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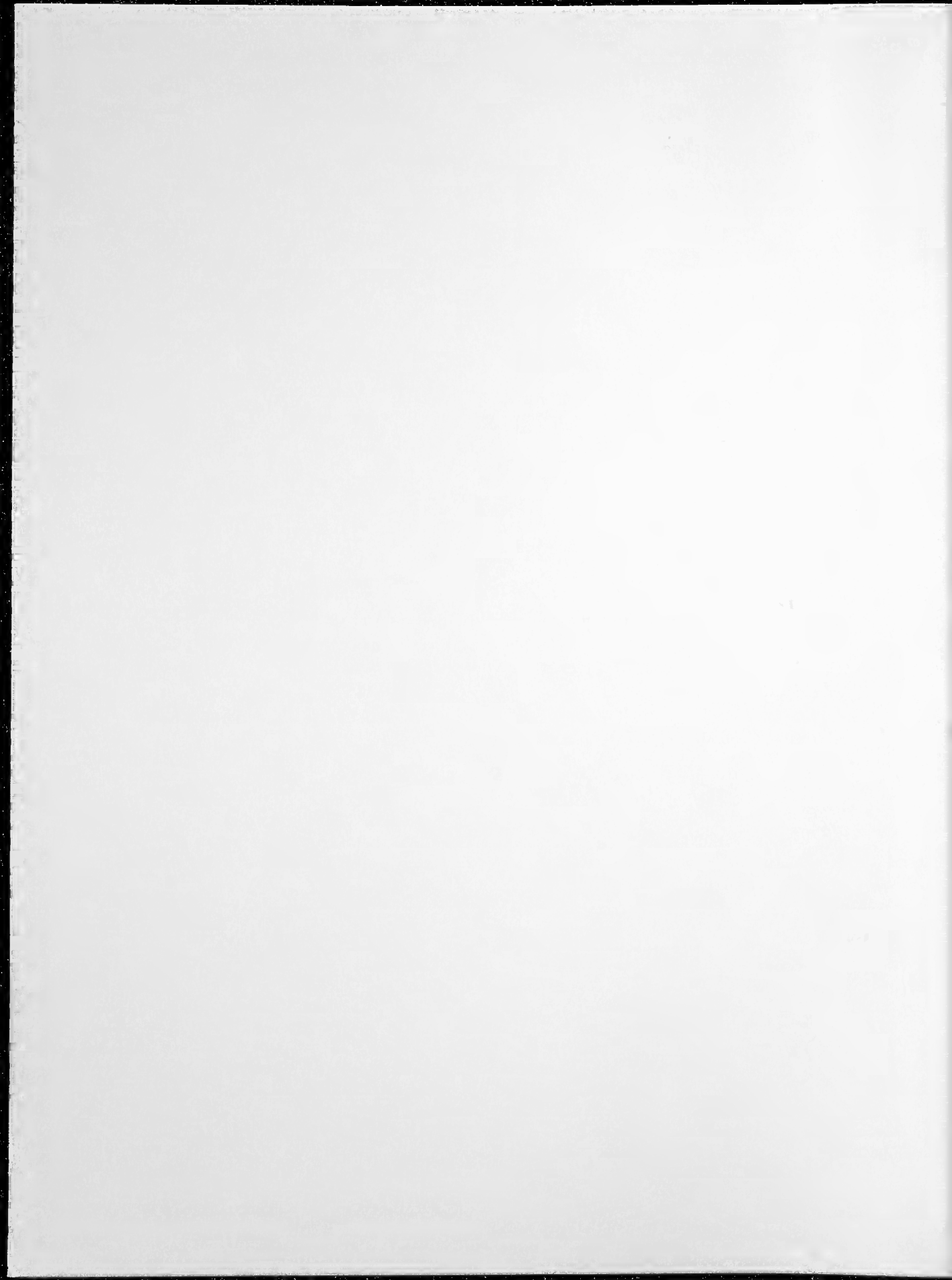
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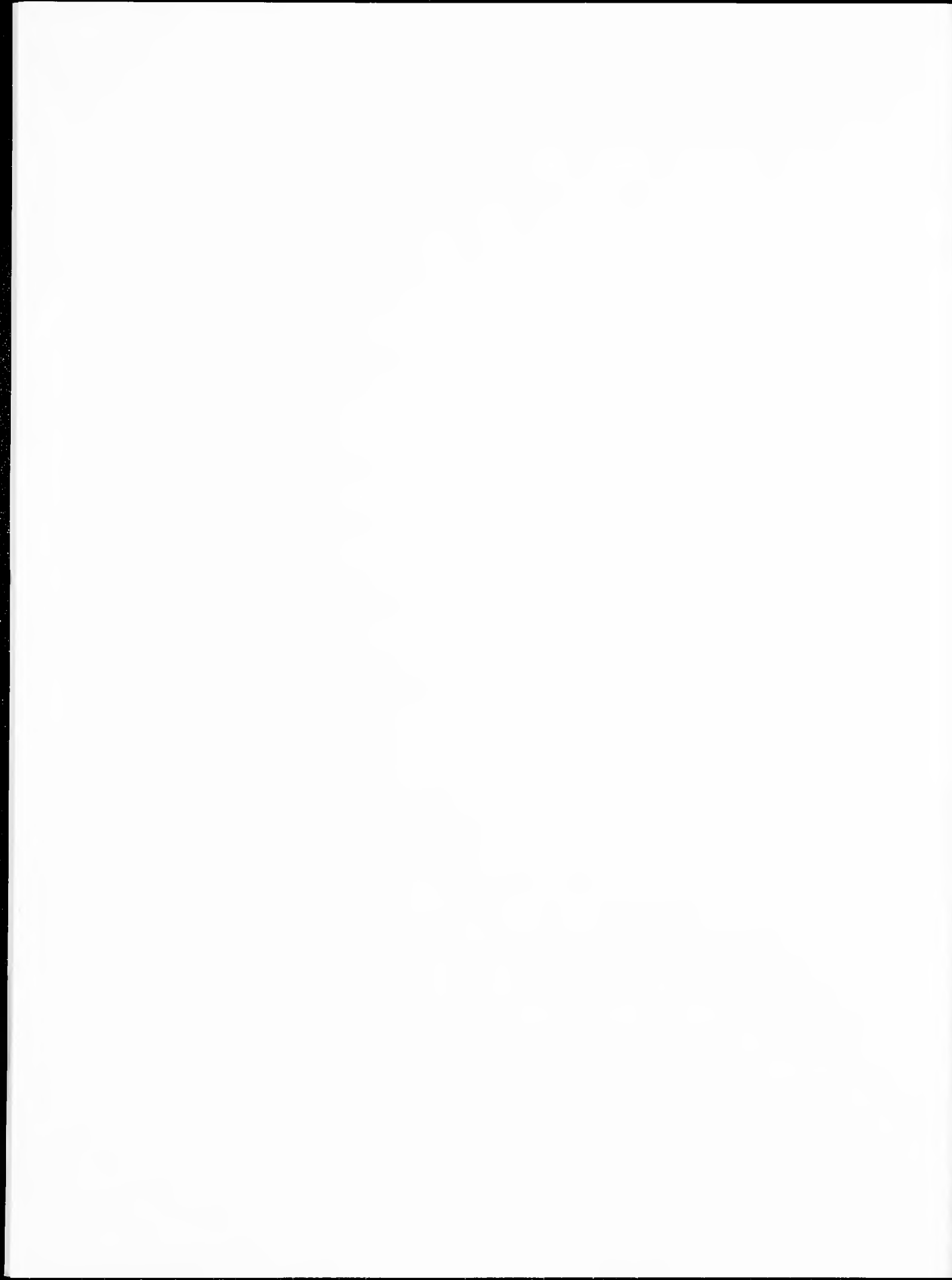
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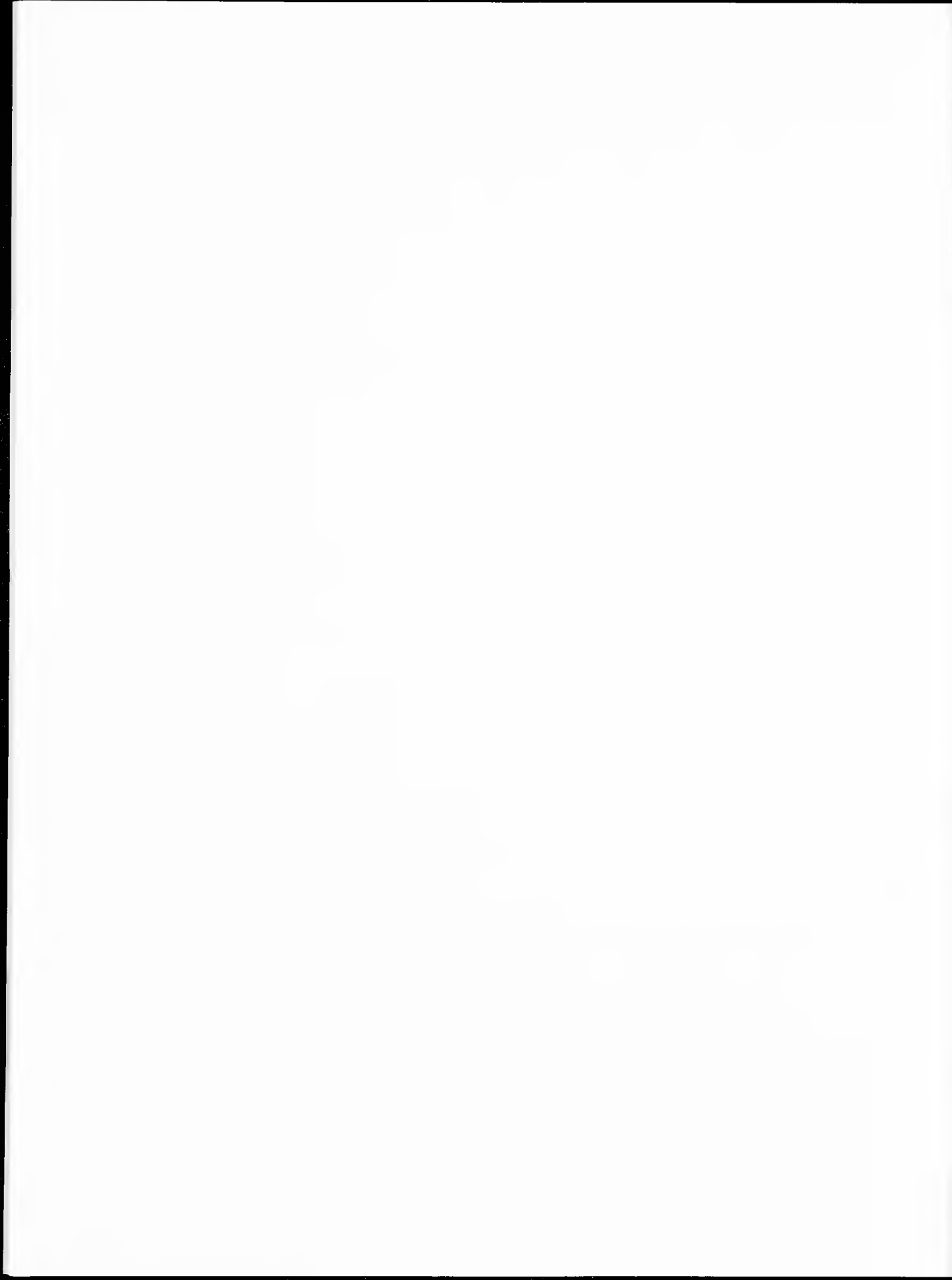
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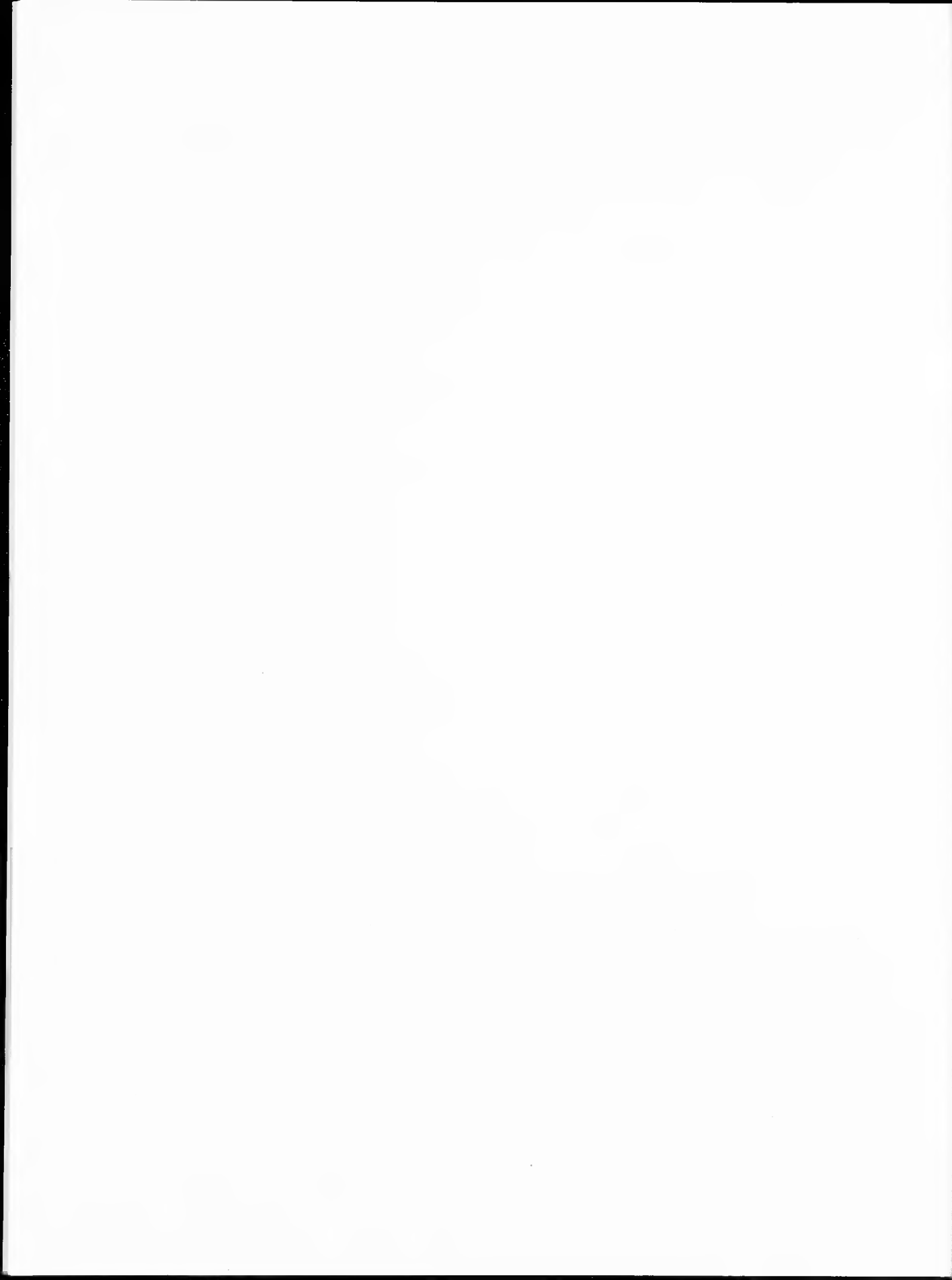
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# From the Editor...

It is my pleasure to welcome a new member of the editorial staff, beginning with this issue. Maciek Nowak is our newest logistics faculty member here at Georgia Southern—and a new associate editor for the *JTM*. Maciek is in the final stages of completing his doctoral degree at Georgia Tech. Welcome, Maciek!

This issue contains well-written articles on very timely issues affecting all parts of the logistics industry. I am very pleased with the variety of topics represented and with the quality of the content. If you like what you read, please share the information with your colleagues. If you do not like what you find in this issue, then please contact me. While I sometimes wish that I could pass it, the “buck” stops on my desk. I welcome your comments and suggestions on this and every issue of the *Journal of Transportation Management*.

In the first article of the issue, Brian Gibson and Jonathan Whitaker take an empirical look at technology-based training programs for logistics employees. They address the extent to which technology-infused training programs have been embraced in logistics firms and provide an overview of both the benefits and profit impact of such training programs. In the second article, Major Kristina O'Brien and Stephen Swartz compare the implementation of radio frequency identification technology by the U.S. military and private industry. They point out similarities and differences in the use of RFID in these two very different application settings.

Greg Kellar and John Zhang take a look at the adoption of web-based services by motor carriers in the United States. While considerable investment is required to design and implement web services, little research has been done to evaluate the impact of such services on the profitability of the firm. They provide interesting results both by size of motor carrier and profitability. In the fourth article, Kathryn Dobie and Rhonda Hensley discuss the use of Six Sigma as a strategic planning tool that logistics and transportation firms can use for process improvement and building better service delivery systems. In the final article of the issue, Garland Chow and Charles Wang provide very valuable insight with respect to the logistics infrastructure and logistics capabilities available in the Peoples Republic of China. This is a must-read for every firm that is attempting to develop business in this rapidly growing world market.

As always, thanks to all of you that had a hand in producing this issue. The authors, obviously, deserve most of the credit. A good portion of the remaining credit goes to members of the *JTM* editorial review board. Thank you for your continuing support and dedication to the quality of the *JTM*.

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!

Jerry W. Wilson, Editor

*Journal of Transportation Management*

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# Journal of Transportation Management

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## OBJECTIVES

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

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

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

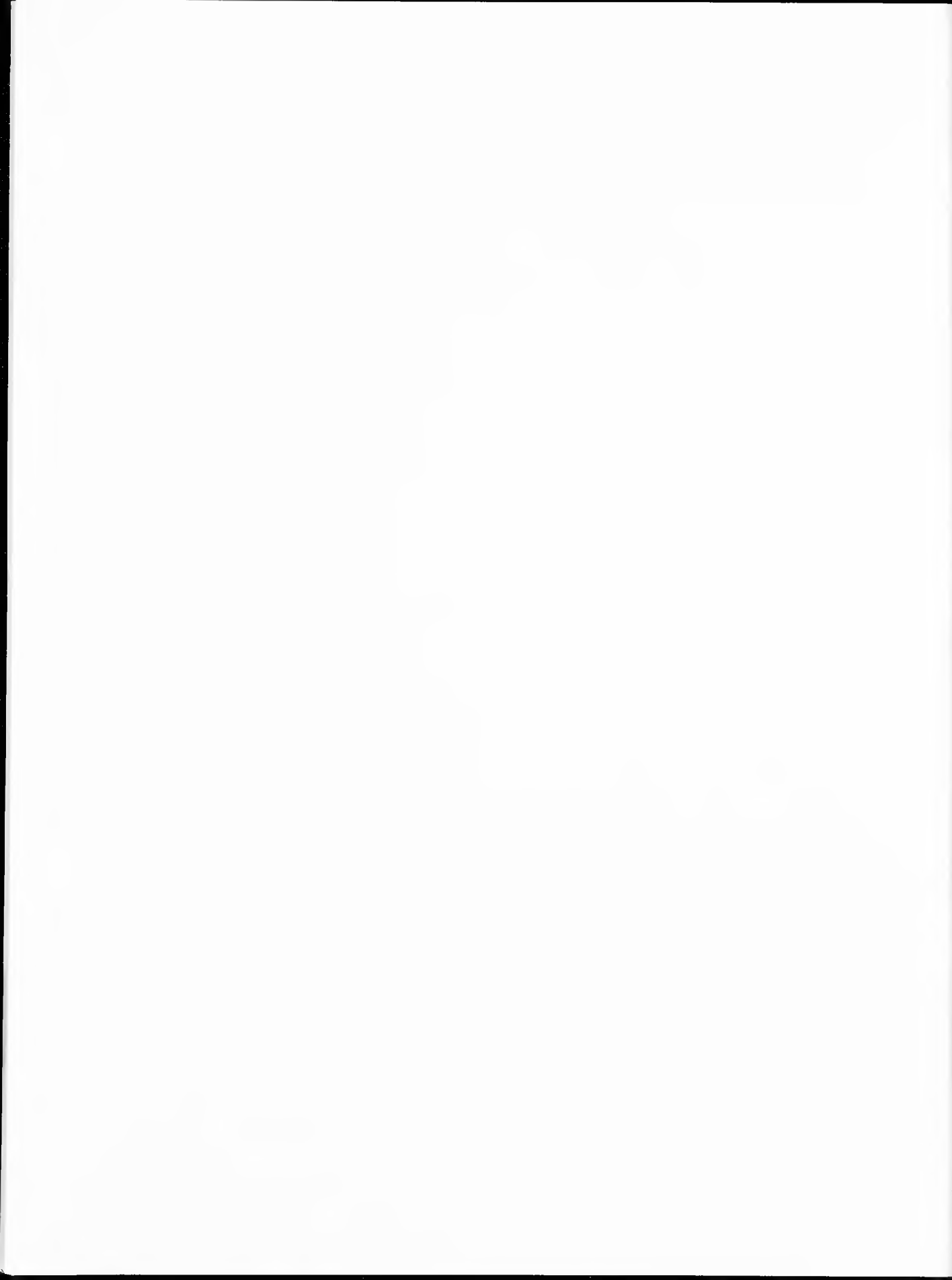
interaction between the two groups. Authors considering the submission of an article to the *JTM* are encouraged to contact the editor for help in determining relevance of the topic and material.

