physical distribution strategy. They noted that the PLC could be used to gauge changing market conditions, guiding the formulation and implementation of physical distribution strategies and tactics. Similar suggestions regarding the role of the PLC have been made in marketing and purchasing (Cravens 1986; Kiser 1976).

Today's global marketplace—characterized by greater uncertainty and a reduction in allowed response time—places particular value on the predictive nature of the PLC (Wyland 1998). Indeed, advances in technology coupled with intensified competition and the emergence of demanding global consumers have greatly compressed product life cycles (Cho 1996; Grant 1997; Lau 1995). The managerial impact of shorter life cycles can be dramatic. For instance, most new, technology-oriented products face serious competition from imitators within the first year of introduction. Getting a new product "on the shelf" in

geographically dispersed markets in a relatively short period of time is critical to gaining and maintaining market share. Firms are thus placing much greater emphasis on global product launches, which tend to be highly logistics dependent. Compressed life cycles thus require managers to design logistics strategies that can provide rapid and widespread geographic coverage at minimal cost.

Specifically, the PLC's value to logistics decision makers comes from the fact that it provides an underlying structure to the life of products. The PLC is thus well positioned to act as a common denominator for the coordination of logistics and customer satisfaction strategies. That is, products in different stages of the life cycle require different types of logistical and technical support to facilitate market success. Once the life-cycle stage has been identified, fairly certain predictive guidelines can be drawn to assist the design and implementation of appropriate logistical processes (Thorelli 1981). For example, a product in the design stage would benefit from value analysis and total cost analysis coupled with the early consideration of packaging needs and future service requirements. During product introduction, logistical efforts would target rapid and responsive delivery to key customers—a high level of customer service is needed to gain favor with these influential market entry points. Success in the growth stage requires careful inventory management and scheduling to assure consistent, on-time delivery and achieve widespread market coverage. Finally, the emphasis in the maturity stage is on logistics cost reduction programs. Using the PLC as a planning framework to guide logistics decision making appears appropriate.

STUDY METHODOLOGY

The primary objective of this research is to provide insight into the potential use of the PLC to strategically align logistics practices to the product/service requirements of customers. To gain this insight, a survey-based empirical methodology was used to collect data regarding logistics practice across a product's life cycle. A single mailing to 500 senior-level managers from manufacturing companies was conducted. The sample was taken from the membership of the Council of Logistics Management. One hundred and thirty-three usable questionnaires were returned for a 28 percent response rate.

Survey Development

The survey instrument was developed after an extensive literature review and was refined through an initial pretest involving 15 industry and professional informants. The pre-test was specifically designed to improve question clarity and modify the list of logistics activities investigated. To make the data collection as easy and straightforward as possible, questions consistently employed seven-point scales. The final survey instrument asked logistics managers numerous questions related to how the PLC is used in their firm. The logistics managers were then asked to match 43 logistics practices to the most appropriate stage in the PLC. Information regarding the implementation status for each of these 43 practices was also collected. To ensure consistency of understanding among the respondents, definitions of the 43 logistics techniques were included with each questionnaire. A detailed definition of the PLC concept, complete with descriptions of each PLC stage, was also included to provide a common reference base for the respondents.

Basic Demographics and Strategic Positioning

Respondents were asked to indicate where their primary products are positioned on the PLC curve. Almost two-thirds (65.5%) of the respondents noted that their products are in the maturity stage of the life cycle. Most of the remaining respondents (29.2%) reported that their primary products are in the growth stage. Additional demographic data that profile the respondent companies are displayed in Table 2. Two measures of firm size were evaluated—number of employees and annual sales. Both showed that firms of all sizes were included in the respondent base. Moreover, firms of all sizes provided similar responses regarding the use of the PLC concept. Looking at general firm performance characteristics shows that the respondent firms are relatively successful when compared to leading competitors. Of note, respondents report the highest levels of performance in R&D aggressiveness and new product innovation, demonstrating a belief that long-term success requires new products entering the life cycle at all times.

Another perspective of the respondent firms' strategic positioning is gained via the organizational adaptation model (Miles 1978). This model classifies firms as prospectors, analyzers, or defenders based on the aggressiveness of the firm's product-market strategy:

- Prospectors possess innovative and adaptive organizational cultures that are conducive to risk taking. They place a premium on being the first to market with new products and services and therefore respond rapidly to early signals of market

TABLE 2
BASIC DEMOGRAPHIC CHARACTERISTICS

Firm Size:

<u>Number of Employees</u>	<u>Percent</u>	<u>Annual Sales</u>	<u>Percent</u>
500 or Fewer	10.4	100 or less	10.4
501 to 1,000	15.2	101 to 250	17.6
1,001 to 2,500	28.8	251 to 500	16.0
2,501 to 5,000	14.4	501 to 1,000	16.0
5,001 to 10,000	5.6	1,000 to 5,000	21.6
Over 10,000	25.6	Over 5,000	18.4

Competitive Positioning:

<u>Firm Performance vis-a-vis major competitors</u>	<u>Relative Rating</u> (1=much less to 7=much greater)
Aggressiveness of R&D/concurrent engineering efforts	5.10
The number of new product introductions in the last three years	5.00
The number of new markets penetrated in the last three years	4.61
Sales growth in the last three years	4.78
Market share growth in the last three years	4.71
Growth in Return on Assets (ROA) in the last three years	4.59
Overall competitive position	5.00

Organizational Aggressiveness:

<u>Company Descriptor</u>	<u>Percent of Firms in Each Category</u>		
	<u>Last Three Years</u>	<u>Currently</u>	<u>Next Three Years</u>
Defender	15.8	3.8	4.5
Analyzer	40.3	47.0	33.1
Prospector	28.1	41.7	55.6
Difficult to Classify	15.8	7.5	6.0

Strategic Focus:

<u>Characteristic</u>	<u>Importance Rating</u> (1 = not important to 7 = very important)
Customer service	6.28
Operating efficiency	5.97
New product development	5.86
Competitive pricing	5.81
Brand identification	5.48
Procurement of raw materials	5.46
Innovation in manufacturing processes	5.28
Innovation in marketing techniques	5.09
Product in high-priced market segments	4.65
Capability to manufacture specialty products	4.62
Serving special geographic markets	4.58
Advertising	4.31

needs or opportunities. Prospectors maintain a constantly changing set of products/services in the marketplace.

- Analyzers are seldom the first to market with new products or services; however, careful monitoring of more aggressive firms affords opportunities to quickly enter the market with a more cost-efficient or well-conceived product/service. This selective product/market approach allows for a relatively stable product/service base and thus improves efficiencies while allowing the firm to respond to selective market developments.
- Defenders concentrate on being the most efficient providers of an established set of products and services. These firms are not at the forefront of product introduction; rather, they introduce new products only after considerable evidence of potential success has been demonstrated. Low-cost and imitation are the keys to success for the defenders.

Respondents note that their firms have become more aggressive in their product-market strategies and expect the trend to continue. Future success will require more adaptable organizational cultures capable of gaining first mover advantages to capture greater market share and generate the cash flows needed to support future product and process innovation efforts. Finally, based on Porter's (1980) paradigm, which suggests that firms compete on the dimensions of low-cost or differentiation, respondents were asked to indicate the importance of various strategic issues to firm competitiveness. The data show that firms are consciously attempting to balance a desire for differentiation with the need to be cost competitive. In fact, the six most important issues are evenly split between differentiation and cost strategies. Clearly, the competitive

environment is intense, requiring firms to provide real value to customers—unique products and services at the lowest possible costs.

LOGISTICS PRACTICE ACROSS THE PRODUCT LIFE CYCLE

The literature suggests that the product life cycle concept has had a pervasive influence on managerial decision making. To verify that the PLC is indeed used in strategic decision making, the respondents were asked to indicate how extensively their firms employed the PLC concept (1=not used and 7=extensive). The responses revealed that the PLC is used almost universally; however, the mean of 3.53 suggests that the PLC is used only moderately as a planning framework (see Figure 1). As for its role in logistics strategy design and implementation, the PLC concept does appear to be influential. On a seven-point scale—1=low influence and 7=high influence—the mean score for the influence for the PLC was 4.52. It is interesting to note that manufacturing and purchasing managers view the PLC concept as more influential in their respective decision-making areas (in parallel studies manufacturing managers scored the PLC influence at 5.02 while purchasers indicated a mean influence of 4.86). Thus, the PLC, with its implications for product and service characteristics, is used by managers to help anticipate and meet customer requirements.

Logistics Priorities Across the Product Life Cycle

Since the PLC is used as a decision tool, it is important to assess the specific linkage that exists between a firm's competitive strategy and the PLC. Respondents were therefore asked to indicate the importance of different priorities to their firms' competitiveness using

FIGURE 1
PLC USE AND INFLUENCE ON FIRM DECISION MAKING

FIGURE 2
IMPORTANCE OF COMPETITIVE PRIORITIES

a seven-point scale (1=not important and 7=very important). The seven priorities of interest are shown in Figure 2. Quality is clearly viewed as the most important driver of competitive success. A high level of emphasis on consistently meeting promised delivery dates and reducing lead times shows a desire to be responsive to customer requests. Indeed, each of the seven priorities received a rating greater than five on a seven-point scale. Managers appear to recognize a need to meet higher levels of performance in order to meet increasing customer demands in the face of fierce competition. Today's competitive rule is that firms must achieve higher performance standards in a number of areas to survive and prosper in today's marketplace.

The information in Table 3 links each competitive priority to the stage of the product life cycle where it has the greatest impact on firm performance. Product innovation has its greatest impact in the design, introduction, and growth stages. Process innovation follows a similar pattern except that its influence extends into the maturity stage of the life cycle. Recent emphasis on process reengineering supports the idea that process innovation is not only important as part of concurrent engineering efforts but also as a major component of continuous improvement programs. Product quality is also viewed as important in the early stages of the life cycle, however, despite Taguchi's claim that 80 percent of all defects are designed into the product, logistics managers view quality as most important in the growth stage of the life cycle (Taguchi 1990). Rapid delivery is very important to the introduction and growth stages—if products are not available in these stages, market penetration is diminished and market share is quickly lost. Delivery dependability and flexible production become critical competitive drivers in the growth stage where product and service proliferation

become important to the firm's competitive strategy. Consistent and dependable delivery has become the most important logistics evaluation criterion in today's just-in-time environment (Bagchi 1988; Lieb 1988; Stock 1992). Because dependability is vital to JIT strategies and to the success of tightly coupled buyer-supplier relationships, it continues to be very important in the maturity stage. Finally, low-cost dominates the maturity stage.

To summarize, aligning competitive priorities to product life cycle stages reveals that logistics differentiation and service responsiveness is vital in the introduction and growth stages while cost and consistency are fundamental to success in the maturity stage. While logistics has long been managed as a cost center and thus done a fairly nice job of meeting the needs of the maturity stage, greater attention to logistics planning appears to be needed in the introduction and growth stages. That is, logistics managers must be more involved and influential in the design of product introduction and roll-out strategies. The need for careful and proactive logistics planning in the earlier stages of the product life cycle is particularly acute as companies increasingly strive to simultaneously introduce products into geographically-dispersed global markets.

From a logistics perspective, these findings highlight the logistics capabilities that must be developed to support the firm's overall product-market strategies as they evolve over time. Specifically, logistics must provide reach and responsiveness during the early life of a new product. Logistics failures early in the product's life cycle can easily discourage customers and thereby cede market share to the competition. For example, when Gillette introduced its Excell razor in the early 1990s, its Superbowl advertising and early promotion created a level of consumer demand that

TABLE 3
IMPORTANCE OF COMPETITIVE PRIORITY BY PLC STAGE*

	<u>Design</u>	<u>Introduction</u>	<u>Growth</u>	<u>Maturity</u>	<u>Decline</u>
Low-cost production	10.9	7.0	28.9	48.5	4.7
Product quality	19.8	22.1	37.5	19.8	0.8
Quick response	3.1	24.4	46.6	24.4	1.5
Delivery dependability	0.8	12.2	49.6	36.6	0.8
Product innovation	28.9	34.4	24.2	9.4	3.1
Process innovation	24.8	26.4	28.7	20.2	0.0
Flexible production	4.7	19.5	50.0	21.1	4.7

* Distributions of responses to the question, "Indicate the stage of the product life cycle where each of the following priorities has the greatest impact on your firm's performance."

outstripped its logistical capability. As a result, product was not available in many stores, frustrating potential consumers and reducing sales. Gillette made sure to do a better job of logistical planning as it recently introduced its new Mach 3 razor. As Gillette learned, excellent logistics responsiveness and service throughout product launch and rollout can create customer support and help the firm achieve the widespread product availability required to capture market share. This early market success is absolutely critical when companies must generate sufficient cash flow to support expensive product development costs (the Mach 3 cost about \$1 Billion to develop). Logistical capability can set the stage to take advantage of scale and information economies over the life of a product. Thus, initial logistics costs that deliver reach and responsiveness should be considered as an investment in the life cycle cash flow and profitability of the product.

As the product moves through growth and approaches maturity, dependable service becomes vital to establishing the relationships that yield a sustainable market presence. Logistical practice must remove delivery variability while decreasing lead times. As the

firm's logistical capabilities enable it to manage unexpected events in a seamless manner, customer loyalty is established and emotional switching costs are created. Finally, products in the mature stage of the life cycle require a routinized logistics system capable of consistently delivering products on time and at a low cost. To summarize, as a product moves through the life cycle, logistics must first provide responsive, then consistent, and finally efficient service. These performance requirements dictate the types of logistics practices that should be employed to successfully implement order-winning logistics strategies.

Matching Logistics Practices to PLC Stage

The above paragraphs point out that a product's position in its life cycle influences managerial decisions and that logistics strategies should vary to effectively support products throughout their market life. We now turn our attention to identifying the stage of the PLC where each of 43 different logistics practices is most appropriate. Based on their experience, respondents were specifically asked to indicate the stage of the PLC where each logistics practice is most effectively

TABLE 4
USE OF LOGISTICS PRACTICES BY LIFE CYCLE STAGE

<u>Logistics Practice</u>	<u>Design</u>	<u>Intro</u>	<u>Growth</u>	<u>Maturity</u>	<u>Decline</u>
Modeling (Simulation, Queuing, Optimization)	32.2	19.8	24.0	21.5	2.5
Value Analysis/Engineering	34.2	18.0	23.1	22.2	2.5
Bar Coding	15.3	34.7	30.6	18.5	0.8
Automation of Materials Handling	10.4	16.0	40.8	32.8	0.0
Benchmarking	17.1	19.5	36.6	24.4	2.4
Capacity Planning	11.2	21.6	51.2	15.2	0.8
Cross-Functional Teams/Employees	18.2	26.5	33.8	21.5	0.0
Cycle Counting/Inventory	4.0	12.4	42.2	38.9	2.5
Distribution Requirements Planning	15.4	20.3	40.6	22.7	0.8
Electronic Data Interchange	14.8	24.6	39.3	21.3	0.0
Employee Involvement	21.2	28.8	37.3	12.7	0.0
Facility Design (Dock, Terminal, Warehouse)	22.8	16.3	30.1	27.6	3.3
Forecasting Shipping Requirements	10.4	30.4	38.4	20.0	0.8
Inventory Management (Finished Goods)	7.3	17.1	39.8	35.0	0.8
Job Enrichment	12.8	18.8	33.3	32.5	2.6
Just-In-Time Transportation	12.3	17.2	36.1	32.0	2.5
Managing Delivery Schedules (Time Windows)	6.7	15.8	49.2	27.5	0.8
Order Cycle Time Reduction	8.3	18.2	41.3	32.2	0.0
Packaging Improvement Programs	12.3	13.9	38.5	33.6	1.6
Quick Response Programs	11.5	31.8	38.5	18.0	0.0
Service Innovation	12.4	15.7	38.8	31.4	1.7
Statistical Process Control (SPC)	20.2	16.0	38.7	22.7	2.5
Strategic Alliances/Partnerships	14.7	13.9	44.3	23.8	3.3
Team Building	25.4	26.2	36.9	10.7	0.8
Total Preventive Maintenance (TPM)	15.8	20.8	30.8	30.8	1.7
Total Quality Management (TQM)	27.3	21.5	32.2	19.0	0.0
Work Measurement	10.0	14.2	40.0	32.5	3.3
Carrier Base Reduction	5.0	5.9	25.4	62.7	0.8
Carrier Certification	4.3	18.8	32.5	41.0	1.7
Consolidated Shipments	2.5	10.7	35.3	48.4	3.3
Cost Reduction Programs	3.3	10.6	24.4	51.2	10.6
Distribution Center Locationing	13.1	14.8	32.8	36.9	2.5
Incoming Receiving/Inspection	14.7	26.2	21.3	31.1	6.6
Intermodal Transportation	12.7	6.0	31.0	43.1	6.0
International Freight Programs	13.6	17.8	28.8	39.8	0.0
Inventory Reduction Programs	3.3	11.5	23.8	50.0	11.5
Loss and Damage Management	6.7	13.3	32.5	45.0	2.5
Profit Sharing	13.8	12.9	31.9	32.7	8.6
Subcontracting	15.1	19.3	23.5	30.3	11.8
Third-Party Logistics Services	17.1	23.1	19.7	31.6	8.6
Total Cost Analysis (Systems Analysis)	29.2	17.5	22.5	30.8	0.0
Vehicle Routing and Scheduling	11.2	19.8	29.3	36.2	3.5
Warehouse Productivity	6.6	13.9	36.1	43.4	0.0

implemented. Table 4 presents the frequency distributions for the responses. The practices are listed based on their "most appropriate" stage starting with design at the top of the table and ending with maturity at the bottom. The stage most frequently identified as appropriate is bolded to make it easier to identify key stages of practice implementation.

