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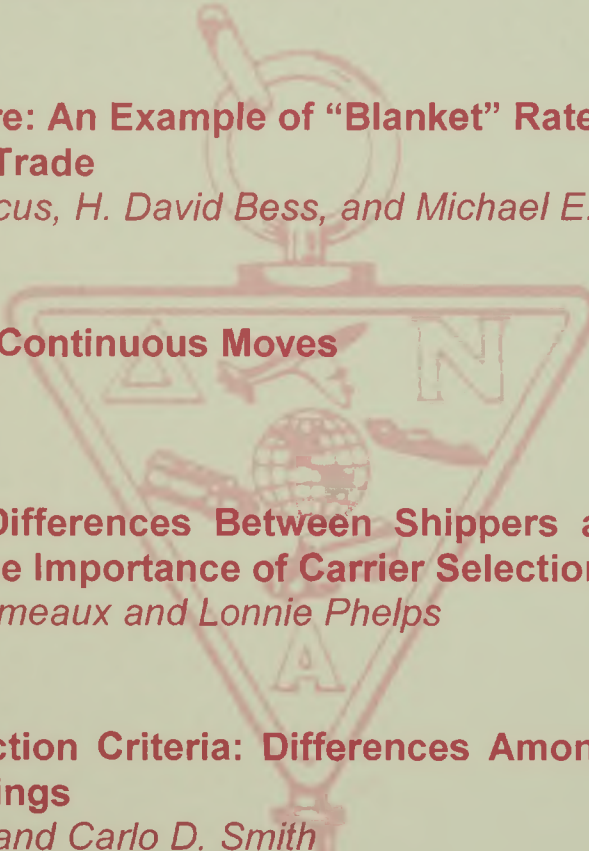
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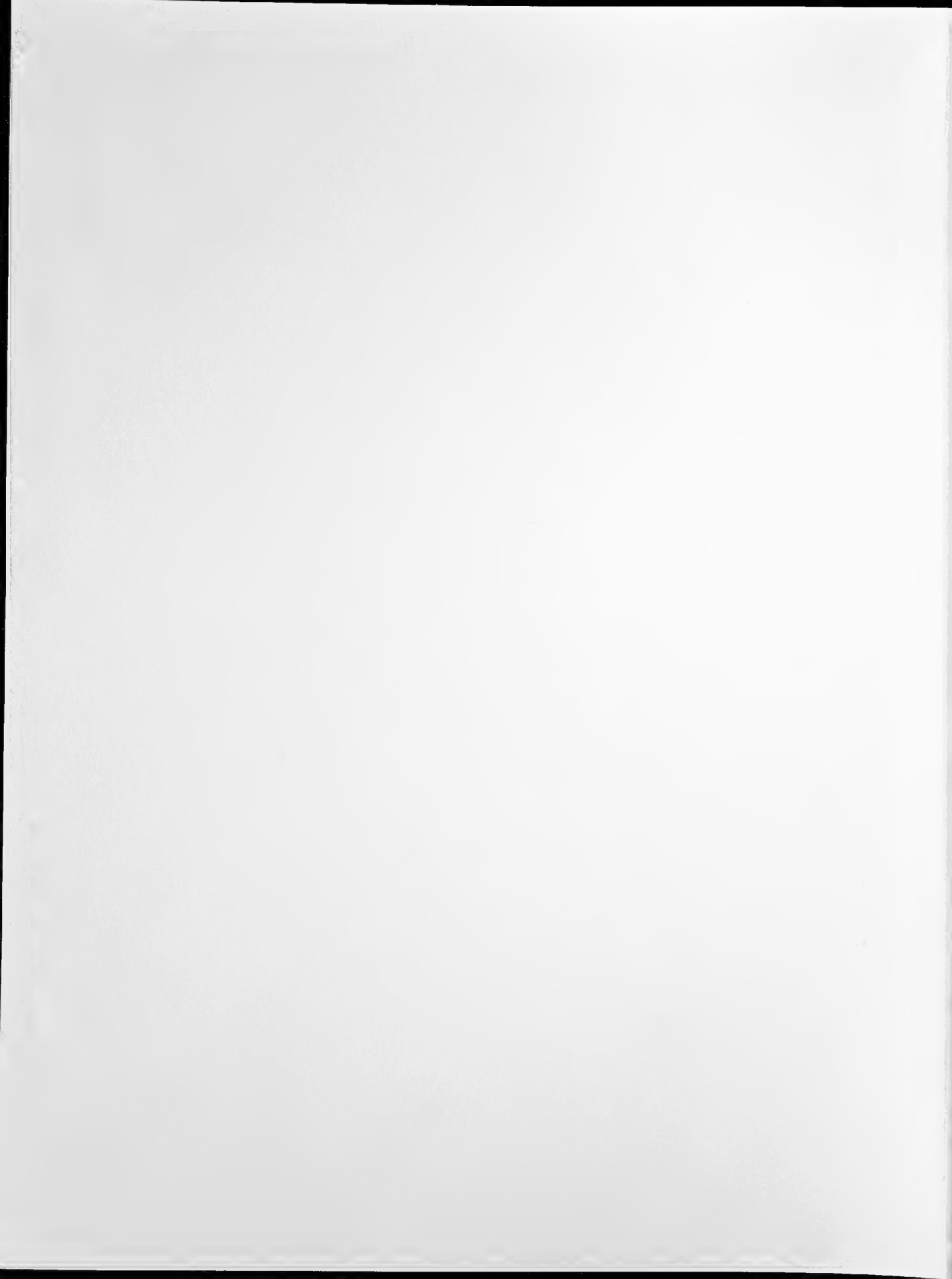
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- 
- 1 The Global Supply Chain: Challenges and Solutions**
Carol J. Johnson and Paul Nuzum
- 14 Common Fare: An Example of "Blanket" Rates in Hawai'i Waterborne Trade**
Henry S. Marcus, H. David Bess, and Michael E. Valdez
- 25 Dispatching Continuous Moves**
David Ronen
- 38 Perceptual Differences Between Shippers and Motor Carriers Regarding the Importance of Carrier Selection Criteria**
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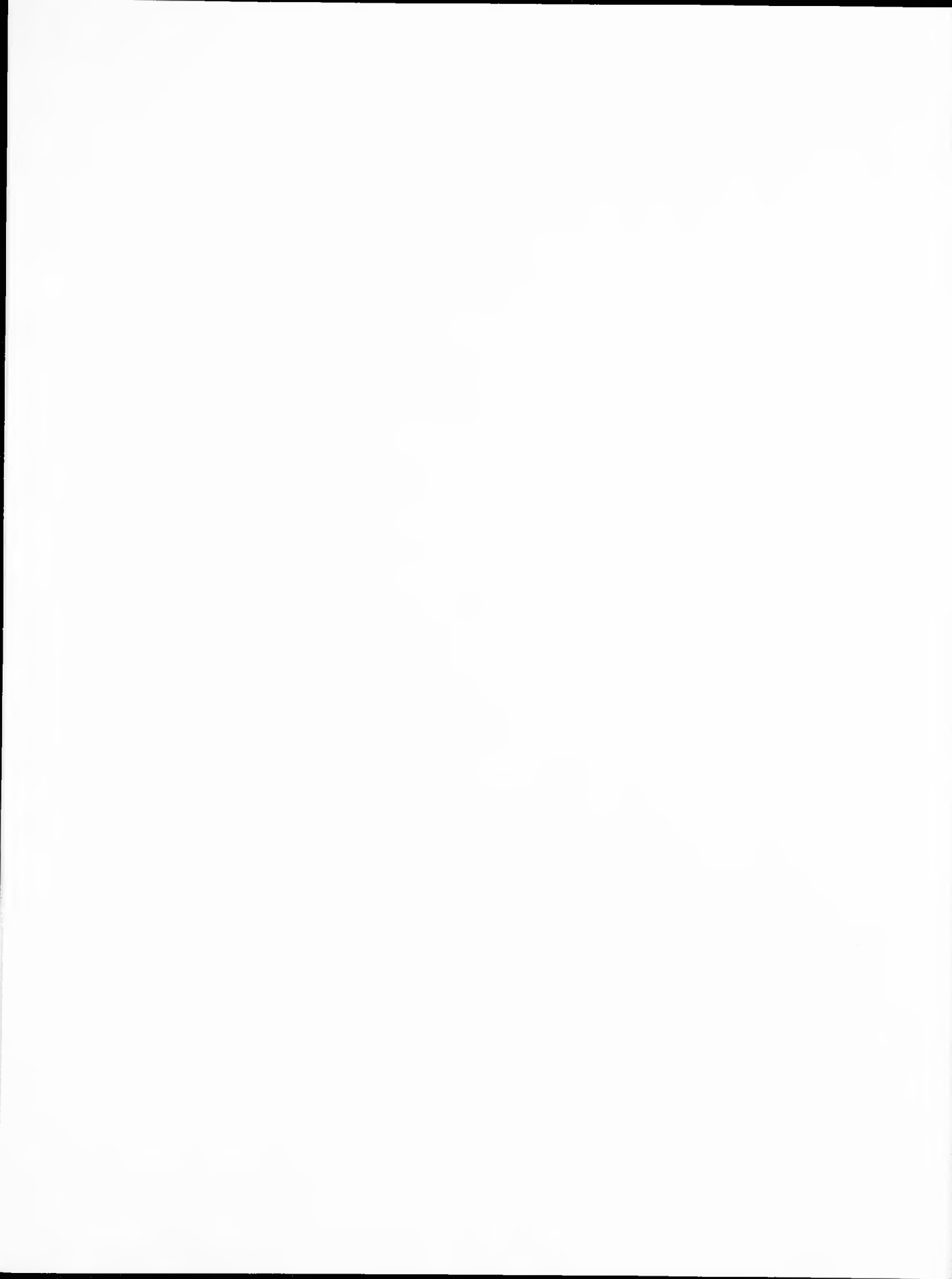


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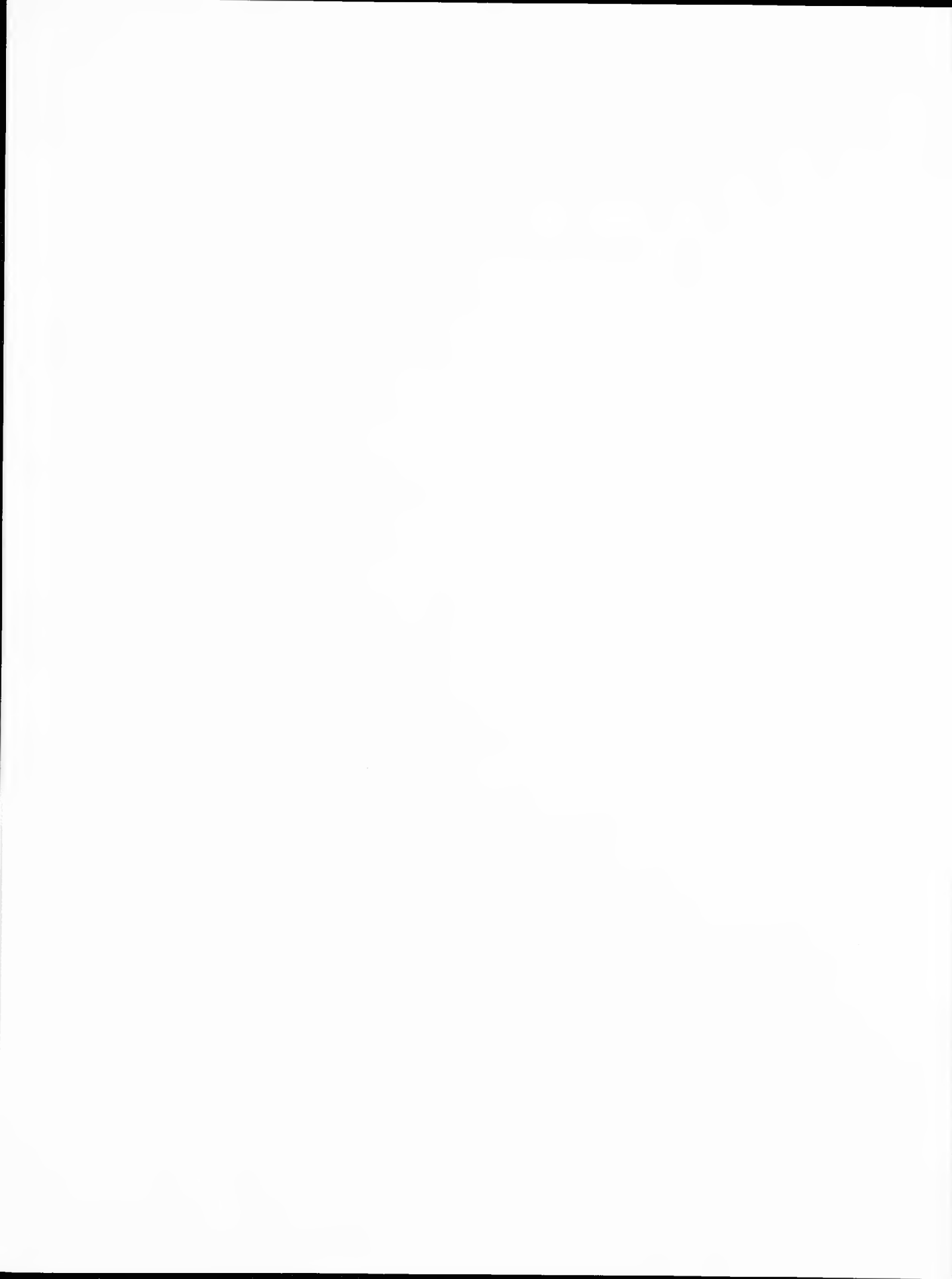
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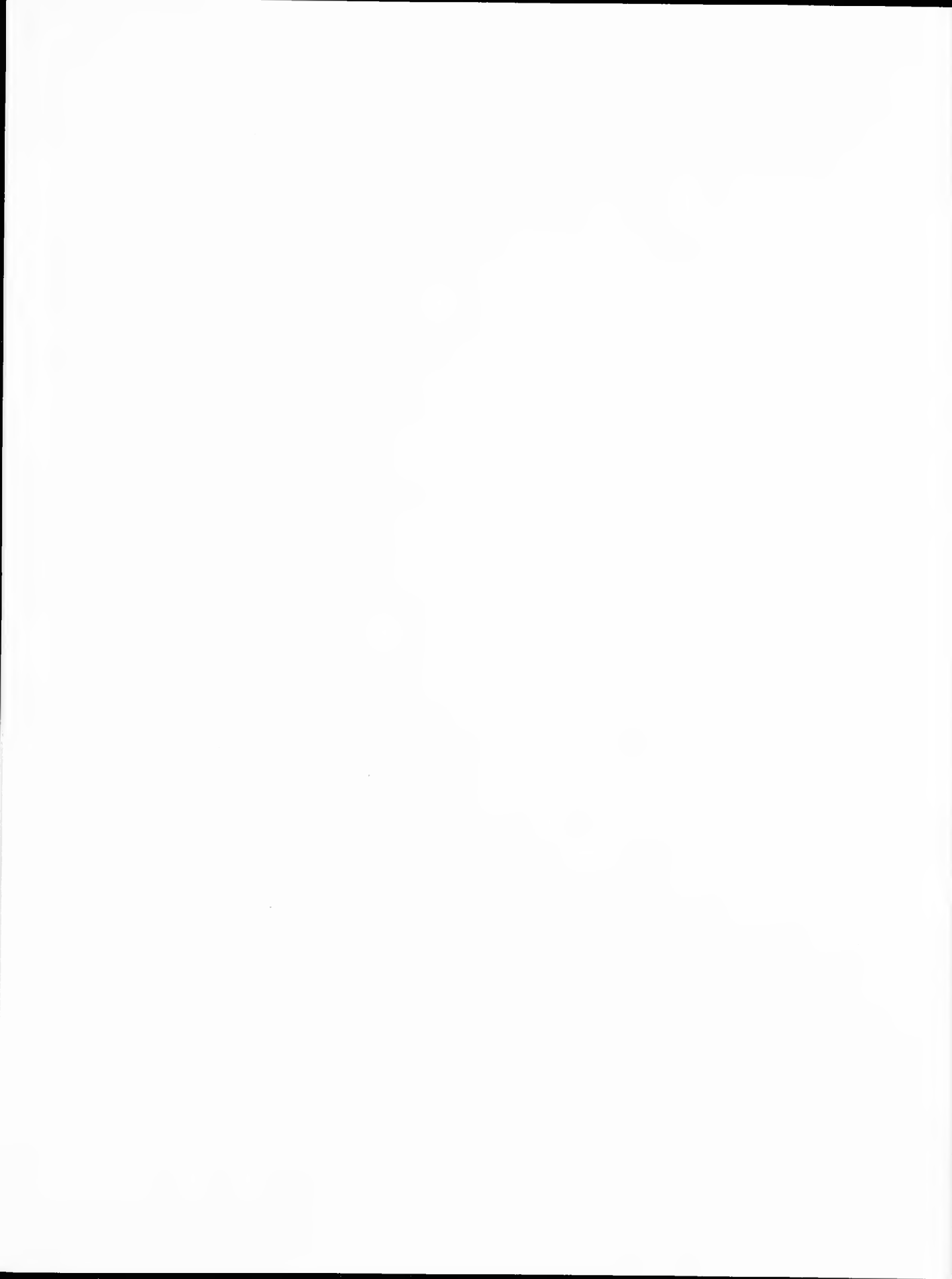
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From the Editor...

Welcome to the second installment for this year. Inside you will find five articles that are well written on a variety of topics that are current and vital to our industry. Take a look and see if you can find something you can use. My guess is that you can.

Here is some good news concerning the Spring 2006 issue. John Kent, associate professor of logistics and transportation at Missouri State University, has agreed to serve as Special Edition Editor. The issue will focus on motor carrier topics, including technology issues, driver retention/recruitment, hours of service, security, NAFTA, etc. If you have a manuscript that is appropriate for this special issue, send it directly to John at the following address:

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Please remember that we cannot survive and continue to publish without reader support. Join or renew your membership in Delta Nu Alpha International Transportation Fraternity today and subscribe to the *Journal of Transportation Management*. Remember that, if you join DNA at the Gold level, a subscription to the *JTM* is included in your membership! That is a deal that is hard to beat!