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



# TECHNOLOGY BASED SUPPLY CHAIN TRAINING: ITS USE AND EFFECTIVENESS

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## ABSTRACT

Employee training is a huge business in the United States with spending in the neighborhood of \$51 billion dollars. Over the last five years a growing proportion of training dollars have been committed to technology based training involving distance learning and e-learning. This article reports on the use of these innovative training methods in supply chain management and their impact on organizations in terms of cost effectiveness, time efficiency, skill development, and return on investment.

## INTRODUCTION

Training presents a vexing challenge for businesses. On one hand, it's viewed as a necessary tool for building employee competency, improving productivity, and establishing competitive advantage (Buhler, 2001). Tom Peters, best selling author and quality guru, goes so far as to recommend that companies "train everyone lavishly, you can't overspend on training" (2004). However, training consumes critical resources (time and money) and organizations find it difficult to measure the return on investment (ROI) of training. Despite its intrinsic value, these realities make training a cost cutting target in times of economic instability.

Recent history attests to the fluctuating commitment to training. Spending on corporate training over the last two years has declined. U.S. companies spent \$51.3 billion on training in 2003 versus \$54.2 billion in 2002 and \$56.8 billion in 2001. Decreased expenditures for training staff salaries, seminars and conferences, and off-the-shelf training materials accounted for the majority of the decline. Technology-based training (TBT) has been the lone exception to the decline over the past two years (Galvin, 2003).

TBT<sup>1</sup> is growing at a very rapid rate. Independent computer-delivered training and instructor-led remote location training are expanding at the



expense of traditional instructor-led classroom training (Galvin, 2003). Research firm IDC estimates that worldwide, Internet-based corporate learning is growing by nearly 70 percent per year (Byrne, 2004). Overall, it is predicted that spending on TBT will top \$18 billion in 2005 (Major, 2002).

TBT is flourishing for a variety of reasons. Cost efficiency is a key driver of its growth. TBT reduces the direct costs of training, including employee travel costs and recurring instructor fees. Indirect costs, such as lost productivity while employees are away at training, are also diminished (Adams, 2002). Flexibility is another benefit of TBT. Training can be scheduled at the convenience of the individual and learners in remote locations can gain access to content, providing "anytime, anyplace" educational opportunities for employees. Overall, TBT is capable of providing 30 percent more training content in 40 percent less time and at 33 percent of the cost of traditional training methods, according to Meta Group (Beckett, 2004).

Anecdotal evidence suggests that supply chain organizations are reaping the benefits of TBT. Early adopters included Burlington Northern Railroad and the Defense Logistics Agency, who both began to use computer-based training programs in the mid-1980s (Anonymous, 1984 and Roman, 1985). United Parcel Service uses TBT to promote company-wide job consistency among drivers and package handlers, Smithway Motor Xpress has cut the cost of training drivers from \$1,000 to \$150, and J.B. Hunt uses TBT simulations to teach technicians how to troubleshoot equipment malfunctions (Kahaner, 2001). Bison Transport, a Canadian truckload carrier, has followed the lead of airlines in TBT, using a full-motion simulator to build operator skills, test knowledge of legal requirements, and train drivers to handle dangerous driving situations (Menzies, 2003).

While these individual success stories are noteworthy and support the justification for TBT in supply chain management (SCM), little research has been conducted in this area to date. Most of the existing research regarding TBT and

SCM has focused on university education rather than employee training and professional development (e.g., Ellram and Easton, 1997; Wan and Wilson, 1999). While the proliferation of distance learning based curriculum from traditional academic institutions and the growth of non-traditional online universities attest to the acceptance of TBT for education, the impact of TBT on corporate supply chain training is not well understood.

The purpose of the study is to investigate the use of TBT for supply chain training. An exploratory study was undertaken to provide insight into the use of TBT for supply chain training, the effectiveness of TBT, and the ROI of supply chain training. The overall objective was to assess the impact of TBT on supply chain training initiatives in corporate America.

## RESEARCH QUESTIONS AND METHODOLOGY

Given the limited knowledge regarding the use and acceptance of TBT for supply chain training, the overall goal of the research was to address three key questions:

1. To what extent have organizations adopted TBT for supply chain training?
2. How well does TBT work for supply chain training?
3. What benefits, including ROI, does supply chain training provide?

An iterative design-critique-revise survey development process produced a 60-item questionnaire regarding supply chain training issues. An HTML version of the questionnaire was developed, posted on the Internet, and tested for data capture accuracy. Shortly thereafter, a wide variety of supply chain, logistics, and transportation professionals received an e-mail requesting their participation in the study. The e-mail also provided a hyperlink to the online survey. The original request and a follow-up reminder e-mail generated 70 usable responses.

The completed surveys were coded, entered into a personal computer and analyzed using Microsoft Access 2003 and SPSS Release 11.5 for Windows. Key statistical tests included independent samples t-tests and paired samples t-tests. All statistical tests were conducted at the .05 significance level.

## RESULTS AND DISCUSSION

The survey respondents represent a variety of businesses and industries. Manufacturers, logistics service providers, and merchandisers accounted for over three quarters of the responses. Table 1 provides details regarding the participation levels by business type.

### TBT Adoption

The initial questions of the survey focused on the training methods used by each organization for supply chain training. Overall, 62.9 percent of the respondents use some form of TBT. The use of TBT methods across the five business groups ranged from 55 percent to 67 percent, with manufacturers and logistics service providers leading the way (See Table 1).

Among the respondents, it is fairly common to use multiple delivery methods for supply chain training. Nearly half of the respondents (44 percent) combine traditional classroom training (TCT) methods with TBT methods to educate their supply chain personnel. A small group (18.6 percent) has eschewed TCT altogether, choosing to rely exclusively upon TBT methods. The re-

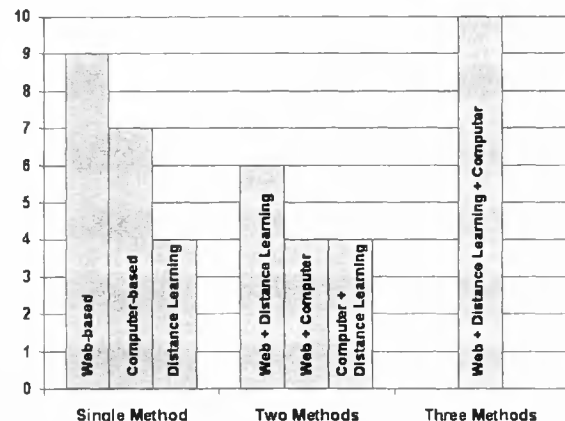
maining respondents (37.1 percent) rely upon TCT methods, mentoring, on the job training, and related approaches for supply chain training.

Of the TBT methods employed for supply chain training, Web-based self study courses (Internet, intranet, and extranet) have been adopted at a slightly higher rate than computer-based self study courses (CD-ROM, DVD, and diskette) and instructor led distance learning courses. Figure 1 highlights these differences as well as the respondents' use of multiple TBT methods.

### TBT Effectiveness

TBT proponents identify a wide variety of benefits that can be gleaned from its implementation. Reduced course delivery costs, consistent instructional quality, user flexibility, and better learning retention are often cited reasons for moving toward TBT (Adams, 2002; Kaupins, 2002; Oakes, 2003). However, the enthusiasm is not universal. Concerns regarding the integration of training into real-world skills, the expense of developing courses, and the ability of TBT to improve employee productivity

**FIGURE 1  
RESPONDENTS' USE  
OF TECHNOLOGY-BASED  
TRAINING METHODS**



**TABLE 1  
DEMOGRAPHIC DATA**

Type of Business	Percent of Responses	Percent Using Technology Based Training Methods
Manufacturing Firm	30.0	66.7
Logistics Service Provider	25.7	66.7
Merchandising Firm	21.4	60.0
Consulting Firm	15.7	54.5
Technology Firm	7.1	60.0

are cited as reasons why TBT has not been implemented on a wider scale (Bowen, 2000; Oakes, 2003).

Given these conflicting opinions, it is important to determine how TBT is perceived by the SCM community. Three relevant issues were studied: cost effectiveness, time efficiency, and skill enhancement. The survey participants were asked to rate various training methods on each of these three issues using a seven-point Likert scale (from 7 = very effective to 1 = not at all effective). To gain greater insight into the responses and actual experiences of the respondents, their responses were split into two groups—TBT users and TBT non-users—for statistical analysis.

The results indicate that neither group has fully bought into the argument that TBT is more cost effective than TCT. Independent samples t-tests revealed that TBT users and nonusers agreed on the cost effectiveness of TCT, assigning it statistically similar high ratings (See Table 2). In contrast, TBT users rated TBT computer methods and TBT distance learning methods significantly higher than nonusers in terms of cost effectiveness. Clearly, those who have no experience with TBT methods are skeptical of their financial benefits, assigning relatively neutral cost effectiveness ratings to both TBT methods.

Further analysis using paired samples t-tests within the two groups also highlights the TBT nonusers' bias against TBT methods. This group rated TCT significantly more cost effective than either TBT computer methods ( $p\text{-value} = .026$ ) or TBT distance learning methods ( $p\text{-value} = .004$ ). In contrast, there were no significant differences in the TBT users' cost effectiveness ratings pairs. The TBT users place all three methods on statistically equal footing in terms of cost effectiveness.

The second issue studied—time efficiency—revealed little divergence of perceptions between the two groups regarding the time required to complete a training program. Although TBT users rated TBT computer methods and TBT

distance learning methods higher than TBT non-users on this factor, independent samples t-tests revealed that the differences were not statistically significant (See Table 3).

Within group analysis produced noteworthy results. Paired samples t-tests indicate that TBT nonusers did not perceive that any particular method holds a time efficiency advantage over the other methods. However, TBT users indicated that TBT computer methods are clearly superior to both TCT methods ( $p\text{-value} = .037$ ) and TBT distance learning methods ( $p\text{-value} = .001$ ) in terms of time efficiency.

While training cost and speed are certainly important factors in selecting a training method, organizations must also consider the impact of the training method upon the job performance capabilities. The third issue analyzed—employee skill enhancement—provided the strongest support for continued use of traditional training methods. It received the highest mean effectiveness ratings across all issues and methods from both respondent groups (See Table 4). However, the groups' perspectives diverged on the TBT methods. Independent samples t-tests revealed that TBT users rated TBT distance learning methods and TBT computer methods significantly higher than TBT nonusers in terms of skill enhancement.

Further strengthening the case for TCT was the within group analysis results. Paired samples t-tests revealed that TBT users rated traditional classroom methods significantly higher than TBT distance learning methods ( $p\text{-value} = .000$ ) and TBT computer methods ( $p\text{-value} = .000$ ) in terms of the ability to enhance employee skills. The group indicated no difference between the two TBT methods ( $p\text{-value} = .570$ ). Similar results were garnered for the TBT non-users.

Collectively, these mean efficiency ratings across three issues—cost, time, and skills—do not identify a clear cut winner among the training methods. TCT methods received the highest mean ratings in terms of cost effectiveness and skill enhancement, while TBT computer methods rated highest in terms of time efficiency. In

**TABLE 2**  
**COST EFFECTIVENESS OF TRAINING METHODS**

Type of Training	Mean Effectiveness Ratings		T-Test Results	
	TBT Users	TBT Non-Users	p-value	Rated higher by
Traditional classroom-based	5.23	5.38	.612	
TBT—computer/web-based	5.14	4.42	.046	TBT Users
TBT—distance learning-based	4.86	4.17	.030	TBT Users

Seven-point scale: 7 = Very Effective, 1 = Not At All Effective

**TABLE 3**  
**TIME EFFICIENCY OF TRAINING METHODS**

Type of Training	Mean Effectiveness Ratings		T-Test Results	
	TBT Users	TBT Non-Users	p-value	Rated higher by
TBT—computer/web-based	5.44	4.83	.063	
TBT—distance learning-based	5.05	4.58	.158	
Traditional classroom-based	4.86	4.85	.958	

Seven-point scale: 7 = Very Effective, 1 = Not At All Effective

**TABLE 4**  
**SKILL ENHANCEMENT CAPABILITIES OF TRAINING METHODS**

Type of Training	Mean Effectiveness Ratings		T-Test Results	
	TBT Users	TBT Non-Users	p-value	Rated higher by
Traditional classroom-based	5.70	5.54	.569	
TBT—distance learning-based	4.76	3.87	.002	TBT Users
TBT—computer/web-based	4.68	4.04	.046	TBT Users

Seven-point scale: 7 = Very Effective, 1 = Not At All Effective

general, the TBT users rated the TBT methods higher than their nonuser counterparts, suggesting that TBT experience is needed to see actual benefits.

Further review of the TBT users' (who are in a stronger, experience-based position to objectively evaluate TBT methods) responses did not reveal an exclusive penchant for TBT. Table 5 indicates that the TBT users' mean ratings of training methods varied across the three issues.

Ultimately, the results suggest that widely cited TBT benefits have not been fully attained in the

supply chain area. TCT remains an effective, important tool in the eyes of supply chain managers. For now, a blended solution consisting of traditional and innovative training methods may be most appropriate and effective.

### **Return on Investment**

The ultimate question regarding training is: "what do we get out of it?" Organizations have great interest in this question because training can have a dramatic impact on their success. The potential for improved productivity, increased customer satisfaction, and competitive advantage

**TABLE 5**  
**COMPARATIVE ANALYSIS OF TRAINING METHOD EFFECTIVENESS**  
**(TBT USER RESPONSES ONLY)**

Issue	Method Comparison	T-test results	Statistically Significant Differences
Cost Effectiveness	Classroom vs. Computer	.724	No difference in mean ratings
	Classroom vs. Distance Learning	.234	No difference in mean ratings
	Computer vs. Distance Learning	.086	No difference in mean ratings
Time Efficiency	Classroom vs. Computer	.037	Higher rating for computer
	Classroom vs. Distance Learning	.421	No difference in mean ratings
	Computer vs. Distance Learning	.001	Higher rating for computer
Skill Enhancement	Classroom vs. Computer	.000	Higher rating for classroom
	Classroom vs. Distance Learning	.000	Higher rating for classroom
	Computer vs. Distance Learning	.570	No difference in mean ratings

due to enhanced employee knowledge and learning are all driving executive focus on training and its ROI (Emrich 2003; Anonymous, 2004). The final section of the survey focused on this critical aspect of supply chain training. Two relevant issues were addressed: the benefits created and the ROI achieved.

The respondents indicated that supply chain training provides tangible benefits that positively impact their organizations. Every respondent identified at least one positive outcome, with the vast majority (90 percent) citing two or more benefits of supply chain training. Table 6 highlights the fact that the benefits are not limited to supply chain operations, as supply chain training also positively impacts the organization and its customers.

In terms of ROI, 79 percent of the respondents felt that supply chain training provided a positive outcome with the benefits exceeding the

costs. The remaining 21 percent indicated that the ROI was neutral (the benefits gained were equal to the costs). No respondent believed that the ROI was negative. The highest percentages of positive ROI responses were provided by the respondents who rely exclusively on traditional classroom methods (84.6 percent of that subgroup) and those who use a combination of traditional and TBT methods (83.9 percent that subgroup). In contrast, the respondents who have migrated completely to TBT methods were almost equally split in their assessment of supply chaining training—53.8 percent reported a positive ROI and 46.2 percent reported a neutral ROI.

Nearly 60 percent of the respondents make some attempt to quantify the ROI of training, with the vast majority assessing ROI informally. Overall, they estimated an average ROI of 104.5 percent for supply chain training with an average payback period of 10.3 months. Organizations who use a combination of training methods reported the highest ROIs (mean = 127 percent) and the fastest payback periods (mean = 6.4 months), followed by those who use traditional classroom methods exclusively, and those who use TBT methods exclusively.

**TABLE 6**  
**IMPACT OF**  
**SUPPLY CHAIN TRAINING**

Benefit Achieved	Percent of Respondents
Competitive advantage in our industry	70.0
Improved productivity	68.6
Superior customer service	62.9
Enhanced profitability	55.7
Labor savings realized	45.7
Reduced staff turnover	32.9

The results suggest that supply chain training is a worthwhile effort. According to the respondents, a wide range of benefits can be attained cost effectively in a relatively short time frame. For now, it appears that employees benefit the most from a mixture of TCT and TBT methods. Used independently, TCT and TBT methods

provide a lower ROI impact. A combined approach may overcome each method's individual limitations, resulting in greater employee skills and knowledge.

## IMPLICATIONS

The results of this exploratory study provide mixed signals regarding supply chain training. While the overall results suggest that supply chain training provides positive benefits, there is not a consensus regarding the best method for achieving these benefits. Managers with supply chain training responsibilities must consider a wide variety of issues and opinions when selecting from among the growing number of training options. Hence, a set of research-based recommendations has been developed to assist managers with this daunting task:

- Recognize the value of training. First and foremost, the training benefits and outcomes realized by the survey respondents should prompt other supply chain managers to adopt a proactive, positive outlook on training. Taking the time to develop integrated training programs that focus on relevant content and employ effective training methods will have a positive net impact on employee skills, organizational performance, and competitive advantage.
- Keep an open mind about TBT. Numerous studies have shown that TBT is a viable option for some training topics and needs. Supply chain managers should not rely on the opinions of inexperienced non-users when investigating TBT options as the results of this research found a tendency on their part to rate TBT effectiveness low across the board. Instead, managers should consult with actual TBT users to access experience-based insights regarding appropriate applications of TBT.
- Filter the TBT hype. The results of this study did not fully support the TBT benefits and promises found in other articles regarding TBT effectiveness. Regardless of what technology vendors promise or training

experts preach, TBT is not a panacea for an organization's supply chain training needs. TBT methods are valuable for some training applications but are not best suited to all situations.

- Adopt a blended solution of TBT and TCT methods. While the respondents indicated that all types of training methods are beneficial, those who combine innovative and traditional training methods claim to enjoy higher ROI's and faster payback periods. Supply chain managers should leverage the strengths of multiple training methods to produce a comprehensive, cohesive program that builds key employee skills, enhances their decision making abilities, and promotes appropriate behaviors.
- Accurately quantify the ROI of training. Half of the respondents informally evaluate the ROI of supply chain training and less than ten percent formally do so. While some training benefits are intangible and difficult to measure, a number of accounting techniques and quantitative methods are being developed for comparing training benefits to the costs (Allen, 2003; Staples, 2003). Supply chain managers would do well to adopt these formal methods as they can provide an accurate assessment of a training program's value (Freriks, 2004).