Perhaps the first point that is evident from the data in Table 4 is that some disparity in opinion exists with respect to which stage is most

appropriate for each logistics practice. For practices such as carrier base reduction, a high level of agreement exists with 63 percent of the managers placing it in the maturity stage. For other practices, the responses are much more evenly distributed among the first four life cycle stages. Two specific circumstances lead to this more even distribution. First, some practices such as total cost analysis are used extensively in the design and introduction stages and then are re-emphasized in the maturity stage. Total cost analysis or life cycle costing is often performed in the early stages of product and process development to allocate resources and justify the development effort. Later, when the product/service package faces intense competitive pressure in the maturity stage, total cost analysis is once again emphasized in an effort to identify opportunities to reduce costs. Second, practices such as the use of cross-functional teams are introduced early in the life cycle and continue to be used throughout the remainder of the product's life. However, for many of these practices, the nature or task performed by the practice changes over the life of the product. In the case of cross-functional teams, the main objective in design is to provide information that can improve both a new product's performance and its deliverability. By

maturity, cross-functional teams play a significant role in improving the efficiency of logistics systems.

Overall, the responses demonstrate that logistics plays a limited role in the design stage with increased importance in the introduction stage. This finding supports the notion that new product development and marketing dominate a firm's approach to product launch. Through product launch, logistics has historically played a tangential support role. The responses also clearly show that by early growth, logistics plays an important role in supporting the product-market strategy. The distributions also highlight the importance of efficient and effective logistics support into and through maturity. Finally, it should be noted that none of the 43 practices was viewed to be highly appropriate or frequently used in the decline stage.

Despite some recent interest in reverse logistics, the responses suggest that relatively little emphasis is placed on closely or strategically managing products that are in the decline stage. The following paragraphs address the fit of logistics practices to the different life cycle stages.

The design/introduction stages are comprised of practices that are either used specifically in the new product development process or are integrative in nature. Practices and techniques used to design the logistics infrastructure and support system dominate this life-cycle stage. These practices include facility design, modeling, total cost analysis, and value analysis/value engineering. Getting third-party logistics companies involved in the logistics system design early in a product's life is important for companies that outsource much of their logistics support. Also, total quality management is widely used early in the

life cycle. This finding suggests that managers truly believe that quality must be designed into a product as well as its accompanying support services. The other type of practice emphasized in the early stages of the life cycle focus on the development of the human resource that is required to support a product throughout its entire life.

The practices that are widely used in the growth stage tend to emphasize the development of the firm's delivery capability. They focus on anticipating demand, establishing sufficient movement and storage capacity, and managing the information that is needed to control product movement. The establishment of quick response programs and strategic alliances points out an existing desire to achieve high levels of responsiveness during the growth stage. The early growth stage is dominated by practices that are aimed at the planning and execution of a delivery strategy that is designed to assure widespread and timely product availability. By contrast, the late growth (and early maturity) phase clearly focuses on putting in place a systematic or routinized logistics support system. Throughout the early growth stage, infrastructure demands are constantly changing. Similarly, a lack of information regarding customers and volumes limits effective planning for continuous operations. As demand patterns emerge and are better understood, variability and uncertainty are reduced and a more standardized approach to logistics management can be successfully implemented. Any efforts that increase information availability earlier in the life cycle would allow for earlier logistical standardization and thus higher levels of logistics service at lower cost levels.

As a firm's products move fully into maturity, the emphasis in logistics practice moves toward cost minimization. At this point, the

logistics process has been developed and is now closely monitored and maintained. Management efforts focus on reducing inventory requirements, consolidating shipments, simplifying transportation requirements, and limiting loss and damage. The reality is that most of the 43 logistics practices must be implemented before a product ever reaches maturity. They are critical to assuring the success of a product long before it gets to the maturity stage. Thus, the number of practices placed in the maturity stage are limited to those that truly emphasize efficient and reliable logistics operations. These practices allow a company to support a product that faces increased competition and decreased margins.

As previously noted, some practices that are classified in earlier stages such as the use of third-party logistics services or the design of incoming receiving and inspection are the object of renewed emphasis in the maturity stage. The target of the renewed emphasis is enhanced efficiency from reengineered or redesigned logistics processes.

EVALUATING THE IMPLEMENTATION STATUS OF LOGISTICS PRACTICES

To better understand the relationship between logistics practice and the PLC concept, the respondents were asked to indicate on a 7-point scale the actual level of implementation for each of the 43 logistics practices (1=not implemented, 7=fully implemented). The data in Table 5 show the implementation status for the overall respondent group. Significant differences ($p=.05$) in implementation status—based on the t-statistic—are shown by the vertical lines. That is, the implementation status of those practices connected by the vertical lines is not significantly different. It is both interesting and important to note that the nine most fully implemented practices all focus

TABLE 5
OVERALL IMPLEMENTATION STATUS OF LOGISTICS PRACTICES

1	Inventory Management (Finished Goods)	5.63	Differences significant at the p=.05 level.
2	Cost Reduction Programs	5.49	
3	Carrier Base Reduction	5.39	
4	Consolidated Shipments	5.25	
5	Incoming Receiving/Inspection	5.21	
6	Cycle Counting/Inventory	5.08	
6	Distribution Center Locationing	5.08	
8	Inventory Reduction Programs	5.07	
9	Warehouse Productivity	4.88	
10	Strategic Alliances/Partnerships	4.87	
11	Forecasting Shipping Requirements	4.85	
12	Total Quality Management (TQM)	4.83	
13	Team Building	4.74	
14	Order Cycle Time Reduction	4.72	
14	Service Innovation	4.72	
16	Capacity Planning	4.69	
16	Managing Delivery Schedules (Time Windows)	4.69	
18	Packaging Improvement Programs	4.67	
18	Cross-Functional Teams/Employees	4.67	
20	Employee Involvement (EI)	4.64	
21	Loss and Damage Management	4.59	
22	Carrier Certification	4.58	
23	Work Measurement	4.54	
24	Quick Response Programs	4.46	
25	Distribution Requirements Planning (DRP)	4.38	
25	International Freight Programs	4.38	
25	Statistical Process Control (SPC)	4.38	
28	Just-In-Time Transportation (JIT)	4.28	
29	Facility Design (Dock, Terminal, Warehouse)	4.26	
30	Electronic Data Interchange (EDI)	4.19	
31	Intermodal Transportation	4.13	
32	Job Enrichment	4.05	
33	Profit Sharing	4.00	
33	Vehicle Routing and Scheduling	4.00	
35	Total Cost Analysis (Systems Analysis)	3.99	
35	Total Preventive Maintenance (TPM)	3.99	
37	Automation of Materials Handling	3.98	
38	Value Analysis/Engineering	3.94	
39	Bar Coding	3.91	
40	Benchmarking	3.90	
41	Subcontracting	3.78	
42	Third-Party Logistics Services	3.64	
43	Modeling (Simulation, Queuing, Optimization)	3.57	

on cost reduction or efficiency. Clearly, logistics management is still driven very much by cost considerations. However, nine of the next eleven techniques emphasize service or effectiveness—an emphasis on continual improvement and a desire to better meet

customer's needs is apparent among these logistics practices. Thus, the long history of managing logistics as a cost center continues to influence logistics management and, in many firms, logistics' overall visibility within the firm. Perhaps more important is that the trend

of using logistics to develop a differentiated service capability appears to be gaining credibility among the respondent firms. Certainly, the success of high-profile companies like Wal-Mart—which places logistics at the core of its competitive efforts to meet customer needs at the lowest total cost—has led many companies to closely examine how logistics can play a proactive role in their own competitive strategies (Nelson 1999).

Several practices deserve comment largely because of their relatively low level of implementation. In particular, neither total cost analysis with an implementation rank of 35 and an implementation score of 3.99 nor benchmarking with a rank of 40 and a score of 3.90 have been implemented as extensively as the trade literature has suggested. Other practices with lower than expected implementation levels included statistical process control (rank=27, score=4.38), Just-In-Time transportation (rank=28, score=4.28), and electronic data interchange (rank=30, 4.19). Interestingly, while these practices are not as highly implemented as the authors had expected, each of these practices excepting EDI have relatively strong, significant impacts on firm performance (see Table 6). The performance relationships are discussed below.

Table 6 separates the respondents into two groups—growth and maturity—based on the position in the PLC of the firm's primary products. The implementation status of the 43 techniques is then compared across these two groups. That is, a strong majority of the respondents (87 firms) identified their primary products to be in the maturity stage. Most of the remaining respondents (39 firms) noted that their primary products are in the growth stage of the PLC. For many techniques (approximately half) very little difference in

implementation status was noted across firms whose primary products are in the growth versus maturity stages of the life cycle. Based on a difference score of .30 or greater, ten practices are more fully implemented by firms whose primary products are in the maturity stage. These ten practices are cost reduction programs, consolidated shipments, incoming receiving, forecasting shipping requirements, service innovation, cross-functional teams, loss and damage management, facility design, vehicle routing, and modeling. Two themes appear among these ten practices. First, an emphasis on cost management and reduction is evident. Second, firms with products in the maturity stage place a high level of importance on establishing a more routinized logistics system. The added emphasis on service innovation and cross functional teams also suggests that efforts are made to develop new service offerings that will potentially lead to a renewed opportunity to differentiate the product/service package. This implementation pattern suggests that some attention is given to breaking out of the margin squeeze status that tends to prevail in the maturity stage of the life cycle by creating differential service offerings.

Using the difference score of .30 or greater, five logistics practices are implemented more fully by firms in the growth stage of the PLC. These practices are managing delivery schedules, statistical process control, value analysis, bar coding, and benchmarking. Each of these practices is used to help the firm design and manage its logistics activities to achieve better delivery capability, especially with respect to time competitiveness. Further, the greater use of these practices, and most particularly the greater emphasis on benchmarking, suggests a more aggressive stance on organizational learning. Some of this emphasis on learning comes from the fact that products in the growth stage often exhibit

TABLE 6
COMPARISON OF IMPLEMENTATION STATUS—
GROWTH VERSUS MATURE PRODUCTS

Rank	Manufacturing Practice	Implementation Status (1 to 7)			Performance Impact
		Growth	Maturity	Difference	
1	Inventory Management (Finished Goods)	5.63	5.68	-.05	.199 ^
2	Cost Reduction Programs	5.29	5.61	-.33	.047
3	Carrier Base Reduction	5.40	5.39	.01	.077
4	Consolidated Shipments	4.97	5.35	-.38	-.10
5	Incoming Receiving/Inspection	4.91	5.38	-.46	.121
6	Cycle Counting/Inventory	5.17	5.03	.14	.140
6	Distribution Center Locationing	4.91	5.21	-.29	.091
8	Inventory Reduction Programs	5.11	5.10	.01	.170
9	Warehouse Productivity	5.03	4.87	.16	.154
10	Strategic Alliances/Partnerships	4.77	5.03	-.25	.261**
11	Forecasting Shipping Requirements	4.51	5.09	-.57	.055
12	Total Quality Management (TQM)	4.82	4.89	-.06	.051
13	Team Building	4.83	4.81	.02	.234**
14	Order Cycle Time Reduction	4.76	4.83	-.07	.219 ^
14	Service Innovation	4.54	4.88	-.34	.253**
16	Capacity Planning	4.71	4.78	-.06	.118
16	Managing Delivery Schedules (Time Windows)	5.14	4.63	.52	.196 ^
18	Packaging Improvement Programs	4.80	4.80	.00	.294**
18	Cross-Functional Teams/Employees	4.46	4.83	-.37	.034
20	Employee Involvement (EI)	4.56	4.78	-.22	.152
21	Loss and Damage Management	4.42	4.77	-.35	.245**
22	Carrier Certification	4.46	4.71	-.25	.036
23	Work Measurement	4.60	4.49	.11	.122
24	Quick Response Programs	4.37	4.63	-.25	.194
25	Distribution Requirements Planning (DRP)	4.31	4.54	-.22	.115
25	International Freight Programs	4.59	4.39	.20	.023
25	Statistical Process Control (SPC)	4.65	4.35	.30	.180 ^
28	Just-In-Time Transportation (JIT)	4.17	4.38	-.21	.229 ^
29	Facility Design (Dock, Terminal, Warehouse)	3.97	4.44	-.46	.144
30	Electronic Data Interchange (EDI)	4.11	4.31	-.20	.099
31	Intermodal Transportation	4.12	4.30	-.18	.102
32	Job Enrichment	4.31	4.03	.28	.175
33	Profit Sharing	4.09	4.09	.00	.191 ^
33	Vehicle Routing and Scheduling	3.85	4.20	-.35	.045
35	Total Cost Analysis (Systems Analysis)	4.23	4.00	.23	.311**
35	Total Preventive Maintenance (TPM)	4.14	4.04	.10	.118
37	Automation of Materials Handling	4.14	3.99	.16	.175
38	Value Analysis/Engineering	4.26	3.86	.40	.224 ^
39	Bar Coding	4.39	3.70	.69	.124
40	Benchmarking	4.36	3.79	.57	.266**
41	Subcontracting	3.97	3.84	.13	.076
42	Third-Party Logistics Services	3.74	3.75	-.01	.107
43	Modeling (Simulation, Queuing, Optimization)	3.41	3.73	-.32	.174

**p=.01; ^ p=.05

a more fluid or flexible set of service requirements, requiring logistics system adaptability to support evolving customer requirements.

Finally, the right-most column of Table 6 consists of data regarding the performance impact of the 43 logistics practices. Performance relationships were measured using the correlation coefficient between each logistics practice and a four-item performance construct. The four items included in the performance construct were overall competitive position and three-year averages for sales growth, market share growth, and growth in return on assets. The Cronbach's alpha score—a measure of internal consistency—for the performance construct was .89, indicating a high degree of construct reliability. Fifteen of the 43 logistics practices were significantly correlated with the performance construct at the $p=.05$ level. As already noted, several of these high-impact practices such as total cost management and benchmarking are not very highly implemented. Firms continue to have problems collecting data regarding all of the many logistics activities that comprise a complete, well-rounded measure of total costs. Interviews with several companies revealed that many use a simplified, three or four-item measure of total costs. While this simplified version of a total cost measure is useful for gauging total logistics costs, it does not provide the richness necessary for extensive trade-off analysis. Interviews also revealed that while some companies are aggressive benchmarkers, many others either place a priori confidence in their logistical abilities or find themselves too busy putting out day-to-

day fires to concentrate on benchmarking initiatives.

From a broader perspective, the correlation data suggest that a disconnect exists between the extent of implementation and the impact on performance. Indeed, the fifteen activities that are significantly correlated with performance have an average implementation rank of 20. That is, with the exception of inventory management, many of the more high impact logistics activities are not highly implemented. Many opportunities to enhance logistics competitive impact appear to exist. Based on the correlation analysis, these opportunities are concentrated in three areas: time-based competition, relationship building within the supply chain, and human resource development.

CONCLUSIONS AND IMPLICATIONS

Logistics strategy has taken on increased importance in today's rapidly globalizing marketplace. A unique opportunity for logistics to not only add value but to provide strategic leverage has been created by the combination of more intense competition, greater distances encountered in manufacturing and delivering products, and higher levels of environmental uncertainty. Given the number of logistics practices and techniques that have been introduced in recent years and the complexity of an intensely competitive world, managers can benefit from a decision framework that can help them design and implement more effective logistics

strategies. The desire to allocate scarce resources so that they deliver the greatest competitive impact increases the need for a useful planning framework. This research has explored the potential of the product life cycle to help logistics managers meet the planning needs of today's ever changing marketplace.

The findings from the empirical matching of logistics practices to PLC stages suggests that managers evaluate the appropriateness of logistics practices based on when a practice first becomes appropriate. Further, the fact that the majority of firms have products in different stages of the life cycle—all of which require logistics support—increases the difficulty of assigning any practice to a single life cycle stage. Nevertheless, the matching analysis provides a framework to guide strategy development and tactical practice.

- Logistics' involvement in the design and introduction stages currently focuses on helping design the service component of the product/service package. The key here is on the design of facilities and processes that will be used to deliver the product. The practices designated as appropriate at these early stages are consistent with concurrent or simultaneous engineering. Issues regarding initial product launch also require input from logistics managers. Overall, the responses suggest that logistics plays a tangential and parallel, rather than a central, role in these first two stages of the PLC. The importance of product development and launch to firm competitiveness highlights an opportunity

for logistics to become more involved in these early stages.