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Journal of Transportation Management Call for Papers

Special Spring/Summer 2006 Edition Motor Carrier Topics

Truckload, Less-Than-Truckload, Small Package, Intermodal, and 3PL

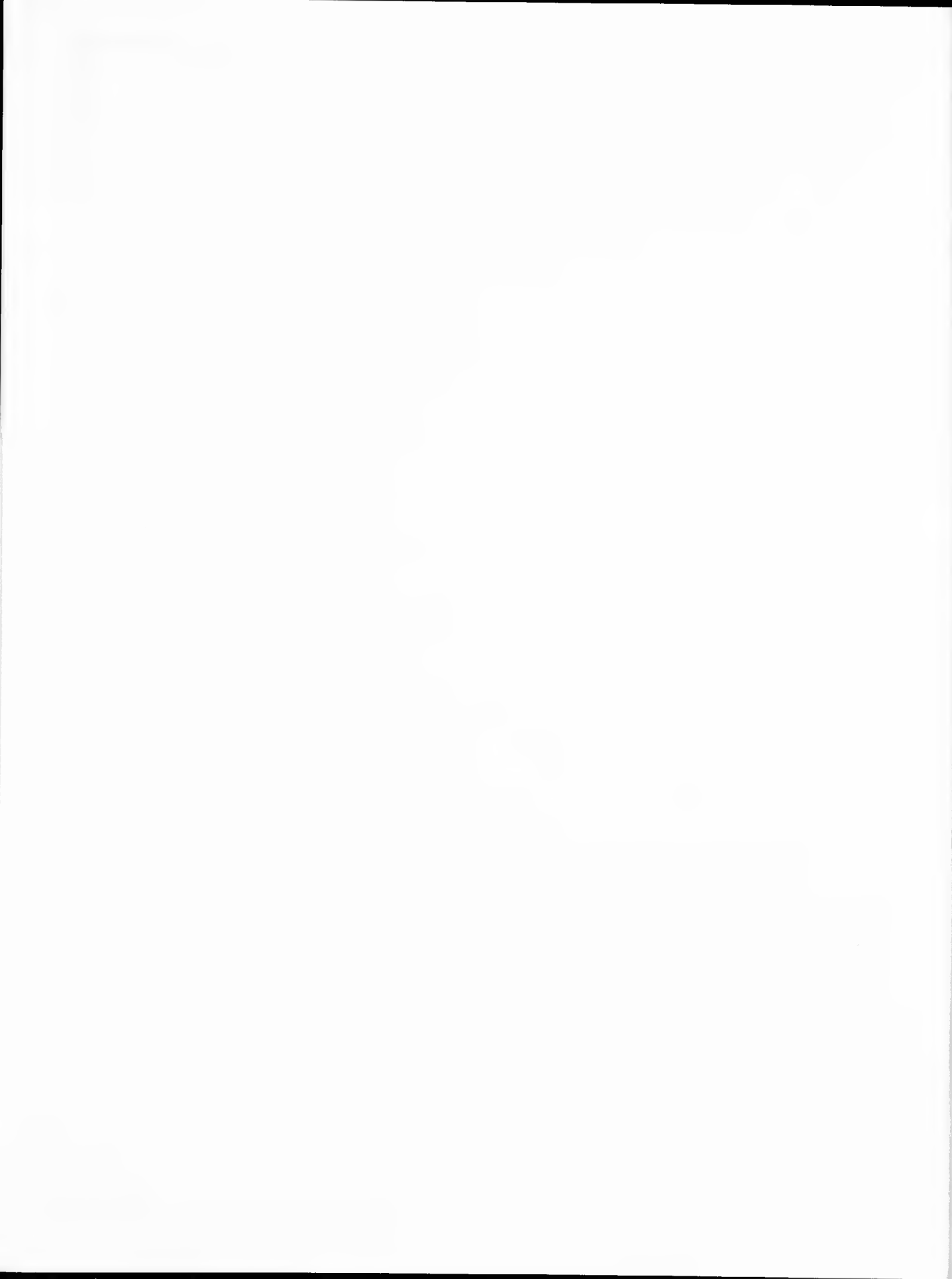
- ▶ Core Carrier
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- ▶ Technology

Practitioners contact an academic or vice versa and share recent presentation with supporting anonymous data. You are encouraged to send a 100 word abstract for prior consideration.

Submit a complete manuscript to the Following address by *February 18, 2006*.

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Journal of Transportation Management

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

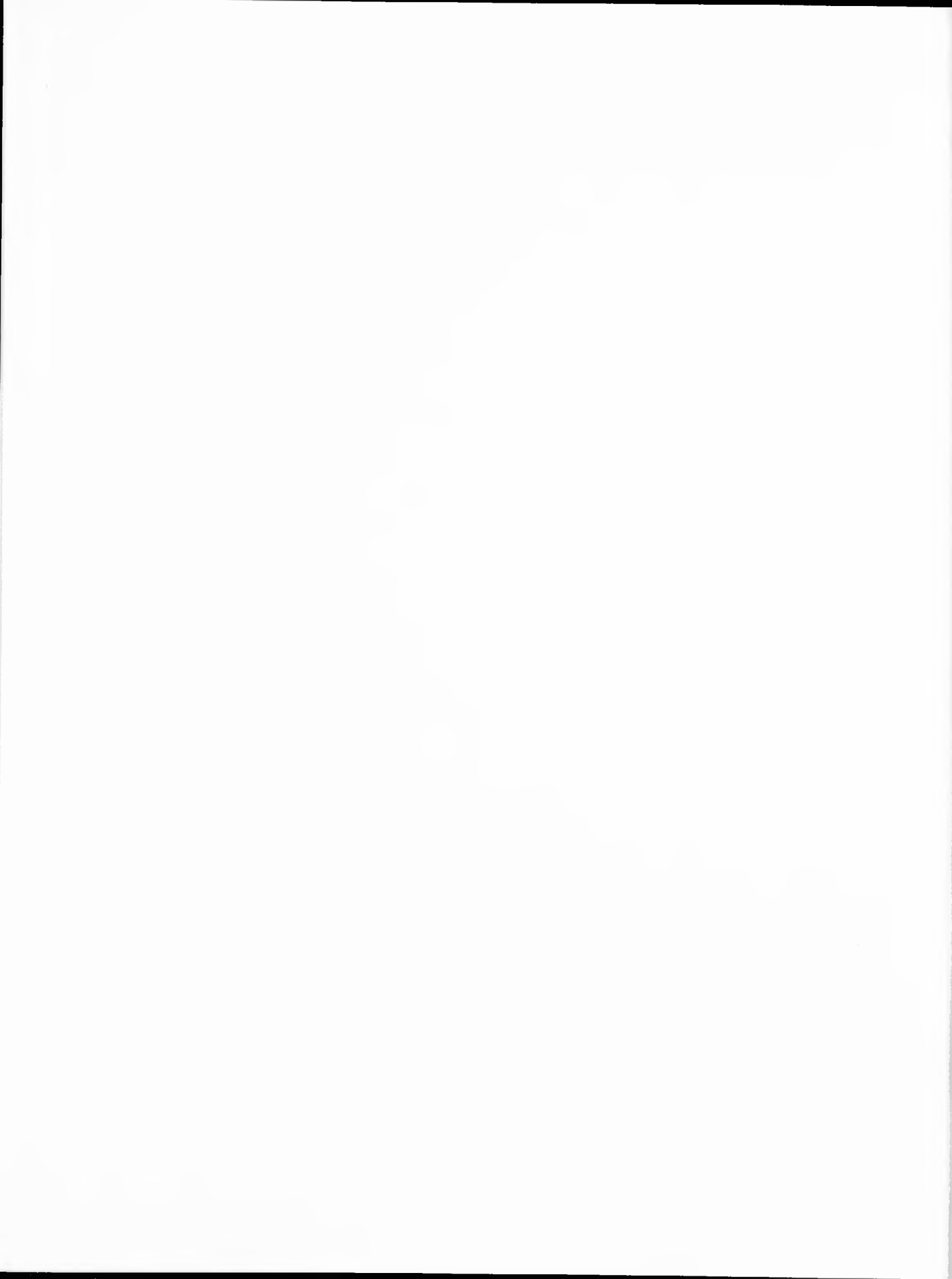
interaction between the two groups. Authors considering the submission of an article to the *JTM* are encouraged to contact the editor for help in determining relevance of the topic and material.

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, or Georgia Southern University.

PUBLISHING DATA

Manuscripts. Four (4) copies of each manuscript are to be sent to Dr. Jerry W. Wilson, Southern Center for Logistics and Intermodal Transportation, 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 \$50 domestic and \$65 international in U.S. currency. Payments are to be sent to the editor at the above address.



THE GLOBAL SUPPLY CHAIN: CHALLENGES AND SOLUTIONS

Carol J. Johnson
University of Denver

Paul Nuzum
Supply Chain Insights

ABSTRACT

While there have been independent examinations of several of the changes that affect the supply chain, to date there has been little in the way of studies that holistically examine the changes facing front line supply chain managers today and the solutions they have implemented to address those changes. Supply chain executives have been interviewed in depth to better understand how manufacturing or distribution network changes, technology implementation, corporate re-structuring and/or increasing customer demands have been addressed in the field. An understanding of the challenges and successes faced by Global 1000 firms as they address these changes should help others in the field to better accomplish supply chain change.

INTRODUCTION

Over the last four decades the logistics discipline has managed two opposing goals: minimize costs of the firm and maximize customer service delivered by the firm. Cutting edge companies such as Dell, Wal-Mart and many others, have managed to do both. Supply chain managers have also designed their supply chains aimed at balancing cost and service. Mentzer (2004) suggests that "customer value is created through collaboration and cooperation to improve efficiency (lower cost) or market effectiveness (added benefits) in ways that are most valuable to key customers." The goal has been to minimize cost, while providing the required level of

service. The costs are often measured in decreasing cash-to-cash cycle time and the customer service, whether internal or external, is often measured in availability, delivery quality, communication and the like (Emerson and Grimm, 1998).

There have been a number of books and papers outlining the definition and scope of supply chain management (Mentzer, et al., 2001; Simchi-Levi, Kaminsky, Simchi-Levi, 2003, Wisner, Leong, and Tan, 2004; for example), research studies to examine supply chain metrics (Lambert and Pohlen, 2001), as well as a comparison of two major supply chain frameworks (Lambert, García-Dastuge, and Croxton, 2005), and sources of

competitive advantage attributable to supply chain management (Mentzer, 2004). While there have been independent examinations of several of the changes that affect the supply chain (network changes (Chopra and Meindl, 2004), technology implementation (Boyson, Harrington and Corsi, 2004), and the demands of customers (Lambert, Cooper and Pagh, 1998)), to date there has been little in the way of studies that holistically examine the changes facing front line supply chain managers and the solutions they have implemented to address those changes. Supply chain executives have not been interviewed in depth to better understand how manufacturing or distribution network changes, technology implementation, corporate restructuring and/or increasing customer demands have been addressed in the field. This article attempts to fill that gap. An understanding of the challenges and successes faced by Global 1000 firms as they address these changes should help others in the field to better accomplish supply chain change.

The manuscript is organized as follows. First, the research questions and methodology are presented. Next, the results of the interviews are summarized, followed by a discussion of the results and implications for supply chains. Finally, future research opportunities and conclusions are presented.

RESEARCH QUESTIONS AND METHODOLOGY

To better understand how companies are managing the issues arising from the balance of cost and service, the researchers conducted extensive interviews with thirty-one top-ranking supply chain professionals from diverse industries. The interviews focused on (1) the challenges that global companies face in managing their supply chains; (2) the resolution of these challenges; and (3) the lessons learned from their experiences.

An extensive interview guide was developed to aid in discussions with the supply chain profes-

sionals and to be sure that the necessary research questions were covered. A list of twenty possible changes in the supply chain was developed from the literature, from initial discussions with industry professionals, and from topics included in several professional conferences. The interview guide included seven research questions for each of the twenty changes. (See Figure 1 for an example of the interview guide for one change.)

Prior to conducting the interview, the researchers sent each interviewee a set of preliminary research questions for the purpose of determining which of the twenty changes had the highest impact upon the informant's company. (See Table 1 for an example of the Pre-Interview Questionnaire.) The informant's four highest impact changes were the topics of their particular interview. In general, each telephone interview lasted between one and two hours and was taped with the permission of the informant. (All informants gave their permission to be tape recorded.) Each of the thirty-one interviews was then transcribed and analyzed. The interviews took place between February and May 2004.

The informants were vice-presidents and directors of supply chain or logistics for Global 1000 companies known for leadership in their respective industries. Annual revenues of these companies ranged from \$839 million to over \$134 billion with average revenues of \$18 billion. Informants represented manufacturers, distributors, and retailers from a wide variety of industries. (See Table 2 for the sectors represented.)

RESULTS

Prior to the in-depth interview, each informant completed the pre-interview questionnaire. Analysis of these questionnaires clearly shows the most important issues that impact the supply chain for the participating firms are:

1. Changing the number, location, or mission of distribution facilities (52%)

FIGURE 1
INTERVIEW GUIDE FOR CORPORATE RESTRUCTURING

1. Can you further explain this change as well as why and how this change impacted your supply chain?
 - a. Merger
 - b. Acquisition
 - c. Entered into a strategic alliance or partnership
 - d. Experienced business unit spin-off

2. Indicate any of the following that describe the impact of this change on your supply:

	N/A	Low	Med	High
Increased or decreased operating cost				
Increased or decreased inventory				
Increased or decreased lead times				
Improved or deteriorated service				
Increased or decreased revenue				
Other				

3. What was your response to this impact upon your supply chain?
 - a. Operational changes such as:
 - i. New processes
 - ii. New policies
 - iii. Training
 - iv. Organizational changes
 - b. Changes to the manufacturing network such as:
 - i. New plant layout
 - ii. New plant equipment
 - iii. Expanded current manufacturing facilities
 - iv. Relocated manufacturing facilities
 - v. Added or eliminated manufacturing facilities
 - c. Changes to the distribution network such as:
 - i. New D/C layout
 - ii. New material handling equipment/systems
 - iii. Expanded current distribution facilities
 - iv. Relocated distribution facilities
 - v. Added or eliminated distribution facilities
 - d. Combined manufacturing and distribution operations into common facilities
 - e. Implemented new supply chain technologies
 - f. Changed relationships or services from supply chain partners
 - g. Changed relationships or services from service providers
4. Was your response successful?
 - a. Yes, ask why in Q. 6
 - b. No, ask why in Q. 7

Figure 1
(continued)

5. How was this success measured?
 - a. Improved operating cost
 - b. Improved inventory turns or ROA
 - c. Improved lead times
 - d. Improved service
 - e. Increased revenue
 - f. Reduced cash-to-cash cycle time
 - g. Improved ROI
 - h. Increased shareholder value

 6. What were the success factors?
 - a. Communication (vision & on-going)
 - b. Collaboration (internal, supply chain partners, service providers)
 - c. Top management support
 - d. Culture change
 - e. Training
 - f. Change management
 - g. Project management
 - h. Technology

 7. What were the lessons learned?
 - a. Communication (vision & on-going)
 - b. Collaboration (internal, supply chain partners, service providers)
 - c. Top management support
 - d. Culture change
 - e. Training
 - f. Change management
 - g. Project management
 - h. Technology
-

TABLE 1
PRE-INTERVIEW QUESTIONNAIRE

Company X Pre-Interview Questionnaire

Please rate the following as to their impact upon your supply chain in the last three years.

- None Has not occurred or does not apply to your supply chain
 Low Has occurred with minimal impact on costs and or benefits
 Medium Has occurred with moderate impact on costs and or benefits
 High Has occurred with a high impact on costs and or benefits

	Impact on Your Supply Chain			
	None	Low	Med	High
1. Corporate re-structuring (e.g., merger, acquisition, business unit spin-off)				
2. Increased lead times from off-shore manufacturing				
3. Changing the number, location, or mission of your distribution facilities				
4. Changing the number, location, or mission of your manufacturing facilities				
5. Increasing customer service requirements (e.g., more frequent ordering, VMI, pay-upon scan)				
6. Selling via new market channels (e.g., direct-to-retailers, direct-to-consumers)				
7. Postponement-based order fulfillment (e.g., custom packaging, make-to-order, assemble-to-order)				
8. Adoption of automated materials-handling technologies				
9. Outsourcing any parts of your distribution facilities or processes				
10. Outsourcing any parts of your manufacturing facilities or processes				
11. Outsourcing any parts of your procurement of either direct or indirect materials				
12. Revising your manufacturing strategy (e.g., from make-to-stock to make-to-order)				
13. Serving global markets from globally dispersed facilities				
14. Product proliferation (e.g., increased items, products, or SKUs)				
15. Complying with new security measures (e.g., CTPAT reporting, new customs regulations)				
16. Adoption of Radio Frequency Identification Technology (RFID)				
17. Implementation of new supply chain software applications (e.g., APS, CRM, SRM, SCEM, TMS, WMS, ERP)				
18. Integration of information flow between supply chain partners (orders, forecasts, planning, tracking, inventory)				
19. Increased collaboration with supply-chain partners (e.g., business reviews, planning, shared processes, CPFR)				
20. Which changes, challenges, or opportunities would you add to this list?				

TABLE 2
INFORMANT COMPANY SECTORS

Manufacturing

- Electrical equipment and appliances
- Food and beverage
- Cosmetics, health and personal care products
- Office equipment
- Computers and computer peripherals
- Electronic equipment
- Communications equipment
- Medical equipment, supplies, and pharmaceuticals
- Athletic apparel, sporting goods, and footwear
- Men's and women's apparel
- Automotive components
- Paper products
- Insulation and roofing materials

Wholesale Trade

- Industrial and consumer paper products
- Food and beverage
- Footwear
- Petroleum and chemical products
- Industrial supplies, machinery, and equipment
- Medical supplies, equipment, and pharmaceuticals
- Cosmetics, health, and personal care products

Retail Trade

- Food and beverage
- Industrial and consumer paper products
- Footwear
- Apparel
- Sporting goods and athletic apparel
- Cosmetics, health, and personal care products
- Home furnishings

-
2. Changing the number, location, or mission of manufacturing facilities (35%)

3. Implementation of new supply chain software applications (35%)
4. Corporate re-structuring (32%)
5. Increasing customer service requirements (32%)

Meeting increasing service requirements while remaining cost competitive was viewed as a fundamental challenge. To meet the challenge, the respondents suggested that their respective companies were making major changes in the supply chain including the first four items in the above list.

The in-depth interview questions included the following:

1. Why and how did this change impact your supply chain?
2. What was the driver of this change?
3. What was your response to the impact?
4. Was your response successful?
5. How was the success measured?
6. What were the success factors?
7. What were the lessons learned?

The results for each of these questions will now be discussed for the four most important changes listed above along with the issue of increasing service requirements.

Changing the Number, Location, or Mission of Distribution Facilities

Sixteen of the thirty-one informants interviewed rated this change as having a high impact on their firm's supply chain strategy. Eight informants suggested that it was the number and location of distribution centers that changed.