## SUMMARY

The development of effective training programs is important to the successful preparation of supply chain employees. An important aspect of training is the method used to deliver training. Today, organizations can employ multiple methods, both traditional and innovative to distribute supply chain content. While the promise of these innovative, technology based training methods has been well publicized, limited research has been conducted regarding their actual implementation and impact on supply chain performance.

This study provides insight into the views of 70 U.S. organizations regarding the use of TBT and

its perceived effectiveness. Analysis of the survey data revealed that TBT users find these methods to be as good as or better than TCT in terms of cost effectiveness and time efficiency. The research also found that organizations using TBT in combination with TCT appear to benefit from higher ROI and faster payback periods.

Supply chain managers with training responsibilities can gain valuable insights from these findings and the related research implications. The study can help them benchmark current training initiatives and gain insight into the abilities and strengths of TBT methods. Clearly,

TBT is here to stay and supply chain managers should make it a core component of a balanced, blended supply chain training program.

## ENDNOTE

1. Technology-based training includes all training methods that involve the use of technology to deliver content. Thus, it covers the broad array of Internet-based training (Internet, intranet, and extranet), computerized self-study (CD-ROM, DVD, and diskette), and distance learning (video-conferencing, audio-conferencing, and satellite broadcasting) (Galvin, 2003).

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# A COMPARISON OF IMPLEMENTATION ISSUES AND STRATEGIES FOR RADIO FREQUENCY IDENTIFICATION TECHNOLOGIES BETWEEN THE U.S. MILITARY AND PRIVATE SECTOR ORGANIZATIONS

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*The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Air Force, the Department of Defense (DoD), or the U.S. Government.*

## ABSTRACT

The purpose of this research was to study the implementation of radio frequency identification (RFID) technologies used to track equipment and supplies. Current implementation issues and strategies for future use were collected from leading edge organizations from the military and private sector. A formal comparison found both similarities and differences between how industry and the Army are implementing and using RFID technologies in their supply chains and logistics networks. This article focuses on these similarities and differences, to include a gap between the Army and industry regarding RFID tag use and implementation, and a difference in the overall focus of how RFID tags are or plan to be used in both environments.

## INTRODUCTION

Some civilian business practices, such as the utilization of radio frequency identification (RFID) tags and just-in-time (JIT) inventory, were used for the first time by the United States

Army in a major conflict during Operation Iraqi Freedom (OIF). RFID tags were attached to containers and pallets in every sustainment shipment entering and exiting the area of operation. Vendors applied tags prior to initial shipment, or tags were added to pallet, bins, or

containers at the aerial ports or at distribution centers. From January to June 2003, over 25,000 containers were tagged (Stewart, 2003). Although RFID tagging and some other Automated Identification Technology applications were somewhat successful during OIF, the logistics network still suffered some significant problems, to include asset visibility and ineffective theater distribution.

In October 2003, the Department of Defense (DoD) established a policy for the use of RFID tags within the DoD. The policy requires the DoD to develop business rules based on the results of initial RFID projects, and requires suppliers to place passive RFID tags on the lowest part, case, or pallet possible by January 2005 (Wynne, 2003). An "RFID-enabled DoD supply chain will provide a key enabler to the asset visibility support needed by our warfighter" (Wynne, 2004). To prepare for the implementation, the DoD is partnering with industry and leveraging commercial sector initiatives (Estevez, 2003).

Similar to the DoD's initiative, Wal-Mart Stores, Inc., announced in June 2003 it will require its top 100 suppliers to attach RFID tags on all shipping crates and pallets destined for Wal-Mart by January 2005 (Brewin and Vijayan, 2003). Wal-Mart is the world's largest retailer, and has extensive influence over industry practices. The DoD is even larger, and has a supply chain unmatched in diversity by any commercial industry (Gilligan, 2004). Although both are implementing RFID technologies, it is important to note that retailers and the DoD may have different objectives for RFID. William Phillips, head of IBM's defense industry consulting business notes that "DoD requirements are similar to industry's at a high level, but as you drill down, DoD's focus is on readiness...its supply chain is more widely distributed and fluid" (Jackson, 2004).

The initial purpose of this research was to determine if the implementation of RFID technologies to track equipment and supplies could be effectively used in a wartime environ-

ment by the Army's logistics network in order to improve asset visibility. As the research progressed, similarities and differences between how industry and the Army are implementing and using RFID technologies in their supply chains and logistics networks became apparent, and this article focuses on those similarities and differences. It is hoped that in areas where the Army has shown advanced practice, this could be helpful to industry; and in areas where industry has solutions, the Army could benefit. The purpose of this study was to provide a preliminary characterization of the similarities and the differences between organizations in these two distinctly different environments, who share common problems and issues. It is believed that the results of this study highlight interesting areas for further investigation.

## METHODOLOGY

This research used a grounded theory methodology to address the initial investigative and research questions, and employed content analysis to assist in the identification of similarities and differences between civilian industry and the Army. How the Army employed RFID technologies in its logistics network during the combat phase of OIF, and the associated lessons learned, were researched as part of the literature review. Academic literature available on the subject was somewhat limited, due to the newness of the topic, and the data for the literature review were extracted from DoD and Army manuals and regulations, OIF articles and lessons learned, and DoD briefings.

Civilian companies currently using or implementing RFID technologies in their supply chains were initially identified during the literature review. First, Auto-ID Center Sponsors were identified. As sponsors, these companies have shown their commitment to the implementation of RFID tag technologies. Global companies with diverse product lines and extensive supply networks that were also sponsors were then identified, as their logistics networks closely mirror that of the Army. Interview candidates were then selected from

companies that met both criteria and that appeared frequently in RFID literature. Eight companies were selected as interview candidates, and five companies agreed to participate. Four of the companies were global suppliers, and one was a global retailer. Based upon data collected during the literature review regarding RFID technology implementation, no global shipping companies were interviewed. This must be kept in mind as the comparisons are made, as it represents a difference in operational focus on the military side vs. private sector.

To discover the similarities and differences regarding the use and implementation of RFID tag use and implementation, five investigative questions were researched:

1. How is RFID technology being used by civilian companies to run their supply distribution network?
2. What processes are employed by civilian companies to successfully implement RFID tags to help achieve asset visibility in situations similar to the Army?
3. What logistical problems did the Army encounter in their overall supply distribution network in Iraq during the combat phase of OIF?
4. How did the Army's logistics network employ automated identification technology (AIT) during the combat phase of OIF?
5. What problems did the Army's logistics network encounter with the different AIT technologies during the combat phase of OIF?

After each of these questions had been thoroughly researched, a sixth question: "What similarities and differences exist between the civilian companies' and the Army's implementation and usage of RFID tags?" was answered. As previously noted, this article focuses on the answer to the sixth investigative question.

A standardized, open-ended interview approach was used to conduct the interviews, and the interviews revolved around seven, standardized questions. This interview method facilitated data organization and analysis, and eased response comparison (Patton, 1990).

## RESULTS

The original focus of this research was to answer the question: How can the business practice of using RFID tags to track equipment and supplies be effectively utilized in a wartime environment by the Army's logistics network? To answer this question, current business practices associated with the use of RFID were researched, and a study was conducted regarding how the Army used RFID during OIF, and what problems the Army's supply distribution network experienced during OIF. Having collected this data, similarities and differences regarding RFID use in the private sector and in the Army and DoD were discovered.

Table 1 outlines the common issues associated with the use of RFID by civilian industry, and the Army's use of RFID tags during OIF. Similarities include concerns associated with the new technology, as well as the support required from suppliers to actually implement and use the technology on a day-to-day basis.

Differences between the Army's and industry's use of RFID tags are outlined in Tables 2 and 3.

Table 2 focuses on areas where industry is unique in their use of RFID technologies in the supply chain, and Table 3 highlights areas where the Army is unique, based on their use of RFID tags during OIF to support their logistics network.

### RFID Tag Use and Implementation Within the Supply Chain

A major difference discovered during the study was the current status of the use and implementation of RFID tags. The DoD used RFID

**TABLE 1  
COMMON CONCERNS<sup>1</sup>**

	Civilian Response (%)	
Improved customer service	80	Important aspect of RFID tag implementation for both the Army/DoD and industry. Improved inventory and asset visibility should both lead to improved customer service.
Improved productivity	60	Personnel productivity improved during OIF at sea and aerial ports as a result of the RFID tags. Productivity is highlighted as a potential improvement by industry.
Reduced assets in the supply chain	40	Based on improved demand visibility, assets in the supply chain should be reduced through the use of RFID tags. This was an issue during OIF, since supplies were often "pushed" forward due to lack of visibility. Reducing assets in the supply chain
Lack of interoperability between systems	20	Highlighted as a problem in OIF, lack of interoperability is also mentioned as a potential concern within industry.
Concerns regarding tag read rates	20	Accurate read rates are vital for both civilian and military use, although there is an assumption read rates will improve as the technology improves.
Concerns regarding reliability of technology	20	The use of RFID tags in the supply chain is a new application of the technology; reliability concerns are shared by both industry and the Army/DoD.
Support required by retailers/suppliers	10	Supplier support is essential to implementation. Suppliers must purchase and apply tags to cases. Although the DoD applied tags to pallets as required during OIF, the

<sup>1</sup>Total percentage of civilian responses noted/identified in literature as military concern.

**TABLE 2  
INDUSTRY UNIQUE ISSUES<sup>1</sup>**

Field testing RFID tag applications	80%	Industry is <i>field testing</i> the use of RFID tags.
Reduce out of stock items	80%	Considered a major advantage of RFID tags by industry. Although a useful Army and DoD application, out-of-stock reduction is not the current focus.
Improve inventory management	60%	Interviews with industry personnel showed the primary initial focus will be on using RFID tags to improve inventory management.
Cost	60%	Industry is concerned about the cost associated with RFID tag use and implementation. Cost was not highlighted during the literature review as a factor for the Army/DoD.
Tag application	20%	Suppliers apply tags by hand, but this process needs to be automated due to efficiency/time constraints. Tags were applied by hand to pallets and containers during OIF, but the requirement and the impact was minimal.

<sup>1</sup>Total percentage of industry responses noted

**TABLE 3**  
**ARMY UNIQUE ISSUES<sup>1</sup>**

Improve asset visibility	100%	Army/DoD focus is on using RFID tags to improve asset visibility for the warfighter.
Using RFID tags in the field	100%	Army/DoD proved the technology by tracking pallets and containers from the U.S. to the AOR during OIF.
Bandwidth/communication infrastructure	80%	Bandwidth/communication infrastructure in OIF could not support the requirement to link logistics information systems. Limited asset visibility even with RFID tags. Should not be an issue in civilian industry.
Insufficient transportation for Army supply forces	60%	Adequate transportation in-theater not always available during wartime to move supplies. Negatively impacted ability to move supplies.
Supply line security	60%	Supply line security was a major issue during OIF, and is unique to the DoD's wartime logistics network.
Long and dynamic supply lines	60%	Army & Marine units were continually on the move during OIF. Changing destinations/lack of existing routes and roads for transport of goods impacted supply lines, and complicated the use of RFID tags.
Set-up/take-down of RFID readers	20%	Moving supply lines during wartime requires set-up and take-down of readers at each location. Generally, set-up occurs once in industry.
Correct placement of RFID readers	20%	With each move during war, correct placement of the RFID readers must be determined prior to set-up. RFID reader placement generally remains static after initial set-up in industry.
Power source/power source maintenance	20%	Power for RFID readers must be supplied by gas or battery-operated generators during war. Power source is not an issue in industry.
Reader/power source security	20%	RFID reader and generator power sources (batteries and fuel) are subject to pilferage during war. Should not be a major factor within industry.
Product variation	20%	Army and civilian companies both have extensive inventory, but wartime supplies are generally considered more diverse/extensive.
RFID tag security	20%	Although privacy issues are a concern with industry, the DoD must determine how to ensure RFID tags don't provide item identification/troop location to the enemy— <b><i>lives are at stake during war</i></b> .

<sup>1</sup>Total percentage of OIF lessons learned responses noted

tags to successfully track pallets and containers shipped from the United States to the Area of Responsibility (AOR) during OIF. In addition, the Army used RFID tags to track supplies from sea and aerial ports to troops in the field. Although tracking supplies with RFID tags in the field was not as successful as from the United States to the ports, tags were applied to all containers and pallets. In contrast, the industry interviews highlighted that a limited number of civilian companies are currently field testing RFID tags, and the technology has yet to be implemented company-wide. Implementation will expand based on the results of the initial field tests, but the results are still unknown.

This finding was interesting because the researcher believed the DoD adopted RFID tags based on a technology proven by industry. The research shows that the DoD is actually parallel or ahead of industry regarding the implementation and use of RFID tags in the supply chain, although the focus for use is somewhat different.

#### **RFID Tag Implementation Focus Within the Supply Chain**

Another major difference discovered during the study was how RFID tags are being used, or plan to be used, by the Army/DoD and industry. The DoD's current focus is to use RFID tags to

improve asset visibility, both to and from the AOR and within the AOR. As highlighted earlier in this study, RFID usage was mandated by the DoD with the belief that an RFID-enabled supply chain "will provide a key enabler to the asset visibility support needed by our warfighters."

In contrast, industry is focused on using RFID tags to improve inventory management and reduction of out-of-stock items at retail. As highlighted earlier, the civilian sector is not yet using RFID-tags to improve inventory management, but is testing the technology. Assuming the tests are successful, RFID tags will initially be applied to improve inventory management.

This finding was interesting because the researcher assumed the DoD mandated RFID implementation based on current industry use of the technology. On the contrary, not only is the DoD parallel or ahead of industry regarding use of the technology, the focus is different. The DoD used RFID tags to improve asset visibility during OIF, and is expanding implementation with the goal of improved asset visibility within logistics networks. Industry has a different focus, and plans to initially use RFID tags to improve inventory management and overall shelf stockage.

### **The Army's Wartime Logistics Network**

In addition to the two major discoveries highlighted above, the majority of the differences found during the research are related to issues associated with the Army's wartime logistics network and supply line. Each of these areas was highlighted in the OIF lessons learned or after action reports and relate to complications associated with moving supplies in a wartime environment. Although bandwidth, transportation, security, and dynamic supply lines do not relate directly to the use of RFID technologies, they have a major impact on the logistic network's ability to communicate and move materials, with or without RFID tags. In addition, dynamic supply lines impact RFID tag effectiveness based on the constant requirement

to set-up and take down equipment, and to provide a power source. Civilian companies do not have to manage these difficulties in their global supply networks, or if they do, not in the same scope or scale.

## **CONCLUSIONS**

During the research, two interesting findings were discovered. First, the research revealed a major gap in RFID tag use and implementation between the Army/DoD and civilian business. The research showed *the DoD is parallel or ahead of industry regarding the implementation and use of RFID tags in the supply chain*. The DoD successfully used RFID tags to track pallets and containers shipped from the United States to the AOR during OIF, and the Army used RFID tags, to some extent, to track supplies from sea and aerial ports to troops in the field. In contrast, civilian companies are still field testing RFID tags, and the technology has not yet been implemented beyond testing.

Second, *the overall focus of how RFID tags are or will be used within the Army/DoD and civilian business is different*. The DoD's current focus is to use RFID tags to improve asset visibility, and this was practiced during OIF. In contrast, industry plans to use RFID tags to improve inventory management and to reduce out of stock items. Although asset visibility may become a focus area in the future, initial focus will be inventory management.

In addition to the two areas highlighted above, a number of similarities and differences exist regarding how industry and the Army/DoD are implementing and using RFID tags. Both industry and the Army have improved or plan to improve productivity and customer service with RFID tags, and they share similar concerns regarding reliability, supplier support, and system interoperability. Despite this, the Army is unique from industry in its use of RFID tags for several reasons. Bandwidth and supply line security are two issues that impact RFID tag usage, as is long and dynamic supply lines. The supply line has a direct impact on the use of

RFID technology, as it impacts the set-up and take-down of RFID readers, the placement of RFID readers, and it requires a secured power source.

The findings, particularly with respect to the focus of private sector RFID implementation, must be considered preliminary. This research identified some areas of potential difference between DoD and civilian implementation issues and strategies. However, a larger scale study would need to be performed. Without a broader analysis of industry practice, it is difficult to put much confidence in the ability of the small number of participants in this initial study to

represent the intent or experience of the industry as a whole. However, it is believed that this small effort has identified some potential areas of difference which, if validated and explored further, could lead to greater progress and collaboration between both sectors, leading to improvements for organizations in both. The findings also emphasize how important it is for the DoD and industry to work together as each tests and implements RFID technologies. Since the organizations have different focuses and implementation plans, each can learn from the other regarding testing and use, and can aid in further development, use, and implementation.

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# THE PROFIT IMPACT OF A STRATEGIC APPROACH TO WEB ENHANCED SERVICES (WES)—A STUDY OF THE MOTOR CARRIER INDUSTRY

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## ABSTRACT

An increasing number of motor carriers offer web-enhanced services (WES) such as real-time-tracking-and-tracing, on-line ordering, and conflict resolution. However, the burst of the Internet bubble raised questions as to whether investments in such Internet-related services increase corporate profitability (e.g., Nagarajan et al., 2000). This article studies financial and operational values that web-enhanced services add to publicly traded interstate trucking companies. Large companies offering WES were found to be more profitable than smaller companies in general, and they were more profitable than other large carriers not offering WES. Investments in WES appear to provide a strategic advantage specifically for large companies.

## INTRODUCTION

From 1995 to the present, the interstate motor carrier industry in the United States has seen growth in the number of companies offering web-enhanced services (WES). These services range from limited tracking and tracing to transactions that are completely Internet-based. New technologies such as automatic vehicle location systems (AVLS), automatic vehicle identification (AVI), and satellite and radio based communication (SRC), make value added real-time service to shippers possible. Several

publications have highlighted this growth. Lancioni et al. (2000) noted that throughout the supply chain, the sector that most widely uses the Internet is the transportation sector. Hickey (2001) reported that most trucking companies are involved in one or more Internet projects aimed at improving customer service. The *Inbound Logistics'* 2000 Annual Top 100 Trucking issue identified specific web-enhanced technologies commonly found in the motor carrier industry—real time tracking and tracing (RTT), electronically available bills of lading, POD's, etc.—and ranked the breadth of each of

"the Top 100 Company's" web-enhanced capabilities.

While success stories abound (e.g., Shulman, 1999) and lead to the assumption that WES capabilities add financial value to a motor carrier, motor carriers are hesitant to embark on a full-scale adoption of WES. According to a study by Nagarajan et al. (2000), motor carrier spending on Internet development has been small, accounting for only 12 percent of their investment in new technology. Implementation is still in its infancy with respect to both breadth and depth (Ellinger et al., 2001). With the recent difficulties that many Internet companies have experienced, some are questioning the cost advantages of WES for motor carriers (Chakraborty and Kazarosian, 2000; Graham, 2001; Nagarajan et al., 1999; Nagarajan et al., 2000).

These concerns reflect the lack of actual knowledge and the scarcity of research regarding relationships between WES and their impact on profitability. Some authors have theorized that companies offering WES would be able to advantage themselves competitively (Chan and Artmangkorn, 2002; Kleindl 2000; Watson et al., 2000), that effective implementation would separate the successful trucking companies from the struggling ones (Panza, 2000), and that web-enhanced capabilities would even the playing field between large establishments and smaller startups (Rodriguez, 2001). However, others have noted that there are no well-established ways to estimate or measure the value of a website (King, 1999), or to accurately account for development costs (Stout and Marden, 2001). Still others have suggested that investment in WES may not be as profitable as other investment opportunities (e.g., Chakraborty and Kazarosian, 2000; Graham, 2001; Nagarajan et al., 2000).