- Logistics' involvement in the growth stage is principally to assure widespread market coverage combined with rapid and responsive delivery service. From this perspective, logistics takes on the responsibility of helping the firm achieve a differential competitive advantage based on availability and service. Clearly, logistics becomes a vital component of the firm's product-market strategy during the growth stage.
- Logistics' involvement in the maturity stage changes rather noticeably with the new focus being on cost management. The data suggest that toward the end of the growth stage, the logistics infrastructure reaches a point where it is generally in place and ready to support continued steady-state operations. Once this point is reached, logistics practices are routinized to provide consistent, cost-effective service. While logistics efficiency is the primary driver of management practice during product maturity, the responses suggest that increasing efforts are being targeted at designing innovative service options to renew competitiveness and extend product life.
- Logistics' involvement in the decline stage is once again somewhat limited. Indeed, logistics initiatives during decline focus almost exclusively on minimizing costs, especially as product is withdrawn from

the market. The respondents suggested that minimal attention is given to strategically managing product once decline has become a reality.

The analysis of implementation status supported the notion that firms with products in different life cycle stages manage logistics practices differently. Firms in the growth stage emphasize techniques that help them get their products to market—where and when customers need them. The vital need is to be responsive in filling orders in a very dynamic and uncertain environment. That is, the firm needs to use logistics to achieve rapid and widespread geographic coverage without expending scarce resources that are needed to support the desired growth in market share. Firms in the maturity stage face continued demands for high-caliber delivery service coupled with the challenge of shrinking margins. To meet these logistics requirements, strategic efforts focus on

simplifying and standardizing the logistics support system. This routinization process is necessary to minimize cost while still providing expected service levels. In addition, the implementation status of the different logistics techniques highlighted the fact that logistics strategy must promote a process that leads to continual improvement in service-oriented capabilities, especially as they relate to delivery responsiveness at the lowest possible costs. Finally, the performance analysis reveals that new logistics trends, including cycle time compression and channel integration, are not only appropriate for today's shorter cycle times but also positively enhance firm performance.

Well-designed logistics strategies that recognize the influence of the product life cycle will be able to help firms meet the challenge of managing perpetual change to meet the emerging needs of world consumers.

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AUTHOR BIOGRAPHY

Stanley E. Fawcett is Professor of Global Supply Chain Management in the Marriott School at Brigham Young University. He received his Ph.D. from Arizona State University and taught for several years at Michigan State University before joining the faculty at the Marriott School. Stan has published numerous papers in leading logistics, operations, purchasing, and marketing journals. His research interests include international logistics, supply chain integration, and customer success.

AUTHOR BIOGRAPHY

Greg Magnan is an assistant professor in the Albers School of Management at the University of Seattle. He received his Ph.D. in operations management from Michigan State University. Greg has published articles in leading purchasing and operations journals. His research interests focus on strategic operations and supply chain management.

AUTHOR BIOGRAPHY

Laura Birou is an associate professor in the School of Business and Public Management at George Washington University. Laura received her Ph.D. from Michigan State University in purchasing and operations management. She is a frequent public speaker and author of several articles in purchasing and logistics management. Her research interests focus on strategic purchasing and supply chain management as well as ethics in materials management.

A FINANCIAL ANALYSIS OF THE INTERSTATE COMMERCE COMMISSION (ICC) TERMINATION ACT OF 1995 ON THE MOTOR CARRIER INDUSTRY

Joe B. Hanna
Auburn University

Robert A. Kunkel
University of Wisconsin-Oshkosh

Gregory A. Kuhlemeyer
University of Northern Colorado

Since the late 1970's the United States has progressively deregulated the motor carrier industry. Throughout the 1980's, deregulation was viewed as a positive trend by most industry practitioners. Past research has determined that, despite the fact that bankruptcies have increased since deregulation, the motor carrier industry has benefitted by less government intervention. The current study attempts to ascertain if motor carrier deregulation is still perceived positively in the mid-1990's. This research uses an event study methodology to examine the immediate financial impact of the ICC Termination Act of 1995 on 44 motor carrier industry participants. The results indicate deregulation is still perceived positively by shareholders as illustrated by the average publicly traded motor carrier benefitting by between \$1.25 million and \$6.1 million during the period surrounding termination of the Interstate Commerce Commission. In all likelihood, shareholders of companies in this industry benefitted due to the perception that industry deregulation leads to the ability to expand and pursue business opportunities previously restricted while operating under a more regulated regime.

INTRODUCTION

Prior to termination of the Interstate Commerce Commission, one of the primary responsibilities of the ICC was to observe surface transportation providers and monitor their

compliance with economic regulations. Primarily due to dramatic deregulation of U.S. surface transportation over the last twenty years, U.S. lawmakers determined the ICC was no longer necessary. As a result, the Interstate

Commerce Commission (ICC) was terminated effective January 1, 1996.

Considerable speculation exists in the transportation industry about the economic and/or strategic impacts associated with a public policy change like termination of the ICC. Past research into market structure has examined the impact of a public policy change on the strategies pursued by members of the transportation industry (Smith & Grimm 1987, Corsi & Grimm 1989). However the authors were unable to identify previous transportation research specifically examining the immediate financial impact created by a public policy change. Therefore the current research focuses on examining the immediate financial response experienced by publicly traded motor carriers when news of termination of the ICC was publicized.

BACKGROUND

Since the late 1970's a major trend in the United States has been to reduce or eliminate economic regulation in the transportation industry. During this era industry practitioners successfully argued that motor carrier regulation made entrance into the motor carrier industry extremely difficult and dramatically reduced or completely eliminated price competition and service enhancement (Chow 1980). As a result the ICC began to reduce enforcement of regulatory policies in the late 1970's (Pickett & Kletke 1984, Pustay 1985). In 1980 Congress responded to pressure to deregulate this mode of surface transportation by passing the Motor Carrier Act of 1980. The act dramatically reformed the regulatory structure of the motor carrier industry and began the process of restoring the industry to a free market.

Since passage of the Motor Carrier Act of 1980 the trend towards further deregulation of the

motor carrier industry has continued. Subsequent acts have facilitated the process of deregulation by abolishing additional regulations. The ICC Termination Act of 1995 was seen by many in the motor carrier industry as a continuation of the trend to reduce government intervention into private enterprise.

As recently as the mid-1990's industry participants have successfully argued that the federal government needs to continue the trend of deregulation. They argue that eliminating some existing regulations is necessary if the motor carrier industry is to operate in a totally free market environment. The ICC Termination Act of 1995 addressed several of the regulatory concerns of industry lobbyists by reducing or eliminating regulations perceived by many to be restrictive. A few key areas addressed in the 1995 ICC Termination Act include: elimination of restrictions on contract carriers, reduction in tariff filing requirements, and further reduction in rate regulation.

STUDY

Past research indicates that the net impact of motor carrier deregulation from 1980 to 1990 was positive (Winston, Corsi, Grimm & Evans, 1990). However, past research also indicates motor carrier deregulation has been a troublesome event for many as evidenced by the significant number of bankruptcies occurring in the years since industry deregulation began (Corsi, Grimm, Smith, & Smith 1991, Harper & Johnson 1987, LaLonde 1984-1985). Therefore, the current research attempts to determine if the trend toward motor carrier deregulation is still perceived positively in the mid-1990's. To accomplish this the researchers look at one specific public policy change (termination of the ICC) perceived by most industry observers and participants to be a move towards further deregulation. If this act of deregulation was

viewed favorably (unfavorably) by the motor carrier industry, then one should find that the stock prices of motor carriers increased (decreased) when it was announced that the ICC would be terminated. Focusing on the stock price reaction to the announcement of the ICC Termination Act will not only permit one to determine the response of the industry to deregulation, but it will also provide information on the financial benefits of deregulation.

DATA COLLECTION AND METHODOLOGY

Compared to previous studies examining the net impact of motor carrier deregulation, the methodology for this study is somewhat unique. Previous transportation studies have traditionally focused on the long-term financial performance of motor carriers subsequent to deregulation. While the traditional approach can provide researchers with valuable insight, there is no certainty the net change in financial performance is solely attributable to deregulation.

The purpose of the event study methodology is to determine whether motor carriers benefitted financially from the ICC Termination Act of 1995. More specifically, we examine stock price changes to determine the stock markets' response to the announcement that President Clinton signed the ICC Termination Act into law.¹ Concentrating on the stock price reaction to this announcement will not only allow us to determine the financial markets' immediate response to the ICC Termination Act, but it also allows us to examine the strategic implications for managers in the motor carrier industry. It is clear from previous research (Chow 1980) that it is costly for motor carriers to comply with governmental regulations. Previous research (Winston, Corsi, Grimm & Evans, 1990) has also shown that deregulation benefits motor carriers because it reduces the costly

burdens of governmental regulation. Our primary goal is to determine if there is an immediate and significant stock price reaction to passage of the ICC Termination Act and to examine the financial impact on industry participants.

We form a sample of motor carriers using the 1996 CRSP² database that includes firms that trade on the New York Stock Exchange (NYSE), the American Stock Exchange (AMEX), and the Nasdaq stock market. To be included in the sample, the firm's primary SIC code must be 4210 (trucking courier), 4213 (trucking, except local), or 4215 (courier services, except by air). Each motor carrier must also be publicly traded and have daily returns over an eleven-day event period. Furthermore, the motor carrier must not have had any major news announcement during the eleven-day event period.³

For each firm we search the *Wall Street Journal Index* for major news announcements to determine whether or not we have a clean event period. If there is another major announcement concerning a firm during this time period, then we do not have a clean event period and cannot determine the impact of the ICC Termination Act on that firm. If a clean event period can not be determined for a firm, it is eliminated from the sample. For example, assume a motor carrier firm received a large federal government contract on the same day it was announced that President Clinton signed the ICC Termination Act. If the firm's stock price increased drastically, the event study methodology cannot determine whether the increase was a result of the government contract or the ICC Termination Act. However, if there are no other major announcements during our event period, then our event study methodology can examine that portion of the stock's return that can be attributed to the ICC Termination Act and that portion attributable to the overall market.

TABLE 1
SAMPLE OF MOTOR CARRIERS, THEIR TICKER SYMBOLS, THE STOCK MARKET ON WHICH THE STOCK IS PUBLICLY TRADED, AND THE SIC CODES

Number	Name	Ticker	Market	SIC Code
1	3 C I Complete Compliance Corp	TCCC	Nasdaq	4210
2	Aasche Transportation Sves Inc	ASHE	Nasdaq	4210
3	Allied Holdings Inc	HAUL	Nasdaq	4210
4	American Freightways Corp	AFWY	Nasdaq	4210
5	Ampace Corp	PACE	Nasdaq	4210
6	Anuhco Inc	ANU	AMEX	4213
7	Arkansas Best Corp Del	ABFS	Nasdaq	4210
8	Arnold Industries Inc	AIND	Nasdaq	4210
9	Arrow Transportation Co	ARRW	Nasdaq	4210
10	Boyd Bros Transportation Inc	BOYD	Nasdaq	4210
11	Builders Transport Inc	TRUK	Nasdaq	4213
12	Cannon Express Inc	CANXA	Nasdaq	4210
13	Celadon Group Inc	CLDN	Nasdaq	4210
14	Consolidated Freightways Inc	CNF	NYSE	4213
15	Country Wide Transport Sves In	CWTS	Nasdaq	4210
16	Covenant Transport Inc	CVTI	Nasdaq	4210
17	F R P Properties Inc	FRPP	Nasdaq	4210
18	Frozen Food Express Inds Inc	FFEX	Nasdaq	4210
19	General Parcel Service Inc	GPSX	Nasdaq	4210
20	Heartland Express Inc	HTLD	Nasdaq	4210
21	Hunt J B Transport Services In	JBHT	Nasdaq	4213
22	Intrenet Inc	INET	Nasdaq	4210
23	K L L M Transport Sves Inc	KLLM	Nasdaq	4210
24	Kenan Transport Co	KTCO	Nasdaq	4210
25	Knight Transportation Inc	KNGT	Nasdaq	4210
26	Landair Services Inc	LAND	Nasdaq	4210
27	Landstar System Inc	LSTR	Nasdaq	4210
28	M S Carriers Inc	MSCA	Nasdaq	4210
29	Mark VII Inc	MVII	Nasdaq	4210
30	Marten Transport Ltd	MRTN	Nasdaq	4210
31	Matlack Systems Inc	MLK	NYSE	4213
32	MTL Inc	MTLI	Nasdaq	4210

Table 1
(continued)

Number	Name	Ticker	Market	SIC Code
33	O T R Express Inc	OTRX	Nasdaq	4210
34	Old Dominion Freight Line Inc	ODFL	Nasdaq	4210
35	P A M Transportation Sves Inc	PTSI	Nasdaq	4210
36	Simon Transportation Sves Inc	SIMN	Nasdaq	4210
37	Swift Transportation Co Inc	SWFT	Nasdaq	4210
38	Trism Inc	TRSM	Nasdaq	4210
39	U S 1 Industries Inc	USO	NYSE	4215
40	U S A Truck Inc	USAK	Nasdaq	4210
41	U S Environmental Solutions In	USES	Nasdaq	4210
42	U S Xpress Enterprises Inc	XPRSA	Nasdaq	4210
43	Werner Enterprises Inc	WERN	Nasdaq	4210
44	Yellow Corp	YELL	Nasdaq	4213

In addition, we also check for any industry announcement during this period that would contaminate the stock returns for all companies in the industry. No industry announcements were found during the eleven day period. Since no firm specific or industry wide announcements were made during the eleven days under study, our event study methodology can determine if there is an abnormal change in stock price that can be attributed to termination of the ICC.

Our sample includes 44 motor carriers that are listed in Table 1.⁴ Our sample includes three motor carriers that trade on the NYSE (Consolidated Freightways, US 1 Industries Inc., and Matlack Systems Inc.) and one motor carrier that trades on the AMEX (Anuhco Inc.). The other forty motor carriers trade on the Nasdaq stock market and include firms like J.B. Hunt, Werner Enterprises, Arnold Industries, Swift Transportation, Heartland Express, and Yellow Corporation. The mean capitalization value for the sample of motor carriers is \$151

million and the standard deviation is \$221 million.⁵ The median capitalization for the sample is \$66 million and the capitalization values range from \$3.3 million for Country Wide Transport to \$1.1 billion for Consolidated Freightways.

An event study methodology is used to examine the reaction of motor carriers' stock prices to the passage of the ICC Termination Act of 1995. The event study methodology is well established and commonly used to analyze the impact of an event on stock prices. The event study breaks the stock price change into two components. The first component is the stock price change that is a result of a general stock market price change. The second component is the stock price change that is a result of an informational event. In the current study the ICC Termination Act serves as the informational event. The first step of an event study is to define an event period that is usually centered on the announcement date which is called day zero ($t=0$). The announcement date in this study is

December 29, 1995, the date that *The Wall Street Journal* reported that President Clinton signed the ICC Termination Act into law.⁶ Since the event period should capture all the event's effects on stock prices, an eleven-day event period is often used. Day minus one, ($t=-1$), is defined as one trading day prior to the announcement, day plus one, ($t=1$), is one trading day after the announcement, and so forth. Thus, day minus five, ($t=-5$), is defined as five trading days prior to the announcement and day plus five, ($t=5$), is defined as five trading days after the announcement.

The next step of an event study is to calculate the predicted (or normal) return for each day in the event period for each firm. The predicted return is the return that would be expected if no event took place. Since the return on the market index is commonly used as the predicted return, we use the return on the S&P 500 Index as the predicted return.

The S&P 500 is a market index of 500 large domestic corporations whose market capitalization represent around 75% of all publicly traded corporations in the United States. Hence, the S&P 500 return is an excellent proxy for the market return. Then we calculate the daily excess return for each stock for each day over the eleven-day event period. An excess return represents that portion of a predicted return that is not due to overall market fluctuations, but is a result of the unique characteristics of the individual firm. The daily excess returns for each individual motor carrier i on day t , ER_{it} , is defined as:

$$ER_{it} = R_{it} - R_{mt} \quad (1)$$

where R_{it} is the return on the stock of motor carrier i on day t and R_{mt} is the return on the market portfolio (S&P 500 Index) on day t . The daily excess return represents the return that is not predicted by the overall market and is an

estimate of the change in the stock price on that day. By summing together the daily excess returns of the 44 motor carriers each day we can calculate the average excess return. The average excess return allows the creation of what can be viewed as a diversified portfolio with firms only within a specific industry. This diversified portfolio-like technique eliminates the unique individual firm returns by offsetting random positive stock return movements with random negative stock price movements. The result is an average excess return that captures only the unique characteristics of the ICC event under examination in this paper. The average excess return for each day of the event period is calculated as:

$$AER_t = \left[\sum_{i=1}^N ER_{it} \right] / N \quad (2)$$

where N is equal to 44, the number of motor carriers in our sample, and ER_{it} is the daily excess return for motor carrier i on day t . Any non-event or insignificant event should result in an AER_t that is not significantly different from zero. Statistical tests of significance are based on the Z statistic defined as:

$$Z_t = \sqrt{N_t} [AER_t / \delta_t] \quad (3)$$

where δ_t is the standard deviation of the daily excess returns on day t and N_t is equal to 44, the number of motor carriers in our sample, and AER_t is the average excess return for day t of the event period.

