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Expanding Horizons and Deepening Understanding via the Use of Secondary Data Sources

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While primary data analysis has been popular in logistics and supply chain research, secondary data methods have been overlooked. These methods, however, have the potential to generate a variety of important opportunities to expand the horizons of logistics and supply chain research. In this article, we emphasize the use of secondary data analysis and how it can address contemporary challenges in logistics and supply chain research. Our review of the logistics and supply chain literature identifies six important methodologies that can be useful for secondary data generation and analysis. We discuss how these methods can help effectively address various logistics research questions.

Keywords: secondary data; archival data; meta-analysis; event analysis; content analysis; Geographic Information Systems; simulation

INTRODUCTION

The empirical study of logistics and supply chain phenomena has relied heavily on data collected through the use of surveys and case studies. In contrast, authors have not used other methodologies as consistently. As shown in Appendix, 76% of the articles published at the *Journal of Business Logistics* in 2009 and 2010 are empirically based. Of those articles, only 21% employed methodologies based on secondary data. On the other hand, 62% of the articles used surveys or case studies as their core research methodology. Moreover, almost half of the articles based on surveys had overlaps with other articles based on the sources that they used to gather their data.

Such imbalance in the use of empirical methodologies can preclude the pursuit of valuable opportunities to expand our understanding of critical logistics and supply chain issues. Consider, in particular, the use of methodologies based on secondary data. Unlike surveys and case studies, secondary data exist prior to the formulation of the research objectives at hand. The assembly of these data is normally conceived and carried out independently of these objectives.

Because of these particular attributes, methodologies based on secondary data have unique advantages (summarized in Table 1) that can yield valuable insights into logistics phenomena. First, secondary data are less subject to biases and ambiguity in measurements because they are normally collected through nonobtrusive approaches that do not interfere with the sources employed, while maintaining these sources independent from the research objectives. Second, secondary data are removed from any goals and preconceptions among those who initially collected the data that could skew the objectivity of the data collection process. Third, collecting secondary data generally requires fewer resources than those involved in other methodologies. Moreover, secondary data are available in greater quantity. By having access to greater volumes of data, researchers will benefit by being able to carry out analyses with higher levels of statistical power. Further, if the data are publicly available, it will give scholars the opportunity to carry out replication studies to validate or fine tune any initial findings that have been obtained from the data.

Despite the fact that recent articles at the *Journal of Business Logistics* have used secondary data in a limited fashion, a broader review of the literature reveals that secondary data has been used quite effectively to pursue research in a wide array of logistics and supply chain management areas. As Table 2 shows, authors have used secondary data to research, for instance, transportation economics, distribution-network operations, inventory management, fulfillment, industrial organization in transportation, forecasting, transportation safety, and logistics costs and financial performance. In fact, a large amount of transportation research in the logistics literature has built on secondary data analysis along with mathematical analytical modeling. Table 2 also shows that logistics research has relied on a variety of methodologies to obtain secondary data. These include the use of traditional approaches involving archival data, event studies, and meta-analyses. But they also include the use of less familiar methodologies based on content analysis, Geographic Information Systems (GIS), and simulation.

The diversity that exists in secondary data methodologies and their potential application underscore the need to understand how researchers can make use of these methodologies more extensively. Therefore, our goal in this article is to explain how researchers can extend the use of secondary data methodologies to logistics and supply chain studies. To that end, we first focus on methodological applications of secondary data analysis that are more familiar to logistics researchers and discuss how these methodologies can be applied to expand current logistics research. We will then focus on methodologies that logistics researchers have not used as extensively in the past but that we believe could add to the literature by giving researchers new perspectives on

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Table 1: Advantages of secondary data methodology

Research step	Advantage
Data source and costs to compile	• Relatively large amounts of data available • Relatively low amounts of resources necessary for data collection
Data collection and integrity	• Limited chances to skew the data collection process based on researchers' preconception and bias
Data analysis and validation	• Higher internal validity of studies due to measurements and statistical inferences constructed by the third-party and derived from less biased database • Greater opportunity for replication when data is publicly available

answers to pressing logistics questions through the use of untapped data sources. Finally, we will offer recommendations for researchers to press forward in the use of secondary data. Our goal with these recommendations is to help our colleagues better employ and evaluate research based on secondary data.