This same group also indicated that the layout of the existing distribution centers changed and that the geographic area serviced by a particular distribution center changed. Some changed or added material handling systems, while three informants changed the technology used by the distribution center.

The primary drivers of these changes to distribution facilities included reducing cost and improving service. Before the change, the informants indicated that their company had experienced increased operating costs and inventory levels along with levels of service that no longer matched customer requirements. When asked about the response to this impact upon the total supply chain, eight informants indicated that distribution facilities were added or eliminated, seven implemented new supply chain technologies and six changed relationships with or services from their service providers.

Six of the eight firms felt the change had been successful. (The other two firms felt it was still too early to tell.) Operating costs improved, along with inventory turns and service levels such as lead times. More importantly, the informants identified factors that contributed to the success. These factors included (in order of importance): project management, top management support, communication, internal collaboration, technology, culture change, collaboration with supply chain partners, collaboration with service providers, change management and additional training. Several informants wished they had acted earlier and would have liked an increase in internal collaboration to accomplish the change.

Changing the Number, Location, or Mission of Manufacturing Facilities

Eleven of the thirty-one informants also chose to comment on why and how this change impacted their supply chains. Six indicated that all or part of the manufacturing function had been outsourced; five established offshore manufacturing facilities. Four of this same group changed the established manufacturing strategy in some way.

The primary drivers of these changes in manufacturing facilities were more diverse than those behind the changes in distribution facilities. Only three informants indicated that cost reduction was a driver. Other drivers included a loss of market share, a gain in competitive advantage, growth, a merger or acquisition, competition from a low cost manufacturing region, changes in the market, service improvement including lead time reduction, and supply chain optimization. Before the change the informants indicated that their firm had experienced increased operating cost and levels of inventory along with an increase in both supplier and customer lead times. One firm noted a decrease in margins. The response to this impact upon the total supply chain included primarily changes to the manufacturing network such as adding or eliminating manufacturing facilities and providing new plant equipment. However, four informants indicated that in addition to the manufacturing network changes, there was a corresponding change in the distribution network as discussed above.

Five informants rated the response of changing the manufacturing network as a success. Measures of success included improved operating costs and improved inventory turnover, improved service including lead times, and improved ROI, revenue, and cash-to-cash cycle time. Factors that contributed to this success were quite similar to those that contributed to success in changes made to the distribution network. These included (in order of importance) communication, internal collaboration, top management support, project management, collaboration with supply chain partners, change management, culture change, collaboration with service providers, and training. Only one informant would have liked more communication. The others said they would have done nothing differently.

Implementation of New Supply Chain Software Applications

Eleven informants reported this change as having a high impact on their firm's supply chain

strategy. The new software applications that were mentioned included warehouse management systems (eight firms), enterprise resource planning systems (five firms), and advance planning and scheduling systems (five firms). While nine informants spoke about this change, the drivers behind the change were varied. Cost reduction in general was mentioned as a driver by three informants, while distribution network optimization, inventory reduction, increases in productivity and improvements in forecasting and planning were mentioned by two informants each. All of the remaining drivers were mentioned by only one informant each. These included: distribution center design, gaining competitive advantage by increasing switching costs, service improvement, gaining control of the supply chain, improving supply chain visibility, increasing customer service requirements, asset utilization, and a reduction in lead time, errors, and damage. Once again, before the change, the informants indicated their firm experienced an increase in operating cost, declining service including increased customer lead times, despite an increase in inventory levels. Additionally two informants mentioned a decrease in margins. The response to this impact upon the entire supply chain, as one might expect, was the implementation of new supply chain technologies. In two cases, this required new processes and training as well as new material handling equipment and systems.

Success on this change was rated a bit more cautiously. Three firms said the implementation was a success, while the remainder indicated it was too early to tell. Measures of success included improved service (including improved lead times), improved operating costs, as well as improved inventory turnover. Once again the factors contributing to success included (in order) communication, internal collaboration, project management, technology, training, top management support, change management, culture change, collaboration with service providers, and collaboration with supply chain partners. Unlike the other changes, there were a number of suggestions regarding what the informant would have liked to have done differently. These

included more training, an increase in project and change management, matching existing processes to technology earlier, and dedication of more resources earlier to the project. Finally one informant indicated it would be useful to better understand the various system set-up issues.

Corporate Restructuring

Seven informants suggested corporate restructuring as a high-impact change. Four informants indicated that the corporate restructuring was due to acquisition, with three indicating the change was due to reorganization or a merger. The justification given by each informant for the change was different and included: the leveraging of the supply chain advantage in one business unit into competitive advantage for other units, leveraging marketplace and supply chain synergies, market access, economies of scale, and overall required cost reduction to remain competitive in the industry. Prior to the restructuring, the impact suggested by the seven informants who chose to comment on this change was either an increase in operating costs or an increase in inventory. Three informants also mentioned a deteriorating service level. The response to this impact upon the entire supply chain crossed operations, manufacturing and distribution. As one might expect, all seven informants indicated their firm had made organizational changes including new processes, policies and training. Additionally three informants indicated manufacturing facilities had been added or eliminated, seven indicated that distribution facilities had been added or eliminated, while five mentioned new supply chain technologies, and changed relationships from service providers. This change had the most overlap with the other four changes.

All seven informants felt the restructuring had been successful. They measured success by improved operating cost and inventory turns, improved service including lead times, reduced cash-to-cash cycle time and ROI, which also increased shareholder value. The factors of success (in order of importance) included internal collaboration, top management support,

project management, communication, culture change, collaboration with supply chain partners and service providers, technology, change management, and training. There were few items that informants would have done differently and they were mentioned by only one person each. The items included increased communication, technology, change management, acting earlier, moving too fast (which resulted in a sub-optimization of the operation), too much focus on execution rather than leadership, and waiting for technology to catch up before making a distribution center network change.

Increasing Customer Service Requirements

Ten informants reported that increasing customer service requirements had a high impact on their firms' supply chain strategy. These customer service requirements included (in order of greatest number of companies reporting): retailers placing orders more frequently, shorter required lead times, on-time delivery as measured by the customer request date, vendor managed inventory, store-ready product (tagging, packing, labeling, and display for a particular store), specific shipping windows, pallet ID by retailer, store, department, and aisle, distributors placing orders more frequently, retailers requiring minimum line-item order fill percentage, perfect order measures in place, drop-shipping to distributors' or retailers' customer and specific delivery windows. Prior to the strategic response, the informants indicated their firms faced increased operating costs and inventory levels, and decreased customer and supplier lead time. The response to this impact upon the supply chain was overwhelmingly to implement new supply chain technologies with all ten firms indicating this solution. Additionally, eight firms implemented new processes, while four added or eliminated distribution facilities, and changed relationships with supply chain partners and service providers, and three made organizational changes.

Eight of the ten informants reported the response to be successful, measured primarily by improved operating costs and service including

improved lead times. Seven informants saw improved inventory turnover while three reported reduced cash-to-cash cycle time. The factors of success (in order of importance) included top management support, collaboration internally, communication, collaboration with supply chain partners, change management, culture change, collaboration with service providers, project management, technology, and training. There was no consensus on what the informants would have done differently. Each of the following items were reported by one informant only: more collaboration with service providers, increased change management, act earlier, simulate the impact of what the company would do before doing it, benchmark with other companies earlier, involve customers earlier and more often, involve the sales force earlier, and three informants reported that they would do nothing differently.

DISCUSSION AND IMPLICATIONS

As the research was completed, a picture emerges of supply chain change for strategic reasons. The changes are not reactions to flashpoints, but rather they are major changes with the goal of increasing competitive advantage through reduced costs and increased service. The following is a discussion of the five highest impact issues, including the linkage of each to competitive advantage along with specific comments from the informants.

Changing the Distribution Network

The changes to distribution networks resulted in the following: (1) fewer, larger facilities, (2) distribution centers designed to meet increasing customer service requirements, (3) changed relationships with 3PL's, and (4) resource intensive implementation projects.

The informants indicated that distribution networks consist of fewer, larger buildings. The reduction of the number of facilities ranged from an 85 percent reduction to a 25 percent reduction. Three reasons were given for this. First, the change was the result of a merger and/or

acquisition; second, there seems to be a trend away from multiple building campuses; and third, fewer stocking locations lead to greater network efficiency. A merger/acquisition was often done precisely to increase synergy by combining distribution networks, leading to much larger distribution facilities. The outgrowth of a single facility seemed to be the cause of multiple building campuses, according to many of the informants. This, in turn led to material handling inefficiencies as a company would handle the product multiple times before it was shipped as part of an order. For example, one company reported that they transfer twenty truckloads of product *per day* between multiple facilities on the same campus. This leads to lengthy receiving times, which delays product availability and increases lead time and inventory on hand. Another company was handling product up to three times before customer shipment, increasing operating costs, and inventory and reducing customer service.

The informants indicated that their respective companies were also seeking the inventory and cost efficiency of stocking products in fewer locations and relying on larger distribution centers of up to one million square feet. To address this much larger size, one company is taking a "warehouse-within-a-warehouse" approach. One area or "warehouse" contained pallets only to support truckload orders of full pallet picks. Another supports consolidated orders, which are a combination of case and pallet picks. A third is for customer specific pallets and the fourth is for third party assembly and packaging operations.

Informants also reported the distribution center design was a result of increasing customer service requirements such as customer-specific product identification on all products, preparation of store-level orders consolidated into truckload shipments, and a reduction in lead time from seven days to three. Overall, the customer service challenge is to do more in less time. One firm addressed these requirements by using a new building, a new automated material handling system, and a new warehouse manage-

ment system, all designed to work together. This resulted in a facility that can prepare any customer order within 24 hours, fully addressing the above customer service requirements.

While the informants used 3PL's extensively both before and after the distribution network change, the relationships and role of the 3PL has changed for these firms. Changes include the separation of the building and system ownership from operational management, consolidation of providers, control of information systems, and ownership of automated material handling systems. For example, one informant explains:

So part of our goal in this distribution network redesign is to separate our facilities from our 3PL's to get more flexibility. We will lease the facilities, but still use a 3PL for operation. We want to be in a position with the 3PL where what we are doing is essentially buying labor. We have benchmarked this with some other companies. Where they have had success is to separate their buildings from their 3 PL's, and also their software so that the cost or impact of switching 3PL's upon the organization is minimal. That drives competition in your distribution supply.

Another company illustrates the resource intensive implementation of a distribution network change. To help mitigate this, the implementation strategy focused on strategic partnerships with outside firms who could provide the needed resources. While two 3PL's were used, there was a single property manager, selected to be a common landlord, to manage the design and construction process of the new facilities, and to conduct state and local negotiations. This company brought five million square feet on line in thirty months by leveraging the strengths of its partners.

Changing the Manufacturing Network

The manufacturing network changed primarily by outsourcing manufacturing to contract

manufacturers in low cost manufacturing regions. Anywhere from 50 percent to 100 percent of production was reported to be outsourced offshore. With this change, companies reported increasing lead times from offshore plants via ocean freight from three to eleven weeks longer than domestic production. A number of strategies were reported to mitigate the increased inventory costs from outsourcing offshore. These included (1) shifting inventory responsibility to the supplier using increased terms, (2) requiring VMI hubs to be positioned to support the manufacturing facility, (3) increasing collaboration so that accurate data is obtained earlier, (4) obtaining security certifications enabling more efficient border-crossings, and (5) employing postponement strategies.

Additionally, some of the informants explained that their company saw cost advantages to bring inventory closer to the customer via geographic-centric manufacturing rather than product-centric strategies. Several companies changed from a product-centric manufacturing strategy, where a plant was focused on one product or product family to a geographic-centric manufacturing strategy, where all products are made in plants that are geographically centered within a major market area. The objectives were to move product closer to the customer, reduce outbound logistics cost, and eliminate steps in the supply chain. For example, one firm has plants in the eastern and western U. S., Europe and Asia. Traditionally, each of these plants produced a portion, but not all, of the product line. By allowing all products to be assembled in each of the plants and to be shipped directly to customers located in the same region as the plant, the firm is now able to assemble and deliver the item to the customer within 48 hours.

Implementation of Supply Chain Software Applications

The applications implemented spanned the horizon of supply chain functions from planning the supply chain with demand planning,

transportation planning, and advanced planning and scheduling systems, to execution with transportation management systems, warehouse management systems, automated materials handling systems, supply chain event management, and e-procurement, to collaboration with Collaborative Planning, Forecasting, and Replenishment. These applications had a high impact upon the supply chain because they created a supply chain infrastructure, which provides visibility throughout the supply chain. The value of visibility was widely recognized as improving forecast accuracy through seeing more accurate demand, reducing inventory, executing faster in response to demand signals, reacting faster to problems, and improved planning of labor and transportation. One informant explains the value of visibility:

Before, our customer orders would come in. Customer service would just drop them on the warehouse, and the warehouse had to fill them as they were received. Now, we are so linked with capacities, planning and smoothing, they [the warehouse] actually pre-work the orders in such a fashion that the warehouse uses capacity to minimize overtime. We have linked the entire order-to-cash process to drive efficiency.

Another states,

The driver [for visibility] was a need to continue to reduce costs to remain competitive in an extremely competitive industry. Our response to this was to make the supply chain more efficient for us as well as the rest of the supply chain. We realize our supplier's inefficiencies will end up in the price of our product. We have learned that lack of visibility causes almost all of these inefficiencies, and providing visibility was the answer. We have established that 85 percent of the problems incurred in our supply chain are the result of a lack of communication.

Corporate Restructuring

While it is common that companies acquire or merge to leverage synergies between them, the informants indicated that their company specifically sought to leverage supply chain synergies. Supply chain was a central thought in these restructurings, not a post-merger afterthought. The supply chain synergies came from aggregating more volume through a common supply chain of facilities and transportation lanes to reduce cost and improve service. The informants also suggested that as merger and acquisition activity increases in many industries, it leaves a trail of challenges to supply chain professionals. The promise is a new supply chain which aggregates the volume of two or more companies to flow through a common network of distribution centers to the same retail outlets resulting in lower transportation cost, inventory efficiency, and lower distribution expenses. The challenges, however, come in consolidating facilities, opening new facilities, integrating systems, and addressing change management issues. Nonetheless, the informants explained that, overall, the restructuring contributed to competitive advantage: "The driver for the merger was to collectively gain business synergies, of which supply chain offered the greatest competitive advantage."

CONCLUSION

This research was conducted by interviewing thirty-one top level managers of Global 1000 companies. The top changes with which the firms were grappling included: (1) Changing the

number, location, or mission of distribution facilities (52%), (2) changing the number, location, or mission of manufacturing facilities (35%), (3) implementation of new supply chain software applications (35%), (4) corporate restructuring (32%), and (5) increasing customer service requirements (32%).

Regardless of which change impacted the firm the most, the suggested success factors were all considered to be important by the informants in effecting a supply chain change. These factors included project management, top management support, communication, internal collaboration, technology, culture change, collaboration with supply chain partners and service providers, change management, and the presence of additional training.

Caution should be used in applying these results to a larger population. While the views of the informants represent thirty-one large firms across a variety of industries, this research is qualitative in nature. It is meant to show the issues facing these managers, the solutions they implemented and the factors the managers saw as contributing to their success. Additional research is needed to better understand if these changes, solutions, and success factors can be applied to a larger set of supply chains.

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COMMON FARE: AN EXAMPLE OF "BLANKET" RATES IN HAWAI'I WATERBORNE TRADE

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ABSTRACT

"Blanket" rate structures apply uniform rates to a geographical region in spite of differences in the costs of carrying the goods. They are generally utilized by carriers to achieve some strategic objective, whether rate simplification, to be more competitive, or to meet some political objectives. While blanket rates are common in land transportation, the Hawai'i waterborne trade offers a unique example of this pricing mechanism. Further, given new and potential competitive factors in this trade, this is a unique case study for those interested in transportation pricing and the economic impacts of changes in the competitive structure in an isolated market.

INTRODUCTION

"Blanket" rates are rate structures that apply uniform rates to a geographical region in spite of differences in the costs of carrying the goods. They are generally proposed by carriers to achieve some strategic objective, whether rate simplification, to be more competitive, or to meet some political objectives. While blanket rates are common in land transportation, the Hawai'i waterborne trade offers a unique example of this pricing mechanism. Further, given new and

potential competitive factors in this trade, shippers and the state government should be aware of the implications of both the existing situation and the potential impacts of impending changes. This is also a unique case study for those interested in transportation pricing and the economic impacts of changes in the competitive structure in an isolated market. Hawai'i is often described as the most isolated populated landmass. As such, there are numerous ways in which it is unique from other states, including the costs of getting goods and people between it

and other locations. Hawai'i has only air and water transportation to connect it to the rest of the United States while other states also have access to rail, highway and pipeline transportation. This isolation gives birth to unique cost and competitive structures and resulting pricing structures with resulting profound impact on both businesses and consumers.

New competitors are about to enter this market. The purpose of this paper is to provide an understanding of the structure to improve business' ability to compete and provide the state and county governments with a tool for addressing the new competitive and economic realities. It also provides students of transportation a unique insight into the reasons for, the consequences of, and potential impacts of change in, voluntary waterborne blanket rates: The Hawai'i Common Fare.

HAWAII'S UNIQUE SITUATION

Due to Hawai'i's location and its comparatively small population, most cargo to Hawai'i is shipped from the continental U.S. (i.e., the mainland). Even freight from foreign countries, like cars from Japan, are often shipped from Japan to the mainland, and then transshipped to Hawai'i on one of the American-flag carriers serving Hawai'i. This places Hawai'i in the unique position of: 1) being served by carriers in heavily regulated trades, 2) also having limited competition, and 3) virtually no competition from foreign-flag vessels. This gives rise to unique pricing structures and one such unique pricing mechanism is the Common Fare.

Hawai'i receives most of the goods it consumes from sources outside Hawai'i. The majority of the goods flowing to and from Hawai'i, as well as among the islands, are transported on water carriers, and the majority of the consumer goods are transported in containers. When fully cellular containerships bring cargo from the mainland, all containers are unloaded from the vessel on O'ahu, where more than 70 percent of the population is located (US Census Bureau, 2000). Those destined for the Neighbor Islands

are reloaded onto a barge and then shipped to the desired island. Consequently, the costs involved for Neighbor Island shipments are always more than the costs to simply ship the containers to O'ahu due to the additional loading and unloading and vessel movement costs. Nonetheless, the tariff (i.e., freight rate) for each container charged by the containership company is generally the same, no matter the destination.¹ This pricing phenomenon is referred to as "Common Fare," "Common Rate" or "Standard Tariff" (henceforth referred to as "Common Fare"). This Common Fare pricing is unique in the United States for in no other state, including Alaska, are all containers transshipped on a particular origin-to-destination movement and the customer not charged for the additional movement and associated costs. Further, this is a voluntary pricing practice by the carriers ("Common Rate Sought," 1972). In this article "Common Fare" refers to any pricing approach where additional costs, such as transshipment or additional distances, are not reflected in the pricing structure.