It is also important to examine the cumulative average excess return, CAER, because information is often leaked to the financial market just prior to the event's announcement and the market often takes several days to completely digest the financial impact of an event upon a firm's future financial performance as captured by the stock price.

The cumulative average excess return, $CAER_{-1,t}$, is defined as:

$$CAER_{-1,t} = \sum_{i=1}^T AER_i \quad (4)$$

where $CAER_{-1,t}$ is determined for a defined interval from day minus one to some day such as day zero ($CAER_{-1,0}$) or day plus five ($CAER_{-1,+5}$). The $CAER_{-1,t}$ is an estimate of the change in stock price that is caused by the event over a period of time. The market participants may quickly begin figuring into the stock price the effect of an anticipated, though unannounced, event. This typically happens the day before the announcement and the amount of change in the stock price is based on the perceived probability of the event occurring. The market will continue to make adjustments over several days following the announcement as analysts and market participants attempt to determine the magnitude of the event on each firm. For example, an announcement that one firm in an industry has much higher earnings than expected will drive up that company's stock price, but the full adjustment may take from hours to days for the market to digest. The smaller the firm the more likely it will take longer for the market to completely adjust and completely reflect the updated news about earnings.

The NASDAQ market is generally considered to trade smaller capitalized stocks whose prices would take slightly longer to adjust to an event. Since our sample has 40 of 44 firms that trade on the Nasdaq market, we expect that it may take several days for the market to completely price the event (termination of the ICC). For robustness and completeness, we examine the $CAER_{-1,t}$ over several different intervals. Again, any non-event period or an insignificant event period should result in a $CAER_{-1,t}$ that is not significantly different from zero. Statistical tests of significance are based on the Z statistic defined as:

$$Z_t = \sqrt{N_t} [CAER_{-1,t} / \delta_t] \quad (5)$$

where δ_t is the standard deviation the average excess returns over the interval, and N_t is equal to 44, the number of motor carriers in our sample, and $CAER_{-1,t}$ is the cumulative average excess return over the interval.

RESULTS

We examine the AERs of the entire sample for each of the eleven days and the CAERs over six time intervals. Table 2 presents the AERs for each day of the eleven-day event period. The AERs range from a low of -1.2% on day minus two to a high of 1.7% on day minus one. As expected, most days have positive AERs (days -3, -1, 0, 1, 2, 3, 4) and two of the seven days have significantly positive average excess returns (AER_{-1} at 1.7% and AER_3 at 1.0%).

The major tests in this methodology involve testing the CAERs over time intervals that allow the financial markets to decipher the effect of the passage of the ICC Termination Act on motor carriers. Thus, we examine the cumulative average excess return, $CAER_{-1,t}$, over six time intervals that are presented in Table 3. If the ICC Termination Act of 1995 is perceived as favorable by the stock market, then the CAERs should be significantly positive. Conversely, if the Act is perceived as unfavorable, then the $CAER_t$ should be significantly negative. The CAER for each time interval is positive (with $CAER_{-1,0}$ the lowest at 1.9% and $CAER_{-1,4}$ the highest at 4.1%). Additionally, every CAER is highly significant (with Z-statistics from 1.527 to 2.779). Thus, on average, motor carriers saw their stockholders' wealth increase somewhere between two and four percent when President Clinton signed the ICC Termination Act of 1995.

The next part of our analysis is to measure the dollar effect on motor carriers and these results are presented in Table 4. If we multiply the smallest cumulative average excess return, $CAER_{1,0}$, by the mean (median) capitalization value for the sample, we find that the average motor carrier gained over \$2.87 million (\$1.25 million) by President Clinton signing the bill. Conservatively, motor carriers gained between \$1.25 million and \$2.87 million when Clinton signed the ICC Termination Act. Applying the same method to the highest cumulative average excess return, $CAER_{1,4}$, we find that the average motor carrier gained over \$6.1 million (\$3.9

million). Thus, in the best case scenario, motor carriers may have gained between \$3.9 million and \$6.1 million with the passage of the ICC Termination Act. In addition to statistical significance, it is clear that the results are economically meaningful. Shareholders in the motor carrier industry economically benefitted dramatically from the passage of the ICC Termination Act. In fact, over the two- to seven-day event period window around which the bill was signed, the owners of these forty-four motor carriers cumulatively gained somewhere between \$55 million and \$272 million.

TABLE 2
AVERAGE EXCESS RETURNS (AER_t)

Day	AER_t	Z-Statistic ¹
-5	-0.479%	-0.470
-4	-1.190%	-1.077
-3	0.372%	0.500
-2	-1.225%	-1.768
-1	1.681%	1.529*
0	0.220%	0.341
1	0.178%	0.230
2	0.573%	0.772
3	1.037%	1.410*
4	0.389%	0.559
5	-0.251%	-0.380

¹ The Z-statistic is a test of the null hypothesis that the AER_t is significantly greater than zero.
***, **, * Denote significantly different from zero at the 1%, 5%, and 10% levels, respectively.

TABLE 3
CUMULATIVE AVERAGE EXCESS RETURNS (CAER_{-1,t})

Interval	CAER _{-1,t}	Z-Statistic ¹
(-1,5)	3.826%	2.482***
(-1,4)	4.078%	2.779***
(-1,3)	3.689%	2.588***
(-1,2)	2.652%	2.150**
(-1,1)	2.079%	1.527*
(-1,0)	1.901%	1.759**

¹ The Z-statistic is a test of the null hypothesis that the CAER_{-1,t} is significantly greater than zero.
***, **, * Denote significantly different from zero at the 1%, 5%, and 10% levels, respectively.

TABLE 4
**FINANCIAL GAINS TO OWNER'S OF MOTOR CARRIERS FROM THE PASSAGE OF THE
ICC TERMINATION ACT OF 1995 (DOLLAR FIGURES IN MILLIONS)**

Interval	CAER _{-1,t}	Average Motor Carrier Gain in Wealth using the Mean (Median) Cap Value ¹	Cumulative Wealth Gain for Industry using Mean (Median) Cap Value ²
(-1,5)	3.826%	\$5.788 (\$2.528)	\$254.7 (\$111.2)
(-1,4)	4.078%	\$6.169 (\$2.694)	\$271.5 (\$118.5)
(-1,3)	3.689%	\$5.581 (\$2.437)	\$245.6 (\$107.2)
(-1,2)	2.652%	\$4.012 (\$1.752)	\$176.5 (\$77.1)
(-1,1)	2.079%	\$3.145 (\$1.374)	\$138.4 (\$60.4)
(-1,0)	1.901%	\$2.876 (\$1.256)	\$126.5 (\$55.3)

¹ The average motor carrier gain in wealth using the mean cap value is calculated by multiplying the cumulative average excess return (CAER_{-1,t}) by \$151 million (\$66 million) which is the mean (median) cap value of the firms in our sample.

² The cumulative wealth gain for industry using the mean (median) cap value is calculated by multiplying the 44 firms in the sample by the average motor carrier gain using the mean (median) cap value.

MANAGERIAL IMPLICATIONS

"The essence of any applied discipline is to accumulate sufficient knowledge to guide practitioners toward successful achievement of their responsibilities" (World Class Logistics 1995). The current research attempts to assist practitioners in accumulating knowledge about the importance of a public policy change on their industry. Since government regulation is costly to motor carriers and deregulation is welcomed by the financial markets, these results have several implications for managers in the transportation industry.

The results of the current research illustrate that the shareholders of the average motor carrier gained between \$1.25 million and \$6.1 million with the passage of the ICC Termination Act. The positive stock price reaction to deregulation should clearly justify to transportation executives that they should consider providing significant resources to trade associations designed to pursue a free market agenda for the motor carrier industry. Motor carrier executives should also consider participating in an active coalition that meets annually with key Representatives and Senators in Washington.

Since the motor carrier industry as a whole recognizes significant gains from deregulation, the industry needs to participate in a coalition designed to work toward a common goal. Establishing a long-term coalition with other executives in the motor carrier industry could dramatically improve the industry's Congressional lobbying power in Washington. Effectively constructed coalitions can provide carriers with a long-term relationship where all the coalition members can benefit from the strong pursuit of further industry deregulation. The popularity of implementing coalition type relationships with other businesses appears to be rising as firms realize the high level of

achievement available by pooling resources with other companies and employing networking techniques.

Building coalitions and pooling resources with other carriers not only provides companies with a better resource base but also allows individual carriers to concentrate on specific lobbying efforts where they have developed an expertise. Properly designed, an effective coalition provides the industry with a powerful cohesive entity while at the same time allowing each participant of the coalition to utilize individual strengths to pursue specific goals. However, for the coalition to work effectively all of the members must feel each participant is willing to dedicate resources to the common efforts of the coalition.

Competition levels in the motor carrier industry have increased dramatically since deregulation (Harper 1982 & 1983). As the U.S. continues to pursue a strategy of industry deregulation it is likely that downward pressure will continue to be placed on prices. Downward pressure on prices often reduces profit margins and increases the importance of each carrier understanding their individual operating costs. In response to the changing operating environment management must have a strategy in place to continually track and monitor costs. Effective implementation of such a strategy allows managers to more accurately determine the costs associated with each movement and adjust the price when necessary.

CONCLUSIONS

Although the study only measures the financial gain to motor carriers by the passage of the ICC Termination Act of 1995, it should be pointed out that deregulation also produces financial gains for other stakeholders, including taxpayers, shippers, and consumers. Taxpayers who do not have to pay the cost of

operating unnecessary government agencies (e.g., ICC) realize a financial benefit since they are no longer required to fund the agency through Federal tax dollars. Customers (e.g., shippers and consumers) also benefit financially since deregulation tends to increase motor carrier service levels and decrease costs. The result is a better overall value for the many customers of the motor carrier industry.

Current participants in the motor carrier industry appear fully aware they may continue to face big adjustments in order to remain competitive in the aggressive environment created by further deregulation (Corsi, Grimm,

Smith, & Smith 1991). Nevertheless, it appears the trend towards industry deregulation is perceived positively by owners and stakeholders throughout the motor carrier industry. The results of our investigation indicate a strong positive reaction to deregulation. The forty-four publicly traded carriers in the current study gained an astonishing \$55 million to \$272 million over the period surrounding termination of the ICC. Therefore, the researchers conclude a strategy of continued deregulation is good for the motor carrier industry and should be pursued vigorously.

ENDNOTES

¹ There are two characteristics of stocks that allow one to examine the impact of an event on an industry or firm. First, stock prices are determined by a firm's expected future earnings. Second, stock prices react quickly and efficiently to news that will impact expected future earnings of the firm. Therefore the announcement of an event that is perceived by investors as favorable (unfavorable), to increase (decrease) future earnings, will result in an immediate stock price increase (decrease). Thus, examination of a firm's stock price reaction to an event via an event study methodology provides a venue by which managers can immediately gauge the expected economic impact on an industry or a firm.

² CRSP stands for the *Center for Research in Security Prices* and is located at the Graduate School of Business at the University of Chicago. The daily stock returns and the S&P 500 Index returns used in this study were also taken from the 1996 CRSP database.

³ Since the event window spans two years (December 21, 1995 through January 8, 1996), we searched the *Wall Street Journal Index* for 1995 and 1996 for major news announcements during the eleven-day event period.

⁴ There are initially 45 firms with primary SIC codes of 4210, 4213, and 4215. Thus, only Rollins Truck Leasing Corp. was deleted from the sample because it is primarily an equipment leasing company.

⁵ The capitalization value of a company represents the market value of its owners' equity. The capitalization value is calculated by multiplying the motor carrier's stock price by its number of shares outstanding. Our event study methodology measures the gain or loss to the capitalization value of motor carriers that can be attributed to the event examined.

⁶ The order of events leading up to the passage of the ICC Termination Act of 1995 is as follows. The House of Representatives passed their version of the bill in June 1995 and the Senate

passed their version in November 1995. Although the House and Senate both passed versions of the bill, President Clinton opposed the ICC Termination Act and according to the December 21, 1995 *Wall Street Journal*, Clinton threatened to veto the bill. This means that there was a clear signal sent to the financial markets that passage of the Act was unlikely. However, over the next week Clinton changed his position and signed the bill into law.

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APPENDIX

FIGURE 1: AERs and CAERs

AUTHOR BIOGRAPHY

Joe B. Hanna is an assistant professor of logistics at Auburn University. He holds a bachelor of accountancy, master of accountancy, and PhD. of business (logistics and marketing) from New Mexico State University. He has published in various academic journals and is coauthor of a Logistics textbook. Past employment includes experience in public accounting and several years with Phillips Petroleum Company.

AUTHOR BIOGRAPHY

Robert A. Kunkel is an associate professor of finance at the University of Wisconsin at Oshkosh. He holds a B.S. from the University of Illinois at Champaign, an M.B.A. from Western Illinois University, an M.A. in economics, and a Ph.D. in finance from The University of Tennessee at Knoxville. He has published in various academic journals and worked a number of years for Consolidated Freightways.

AUTHOR BIOGRAPHY

Gregory A. Kuhlemeyer is an assistant professor of finance at the University of Northern Colorado. He holds a bachelor in business from Western Illinois University, and a master of business administration and Ph.D. in finance from The University of Tennessee at Knoxville.

QUALITY ASSESSMENT AND IMPROVEMENT PRACTICES IN THE U.S. RAILROAD INDUSTRY

Joel D. Wisner
University of Nevada, Las Vegas

Michael C. Mejza
University of Nevada, Las Vegas

This article presents the findings of a comprehensive survey sent to members of the American Society of Transportation and Logistics. The survey investigated various elements of quality improvement programs in use among U.S. rail carriers, including program design and subsequent successes. Perhaps due to the heavy competition within the transportation industry, it was found that the vast majority of U.S. rail respondents did indeed utilize formal quality assessment and improvement programs, making this an interesting industry segment to study. The survey findings are summarized in the article.

INTRODUCTION

Competition in the U.S. among rail carriers and between rail and other modes of transportation has increased dramatically over the past twenty years, due in part to deregulation of the transportation industry, and more recently to the growing demands among shippers for intermodal and other transportation services (Assoc. of American Railroads 1998). Efforts to improve competitiveness, service, cost, and ultimately profit performance have led most railroads to consider their service capabilities and ways to improve or increase them.

Quality assessment and improvement efforts in the U.S. manufacturing sector have been the focus of many research efforts and the results achieved by these companies have been well documented (see for example Cusumano 1988; Finch 1986; Garvin 1983; Im and Lee 1989; Krafcik 1988). Conversely, research concerning quality assessment and improvement strategies of U.S. railroads has been quite limited, even though this industry is experiencing a substantial increase in service demands from shippers, and quality improvement efforts are prevalent throughout the industry.

In the transportation sector in general, and in particular the railroads, very little substantive research has appeared describing quality practices from the carriers' perspective. The objectives of our research were to review the relevant transportation and railroad-specific quality literature, address the apparent gap in the empirical quality improvement literature through use of a survey sent to railroads and other transportation companies, compare quality improvement practices within the railroad industry, and provide suitable benchmarks of quality improvement practices and programs to transportation company managers. Since service quality practices are somewhat generalizable, managers of all transportation companies should find the information useful. The survey utilized for this paper investigated various elements of the quality improvement programs and practices employed by rail carriers, the design of these programs, and the successes attributed to them. Related areas in need of further research are also discussed.

A REVIEW OF THE RELEVANT QUALITY IMPROVEMENT LITERATURE

To date, the few articles dealing with the subject of transportation quality, regardless of mode, have largely tended to be anecdotal, with little or no empirical data to accompany the discussions. In this review, articles discussing quality-related topics from the transportation industry in general will be reviewed first, followed by those more specific to the rail industry.

Service quality within the transportation industry in general has been the subject of several articles. Chow and Poist (1984) surveyed shippers to determine if and how they measured carrier service quality. They found six factors that many of the respondents measured and formally recorded

(transportation costs, freight loss and damage experience, claims processing experience, transit time reliability or consistency, experience with carrier in negotiating rate changes, and shipment tracing). Brown's (1989) conceptual article discussed the economic implications of freight service quality, namely that optimal service quality policies should minimize the sum of total shipping costs for both carriers and shippers.