TRADITIONAL APPLICATIONS OF SECONDARY DATA ANALYSIS

Our literature review in Table 2 reveals that authors have relied fairly extensively on three well-known secondary data methodologies. These methodologies are based on meta-analyses, event studies, and the use of archival data sources. In the remainder of this section, we expand on these methodologies and provide a summary of this discussion in Table 3.

Meta-analyses

The vast majority of the articles in our review that used meta-analyses did so to summarize different approaches to operationalize constructs and to synthesize research gaps in logistics and supply chain management. Meta-analyses, however, have other equally relevant research applications.

Specifically, researchers can use meta-analyses to generate data in order to test hypotheses related to prior studies. Whereas scholars can summarize prior studies on a particular subject through literature reviews, through meta-analyses they can subject those studies to examination based on statistical tests. In so doing, researchers can use meta-analyses to evaluate critically prior studies' results. For instance, meta-analysis can assess whether the results are statistically meaningful (e.g., depending on the size of the sample, the magnitude of the values obtained in the results, the likelihood that the values are statistically different from zero) and whether they actually support the conclusions reached in the studies (Hunter and Schmidt 1990; Hunt 1997).

This distinction is important because it forms the basis for the role that meta-analyses can play in generating new insights for logistics and supply chain management researchers. For example, meta-analyses can help researchers uncover patterns in the evolution of constructs that have been measured over multiple points in time. A promising application in this area could be to understand the evolution in the use of different forms of logistics service providers in multiple industries or changes in compensation and other human resource management practices in the logistics industry. Meta-analyses can also inform about the relative importance of different transaction-cost dimensions in outsourcing decisions in supply chain management. Researchers, for instance,

Table 2: Topic areas and data collection and generation methods of papers using secondary data

Topic areas	Number of papers	Methods	Number of papers
Transportation Networks, Market Trends, and Policy	51	Archival	180
Transportation Economics	45	Simulation	21
Inventory Management	19	Content Analysis	7
Industrial Organization and Competitive Dynamics	15	Event Study	5
Fulfillment and Distribution	15	Meta-Analysis	4
Safety in Transportation	13	Geographic Information System	3
Literature Review	13		
Logistics Links to Costs and Financial Performance	13		
Sustainability	6		
Risk and Disaster Management	5		
Quality Management	4		
Forecasting	4		
Strategy	3		
Human Resources	2		
Construct Development	2		
Information Technology	1		
Demand Management	1		
Buyer–Supplier Relationship	1		
Total†	213	Total†	220

Notes: *We covered papers published since 2000 at the following journals: The Academy of Management Journal, The Journal of Business Logistics, The International Journal of Logistics Management, The Journal of Operations Management, The International Journal of Physical Distribution and Logistics Management, The Journal of Supply Chain Management, The Strategic Management Journal, The Transportation Journal,* and *Transportation Research Part E.*
†Total number of papers is not matched to the summation of subcategories due to the papers based on multiple topics and methods.

Table 3: Summary of secondary data methodologies

Methodology	Definition	Examples of research opportunities	Key implementation practices and issues	Data sources
Meta-Analysis	Compilation and evaluation of prior studies that address related research questions or hypotheses	Uncover patterns in the evolution of logistics constructs that have been measured over multiple points in time Establish the relative importance of different transaction-cost dimensions in outsourcing decisions in supply chain management across studies	Well-formulated and measurable research questions are essential to bound the search for data Broad coverage of populations and settings is necessary to ensure external validity Strong correspondence in the operationalization of constructs across studies will ensure appropriate construct validity	Published studies obtained through the Social Sciences Citation Index or databases, such as ProQuest's ABI-Inform Dissertations, unpublished reports, conference papers, and federally supported studies available through the University Microfilms International Dissertation Service (UMIDS) database, the Educational Resources Information Center (ERIC) database, the National Technical Information Service (NTIS) database, and, in Canada, the University Research (UNIVRES) directory
Event Studies	Evaluation of impacts caused by the occurrence of events on dependent constructs	Evaluation of effects of supply chain disruptions across national boundaries and over time Study of competitive dynamics in the motor carrier industry Assessment of the impact that the privatization of ports has had on the operations of ocean liners and on the economic activity of port regions and communities	Clearly define the event(s) of interest and the period when it (they) occurred Do not limit your evaluation of the event(s) to publicly available information. Supplement with nonpublic sources Set clear criteria for the measurement of dependent constructs to ensure that the data collected adequately reflects the changes in the constructs as a result of the event(s)	Stock exchange reports News releases Company websites Industry association reports Company filings with regulatory agencies

Continued.