The existing containership carriers between the mainland and Hawai'i use the Common Fare for Neighbor Island shipments. Further, no current containership company has service (denoted by bills of lading) to only O'ahu without also serving the Neighbor Islands. This means that people that ship goods between the mainland and O'ahu (with O'ahu being the origin or destination) are subsidizing the freight movement of containers to the Neighbor Islands. As discussed below, this subsidy amounts to about \$200 per container.

As an aside, a Common Fare approach can apply to passengers and/or freight. Before U.S. airlines were deregulated in 1978, a passenger Common Fare structure existed between the mainland and Hawai'i ("For the Common Fare," 1960). However, since deregulation, this practice has fallen into disuse as some airlines—often new entrants—have "cherry-picked" the most profitable routes, while not serving the less profitable ones. Over time, the heaviest trafficked (most profitable) routes have seen declines in their freight rates reflecting both competition and the

allocation of carrier costs among greater volume. Hence, the rates between each airport pair reflect the respective costs and competitive situation. Due to the Common Fare, this is not the case for ocean transportation freight.

REGULATORY BACKGROUND

Before getting further into the details of this unique rate structure, it is helpful to understand the regulatory environment in which this rate system exists. Movement of cargo between two United States ports, including traffic among the Hawaiian Islands and between Hawai'i and the mainland, is covered by the Merchant Marine Act of 1920. Vessels transporting cargo in this domestic, or cabotage, trade must be built in the U.S., crewed by U.S. citizens (with some exceptions.), fly the U.S. flag, and be owned by a U.S. company.² To partially offset the higher costs of using U.S.-flag ships, carriers in the domestic trades are permitted to apply for Title XI mortgage insurance whereby the U.S. government will guarantee up to 87.5 percent of the construction price of a new vessel. The guarantee means that the shipowners are assured of obtaining low interest rates on their mortgages. This assistance aside, domestic carrier operating costs are significantly higher than those of most foreign flag vessels and these costs are passed on to the shippers, and ultimately the consumer.

At the present time there are two common carrier containership companies serving the route between the mainland and Hawai'i, Matson Navigation Company, Inc. (Matson) and Horizon Lines (Horizon) plus a few smaller barge lines. These companies carry only interstate containers (which are defined as having bills of lading with origins and destinations in different states). Young Brothers is the only common carrier with a state Public Utilities Commission (PUC) Certificate of Public Convenience and Necessity to carry intrastate containers (with origins and destinations in Hawai'i) between O'ahu and the Neighbor Islands.³ Young Brothers carries both intrastate and interstate

containers. The PUC regulates only the intrastate containers.

When Horizon moves interstate containers between the mainland and a Neighbor Island, the container is transshipped in Honolulu and is carried between O'ahu and the Neighbor Island by Young Brothers. Matson also uses Young Brothers for interisland interstate movements; in addition, it has its own barges for interisland interstate movements. (Matson cannot, for example, carry containers originating in Honolulu to a Neighbor Island.) (Chamber of Commerce of Hawaii. Ad Hoc Committee on Interisland Transportation, 1978; Hawaii, Governor's Task Force on Interisland Surface Transportation, 1979)

A new carrier, Pasha Hawaii Transport Lines, LLC (PHTL), a subsidiary of the Pasha Group, obtained Title XI mortgage guarantee and has built a roll-on/roll-off vessel and entered the mainland-Hawai'i trade in late March 2005. A potential carrier, Santa Maria, has stated its intention to build a small containership that would also enter the Hawai'i trade; this company has not yet received approval for the use of Title XI mortgage guarantee. Santa Maria may provide service between Hawai'i and the mainland or it may prefer to operate between O'ahu and the Neighbor Islands. Still another potential entrant, Hawaii Superferry, has stated its intention to build two new 340 foot catamarans capable of speeds up to 45 miles per hour for an interisland ferry service carrying both passengers and freight. This firm has not yet received approval for the use of Title XI mortgage guarantee; however, it has begun construction of the first vessel. Any new carrier, particularly if its service is selective and "cherry picks," will have serious ramifications on existing carriers, and the Common Fare.

HISTORICAL TRANSITIONS

Captain William Matson made his first sailing to Hilo from California in 1882. In the years that followed, Matson Lines established itself as the

dominant common carrier between the Mainland and Hawai'i (Worden, 1981). Since Matson Lines was owned by the major sugar factors, the Common Fare was introduced to both help develop the Neighbor Islands as well as to attract backhaul cargoes given the dominant Hawai'i to mainland sugar exports (Mund & Hung, 1961; Mifflin, 1983; B. Mulholland, personal communication, July 27, 2003). Diversifying the state's population and economy has long been a political issue, and since the Common Fare assists in this effort, carriers have been "encouraged" to maintain this practice (Hewlett, 1970; Chamber of Commerce of Hawaii. Ad Hoc Committee on Interisland Transportation, 1978). In the past century many things have changed. The regulation of waterborne transportation on both the interstate and intrastate levels has been altered. Vessel technology as well as the technology of the cargo handling equipment has changed. The economic drivers of the Hawai'i state economy have transitioned from an agricultural economy to one based on tourism. The mix of waterborne cargos as well as the dominant direction of cargo flow have been modified (Department of the Army Corps of Engineers, 1961, 1962, 1987, 1992, 2000, 2004). In recent decades the Neighbor Islands have exhibited a higher growth rate of several economic factors when compared with O'ahu (Bank of Hawaii; Smith, 1992). With all these changes, the rationale for the Common Fare has been weakened, if not eliminated.

THE IMPACT OF THE COMMON FARE

Since there are no additional charges for containers transshipped from O'ahu, the mainland to Honolulu containers "cross subsidize" those destined for the Neighbor Islands. The extent of this subsidy and the impact on shippers and consumers dramatically affects cost and competition.⁴ This section addresses those factors.

Because the two containership companies serving Hawai'i from the mainland are common carriers, all their tariffs are published. However, through decades of "evolution," tariff books have

become a maze of information on different commodities, different sizes of containers, different types of containers (e.g., refrigerated, dry box, liquid tank), and different types of service (e.g., port-to-port, door-to-door). The result is a myriad of different freight rates, expressed in hundreds of pages of tariffs, that exist under various scenarios. It is virtually impossible to secure precise figures on the actual freight rates paid by various shippers. After discussions with shippers and carriers it was concluded that a charge of \$3,200 for the movement of any container from the mainland to any port in Hawai'i is a representative Common Fare rate. Further, for any container in an intrastate movement (A container that originates on one island, such as O'ahu, and is transported to another island.) the representative rate is \$600. In other words, a "representative" shipper would pay \$3,200 to ship a container from the mainland to any port in Hawai'i. The same shipper would pay \$600 to ship a container between two ports in Hawai'i. Since shippers and carriers agree that these rates are representative of the rates actually charged, we can assume that the rates cover the full costs (with a reasonable profit) of the service. In either case, the cost to the shippers of a container destined for a Neighbor Island will be only \$3,200 if carried under the Common Fare, but would incur an additional \$600 charge if off-loaded on O'ahu and then sent to a Neighbor Island under a new bill of lading.

The percentage of containers from the mainland to Hawai'i that are transshipped in Honolulu to the Neighbor Islands is steadily growing and at the current rate of growth will soon account for one third of containers from the mainland (Department of the Army Corps of Engineers, 1987, 1992, 2000, 2004; Hawai'i Department of Transportation Harbors Division, 2004). Young Brothers is the only interisland intrastate common carrier serving O'ahu. Assuming that one-third of the containers are transshipped to the Neighbor Islands, and given the \$600 representative interisland rate for the interisland movement, then each container moving from the mainland to O'ahu contributes \$200 to the interisland

movement of the one out of three containers that is transshipped. In other words, shippers who move containers from an origin on the mainland to a destination on O'ahu are cross subsidizing (or being overcharged) to the tune of \$200 per container.

Given the \$3,200 representative rate of moving a container between the mainland and any major Neighbor Island port, when the cross subsidy of \$200 is subtracted from this amount, the actual cost to a shipper of the mainland to O'ahu movement is \$3,000.

THE COMMON FARE STAKEHOLDERS

The impacts of the cross subsidy on the different categories of stakeholders in the Common Fare environment vary. There are both current winners and losers associated with differing future alternative strategies. Key variables are whether carriers that serve O'ahu also serve the Neighbor Islands and whether shippers/consignees can take advantage of the Common Fare practice to ship full container loads (FCL) from the mainland to the Neighbor Islands.

Table 1 identifies 19 stakeholders and shows whether the Common Fare works to their advantage or disadvantage. In general, the Common Fare puts those interests on O'ahu at a disadvantage and those on the Neighbor Islands at an advantage.

It should be noted that the actual situation for the shippers/consignees is more complicated than described. Theoretically, an O'ahu-based manufacturer/distributor may focus on expanding its business by shipping more goods from its warehouses on O'ahu to the Neighbor Islands. However, in actuality, we have found few companies in this category. This is true because there is no point in fighting against competitors on the mainland who have subsidized transportation service to the Neighbor Islands (Garrod, 1975). Instead, distributors on O'ahu who are selling products available from the mainland typically have a two-part strategy to serve the Neighbor Islands: (1) they will order

products from the mainland to be delivered to the Neighbor Islands to take advantage of the transportation subsidy if there is sufficient time to take advantage of this longer, but less costly, supply chain, and (2) if time doesn't permit the low cost alternative, they will ship products from O'ahu to the Neighbor Islands paying the interisland intrastate freight rate.

POSSIBLE CHANGES IN THE COMMON FARE STRUCTURE

The major Neighbor Islands are expected to continue to grow at a faster rate than O'ahu (Bank of Hawaii; State of Hawaii Department of Business, Economic Development & Tourism, and Research and Economic Analysis Division), so we can anticipate that the amount of cross subsidy will also grow over time. In other words, the amount of "overcharge" to the containers going to O'ahu will continue to increase. Since there is no legal requirement to maintain the Common Fare approach and the original justifications for this unique system have mostly disappeared over time, under what conditions would this freight rate system end?

One trigger is potential actions by the carriers. They could increase rates differentially so that containers moving from the mainland to the Neighbor Islands (versus O'ahu) would face higher rate increases. This would reduce, or eliminate, the cross subsidy to the Neighbor Island shippers.

As mentioned above, a more dramatic event would be a new entrant—or the threat of a new entrant—into the mainland-Hawai'i trade that served only O'ahu and not the Neighbor Islands. Using the sample calculations above, the new carrier could reduce its container rates from the mainland to O'ahu by \$200 just by eliminating the cross subsidy. Existing carriers could meet the new carrier's rates by lowering their own and even do away with the Common Fare approach in order to put themselves on a "more level footing." A new entrant offering direct sailings to a major Neighbor Island port could trigger parallel responses.

TABLE 1
IMPACT OF COMMON FARE ON STAKEHOLDERS

Category	Disadvantage	Neutral	Advantage
Container Waterborne Carriers			
Between Hawai'i and Mainland			
-also serve Neighbor Islands	X		
-only serve O'ahu			X
Between O'ahu and Neighbor Islands			
-carry only interstate cargo	X		
-carry intrastate cargo	X		
Shippers			
On Mainland serving Hawai'i			
-serve O'ahu	X		
-serve Neighbor Islands			X
On O'ahu			
-serving the mainland	X		
-serving the Neighbor Islands	X		
On the Neighbor Islands			
-serving the mainland			X
-serving O'ahu			X
Receivers/Consignees			
Mainland Businesses			
-receiving from O'ahu	X		
-receiving from Neighbor Islands			X
O'ahu Businesses			
-receiving from the mainland	X		
-receiving from the Neighbor Islands			X
Neighbor Island Businesses			
-receiving from the mainland			X
-receiving from O'ahu	X		
Non-Users of Waterborne Transportation			
Local Businesses Selling on Their Own Island			
-on O'ahu			X
-on Neighbor Island	X		
State Elected Officials			
-considering local and statewide impacts	?	?	?

Legend: ? signifies unknown (combination of others)

The details of changing the rate structure could be quite complicated for the following reason: the existing tariff is very complex. There are a variety of items that could be changed (e.g., general tariff rate, terminal handling charge, Neighbor Island surcharge); and it may be easier to increase rates differentially rather than reduce the rates to O'ahu.

THE IMPACT OF CHANGE

If the Common Fare ended, the effects would vary greatly depending on the individual stakeholder's situation. Shippers between the mainland and the Neighbor Islands would pay more for transportation. In theory, consumers on O'ahu would pay less for their shipments. (Shippers have noted that they have no guarantee that such decreases would occur.) Manufacturers/producers on O'ahu shipping to the Neighbor Islands would now theoretically have a "level playing field" with their competitors on the mainland in terms of the transportation cost between O'ahu and the Neighbor Islands. In contrast, companies located solely on a Neighbor Island would now face more competition from O'ahu-based firms wishing to extend their reach to the Neighbor Islands. Carriers between the mainland and Hawai'i would be better able to deal with competitors that only served O'ahu but not the Neighbor Islands (or the threat of such competitors).

A few examples will provide a more detailed view. Starting with the representative values above, assume that the container rate from the mainland to O'ahu is reduced from \$3,200 to \$3,000. Interisland rates for all containers from the mainland will be \$600, so the rate from the Mainland to a Neighbor Island will now be \$3,600 (up from \$3,200).

The question is: How important is a decrease of \$200 or an increase of \$400 to shippers? One way of addressing this is to compare it with a recent increase in freight rates from the mainland to Hawai'i introduced by Matson and matched by Horizon. The rate increase (effective January 11, 2004) was \$150: \$125 per container, plus the

Terminal Handling Charge increase from \$200 to \$225 per container (Matson Navigation Company, 2003). In addition, shippers also pay a 7.5 percent fuel surcharge that will cause the shippers to pay more as this percentage will apply to a larger base after the rate increase. Rate increases typically occur on this trade route annually or more frequently. Therefore, the total impact of the Common Fare is equivalent to the amount of rate increases shippers now experience every few years.

The impact on a given shipper/consignee will depend on the specific amount of the increase to the product involved and the alternatives open to competitors and customers. The freight rate from the mainland to Hawai'i typically accounts for between 3 and 25 percent of the delivered price of a product.⁵ Note that for a higher value product where the ocean transportation accounts for 10 percent of the delivered price, a 50 percent increase in freight rate results in only about a 5 percent increase in delivered price. For a lower value product where the ocean transportation accounts for 20 percent of the delivered price, a 50 percent increase in freight rate results in approximately a 10 percent increase in delivered price. (A container of electronic goods is less affected by the transportation cost than a container of peat moss.) If we consider the impact of a 10 percent increase of the higher and lower valued goods, the results are about 1 percent and 2 percent, respectively. For example, for a 40 foot container full of 12 oz. soda cans, the freight rate from the mainland to the Neighbor Islands is about six cents per can. Any normal freight rate increase would amount to less than a penny per can in the delivered cost.

A key issue is to what extent businesses can pass on higher costs to their customers (the elasticity of demand). Since most commodities shipped in ocean containers to Hawai'i have little alternative forms of transportation (i.e., air freight is too expensive), as long as all carriers/businesses raise their rates together, the consumer has little option except to pay more (or stop using the product).

Another key issue is whether factors other than transportation rates play a more important role in the delivered price of the product. A manufacturer with a major presence and a large warehouse on O'ahu may choose to subsidize product sales to the Neighbor Islands so that it is less expensive for a Neighbor Island business to order from him/her than ordering from the mainland. Where perishable produce is involved, a Neighbor Island business may prefer to pay the interisland intrastate barge rate in order to obtain fresh, high quality product quickly from O'ahu rather than waiting for less expensive product from the mainland.

Small businesses located only on the Neighbor Islands are concerned about large "Big Box" competitors with a presence on all the major islands. These firms can: (1) obtain a lower price from the supplier on the mainland, (2) obtain a lower price from the ocean carriers, and (3) sell at one price statewide by averaging their lower cost traffic to O'ahu with their higher price business in the Neighbor Islands.

Other market forces are also at work. The costs of transportation do not explain, for example, why it is possible to pay \$3 more for a 14.1 ounce/400 gram box of cereal on O'ahu than on the mainland. The ocean freight rate makes up less than 20 percent of this difference. There are numerous examples of such "aberrations." Obviously the competitive situation in Hawai'i has a profound impact on costs to consumers over-and-above the costs of transportation.

In the past, various Hawai'i government officials have made public statements in favor of the Common Fare. The rationale generally being that the Neighbor Islands required differential treatment to assist their development and that it was in the entire State's interest to do so. This may now be questionable since the Neighbor Islands are growing at a faster rate than O'ahu. It is reasonable to ask whether the Hawai'i state government should play a role in trying to aid the Neighbor Islands by preserving the Common Fare system. There are possible legal problems involved with attempting to constrain ocean

carriers in interstate commerce through legislation (e.g., requiring carriers that serve O'ahu to also serve the Neighbor Islands). Another approach is for the state to subsidize the movement of interisland cargo. At least three other states (North Carolina, Mississippi and Massachusetts) have used state tax credits to promote the use of their state ports. There are also other alternatives. Let it suffice to say that this is an issue that affects the entire state and it is not unreasonable to expect the government to understand the implications of the current Common Fare practice.

CONCLUDING COMMENTS

Within the waterborne trades of the U.S., the Common Fare system is an anachronism that exists in its present form only in Hawai'i. Just as it disappeared from the airline rate structure, the authors feel that it will someday disappear from the ocean freight rate structure. It is impossible to predict when the Common Fare approach will end, but the introduction of a new containership carrier that serves only O'ahu and not the Neighbor Islands—or the threat of such an entrant—is the event most likely to trigger the reevaluation of the practice. The introduction of the Superferry will also generate new competitive issues. A more evolutionary approach on the part of the existing containership operators would be the gradual introduction of surcharges for containers being transshipped in Honolulu for the Neighbor Islands, but given the potential new entrants it is more likely that the gradual approach will receive secondary consideration.

The best strategy for all stakeholders is to understand the current circumstances and potential changes on the horizon with their possible impending changes to the Common Fare practice. It is important that the stakeholders begin the process of determining how the end of the Common Fare system should alter their business strategies and operations. Through this early recognition stakeholders will be able to position themselves to take advantage of their new business environment. Further, this is an

interesting case for transportation researchers to follow as it is unique in the waterborne trades.