This study clarifies some of these issues by investigating relationships between adoption of WES and a motor carrier's financial performance. In particular, this study measures the financial results that firms should expect from offering WES in the motor carrier industry. This

study also identifies distinguishing characteristics of companies that offer WES and addresses the issue of whether recent technological advancements have allowed smaller companies to compete more effectively with larger companies in service levels.

Due to significant website development and maintenance costs and the lack of ability to clearly measure the financial value of WES, motor carriers are incurring substantial risks in committing resources for implementing and maintaining WES. This research provides empirical evidence that establishes a clear relationship between the offering of various web-enhanced services and their impact on profitability. This increased understanding offers great value and allows firms to allocate resources to WES with greater understanding of the likely effect of these investments.

## **BACKGROUND AND HYPOTHESIS DEVELOPMENT**

### **Historical Background**

The motor carrier industry in the U.S. was economically deregulated in 1980, resulting in increased competition and substantial reductions in shipping rates. As a result, motor carriers have been experiencing profit deterioration and financial difficulties. In fact, marginal costs often dropped below average costs. At the same time, there have been many new entrants into the industry despite reduced profitability. This ultimately led to high bankruptcy rates (Belzer, 1995a). Adding to these pressures, shippers continued to demand better and faster services from carriers.

Pressures from customers for lower rates and greater reliability of on-time delivery have forced carriers to seek new ways of developing profits while maintaining or improving service levels (McMullen and Lee, 1999; Voos, 2001). Recent developments in information technologies have opened much-needed new avenues for motor carriers to both improve efficiencies and to differentiate themselves from their competitors.

The Internet, particularly WES, provides a new avenue to link shippers and carriers. According to a 1999 survey of shippers (Purchasing, 1999), 62 percent said their use of the Internet had increased in the previous year and 76 percent said they expected to use it more in the coming years. Carriers and shippers both recognize that the key to greater operational efficiencies is improved integration of processes, including the use of mechanisms that bring shippers and carriers together in the transport process (Dornier et al., 1998; Onliner and Sichel, 2000). Increasingly, shippers, transport carriers, and logistics intermediaries such as international freight forwarders are turning to the Internet for effective information management (Litan and Rivlin, 2001).

As customers are expecting carriers to be Internet savvy, motor carriers have no choice but to adapt themselves by installing some form of web-enhanced systems. This transition is being facilitated by an increase in Internet usage among drivers. According to Machalaba (2000), at least 40 percent of truck drivers are computer literate and 25 percent have routine access to the Internet. One example of how Internet usage is affecting the motor carrier industry is Landstar, which allows its connected drivers to link to the web via cell phones, scan available freight shipments posted at landstar.com by Landstar's network of independent agents, and select the most lucrative loads. This has produced considerable financial and operational advantage for Landstar (Machalaba, 2000). A study by Bradley et al. (2000) suggests that Landstar's practices may be representative of what motor carriers will experience in the future. To put this forecast into perspective, according to the American Trucking Association's Year 2000 estimate, almost 60 percent of motor carrier companies have websites, providing services ranging from simple company information to more and increasingly enhanced, even interactive, Web-based services for shippers.

## **Potential Influence of Web-Enhanced Services**

Some studies revealed positive effects of Internet usage by companies, including increased efficiencies in a wide range of functions (e.g., Onliner and Sichel, 2000), such as enhanced purchasing functions in the petroleum refinery industry with measurable financial benefits (Lyle, 2000), and a wide range of old economy arenas (Litan and Rivlin, 2001). Implementation of web-enhanced services also leads to improved and expanded customer service levels and coordination (Litan and Rivlin, 2001), and reduced coordination costs (Garicano and Kaplan, 2000), making the supply chain more reliable for a large variety of companies in both traditional and services fields (Walker et al., 2000). Garicano and Kaplan (2000) classified these positives into three broad categories: (1) process improvements, (2) marketplace benefits, and (3) indirect improvements, and further suggested that process improvement and marketplace benefits could potentially be large. As Brynjolfsson and Hitt (2000, pg. 23) stated,

rather than being paradoxically unproductive, computers have had an impact on economic growth that is disproportionately large compared to their share of capital stock or investment, and this impact is likely to grow in the future.

## **Benefits of WES in the Motor Carrier Industry**

In spite of the interest in the value that the Internet provides to companies in general, studies about the specific impact of web-enhanced services on profitability in the motor carrier industry are scanty. Some scholars have argued that WES would potentially benefit the motor carrier industry (e.g., Walker et al., 2000) because the trucking industry's future success

will rely heavily on its ability to anticipate changes and to innovate to meet market demands (Panza, 2000). A recent KPMG survey confirmed that web-enhanced services allow motor carrier companies to provide better shipment tracking, on-line ordering, invoicing/payment, etc. (Rosencrance, 2000). Murphy and Daley (2000) found that these opportunities extend to freight forwarder operations where they are taking advantage of the Internet to offer the benefits of quick access to information with improved tracing and expediting of services to customers. A related study indicated that such web-enhanced activities could result in a reduction of 50 percent to 70 percent in transaction costs in some instances, and have the potential of providing additional benefits from disintermediation (Carr, 2000). This demonstrates the view that the strategic use of information in the motor carrier industry will become a principal facilitator in the integration of processes because "operations and logistics have evolved from simply moving products through the supply chain to being information providers" (Dornier et al., 1998).

Another potential benefit of WES is the influence on potential economies of scale in the motor carrier industry. Previous research has shown that motor carriers apparently do not enjoy economies of scale (e.g., Adrangi et al., 1995; Belzer, 1995a, 1995b). However, there is some evidence that, independent of WES, large firms can achieve competitive advantages through increasing long haul shipment distance and number of loads per shipment (Xu et al., 1994). One inference from Xu et al. (1994) is that in the pre-Internet era, large firms could leverage their operations, thus achieving some economy of scale over smaller trucking companies. In fact, in the past, large firms have maintained a measurable advantage in attracting these preferred shipments (Xu et al., 1994). However, long-haul shipments have longer and more variable transit times than do short-haul shipments. Reduction in this variability through the use of Internet-based RTT might encourage participating companies to pursue more long haul shipments. Thus, one possible value of WES in the motor

carrier industry is the potential it offers to develop economies of scale. On the other hand, WES might offer smaller firms an opportunity to compete more effectively with larger firms for these preferred shipments. It has been argued that the ability to compete for standardized EDI transactions through use of the Internet might advantage small firms (Nagarajan et al., 2000). It is therefore unclear who will ultimately benefit the most from use of WES. This study investigates these issues.

### **Financial Performance**

In spite of predictions of the potential value being offered by implementing WES, there has been no clear-cut evidence that trucking companies have gained significant advantages by providing an Internet presence, either financially or competitively (e.g., Nagarajan et al., 2000). In fact, a study by Chakraborty and Kazarosian (2000) found that productivity increases were not significant for companies that pursued Internet strategies. The authors reasoned that this was due to the difficulty of correctly identifying outputs, particularly in a service sector such as the motor carrier industry where WES offerings are often differentiated by quality attributes of the services provided rather than merely the physical content of the goods delivered. Furthermore, many of the previous measurements of the profitability of Internet implementation have centered on increasing sales through the addition of another channel, i.e., the Internet or e-commerce, which did not capture the operational improvement WES may bring.

Perhaps a better measurement would focus on the influence of comprehensive web-enhanced services on a motor carrier's performance. In another study, Nagarajan et al. (2000) failed to find a relationship between the use of information technology and economic performance. According to that article, 75 percent of the trucking companies have set up websites, but by 1999 only about 5 percent of the shipments by firms offering Internet activity were produced via the Internet. They argued that the motor carriers that implemented Internet technologies

were simply adding tasks, and that these tasks might become inefficient as the new Internet becomes more complex. They concluded that adoption of new information technology would not necessarily lead to greater profitability for most firms.

The unproven effects of various WES on profitability has certainly reduced the number of motor carriers pursuing WEB based initiatives and impeded efforts to implement WES projects. In order to clarify the issues involved, this study examines the relationship between trucking companies' web-based technologies and their performance. It should be noted that while this research has been limited to publicly traded companies with revenues greater than \$25 million, it is reasonable to expect that these findings can be generalized across all large and medium-sized motor carriers. The study first identifies the most widely adopted WES, then explores the role of company size in their implementation. Finally, the impact of WES on motor carriers' profitability is investigated.

### Hypotheses

Consistent with the objectives stated above, the following hypotheses were developed and examined by this research:

- H1. Given the overall push to meet customer demands, it is hypothesized that among the various web-enhanced services being offered by motor carriers, real time tracking and tracing (RTT) is proving to be one of the more important "first step" technologies for motor carriers interested in utilizing web-enhanced technologies.
- H2. In spite of conflicting evidence in the literature, due to the potential advantages and the rapid development of Web technologies, it is hypothesized that company size will not influence the implementation of WES. In particular, successful implementation of WES by both medium and large, publicly traded,

interstate motor carriers will be independent of firm size.

- H3. It is hypothesized that the implementation of WES by publicly traded interstate motor carriers will lead to improved financial performance.

## METHODOLOGY

### Data Collection and Sample

Information is widely available on publicly traded companies, facilitating research regarding profitability of these companies. Since the literature suggests that large motor carriers are much more likely to utilize the Internet than their smaller counterparts (Nagarajan et al., 2000), a sample consisting of larger, publicly traded motor carriers should be representative of all companies with sufficient resources and impetus to implement WES. The *Inbound Logistics* 2000 Top 100 list provided the initial list of companies in the study. This list was expanded by searching Standard and Poor's COMPUSTAT database for similar companies. The representative sample companies from the search had annual revenues greater than \$25 million and cumulative annual revenues of about \$33 billion. This represents almost 10 percent of annual revenues for the industry, and, as previously mentioned, represents the companies most likely to implement and benefit from the use of WES.

Once the representative sample of motor carriers was obtained, extensive efforts and processes were utilized to exclude any company whose primary focus might be in peripheral or related businesses such as freight forwarding, logistics services, or transportation consulting rather than trucking. Sources for this determination included: *Moody's* (or more recently *Murgent's*) *Transportation Manual* (1997-2001), *Wall Street Journal Index* (1997-2001), *Dun and Bradstreet's Million Dollar Directory* (1997-2001) and the existing web sites of the companies in the sample.

The screening and validation processes identified the companies that 1) had trucking as a main offering/ focus, 2) had annual net sales of over 25 million dollars, and 3) were publicly traded. These were then classified as medium or large companies, using the cutoff of 100 million dollars in annual net sales to distinguish between the two groups. Since web-enhanced services were not widely available before this time, the starting point was 1997. Full content data were available and collected for dates through the end of 1999. This date was chosen since, according to the survey mentioned earlier by Nagarajan et al. (2000), 75 percent of trucking companies reported having at least minimal Internet activity by early 2000. Their finding makes it reasonable to expect that the impact of WES should be demonstrable by data from this time period. Interestingly, our sample displayed a level of Internet activity that exceeded the reported 75 percent, supporting the methodology employed.

### Web-Enhanced Services

*Inbound Logistics* 2000 identified the following as web-enhanced Services (WES): 1) Real Time Tracking and Tracing, 2) POD, BOL in Image Format, 3) Creating BOL, 4) Transit Times by Origins/Destination, 5) Individual Rates, 6) Standard Rates, 7) Individual Account Information, 9) Activity Management Report, 10) Claims Ratio Statistics, 11) On-time Statistics, 12) Location Directory, and 13) Filing Claims. These WES enable shippers to timely and accurately track and trace shipments and streamline other existing processes. Information on the existence of company Internet sites as well as which of the WES technologies were offered was determined on a company-by-company and service category by service category basis. These determinations were made by collecting data included in the *Inbound Logistics* 2000 Top 100 list, on corporate web sites, and information gathered from direct telephone contacts with information service departments. Only companies that offered at least one of the above services were classified as WES companies (WESC). All other companies were classified as

non-WES companies (NWESC). Table 1 lists the WES offered and the corresponding number of companies offering the services for all years of the study period. A breakdown of these numbers into their WESC and NWESC categories is also included.

### Size and Financial Performance

Size and financial performance of each company in the study were established. Company size is traditionally determined based upon revenues, assets, number of employees, or some combination of these three items. A preliminary size analysis was employed comparing number of employees with net sales revenues, and these two factors correlated highly in the motor carrier industry (0.98,  $n = 121$ ).

Net-sales was chosen as the measure of company size for this study. Corporate financial performance for each firm was determined based upon return on assets (ROA), return on equity (ROE), and return on investment (ROI).

### Statistical Procedures and Analysis

In order to reveal differences between the WESC and NWESC companies, several tests were conducted. Figure 1 illustrates the flow of the analyses conducted throughout this research. Notice that the map shows how the results of a particular analysis naturally led to the analyses that followed.

### Testing of Normality

First, the data were analyzed to determine if they were distributed normally. Several analyses and tests were used for this purpose. Graphical tests were used (histograms and normal probability plots) as well as analytical tests: Shapiro-Wilk's W-test, Kolmogorov-Smirnoff and Chi-Square tests of normality. Figure 2 is a representative graph used to investigate the normality of the data. In every case, normal plots suggested that the normality assumption was not appropriate. This result, coupled with the size of our data set (less than 100 observations in

**TABLE 1**  
**WEB-ENHANCED SERVICES**

Services Offered	Number of Companies		
	WESC	NWESC	TOTAL
RTT	75	0	75
POD, BOL in Image Format	63	36	6
Request for Shipment P/U	42	3	45
Creating BOL	33	0	33
Transit Times by Origins/Destination	44	1	45
Individual Rates	51	4	55
Standard Rates	62	4	66
Individual Account Information	35	0	35
Activity Management Report	33	0	33
Claims Ratio Statistics	21	3	24
On-time Statistics	19	2	21
Location Directory	75	82	157
Filing Claims	23	1	24

each group), dictated the use of non-parametric statistics throughout the remainder of the analyses. The Mann-Whitney U-test was employed for this purpose (Statsoft, 2002—see, in particular, discussion of sample size requirements for utilization of parametric statistics with non-normal data).

## RESULTS

### RTT (Real Time Tracking and Tracing)

Confirming our first hypothesis, RTT did, in fact, emerge as the “first step” technology for the companies in this study. In fact, every company that offered any value added WES service via the Internet also offered RTT. Previously, RTT has received attention due to its successful implementation by Federal Express, UPS and the USPS. Many trucking firms are offering RTT and customers are increasingly demanding it. A case study by Shulman (1999) offered some pictures of the benefits of successful implementation of RTT at Giant Foods, which has used WES effectively to improve its trucking fleet operations. Through development of RTT, digitized driver reporting systems, etc., the company has substantially improved timely delivery. Moreover, RTT via the Internet is developing as a common way to help improve transit time problems. At a time when

congestion on US roadways is increasing transit time and variability of transit time (Regan and Golob, 1999), WES and developing information technologies are seen as ways to combat this. As attempts are made to utilize WES to its full advantage, help with on-time delivery appears to be extremely relevant (Hickey, 2001). This suggests that companies are implementing this technology early in the process of developing WES. In fact, many companies offered only RTT in their attempts to establish online services. RTT has been used as an important “first step” technology for motor carriers interested in utilizing web-enhanced technologies. One implication from this is, accordingly, that RTT can be used as a cutoff mark to easily distinguish WESC (companies offering WES) from NWESC (companies not offering WES) in future studies.

### Size

The second hypothesis (that WES implementation would be independent of company size) was tested by comparing measurements of the size of interstate motor carriers that do not offer web-based services and those that do offer web-based services. The Mann-Whitney U-test rejected the null hypothesis with a p-value of 0.0036. This allowed us to conclude that a relationship did, in fact, exist between corporate size and the implementation of WES. It was found that companies



that have implemented WES are larger (on average) than their counterparts that have not implemented WES, suggesting that although barriers to entry in offering WES can be low, smaller companies have not been able to, or have not chosen to add these capabilities.

### Financial Performance

The third hypothesis (that use of WES would lead to improved financial performance) was tested using the Mann-Whitney U-test. The results of these tests are captured in Table 3. The statistical tests show that, when the financial performance of both WESC and NWESC are compared, ROA, ROE and ROI are all significantly higher for WESC with p-values of 0.0115, 0.0046, and 0.0031 respectively. This indicates that a relationship exists between implementation of WES and the financial measures tested. In other words, companies that have implemented WES enjoy higher profitability than their counterparts that have not implemented WES (see Figures 3, 4, and 5). These findings support arguments made in the literature that WES could lead to improved financial performance (e.g., Garicano and Kaplan, 2000; Nagarajan et al., 2000).

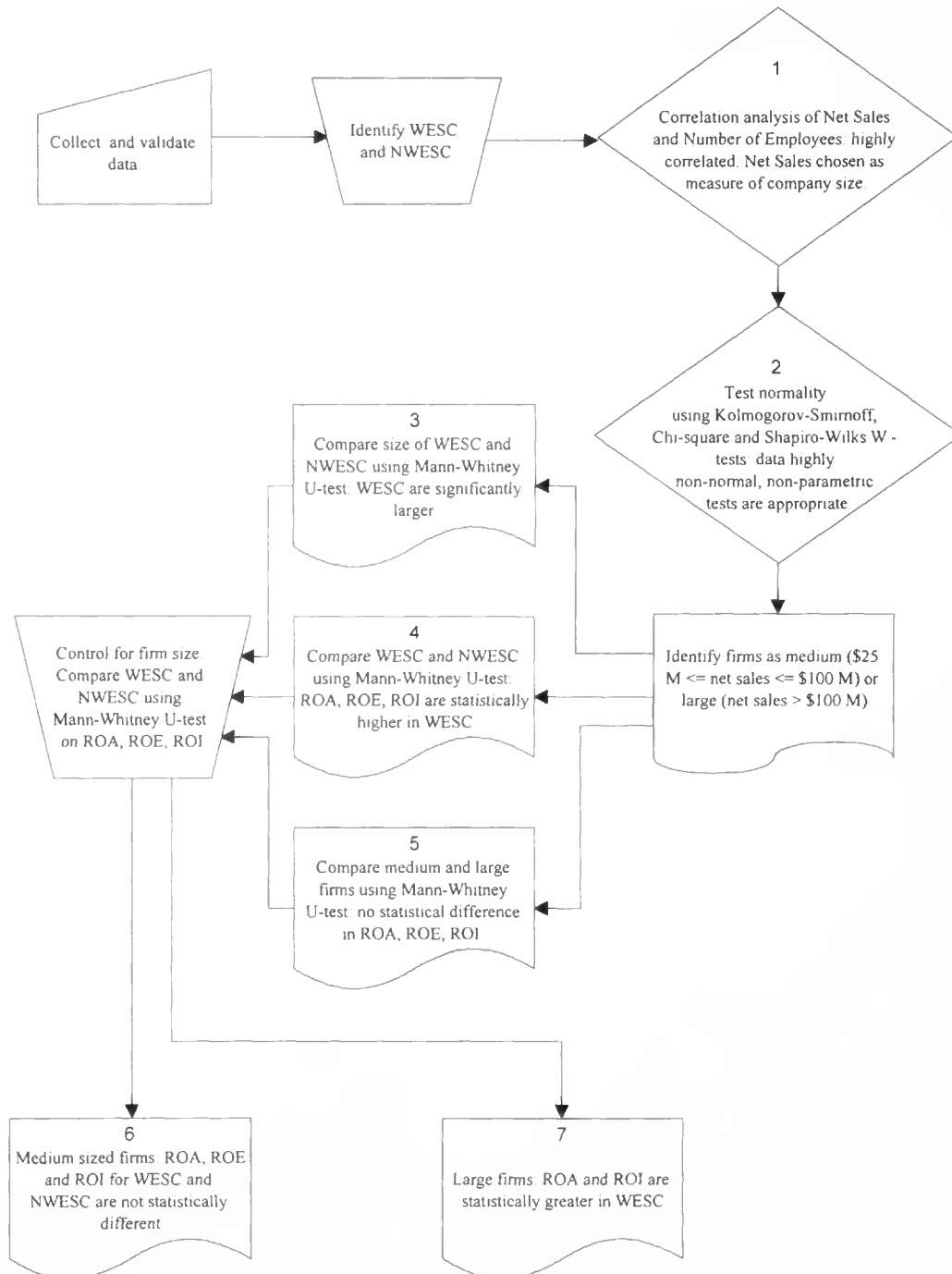
A question was raised as to whether the enhanced profitability could be attributed to company size. That is, did the findings merely imply that larger motor carriers were more profitable in general than smaller motor carriers? To answer this question, corporate size was controlled for and profitability ratios of large and medium-sized firms were compared. The results from the Mann-Whitney U-test failed to suggest a significant difference in financial performance (ROA, ROE, ROI, p-values 0.29, 0.33, 0.36 respectively) between the large and medium sized firms in the sample, with \$100 million as the cutoff point. This clearly indicates that WES, instead of size, is the distinguishing factor in the sample that contributed to the difference in performance between WESC and NWESC motor carriers.