Table 3: (Continued)

Methodology	Definition	Examples of research opportunities	Key implementation practices and issues	Data sources
Archival Data Collection	Gathering of preexisting evidence that is based upon records or documents relating the activities of individuals, institutions, governments, and other groups	Impact of Internet data regarding real-time traffic and weather on efficiency in the haulage of products Differences in inventory policies across offline and Internet channels as a result of differences in merchandise variety Effect of customer recommendations and customer-to-customer interactions on demand forecasts and inventory management policies	Data are often proprietary. It may not be possible to guarantee integrity of information without disclosure subject to authorization Data may not be collected with regularity, making it difficult to do follow-up analyses or longitudinal testing Data must be representative of the population of interest Data must be collected unobtrusively to minimize possible measurement bias	Company sources involving the tracking of shipments, sales, and supplies Customer communications Buyer–seller transactions Government agency databases Industry data collected by professional associations such as CSCMP or ISM
Content Analysis	Identification and synthesis of a variety of sources of texts in a scientific, systematic, and quantitative fashion	Articulate in greater detail the relationships involving organizational conduct pertaining to pricing and logistics services and the organizational structures and assets involved in managing those relationships Identify the role of stakeholders in the design of socioenvironmental policies by logistics firms	Counting the number of times key words or phrases are included in a source is not enough. This needs to be complemented by an analysis of inferences in the use of words and phraseology and by a classification of the effects in the communication of this content Standardization in the interpretation and analysis of content is essential to preserve research validity. Software packages can be very useful in this effort	Company annual and quarterly reports Financial analysts' reports Published interviews with company executives News stories involving organizations or decision makers

Continued.

Table 3: (Continued)

Methodology	Definition	Examples of research opportunities	Key implementation practices and issues	Data sources
Geographic Information Systems (GIS)	GIS capture, edit, analyze, and display geospatial and network characteristics of natural phenomena and human-generating activities and relationships, based on geostatistical techniques and cartographical representations	GIS can help integrate a wide variety of information using spatial and nonspatial databases to tackle problems in distribution networks and fulfillment channels. Some examples include: (a) Describing a sample of events and analyzing macro level network patterns and interactions among multiple logistics parties involved in those events (b) Developing models that evaluate distribution-network and channel-design infrastructure requirements and operational costs	In the process of matching spatial and nonspatial databases, researchers should assign a spatio-temporal location for each observation in the databases as a key index variable to work with relational matrices storing other types of information. This requires: (a) Assembling databases to link different units of analysis (b) The use of Global Positioning Systems to generate rich data on logistics flows and real-time network tracking (c) Accessing directories with data with all the links preset Since the variables in the databases are space-dependent, and are often auto-correlated, researchers should carefully control for spatial commonalities to construct statistical models in a similar way as in temporal auto-correlations for time-series data	GeoDa Center at Arizona State University Federal Geospatial Data Clearinghouse Search Engine GIS Data Depot available from the GeoCommunity at http://www.data.geocomm.com ArcGIS online (ESRI's data clearinghouse and map services) Geospatial One Stop—U.S., Federal, State and Local GIS Data The National Map from the U.S. Geological Service
Simulation	The use of reasonable assumptions obtained from different cases and behaviors to emulate real-world logistics systems through the use of information technology	Shipping-network and channel design Design of inventory auditing policies Analysis of transactions between logistics parties and their effect on logistics systems performance	Identify all the phases in the simulation where input data will be needed Incorporate all significant variables and associated input and output data in the simulation. Be exhaustive to avoid data representation biases Ensure that enough relevant data will be available to achieve statistical power for the results Use statistically accurate probability distributions to represent the input data	Company archives involving inventory policies and transportation lead times U.S. Census reports to collect economic activity data to capture demand volumes and seasonality

have rarely compared within the same study the relative importance of transaction-cost dimensions (asset specificity, frequency, and opportunism) in supply chain outsourcing decisions. Moreover, researchers have provided very little insight into the relationship between governance choice and performance by explicitly incorporating, for example, the effects between outsourcing decisions and costs into their studies. Meta-analyses can fill in these gaps in the literature by gathering information from studies in different industrial and contextual settings and over different time periods.