ENDNOTES

1. This excludes a separate charge by the State of Hawai'i for use of the port: wharfage fees.
2. The Passenger Services Act of 1886 places similar requirements on shipowners carrying passengers from one U.S. port to a destination at a different U.S. port. Note, however, that recent accommodations have been made to permit access to non-U.S.-constructed vessels by Norwegian Cruise Lines (NCL) to provide domestic cruise services within the Hawaiian Islands.
3. In addition, other common carriers are Sea Link of Hawaii, Inc., a passenger and cargo

carrier providing water transportation services between the islands of Maui and Molokai, and Hone Hene Corporation, a passenger and cargo carrier providing water transportation services between the islands of Maui and Lanai.

4. The authors were unable to find accurate state or federal published information on the movement of containers or their average tariffs in the Hawai'i trade. Nevertheless, from discussions with governmental bodies, carriers, and shippers, we are confident that the data utilized are well within reason.

5. Normally, carriers price on the basis of the "value of service" concept. In other words, high value goods are charged more than low value goods.

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DISPATCHING CONTINUOUS MOVES

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ABSTRACT

Continuous Moves (CM) is a term coined by the trucking industry. This paper defines CM's, classifies them and discusses their economies. A unifying mathematical optimization model for dispatching orders is then presented. The model selects the best way to dispatch each and every order, whether as a part of a CM or not. However, the model does consider all the feasible types of CM's. Practical aspects associated with implementing CM's are also discussed.

The term *continuous move* has emerged from the trucking industry during the last decade. A truck is productive (i.e., generates revenue) only when it moves loaded. From the truck operator(s) perspective loading and unloading are necessary facilitating activities that rob truck time, whereas waiting and driving an empty truck are counter productive and should be minimized. Thus, the basic concept behind the term *continuous move* is that a truck should be kept moving with revenue generating loads. However, the term *continuous moves* has a variety of meanings depending on the type of operation with which it is associated. It usually refers to long-haul trucking operations where a truck is assigned several days of work and does not necessarily return to its starting location. In order to keep their trucks moving loaded, truck operators give a variety of economic incentives to shippers (or to third party providers) who provide *continuous moves* for their trucks.

This paper reviews continuous moves (CM) in the context of a variety of operational environments. It introduces a classification of

continuous moves, discusses the economic incentives offered by truck operators for continuous moves, presents a mathematical model that is used to construct and select an efficient set of continuous moves while simultaneously considering other feasible alternatives for dispatching the orders, and discusses practical considerations for implementing continuous moves. For the sake of clarity the next section provides definitions of commonly used terms, and defines and classifies CM's. It is followed by a brief literature review of dispatching CM's. Then, the orders dispatching environment is presented with a unifying mathematical optimization model that is used to dispatch orders. A discussion of practical considerations in dispatching CM's follows, closing with a brief summary.

CLASSIFICATION OF CONTINUOUS MOVES

In order to facilitate clear classification of continuous moves (CM's), definitions of some basic common terms are required:

- Origin-** A single location (a stop).
- Destination-** A single location (a stop).
- Order-** A shipment from a single origin to a single destination with a size that does not exceed a truck(s) capacity. If an order requires more than a truck(s) capacity, it must be split into several orders.
- Load-** The cargo on a truck at any given moment.
- Truckload (TL) order-** An order that requires a full truck capacity or an order that is shipped separately on a truck (such an order may be a combined order consisting of several orders with a common origin and a common destination).
- Inbound TL-** A load on a truck consisting of several orders that have more than one origin, but a single destination. The intermediate origins are usually referred to as pick up locations.
- Outbound TL-** A load on a truck consisting of several orders that have a single origin and multiple destinations. The intermediate destinations are often referred to as stop-offs.
- Less-than-Truckload (LTL) order-** An order that requires less than a full truck capacity. Multiple such orders may be on a truck simultaneously.
- Truck mode-** A set of trucks that have the same operating rules and the same cost structure.
- Truck type-** A set of trucks of the same mode that have the same physical characteristics (e.g., capacity, compartments).
- The terms TL and LTL above correspond to a large extent to carriers' mode of operation and their freight rates.
- Generally, a continuous move (CM) is a sequence of shipments (orders) assigned to a truck. However, not every sequence of shipments is a continuous move. For the purpose at hand, a CM is defined as a truck route spanning more than one day and consists of a sequence of legs during which the truck is loaded (fully or partially) more than once, unloaded (fully or partially) more than once, and these activities are interwoven (all the loading activities do not precede all the unloading activities). Although multiple local delivery (and/or pick up) routes during a truck shift (or a route with a backhaul) can also be considered a CM, such is not the case here. CM refers only to long haul operations with open (one-way) routes.
- The objective of a CM is to improve the truck's utilization and profitability. Therefore, the truck's operator offers economic incentives to the shipper to assemble CM's. The definition of a CM and the corresponding discounts are subject to negotiations between the shipper and the truck operator. Usually a CM limits the time the truck has to wait for a second (or subsequent) order of the CM (the dwell time), or limits the deadhead distance that the truck has to go to pick up the second (or subsequent) order of the CM (or it may limit both time and distance). There may be other limitations on a CM, such as minimal distance of a loaded leg, or maximal time of a CM. The discount given to the shipper for a CM may be a fixed dollar amount for each order following the first one, a percentage discount on the freight rate for all the orders in the CM (or only on the orders following the first one), or a combination thereof. The actual discount may also depend on the CM characteristics.

Using the definitions above, several types of CM's can be identified:

Pure TL-CM- The continuous move consists of a sequence of TL orders (see Figure 1).

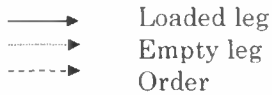
Combined TL-CM- The continuous move consists of a sequence of orders that is a combination of TL orders, Inbound TL loads, or Outbound TL loads (see Figure 2).

LTL-CM- The continuous move consists of multiple LTL orders with different origins and different destinations. Some orders may

share an origin, and some orders may share a destination. This is actually a sequence of interwoven pick-ups and deliveries where the truck may not be empty till the end of its route (see Figure 3).

The hypothetical examples in Figures 1 through 3 are intentionally simple ones in order to demonstrate the concepts. An example of an actual LTL-CM is provided in Table 1. The truck loads three orders in the initial source in Detroit (MI), one to OH, one to NY, and one to CT. It delivers first the OH order, and, at the same location, loads two additional orders, one to NY, and one to MA. Then it delivers the two NY orders (at two different locations), the CT order, and, finally the MA order.

**FIGURE 1
PURE TL CONTINUOUS MOVE**



Truck capacity: 45,000

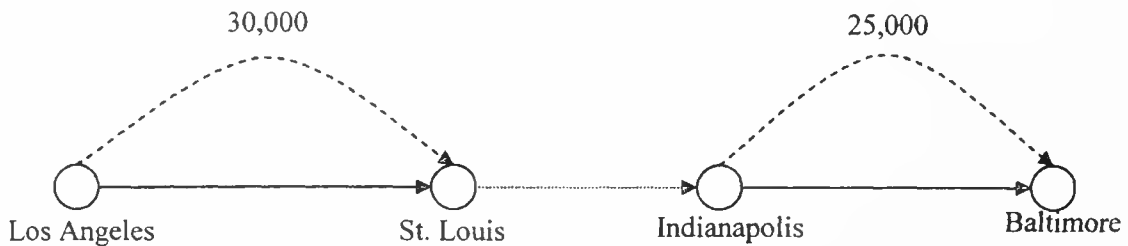


FIGURE 2
COMBINED TL CONTINUOUS MOVE

———→ Loaded leg
 - - - - -→ Empty leg
 ·····→ Order

Truck capacity: 45,000

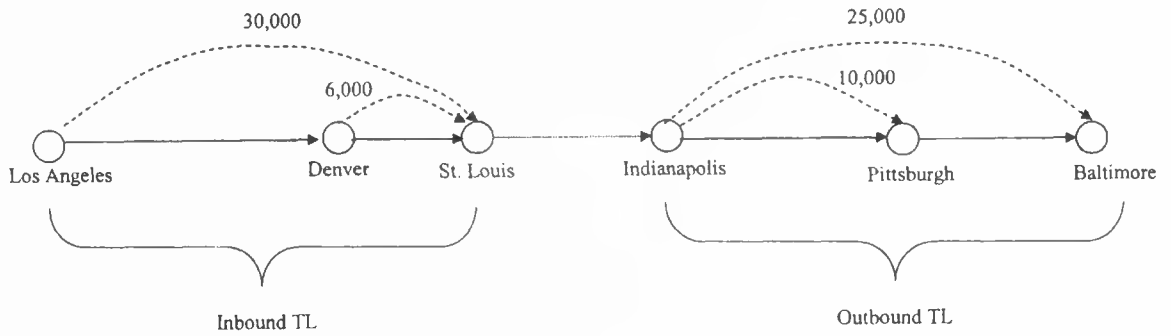


FIGURE 3
LTL CONTINUOUS MOVE

———→ Loaded leg
 - - - - -→ Empty leg
 ·····→ Order

Truck capacity: 45,000

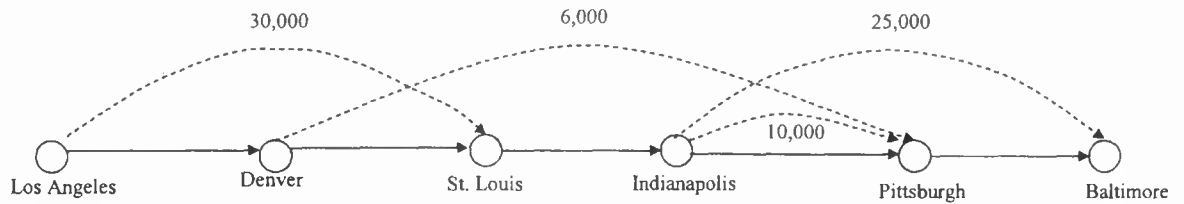


TABLE 1
EXAMPLE OF LTL-CM ROUTE

Order No.	Location		Weight (Lbs.)*	Load on Truck (Lbs.)
	No.	State		
141	13	MI	16,542	
64	13	MI	10,012	
99	13	MI	6,944	33,498
-141	18	OH	-16,542	
135	18	OH	11,074	
151	18	OH	2,719	30,749
-99	63	NY	-6,944	23,805
-151	109	NY	-2,719	21,086
-64	49	CT	-10,012	11,074
-135	101	MA	-11,074	0

*A negative number indicates delivery

LITERATURE REVIEW

The term *continuous moves* (CM) does not seem to appear in the academic literature, but different types of CM's have been addressed to some extent. Continuous moves fall in the domain of the vehicle routing literature, which is vast (for a recent review see Toth and Vigo, 2002). However, very few papers deal with vehicle routing problems that include CM's, and usually not in the context of the wider perspective of dispatching orders, where CM's are only one alternative out of several options for how to dispatch an order. Moreover, a uniform fleet is usually assumed, which allows mini-mizing miles rather than costs. Skitt and Levary (1985) and later Desrosiers et al. (1988) dealt with a Pure TL-CM problem where the fleet is uniform and, therefore, they minimize truck miles. A more complicated TL-CM problem that involves multiple products and non-uniform fleet was addressed by Brown et al. (1987).

Goetschalckx (1988) described a decision support system for dynamic truck dispatching. It is used for assigning orders to a uniform fleet of contract carrier trucks. When a new order comes in, the

system evaluates incrementally, adding it to existing routes or establishing a new route for it. Route alternatives for the order are ranked and presented to the dispatcher for selection. This system is for LTL-CM but dispatches one order at a time using a uniform fleet. In a review paper, Savelsbergh and Sol (1995) present "the general pickup and delivery problem," which covers a large variety of vehicle routing problems, including some types of continuous moves. Their "static full truck load pickup and delivery problem" is the TL-CM move used here. They discuss the various types of problems and corresponding solution algorithms. However, each type of problem corresponds to a single mode of truck. When an order can be assigned to different (alternate) modes of trucks, separating the orders by truck mode before solving the dispatching problem may be far from optimal. Later, Savelsbergh and Sol (1998) presented a system for dynamic dispatching of Outbound TL loads using a heterogeneous fleet of a single mode of trucks. Multi-day routes that are a sequence of Outbound TL loads are assigned to each truck. These are one type of the Combined TL-CM move used in the current research.

More recently, a proposed system for solving a diverse variety of vehicle routing problems was outlined by Desrochers et al. (1999). The perceived system first identifies the type of problem through a dialog with the user. Then the system selects or constructs a suitable algorithm to solve the problem based on what was learned in the previous step. The authors did some initial exploratory work using expert system tools. However, it is not clear how such a system would deal with multiple different overlapping vehicle routing problems.

A unifying approach to dispatching orders that considers simultaneously all feasible truck modes and route types for each order is presented here. An outline of a LTL-CM route generator, a route type that, to the best of the authors' knowledge, has not been published before in the literature is also presented here. To solve the orders dispatching problem that includes (optional) CM's, a variant of the familiar set partitioning model is used. Set partitioning models have been used also to solve other complex resource scheduling problems, such as crew scheduling (see, for example, Butchers et al., 2001).

DISPATCHING ORDERS

Shipping an order as a part of a CM is only one option faced by a dispatcher. At any given time, the dispatcher has to assign a set of orders to the available trucks at minimal cost while meeting the service requirements. Usually different modes of trucking services can be used to ship an order. Even when there is no choice of mode of truck for a specific order, there still may be alternate possibilities to consolidate that order with other orders into truck routes. Generally, the following modes of trucks may be available to the dispatcher:

- Contract carrier—paid either by miles (where the mileage rate may depend on the final destination) or on a point-to-point basis (based on origin and destination), with additional charges for stop-offs. Usually assigned open routes.
- LTL common carrier—paid by class, order size, origin and destination. Each order is charged separately (no economies in consolidation of orders).
- TL common carrier—paid by origin and destination on a point-to-point basis. Each order is charged separately (no economies in consolidation of orders).

Private fleets and dedicated carrier trucks are usually kept close to their origin and assigned one- or two-day closed routes. Some of these routes may be viewed as short CM's. However, because they charge by miles and hours and their routes are closed, a different procedure (generator) is required to create their routes. Due to the way contract carriers charge for their trucks, they are the primary candidates for CM's. Properly implemented CM's have the potential to save cost both to the shipper and the carrier involved.

When one tries to dispatch a set of orders at minimal cost while meeting service requirements using various modes of trucks, it is necessary to take a comprehensive view of the dispatching alternatives. Except for special situations, it is difficult to know in advance what is the best way to ship a specific order without considering the other orders that are being dispatched at the same time. An order with a given size, origin and destination may one day be best shipped by one mode of truck and the next day by another mode of truck, depending on availability of other orders with which it could be consolidated on a truck. Most models found in the literature deal with each truck mode separately. Such an approach requires assigning (in advance) each order to a truck mode. The approach used here is to consider all truck modes and all orders

simultaneously, and assign each order to a truck mode and route in a manner that minimizes the cost of shipping all the orders while meeting all service requirements.

A variant of the familiar set partitioning model to select a set of routes that provides the least-cost way to ship the given set of orders using the available fleet of trucks is used in this research. Set Partitioning (SP) is a mathematical model that has been very useful for transportation routing and scheduling (see Ronen, 1995). It accommodates discrete and nonlinear costs that are common in transportation of goods, allows incorporation of a large variety of operational considerations, and provides a minimal cost dispatch. For a given set of orders and trucks, a large number of feasible candidate routes is generated in an SP model. A given order may be included in multiple (alternate) routes. A candidate route consists of a specific truck and a specific subset of the considered orders with a detailed schedule of their pick up and delivery. Only feasible routes that satisfy all the operational requirements are considered. The cost of each route is calculated, and the SP model selects the subset of routes that minimizes the total cost of shipping the considered set of orders while assuring that each order is shipped exactly once, and each truck is used exactly once.

The author prefers to use a variant of the SP model, an Elastic Set Partitioning (ESP) model. In ESP, violation of the SP constraints is allowed at a cost that is included in the objective function (see Appendix C). ESP is a more compact and flexible model where shipping each order by a common carrier is not considered explicitly, but rather through the constraint violation penalties, and not all trucks must be used, as explained in Appendix C. The elastic model assures mathematically feasible solutions even when there is insufficient truck capacity to dispatch all orders (in that case the excess orders are assigned to common carriers). A detailed numerical example of an ESP model was provided in Bausch et al. (1994).

The problem with the SP (and ESP) approach is that when a very large number of alternate routes are considered it may take a significant amount of time to find the minimal cost dispatch. However, with the rapid development of computing power this is becoming less of a concern. The key to achieving good results is in the generation of the candidate routes. The time window of each order (earliest time available and latest delivery time) introduces a natural sequence of the orders and reduces the number of potential routes. Tighter time windows that result from the shift to just-in-time requirements further improves the route generation process.

An Elastic Set Partitioning (ESP) model can be used as a unifying approach for dispatching orders from multiple origins to multiple destinations. In addition to other types of routes, it can consider all the types of CM's and select the most efficient way to dispatch each order in a given set of orders. Several different route generators are necessary to implement this approach: (a) Private/dedicated trucks, (b) Inbound TL, (c) Outbound TL, (d) LTL-CM (see Appendix A), and (e) routes chaining. The first generator (a) creates routes for private or dedicated fleet trucks. These are closed routes that may implicitly include CM's. The last generator (e) chains TL orders with routes generated by (b) and (c) to create additional CM routes. This approach is outlined in Appendix B.

In order to assemble CM's, some basic data are necessary for each order: origin, destination, size, earliest available time, latest delivery time, and special requirements (equipment, handling). In addition, distance and driving time among locations must be known, as well as loading and unloading time and delays, operating hours of the various locations involved and driver work restrictions. In order to determine the economies of CM's, the basic freight rates and the relevant discounts must be known. In addition, the characteristics of the various available trucks must be known, such as: location, capacity, equipment, operating rules, cost structure and specific costs.

In order to use CM's, one first has to create a set of potential CM's, and evaluate their operational feasibility and economic viability. Creating Pure TL-CM's is relatively easy, especially when one uses a fast computer. Since each order is shipped separately, the issue is how to chain the TL orders into an efficient set of CM's, and which orders to ship without CM's. A large number of potential CM's can be generated and the best subset can be selected. This type of problem has been addressed by multiple authors without mentioning the term CM (for a recent example see Ronen, 2000).

Creating Combined TL-CM's is more complicated because they may also include Inbound TL loads and Outbound TL loads (for Inbound and Outbound TL loads see Bausch et al., 1995, and Brown and Ronen, 1997). Once a set of potential Inbound TL loads and potential Outbound TL loads is generated, one can chain them together (while also considering pure TL orders) into potential Combined TL-CM's.