Other research studied the service-intensive transportation requirements of Just-In-Time (JIT) manufacturers. Bagehi, Raghunathan, and Bardi (1987) compared JIT and non-JIT manufacturers and found that the JIT respondents placed significantly greater importance on the willingness to negotiate rate changes, equipment availability, frequency of service, shipment expediting, scheduling flexibility, and the willingness of carriers to negotiate service changes. In somewhat similar studies, Lieb and Millen (1988) and Harper and Goodner (1990) found more use of contract and common motor carriers, less use of rail, use of fewer carriers coupled with a greater requirement for on-time performance, greater responsiveness to short term needs, shipment tracing capabilities, greater use of specialized equipment, and more frequent communication among the JIT-oriented respondents. Perry (1988) looked at the distribution channels of a small number of JIT firms and found several common characteristics: substitution of transportation assets for inventory assets, more customized transportation systems, carrier contracting, and shipments scheduled for hour-of-day arrival instead of day-of-week. Higginson and Bookbinder (1990) described the impact of JIT requirements specifically on rail freight systems. Their "ideal JIT railroad" involved the use of dedicated intermodal equipment, proximity to TOFC (trailer-on-flatcar) terminals, use of EDI (electronic data interchange) devices, contract agreements with

buyers/shippers, and use of shipment consolidation/breakbulk services.

One study is conducted annually seeking the transportation quality or service assessments of shippers in each of six transportation categories, including rail. *Chilton's Distribution* (1998) asks shippers to rate various carriers on a number of quality-oriented characteristics. As in previous years, on-time performance and value or rates were seen as the two most important quality characteristics for rail shippers. Unfortunately, the assessment scores deteriorated in several of the categories for 1998.

To date, only a small group of articles have requested information directly from the railroads. Curtis (1984) described the use of quality circles (departmental employee groups meeting at regular intervals to solve work problems) at Milwaukee Road. Over the period of investigation, the railroad reported significant cost savings, combined with ultimately better labor/management cooperation and better quality of work life. Grimes (1989) described an information system to analyze service quality performance at railroads, that when properly used, could help measure service performance, identify service failures and their causes, and determine the impact of operating changes on service performance. Koot and Tyworth (1985) discussed the need for a track quality index to monitor the timing of track maintenance to reduce derailments. Carman (1993) presented a case study of Southern Pacific's use of continuous quality improvement since 1990. Their program involved getting top management commitment, use of performance information and benchmarking, developing and implementing action plans, and involving the unions.

While the previous research in this area has addressed numerous aspects of general transportation and railroad service quality, few articles have attempted to determine specific quality assessment or improvement practices among carriers, and in particular, among rail carriers. This research sought to fill this empirical gap in the literature by surveying current practices within the railroad industry in the area of quality assessment and improvement.

METHODOLOGY

A general transportation industry survey was designed to identify the types of transportation companies using formal quality improvement programs, the characteristics of these programs and the successes attributed to the use of these programs. The initial survey was pretested on a pilot sample of fifty transportation company managers (who were contacted using mailing lists obtained from the American Society of Transportation and Logistics and Delta Nu Alpha).

Based on feedback from the pretest, a revised survey was mailed to 851 transportation company members of AST&L (including thirty-one railroads, several with multiple regional offices). Efforts were made to delete non-transportation company members of the Society (for example transportation professors), and duplicate employees of the same local or regional transportation offices. Three complete mailings of the survey were conducted at approximately three week intervals. Survey recipients were asked to respond using the supplied, postage-paid envelopes and remain anonymous. The respondents were also offered a copy of the survey results in return for their participation. Most of the survey questions required either yes/no or 5-point interval scale

responses. Respondents were also encouraged to add other information to clarify their answers, if needed.

Ultimately, a total of 197 responses to the general transportation survey were received for a response rate of 23.1 percent. Of those, 47 responses were from rail carrier personnel. Forty-five or 95.7 percent of the rail carrier respondents reported the existence of formal quality assessment and improvement programs at their firm. These 45 responses provided the data for our study. Given the exploratory nature of this study and the length of the survey, the response rate was deemed acceptable and high enough to mitigate the bias potentially posed by the relatively small sample size of rail carriers. Again, it should be noted that multiple responses from different regional offices of the same rail carrier were most likely received. This was not seen as a problem considering that management perceptions are likely to vary from response to response, and also that regional offices are likely to have somewhat different operating characteristics and quality practices. Nonresponse bias was examined by comparing the surveys received from the first mailing to the surveys received from the second and third mailings (Armstrong and Overton 1977). No significant differences among the survey variables were found, therefore nonresponse bias was assumed to be minimal.

SURVEY RESULTS

The survey results revealed a number of interesting characteristics with respect to the design, use, and successes of the quality improvement programs used by railroads. A profile of the rail carrier respondents is presented first, followed by a description of the respondents' overall focus on quality and customers, descriptions of the respondents' formal quality improvement programs, and

finally, descriptions of the successes attributable to the quality improvement efforts of the rail carriers as well as the current status of the programs.

A Profile of the Railroad Respondents

Table 1 presents the profile information of the rail carrier respondents and their firms. Most respondents (over 74 percent) were either transportation/shipping managers or marketing/sales managers. The remaining respondents were either owners/CEOs or other (quality control managers, regional or district managers, or accounting/finance managers). Additionally, most of the rail respondents (93.6 percent) described themselves as *only* common carriers, while 6.4 percent said their firm offered common, contract, and private carrier services.

A wide range of firm size (based on annual sales) was also represented. Over 68 percent of the rail respondents worked for firms with annual sales of greater than \$1 billion while the remaining rail firms had annual sales ranging from \$5 million to \$1 billion. Thus, most of the respondents represented a number of the regional offices of the largest U.S. rail carriers.

The Respondents' Focus on Quality and Customers

Table 2 describes various aspects of the respondents' focus on quality and customer service. The survey asked if their firm had a formal quality improvement program and over 95 percent responded yes to this question. Another question sought to determine the nature of commitment to quality by asking respondents if their firm's mission statement contained any reference to quality goals. Again, a very large portion of the respondents (over 87 percent) stated their firm's mission statement did contain references to quality

TABLE 1
A PROFILE OF THE RAILROAD RESPONDENTS

	<u>Percent of Respondents</u>		<u>Percent of Respondents</u>
Respondent's Position with the Firm		Legal Status of Carrier	
Transportation/Shipping Mgr.	38.3	Common Carrier	93.6
Marketing/Sales Mgr.	36.2	Common/Contract/Private	6.4
Owner/President/CEO	10.6		
Other	14.9		
 Annual Sales (\$)			
Less than 5,000,000	0.0		
5,000,001-50,000,000	12.8		
50,000,001-250,000,000	2.1		
250,000,001-1 billion	14.9		
Greater than 1 billion	68.1		
No response	2.1		

goals. Given the economic problems faced by most railroads, these general findings are not surprising.

Periodically assessing customer satisfaction, either formally or informally, and then using the customer feedback information for designing operating improvements is considered a necessary and extremely effective method of achieving long term competitiveness in service organizations (see for example Nagel and Cilliers 1990; Parasuraman, Zeithaml, and Berry 1985). The remaining items in Table 2 refer to this aspect of service quality improvement. The results showed that all railroad respondents asked customers for feedback concerning quality at least sporadically. The responses were split fairly evenly between obtaining customer feedback either monthly to quarterly (40.4 percent) or semiannually to annually (42.5) percent. Significantly fewer respondents asked

customers for information more frequently (daily or weekly).

Respondents were also asked if and how their customer feedback information was analyzed. Most indicated they either tracked the information to note internal improvements over time (53.2 percent) or to compare it to industry benchmarks (42.6 percent). A small percentage of the respondents asked for customer feedback, but did no apparent analysis of the information. It is interesting that while most or all respondents evidently saw the value of customer feedback information, less than half perceived a need to compare customer service performance to the industry's best. Industry benchmarks help clarify a carrier's competitive positioning. Thus, a railroad not measuring performance against industry benchmarks could potentially perceive their service performance as excellent (by looking only at internal service performance over time), while

compared to industry competitors, it might be considered poor.

Finally, respondents were asked to categorize the type of customer feedback information obtained. The feedback information most often obtained was overall customer satisfaction (over 95 percent of the rail carrier respondents). Information on several other areas of concern was requested by significantly fewer respondent companies. These included delivery satisfaction, sales staff problems, pricing problems, staff promptness, and shipment tracking problems. Several remaining customer feedback items were requested even less often by the respondents. These included information request problems, ordering/contracting problems, staff helpfulness, and damage/loss claim satisfaction.

Based on the data presented in Table 2, almost all of the railroad respondents had a formal quality improvement program and most of the respondents had some level of commitment to assess and improve transportation quality.

The Formal Quality Improvement Programs

Table 3 describes the characteristics and elements of the formal quality improvement programs of the 45 railroad company respondents stating they had such a program. Most of these formal programs (over 64 percent) were quite new and had existed for fewer than four years. None of the respondents had quality improvement programs in place for more than ten years.

The survey asked a number of specific quality improvement program design questions. Interestingly, while most respondents had formal quality improvement programs, relatively few had designed their own programs (28.9 percent) and had chosen instead to purchase their program from an outside source

(over 62 percent). Using an outside source for the design of a quality improvement program could pose problems for firms, particularly when using "experts" unfamiliar with railroad industry practices and specific operating characteristics of the firm. When asked to describe where the responsibility for the education, planning, and control of quality resided in their firm, the responses were fairly closely divided between a centralized quality control department (57.8 percent) and decentralized responsibility among all departments (40 percent). Since customer request response time is seen as an important aspect of service quality, this finding suggests a need for greater departmental flexibility and control over responding to customer service requests and service quality needs.

Since, over time, employees can lose their enthusiasm for continued attention to service quality assessment and improvement, top management encouragement and support is generally recognized as being a key element in the initial and continued success of any quality improvement program. The railroad respondents with formal quality programs were asked to state the level of support given by top management to the ongoing operation of the firm's quality improvement program. It appeared that top management strongly supported quality improvement efforts in these companies. The average response was a 4.18 level of support on a scale of 1 to 5, with 5 corresponding to the highest level of support. The 4.18 level of support was found to be significantly greater than the scale midpoint of 3.0.

Finally, the survey sought to determine the importance of certain elements contained in the quality improvement programs. The 45 railroad respondents were asked to state an importance level for a number of potential program elements (in this case, a "1" corresponded to not

TABLE 2
RESPONDENTS' FOCUS ON QUALITY AND CUSTOMERS

	Percent of Respondents	Significance
Does Your Firm have a Formal Quality Improvement Program?		
Yes		
No	95.7	.000 ^a
	4.3	
Quality Goals		
Formally stated in mission	87.2	
Not formally stated in mission	12.8	.000 ^a
Frequency of Customer Feedback Request Concerning Quality		
Semiannually-annually	42.5	.01 ^a
Monthly-quarterly	40.4	
Daily-weekly	8.5	
Sporadically	8.5	
Never	0.0	
Analysis of Customer Feedback Information		
Tracked to note improvements	53.2	.01 ^a
Tracked and compared to industry benchmarks	42.6	
Obtained but not tracked/compared	4.3	
Not obtained	0.0	
Feedback Information Requested From Customers		
Overall satisfaction	95.7	.01 ^a
Delivery satisfaction	80.9	
Sales staff problems	80.9	
Pricing problems	74.5	
Staff promptness	72.3	
Shipment/tracking problems	68.1	
Information request problems	63.8	
Ordering/contracting problems	63.8	
Staff helpfulness	61.7	
Damage/loss claim satisfaction	59.6	
Service flexibility problems	55.3	
Shipment damage/loss problems	53.2	
Expediting problems	48.9	

^a Significance level is based on a t-test of equal response rates.

^b No significant differences in response rates were found among bracketed items using t-test comparisons at the .01 significance level.

important and a "5" corresponded to very important). Four elements that received importance averages significantly greater than 4.0 were continuous quality improvement efforts, obtaining customer feedback, using quality measurements, and finding the root causes of poor quality.

A second group of elements were found to be slightly lower in importance (statistically equivalent to an importance level of 4). These elements were instituting quality awareness training, the ongoing commitment of top management, using quality goals and standards, decentralizing the responsibility for quality,

using quality circles or teams, benchmarking quality performance, empowering workers, facilitating mutual respect between workers and managers, using statistical quality control techniques, and determining the costs of quality.

A third, somewhat less important element (an importance level significantly greater than 3.0, but less than 4.0) was the use of non-monetary rewards for quality improvements. Elements seen by the respondents as only moderately important were the use of Deming's 14 quality principles, the use of the Baldrige Quality Award criteria to assess quality improvement efforts, and finally, using monetary rewards for quality improvements. Unfortunately, while the literature is filled with examples of firms adhering to Deming's quality principles and using the Baldrige Quality Award application as a self-assessment tool, these practices have yet to find themselves as popular within the rail carrier sector.

The Performance of the Formal Quality Improvement Programs

The 45 rail carrier respondents with formal quality improvement programs were also asked several questions pertaining to the performance characteristics and success of their quality programs. These responses are summarized in Table 4. When asked to assess the relationship between their quality program and various performance changes, respondents indicated improvements in competitiveness, customer service, on-time deliveries, expectations of future sales growth and equipment utilization were strongly related to their firm's quality program. These performance characteristics were found to be statistically equivalent to 4.0 on a 5-point interval scale.

Six other performance improvements were found to be more than moderately related to the quality improvement programs of the respondents (significantly greater than 3.0, but less than 4.0).

These were decreases in customer complaints, late deliveries and damage/loss claims, and increases in the number of services offered, sales and employee productivity.

A third group of thirteen performance characteristics were found to be moderately related to the quality improvement programs (statistically equivalent to 3.0). These included increased preventive maintenance, profits, JIT capabilities, use of automation, shipment tracking ability, tonnage shipped, employee morale, and partnership agreements with competitors. Thus, firms seeking to begin measuring service quality performance should consider using some or all of these elements.

Another survey question asked the respondents with formal quality improvement programs to compare the current level of success of their quality programs to their initial expectations. The results here were somewhat mixed. While most of the respondents (86.7 percent) thought their programs met at least some of their initial expectations, only about one-third of the respondents felt their programs had met most, all or exceeded initial expectations. This suggests some need for improvement in the quality programs themselves, or that perhaps many managers' initial expectations were simply unrealistic.

The railroad respondents were also asked if the costs of their quality improvement programs were being recovered by either decreases in firmwide operating costs or increases in revenue as a result of implementing the quality programs. An impressively large portion (over 77 percent) said program costs were being recovered. This information could potentially be useful for managers seeking to justify the investment of resources to improve quality.

Finally, the 45 railroad respondents were asked if the emphasis on transportation quality at their organization was increasing, decreasing,

TABLE 3
THE FORMAL QUALITY IMPROVEMENT PROGRAMS^a

	<u>Percent of</u> <u>Respondents</u>	<u>Sig.</u>	<u>Perceived Importance of</u> <u>Quality program Elements</u>	<u>Importance^e</u>
Number of Years Program in Use				
0-2	15.6	.000 ^b	Continuous quality improvement	4.52
3-4	48.9		Customer feedback	4.52
5-6	24.4		Quality measurement	4.39
7-10	11.1		Finding the root causes for poor	4.36
Greater than 10	0.0		Quality	
Overall Design of Program			Improving worker quality	
Purchased from outside source	62.2	.017 ^c	awareness through training	4.28
Designed in-house	28.9		Top management commitment	4.27
Combination of the above	8.9		Quality goals/standards	4.11
			Making each dept. responsible	4.09
			for quality in their area	
Responsibility for Quality			Quality circles/teams	4.09
Education, Planning & Control			Benchmarking performance to	4.07
Centralized in one quality dept.	57.8	.232 ^d	the best in the industry	
Decentralized among all depts.	40.0		Worker empowerment	3.93
Combined central /decentral.	2.2		Facilitating mutual respect	3.74
			between workers and managers	
			Statistical quality control	3.74
			Determining the costs of quality	3.74
Top Management Support			Non-monetary rewards to quality	
Given to Quality Program	4.18	.000 ^f	Improvements	3.48
			Deming's 14 quality principles	3.26
			Baldrige Quality Award criteria	3.21
			Monetary rewards for quality	2.93
			Improvement	

^aThe results shown refer to the 45 respondents stating that they had a formal quality improvement program.

^bSignificance level is based on a t-test of equal response rates for 0-4 years versus greater than 4 years.

^cSignificance level is based on a t-test of equal response rates for in-house versus outside design.

^dSignificance level is based on a t-test of equal response rates for centralized versus decentralized responsibility.

^eScale: 1 = very low support, 3 = moderate support, 5 = very high support.

^fSignificance level is based on a t-test of the sample mean against the scale midpoint of 3.0.

^gScale: 1 = not important, 3 = moderately important, 5 = very important.

^hBracketed sample means were significantly greater than 4.0 in t-test at a significance level of .01.

ⁱBracketed sample means were not significantly different from 4.0 in t-test at a significance level of .01.

^jBracketed sample means were not significantly different from 3.0 in t-test at a significance level of .01.