Ultimately, the validity of meta-analyses will depend on how rigorously they are performed. To that end, meta-analyses must begin with well-formulated research questions. On one hand, by combining multiple results from prior research, meta-analyses can be very effective in validating results across a broader population. Meta-analyses can also leverage prior results to empirically evaluate normative research questions regarding the effects of certain practices or factors on the performance of one or multiple firms in the supply chain. Once research questions are articulated, one should carefully operationalize the constructs in those questions and identify the samples necessary to generalize the results across a broader population. Only then, will it be possible to design strategies to zoom in on relevant data to address the research questions.

These data may originate from published studies obtained through the Social Sciences Citation Index or databases, such as ProQuest's ABI-Inform. But the data must also include unpublished studies to avoid biases that may result from the tendency to publish studies with statistically significant results. Sources for dissertations, unpublished reports, conference papers, and federally supported studies include the University Microfilms International Dissertation Service (UMIDS) database, the Educational Resources Information Center (ERIC) database, the National Technical Information Service (NTIS) database, and, in Canada, the University Research (UNIVRES) directory.

Event studies

Through event studies, authors can find abnormalities in the measurements of dependent constructs that may be attributable to a specific event of interest. The use of this methodology is not new in the logistics literature. In fact, it was used several decades ago to evaluate industry effects brought about by deregulation in the transportation industry in the United States (see, e.g., Bailey 1986). More recently, authors have used event-study data to investigate inventory management and logistics links to cost and financial performance (Table 2).

There are also interesting opportunities available for researchers to use event studies to evaluate the effects of supply chain disruptions across national boundaries and over longer periods of time. The use of event studies would provide unique insights into how these disruptions propagate and how their effects can be ameliorated.

Event studies can also be very effective in studying competitive dynamics in different logistics industries. Strategic management papers have used event studies to evaluate competitive conduct in the airline industry to understand the effect that certain actions by companies (e.g., price cuts, entry into new airports) have on their competitors' behavior. Logistics researchers can draw from this literature to evaluate conduct among motor carriers as they engage in competition to attract shippers. Motor carrier conduct may involve changes in rates as well as new service offerings to shippers. Event studies could also shed light on the effects that mergers among ocean carriers or airlines have had on their financial performance. The method can also be very effective in studying the impact that the privatization of ports has had on the operations of ocean liners and on the economic activity of port regions and communities.

An important task in conducting an event study is to define the event of interest and identify the period over which the event occurred. In many cases, events do not take place in single, discrete instances. Instead, they take place over extended periods of time. For example, while the policy on Australian airport privatization was reviewed and decided in 1993, the actual privatization of specific airports was initiated in April 1996 and completed in July 1997. Since the impacts of these and other events are lagged over long time periods, researchers must define the periods when these events took place and isolate the events during these periods.

Researchers must also establish how they will identify the events. To that end, researchers may use publicly available sources, such as financial reports or press releases. However, because these sources may not provide a complete account of event occurrences, researchers must consider supplementing these sources with information gathered directly from individuals inside firms and from industry and professional associations, who may have more intimate knowledge of the events.

After isolating the events, it is necessary to establish the criteria for the measurement of the dependent constructs that the researchers expect will be affected directly by the events. These criteria may involve constraints imposed by data availability, sample characteristics, and the time horizon used to measure the dependent constructs. A failure in considering these criteria may introduce biases in the measurement of the relationships between the events and the dependent constructs.

Frequently, dependent constructs involve performance measurements at the firm level, which are gathered from financial reports or using stock values obtained from listings on the New York Stock Exchange, for example. But, they may also involve measurements involving firm conduct, especially when the events of interest correspond to changes in regulations introduced by legislation such as the Staggers Rail Act and the Motor Carrier Act in 1980, the introduction of the North-American Free-Trade Agreement (NAFTA) legislation in the mid-1990s, and, more recently, the passing of the Sarbanes-Oxley Act. In these cases, measurements may track variations in actions by firms involving prices, for example, or managerial practices involving transportation and inventories. These are only a few examples that point to the versatility that event studies can offer in addressing research questions that span multiple levels of the supply chain.