Creating good LTL-CM's is much more challenging due to the enormous number of order combinations possible. Logically, an LTL-CM starts with an Outbound TL load and then additional orders are added to it. The Outbound TL load usually starts at a major (primary) origin. Some simple rules may be used to focus the search for orders to be added: minimal size of an order to be considered for addition to the CM, maximal additional driving time (or distance) to load (or unload) an order, maximal number of orders on the truck at any time (the more orders on a truck the more chance of delays on the route), maximal allowed utilization of truck capacity (to allow access to orders at the nose of the truck), only orders moving in the same general direction. When an order is added to a CM one must also make sure that the addition will not cause a delay in delivery of another order that is already in the CM beyond its latest delivery time. The generator that generates LTL-CM's must perform a detailed deterministic simulation of the route in order to assure feasibility of the generated CM's. It must assure

that every order on the route is picked-up and delivered on time, while the operating rules of the truck are not violated. Only routes that are deemed feasible are considered by the optimization model. Such a generator is outlined in Appendix A.

After the candidate set of routes is generated, each route must be priced before the set is submitted to the optimization model. Carriers may charge differently for different types of CM's. A Pure TL-CM will usually be charged at a TL rate with the agreed upon discounts for the CM. A Combined TL-CM will usually be charged at the TL rate with stop-offs, with the CM discount. However, a LTL-CM may be charged at the TL rate with stop-offs or at a mileage rate, with or without a CM discount.

Creation of CM's may be easier or harder, but one should not lose perspective. Using CM's to ship orders is not the objective, it is just a means to reduce shipping costs (while meeting service requirements). When one has to ship a given set of orders, the objective is to ship that set at minimal cost while satisfying customer service requirements. Thus, each order should not be considered separately, but rather the shipping of the whole set of orders should be optimized. Usually there is a large variety of ways to ship a given order. An order may be shipped by a private-fleet truck, a dedicated truck, a contract carrier, or a common carrier. It may be shipped alone, or as a part of a consolidated load which may, or may not, be included in a CM. Each one of these possibilities has a different cost. Due to economies of scale in shipping that are reflected in rate structures, the cheapest way to ship a given order usually depends on which other orders are shipped with it.

An ESP-based dispatching system that considers various types of CM's has been implemented in a commercial dispatching system. It selects the optimal set of routes out of hundreds of thousands of considered routes. The cost savings that result from considering CM's depend to a large extent on the specific mix of orders, the

carrier freight rates, and the associated CM discounts.

PRACTICAL ASPECTS

There are economies of scale in assembling CM's. The denser the set of orders that is considered for CM's, both geographically and temporally, the higher the likelihood to match orders and assemble CM's. Due to these economies of scale, third party providers are in a better position (than shippers) to assemble CM's by combining orders from different shippers. However, combining orders from different shippers in a CM can pose some complications, such as: equitable distribution of the carrier(s) discount for the CM among the participating shippers, objection from one shipper to ship his orders with a competitor's orders on the same truck, or objections from competing destinations to receiving their orders on the same truck. In addition, it must be assured that all the orders that end up on the same truck can be shipped together (don't ship packaged lube oil with packaged food). Further complications in CM's may be posed by requirements for loading or unloading appointments. One missed appointment may disrupt the remainder of the CM.

Economies of scale call for centralized dispatching, and possibly releasing the orders that are not combined into CM's to regional dispatching centers. Some final destinations are preferred by certain carriers (they may have loads originating in the same area) whereas other destinations may be deemed undesirable. These preferences are usually reflected either in the rates or in the discounts given for CM's ending in such destinations.

Another major issue is availability and reliability of data concerning future shipments. CM routes usually span several days and require commitment of future shipments that may not be ready at the time the CM commitment is made. Information regarding order timing, size, and even origin or destination may change till the truck shows up to load the order. The farther into the future one ventures, the less reliable the

data are.

From an operational perspective, CM's can be divided into two categories:

"Give me another load"—an inbound truck is available for an outbound load. Due to carrier requirement to return a driver home by a certain time, a CM may have to head in a certain direction and end by a specified time.

"Use the truck for X days"—a specified period commitment with defined start and end locations will usually result in a lower mileage rate, but will require a minimal charge. Both of these categories can be incorporated into the ESP model.

The dynamic aspects of dispatching must also be taken into account. At any given time trucks are moving with assigned loads and changes in their schedules may happen for numerous reasons. The approach outlined above can be used in a dynamic mode if one knows what orders are on each truck, where each truck is heading, and other relevant data. However, when creating a dynamically updated dispatch one should take into account the time it takes to communicate the revised instructions to the field.

SUMMARY

Continuous moves represent an effort to increase the utilization (and revenue generation) of trucks. Economies of scale in assembling CM's call for centralized dispatching. The various varieties of TL continuous moves are much easier to assemble than LTL continuous moves. However, in the current competitive business environment with pressures to reduce inventory and to ship just-in-time, few shippers have the luxury of shipping exclusively full TL loads to their customers. Thus, LTL continuous moves, although much harder to assemble, may represent a significant opportunity.

An order usually can be shipped by a variety of truck modes, and the cost of shipping the order on a given day usually depend on other orders

that are shipped with it. Therefore, if one wishes to minimize shipping costs, CM's must be considered in the context of the total dispatching

picture. ESP is an optimization approach that facilitates minimizing the total shipping costs of all orders every day.

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APPENDIX A
OUTLINE OF LTL-CM GENERATOR

1. Start and read data
2. Create seed CM's:
 - 2.1 Take the next primary source. If none left go to 3
 - 2.2 Sort originating orders by earliest available time
 - 2.3 Create Outbound TL loads going in the same direction following all CM rules. Put each one of them in the candidate CM list
 - 2.4 Take each originating order that is not included in any of the Outbound TL loads and make it a candidate CM
 - 2.5 Go to 2.1
3. Append an order to a candidate CM:
 - 3.1 Take the next CM from the candidate CM list. If none left go to 4
 - 3.2 Take each order that is not included in the candidate CM and try to add it to the CM. If an order can be added to the candidate CM write the new candidate CM (the one with the additional order) at the end of the list of candidate CM's.
 - 3.3 Go to 3.1
4. Cost the candidate CM's:
 - 4.1 Take the next CM from the candidate CM list and cost it. If none left go to 5.
 - 4.2 If the cost of the candidate CM is larger than the cost of shipping each order included in it separately, eliminate this candidate CM.
 - 4.3 Go to 4.1
5. Stop.

APPENDIX B
OUTLINE OF ROUTES GENERATOR

1. Start and read data
2. Generate routes for private and dedicated fleet trucks
3. Generate non-CM routes for contract carrier trucks (some of these routes may be Inbound TL or Outbound TL loads)
4. Create candidate TL-CM's (pure and combined) for contract carrier trucks:
 - 4.1 Sort TL orders, Inbound TL loads, and Outbound TL loads by earliest start
 - 4.2 Chain the entities in 4.1 to create new candidate TL-CM's.
 - 4.3 Cost each new candidate TL-CM. Delete the TL-CM if it(s cost is higher than the cost of shipping each order separately
5. Create candidate LTL-CM's (see Appendix A)
6. Submit all remaining routes (CM and non-CM) to the ESP model.

APPENDIX C ELASTIC SET PARTITIONING MODEL

The author cast the orders dispatching problem into the following Elastic Set Partitioning (ESP) model.

Indices:

o = 1, ..., orders
 r = 1, ..., routes
 t = 1, ..., truck types
 R(t) routes for truck type t
 R(o) routes delivering order o.

Data:

Cost_r—cost of route r (a function of the truck type and the set of orders in the route).
 CCost_o—cost of shipping order o by common carriers.
 ICost_t—cost of keeping a truck of type t idle.
 N_t—Number of trucks of type t.

Binary Decision Variables:

ROUTE_r = 1 if route r is selected.
 COMMON_o = 1 if order o is shipped by common carrier.

Integer Decision Variable:

IDLE_t = Number of trucks of type t that are not assigned a route.

ESP Formulation:

$$\text{Min} \left\{ \sum_r \text{Cost}_r \text{ROUTE}_r + \sum_o \text{CCost}_o \text{COMMON}_o + \sum_t \text{ICost}_t \text{IDLE}_t \right\} \quad (1)$$

Subject to:

$$\text{for every order: } \sum_{r \in R(o)} \text{ROUTE}_r + \text{COMMON}_o = 1 \quad (2)$$

$$\text{for every truck type: } \sum_{r \in R(t)} \text{ROUTE}_r + \text{IDLE}_t = N_t \quad (3)$$

Constraints (2) assure that every order will be shipped, either as a part of a truck route or separately by a common carrier. If the order is not included in a selected route the variable COMMON must equal 1, and the cost associated with shipping the order by a common carrier is paid. Constraints (3) assure that every truck is either assigned a route or is paid the cost of keeping it idle (the cost of keeping a truck idle may be zero if there is no commitment to use it or pay for it). The objective function minimizes (the cost of performing the selected routes + the cost of common carrier shipments + the cost of not using the trucks).

A truck type is a set of trucks that have identical physical, economic and operational characteristics. Clustering trucks into types may reduce very significantly the size of the problem, depending on the specific operation. Instead of generating routes for each truck separately one can generate routes for each truck type, and the number of routes assigned to a truck type is limited to the number of trucks of that type.

The routes are those generated by the routes generator (see Appendix B) and may include continuous moves.

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PERCEPTUAL DIFFERENCES BETWEEN SHIPPERS AND MOTOR CARRIERS REGARDING THE IMPORTANCE OF CARRIER SELECTION CRITERIA

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ABSTRACT

The primary focus of this study is the identification of significant differences in the assessment of the importance of 36 carrier selection variables by both carriers and shippers. This study is based on the original 1992 investigation. Currently, statistically significant differences resulted between shipper and carrier mean ratings for nine of the thirty-six selection criteria. In the original study, there were significant differences for nineteen of thirty-five selection variables. The rating and ranking discrepancies in this study indicate that shippers and carriers do not classify the importance of some selection variables similarly, but carrier understanding seems to be improving. Carriers must take the forefront by providing leadership and innovation in relation to their selection mixes, rather than keying on past performance and relationships.

Since the mid-1990's, competition in the motor carrier industry has greatly intensified with globalization, NAFTA, and the move toward requiring technological information support systems (Milligan, 1999). Because of this intense competition, even more attention was focused on satisfying shipper preferences. According to Crum and Allen, "shippers are increasingly demanding better quality service from carriers" (Crum and Allen, 1997). An effective marketing

strategy will deliver better quality service and result in greater shipper satisfaction. Shipper satisfaction is a function of carriers providing a selection variable mix that best serves shippers. Surprisingly, little has been done to determine the nature of carrier understanding of the most significant carrier selection variables. In fact, previous studies indicate that the carrier choice decision may be regarded by shippers and carriers in a much different manner. Specifically,

some shippers and carriers appear to have very different notions of what constitutes satisfactory service by motor carriers.

It is important that the buyer-seller dyad be understood from *both* the shipper and carrier perspectives. Evans and Southard's 1974 study of manufacturers, wholesalers, retailers and motor carriers in Oklahoma investigated how *both* shippers and carriers perceived 28 factors, thought to be important in the selection decision. Respondent evaluations were measured on a five-point scale. Perceptions were then compared by means of t-tests. Evans and Southard found that there were six perceptual differences between shippers and carriers (Evans and Southard, 1974).

Prior to deregulation, only the Evans and Southard study sampled *both* shippers and carriers and specifically investigated the variables related to the selection of motor carriers. In the 1970's, other empirical studies dealing with carrier selection did not specifically investigate the views of both shippers and motor carriers (Stock, 1976; Jerman et al., 1978 and McGinnis, 1979). In the 1980's, studies had a narrow focus, examining only the shipper perspective of the transportation seller-buyer relationship (Krapfel and Mentzer, 1982; Baker, 1984; Chow and Poist, 1984 and Granzin et al., 1986). The original 1992 study investigated the importance of certain motor carrier selection variables to *both* shippers and carriers (Premeaux et al., 1992). No other researchers have investigated the importance of motor carrier selection variables to *both* shippers and carriers since deregulation. This study expands on the original investigation and seeks to provide the information necessary for carriers to better understand the importance of thirty-six motor carrier selection criteria to shippers.

RESEARCH DESIGN

This research attempts to determine the factors that most influence carrier selection and how *both* carriers and shippers differ in relation to the importance placed on these variables. A

systematic sample of traffic managers and motor carrier managers provided the database for this study. The sample of traffic managers was composed of individuals employed by various manufacturing, wholesaling and retailing organizations and was selected from *The Official Directory of Industrial and Commercial Traffic Executives*. The motor carrier manager sample was drawn from a list of motor freight trucking companies supplied by American Business List.

A mail questionnaire was chosen because of the time necessary to complete the survey and the geographic dispersion of the respondents. Questionnaires were mailed to 2000 shipper traffic managers and 2000 motor carrier managers. Of those queried, 794 shippers and 685 carriers responded. The number of usable questionnaires was 762 and 651, respectively. The usable responses comprised 38.1 percent and 32.5 percent of the survey population, which should provide a reasonably accurate representation of the actual population.

Only nationwide motor carriers were surveyed and their demographic profiles differed only slightly from the 1992 carrier group. These carriers estimated that the majority of their shipments were truckload. The averages for the sample were 74 percent TL shipments and 26 percent LTL shipments. However, it should be noted that these percentages are averages of the total sample of respondents' estimations. Of the shippers responding, 24 percent were producers of home products, 25 percent produced industrial goods destined for further processing, 22 percent were food producers, 11 percent produced electronics products, and 18 percent classified themselves as "other" types of producers. Seventy-eight percent of the shipper sample stated that they normally ship in large lot sizes.

The original 1992 study used thirty-five carrier selection criteria that were drawn from previous work. This research includes the thirty-five original motor carrier selection variables, plus a Web-enhanced Electronic-Data-Interchange (EDI). A Web-enhanced EDI is a frequently mentioned selection variable because it offers

many advantages including electronic billing, rate charge calculations, pickup and delivery scheduling, and shipment tracing. Specifically, utilizing the Internet whenever possible lowers overall transaction costs. However, since Web-based services are only as good as the information systems that support them, hybrid systems that use network providers for some services, and the Internet for others, were most prevalent among the survey respondents. Many in the transportation industry are adopting advanced Web-enhanced EDI systems to enhance customer service (McGovern, 1998). The thirty-six selection criteria listed in Table 1 are thought to be used by shippers in their motor carrier selection decisions. Each of the thirty-six variables included in the survey were briefly defined on the survey instrument to help ensure respondent understanding of each variable. Carrier managers were asked their perceptions of the importance that shippers place on each selection variable. Traffic managers were also asked to rate the importance of each selection variable. The following scale was used:

1. Not important
2. Slightly important
3. Moderately important
4. Very important
5. One of the most important factors

PERCEPTUAL DIFFERENCES BETWEEN SHIPPERS AND MOTOR CARRIERS

Initially, descriptive statistics in the form of frequency and cross-tabulation tables were computed to get a "feel" for the data. Then, a comparison was made to determine if a difference exists between the perceptions of shippers and carriers regarding the 36 motor carrier selection criteria. Analysis of variance was used to compare the perceived importance assigned to each selection criterion by both shippers and carriers. A mean rating score was calculated for each of the factors for both groups. These responses were compared, and an "F" statistic computed. In all cases, a significance level of .05 was used. The variables with a statistically significant difference between the perception of

shippers and carriers are identified by *asterisks* in Table 1. To evaluate the level of satisfaction provided shippers by carriers, an analysis of the importance of various selection criteria to shippers was conducted. The statistically significant mean ratings and rankings for both shippers and carriers were analyzed and the overall results presented in Table 1.

In both the current and the original 1992 investigation, only six carrier selection variables were ranked exactly the same by both groups. The reliability of on time delivery and pick-up were ranked first and second in both studies, indicating that the importance of these criteria are well understood by both carriers and shippers. A review of the information in Table 1 further reveals that there was general agreement on the relative importance of twenty-seven of the thirty-six selection variables. In the original 1992 study, there was general agreement on only sixteen of thirty-five selection criteria. Currently, statistically significant differences resulted between shipper and carrier mean ratings for nine of the thirty-six selection criteria. In the original study, there were significant differences for nineteen of thirty-five selection variables. Currently, five of the nine statistically significant selection variables were rated higher by shippers. Originally, only four variables were rated higher by shippers than by carriers. The other four statistically significant selection factors were rated higher by carriers, down from fifteen in the original 1992 investigation.

Currently, carriers ranked three of the shippers' ten most important selection variables the same as shippers did. In the original study, carriers ranked only two of the shippers' top ten variables the same. Currently, five of the top ten variables were significantly different. Four of these factors were rated higher by shippers than by carriers. The fact that carriers were not as concerned as shippers with emergency response and providing leadership in offering more flexible rates, could well result in shipper dissatisfaction. Not only was the emergency response issue statistically significant, but it was

TABLE 1
SUMMARY OF FINDINGS: PERCEPTIONS OF SHIPPERS & CARRIERS REGARDING
THE IMPORTANCE OF CARRIER SELECTION VARIABLES

Carrier Selection Criteria	Shipping Mean Rating	Carrier Mean Rating	Shipper Ranking	Carrier Ranking
Reliability of on time delivery	4.51	4.55	1	1
Reliability of on time pick-up	4.46	4.49	2	2
Financial stability of carrier	4.23	4.21	3	6
Total transit time for the shipment	4.31	4.23	4	4
Carrier response in emergency or unexpected situations	4.57*	3.81	5	10
Web-Enhanced Electronic-Data-Interchange (EDI)	4.63*	4.09	6	9
Carrier's reputation for dependability	4.09	4.63*	7	3
Handling expedited shipments	4.13	4.19	7	8
Carrier's leadership in offering more flexible rates	4.33*	3.68	9	15
Computerized billing and tracing services	4.49*	4.07	10	16
Geographic coverage of carrier	4.05	4.01	11	13
Past performance of the carrier	4.11	4.62*	12	11
Information provided to shippers by carriers	4.48*	4.07	13	17
Ease of claim settlement (loss or damage)	4.03	4.12	14	12
Carrier cooperation with shipper's personnel	3.91	4.52*	15	7
Carrier representative's knowledge or shipper's needs	3.71	4.62*	16	5
Freight loss experience with the carrier	3.78	3.82	17	18
Condition of equipment	4.08	4.11	18	14
Discount programs offered by carriers	3.69	3.58	19	20

Table 1
(continued)

Carrier Selection Criteria	Shipping Mean Rating	Carrier Mean Rating	Shipper Ranking	Carrier Ranking
Scheduling flexibility	3.92	3.89	20	21
Freight damage experience with the carrier	4.29	4.31	21	19
Carrier assistance in obtaining rate or classification changes	3.64	3.63	22	23
Carrier attitude toward acceptance of small shipments	3.66	3.62	23	27
Carrier honors shipper's routing requests	3.46	3.41	24	24
Personal relations with the carrier	4.19	4.22	25	25
Carrier transportation equipment designed to facilitate easy and fast loading and unloading	3.10	3.08	26	29
Overcharge claims service	3.31	3.35	27	26
Feedback from the consignee to the shipper about the quality of service given by specific carriers	3.79	3.77	28	28
Courtesy of vehicle operators	3.94	4.01	29	22
Carrier's ability to handle special requests	3.06	3.09	30	31
Diversion and reconsignment privileges	2.93	2.98	31	33
Fabrication in transit privileges	2.58	2.55	32	36
Carrier willingness to participate in freight consolidation practices	2.43	2.47	33	34
Regular calls by carrier sales representatives	3.68	3.73	34	30
Opinions or recommendations of employees of other firms	3.12	3.19	35	32
Gifts/gratuities offered by carriers	1.39	1.46	36	35

*Variables were found to be statistically significant at the .05 level

ranked fifth by shippers and tenth by carriers. The ranking discrepancy of the rate flexibility issue was even greater, with a shipper ranking of nine and a carrier ranking of fifteen. The likelihood of shippers being dissatisfied is heightened because these criteria are among the ten most important variables as ranked by shippers. Also, these variables were similarly misunderstood in the original 1992 study. The three other variables both ranked and rated higher by shippers than by carriers are data related. The two statistically significant top ten variables are computerized billing and tracing and a Web-enhanced EDI. The other variable where significant differences exist between shippers and carriers is information provided to shippers by carriers.