In order to further isolate the size effect, company size was controlled and two comparisons were made: large WESC vs. large NWESC; and medium WESC vs. medium NWESC. For the large motor carriers, WESC have greater ROE and ROI than their similarly sized NWESC counterparts. ROA was not found to be different at a statistically significant level (p value = 0.11). However, the average ROA of large WESC were greater than their large NWESC counterparts and tended towards significance. For the medium motor carriers (those with revenues in the range of \$25 million to \$100 million), results were not as clear. Although medium WESC were generally more profitable than medium NWESC, the Mann-Whitney U-test did not reveal a statistically significant difference in ROA, ROE, or ROI between these two groups of companies. These results indicate that while WES does provide certain financial advantages for large companies when WESC and NWESC of equivalent size are compared, this does not appear to hold true for medium-sized companies.

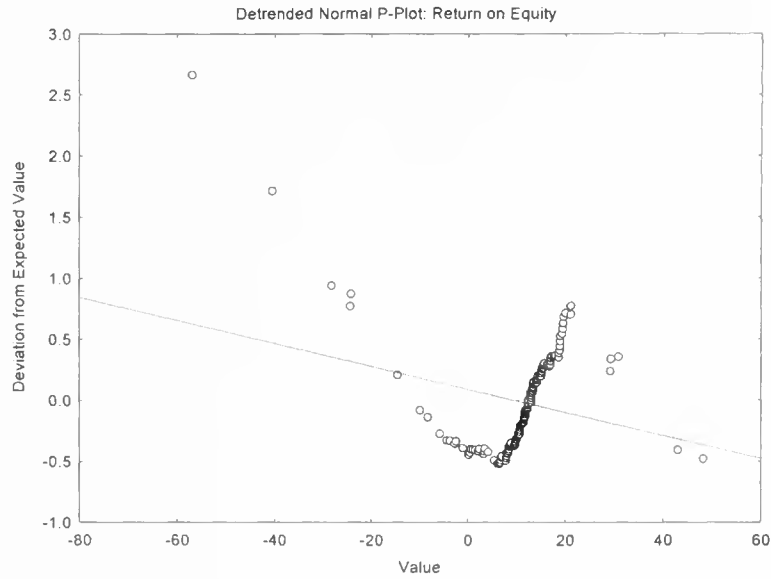
### Discussion

Until recently, the issue of determining whether WES provides increased profitability has been complicated by the diversity of companies developing these services, by company size, and by the lack of understanding of what value these services offer to motor carriers. This study is the first that empirically clarifies relationships between investment in WES and financial returns. It identifies certain practices that enhance the operational and financial performance of interstate motor carriers. Results from this study indicate that companies adopting WES are usually large companies and exhibiting better financial performance, and that large companies that offer WES are statistically more profitable than their large counterparts that do not offer such services. This financial performance difference was confirmed across ROE and ROI, and tended towards significance with ROA. It confirms the belief that current technologies

**FIGURE 1**  
**FLOW CHART FOR ANALYSIS**

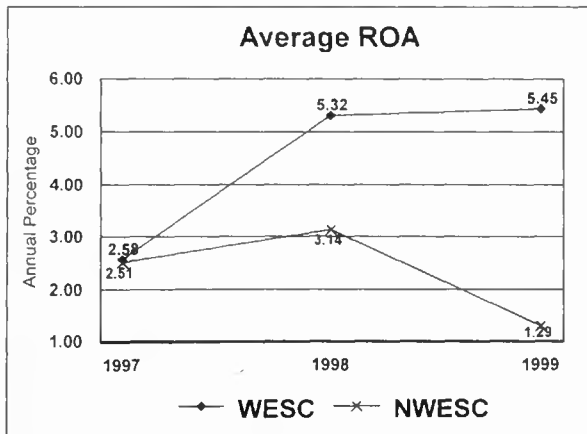


**FIGURE 2**  
**NON-NORMALITY CHART**



**FIGURES 3, 4, AND 5**  
**DIFFERENCES IN PERFORMANCE BETWEEN WESC AND NWESC**

**FIGURE 3**



**FIGURE 4**

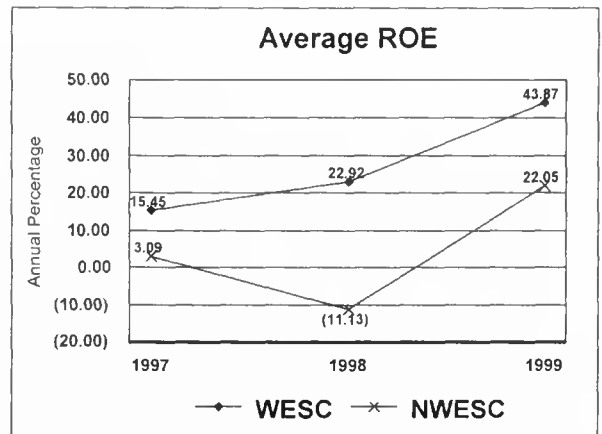


FIGURE 5

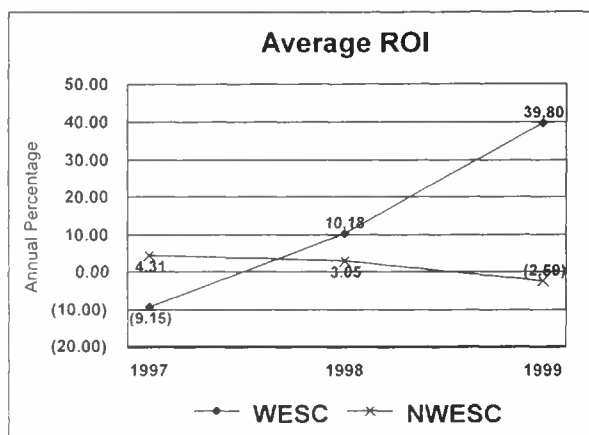


TABLE 2  
STATISTICAL RESULTS

Task	Statistical Test(s)	Hypotheses Tested	Statistical Results	Conclusions	p-value*	Sample Size
1. Correlation Test	Correlation Matrix	H0: Employee number and Net sales is not correlated	Reject hypothesis	Select Net sales as measurement for size	< .05	
2. Normality Test	Kolmogorov-Smirnoff, Chi-Square and Shapiro-Wilk's W - tests	H0: # Employees data is normally distributed	Reject hypothesis	Non- parametric tests should be used	< .01	WESC n = 75
		H0: Net sales data is normally distributed	Reject hypothesis	Non- parametric tests should be used	< .01	NWESC n = 74 WESC n = 75
		H0: ROA data is normally distributed	Reject hypothesis	Non- parametric tests should be used	< .10	NWESC n = 82 WESC n = 75
		H0: ROE data is normally distributed	Reject hypothesis	Non- parametric tests should be used	< .01	NWESC n = 82 WESC n = 75
		H0: ROI data is normally distributed	Reject hypothesis	Non- parametric tests be used	< .01	NWESC n = 82 WESC n = 75
3. Test on Size	Mann-Whitney U-test	H0: Mean number of employees is the same for WESC and NWESC	Reject hypothesis	Mean number of employees is greater for WESC than NWESC	0.0036	NWESC n = 82 WESC n = 75
		H0: Mean net sales is the same for WESC and NWESC	Reject hypothesis	H0: Mean net sales is greater for WESC than NWESC	0.0036	NWESC n = 74 WESC n = 75 NWESC n = 82
4. Test on Profit between WESC and NWESC	Mann-Whitney U-test	H0: Mean ROA is the same for WESC and NWESC	Reject hypothesis	Mean ROA is greater for WESC than NWESC	0.0115	WESC n = 75 NWESC n = 82
		H0: Mean ROE is the same for WESC and NWESC	Reject hypothesis	Mean ROE is greater for WESC than NWESC	0.0046	WESC n = 75 NWESC n = 82
		H0: Mean ROI is the same for WESC and NWESC	Reject hypothesis	Mean ROI is greater for WESC than NWESC	0.0031	WESC n = 75 NWESC n = 82

**Table 2**  
**(continued)**

Task	Statistical Test(s)	Hypotheses Tested	Statistical Results	Conclusions	p-value*	Sample Size
5. Test on Profit between Large and Medium firms	Mann-Whitney U-test	H0: Mean ROA is the same for large as for medium firms	Fail to reject hypothesis	Statistically indeterminate	0.29	Large firms n = 83
		H0: Mean ROE is the same for large as for medium firms	Fail to reject hypothesis	Statistically indeterminate	0.33	Medium firms n = 74 Large firms n = 83
		H0: Mean ROI is the same for large as for medium firms	Fail to reject hypothesis	Statistically indeterminate	0.36	Medium firms n = 74 Large firms n = 83
						Medium firms n = 74 Medium WESC n = 24
6. Test on Profit between medium WESC and medium NWESC	Mann-Whitney U-test	H0: Mean ROA is the same for Medium WESC as for Medium NWESC	Fail to reject hypothesis	Statistically indeterminate	0.31	Medium WESC n = 24
		H0: Mean ROE is the same for Medium WESC as for Medium NWESC	Fail to reject hypothesis	Statistically indeterminate	0.24	Medium WESC n = 24
		H0: Mean ROI is the same for Medium WESC as for Medium NWESC	Fail to reject hypothesis	Statistically indeterminate	0.23	Medium WESC n = 24
						Medium NWESC n = 50 Medium WESC n = 24
7. Test on profit between large WESC and large NWESC	Mann-Whitney U-test	H0: Mean ROA is the same for large WESC and large NWESC	Fail to reject hypothesis	Statistically indeterminate	0.11	Medium NWESC n = 50 Large WESC n = 51
		H0: Mean ROE is the same for large WESC and large NWESC	Reject hypothesis	Mean ROE is greater for large WESC than large NWESC	0.004	Large NWESC n = 32 Large WESC n = 51
		H0: Mean ROI is the same for large WESC and large NWESC	Reject hypothesis	Mean ROI is greater for large WESC than large NWESC	0.003	Large NWESC n = 32 Large WESC n = 51
						Large NWESC n = 32

\* reported p-values for Shapiro-Wilk's W-test, Kolmogorov-Smirnov and Chi-Square tests (testing hypothesis of the underlying distribution being normal) is the higher of the three values. In all cases, this was the value calculated for the Kolmogorov-Smirnov test.

have begun changing operational efficiencies with improved financial performances. Since a very strong positive relationship was found between company size and the existence of web-enhanced capabilities, our results contradict the conventional thought that the Internet would be employed equally, regardless of company size.

Explanation of this finding is not difficult. It is relatively easy for a company with a very limited budget to create and maintain small, non-interactive websites that only present company information. However, development of advanced WES (particularly interactive WES) requires greater commitments of development funds. As

such, it is possible that medium-sized companies will carry a larger burden as a percentage of development funds than their large counterparts in offering the same level of WES. Therefore, there is a smaller percentage of medium size firms that adopted WES, and the financial returns of WES may not be as great for medium-sized firms. It is very possible that, because of the high costs associated with developing and maintaining WES, the added benefits to medium-sized firms are actually offset by the disproportionately large costs, minimizing the financial benefits for the medium-sized WESC. Thus, barriers to entry for adopting Web technologies may exist which prevent smaller companies from offering comprehensive WES, or may actually cause them to not realize financial benefits from offering WES. In general, web-enhanced services do not appear to offer competitive disadvantage to companies, although the financial implications are not clear at this point.

### **Managerial Implications**

The significance of the findings is threefold. First, since WES implementation provides financial advantages to certain companies, those firms that have developed WES may enjoy a first mover advantage in the field. This advantage may serve as a threat to those companies that are slow to implement WES in their businesses. As such, motor carriers may need to implement WES as a competitive weapon. Second, company size appears to be related to propensity to adopt WES. The association between company size and the implementation of WES is quite strong. The Internet has not facilitated the creation of a level playing field for large and small trucking companies. Rather, it has further polarized companies with size as the factor of differentiation. The study results indicate the Internet has actually widened the gap between small and large companies. Third, if financial barriers to adoption of WES restrict smaller companies from participating in these services, then perhaps an opportunity exists for third party providers to bridge the gap. Clearly, these points have profound significance for the motor carrier industry.

### **Limitations and Future Research Opportunities**

At present, these findings are interesting and raise questions for future research. The findings tend to point out that corporate size may be a reliable predictor of which companies have implemented web-based technologies, and which might benefit from the new technologies. Large companies are more prone to develop web-enhanced capabilities and offer such services to their customers, making a difference on corporate profitability. However, causal relationships could not be established, thus limiting the generalizability of these results across the industry. Future research needs to investigate the relationships found in this study. Moreover, research is needed to further identify which WES provide the greatest value to companies, thus providing practical guidelines to companies that engage in phased decisions for adopting WES. A second limitation is that, since the study has been restricted in scope to publicly traded companies, the impact of WES implementation on private trucking companies is still unknown. However, it is reasonable to expect that these private motor carriers follow patterns similar to those demonstrated among publicly traded companies due to the similarity of their operational environment. Future research should include these companies.

### **CONCLUSION**

The motor carrier industry finds itself in a difficult economic situation. Pursuit of adequate profit-ability is of the greatest importance. One option available to motor carriers in attempting to increase efficiencies and improve customer service is the adoption of web-enhanced services. This study has addressed the question of whether WES is implemented uniformly across all motor carriers and whether such services provide any financial value. The study found that companies that adopt WES tend to be large. It also showed that large companies that utilize WES tend to be more profitable than their similarly

sized counterparts that do not. It also found that every company that offers any WES offers RTT.

Several implications can be drawn from these findings. Since size is positively related to a trucking company's propensity to adopt WES, use of the Internet further polarizes companies based upon size, rather than leveling the playing field for both large and small trucking companies. Further, since the use of WES gives trucking companies financial advantages, those companies that have begun to utilize WES may enjoy a

first mover advantage, while for those firms that have not incorporated the use of WES, the Internet may represent a significant threat.

In conclusion, motor carriers pursuing the elusive objective of increased profitability and greater customer satisfaction should consider offering WES. The key to success is to reshape for the Internet and devise an evolving business plan that responds to changes in the market as they occur.

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# MEETING THE CHALLENGE OF SUPPLY CHAIN INTEGRATION: USING SIX SIGMA FOR PROCESS IMPROVEMENT

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## ABSTRACT

Increased performance expectations, a more complex operating environment, rising costs, and declining operating margins have become every day challenges for carrier management. In order to meet these challenges, business-as-usual is not an adequate response. The time has come to take a new look at the way things are being done and the results that are being achieved. One method of making such an examination, Six Sigma, has produced extraordinary results for many of the manufacturing and service companies, large and small, that have implemented it. The introduction of Six Sigma as a means of examining and improving carrier service delivery processes is discussed and illustrated.

## INTRODUCTION

Looking back to the passing of the Motor Carrier Act of 1980 and similar acts affecting the other modes of freight carriage, one can only marvel at the changes that have taken place. The 1980's were characterized by free entry into the industry (especially motor carriage), industry over-capacity, fierce competition for a share of the existing shipper business (fought mainly on price), and the struggle to understand and implement marketing and differentiation strategies to create a competitive advantage. At the same time shippers were discovering the possibilities of developing cost saving distribu-

tion strategies based on the ability of carriers to be more responsive to their needs and the ability to negotiate rates (Rakowski, Southern and Jarrell 1993).

In the 1990's, carriers were developing strategies to operate as both common and contract carriers in an effort to better serve shipper needs and to make more efficient use of assets. This involved the use of marketing strategies such as shipper segmentation based on the identification of shipper segments with similar needs, the implementation of technology to track and trace shipments, and the initial efforts to use the Internet (Cottrill 2003). During this same period,

shippers were engaged in a reexamination of their business processes in an effort to identify and reduce waste in areas such as efficiency of manufacturing operations, the inability to match supply and demand leading to improper inventory levels and poor customer service (Drickhamer, 2003; Vollum, 2004). In an effort to be more competitive, companies sought to identify core competencies and investigated the efficacy of outsourcing these functions that did not contribute to their core competencies (Ewaldz, 2004). The view of logistics changed from a cost center to a source of profit and a vital link in the delivery of customer service.

By the turn of the century, the focus in the competitive arena had moved from the individual firm to the supply chain. The emphasis on process improvement within the firm has been expanded to embrace the design and implementation of processes connecting members of the supply chain. The Internet has become a communication tool used to create a user-friendly electronic environment to provide information, conduct transactions, and build better customer relationships. Intranets allow the members of the supply chain to engage in joint research, product development, and process improvement projects. In the effort to meet their customer demands and stay competitive in an increasingly globally based competitive environment, shippers continue to demand more from carriers. They expect individualized services that improve operations and meet stringent time requirements, and, at the same time, hold actual transportation costs to a minimum (Kent, Parker and Luke, 2001).

Each firm has a different vision for supply chain integration and strategies for implementation. However, regardless of the shipper's vision and resulting strategies, carriers must be prepared to become an integral part of supply chain operations, an equal partner in the smooth delivery of product and service from raw materials to final customer and back to final disposal (Premeaux, 2002). The challenge of meeting this requirement is in developing a proactive strategy and mind set that facilitates the ability of the carrier to

provide flawless service and the flexibility to respond to changes in customer requirements today and in the future.

## THE CARRIER'S DILEMMA

Actually, carrier management finds itself on the horns of a dilemma. Shippers are demanding more services which will contribute to their own ability to maintain a competitive advantage and provide better execution of transportation services that facilitate the time-sensitive, inter-organizational flow of products throughout the supply chain. At the same time, carriers must achieve a level of process excellence that allows them to meet the additional demands made by shippers while maintaining operating margins that provide sufficient funds to invest in state-of-the-art technology, equipment, and infrastructure, and provide the trained personnel at all levels needed to execute strategic customer service initiatives.

To further complicate the situation, a series of new laws targeting safety, security, and environmental concerns, rising fuel prices, and an ever increasing level of global operations have placed even greater demands on supply chain operational performance in general and, more specifically, on the ability of transportation to meet the demands of customers throughout the supply chain. The net result of these changes in the operating environment has been to add costs in the form of additional time requirements, personnel, IT infrastructure, and equipment assets, plus the more publicized cost increases for fuel and insurance.