Archival data

The use of archival data in logistics research has relied in the past on a wide accessibility to public information available in the transportation industry. Researchers in the United States have had relatively easy access to this information due to requirements imposed by the government on firms in this industry to disclose these data. As summarized in Table 2, these scholars have used archival data to investigate transportation economics and transportation safety issues. But they have also drawn from these data to study transportation networks, market trends, and policy in this industry.

The growth of the Internet as a tool to generate, transmit, and store information has opened new doors for researchers in our field to use archival data to generate new insights and knowledge on a variety of issues. This information comes from the tracking of shipments, sales, supplies, and even customers' individual product preferences and recommendations. Information is also available from corporate e-mails and social network links, written comments, and videos that firms may generate themselves or receive from individuals on the Web.

Articles published by Rabinovich (2004, 2005) have leveraged this type of data to address supply chain management challenges in the Internet retailing industry. These articles used data gathered from transactions carried out at the retailer–customer dyad of the supply chain to evaluate performance and costs in the fulfillment of online orders. But additional opportunities exist to use data like these to answer other research issues in logistics. For instance, research could draw from data in Internet social networks and from customer recommendations on Internet retailers' sites to evaluate how customer opinions influence demand by their peers and how these effects alter demand forecasts for products sold on the Internet. With these insights, researchers could develop more effective inventory management policies for products sold online.

More work is also necessary to understand the inventory management implications stemming from the greater variety of products available to customers on Internet. If, in fact, the Internet gives customers the ability to buy increasingly obscure, individualized products, should Internet retailers' inventory management policies for mainstream, best selling items change? How should multi channel retailers change their policies? Should retailers like Wal-Mart or Best Buy make adjustments to the inventory assortments at their stores or at their distribution centers?

The widespread availability of data over the Internet through fixed and mobile devices also has implications for transportation firms that are worth examining. Through the use of archival data collected from motor carrier firms, researchers could learn how Internet data on real-time traffic and weather are helping these organizations be more efficient in their haulage of products.

To pursue these research opportunities, scholars need to be aware of particular attributes in their data sources. First, data sources may be proprietary and, as a result, it may be impossible for researchers to verify the integrity of the information in these sources and guarantee the validity of the results obtained from the data. Second, the data sources available may provide information that is not collected with regularity, making it difficult to do follow-up analyses or longitudinal assessments. Third, the data available may not be representative of the population. Fourth, even if the data were representative of the population, they may not have been collected unobtrusively. Therefore, the measurements obtained may be subject to biases. Finally, the unit of analysis of the information available may not correspond to the unit of analysis in the study's theoretical framework. In some cases, this information may be available across different levels of analysis, even within the same data source. For instance, the data may correspond to buyer–supplier transactions that are nested within different buyers and suppliers. In situations like these, researchers must separate the variability of the measurements obtained from these sources across the different levels of analysis.

PROMISING METHODOLOGIES FOR SECONDARY DATA ANALYSIS

Our literature review also identified several important methodologies that have strong potential for logistics research based on secondary data. A few representative methods involve the use of content analysis, GIS, and simulation. Below, we discuss these methodologies in great detail and provide a summary of this discussion in Table 3.

Content analysis

Content analyses enable researchers to identify and summarize a variety of sources of texts in a more scientific, systematic, and, sometimes, quantitative way. Through content analysis, text is usually encoded as data to capture characteristics of a certain variable or a construct, and the encoded data can then be utilized to carry out further second-stage analyses with statistical and econometric models.

While content analysis has been rarely used in the logistics literature, it has been quite popular in other social science and humanities disciplines, such as communications, political science, and history. As applied in these disciplines, content analysis has been useful in the acquisition of critical information regarding the timing and location of behaviors by individuals and of organizational conduct.

Therefore, through this methodology, logistics researchers could address questions regarding managerial decisions in different organizations. These decisions may involve the transformation of organizational structures or the implementation of practices and policies (e.g., logistics functions' ownership, alliances, logistics managerial views on sustainability) in response to stakeholder influence or governmental regulation.

For instance, content analyses can help researchers understand some of the relationships involving organizational conduct pertaining to pricing and logistics services. In fact, recent research has applied content analysis to analyze online retailers and their pricing strategies and fulfillment services

(e.g., Ranchhod et al. 2000). Additional research based on content analysis could make use of documents published by logistics service firms to identify their organizational structures and asset management policies (e.g., Cheon et al. 2010). Further, published statements by transportation companies (e.g., Cantor and Terle 2010) can be used to interpret these organizations' safety and sustainability strategies, and their practices regarding socioenvironmental issues. This analysis could also be very useful in understanding the influence that some customers have on these organizations' design of environmental practices.