Carriers overrated the importance to shippers of four motor carrier selection criteria which may indicate that carriers do not adequately appreciate the nature of shipper needs. The statistically significant variables ranked higher by carriers than by shippers dealt with the carrier's reputation for dependability, carrier representative's knowledge of shipper needs, carrier cooperation with shipper personnel, and past performance of the carrier. They were ranked third, fifth, seventh, and eleventh, respectively. All four of the selection criteria rated higher by carriers than by shippers in the current study were also rated higher by carriers than by shippers in the original 1992 investigation. Carriers also ranked all of these selection variables higher than did shippers. While maintaining the quality of these and other service factors, carriers should probably key on the selection criteria that are rated more important by shippers.

SUMMARY OF DIFFERENCES, CAUSES, AND METHODS OF OVERCOMING DIFFERENCES

Basically, shipper satisfaction is a function of carriers providing a selection variable mix that best serves shippers. Shippers are now "highly involved, critical, and discerning in their selection of a carrier" (MacLeod et al., 1999). To

evaluate the level of satisfaction provided shippers by carriers, an analysis of the importance of various carrier selection criteria is essential. Areas where statistically significant differences exist should be of major concern to carriers. Recognizing the existence of these differences and possible causes of each difference affords the carrier an opportunity to develop more effective strategies to better serve shippers. A comparison of both shipper and carrier rankings revealed that only six selection variables were ranked exactly the same by both groups. Statistically significant differences resulted between shipper and carrier mean ratings for nine of the thirty-six selection criteria. This was a marked improvement over the nineteen of thirty-five significant differences in the original study (Premeaux et al., 1992).

As may be seen in Table 2, five of the nine statistically significant selection variables were rated higher by shippers. Shippers rated carrier response in emergency or unexpected situations, carrier's leadership in offering more flexible rates, information provided by carriers, computerized billing and tracing and a Web-enhanced EDI higher than did carriers. These differences could have a negative impact on shipper profitability. Since carrier selection decisions are often made to maximize gains, an inappropriate mix could result in lost business for carriers who misinterpret the importance of these selection factors. These differences, and the resulting shipper dissatisfaction, could be overcome by offering a selection variable mix that focuses on the most important carrier services.

As may be seen in Table 3, carriers rated four statistically significant selection factors higher than did shippers. Carriers rated reputation for dependability, carrier cooperation, past carrier performance, and carrier representative's knowledge of shipper needs higher than did shippers. These differences may be caused by carriers placing too much emphasis on past relationships, rather than being responsive to current shipper needs. In the highly competitive motor carrier industry, this strategy may be disastrous.

TABLE 2
STATISTICALLY SIGNIFICANT VARIABLES RATED HIGHER THAN BY CARRIERS

Carrier Selection Criteria	Shipper Mean Rating	Carrier Mean Rating	Shipper Ranking	Carrier Ranking
Carrier response in emergency or unexpected situations	4.57*	3.81	5	10
Web-Enhanced Electronic-Data-Interchange (EDI)	4.63*	4.09	6	9
Carrier's leadership in offering more flexible rates	4.33*	3.68	9	15
Computerized billing and tracing services	4.49*	4.07	10	16
Information provided to shippers by the carrier	4.48*	4.07	13	17

The variables marked with an asterisk were found to be statistically significant at the .05 level.

TABLE 3
STATISTICALLY SIGNIFICANT VARIABLES RATED HIGHER BY CARRIERS THAN BY SHIPPERS

Carrier Selection Criteria	Shipper Mean Rating	Carrier Mean Rating	Shipper Ranking	Carrier Ranking
Carrier's reputation for dependability	4.09	4.63*	7	3
Carrier representative's knowledge of shipper's needs	3.71	4.62*	16	5
Carrier cooperation with shipper's personnel	3.91	4.52*	15	7
Past performance of the carrier	4.11	4.62*	12	11

The variables marked with an asterisk were found to be statistically significant at the .05 level.

Overemphasizing any or all of these selection factors is costly and probably does not significantly enhance shipper satisfaction. Even though these variables basically focus on important areas related to carrier performance, it may be that shippers are fairly satisfied with carrier performance in these areas, and therefore carriers may want to key on other more highly rated criteria. Quite possibly, carriers overemphasize these factors because some shippers are prone to select carriers based on their past performance record and long-established relationships. However, shippers may well change carriers if they are not responsive enough to their actual needs, especially those needs that are most important.

The basic method of overcoming these differences involves the development of a reformulated mix which focuses on offering shippers better response in emergency or unexpected situations, providing real leadership in offering more flexible rates, and providing information and services through a comprehensive Web-enhanced EDI. Fulfilling shipper information needs with a Web-enhanced EDI approach is expected to increase in importance in the future because shippers and carriers can use information technology to "help them act with the agility of a single entity" (Andel, 1996). Basically, the new mix should enhance the quality of service and profitability of shippers in the carriers' target markets.

IMPLICATIONS

Carriers ranked their representative's knowledge of shipper needs as the fifth most important carrier selection variable, but apparently are not striving hard enough to really understand shipper needs. A lack of understanding could make it impossible to maximize shipper satisfaction. Carriers should strive to appreciate the importance of all selection criteria to their target markets, and develop marketing strategies to best satisfy these needs. A superior

carrier strategy emphasizes a mix of selection variables in line with the importance placed on them by shippers. Developing a service system that places too much emphasis on the less significant variables, and that de-emphasizes the more significant selection variables, may lead to shipper dissatisfaction and possibly even carrier losses.

For motor carriers aspiring to provide their customers with the highest possible level of satisfaction, an understanding of the most important criteria used by shippers in selecting and retaining carrier services is essential. Fortunately, carrier understanding of shipper needs has improved greatly since 1992. However, since there were still some significant differences between the perceptions of this group of carriers and shippers regarding the relative importance of various selection criteria, carriers may not be satisfying shippers to the greatest degree possible. To overcome these differences carriers should provide leadership and innovation in relation to their selection mixes rather than keying on past performance.

Carriers may well have been selected because of their past performances and long-standing relationships, but shippers may not continue to utilize their services if carriers are not more responsive to actual shipper needs. Specifically, carriers should identify and emphasize those elements of their selection mix that are perceived as most important by the decision makers in the shipping organization (Andel, 1996). Quite possibly, a reformulated mix keying on offering shippers better response in emergency or unexpected situations, providing real leadership in offering more flexible rates, and providing information and services through a comprehensive Web-enhanced EDI will enhance shipper satisfaction. Carriers who know which of the selection criteria are most important can develop a selection variable mix to more thoroughly satisfy shipper needs, thereby attracting new customers and maintaining existing clients.

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CARRIER SELECTION CRITERIA: DIFFERENCES AMONG TRUCKLOAD MOTOR CARRIER OFFERINGS

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ABSTRACT

Effective customer service begins with an understanding of the service components customers' view as most important to their operations and business success. Within the transportation industry research has investigated the importance of such criteria at an industry level. This article offers detailed rankings of service criteria priority from a shipper's perspective by comparing criteria across five types of motor carrier offerings including dry van, temperature controlled, intermodal, tank, and flatbed. Results identify the ranked importance of 20 service characteristics, common themes, and distinct differences in the importance of service criteria among the alternative supplier offerings.

INTRODUCTION

Understanding customer criteria for product and service selection is an important consideration in any supplier management and marketing effort. Such an understanding helps to establish key customer-facing performance metrics and provides a means to more clearly define customer value and the factors that may help them establish differential advantage.

In transportation management, research has investigated carrier selection by comparing perceptions of service priorities between carriers and shippers (Premeaux 2002; Premeaux et al. 1995; Abshire and Premeaux 1991). Studies have

also addressed carrier selection criteria and processes as one implementation of customer-supplier relationships (Gibson, Rutner and Keller 2002), and as part of a broader service gap analysis framework (Kent and Parker 1999; Hopkins et al. 1993).

While such analyses have investigated selection criteria across one or more transportation modes, studies have not considered how such criteria may differ among specific services offered within a mode. The motor carrier industry, with its alternative forms of equipment and services, provides a context in which to evaluate whether, and to what degree, shipper's rank service attributes differently based on a subset of

product/service offerings. This article reports the results of a study which investigated the importance of carrier selection criteria across five truckload (TL) motor carrier service offerings including Dry Van, Temperature Controlled, Tank, Intermodal, and Flatbed. An evaluation of how such criteria may differ depending on the primary service requirements of the shipper is also provided.

LITERATURE REVIEW

Research investigating carrier selection criteria has been published in the logistics and distribution literature as well as the marketing literature within the context of customer service elements, service quality delivery and buyer-seller relationships.

Bardi (1973) identified carrier selection criteria and surveyed industry shippers concerned with the movement of household goods. Prior transportation research had been concerned primarily with mode selection characteristics. His study identified 21 relevant carrier selection determinants in areas such as reliability, security, user satisfaction, availability, transit time, costs and others. As he expected, due to the regulatory environment and joint rate publications, transportation cost was found to be less important than other service related characteristics. Factors related to shipment reliability, security, and satisfaction ranked highest among the survey participants.

Prompted by the deregulation of the transportation industry, Bruning and Lynagh (1984) investigated the extent to which shippers evaluated carriers, the selection criteria used in those decisions, and how they ranked seven key selection criteria. As part of their analysis, they considered the education level of those individuals responding to the survey, the commodity and industry areas of responding organizations, and the relative weight of the criteria. Their results suggested a positive relationship between education level of respondents and the application of more quantitative/objective evaluation criteria. In

addition, they identified variation in the frequency of carrier evaluation among industries, types of commodities transported, and types of mode employed in transportation.

Bardi et al. (1989) also investigated the impact of deregulation on carrier selection by asking survey participants to assess the importance of carrier selection criteria and to indicate whether the emphasis in selection criteria had changed over the previous five years transition to a deregulated transportation environment. Their study refined 18 carrier selection determinant measures into four selection factors including rate related factors, customer service, claims handling and follow up, and special equipment availability and flexibility. While his earlier study indicated little importance in transportation costs, the rate related factors ranked highest as a selection criteria in a deregulated environment followed by customer service, claims handling, and equipment availability and flexibility.

Abshire and Premeaux (1991) and Premeaux et al. (1995) investigated differences in the perceptions of carriers and shippers with regard to the importance of carrier selection criteria. Their analysis considered whether shippers and motor carrier perceptions of importance differed among 35 carrier selection criteria. At the time, findings indicated significant differences in priority with 19 of the 35 criteria. Summarizing their results, they noted that carrier understanding of the importance of selection variables to shippers was "moderately" well understood. They pointed out however, that carrier's overestimated importance of eleven criteria considered moderately important by shippers and underestimated four criteria rated as important by shippers.

Repeating his 1991 study, Premeaux (2002) reassessed carrier and shipper perceptions of 36 selection criteria (the study included one additional measure of web enhanced EDI). To establish a longitudinal view of how selection criteria may have changed, he compared responses from the two studies, including carrier to carrier responses and the relationship

between shippers and carriers responses. Significant differences between the perceptions of carriers over the 1991 to 2001 time period indicated greater importance for criteria related to information availability and the flexibility in rates and services. Significant differences between the perceptions of shippers and carriers over the same time period indicated greater agreement between the two groups among 25 of the 36 items. He concluded that shippers have become more concerned with certain selection criteria over time and that carriers were becoming more adept at assessing shipper needs.

Carrier selection criteria have been assessed in the literature from buyer-seller relationships to broader management strategies. Acknowledging the critical nature of JIT relationships in environments where perishability is a concern, Natarajan and Sersland (1994) focused on shipper perceptions of the importance of eight carrier selection criteria, comparing the criteria for bakeries which rely on JIT supplier relationships to those who do not rely on JIT relationships. Their results indicated that firms concerned with JIT supplier relationships found carrier willingness to negotiate service changes, equipment availability, shipment tracing and expediting, and transit time reliability to be significantly more important than those firms not involved in JIT supplier relationships.

Carrier selection has also been investigated within an international transportation context. Kent and Parker (1999) assessed the differences in perceptions between export shippers, import shippers and the container companies that provide global transportation services. They measured relative importance among 18 selection criteria evaluated in earlier studies on motor carrier selection. Results of their study identified two criteria with significant differences between import shippers and carriers (importance of loss and damage, and equipment availability were both assessed as more important by import shippers). Export shippers were found to consider rate changes, service frequency, financial stability, service changes, and equipment availability as significantly more

important than carriers. When compared to one another, import shippers identified one criteria (rates) as significantly more important than export shippers.

Hopkins et al. (1993) investigated perceived differences in customer and supplier evaluations of selection criteria within a broader conceptual model of service quality (Parasuraman et al. 1985). Parasuraman et al. (1985) developed a SERVQUAL model of service quality that illustrated five potential gaps where service breakdowns could occur. Gap one is concerned with a consumer expectation-management perception gap. Gap two is described as a gap between management perceptions and service quality specifications. Gap three is associated with the differences between service quality specifications and actual service delivery. Gap four involves the difference between service delivery and external communications of the company. Gap five addresses the differences between customer expected service and perceived service.

Hopkins et al. (1993) applied the SERVQUAL model after combining gaps two and three for ease of analysis. The population included shippers and carriers providing service using a variety of transportation modes. Of 19 measures collected regarding gap one, Hopkins et al. identified a significant difference in shipper/carrier perceptions involving equipment, delivery promises, record accuracy, individual attention, convenience of operating hours, and personal attention. Of 19 measures related to gap two/three, 16 items were perceived as significantly different between shippers and carriers. A significant difference was also noted in relation to gap four (1 of 1 measure) and gap five (18 of 19 measures indicated a significant difference).

Gibson et al. (2002) drew on a theoretical framework involving buyer-seller relationships (Dwyer et al. 1987) to compare the perceptions of shipper-carrier partnerships from each entities perspective. Their study extended research by adopting more robust, multi-item measures to evaluate the importance of and level of

satisfaction with 13 factors associated with buyer-supplier relationships in the motor carrier industry (Cost, Effectiveness, Trust, Flexibility, Channel Perspective, Information Sharing, Time Horizon, Performance Management, Planning, Strategic Fit, Rules of Engagement, Control/Power, Sharing of Risks and Rewards). Of the 13 factors developed involving importance and satisfaction, shipper assessments identified a significant difference in nine items. From a carrier perspective, 12 of 13 factors were found to be significantly different. When comparing shipper and carrier perceptions of the importance of partnership factors, four items including cost, flexibility, planning and the sharing of risks and rewards were significantly different. There were no significant differences in the evaluation of satisfaction between shippers and carriers among the 13 factors.

METHODOLOGY

The research methodology utilized in this study was a mail survey. The survey consisted of 20 services and other characteristics (see Table 1) that are offered by motor carriers and was sent to 2,132 companies. The sample of companies consisted of shippers that subscribed to *Distribution Magazine*. The TL shippers were categorized into dry van, temperature controlled, tank, intermodal, and flatbed. The shippers were asked to identify the importance of each of the 20 services and other characteristics on a 1-7 likert scale where 1 was not important and 7 was very important. A total of 420 usable surveys were returned resulting in a 20 percent overall response rate. Each of the companies in the sample was mailed, via USPS Priority Mail, a survey, postage paid return envelope, and complimentary mouse pad.

Non-response bias was analyzed by comparing earlier responses to later responses for all 20 of the factors analyzed (Armstrong and Overton 1977). No statistically significant differences were found from the comparisons, therefore, non-response bias was not considered to be a problem.

RESULTS

The results of this study are presented by evaluating mean importance scores and an ANOVA on a set of 20 services characteristics across five types of TL motor carriers. The 20 services characteristics are listed in the overall rank order of importance based on mean scores in Table 1. The respondents in this research were divided into five groups. The groups are: (1) Dry Van TL shippers, (2) Temperature Controlled TL shippers, (3) Tank TL shippers, (4) Intermodal TL shippers, and (5) Flatbed TL shippers.

The mean scores for all the characteristics in each of the groups were sorted in descending order. The characteristics were then ranked 1 through 20. The rankings are notated for each group with a superscript next to each mean score under each group heading. After sorting and ranking all five groups the table was reordered in the overall rank order for the 20 characteristics. Additionally, an ANOVA using Bonferroni post-hoc analysis was performed and statistical differences were found for five of the service characteristics between the five TL types (* indicates significance at a .05 level).

Overall, the results indicate that there are both rank mean and statistical differences for all five of the TL types. For instance, the most important service characteristic for dry van and tank shippers was consistent dependable transit times, temperature controlled shippers was communication of service disruptions, intermodal shippers was action and follow-up on service complaints, and flatbed shippers was billing accuracy. Consistent with prior research, competitive pricing did not rank as the most important characteristic for any of the groups. Competitive pricing ranged from 2nd most important for intermodal shippers to the 9th most important for temperature controlled shippers.