TABLE 4
PERFORMANCE OF THE QUALITY IMPROVEMENT PROGRAMS^a

Performance Characteristics	Relationship to Quality Program ^b		Percent of Respondents
Increased competitiveness	4.00	c	Program Success in Relation to Initial Expectations Met some expectations 53.3 Met most or all expectations 26.7 Met few expectations 13.3 Exceeded all expectations 6.7 Met no expectations 0.0
Increased customer service	3.95		
Increased on-time deliveries	3.89		
Increased expectations of future sales growth	3.74		
Increased equipment utilization	3.74		
Decreased customer complaints	3.59	d	Are Costs of Program Being Recovered by Success Factors? Yes 77.8 No 15.6 No response 6.7
Decreased late deliveries	3.58		
Increased number of services	3.55		
Decreased damage/loss claims	3.42		
Increased sales	3.40		
Increased employee productivity	3.40	e	Current Emphasis on Transportation Quality Increasing 68.9 Staying the same 22.2 Decreasing 8.9
Increased preventative maintenance	3.39		
Increased profits	3.39		
Increased JIT capabilities	3.29		
Increased use of automation	3.29		
Increased tracking ability	3.26	f	
Increased tonnage shipped	3.24		
Increased employee morale	3.22		
Increased "partnership" agreements with competitors	3.12		
Decreased average shipping time	2.93		
Decreased inventory costs	2.83	g	
Decreased shipping costs	2.77		
Increased backhauls	2.72		
Increased employee pay/benefits	2.68		
Increased use of third party services or agents	2.09		
Decreased use of third party services or agents	1.92		

^a The results shown refer to the 45 respondents stating that they had a formal quality improvement program.

^b Scale: 1 = not related, 3 = moderately related, 5 = highly related.

^c Bracketed sample means were not significantly different from 4.0 in t-test at a significance level of .01.

^d Bracketed sample means were significantly greater than 3.0 in t-test at a significance level of .01.

^e Bracketed sample means were not significantly different from 3.0 in t-test at a significance level of .01.

^f Bracketed sample means were significantly less than 3.0 in t-test at a significance level of .01.

^g No significant differences in response rates were found among bracketed items using t-test comparisons at the .01 significance level.

or staying about the same. Over 68 percent of the respondents said the emphasis on transportation quality at their firm was

increasing. Only 8.9 percent said the emphasis on quality was decreasing.

CONCLUSIONS

Based on these findings, it appears that most railroad companies have implemented formal quality assessment and improvement programs and are considering and formulating strategies to improve service quality. Thus, quality improvement efforts appear to be recognized as an important element in the quest to remain competitive or increase competitiveness. Most of the programs identified here were also experiencing at least partial success compared to initial expectations. This finding, coupled with the finding that many quality programs were less than four years old, indicates that many programs may have yet to reach their full potential.

The commitment to quality is characterized in our railroad sample by a widespread implementation of formal quality improvement programs, a high level of top management support, quality-oriented statements in company mission statements, the extensive use of customer feedback information, continuous efforts to improve quality, use of quality measurements throughout the organization, continuous efforts to find the root causes for poor quality and a generally increasing emphasis on transportation quality assessment and improvement.

Continuous quality improvement efforts and obtaining customer feedback information are considered the most important elements of the formal quality improvement programs. Respondents also felt that the improvements in competitiveness, customer service, on-time deliveries, expectations of future sales growth and equipment utilization were strongly related to their quality improvement program's existence.

Areas perhaps in need of additional emphasis by these quality programs include the use of a

quality improvement reward or motivation system, the integration of quality philosophies and performance criteria (for example, the philosophies of W.E. Deming and the Baldrige Quality Award criteria) into the programs themselves, and the decentralization of responsibility for quality improvement among the entire organization. It was interesting to note that while the respondents perceived the decentralization of responsibility for quality improvement as important, a large percentage of the respondent firms (40 percent) were not employing this practice.

Based on the apparent successes of the railroad respondents summarized in this article, other transportation industry practitioners should consider increasing their efforts in the area of quality improvement. It is hoped that this information will provide some direction to those companies seeking to gather information and justification for such programs.

While the findings here are generalizable to a large degree over the rail carrier sector, more detailed studies within this and other transportation modes remain to be performed. Transportation researchers might consider addressing the other modes of transportation or specific regional rail carriers or multimodal carriers. One limitation of this study was the relatively small number of railroad respondents. This limitation precluded more detailed analyses comparing, for instance, differences between carrier size, or geographic region of operations. Additionally, comparisons of transportation customer or shipper expectations and transportation company service quality offerings would be beneficial to identify performance gaps that should become the focus for further transportation quality improvement efforts.

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AUTHOR BIOGRAPHY

Joel D. Wisner, CTL, C.P.M., PE is an associate professor of management at the University of Nevada, Las Vegas. He received his PhD in operations management and logistics from Arizona State University in 1991. Dr. Wisner's research interests are in the area of quality management in purchasing, transportation, and operations. His articles have appeared in numerous journals including *European Journal of Purchasing and Supply Management*, *International Journal of Purchasing and Materials Management*, *International Journal of Quality and Reliability Management*, *Journal of Business Logistics*, *Journal of Transportation*, and *Production and Operations Management*.

AUTHOR BIOGRAPHY

Michael C. Mejza is an assistant professor of marketing at the University of Nevada, Las Vegas. He received his PhD in transportation and logistics from the University of Maryland in 1998. His current research interests include transportation quality and safety, and service industry logistics.

THE ROLE OF TRANSPORTATION IN CUSTOMIZED SUPPLY CHAINS

Remko I. van Hoek

Cranfield School of Management, UK, University of Ghent, Belgium, and
Erasmus University Rotterdam, the Netherlands

This paper empirically explores the role of transportation in creating a customized supply chain using postponement. Based on a survey among manufacturers in three countries, it was found that a reconfiguration is needed for the creation of a customized supply chain. In this reconfiguration process, transportation considerations are extremely important, resulting in supply chains and distribution channels that are globalized and reliant on international transport. Postponement is increasingly applied in both manufacturing and distribution. Thus, through the facilitation of postponement and customization activities in the distribution channel, much business is to be gained for transportation and logistics companies.

INTRODUCTION

Mass customization is argued to be a "new competitive paradigm" (Kotha 1995). Numerous authors have stressed the importance of interactively marketing and manufacturing products (McKenna 1995) and customizing products in response to individual customer orders, while retaining cost effectiveness in operations (Pine 1993; Gilmore and Pine 1997). For this mass customization of products, the supply chain has to be organized in such a manner that it allows for customer responsive and cost competitive operations (Kotha 1995; Feitzinger and Lee 1997). Bundles of supplementary services such as customer-specific product configuration, the adding of product features or specific packages and product displays are often used to customize product/service offerings (Anderson and Narus 1995). Postponing product finalization is also

used for achieving customization. Having postponed final assembly, configuration, or even packaging, allows a company to be more able to align products and shipments to the individual customer (Feitzinger and Lee 1997). Pine (1993) stated that modularizing products into generic components and assembling them into customer specific products is one of the best methods for realizing mass customization. Also, Lampel and Mintzberg (1996) state that, to achieve customization, varying activities in the supply chain may be customized and postponed, and others may be standardized.

Postponement is the concept that centers around the delay of activities in the supply chain until customer orders are received. These activities can include, as mentioned, shipment and packaging, but also assembly and even procurement. Postponing these activities allows them to be customized for specific customers. In

order to assure speed of delivery and interaction with customers, the postponed activities are often positioned close to the final market. This brings us to the role of transportation.

One of the consequences of this development is that customization is increasingly performed in the distribution channel. Daugherty et al. (1992), state that a number of activities can be placed in the distribution channel in order to contribute to the offering of customized services at competitive cost levels to the end-customer in the supply chain. In the distribution channel, displays can be assembled, customized delivery services can be offered and products can even be assembled to order. This is confirmed by the CLM (1995) which states that the application of postponement operations has increased over a five year period. Further, Morehouse and Bowersox (1995) state that, at least in food supply chains, postponement is increasing. In particular they predict that by the year 2010 no less than half of all stock will be stored until final customer specifications have been received and goods can be finalized and packed for shipment.

With these customizing activities placed in the distribution channel, it is not surprising that third party logistics services providers and transport companies consider these as a viable extension of their service offerings. Third party logistics service providers have, by operating warehouses and transportation systems for manufacturers, successfully earned a position in distribution channel operations. Cooper et al. (1998) mention the facilitation of postponement as one of the possible contributions of transport companies to supply chain management.

Based upon the above reflections in literature, the objective of this paper is to empirically explore the role of transportation in the development of customized supply chains using

postponement. The main question for this study is *what is the role of transportation in a customized supply chain*. Specific research questions are:

- To what extent is postponement applied in the distribution channel,
- What is the role of transportation in structuring a customized supply chain,
- What is the structure of the transportation and distribution channel in a customized supply chain,
- What are the roles of transport companies and logistics service providers in performing customizing activities in a customized supply chain.

The objective is to contribute to a further understanding of mass customization and postponement from a transportation angle, and to contribute to an understanding of the role of transport companies and logistics service providers in facilitating postponement and mass customization. The next section will outline the survey methodology used in this study. Results will then be presented, including applications of postponement, considerations used in structuring the customized supply chain, the structure of the customized supply chain, and the role of transport companies and logistics service providers in performing customizing activities. The final section will draw conclusions and reflect on the implications of these findings.

METHOD

An international survey was conducted among internationally operating manufacturers in the Netherlands, Germany and Belgium. Four industries were selected for the study: electronics, automotive supply, clothing and

food. The four selected industries also represent theoretical categories of postponement applications mentioned by Cooper (1993) (see Figure 1). Cooper uses a set of operational characteristics as criteria for assessing the viability of different types of postponement. The postponement applications range from postponed distribution from a global factory (on the left) through postponed assembly and postponed final manufacturing in a warehouse or European factory to postponed packaging in a regional warehouse (on the right). For all structures a global brand is needed. For products with varied peripherals (such as packages and labels) postponed assembly or packaging may be viable. For products with varied formulation (such as different voltages or product form and function) bundled manufacturing and deferred assembly may be viable, resulting in significant customization through product formulation. The electronics and automotive industries can be positioned in these segments, while the clothing industry fits in both the unicentric and deferred packaging application. Food fits into the deferred packaging application due to its homogenous product formulation and variations in peripherals (packages etc.), resulting in customization at a lower level. In studying these industries, the intent was to be able to assess a broad spectrum of postponement applications in the context of customization.

The questionnaire used in the study was developed through a search for items in the literature and discussions with a steering group of funding companies in the logistics business. The questionnaire was then tested in 25 interviews in the three countries. Based upon the remarks of experts interviewed, several

non-relevant items were deleted and missing items were added. The survey was mailed to 520 companies in the Netherlands. After one follow-up mailing, 78 companies responded (15%). In Belgium and Germany, 71 companies responded to the first mailing to 1450 companies. As a result of the low response rate in Belgium and Germany, the analysis in the following sections will concentrate on Dutch respondents. German and Belgian responses will be used, however, as a reference. The low response level of course does not allow for statistical comparisons of differences between the three countries.

THE APPLICATION OF POSTPONEMENT IN THE DISTRIBUTION CHANNEL

Figure 2 shows the level at which postponement is applied in the supply chains studied. Postponement was measured along the supply chain, from engineering to distribution, without limiting the measurement to manufacturing as done in Dröge et al. (1995). Lampel and Mintzberg (1996) state that customization can be applied throughout the entire supply chain. Respondents were asked to specify the share of activities, out of the total of annual orders, that are performed based upon customer orders. This allowed for precise measurement of the level in the chain at which postponement is applied and the extent to which it is applied at this level. The reasoning behind this measurement was that postponement can not only be applied at multiple levels in the chain, but also to varying degrees (van Hoek 1998).

Figure 2 displays the average levels at which postponement is applied throughout the supply chain. On average, 44.05% of activities are postponed, with a concentration in the

FIGURE 1
THE SELECTION OF SUPPLY CHAINS TO BE STUDIED

	Unicentric Central production & distribution	Bundled manufacturing Design product so that customization can take place at the latest possible stage of production process	Deferred assembly Final assembly and final configuration in central warehouses	Deferred packaging Labeling and packaging at regional warehouses
Brand: is it global?	Yes	Yes	Yes	Yes
Formulation: is it common to all markets?	Yes	No	No	Yes
Peripherals: are they common to all markets?	Yes	Yes	No	No
Spatial position of final manufacturing	Global plant	Europlant	European Distribution center	Regional warehouse
Chains in this study:	Clothing	Electronics/ automotive	Electronics/ automotive	Food/ clothing

Source: adapted from Cooper (1993)

FIGURE 2
THE APPLICATION OF POSTPONEMENT

downstream stages of the chain. Distribution and final manufacturing activities are postponed to a larger extent than purchasing and primary manufacturing. Thus, distribution plays an important role in the application of postponement. Tables 1 to 3 further detail the findings. Table 1 displays the postponement applications across the industries studied. For the measurement of postponement, both the single items and a multi-item construct containing all the postponement applications in the survey (with a reliability of alpha 0.89) were used. The single items reflect specific postponement applications, whereas the construct is used to reflect the overall application along the supply chain.

Comparing average levels, the electronics and automotive supply chains apply postponement at higher levels, and food and clothing at lower levels, than the average of 44.05%. The levels of application were compared using oneway Anova. Consistent with the reasoning of Cooper (1993), it was found that the electronics and automotive supply chains also apply postponement at a higher level in the upstream stages of the supply chain, resulting in higher levels of customization at a product formulation level. No significant difference was found for peripherals (packaging, labeling and documents) and distribution postponement, despite the higher levels of application in electronics (excluding distribution) and automotive. Apparently electronics and automotive supply respondents outscore food and clothing respondents in the application of postponement along the entire supply chain.

Table 2 displays the application of postponement through time and compares the application by Dutch respondents with that of Belgian and German respondents. Respondents were asked to specify the application of postponement along the supply chain three years ago to the expected application three years from now, and in comparison with the current application. The general pattern displayed in the table is one in which postponement increases for each of the activities in the supply chain over time and in each of the countries studied. A slight difference is found in the application of postponement across the countries studied, in favor of Belgian and German respondents. These figures, however, should be interpreted with some caution, as the response rates differ between countries.

Respondents were then asked which activities are used to customize products in the supply chain. It was found that manufacturing activities, such as final assembly and the adding of product features, score high. These findings shed some additional light on the findings presented in Figure 2 and Table 2. Even though it was found that international distribution is postponed at the highest level in the supply chain (products are shipped based on customer orders), final manufacturing activities are most important in customizing products. Thus, distribution plays an important role in postponement, but for customization manufacturing is most relevant.

TABLE 1
THE APPLICATION OF POSTPONEMENT IN TOTAL AND BY INUSTRY
(% OF ANNUAL ORDERS)

	Electronics	Automotive	Food	Clothing	Other	Significance	Total average
Postponed product engineering	59.62	51.25	19.00	13.20	61.43	<0.01	37.49
Postponed purchasing	51.56	60.63	18.41	44.29	45.00	<0.01	37.42
Postponed primary production	54.86	55.63	21.65	24.80	63.33	<0.05	39.55
Postponed final manufacturing	71.00	71.88	29.68	30.57	66.67	<0.01	50.12
Postponed peripheral activities	71.07	52.14	45.92	36.00	67.50	n.s.	53.95
Postponed international distribution	47.00	72.14	57.83	53.80	55.00	n.s.	56.93
Postponement (overall average)	51.67	57.98	34.34	10.94	66.25	<0.10	44.05

Key: One-way Anova analysis

TABLE 2
THE DEVELOPMENT OF POSTPONEMENT OVER TIME AND BY COUNTRY
(% OF ANNUAL ORDERS)

	Past (3 years ago)		Present		Future (in 3 years)	
	NL	Bl & Germ	NL	Bl & Germ	NL	Bl & Germ
Postponed engineering	34.91	36.25	37.49	38.92	41.39	41.51
Postponed purchasing	33.89	40.44	37.42	43.08	40.76	44.96
Postponed primary production	38.00	36.88	39.55	38.86	40.31	39.85
Postponed final manufacturing	46.27	53.21	50.12	58.88	53.29	60.89
Postponed peripheral activities	49.73	54.69	53.95	62.27	58.02	64.25
Postponed international distribution	52.50	50.40	56.93	58.88	59.88	58.44

TRANSPORT CONSIDERATIONS IN THE CUSTOMIZED SUPPLY CHAIN

Lee, et al. (1993), explain how the implementation of postponed manufacturing at Hewlett Packard involved a reconfiguration of the supply chain. Final manufacturing activities were relocated downstream in the chain, closer to market areas. Also, cross-functional relations may have to be reshaped. Pine (1993) outlines how sourcing, production and logistics are involved in performing modular production, with the intention of better serving marketing objectives. Production now becomes a

significant marketing function and production activities are performed in the distribution channel. The creation of a customized supply chain, using postponement, thus requires structural reconfiguration along the supply chain. In fact, the structural reconfiguration requirements can be expected to hamper the effectiveness of postponement implementation programs (van Hoek et al. 1998).