Carrier management no longer has the luxury of reacting to changes regardless of whether the changes are legal or technological, local or industry-wide, customer specific or supply chain wide, national or global in scope. Reactive strategies tend to be problem or situation specific. When the issue under consideration is considered to have been solved, business-as-usual prevails. After the fact response mechanisms are not adequate for providing the capacity, agility, and cost effective strategies needed to be an active participant in an integrated supply chain

network. What is needed is a continuous, systematic approach to process improvement that is used throughout the organization to specifically identify and eliminate obstacles to the provision of error-free service that is responsive to changes in the operating environment and shippers' needs.

### **ADOPTING A PROACTIVE APPROACH TO CHANGE THROUGH PROCESS IMPROVEMENT**

The objective of process improvement is to reduce waste and the costs associated with inefficient process design and execution (Hoerl and Snee, 2002). Initially, process improvement efforts were associated with the production function of the firm. The ultimate goal was to reduce costs and improve customer satisfaction with improved product quality. This same objective applies to the delivery of quality service. Most importantly, incidences of poor process design and execution lead to service delivery errors and ultimately to lost customers and missed opportunities.

The importance of service quality efforts is reflected in improved firm productivity and reduced organizational costs leading to increased profits (Kandampully and Duddy, 1999). Service providers have found that, like their manufacturing counterparts, providing service quality is critical to maintaining comparative advantage in a competitive global marketplace (Kandampully and Duddy, 1999; Sharma and Gadenne, 2002). Customer perceptions of overall service quality are influenced by the interaction between the customer and the company's representatives as much as the functional and technological quality of the service experience (Kang and James, 2004). The overall results of service quality research highlight the importance of meeting customer requirements in order to ensure service quality (Wycoff, 1984).

There are numerous quality improvement programs available which may be used for service process improvement. Some have been developed to target a specific problem or situation. Other

such programs are more general in nature. Two of the more commonly applied programs are Total Quality Management and Six Sigma. Total Quality Management (TQM) has been shown to lead to improvements in teamwork, feelings of process ownership, organizational efficiency, and customer orientation (Sharma and Gadenne, 2002). TQM projects can have a managerial or process control orientation and emphasize continuous, incremental change.

The Deming management philosophy which incorporates statistical thinking and statistical process control (SPC), total quality management (TQM) and continuous quality improvement provides the foundation for Six Sigma programs (Benedetto, 2002). Six Sigma is customer focused, using data and facts to drive better solutions. Unlike TQM, Six Sigma emphasizes the achievement of breakthroughs in every function and process of the firm. The benefits to be gained through the adoption of a Six Sigma management orientation have been publically reported by diverse companies such as Honeywell, General Electric, Sears Roebuck and Co., Ford Motor Company, Johnson & Johnson, American Express, and Starwood Hotels.

Six Sigma quality initiatives specifically target process improvement for the purpose of reducing errors and cycle time, and increasing customer satisfaction. The company benefits by achieving cost savings as well as providing opportunities to retain existing customers and gain new ones due to the ability to deliver extraordinary service. The customer benefits by receiving the service elements desired every time, thus reducing their own costs and improving their ability to provide the same levels of service to their customers.

### **SIX SIGMA FOR CARRIER PROCESS IMPROVEMENT**

Carriers are faced with the need to meet shippers' demands for improved services. They expect carriers to contribute to their ability to maintain a competitive advantage, better execute transportation services that facilitate the time-sensitive, inter-organizational flow of products throughout

the supply chain, and to make changes in service mix and delivery when needed. At the same time, carriers must achieve a level of process excellence that allows them to meet the additional demands made by shippers while maintaining operating margins that provide sufficient funds to invest in state-of-the-art technology, equipment, and infrastructure, and provide the trained personnel at all levels needed to execute strategic customer service initiatives, all in a rapidly changing operating environment. Considering the task before them, the adoption of a Six Sigma management philosophy by carriers is especially appropriate due to its customer orientation, opportunities for major returns on investment, and new approaches to thinking, planning and executing business processes throughout the firm (Tagha-boni-Dutta and Moreland, 2004).

Six Sigma is more than a buzzword. It is a multidimensional approach to eliminating waste. Waste resulting from the poor execution of any process in the organization, whether it be order processing, routing, accounting, or any other process, leads to costs associated with the inefficient use of resources, the need to correct errors and essentially repeat what was done incorrectly, lost opportunities for revenue due to overpricing or under-pricing, or any number of other examples (Ramakumar and Cooper, 2004). Process measurement, goal setting, and management involvement are all essential to successful change through the use of Six Sigma (Harry and Schroeder, 2000; Beneditto, 2002; Hoerl and Snee, 2002).

### **Process Measurement**

Traditionally, measures of performance have been focused on the execution of processes internal to the firm. Six Sigma changes the focus to measures that are important to customers (Taghaboni-Dutta and Moreland, 2004). This provides the ability to compare the performance of different processes as they contribute to the goal of meeting customer requirements. In the transportation industry, the ultimate goal might be the on-time delivery of goods to the customer

without damage in transit. This entails the coordination and execution of a number of different processes such as scheduling, routing, driver and equipment availability, loading methods that minimize the probability of damage, etc. Each of these in turn is dependent upon the execution of other processes. For instance, equipment availability is dependent upon the absolute number of units, location, repair status etc. Repair status is dependent upon training, parts availability, routine maintenance and repair schedules, etc. It becomes obvious that each of the supporting processes contribute to the ability of the carrier to meet customer service requirements. Poor performance at any level will effectively prevent the carrier from meeting service goals and contribute to higher costs and missed market and revenue producing opportunities.

### **Goal Setting**

The setting of performance goals has often been a rather haphazard affair. Goals of 90%, 95%, or even 99% on time delivery sound admirable. But changing the perspective to one of how many unhappy customers or how many missed delivery times will be tolerated provides a different picture. The use of percentages hides the impact of even a 4 sigma (99.38%) rate of on time delivery. At the 4 sigma level, assuming a volume of 250,000 deliveries, 1,550 deliveries do not meet the service delivery time specification! Remember, on time delivery also assumes that the product is undamaged. Now, for each of these missed delivery opportunities, how many lead to financial penalties, lost customers, or the loss of opportunities to gain additional business due to lack of shipper confidence in the carrier's ability to meet performance requirements? Complaints about the inability of railroads to meet service requirements have affected both rail specific traffic and the willingness of shippers to use intermodal shipping options. This provides a vivid example of the ramifications of missed delivery commitments. Using the goal of Six Sigma, one would only expect 3.4 missed delivery commitments per 1,000,000 attempts. Using the previous example of 250,000 deliveries, there

would be .85 missed delivery times. This would mean only one incident of failure to deliver according to customer specifications. This is definitely a goal worth working for.

### **Management Involvement**

Six Sigma managerial involvement takes place at all levels of the organization. Given the opportunity and responsibility, personnel who are in direct contact with shippers generate ideas, create solutions for problems as they arise, identify changes in existing processes that will lead to better performance and eliminate wasted steps. Operators, customer service personnel, and sales personnel are positioned to make tremendous contributions in this way. Middle managers and supervisory personnel are responsible for identifying the need for Six Sigma teams to address problem areas due to recurring service failures, customer complaints, or declines in process performance measures. In this way, a proactive, customer-directed approach to strategic management becomes an integral part of the management focus (Thompson, DeSouza, and Gale, 1985). This may occur at the individual facility and/or regional level as the design, execution and integration of processes to provide customer service is measured and improved using input from the customer contact personnel. The upper levels of management are responsible for ensuring that the Six Sigma philosophy of customer focus and error-free process performance for service delivery is part of the vision and strategic planning for the carrier's future goals and objectives.

### **ADOPTING SIX SIGMA**

An initial issue that must be addressed when considering the adoption of Six Sigma or any other quality improvement initiative is the definition of the expected outcome. This is doubly important when considering the use of Six Sigma, which necessitates the involvement of every individual in the carrier's organization. It has been shown that successful implementation of a Six Sigma program provides the ability to track quality improvement progress leading to more

consistent process performance and service delivery. The net result of the efforts to improve process performance at all levels is to increase the focus on the customer, reduce waste and increase profitability (Harry and Schroeder, 2000; Bane, 2002; De Feo and Bar-El, 2002).

The second consideration is to determine the best approach for incorporating Six Sigma into the individual organization's operations. Six Sigma can be incorporated using anything from the toe-in-the-water approach, which entails focusing on persistent problem areas using a team trained in the use of six sigma tools, to the big-plunge approach that is needed to break old habits and transform a business that has lost its customer focus and instead is dealing with the consequences of continual service failures (Pande and Holpp, 2002).

The most comprehensive approach to Six Sigma is used to effect a business transformation. There is an urgent need to change the way business is conducted in order to meet competitive and customer pressure to improve performance. Time, effort and financial resources are not being used in a productive manner as reflected in shrinking profit margins, service failures, and customer defections. Taking this approach requires the commitment of the entire organization. It entails training, active participation on project teams, and a willingness to approach the improvement of each critical business process (such as delivery, sales, creation of innovative service packages, customer complaint response, and information systems) in an open and creative manner. There will be changes in performance measures for people and processes, customer interaction, and the integration of all internal processes to meet the ultimate goal of exceptional service delivery.

A less comprehensive and more flexible approach to Six Sigma is to focus on strategic improvement efforts. In this case, teams address issues such as determining the appropriate approach to taking advantage of opportunities that have arisen or addressing weaknesses that are hindering competitive positioning. This might

occur when one carrier is acquired by another or when customers indicate that they are not willing to utilize a carrier that does not offer them the opportunity to have one point of contact for all their shipping needs on a global basis. In other instances, efforts might be focused on a specific functional area that has been the source of customer complaints.

The least comprehensive use of Six Sigma focuses on the use of Six Sigma methods and problem analysis tools to gain a fact-based understanding of the causes of persistent problems. With this information, solutions to the problems can be identified and implemented. The benefit of this approach is that root causes to problems can be identified based on facts and data. This circumvents the use of trial and error problem solving that does not achieve lasting results. Another advantage is that this approach is less intimidating and can be effectively used with fewer people actively involved in the effort. The danger, of course, is that this approach focuses on obvious problem areas and does not attempt to change the underlying organizational issues that contribute to these problems.

## IMPLEMENTATION

The choice of Six Sigma adoption approach is dependent upon carrier specific needs, resources and objectives. The most important consideration is that the project be conducted thoroughly, using fully trained personnel having the full support of all levels of management. The problem solving process hinges upon maintaining a customer focus because, no matter whether the objective is to improve an internal process or one that directly involves customer contact, the solution will impact the ability of the carrier to deliver the shipper specified services. For instance, improving the process used to resolve damage claims directly impacts the shipper, but improving processes to ensure that loads are properly secured to prevent damage in transit indirectly affects customers through the reduction in the incidence of damage and the resultant need to engage in the claims process. The steps

used in the Six Sigma process are Define, Measure, Analyze, Improve, and Control (DMAIC).

## Definition of the Problem

It is common to focus on the symptoms of a problem and never actually address the problem. Using Six Sigma, the problem identification must be supported by facts. This requires a greater depth of understanding of processes and their contribution to the successful completion of tasks. Building on the previous example, a superficial definition of the problem may be that there is a high level of complaints regarding the handling of damage claims. Therefore, solutions might center around clerical improvements that speed up the process. Obviously, this solution will alleviate the complaints about the speed of processing, but the real issue is the occurrence of damage leading to the need for claims processing. Therefore, a renewed emphasis should be placed upon preventing damage from occurring.

## Measuring the Problem

Once the problem has been defined, it is necessary to gather data to quantify what is taking place which contributes to the problem. The objective is to examine all aspects of the process to determine the root cause of process deficiencies. The process can be thought of as having three basic elements; inputs, process activities, and outputs or results. The first task is to develop measures of the output. This provides insight into what the problem might be. In our damage example, measures of the rate of damage broken down by shipper, route, and product would be appropriate measures. This would serve to narrow the focus from damage in general to specific problem areas.

A second point of measure involves the inputs. The inputs into the process have a major effect on the outputs. The process cannot produce excellent results if the inputs are faulty. Following the damage example, assume that the preponderance of damage claims are originating from a specific shipper or product category.

Packaging is an important element of damage prevention that is under the control of the shipper. Measures might include analysis of all elements of the package and packing materials to see if they are sufficient to protect the contents under reasonable handling conditions.

The third area of measurement is the process itself. Again assume that the packaging materials were sufficient to protect the contents under normal shipping conditions and that the products were not damaged when they were presented for shipment. At this point a careful examination of the loading, unloading, and movement elements of the carriers shipping process would be appropriate. The problem might originate with the loading process. Other activities, such as stacking, bracing, and handling, may also contribute to damage if not performed correctly. During the actual transport, goods may become damaged due to vibration, sway, or other transit conditions. If there are several deliveries prior to reaching the product's destination (common in LTL), is there sufficient bracing to prevent movement of the remaining goods during transit to the final destination? Are the products unloaded and reloaded so that the shipment to be unloaded first can be reached? An answer of no to either of these questions can indicate the potential source of the damage. Finally, during the unloading process, is appropriate care given to the handling of the items? Does the driver note any damage to the products when they are accepted by the customer? Is it possible that the damage is actually occurring after the shipment has been delivered?

### **Analyzing the Data**

An analysis of the data that has been collected gives a picture of the complete process and hopefully identifies the root cause or source of the problem. From the example, the source of shipment damage could have originated at the input stage, during the shipment process, or at the point to delivery. If no historical data are available, it may be necessary to actually track

current shipments and document all of the events along the way. It may be possible, especially if the incidence of damage has risen fairly recently, to track any changes that have taken place in the intervening time between a period of few damages and the current period of rising damages.

### **Making Improvements**

At this point, it is time to create problem solutions based upon improving the identified underlying cause. There is usually more than one possible solution, each of which will affect not only the immediate problem under consideration but will also impact other areas of carrier performance. If our damage problem originated with the packaging, some obvious approaches might be to require different packaging or the shipper may be asked to pay higher rates or carry his/her own insurance. If the damage occurred during the transportation process, do changes need to be made to the packing or bracing configurations or materials? Does the load need to be packed according to delivery order? If, for a shipment by truck, the damage is attributable to actual road conditions, should the routing be changed or should air shock equipped trailers be used? If there is a possibility that the damage is actually occurring after the load has been delivered, does there need to be an open package inspection made before the driver leaves the receiving dock? Understandably, this particular issue will be a touchy one.

### **Implementation Control**

Once the proposed solution has been agreed upon, it must be put into place—and monitored to ensure that things do not revert back to the old, and familiar, way of doing things. Continuing to measure inputs, process performance, and outputs will serve to identify deviations from the expected performance before they become a source of customer service failures. It also serves to reinforce the importance of the “new way of doing things.”



## DISCUSSION AND IMPLICATIONS

The publicity surrounding Six Sigma appears to be centered on applications by Fortune 1000 or other high profile corporations. However, the benefits to be gained from the use of a Six Sigma managerial orientation are not limited to the largest of companies. It is especially useful for service providers because service delivery depends upon the execution of processes that may not be well understood and controlled and are less likely to have quantitatively-based quality improvement processes. It is all too easy to focus on quick fixes without conducting a thorough examination of the factors which underlie and contribute to the problem.

Carriers must meet shippers' demands for different, and in many cases, more complex services which must be executed flawlessly in order to be the carrier of choice, maintaining close working relationships with shippers and making significant contributions to providing the uninterrupted flow of goods throughout the supply chain. To do this, carriers must achieve a level of process excellence that allows them to meet shippers service demands and maintain operating margins sufficient to provide funds to invest in state-of-the-art technology, equipment, infrastructure, and personnel training. A rapidly changing operating environment contributes to the complexity of the task. In view of the challenges facing carrier managers, the adoption of a Six Sigma management philosophy is an appropriate response. Six Sigma, with its customer orientation, opportunities for major returns on investment, and new approaches to thinking, planning and executing business processes throughout the firm can provide the framework to move forward.

The obvious benefits of Six Sigma adoption include gaining a better understanding of the customer's requirements and expectations. This provides an opportunity to assess the carrier's ability to meet an individual shippers service needs based upon resource availability and profit potential. It also requires carriers to objectively examine and assess the performance of the

processes at all levels which contribute to the flawless execution of service to the shipper and the efficient operations of the carrier. A clearer understanding of process capabilities, performance, and value-adding potential is a basic result of Six Sigma analysis projects. The development of meaningful performance measures that are shipper-focused enables the carrier to detect performance discrepancies before they become major impediments to service delivery. Six Sigma also contributes to the ability to identify the most critical projects. Team working to improve process performance must cross functional boundaries as they track the process from beginning to end. It allows everyone to see the inefficiencies that result in the absence of cross-boundary cooperation.

Some less obvious, but vitally important benefits center on the effects of Six Sigma management methods on the workforce. As a result of improved process performance and a carrier-wide commitment to quality, the work environment becomes less chaotic due to the occurrence of fewer preventable emergencies. Employees can work more effectively and find it to be more rewarding. They benefit from the training, additional responsibility and their contribution to making process improvements. They are more likely to take pride in their individual contribution to the effort. Drivers are an integral part of the effort to deliver flawless service to the shipper. The training, additional responsibility and ability to suggest and make process improvements provides an additional pride of ownership that serves as an incentive to be a long-term contributor to carrier success.

If present trends extend into the future, successful supply chain operations will hinge upon the ability of all members to contribute to the flawless execution of processes that transcend firm boundaries, promoting the seamless flow of product, service, information and financial resources to meet the needs of the final customer. As an integral part of the supply chain, carriers must differentiate themselves by their ability to provide exceptional service in order to participate as a full partner in the

strategic operations of the supply chain. The decision to use Six Sigma methods as a problem solving framework, to effect strategic improvement, and/or to serve as the vehicle for a transformation of the business and its operations

provides a sound, data-based approach to meeting the challenge to improve shipper-based service performance and maintain a sound level of financial performance.

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# THE TRANSPORTATION AND WAREHOUSING CHALLENGE FOR MULTI- NATIONAL CORPORATIONS IN CHINA

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## ABSTRACT

Logistics is a major challenge for multinational corporations seeking to do business in China. Transportation and warehousing are two core activities of logistics which will have to be outsourced or produced internally by foreign firms entering the China market. This paper focuses on road and rail transportation, the primary forms of transport utilized to move finished goods, as well as the warehousing and distribution center service sector.

Trucking services and costs are observed to be poor by Western standards. There is no established less-than-truckload (LTL) industry and there are limited trucking networks offering one stop shipping across the country. None the less, trucking will have to be the backbone of any distribution network in China for finished products. Rail service is even poorer. There are capacity constraints and finished goods movement is not a priority of the Chinese railways. Warehousing capacity inherited from state owned enterprises is inadequate, but new distribution centers are being built rapidly.

Foreign firms need to recognize these limitations in service, capabilities and capacity in planning their distribution networks. The fragmented nature of both the trucking and warehousing sectors places a premium on the value added by third party logistics providers (3PL's) who have the knowledge and the relationships with local trucking and warehouse firms to minimize the risk of a supply chain breakdown. The selection of logistics suppliers is the most critical logistics decision in the Chinese environment.

## INTRODUCTION

China has enjoyed significant economic growth leading to a position in the world as a global manufacturing center with the ability to produce quality products of all types, at a cost and degree of efficiency that is difficult to match in most other countries. Companies who have produced products in other parts of Asia, such as Hong Kong and Taiwan, have shifted their manufacturing to China. Firms which once found Mexico to be a low cost manufacturing location have begun to relocate production to China. Many of these firms are multi-national corporations (MNC's), outsourcing their manufacturing, or international retailers who are sourcing products for consumption in Europe and North America. In addition, production is increasingly relocated in China as the basis for penetrating the growing domestic market within China itself and the rest of Asia.