TABLE 1
20 SERVICE CHARACTERISTICS

Item	Description	Dry Van	Temp. Ctl.	Tank	Intermodal	Flatbed
1.	Consistent dependable transit times	6.48 ¹	6.50 ³	6.46 ¹	6.36 ⁵	6.34 ²
2.	Billing accuracy	6.46 ²	6.29 ⁸	6.15 ⁶	6.50 ²	6.36 ¹
3.	Competitive pricing	6.45 ³	6.12 ⁹	6.31 ⁴	6.50 ²	6.09 ⁵
4.	Action and follow-up on service complaints	6.31 ⁵	6.69 ²	5.92 ⁹	6.76 ¹	6.15 ⁴
5.	Communication of service disruptions	6.31 ⁴	6.75 ¹	6.0 ⁸	6.36 ⁵	6.28 ³
6.	Equipment availability	6.11 ⁶	6.33 ⁶	6.46 ¹	6.00 ¹⁰	6.0 ⁶
7.	Knowledge and problem solving skills of contact personnel	6.04 ⁷	6.38 ⁵	5.92 ¹¹	6.43 ⁴	5.81 ⁸
8.	Quality of drivers	6.03 ⁸	6.30 ⁷	6.31 ⁴	6.21 ⁷	5.96 ⁷
9.	General reputation for quality and integrity	5.95 ⁹	6.09 ¹⁰	6.33 ³	5.93 ¹¹	5.72 ⁹
10.	Financial Stability	5.85 ¹⁰	5.77 ¹³	6.08 ⁷	5.29 ¹³	5.55 ¹⁰
11.	Proactive monitoring of delivery appointments	5.70 ¹¹	6.40 ^{4*}	5.92 ¹⁰	6.07 ⁹	5.38 ^{12*}
12.	Ability to provide expedited service	5.53 ¹²	5.94 ¹¹	5.62 ¹²	6.14 ⁸	5.41 ¹¹
13.	Ability to handle all transportation needs	4.91 ¹³	5.08 ¹⁴	5.33 ¹³	5.93 ¹²	5.11 ¹³
14.	Satellite tracing and communications	4.88 ^{14*}	5.83 ^{12*}	5.15 ¹⁵	4.79 ¹⁴	5.02 ¹⁴
15.	Traditional EDI capabilities	4.43 ¹⁵	4.58 ¹⁵	4.83 ¹⁶	4.64 ¹⁵	4.28 ¹⁶
16.	Internet tracking	4.42 ¹⁶	4.44 ¹⁶	4.23 ²⁰	4.64 ¹⁶	4.51 ¹⁵
17.	Internet POD	4.06 ¹⁷	3.49 ¹⁸	4.50 ¹⁸	3.64 ¹⁹	4.23 ¹⁷
18.	Ability to implement fuel surcharge	3.76 ¹⁸	4.19 ¹⁷	5.33 ^{14*}	2.93 ^{20*}	3.60 ^{18*}
19.	Internet freight posting services	3.25 ¹⁹	2.91 ^{19*}	4.54 ^{17*}	3.79 ^{18*}	3.17 ¹⁹
20.	Internet pricing	3.14 ²⁰	2.66 ^{20*}	4.38 ^{19*}	3.86 ¹⁷	3.02 ²⁰

The importance of the information technology service characteristics (internet, satellite, and EDI) varied only slightly among the five groups, all five groups ranked them in the bottom quarter of the 20 characteristics as the least important services. The one exception was for satellite tracing and communications for temperature controlled shippers. They ranked satellite tracing and communications as the twelfth most importance characteristics.

The specific results for each of the five individual groups are presented in the following five subsections. Each TL type is presented with a top eight most important service characteristics table, discussion of significant findings, and observations. Note that all 20 characteristics for each TL type are ranked and presented in Table 1.

Dry Van Shippers

The top eight most important service characteristics for the Dry Van shippers are ranked one to eight in Table 2. The overall rank number for each characteristic is listed in the first column and the mean score and rank number superscript is listed for each of the other four TL types.

No significant differences were found in the top eight most important service characteristics. However, a significant difference was found between Dry Van shippers and Temperature Controlled shippers on the satellite tracing and communications characteristic. Dry Van shippers mean score for satellite tracing and communications of 4.88 was the lowest among four of the TL types, with intermodal being the lowest, and Temperature Controlled shippers mean score was 5.83.

Based on the results from the ANOVA, Dry Van shippers clearly believe that satellite tracing and communications is not as important as Temperature Controlled shippers. Satellite tracing and communications was the highest ranked information technology characteristic at Number 14 with the internet characteristics and EDI falling below that.

Consistent dependable transit times was ranked as the number one most important characteristic followed closely by billing accuracy and competitive pricing. While competitive pricing was third, it was only .03 behind the number one ranking, indicating a TL market segment with very competitive pricing and service requirements. Quality of drivers rounded out the top eight most important characteristics for this segment.

Temperature Controlled Shippers

The top eight most important service characteristics for the Temperature Controlled shippers are ranked one to eight in Table 3. The overall rank number for each characteristic is listed in the second column and the mean score and rank number superscript is listed for each of the other four TL types.

No significant differences were found in the top eight most important service characteristics. However, a significant difference was found between Temperature Controlled shippers and Tank shippers on the internet freight posting services and internet pricing characteristics. A significant difference was also found between Temperature Controlled shippers and Flatbed shippers on the proactive monitoring of delivery

TABLE 2
DRY VAN SHIPPERS

Item	Description	Dry Van	Temp. Ctl.	Tank	Intermodal	Flatbed
1.	Consistent dependable transit times	6.48 ¹	6.50 ³	6.46 ¹	6.36 ⁵	6.34 ²
2.	Billing accuracy	6.46 ²	6.29 ⁸	6.15 ⁶	6.50 ³	6.36 ¹
3.	Competitive pricing	6.45 ³	6.12 ⁹	6.31 ⁵	6.50 ²	6.09 ⁵
4.	Action and follow-up on service complaints	6.31 ⁴	6.69 ²	5.92 ⁹	6.76 ¹	6.15 ⁴
5.	Communication of service disruptions	6.31 ⁴	6.75 ¹	6.0 ⁸	6.36 ⁶	6.28 ³
6.	Equipment availability	6.11 ⁶	6.33 ⁶	6.46 ²	6.00 ¹⁰	6.0 ⁶
7.	Knowledge and problem solving skills of contact personnel	6.04 ⁷	6.38 ⁵	5.92 ¹¹	6.43 ⁴	5.81 ⁸
8.	Quality of drivers	6.03 ⁸	6.30 ⁷	6.31 ⁴	6.21 ⁷	5.96 ⁷

TABLE 3
TEMPERATURE CONTROLLED SHIPPERS

Item	Description	Dry Van	Temp. Ctl.	Tank	Intermodal	Flatbed
5.	Communication of service disruptions	6.31 ⁴	6.75 ¹	6.0 ⁸	6.36 ⁶	6.28 ³
4.	Action and follow-up on service complaints	6.31 ⁵	6.69 ²	5.92 ⁹	6.76 ¹	6.15 ⁴
1.	Consistent dependable transit times	6.48 ¹	6.50 ³	6.46 ¹	6.36 ⁵	6.34 ²
11.	Proactive monitoring of delivery appointments	5.70 ¹¹	6.40 ⁴	5.92 ¹⁰	6.07 ⁹	5.38 ¹²
7.	Knowledge and problem solving skills of contact personnel	6.04 ⁷	6.38 ⁵	5.92 ¹¹	6.43 ⁴	5.81 ⁸
6.	Equipment availability	6.11 ⁶	6.33 ⁶	6.46 ²	6.00 ¹⁰	6.0 ⁶
8.	Quality of drivers	6.03 ⁸	6.30 ⁷	6.31 ⁴	6.21 ⁷	5.96 ⁷
2.	Billing accuracy	6.46 ²	6.29 ⁸	6.15 ⁶	6.50 ³	6.36 ¹

appointments. The only other significant difference was between Temperature Controlled shippers and Dry Van shippers for satellite tracing and communications characteristic.

Based on the results from the ANOVA, Temperature Controlled shippers clearly believe that the satellite tracing and communications characteristic is more important than the Dry Van shippers and based on the face value of the mean scores, Temperature Controlled shippers believe that this characteristics is more important than any of the five TL shipper types. Satellite tracing and communications was the highest ranked information technology characteristic at number 12 with the internet characteristics and EDI falling below that.

Communication of service disruptions was ranked as the number one most important characteristic followed by action and follow-up on service complaints, consistent dependable transit times, and proactive monitoring of delivery appointments. All four of the top characteristics are very customer service intensive characteristics. Competitive pricing was not even ranked in the top eight for Temperature Con-

trolled shippers while quality of drivers was ranked as 7th most important for this segment.

Tank Shippers

The top eight most important service characteristics for the Tank shippers are ranked 1 to 8 in Table 4. The overall rank number for each characteristic is listed in the third column and the mean score and rank number superscript is listed for each of the other 4 TL types.

No significant differences were found in the top eight most important service characteristics. However, a significant difference was found between Tank shippers and Intermodal shippers and Tank shippers and Flatbed shippers on their ability to implement a fuel surcharge. A significant difference was also found between Tank shippers and Temperature Controlled, and between Tank shippers and Intermodal shippers on internet freight posting. Finally, a significant difference was found between Tank shippers and Temperature Controlled shippers on internet pricing.

TABLE 4
TANK SHIPPERS

Item	Description	Dry Van	Temp. Ctl.	Tank	Intermodal	Flatbed
6.	Equipment availability	6.11 ⁶	6.33 ⁶	6.46¹	6.00 ¹⁰	6.0 ⁶
1.	Consistent dependable transit times	6.48 ¹	6.50 ³	6.46¹	6.36 ⁵	6.34 ²
9.	General reputation for quality and integrity	5.95 ⁹	6.09 ¹⁰	6.33³	5.93 ¹¹	5.72 ⁹
3.	Competitive pricing	6.45 ³	6.12 ⁹	6.31⁴	6.50 ²	6.09 ⁵
8.	Quality of drivers	6.03 ⁸	6.30 ⁷	6.31⁴	6.21 ⁷	5.96 ⁷
2.	Billing accuracy	6.46 ²	6.29 ⁸	6.15⁶	6.50 ³	6.36 ¹
10.	Financial Stability	5.85 ¹⁰	5.77 ¹³	6.08⁷	5.29 ¹³	5.55 ¹⁰
5.	Communication of service disruptions	6.31 ⁴	6.75 ¹	6.0⁸	6.36 ⁶	6.28 ³

Based on the results from the ANOVA, Tank shippers indicated that they believe the internet freight posting and internet pricing characteristics are significantly more important than the Temperature Controlled shippers. Additionally, based on the face value of the mean scores, Tank shippers believe that those two characteristics, along with internet POD and traditional EDI capabilities, are more important than any of the five TL shipper types. Interestingly, the tank shippers ranked all the information technology characteristics, except internet tracking and satellite tracing and communications, above the other five TL shipper types.

Equipment availability, along with consistent dependable transit times, tied as the most important characteristic for Tank shippers. Tank shippers ranked quality of drivers 4th, and that is higher than any of the other TL shipper types. Competitive pricing was tied with quality of drivers with a mean importance score of 6.31. Additionally, different from any of the other shipper types, general reputation for quality and integrity and financial stability were ranked in the top eight most important characteristics for Tank shippers.

Intermodal Shippers

The top eight most important service characteristics for the Intermodal shippers are ranked 1 to 8 in Table 5. The overall rank number for each characteristic is listed in the fourth column and the mean score and rank number superscript is listed for each of the other 4 TL types.

No significant differences were found in the top eight most important service characteristics. However, a significant difference was found between Intermodal shippers and Tank shippers on their ability to implement a fuel surcharge. A significant difference was also found between Intermodal shippers and Tank shippers on internet freight posting.

From the ANOVA results, Intermodal shippers indicated that they believe the internet freight posting and the ability to implement a fuel surcharge characteristics are significantly less important than the Tank shippers. Additionally, based on the face value of the mean scores, Intermodal shippers believe that action and follow-up on service complaints, billing accuracy, competitive pricing, knowledge and problem

TABLE 5
INTERMODAL SHIPPERS

Item	Description	Dry Van	Temp. Ctl.	Tank	Intermodal	Flatbed
4.	Action and follow-up on service complaints	6.31 ⁵	6.69 ²	5.92 ⁹	6.76¹	6.15 ⁴
2.	Billing accuracy	6.46 ²	6.29 ⁸	6.15 ⁶	6.50²	6.36 ¹
3.	Competitive pricing	6.45 ³	6.12 ⁹	6.31 ⁵	6.50²	6.09 ⁵
7.	Knowledge and problem solving skills of contact personnel	6.04 ⁷	6.38 ⁵	5.92 ¹¹	6.43⁴	5.81 ⁸
5.	Communication of service disruptions	6.31 ⁴	6.75 ¹	6.0 ⁸	6.36⁵	6.28 ³
1.	Consistent dependable transit times	6.48 ¹	6.50 ³	6.46 ¹	6.36⁵	6.34 ²
8.	Quality of drivers	6.03 ⁸	6.30 ⁷	6.31 ⁴	6.21⁷	5.96 ⁷
12.	Ability to provide expedited service	5.53 ¹²	5.94 ¹¹	5.62 ¹²	6.14⁸	5.41 ¹¹

solving skills of contact personnel, and the ability to provide expedited service are more important characteristics than any of other the five TL shipper types.

Action and follow-up on service complaints ranked as the most important characteristic for Intermodal shippers. Billing accuracy and competitive pricing tied as the 2nd most important characteristics. Intermodal shippers were the only TL shipper type to rank ability to provide expedited service in the top eight most important characteristics.

Flatbed Shippers

The top eight most important service characteristics for the Flatbed shippers are ranked 1 to 8 in Table 6. The overall rank number for each characteristic is listed in the fifth column and the mean score and rank number superscript is listed for each of the other 4 TL types.

No significant differences were found in the top eight most important service characteristics. However, a significant difference was found between Flatbed shippers and Tank shippers on their ability to implement a fuel surcharge. A

significant difference was also found between Flatbed shippers and Temperature Controlled shippers on proactive monitoring of delivery appointments.

From the ANOVA results, Flatbed shippers indicated that they believe the ability to implement a fuel surcharge characteristic is significantly less important than the Tank shippers. Additionally, Flatbed shippers indicated significantly less importance on proactive monitoring of delivery appointments than for Temperature Controlled shippers.

Billing accuracy ranked as the most important characteristic for Flatbed shippers. This was the highest ranking for billing accuracy among all five of the shipper types. Competitive pricing ranked 5th for the Flatbed shippers.

SUMMARY AND CONCLUSIONS

While all five of the TL shipper types had a different mean score ranking of the 20 service characteristics, there were a few common themes and some distinctly different results. In common, all five shipper types ranked the billing accuracy, communications of service disruptions,

TABLE 6
FLATBED SHIPPERS

Item	Description	Dry Van	Temp. Ctl.	Tank	Intermodal	Flatbed
2.	Billing accuracy	6.46 ²	6.29 ⁸	6.15 ⁶	6.50 ³	6.36¹
1.	Consistent dependable transit times	6.48 ¹	6.50 ³	6.46 ¹	6.36 ⁵	6.34²
5.	Communication of service disruptions	6.31 ⁴	6.75 ¹	6.0 ⁸	6.36 ⁶	6.28³
4.	Action and follow-up on service complaints	6.31 ⁵	6.69 ²	5.92 ⁹	6.76 ¹	6.15⁴
3.	Competitive pricing	6.45 ³	6.12 ⁹	6.31 ⁵	6.50 ²	6.09⁵
6.	Equipment availability	6.11 ⁶	6.33 ⁶	6.46 ²	6.00 ¹⁰	6.0⁶
8.	Quality of drivers	6.03 ⁸	6.30 ⁷	6.31 ⁴	6.21 ⁷	5.96⁷
7.	Knowledge and problem solving skills of contact personnel	6.04 ⁷	6.38 ⁵	5.92 ¹¹	6.43 ⁴	5.81⁸

consistent dependable transit times, and quality of drivers characteristics in their top eight most important characteristics. Additionally, with only one shipper type exception, action and follow-up on service complaints, competitive pricing, and equipment availability were in their top eight most important lists. Also in common, all five ranked the information technology characteristics of internet, satellite, and EDI at the bottom of the list as least important characteristics.

The distinctions among the various shipper groups are evident and supported more on face value of the mean rankings than by the statistical differences. The Tank shippers seem to place more importance on internet freight posting services, internet pricing, internet POD, and quality of drivers. This may be a chemical tank characteristic. First, while all of the shipper types ranked quality of driver in their top eight, the Tank shippers ranked quality of drivers higher than all four other shipper types. Second, the chemical industry was one of the first to organize their industry around internet based purchasing groups and this may have influenced TL transportation requirements as well.

The distinguishing characteristics for the Temperature Controlled shippers appear to be two fold. First, ranked at 9th, competitive pricing fell outside the top eight most important listing for Temperature Controlled shippers. Second, Temperature Controlled shippers appear to be the most "customer service" demanding shipper group. Their top five most important characteristics are tied to communication, follow-up, consistency, proactive monitoring, and knowledge of contact personnel.

In conclusion, the information provided in this article should provide benefits to shippers, motor carriers, and for future research. Shippers will benefit from the information by identifying important service characteristics that should be measured to help insure continuous improvements within each of the service characteristics. Additionally, individual shippers will be able to benchmark their own list of important service characteristics to those in their industry peer group and overall in the TL transportation industry. This research provides an empirical reference for TL motor carriers to help them identify areas where they should allocate resources to better match their service offering

with the requirements of their customers. Finally, from an academic perspective, future transportation research should begin to identify important service factors or groupings of individual service characteristics. While a factor

analysis was beyond the scope of this article, potential factors that appeared to emerge from the data in this research were information technology and customer service.

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Journal of Transportation Management

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1. First Page—Title of the paper, name and position of the author(s), author(s) complete address(es) and telephone number(s), e-mail address(es), and any acknowledgment of assistance.
2. Second Page—A brief biographical sketch of each author including name, degree(s) held, title or position, organization or institution, previous publications and research interests.
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$$y = c + ax + bx \tag{1}$$

$$y = a + 1x + 2x + 3x + ax \tag{2}$$

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Book Chapter:

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Book:

Coyle, John J., Bardi, Edward J., and Novack, Robert A. (2004), *Transportation*, 6th ed., Cincinnati, OH: South-Western College Publishing.

Website:

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

MANUSCRIPT SAMPLE

A FRAMEWORK FOR EVALUATING SUPPLY CHAIN PERFORMANCE

Terrance L. Pohlen, University of North Texas

ABSTRACT

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

INTRODUCTION

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

Table 1 about here

Developing and Costing Performance Measures

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

$$y = a^2 - 2ax + x^2 \tag{1}$$

REFERENCES

Manrodt, Karl (2003), "Drivers of Logistics Excellence: Implications for Carriers," In J. W. Wilson (Ed.), *Logistics and Transportation Yearbook 2003* (pp. 126-154) Englewood Cliffs, NJ: Prentice-Hall, Inc.

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