In order to assess the role of transportation in the reconfiguration of the supply chain, respondents were asked to specify which considerations are critical for them in

structuring the supply chain. Considerations along the entire supply chain, from sourcing to distribution, were used, given that postponement involves cross-functional input. Also, this allows for the comparison of the relevance respondents assign to transportation considerations, in comparison with the relevance they assign to non-transportation considerations. Table 3 lists a set of considerations expected to be relevant in structuring the supply chain in general. The items include supply (product availability, JIT supplies etc.), manufacturing (manufacturing costs, responsiveness regarding order-quantities), logistics (costs of storing finished goods, delivery reliability) and transport and distribution considerations. On a seven point Likert scale (from not important in structuring the supply chain to very important in structuring the supply chain), customer service considerations (consistency and reliability of delivery, speed of delivery, and product availability) are ranked highest. These considerations have a clear transportation and distribution dimension attached to them. Speed, consistency, and reliability of delivery along the supply chain, including that of suppliers, are top considerations in structuring the supply chain.

In order to assess the specific relevance and role of these considerations in the context of customization, the correlation coefficients between these items and the application of postponement were calculated. Negative relations were found between the application of postponement and the importance of freshness, prevention of economic obsolescence of products, responsiveness in ordering quantities, cost of storing finished goods and costs of physical distribution. This final point suggests that transport considerations are less relevant in the context of postponement. On the other hand, positive correlation coefficients were found between the application of postponement

and responsiveness in product specification, a high frequency and delivery speed of suppliers, import duties and global sourcing considerations. Whereas responsiveness in order quantities is negatively related to postponement, responsiveness in product specification is positively related to postponement. Apparently, it is not so much the volume as it is the product formulation and the presentation that is customized through postponement. Whereas physical distribution costs are not a leading consideration in the sphere of postponement, supplier distribution performance is. This is reasonable, based on the notion that postponing (final-) manufacturing results in order-driven manufacturing, as opposed to storage of finished goods. The postponement of manufacturing makes the delivery of parts and components a critical success factor in meeting the required lead-times. Unavailability of parts will result in back-orders and lowered customer service levels to final customers. Additionally, the application of postponement is positively related to sourcing from third parties. Other distribution related considerations are import duties and global sourcing structures. Importing parts and modules instead of finished products in a postponement system allows for avoidance of duties as lower value goods are imported.

THE STRUCTURE OF THE DISTRIBUTION CHANNEL

The reconfiguration of the supply chain needed for the implementation of postponement involves a spatial element, in that activities are relocated in the supply chain. In the example of Hewlett-Packard (Lee et al. 1993), final manufacturing activities were decentralized, moving downstream in the supply chain. Alternatively, the implementation of postponement can involve the centralization of inventories, combined with a relocation of other

TABLE 3
AVERAGE IMPORTANCE OF CONSIDERATIONS IN STRUCTURING
THE SUPPLY CHAIN BY COUNTRY

	NL	Bl & Germ
Delivery-reliability of suppliers	6.43	6.14
Consistency, reliability of delivery (maintaining promised schedule)	6.21	6.32
Lead/delivery time (speed)	6.08	6.15
Delivery speed of suppliers	5.93	5.58
Product availability	5.82	5.71
High percentage of inputs is purchased from third party suppliers	5.70	4.57
Flexibility regarding required lead times	5.68	5.89
Responsiveness regarding product specification	5.51	5.78
Manufacturing costs (including labor)	5.44	5.56
Responsiveness regarding order quantities (volume-flexibility)	5.44	5.45
Low cost of suppliers	5.43	5.14
Costs of storing finished goods	5.43	4.48
JIT-supply	5.16	4.66
Physical distribution costs	4.85	4.70
High frequency supply (by external parties)	4.81	4.62
Preventing economic product obsolescence	4.36	3.50
Costs of storing semi-finished goods	4.16	3.80
Import duties/preferential duty systems	3.49	2.84
Freshness of product (technical/economical)	3.42	4.12

Key: mean scores on a Likert scale from 1 (not important at all) to 7 (very important)

activities in the supply chain, including sourcing (directly to the distribution center) and distribution (van Hoek 1998). This suggests that not only the spatial structure of the distribution channel is affected, but that wider segments of the supply chain may have to be restructured to create a customized supply chain.

Table 4 lists average levels of centralization for activities along the entire supply chain in countries studied and over time. Given the potential impact of spatial restructuring throughout the entire supply chain, the question

was not limited to distribution only. Respondents were asked to specify the level of centralization on a four point scale for activities along the supply chain. Table 6 indicates how centralization is increasing for most activities along the supply chain, not just for distribution. This indicates how supply chains are globalizing and that transportation, like the distribution channel is, as a logical consequence, becoming more and more international throughout the entire supply chain. With the advance of globalization, transport linkages among activities and facilities in the supply chain are extended and,

TABLE 4
CENTRALIZATION IN THE SUPPLY CHAIN OVER TIME AND BY COUNTRY

	Past		Present		Future	
	NL	Bl & Germ	NL	Bl & Germ	NL	Bl & Germ
R&D	3.08	2.58	2.94	2.41	2.73	2.22
Purchasing	2.93	2.68	2.71	2.39	2.77	2.12
Primary manufacturing (parts and components)	4.21	2.97	3.13	2.83	3.06	2.70
Final manufacturing	3.23	2.96	3.20	2.79	3.14	2.64
Packaging	3.32	2.90	3.54	2.72	3.18	2.60
Distribution	2.99	2.59	2.89	2.45	2.67	2.27
Sales	2.93	2.51	2.89	2.35	2.62	2.24

Key: Scores on a Likert scale; 1 (global level of operation), 2 (continental level), 3 (international level), 4 (local level)

with distance, increase in relevance given the increased dependence on cross-border shipments.

Respondents were asked which selection factors they used in locating operations in the supply chain, in order to assess the role of transportation factors in the spatial reconfiguration involved in the implementation of postponement. Apart from quality of labor, telecommunication facilities, and access to suppliers, transport and distribution related considerations were ranked highly. These considerations include the availability of transportation modes and customs facilities. Immediate proximity of sea- and air-ports is less critical than the availability of transportation modes to connect ports.

In order to assess which location selection factors are specifically relevant in structuring (and centralizing) the customized supply chain, a correlation analysis was conducted. Significant correlation coefficients were found between the application of:

- Postponed engineering and proximity of raw materials; -.260 (0.01 level),
- Postponed primary manufacturing and customs facilities; .288 (0.05 level),
- Postponed packaging and the availability of IT-networks; -.311 (0.01 level),
- Postponed distribution and the proximity of seaports; .392 (0.05 level), the quality of telecommunication; -.330 (0.05 level) and the availability of IT-networks; -.388 (0.01 level).

These coefficients indicate that telecommunication infrastructure and the availability of IT networks are negatively related to the application of postponement in packaging and distribution. The proximity of seaport and the availability of customs facilities, as distribution related considerations, are important considerations in locating activities in the customized supply chain. Thus, while advanced distribution related considerations (data distribution through IT

networks) are not related to the location of activities in the customized supply, traditional distribution related considerations are.

THE ROLE OF TRANSPORT AND LOGISTICS COMPANIES IN THE CUSTOMIZED SUPPLY CHAIN

If there is indeed is a role for transport companies in facilitating postponement, as Cooper et al. (1998) suggested, what are the considerations manufacturers use in selecting third parties? Insights both in the pattern of outsourcing and the third party selection criteria are relevant in assessing the role of third party logistics service providers in facilitating and performing postponement. There may be some counter forces working against the role of third parties, the most prominent being the fact that final manufacturing activities are not the traditional core business of third party logistics service providers. Despite the fact that third parties in a trade-overview (PD group 1998) indicated a willingness to perform final manufacturing activities for customers, hardly any had extensive experience in doing so.

Table 5 lists the share of customizing activities outsourced over time. Apart from the traditional areas of outsourcing, transportation and (to a lower extent) warehousing, customizing activities are outsourced to a relatively low level. Still, the levels of outsourcing are expected to increase over the following 3 years. Across industries studied some variations are found. A statistical test of differences, however, indicates that only warehousing is outsourced at a significantly higher level by respondents from the clothing and food industry, whereas product configuration is outsourced at a higher level by respondents from the clothing and electronics industry. At an overall level, the levels of outsourcing of customizing activities are relatively low across industries. A slight difference between countries is displayed in Table 5. Dutch respondents outsource customizing activities at a higher level. Again these figures should be interpreted with some caution, given the lower response level from Belgian and German companies.

TABLE 5
OUTSOURCING OF CUSTOMIZING ACTIVITIES, DEVELOPMENT IN TIME,
AND BY COUNTRY (IN %)

	Past (3 years ago)		Present		Future (in 3 years)	
	NL	Bl & Germ	NL	Bl & Germ	NL	Bl & Germ
Final assembly	11.48	7.38	13.69	8.53	15.59	13.13
Configuration	11.53	6.83	9.55	8.92	13.02	10.10
Final processing	9.83	3.94	8.57	4.60	10.86	6.33
Sizing adjustments	8.09	5.78	6.29	6.98	9.20	7.38
Packaging	13.14	9.83	13.13	11.81	16.86	13.41
Inserting manuals	8.80	2.33	10.71	2.91	14.34	6.55
Warehousing	21.62	15.07	26.67	18.51	33.64	25.33
Transport	79.29	66.27	86.55	72.05	87.60	76.15

TABLE 6
THE RELATION BETWEEN OUTSOURCING AND POSTPONEMENT

Outsourcing of :	Postponement (overall)
Final assembly	0.3077 ^b
Configuration	0.3505 ^b
Final processing	0.4446 ^a
Sizing adjustments	0.3254 ^b
Packaging	0.1909
Inserting manuals	0.2185
Warehousing	-0.1166
Transport	-0.1855

Key: Pearson direct correlation coefficients a: $p < 0.05$ b: $p < 0.10$

Table 6 shows correlation coefficients between the outsourcing of customizing activities and the application of postponement (using the multi-item construct for all the postponement applications). The positive correlation coefficients between the final manufacturing activities and the application of postponement indicates that these activities are considered candidates for outsourcing in the customized supply chain. The negative correlation between the outsourcing of transport, warehousing and the application of postponement is not significant. It does provide an indication of how the outsourcing debate in the customized supply chain differs from that in the traditional supply chain, where transport is outsourced at a very high level. This is also reflected in Table 7.

In order to assess which type of service providers are earning the business of performing outsourced customizing activities, respondents were asked to define the types of company they outsource these activities to. Respondents that mention the use of a specific service supplier for a customizing activity were divided by the total number of respondents, resulting in the share of respondents that

outsource to the type of service supplier. Figures are presented by industry. From this analysis, it can be deducted that industrial service providers, instead of transportation and logistics service providers, are mentioned most frequently for customizing activities. Electronics companies often mention logistics service providers and clothing companies often mention the use of transport companies for performing customizing activities. For warehousing and transportation, logistics service providers and transport companies are mentioned most frequently. These figures suggest that final manufacturing activities used to customize products are a different business than traditional transport and logistics services. This is despite the general relevance of distribution related criteria used in selecting third parties.

Table 8 displays averages scores of selection criteria used (on a seven point Likert scale ranging from not important at all to very important). In all three countries studied, reliability and speed of delivery rank highest. This is in line with the top importance of the customer service considerations used in structuring the supply chain. Given the

TABLE 7
SHARE OF RESPONDENTS, BY INDUSTRY, THAT REPORT TO BE OUTSOURCING
ACTIVITIES TO SPECIFIC SERVICE PROVIDERS

	Logistics service supplier					Transportation company					Industrial service supplier					Other				
	EL	AT	FD	CL	O	EL	AT	FD	CL	O	EL	AT	FD	CL	O	EL	AT	FD	CL	O
Final assembly	23.5		6.7			17.6		3.3	11.1		29.4	25.0	23.3	44.4		5.9		6.7	11.1	
Configuration	11.8								11.1		11.8			22.2				3.3		
Final processing	23.5					5.9					5.9	25.0	6.7	11.1	14.3	5.9		3.3		
Sizing adjustments	5.9										5.9	12.5	6.7					3.3		
Packaging	11.8		10.0	11.1		5.9		3.3	11.1				30.0	11.1	14.3	11.8		3.3		
Adding documents	11.8								11.1		5.9	12.5	3.3	11.1		5.9		3.3		
Warehousing	17.6	12.5	43.3	22.2	28.6			16.7	11.1	42.9			3.3	11.1						
Transport	23.5	25.0	6.0	11.1	28.6	52.9	75.0	70.0	33.3	85.7	5.9		6.7					3.3	11.1	

Key: EL = electronics, AT = automotive supply, FD = food, CL = clothing, O = other

TABLE 8
THE AVERAGE RELEVANCE OF THIRD PARTY SELECTION CRITERIA BY COUNTRY

	NL	Bl & Germ
Reliability of delivery by third party	6.26	6.39
Speed of delivery provided by third party (order cycle time)	5.84	5.97
Cost of third party	5.64	5.65
Flexibility in time-fluctuating delivery by third party	5.61	5.66
Third party's active assistance in problem solving	5.52	5.31
Volume-flexibility in delivery by third party	5.42	5.51
Third party's willingness to long term relationships (long term contracts)	5.39	5.00
Quality of personnel	5.31	5.30
Third party's proactive attitude concerning potential problems	5.25	4.94
Operating flexibility in response to requests (handling change)	5.08	5.49
Geographic location of third party	4.98	4.41
Third party is willing to make dedicated investments	4.72	4.51
Third party's top-management support	4.62	5.14
Technological capabilities of third party (manufacturing related activity)	4.62	4.55
Relevant product knowledge/experience of third party	4.62	4.46
Prior experience with third party. performance history	4.56	4.38
Contribution to logistics and production process innovations	4.56	4.56
Availability of compatible information systems	4.43	4.51
Ability of providing periodic performance reports	4.39	4.30
Wide range of logistics capabilities	4.21	4.82

Key: mean scores on a Likert scale from 1 (not important at all) to 7 (very important)

tendency to outsource customizing activities in the context of postponement, and the expected increase of postponement applications, transport companies and logistics service suppliers may earn larger shares of this growing market, given their strength in distribution. However, due to the low number of respondents that outsource customizing activities, it was not possible to calculate significant correlation coefficients between the outsourcing of customizing activities and third party selection criteria.

CONCLUSIONS AND IMPLICATIONS

The application of postponement was found to increase along the supply chain, in those chains where postponed distribution is applied at the highest level in distribution. For the customization of product formulation and presentation, however, final manufacturing activities are more important than postponed distribution. Electronics companies and automotive suppliers apply postponement at a higher level than food and clothing companies, especially in manufacturing. The application of postponement is increasing for each of the activities in the supply chain measured, in the three countries studied.

In general, transport and distribution elements (speed, consistency and reliability of delivery along the supply chain, including that of suppliers) are top considerations in structuring the supply chain. In the context of postponement applications, import duties, global sourcing and supplier delivery issues are important considerations used in structuring the supply chain.

Supply chains in the European countries studied are being centralized, resulting in more international transportation between operations, in the distribution channel and other segments of the supply chain. Both for the

general location of activities in the supply chain and the establishment of postponement operations, various transport and distribution related factors are ranked highly (including availability of transport modes and availability of customs facilities). Thus, transportation considerations are actively used in structuring the customized supply chain. Cooper et al. (1998) appear to be correct when they state that transportation companies can facilitate postponement applications. But to what extent are they actually involved in performing postponement application and customizing activities?

Despite the expected increase of outsourcing of customizing activities and the relation between the application of postponement and the outsourcing of customizing activities, outsourcing is practiced at a relatively low level to date. For warehousing and transportation, logistics service providers and transport companies are used most frequently, whereas industrial service providers are used most frequently for manufacturing activities. These figures suggest that final manufacturing activities, used to customize products, are a different business than traditional transport and logistics services. Such manufacturing activities are currently outsourced more often to industrial service providers than to transport and logistics service providers.

Related to the objective of developing a further understanding of mass customization and postponement in the supply chain, the findings presented in this paper contain various implications for transportation managers. First, the creation of customized supply chains indeed seems to be a critical management consideration (as predicted by Gilmore and Pine 1997; Kotha 1995 and Lampel and Mintzberg 1996). In the context of postponing (final) manufacturing and reconfiguring the supply chain, management should not limit its

focus to manufacturing operations and supply considerations. Cross functional concepts such as postponement deserve a supply chain-wide focus. In that respect, transportation and transportation considerations prove to be among the top ranked considerations in this paper. Given the relation between postponement and a tendency to outsource final manufacturing activities, third party service providers should consider focussing on the development of customizing capabilities outside their direct operating experience in warehousing and transport. In doing so, they may focus on food and clothing industries that have a greater tendency to outsource. Alternatively, third party providers may concentrate on electronics and automotive supply firms that are more focused on postponement, and persuade them into more outsourcing. The third party selection criteria found to be relevant may guide these efforts.