The quality and cost of transportation and logistics services are important factors in considering the role of China as a source of products or materials, as a manufacturing location, or as a market for products. MNC's need to assess how products will be moved to and from locations in China to determine the total landed cost of sourcing products or contracting production in China. Sourcing from or manufacturing in China may result in longer, more variable supply lines that affect product availability and responsiveness of the supply chain. This, in turn, may require increased inventories or dependence on premium transportation. Firms that are seeking to enter China to market their products must recognize the logistical capabilities that exist in China and adapt their manufacturing and distribution strategies accordingly.

Most of the economic growth of China has been in coastal regions, specifically around three major metropolitan areas: Guangdong, Shanghai and Beijing/Tianjin. Much of the initial foreign investment, sourcing and manufacturing subcontracting is concentrated in these areas. Further, these regions have become significant consump-

tion centers as the income and local population have grown with the increase in industrial output. These industrial areas are relatively well served by modern sea and air ports and the most highly developed highways in China surround these cities. Transportation and logistics service is available from domestic, foreign and joint venture logistics service suppliers, competing for international and local freight movement. In contrast, the domestic transportation and logistics system connecting these regions to each other is not so well developed and the logistics system connecting these regions to inland China is even less developed. The quantity and quality of domestic logistics services will become increasingly important as the sourcing and production of finished products moves further inland. This is occurring because of growing income and cost disparities between regions in China, making coastal locations more expensive for business. In addition, central government is actively promoting more balanced development across the country. As other geographic regions of China develop, comparative and absolute advantages of each region will emerge. Supply chains requiring intercity and interregional product flows will grow. Finally, domestic logistics is growing in importance as the non-coastal retail markets develop.

The purpose of this article is to evaluate the status of selected logistics service sectors within China for the movement of finished (non-bulk) goods. This may be purely domestic movement or movement of products moving internationally but with a significant inland portion. Transportation and warehousing are two core activities of logistics which will have to be outsourced or produced internally by foreign firms entering the China market. The focus here is on road and rail transportation, the primary forms of transport utilized to move finished goods, as well as the warehousing and distribution center service sector. An attempt is made to appraise the current situation, the underlying problems and opportunities, and the implications for the logistics strategy of foreign firms operating in China.

## MACRO-LOGISTICS PERFORMANCE IN CHINA

Numerous studies have found that logistics costs are comparatively higher in China than in most other developed countries. The Logistics Institute-Asia Pacific (2002) estimated that logistics costs were between 16 and 20% of China's GDP but only 12% for Japan, 10% for Europe and 9.9% in the US in 1999. An estimate of 16.7% of GDP is given by Wang (2004) who also indicates that during the tenth five-year plan period, the nation's goal is to decrease logistics costs to 15% of GDP, providing an annual savings of 240 billion.<sup>1</sup> This aggregate productivity is corroborated by more specific evidence. Morgan Stanley estimates that logistics costs are 40% of total industry product costs in China versus 20% in the U.S. and only 5 to 8% for most MNC's, and that accumulated inventory to GDP is 50% in China versus 4% in the U.S. (Ho and Lim, 2001). Mao, He, and Wang (2004) add that not only do logistics costs account for more than 40% of the total costs of goods, if the costs of packing, transportation, storage and damage resulting from improper transportation and handling are added, logistics costs would exceed 60% of total costs. Ho and Lim (2001) find that electronics and food products cost 40- 50% more to ship in China than in North America. They conclude that the Chinese logistics sector is a "huge market calling for efficiency."

The failing of China's logistics sector is also reflected in perceived service levels. Poor handling and transportation protection is reflected in the higher cost of logistics quoted above by Mao et al. (2004). According to a study by the China Association of Warehouses and Storage in 2001, the goods damage rate for all modes of transport exceeded 2% and on-time delivery was less than 90%. The survey found that 57% of the manufacturing corporations surveyed were dissatisfied with their present logistics outsourcing service, and would seek new logistics service providers in the following year. This showed that most logistics enterprises cannot meet the service standard of the modern logistics market (Ma and Shi, 2004).

China's logistics services sector is composed of third party logistics (3PL) firms, various modes of transport and the providers of warehousing and distribution center services. In the following sections, the road, rail and warehousing/distribution center segments are examined. These are the building blocks upon which most MNC's will have to rely for basic logistics services whether provided through a 3PL or directly by such providers.

### TRUCKING SERVICE AND PERFORMANCE CHALLENGES FOR MNC's

#### The Role of Trucking in China

Trucking is the most widely used mode of transport in the world for moving packaged or finished goods and this is no less true in China (Easton, 2003). As reported in Table 1, trucking accounted for almost 10 billion tons of freight or about 77% of the country's tonnage in 1999. However, trucking is traditionally used for short haul movement less than 500 kilometers with the average ton moving only 59.9 kilometers in 1999. Urban congestion is a problem for such short haul movements, but intercity long haul trucking is the bigger challenge for MNC's as production moves inland and many multinational corporations expand their domestic networks. The lack of efficient and effective intercity truck service is one of the most urgent logistics challenges in China.

#### China's Trucking Industry and Regulation

China's trucking industry is highly fragmented, with more than 5.4 million trucks registered to more than two million truckers and little or low entry barriers (Easton, 2003). Companies tend to be small scale, with the average trucking company having fewer than two units. For example, the Hubei province has 28,600 operators, but each has an average of only 1.43 vehicles. Heilongjiang province has 117,911 registered vehicles and each operator has less than 1.6 vehicles (Xu, 2004). Sinotrans is the largest trucking operator in China with only

TABLE 1  
FREIGHT TRANSPORTATION IN CHINA

Mode	Ton - kilometers (Billions, 2002)	Tons (Billions, 1999)	Average Length of Haul (KM, 1999)	Kilometers of routes (1000, 1999)
Road	678.3	9.904	58	1351.7
Rail	1551.6	1.672	768	57.9 <sup>1</sup>
Water	2751.1	1.146	1855	116.5
Air	5.2	.017	2482	1522.2 <sup>2</sup>

Sources: *China Statistical Yearbook* 2003, Ho and Lim 2001

<sup>1</sup> Excludes electrified railways

<sup>2</sup> Excludes international routes

3000 registered vehicles specializing in long distance.

The legacy of the planned economy was that most state-owned enterprises (SOE) were vertically integrated, and had their own private fleets that operated at very low vehicle utilization rates (Ho and Lim, 2001). Many SOE's produced and distributed their products regionally or locally and when long distance transport was needed, rail was utilized. These private fleets entered the for-hire market in the 1990's and early 2000's, providing a vast supply of trucking services locally and regionally.

A complicated licensing system restricts competition in the trucking industry. At the national level, the Ministry of Transport requires every service provider to obtain a national truck license. Each provincial government requires a license in the province of origin of the vehicle operation (e.g., the domicile of the operation). In most cities a local transportation bureau requires a local truck title for the purchase of a truck and its registration. Finally, the local police authority will require a local truck operating license to provide transport services within

a city (Hertzell, 2001). Even permission at the national level is no guarantee that local regulations will not prevent a national company from operating in many provinces or cities.

There are few nationwide trucking companies able to offer integrated, one-stop shopping for truck services. Those that exist are not integrated carriers, but generally networks of long haul and local trucking companies. Inefficiency in the form of interlining is caused to a large degree by local protectionism. Long haul freight may mean loading and unloading at provincial borders as it is handled from carrier to carrier (Trunick, 2003).

Today in many localities, out of province trucks are arbitrarily stopped at city borders and subjected to tolls that local trucks don't pay, or to flat restrictions on completing delivery. In many cases this requires an entire truckload to be unloaded and reloaded onto a local truck. This costs both time and money, and also creates opportunities for local protectionism and corruption, (American Chamber, 2002 and 2003).

For example, non-Shanghai trucks are prohibited from entering Shanghai during the 7 am to 11 pm period due to traffic control, while Shanghai licensed trucks have limited access (Ho and Lim, 2001). Permits are also very costly and road tolls are high, with some tolls unauthorized. It is estimated that tolls make up 15-20% of the trucking costs in many traffic lanes compared to 2-3% in Europe (Drewry, 2003). Regulations equivalent to the Interstate Commerce Act in the U.S. do not exist to support free and efficient movement between different cities or states in China. Reform of the highly bureaucratic and restrictive licensing systems seems unlikely in the short run because local provinces would lose a significant source of tax revenue (Drewry, 2003).

In summary, the fragmented nature of the industry, the regulatory restrictions and historical lack of demand for for-hire trucking due to SOE trucking, has provided little opportunity or incentive for developing an integrated truck network across China.

Less-than-truckload (LTL) operations, which involve consolidation of many small shipments into large line haul vehicles, is inherently a network operation. Due the lack of an integrated truck network, shipping partial loads is difficult (Modern Materials Handling, 2002). What LTL services do exist are limited to very long distances where some co-loading takes place. Unless the co-loading is well planned, transit times are usually long and inconsistent, especially on inland routes (Pinnekamp, 2003). The result is that manufacturers usually do not move small loads over long distances and the existing practice in China is that almost all intercity cargo moves as full vehicle loads. What is variable is the size of the vehicle. If the load is 5 tons, then a 5-ton truck is used, and if the load is 8 tons, an 8-ton truck is used and so on. The consequence of industry fragmentation and the heritage of SOE trucking is that an integrated LTL industry has yet to develop and mature.

## Trucking Performance and Operating Practices

Direct transportation and, in particular, trucking costs are not high by international standards but are high as a percentage of the total cost of the product. Unfortunately, the costs of trucking are often minimized through operating practices that are unlawful, unsafe or sacrifice service quality. As a result, the total logistics cost becomes a barrier to profitably doing business in China.

Truck service is frequently evaluated as unreliable when it is cheap, and reliable when it is expensive. The absence of an effective network is a barrier for filling backhauls, thereby requiring the purchase of round trip capacity. This is exacerbated by natural imbalances in freight movement. Front hauls from the coast to western China tend to be finished goods and consumer goods while front hauls from western China to the coast are bulk products. Refrigerated vehicles going west typically run back empty. Door to door service of dry goods to and from top tier cities is easiest and cheapest, but trucking to second tier cities and for specialized commodities such as refrigerated or dangerous goods is much harder. LTL reliability is compromised by the tendency to delay schedules until full loads are accumulated, unless of course the shipper is willing to pay the premium for under loaded line haul movement. Furthermore, the low volume of consolidated LTL freight results in the utilization of small, inefficient line haul vehicles, at least by Western standards.

Although there are large fleets of modern tractors pulling chassis for containers at port cities, the majority of the road equipment is substandard. Historically, trucks were open-back and tarpaulin-covered with poor protection for goods (Alberts, Randall, and Asbury, 1997). Due to the small size of most operators, very few of these trucks are set up to move containerized freight with only 20% of freight trucks in China being containerized (Ho and Lim, 2001).<sup>2</sup> Very



few of these companies can afford to upgrade their equipment because of limited access to capital. Shipments are often hand loaded and unloaded (Pinnekamp, 2003), and people loading trucks sometimes lack the training or initiative to pack a truck in an effective and efficient manner. This leads to cargo damage from cargo shifting and movement which is compounded by the lack of pallet standardization, leading to longer truck loading and unloading times, more cargo shifting and less efficiency.

Many transport vehicles are moving overloaded. It is an issue that almost anyone moving products in China will encounter. Transporters, as a norm, are known to haul 50% in excess of their legal payload, and sometimes as high as three times their legal limit. This is more the standard business practice than the exception with companies in China taking advantage of this cost savings despite the inherent problems that result. Recently, new legislation was applied evenly across state and local levels whereby haulers have to pay RMB 200 for every vehicle overloaded by 30% and about RMB 400 for each overloaded by 50%. Previously fines were a maximum of RMB 50 for each overloaded vehicle.

Before the clampdown, haulers would modify and strengthen their vehicles to carry up to double the legal weight capacity. Checks were also not as stringent then ... now they are conducting checks at toll stations and trucks found to be overloaded will be forced to unload excess cargo on the spot (Viswanathan, 2004).

For those firms which cannot risk violating the law, costs will inevitably rise. SembCorp Logistics (2004) reported that their China operations had been impacted by rising costs of road transportation services brought on by the Chinese government's initiative to control the overloading of trucks. Multinational chemical companies have found that their transport costs had gone up for the same reason.

Fierce and destructive competition between carriers continues to make the whole industry

unprofitable. When competitors can obtain old and frequently unsafe trucks to move goods, they compete with trucks which are fully depreciated. The cost structure of these competitors is very low compared to operators that purchase newer equipment in order to meet or exceed standards of safe operation (American Chamber, 2002). The costs of trucks have been rising due to more stringent emissions standards as well as the demand for newer, safer equipment. Many of the smaller operators do not have the capital to make such investments. However, government enforcement of regulations, such as annual vehicle inspections has increased the pressure to buy newer equipment.

Shippers have difficulties in tracking freight while in transit by road. For most Chinese trucking firms, the cost of installing a satellite tracking system is too high. Cheaper alternatives for track and trace such as mobile locators and telephone call monitoring are being improved and developed. Statistics validate the benefits of adopting new information technology.

Among the 200 logistics service providers in Xian, the 72 highway transportation operators that included (integrated) communication services as part of their overall services had better business performance (Xu, 2004).

### **Highway and Trucking Infrastructure**

In the past, poor trucking service has been the result of a poorly developed highway infrastructure. For example, during the mid 1990's, it was observed that a team of two drivers working 16-hour days could be expected to cover only 496 miles per day, a rate of less than 32 miles per hour (Alberts et al., 1997). However, this has rapidly improved in the last decade. There has been substantial improvement with the Chinese government (Ministry of Communications) investing billions of dollars on new highways. In 2003, the Chinese highway network consisted of more than 1.3 million kilometers, with 0.2 million additional kilometers scheduled for completion in 2005, making up a national network of nearly

1.5 million kilometers. The National Truck Highway program has over 35,000 kilometers of toll roads with a total of five vertical and seven horizontal national routes scheduled for completion by 2015 (Institute of Highway Economics, 2003). The trip from Shanghai to Guangzhou, for example, has been reduced from three to five days to 36 hours with two drivers, thanks to newly constructed expressways (Wu, 2003).

Road quality will continue to vary in such a vast country. Larger cities and coastal regions have decent roads and highways, while western regions and less developed interior areas of the country need major upgrading. The mountainous and desert terrain will always be a problem. Twenty-five percent of villages still have no access to suitable roads. However, the Chinese government has planned a considerable increase in highway investment for the western region (Institute of Highway Economics, 2003). Despite the government's increasing expenditures on new roads, many of the existing roads are still in poor condition or remain unpaved. Thus, average travel speed is quite slow compared to North American standards. It will be many years before the practical speeds and transit times within China will be comparable to speeds in North America and Europe for comparable distances.

In addition to building roads, the Ministry of Communications has planned to build 45 main road hubs in central cities, as well as cargo concentration and distribution centers throughout the country (Institute of Highway Economics, 2003). These would form the fixed nodes in a national logistics network, facilitating freight transfer, consolidation and communication.

### **The Prospects for Trucking in China**

Highway infrastructure barriers are being reduced through massive building programs but the real barrier that needs improvement is how the trucking industry that utilizes the highways is managed and organized. The majority of the trucking industry is too fragmented to meet the demands of modern large scale production. The

majority of the industry cannot offer one-stop shopping, door-to-door shipment visibility or nationwide LTL services frequently demanded by MNC's moving finished products. The potential for loss and damage, unreliable service and slow transit times must always be considered by MNC's in choosing trucking service providers and designing a distribution network in China. MNC's need to exercise a significant amount of due diligence in selecting their Chinese trucking suppliers.

Since January 1, 2001, with China's entry into the WTO, foreign companies were allowed to establish jointly-owned firms with local companies to enter the highway transportation market. From 2003 onward, foreign investors are allowed to be sole proprietors of highway transport companies, and both sole proprietors (local or foreign-owned) and local joint ventures can enjoy the same privileges. This has increased competition within China's highway transport sector. These new entrants will bring new capital and new technology, and bring more experience and advanced business management techniques into the trucking sector (Zhou, Zhu, and Xiao, 2001). However, this will only bring marginal improvements if the regulatory and licensing impediments to developing a truly integrated network for a trucking firm cannot be reduced. The root cause of many operational inefficiencies is the provincial and local restrictions that have limited cross province movement of freight.

## **RAIL: ANOTHER LOGISTICS CHALLENGE FOR MNC's**

### **Rail's Role in China**

Rail is the second most utilized mode of transport in China with respect to tonnage, moving 1.7 billion tons, or about 13% of total transportation tonnage in 1999 (see Table 1). Rail is the main mode of transport in terms of ton kilometers since the average length of haul by rail is more than 13 times the distance by truck. The core of the rail system was built for and is the lifeline for moving bulk goods such as

coal, minerals, and grain, but it is unsuited for transporting finished goods or perishables (Hertzell, 2001; Wu, 2003). Extensive delays, inflexibility, and lack of service orientation have prevented both domestic and international users from using rail, and this is exacerbated by the lack of rail sidings at both plants and ports. Surveys consistently find that foreign joint ventures use rail even less than domestic companies.

### **China's Rail Industry and Regulation**

The rail industry is highly concentrated, with the Ministry of Railways (MOR) controlling most of the country's rail service under the China Rail umbrella (Easton, 2003). Many vestiges of operating as a firm in a traditional planned economic system remain. Therefore, organizational and managerial reforms will be more difficult in this transport sector (Network & Information, 2001).

The MOR has made progress.

Three years into the ninth five-year plan, the China rail system was restructured and major non-transportation enterprises were spun off including rail engineering, rail construction, locomotive vehicle building, communication signaling and civil engineering, ten higher education institutes, and other vocation training or adult education schools. MOR has opened 227 independent stations. The MOR was downsized by 320,000 people in this process. The MOR, in the tenth five-year plan, will try to improve its transportation and service standard. MOR aims to set up a comprehensive network throughout the nation for passenger transport to accomplish the goals for "out by dawn, in by dusk" within 500 km, "out by dusk, in by dawn" within the 1,200-1,500 km range, and "arrival in one day" if traveling within 2000-2500km. For goods transportation, the goals are to improve delivery time, develop express delivery systems, and explore and utilize modern management models to provide complete door to door

transport service. MOR aims to speed up the development in consolidated transport and refrigerated transport in order to expand market availability for new economic growth. To accomplish these goals, MOR will speed up the construction of western railways to strengthen its "eight horizontal and eight vertical" network during the tenth five-year plan. Near the end of this tenth five-year period, the national track network will cover 75,000 km, including the new expansion of over 2,000 km in the West. Express tracks will increase to over 14,000 km, double tracks to 25,000 km and electrical tracks to about 20,000 km. The tenth five-year plan will adopt new technologies including railway modernization, improving IT and communication systems, and setting up safety and security standards, etc., diminishing the shortcomings of traditional railway transport (Translated from Chinese, Network & Information, 2001).

Organizational impediments may have been as significant as infrastructure. In the past, each of the MOR's regional divisions prohibited their locomotives from crossing divisional boundaries in order to retain control over their key equipment. This increased transit time and trip variability. The MOR recently converted its 14 geographical administrations into semi-autonomous legal entities. Each administration manages and operates the assets (infrastructure and rolling stock) allocated, while the MOR carries out overall coordination of inter-administration traffic. This decentralization does not appear to have addressed the power switching issue. Furthermore, the State Planning Commission (as opposed to the MOR) controls the prioritization of industries receiving rail service (Alberts et al., 1997).

### **Rail Performance and Operating Practices**

Numerous studies have documented the failings of the Chinese railway system with respect to the movement of non-bulk goods and perishables (Hertzell, 2001; Ho and Lim, 2001; Wu, 2003). Cost is not one of these failings. Rail cost is

substantially lower than truck cost, not only because of the economic features of rail, but because the state-owned railway is subsidized. However, low costs are more than offset by poor service in the movement of finished goods.