Findings presented in this paper also hold a number of consequences for research. The share of respondents outsourcing customizing activities to third parties was measured by asking them whether or not they outsourced to these companies. Measurement of these frequencies does not say anything about the volume of the business outsourced and level of involvement (dedicated services, ad-hoc temporary services etc.). The pattern of outsourcing and outsourcing relations deserves further study, especially given the correlation between the application of postponement and outsourcing found. This relation suggests that as postponement is increasing, so will outsourcing. Further study may also target the use of multivariate models that go beyond the empirical exploration and move into formal hypothesis testing and validation. A larger study, including a larger sample from more countries is needed. Adding experiences and patterns from other continents (US, Asia, ...) may be a valuable expansion of the study area.

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AUTHOR BIOGRAPHY

Dr. Remko I. van Hoek is a professor in supply chain management at the Cranfield School of Management in the UK and a professor in logistics at the University of Ghent, Belgium. He is also a director of FIER, a research company affiliated with the Erasmus University Rotterdam and is a member of the editorial advisory board of three journals: the *International Journal of Logistics Management*, *The International Journal of Logistics: Research & Applications* and *Supply Chain Management*. He recently published a book, *Postponed Manufacturing in European Supply Chains*, (KNAG, NGS 238, ISBN 90-6809-259-6, fax +31 30 2535523) and has published articles on postponement and supply chain management in journals such as the *International Journal of Logistics Management* and the *Journal of Business Logistics*.

REVISITING LOGISTICAL FRIENDLINESS: PERSPECTIVES OF INTERNATIONAL FREIGHT FORWARDERS

Paul R. Murphy
John Carroll University

James M. Daley
John Carroll University

Logistical friendliness (unfriendliness) refers to the ease (difficulty) of arranging international freight operations to/from a particular country. The present paper builds upon previous research by 1) examining logistical friendliness and unfriendliness as two different constructs (rather than as opposite ends of the same continuum), and 2) linking the delineation of logistically friendly and unfriendly countries with the reasons for friendliness (unfriendliness). The study results could be quite valuable with corporate decisions as to which countries to do business in, as well as with the appropriate organizational strategies for entering the chosen countries.

As the level of cross-border trade continues to expand, so does the prominence and importance of efficient logistics management. Indeed, there is little question that international logistics is more costly and more challenging than domestic logistics. With respect to the former, Hise (1995) has estimated that between 10% and 30% of the costs of international orders are logistics-related. Challenges associated with cross-border logistics include, but are not limited to, longer lead times, increased inventory levels, and unfamiliar and/or inadequate transportation systems.

While it has been suggested (Czinkota and Ronkainen, 1998) "...that logistics may well become the key dimension by which firms

distinguish themselves internationally...", logistical considerations may not assume high priority when companies are making decisions about 1) countries to do business in and 2) the appropriate organizational strategy (e.g., exporting, direct investment) for entering these countries. Previous research by the current authors has suggested that logistical considerations can be incorporated into the country of choice and method of entry decisions by evaluating a country's logistical "friendliness" or "unfriendliness." Briefly, logistical "friendliness" ("unfriendliness") refers (Murphy and Daley, 1994) to the ease (difficulty) of arranging international freight operations to/from a particular country.

Previous empirical research involving both international freight forwarders (IFFs) and smaller businesses revealed that participants could clearly articulate logistically friendly and unfriendly countries. IFFs, for instance, listed (Murphy, Daley, and Dalenberg, 1993a) Great Britain, Germany, Japan, and Holland as particularly friendly countries; China, Saudi Arabia, and Brazil emerged as particularly unfriendly. According to small business managers, Canada, Great Britain, and Hong Kong (Murphy, Daley, and Dalenberg, 1993b) were viewed as the most logistically friendly countries, while Japan, Brazil, and China were the most logistically unfriendly.

Unfortunately, neither the IFF study nor the small business study identified features or attributes of logistical friendliness (unfriendliness). A subsequent research project (Murphy and Daley, 1994) identified a number of overriding themes associated with logistical friendliness, and suggested that many of these themes were *non-logistical* in nature. Prominent non-logistical themes included "trade relationships", "economic conditions", and "cultural issues."

THE PRESENT STUDY

Our previous research on logistical friendliness, while valuable, is lacking in several respects. First, as pointed out above, the research on the features or attributes of logistical friendliness was conducted separately from that involving the delineation of logistically friendly (unfriendly) countries. In short, the features or attributes of logistical friendliness cannot be linked *directly/explicitly* with individual countries. Second, the research on the features/attributes of logistical friendliness only investigated logistical friendliness, and not logistical unfriendliness. Is it possible that certain features/attributes are associated with logistical friendliness, while different features/

attributes are associated with logistical unfriendliness?

In an attempt to address these shortcomings, the present paper reports the results of a study involving international freight forwarders (IFFs) designed to learn 1) about logistically friendly and logistically unfriendly countries and 2) the reasons why these countries are viewed as logistically friendly (unfriendly). IFFs appear to be an excellent sampling frame for investigating logistical friendliness (unfriendliness) because they are widely used logistical intermediaries (Lambert, Stock, and Ellram, 1998) that provide numerous functions (e.g., preparing export declarations, determining shipment routings) to facilitate cross-border trade. As such, IFFs should possess valuable knowledge concerning logistically friendly (unfriendly) countries.

With respect to the study methodology, a total of 431 IFFs were identified from a recent edition of *The Official Intermodal Guide*. Each of these 431 companies was mailed a four-page survey dealing with various issues influencing the contemporary IFF industry. The initial mailing consisted of a cover letter explaining the purpose of the study, a copy of the survey, and a postage-paid return envelope. Approximately one month later, there was a follow up mailing, which was identical in content to the initial one.

A total of 86 surveys were returned as undeliverable, thus reducing the effective sample size to 345. While there may appear to be a relatively large number of undeliverables in this study, it should be noted that our previous IFF study (Murphy and Daley, 1995) also reported an unusually large number of undeliverables (i.e., 105). The large number of undeliverables in these two studies is possibly indicative of a continuing shakeout (Ozsomer, Mitri, and Cavusgil, 1993) in the forwarding

industry. Indeed, some have suggested (Gillis, 1996) that smaller IFFs will be extinct by the turn of the century.

We received 79 usable responses, representing an effective response rate of 22.9%. As shown in Table 1, the 79 responding organizations offer a broad diversity in terms of their length of time as IFFs. Indeed, 5% indicated that they were founded prior to 1900, with another 35% beginning operations between 1900 and 1949. On the other hand, approximately 35% of the responding organizations have been founded since 1975.

The size of the responding organizations, as measured by the number of employees, reveals (see Table 2) that approximately 70% of the responding organizations employ fewer than 50 people. Thirteen percent of the companies employ between 50 and 99 workers, with 17% employing 100 or more employees. Interestingly, these percentages are nearly identical to those reported in our previous IFF study (Murphy and Daley 1995). Approximately 75% of the respondents are in a senior management position—owner, CEO, president, vice president—suggesting that they should be quite knowledgeable about the relevant subject matter.

TABLE 1
YEAR FOUNDED

Year founded	Percentage of respondents
Prior to 1900	5.1
1900-1924	14.1
1925-1949	19.4
1950-1974	26.8
1975-1997	34.6

TABLE 2
NUMBER OF EMPLOYEES

Number of employees	Percentage of respondents
1-9	19.0
10-49	51.9
50-99	12.7
> 99	16.5

RESULTS

In separate open-ended questions, respondents were asked to identify two logistically friendly countries (i.e., those perceived as being the easiest in arranging international freight operations) as well as two logistically unfriendly countries (i.e., those perceived as posing the greatest challenge in arranging international freight operations). An open-ended question was also employed to learn why respondents view particular countries as either logistically friendly or unfriendly. Not every respondent could/would identify two logistically friendly and two logistically unfriendly countries; similarly, some respondents could not/would not explain why particular countries are logistically friendly (unfriendly).

Simple frequency distributions are used to tabulate information on logistically friendly (unfriendly) countries; this section includes results only for those countries named by at least 10% of the respondents. Similar to research by Johnson and Schneider (1995), content analysis is used to first delineate, and then categorize, the reasons for logistical friendliness (unfriendliness).

Logistically Friendly Countries

Nearly 20 different countries were identified as being logistically friendly by the respondents, including Australia, Italy, the Netherlands, and Singapore. As shown in Table 3, the United Kingdom (UK) was most frequently cited as a logistically friendly country, having been named by approximately 50% of the respondents. Four other countries were cited by at least 10% of the respondents, namely, Germany, Japan, Hong Kong, and Canada.

TABLE 3
LOGISTICALLY FRIENDLY COUNTRIES

Country	Percentage of respondents
United Kingdom	50.6
Germany	21.5
Japan	15.2
Hong Kong	11.4
Canada	10.1

Analysis of the reasons associated with logistical friendliness yields some intriguing results. The United Kingdom, for example, is viewed as logistically friendly primarily because of its language similarity to the United States. Other key reasons for the UK's logistical friendliness include reasonable documentation, its overall similarity to the US, and "good agents." "Good agents" were also a prominent reason for Germany's logistical friendliness, as were its relatively low language barriers and its perceived similarity to the US. Not surprisingly, Canada's logistical friendliness stems largely from its geographic proximity to the United States, as well as its limited documentation requirements. There were no dominant reasons offered for the logistical friendliness of either Japan or Hong Kong.

Logistically Unfriendly Countries

The IFF respondents identified over 30 separate countries, such as Bolivia, Iraq, Korea, and Uzbekistan, as being logistically unfriendly. The information in Table 4 indicates that the most frequently named logistically unfriendly country, by one-third of the respondents, was Russia. Other countries that were identified as logistically unfriendly by at least 10% of the respondents include Brazil, China, India, and Nigeria.

TABLE 4
LOGISTICALLY UNFRIENDLY COUNTRIES

Country	Percentage of respondents
Russia	32.9
Brazil	20.3
China	15.2
India	11.4
Nigeria	10.1

Analysis of the reasons for logistical unfriendliness reveals a number of different issues. According to the IFFs, a lack of cargo security, corruption, and an inadequate transportation infrastructure are the major contributors to Russia's logistical unfriendliness. Brazil's logistical unfriendliness is overwhelmingly viewed as stemming from the country's extraordinary bureaucracy. China, on the other hand, is seen as logistically unfriendly largely because of its poor transportation infrastructure. Documentation issues and government bureaucracy account for much of India's logistical unfriendliness, and the most common complaint about Nigeria involves corruption.

Comparing Logistical Friendliness and Unfriendliness

The primary contributors to logistical friendliness and unfriendliness are presented in Table 5. A common theme among the logistical friendliness variables appears to be "similarity", as evidenced by "language similarity" and "overall similarity to the United States." By contrast, logistical unfriendliness appears to be reflecting elements of "risk", as manifested in the variables "lack of cargo security" and "corruption."

TABLE 5
PRIMARY CONTRIBUTORS TO
LOGISTICAL FRIENDLINESS
(UNFRIENDLINESS)

Friendliness:

- Language similarity
- Overall similarity to the United States
- Reasonable documentation
- Good agents
- Geographic proximity

Unfriendliness:

- Lack of cargo security
- Corruption
- Inadequate transportation infrastructure
- Bureaucracy
- Documentation problems

The information in Table 6 indicates that none of the most logistically friendly countries ranks lower than 25th in the 1998 Index of Economic Freedom (Johnson, Holmes, and Kirkpatrick, 1998). On the other hand, none of the most logistically unfriendly countries ranks higher than 90th in the Index of Economic Freedom. This index, which measures the economic

freedom of approximately 160 countries, is based on the openness of each nation's markets, along with each nation's level of taxation and degree of government regulation. The lower the ranking, the greater the level of economic freedom.

TABLE 6
INDEX OF ECONOMIC FREEDOM
RANKINGS FOR LOGISTICALLY
FRIENDLY (UNFRIENDLY) COUNTRIES

Category	Country	Economic freedom rank ^a
Friendly	Hong Kong	1
Friendly	United Kingdom	7 (tie)
Friendly	Japan	12 (tie)
Friendly	Canada	14 (tie)
Friendly	Germany	25 (tie)
Unfriendly	Brazil	90 (tie)
Unfriendly	Nigeria	95 (tie)
Unfriendly	Russia	106 (tie)
Unfriendly	India	120 (tie)
Unfriendly	China	124 (tie)

a: Derived from Johnson, Holmes, and Kirkpatrick (1998)

The information in Table 6 indicates a positive rank order correlation between a country's perceived logistical friendliness/unfriendliness and its economic freedom. As such, the Index of Economic Freedom offers an initial indication as to the degree of a nation's logistical friendliness/unfriendliness. Designed for other purposes, the Index does not provide

insight on the *dimensions* of a nation's logistical environment.

IMPLICATIONS

This study's findings have implications for a number of logistical constituencies, to include international shippers and receivers, international freight forwarders, federal governments, and academicians. With respect to international shippers and receivers, at a minimum the study introduces the concept of logistical friendliness, a concept which might be explicitly incorporated into company decisions about which countries to do business with. Our discussions with companies involved in global business have indicated that a particular country's logistical capabilities are sometimes given little or no emphasis in the country choice decision.

The study results offer information about some of the more logistically friendly and unfriendly countries, as well as reasons for the friendliness/unfriendliness. Such information would be especially valuable in the case of logistical unfriendliness. For example, the fact that "lack of cargo security" emerges as an important component of logistical unfriendliness suggests that companies choosing to do business in potentially unfriendly countries should prepare to take extra measures (e.g., package labeling which does not reveal shipment contents, the use of armed guards, etc.) to bolster the security of their shipments.

The findings are also valuable for international freight forwarders. For example, several of the most frequently named unfriendly countries (Brazil, China, India) have been identified by the U.S. Department of Commerce as Big Emerging Markets, or those deemed to possess a great deal of business potential over the next decade. International freight forwarders may

choose to specialize in serving logistically unfriendly countries; so doing might generate a great deal of business as well as provide important market differentiation from other forwarders. Indeed, the authors are aware of an international freight forwarder (annual revenues of about \$1 million) that in a one year period in the early 1990s added over \$10 million in revenues upon specializing in serving Russia.

The study results would also be valuable to governments, particular those of logistically unfriendly countries. For example, inadequate transportation infrastructure could be the catalyst for government involvement in terms of improving highways, railways, water ports, and airports. Indeed, the Chinese government is actively involved in upgrading China's highways and airports.

As another example, the Brazilian government is actively involved in efforts to improve the Brazilian shipping system. Their focus (Fabey, 1998) is to make Brazil as cost and service efficient as other industrial countries in terms of moving freight through Brazil (which is South America's largest country, population-wise). To this end, some of Brazil's largest water ports are in the process of being transferred from government to private control.

Finally, from an academic perspective, much remains to be learned about the concept of logistical friendliness. For example, the present study reported information from U.S. employees of international freight forwarders. How do international freight forwarders in other countries view logistical friendliness? What are the components of logistical friendliness/unfriendliness? The answers to these and other questions will hopefully result in more efficient and effective global logistics management practices.

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AUTHOR BIOGRAPHY

Paul R. Murphy is a professor of business logistics at the Boler School of Business, John Carroll University. His Ph.D. is in transportation from the University of Maryland, College Park. Dr. Murphy has published extensively in the logistics literature and is a co-author of *International Logistics* and *Contemporary Logistics*. His research interests include social responsibility in logistics and e-logistics.

AUTHOR BIOGRAPHY

James M. Daley currently serves as associate dean and professor of marketing, Boler School of Business, John Carroll University. His Ph.D. is in marketing and transportation from the University of Arkansas. He has published over 50 major journal articles and continues to conduct research concerning issues in supply chain management. Dr. Daley has recently been an instructor for MBA courses in both China and Macau.

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Johnson, James C. & Donald F. Wood (1996), *Contemporary Logistics*, 6th ed., Upper Saddle River, NJ: Prentice-Hall, Inc.

MANUSCRIPT SAMPLE

TEACHING LOGISTICS STUDENTS TO TAKE OWNERSHIP OF INFORMATION INFRASTRUCTURE DEVELOPMENT

Frank W. Davis, University of Tennessee
Kenneth J. Preissler, Logistics Insights Corporation

Logistics systems, developed gradually over the past decades, are undergoing necessary radical change in this era of increasing global competition. This article describes an approach taken by the authors to teach logistics students how to take ownership of designing their own information infrastructure and how to use it to make their organizations more flexible, providing more strategic options.

INTRODUCTION

Advances in information systems technology such as data base management systems, bar code scanning, telecommunications, and image processing have enabled logistics and information managers with vision to reengineer the way the firm conducts its business. The usage of mainframe computers, personal computers, and logistics information systems has been widely studied (Gustin 1989). These studies have universally concluded that there has been a rapid growth in the usage of computers and logistics information systems.

Computer Usage in the Classroom

The usage of computer applications in a logistics course has also been studied. Rao, Stenger and Wu stated that there are several approaches to integrating computers into the classroom in a business curriculum, each with its individual advantages and drawbacks (1992).

Table I about here

Systems Development In Practice

The study of the information systems development process of computer applications has been almost universally left up to the computer science, software engineering, and information systems educators and practitioners.

$$y = a + 1x + ax \quad (1)$$

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