Railroad service is viewed as inefficient and unreliable, and is mostly used to ship cargos that are not needed urgently. Transit times are long and service reliability is poor (Ho and Lim, 2001). Wu (2003) notes that some cross country deliveries take up to 60 days, which is too slow for goods such as perishables or anything of high value. More importantly, train service is not responsive, with long lead times for services. On frequently serviced routes, such as Beijing to Shanghai, bookings can be made a week in advance (Ho and Lim, 2001). For less than carload, two weeks advance booking is required (Hertzell, 2001). For less frequent routes, such as to and from Xinjiang, bookings generally need to be made 30 to 40 days in advance (Alberts et al., 1997; Wu, 2003).

Shipment delays are common and the railways are plagued with seasonal capacity shortages. The general policy is to give priority to passengers and then to basic commodities from the agricultural and extraction industries. Forty percent of rail capacity is taken up by the coal industry, resulting in unmet demand for rail movement from the agriculture sector during the harvest season. This policy results in seasonal availability of services to other shippers as well. Passengers traveling during the long holidays in May, October, and the New Year, coupled with agriculture shipments, result in reduced capacity for the movement of packaged or finished goods (Ho and Lim, 2001). During harvest season, for example, lower density routes require a month to a month and a half advance booking for space (Drewry, 2003). A Chinese firm reported that extra payments may be demanded by local rail line operators to make box cars available or to give priority to a cargo during high traffic periods (Wu, 2003). Recently, general merchan-

dise has been accorded a much higher priority in the MOR's booking system and container block trains have the highest priority within this general cargo sector (Drewry, 2003).

Railways have very few connections to industrial parks and seaports or sidings at manufacturing plants. This means that practically all finished goods moving by rail have to be unloaded and reloaded onto trucks for final delivery. The extra handling results in added exposure to loss and damage. The damage rate on rail is 2-3 times higher than trucking (Hertzell, 2001). Damage usually occurs when goods are transferred from rail to local trucking and is most typically due to transportation workers who are not adequately trained in handling sensitive goods (Wu, 2003). Theft is an endemic problem. This has led manufacturers to employ their own security guards on trains to safeguard goods (Wu, 2003).

Poor information systems make it almost impossible to track goods in transit. There are few services such as notification of arrival at rail stations, automated car tracking, and integrated information technology between the provincial railways. Loss of refrigeration after reconfiguration of compartments at changeovers is also common. Several of these deficiencies appear to stem from the regionalized operating structure of the Chinese railways.

Until recently, most rail cars were 60-ton closed boxcars and containerization was limited (Alberts et al., 1997). A small fleet of five to ten-ton domestic containers that fit onto open-top railcars has recently been introduced and the flatcar fleet is being expanded to handle more maritime containers. In general, however, railway containers are not compatible with those used by shipping companies, and overseas shipments require the unloading and reloading of cargo (Alberts et al., 1997; Wu, 2003). Cargoes have to be unloaded and reloaded when using rail, resulting in higher handling costs and higher damage rates.

## Rail Infrastructure

In contrast to trucking, China's rail infrastructure continues to be a significant part of the problem. China now boasts railways of 73,000 km when electrified track is included (Wah, 2004). Although about 27% of this total is double tracked, capacity is still less than demand, and the rail freight infrastructure has yet to meet containerized multimodal transport demand. Rail system modernization is lagging behind road development, although plans to expand in the West are in place. There is little intermodal capability in China, although this area has been targeted for improvement (Government of Canada, 2003). In 2003 there were more than 100 joint venture railway lines including Maersk, Orient Overseas Container Lines, U-Freight and DHL, operating trial joint ventures with SOE's. Foreign rail operators often bring specialized services and new technology, and this will increase as WTO commitments encourage foreign investors to enter the rail sector. As of 2004, foreign majority shares in rail joint ventures were allowed and the entire domestic rail cargo sector will be fully opened to foreign investment in 2006 under a WTO agreement (Wu, 2003).

## The Prospects for Rail in China

Rail in China will improve but it cannot be depended upon to be a core transportation provider for finished goods across China. The railway continues to be an SOE with the traditional political, organizational, and human resource constraints that impede streamlining operations and making the service-operations mix more market responsive. Many of rail's failings can be traced to economic policies (prioritization of freight), lack of infrastructure (tracks, loading facilities), and organization (regional administration), but the basic fact of life is that the majority of China's rail system is run by an SOE which holds a monopoly on intercity rail service. Commercialization of the enterprise is needed, including incentives for productivity and customer service.

The WTO will require changes in this situation but, while deregulation is in the future, there is little or no potential for privatization in the near term. It appears that the state-owned enterprise in rail will remain, but it will welcome foreign investment. China's rail system will be under pressure to restructure to attract more commercial business and to achieve higher efficiency. One restructuring plan is to establish separate market oriented corporations to manage freight transport, passenger transport and railway infrastructure. Authorities will most likely release control of the transportation of general merchandise and free up prices in incremental steps (Ho and Lim, 2001).

MNC's must recognize the limitations of China's railway system as their economic activities move further inland and into Western China. Unlike the U.S. and Europe, a well-developed intermodal system does not exist, so long distance transport of volume shipments will continue to depend on much costlier trucking. Much longer lead times must be planned for when using rail. On less congested routes, companies have planned around a one week delivery window. On congested routes, a four-week arrival window is more common. Interestingly, this has led some Chinese firms to prefer an imported product to a domestic product in part due to the unreliability of domestic rail transportation (Wu, 2003).

Some third party logistics providers have bypassed the rail capacity and service problem by contracting out rail capacity. G-time Logistics, which had a long relationship with the MOR, has chartered rail services on North-South routes, carrying fresh food and products from the South, and grains from the North. This is similar to the situation in the U.S. in the 1970's and early 1980's, when confronted with poor rail service, APL chartered rail service to go from the West to East coast of the U.S. in land bridge service. Interestingly, APL Logistics, now a wholly-owned subsidiary of Neptune Orient Lines, is in the process of doing the same in China. They signed a memorandum of understanding with

Eastern China Railway Express to take advantage of the railway supply chain network with 160 rail hubs. Other heavy users of rail are third party providers such as Bao Gong, PG Logistics and St. Anda (Chow, Wang, Xu, and Ding, 2003), who all have the scale to charter rail routes to get better control on scheduling and operations. In short, large customers and 3PL's who can aggregate rail freight can contract the train service out to get reliable rail service and assured capacity. MNC's should consider this option if they have the volume, or leverage 3PL's that have established these contracts.

## **WAREHOUSING AND DISTRIBUTION CENTER SERVICES**

### **Warehousing in China**

Traditional warehousing in China focuses on long-term storage of raw materials and manufactured goods that are held as stock that companies sell. These warehousing facilities barely meet the needs of these "push" type supply chains, much less the needs of MNC's and progressive Chinese firms whose supply chains need to be responsive and agile.

Ninety percent of China's warehousing capacity is controlled by SOE's (Easton, 2003). Up to the mid-1980's, SOE's all used private warehousing. By 1985, they realized that they had excess capacity and started selling warehouse services commercially. This warehouse space was generally located and designed for a specific company. Thus, while there was actually a lot of warehouse space, much of it was not up to standard or in the right location. Since most SOE's owned their own space, there was little demand for commercial warehousing and this sector remained underdeveloped. Furthermore, most SOE's served regional markets, with few formal regional warehouse networks and, until recently, no formal national network of public warehouses.

The major exceptions were the state-owned transportation companies that owned and operated warehouses to supplement their transportation operations. Sinotrans is the largest

freight forwarding company in China controlling more than three million square meters of warehousing space. Guo (2001) notes that China Rail offers "an extensive network throughout China and adequate warehousing facilities are available at or near rail stations in most cities." China Material Storage and Transportation Company operates warehousing and trucking across the country. In addition, 3PL's often provide warehouse service as part of their fulfillment services. A recent survey of 3PL's operating in China indicates that approximately 32% contract out warehousing, but most build their own facilities (Dai, Wang, Wong, Wang, and Xiaohong, 2003).

### **Warehousing Performance and Operating Practices**

Most of the warehousing capacity built before the mid 1990's was for bulk cargo and many are multi-story facilities. These warehouses are poorly designed, use little automation, and are highly dependent on manual labor. Poor information systems lead to inaccurate stock counts and high loss rates. Lack of integration between warehousing and transportation service makes it difficult to achieve shipment visibility across the whole supply chain. There is little racking and modern inventory management is absent. Weather protection from heat, rain or snow is minimal. The result of these poor designs is inefficient material flow, including multiple manual handling which leads to high damage and pilferage rates.

A case study of the type of warehousing available to an MNC in northeastern China (outside of the major metro areas of Shanghai, Beijing/Tianjin and Guangdong) is a joint venture automobile plant which did not have enough storage facilities at the plant site. The existing plant complex could not be expanded to provide storage space, but storage space was available at a nearby military base. However, the warehouses were vintage 1930's buildings built by the Japanese during their occupation. They had poor electricity, poor temperature control, substandard pest control, little shelving, and were multi-storied.

They contained no automation to facilitate movement (Pinnekamp, 2003).

Palletization is not common in Chinese warehousing. The older warehouses are not designed for fork lift equipment and the incentive to use pallets seems to be missing from SOE's. More importantly, there is no standard pallet size in China. China uses all the different types of pallets from different countries, though the European 1,000 mm by 1,200 mm pallet is most widely used. Utilization of pallets and other transport aids is also very limited. There is no available or manageable pallet pool for hire.

Finally, the quality of warehouse management is suspect. High discrepancies in actual and recorded inventory data, high damage and missing rates, and a general lack of real-time product and order tracking have forced manufacturers to build (and operate) their own facilities (Ho and Lim, 2001).

### **Distribution and Logistics Centers (Parks)**

The absence of a modern, responsive warehousing industry has led many MNC's, operating as joint ventures, to build their own warehousing capacity or obtain such services from 3PL's.

In the last 20 years, with the emergence of "zero-storage" "logistics alliance" and "logistics supply chain" concepts, the logistics goals for warehouses have become to shorten turnover time, lower storage rate and costs, and improve services. Warehousing holds great significance as it provides a time factor between raw materials, industrial goods and final products. As corporations start to regard customer service as an active and value-added competitive tool, warehousing will become more important. To achieve these goals in warehousing, third party logistics service providers made a thorough analysis of labor productivity and costs. They focused on redesigning the warehouses to build modern logistics centers based on location models, and analyzed

the planning and relocation of advanced logistics centers to speed up the processing of orders and to lower logistics costs (Translated from Chinese, Liang and Yu, 2004).

MNC's and foreign logistics service providers could only have minority ownership of warehousing and storage in a joint venture up to 2002. But in 2003, with the WTO accession, foreign firms can have majority ownership of warehousing and storage, and may operate wholly-owned warehousing and storage subsidiaries by 2005. Private, foreign-operated firms after WTO accession may put government-run facilities at a disadvantage. However, government and private companies are in a program of building modern logistics centers in major cities. This is at both the National and regional levels.

The government stills controls more than 90% of the warehouses and has planned modernization of the warehousing industry in China. The Chinese government is planning to build 45 distribution hubs throughout China over seven years starting from 2002. These hubs operate advanced warehouse management systems with automated materials handling, cold storage and customs clearance. There has been some concern expressed about how capable these government-run centers will be in competing with foreign operated firms once the WTO agreed to relaxation of foreign entry comes into effect (Government of Canada, 2003).

According to the statistics from the State Planning Commission, most cities have plans to build more logistics parks in their region. The Chinese government believes in consolidating types of industrial activity in one area. Many local governments have designated logistics as their pillar industry. In order to encourage development in this industry, each government has their favored policies. In the Yangtze River Delta for example, the government nominates "Key Logistics Firms," based on the firm's record of good service and reputation. With this government recognition, these "key logistics firms" enjoy favored policies which include (Chow et al., 2003):

- Funding of logistics projects where the government either guarantees the loan or provides direct financing.
- Relaxed market entry within Shanghai and in Shenzhen for the Pearl River Delta. By 2005, when a substantial amount of China's WTO commitment will be realized, most firms will be registered in Shanghai or Shenzhen.
- With municipality authorization, companies are charged lower local business fees.
- Favored land price. In China, land prices differ for different land uses. The lowest price level is charged for industrial usage, while the highest is for commercial or trade purposes. When a company applies for the building or development of a new logistics park or project, it enjoys the lowest land price level, the industrial land price.

In Shanghai, three major logistics parks have been developed. They are the preferred locations for logistics development in Shanghai. One of them is WaiGaoQi Free Trade Zone adjacent to the Shanghai Port, focusing mainly on export logistics. There are 700 companies gathered together along with warehouses and distribution centers in this district. The second is PuDong Logistics Park near the PuDong New Airport. This logistics park focuses on air cargo and is occupied by numerous airfreight logistics companies. The third is the North-West Logistics Park. At this location, most of the retail and wholesale stores have their own distribution centers. In addition, Shanghai is planning to build a new port on the two Yangshan islands on the southern border of Shanghai, which will become another important seaport logistics center in China.

However, while the government objective to stimulate new business is a legitimate goal, there is a danger in granting special privileges in a non-transparent manner. The Shanghai government has actually taken equity stakes in some favored firms, granting them special privi-

leges or financial assistance, or free advertising for certain firms solely based on their friendships with the government. For instance, government protection within the air cargo handling business has created a "duopoly" of two companies favored with exclusive licenses to perform air cargo ground handling services at the Pudong Airport. This protection from competition has led to high prices and poor performance relative to global standards (American Chamber of Commerce, 2003).

### **The Prospect for Warehousing in China**

Warehousing capacity and services are rapidly improving to meet the needs of the MNC's who require modern facilities built for movement rather than storage as well as value-added services. The Chinese government's active support of distribution and logistics center development and relaxation of regulations will increase both capacity and quality in this sector. What is more important, the government is actively promoting organizational reform in SOE's, which will increase the outsourcing of non-core activities such as transportation and warehousing, fueling, and the demand for a logistics services industry.

Foreign participation in rail, trucking, and other logistics sectors such as customs brokerage and forwarding are regulated. Unlike those sectors, foreign participation in warehousing and logistics centers is encouraged (Wu, 2003). For example, China's leading 3PL's are large foreign companies licensed to operate as Wholly Foreign Owned Entities (WFOE's). Also growing in importance are foreign companies that are currently restricted to operating as joint venture partners or through free trade zones (FTZ's). In 2001, the government of Shanghai's Pudong New Area lifted all restrictions on warehousing and logistics companies setting up operations in the WaiGao Qiao Bonded Zone, equalizing their position with trading companies in the zone. Foreign companies are now allowed to operate these warehouses themselves to store a wide variety of raw materials, parts and other finished goods for onward sale and shipment into China. In Wai Tao Qiao, foreign operators gener-



ally maintain high standard warehouses at their manufacturing facilities, which can double as regional distribution centers. A growing number of providers are "one-stop-shops" that offer wide ranging import services that extend beyond logistics (Wu, 2003). At the same time, large SOE's in the logistics sector are actively transforming themselves. There is substantial evidence that they are determined to become leading logistics providers, having initiated restructuring plans to transform themselves from basic service providers to 3PL's. Often the changes are in conjunction with a joint venture or a less formal partnership with a foreign 3PL that brings new management and information technologies to the partnership.

### **SUMMARY AND IMPLICATIONS FOR MNC's**

Multinational companies are taking advantage of China's manufacturing capabilities and require logistics services both within the developed coastal regions and inland. They also want to capitalize on China's growing domestic market. One challenge will be to find reliable and fast truck service in a fragmented, localized industry that operates under a patchwork of local regulations. Another challenge will be to find rail service in the capacity constrained and mostly state owned rail network. Obtaining good distribution center service as opposed to warehousing space is also difficult. China is making great strides in providing new intercity highways, new railway trackage and building modern distribution facilities in logistics parks. However, the full benefit of these massive infrastructure improvements will not be achieved if these assets are not utilized effectively by the service providers themselves.

The root problems that remain are primarily managerial and inherent in the structure of these logistic service sectors. An asset-based, integrated network of either TL or LTL service will not be forthcoming until local and provincial regulations that restrict competition in trucking are removed. These same barriers impede the growth of larger scale firms which can better

afford information technology. The railroad monopoly that exists today is unlikely to disappear in the near future so change in the railway's operating practices and service priorities will come about slowly. Only in the warehousing sector, where there are both government investment and relaxed entry to foreign operators can major improvements in service levels and capabilities be expected in the near term. MNC's now have more options to build their own distribution facilities when for-hire services are inadequate. The overall reality is that MNC's will find transportation and warehousing services in China to be slower, less reliable, less visible, less responsive, more expensive and perhaps less available than in most Western countries. MNC's will have to plan their overall distribution network and supply chains to recognize these realities.

Many industry observers and even the Chinese government sees the development of a healthy and competitive third-party logistics industry as one of the solutions to the lack of integrated and professional trucking services. Wu (2003) indicates that while foreign companies often form a patchwork of partnerships with local logistics and transportation operators to form some sort of distribution network, few licenses for transportation are granted for nationwide operations (and even those are subject to protectionist measures of local governments). Thus, 3PL's have emerged as a popular choice for MNC's seeking to move products across the country. These include non-asset based as well as asset-based 3PL's who are knowledgeable of local regulations and who can build relationships with local logistics service suppliers in the truck and warehouse sectors. Some of these 3PL's are large global logistics service providers who have expanded their coverage in China by working with many Chinese agents in order to provide broad coverage of China. Others are SOE's with large transportation or warehousing assets across the country such as Sinotrans, China Post or China Material Storage and Transportation Company who are seeking to modernize rapidly. Many are regional transportation companies which have successfully serviced important MNC

clients and leveraged their success into wider operations and expanded services. Similarly, some of the most successful 3PL's have risen from in-house logistics divisions that are leveraging the logistics capabilities and network developed for the parent company. Another benefit of using established 3PL's of significant size is that they may be able to open the doors to reliable rail service in corridors where they have contracted out rail capacity. It may still be unwise to only deal with one 3PL, as all the provinces have different rules and regulations and no one agent can provide full coverage. A strategic solution is to focus on achieving depth, rather than breadth, of market penetration. By focusing activities on a single city or region, the distribution problem is simplified.

Manufacturers and exporters should consider regulatory risks whether using a 3PL or working directly with multiple transportation and warehousing suppliers. Enforcement of commercial regulations at the national level has become transparent under the WTO but local enforcement remains arbitrary. Some rules are not widely publicized, while others are vague and open to interpretation. Reliance on a favorable interpretation of the regulations is dangerous. Companies should be aware of the potential risks and consider preparing a strategy to cope with an unfavorable change in interpretation. Since many of the rules are not publicized, identifying them will require working closely with an experienced Chinese partner. Consequently, carrier or 3PL selection is perhaps the most important logistics decision an MNC can make once it has decided to enter China. Chinese partners can be the key to success especially if they have prior experience in the geographic

area requiring logistics services. Such partners will be able to identify potential pitfalls and will have the network of business and government contacts needed to do business in China. To remain adaptable in China's ever-changing markets, it is advisable not to become overly reliant on a single partner.

Partnerships between shipper and logistics service providers have long been offered in Western economies as a means for achieving increased productivity. In the Chinese transportation and logistics environment, partnerships may be a strategic necessity to ensure that products indeed move to the right place at the right time at the right cost.

### ACKNOWLEDGEMENT

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### ENDNOTES

1. China's 10<sup>th</sup> five year plan is for the period 2001 to 2005. These plans reflect the economic development priorities of the country and provide a blueprint and strategy for government economic development and reform activity. The first plan in 1953 targeted heavy industry. The tenth five year plan focuses on information technology but also identifies logistics as an industry to develop.

2. Containerized trucks refer to closed van type trucks versus open trucks such as flat decks or "open bed" vehicles.

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Book:

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

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.

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Table 1 about here  
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### 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.

$$y = a^2 - 2ax + x^2 \quad (1)$$

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