To perform content analyses, researchers could simply count the number of times specific words appear in data sources (e.g., latent semantic analysis). But, then, they would need to analyze inferences in the usage of words and uncover related effects of communications. Content analyses may also involve the formation of networks of corporate documents and communications that are linked to each other on the Internet through social networks, forums, blogs, and wiki-based sites (Mehler 2008). Researchers could also analyze networks linking different types of records including scientific articles (e.g., citations from digital libraries), press (e.g., the *New York Times*), and inter organizational documents (e.g., web-published memos). These analyses could rely on specialized software, such as Crawdad Text Analysis (http://www.crawdadtech.com), to build networks in which vertices (nodes) represent words, sentences, or texts, while edges (links) are constructed by coherence relations among the words, sentences, or texts in the nodes.

Geographic Information Systems

GIS capture, edit, analyze, and display geospatial and network characteristics of natural phenomena and human-generating activities and relationships, based on statistical techniques and cartographical representations. Scholars in disciplines, such as geography, environmental management, urban transportation planning, and public utility management, have used GIS extensively. Logistics researchers may benefit from following their lead and use GIS to integrate a wide variety of information using spatial and nonspatial databases to tackle problems in distribution networks and fulfillment channels.

For example, GIS can be used to describe a sample of events and analyze macro level network patterns and interactions among multiple logistics parties involved in those events (e.g., Lei and Church 2011). Further, researchers may use GIS to develop models that evaluate distribution-network and channel-design infrastructure requirements and operational costs. To that end, researchers could use frameworks such as that used by Parker et al. (2010) to estimate the costs of renewable energy production from agricultural waste based on different designs of delivery pathways for this waste.

GIS usually treat data using two major forms of abstractions-mapping references. One of these is known as "raster" and corresponds to digital images represented by pixels. The other one is known as "vector" and contains features represented as geometric shapes such as points, lines, and polygons. Both data forms characterize spatial and network features of observations that can be used to construct second-stage statistical models at the units of point, link, polygon, or even pixel for raster data, when combined with other spatial and nonspatial data. Since these units of data are space-dependent and are often auto-correlated, researchers should carefully control for spatial commonalities to construct statistical models in a similar way as in temporal autocorrelations for time-series data.

In the process of matching spatial and nonspatial data, researchers should assign a spatio-temporal location for each observation as a key index variable to work with relational matrices storing other types of information. This requires assembling databases to link different units of analysis. It may also involve the use of Global Positioning Systems to generate rich raster data on logistics flows and real-time network tracking (e.g., Lei and Church 2011). Also, researchers may find it useful to access directories such as the one at the GeoDa Center at Arizona State University, which is a source of rich resources for a variety of preassembled GIS data and information on geospatial and network analysis (see http://geodacenter.asu.edu), or national data clearing houses such as the Geography Network from the Environmental Service Research Institute (ESRI).

Simulation

Simulation uses reasonable assumptions and information obtained from different cases and behaviors to emulate real-world logistics systems. This method can also be useful to confirm the validity and the sensitivity of analytical models and to expand on the implications of propositions derived from these models.

Although logistics researchers are familiar with simulation, they have mainly used it to illustrate numerical applications of different modeling approaches. Recently, however, a significant expansion in computational capabilities and information systems has provided simulation with new opportunities to be applied in much more diverse research endeavors. This has enabled scholars to start combining simulation with a more intensive use of empirical data and analyses to project future logistics trends and behaviors. This will also create new opportunities for simulation to be combined with experimental designs to generate larger-scale databases for second-stage empirical analyses.

A series of techniques such as Monte Carlo simulation, logical and decision support systems (e.g., Artificial Neural Networks, Analytical Hierarchical Process, Fuzzy Logics), and other stochastic models can promote rigorous research on a variety of operational issues in logistics, including the design of shipping networks and channels, the design of inventory auditing policies, and the analysis of transactions between logistics parties and logistics systems performance (e.g., Saldanha et al. 2009). Under these techniques, it is important to identify all the phases in the simulation where input data will be needed to guarantee an adequate empirical grounding of the simulation design. Also, researchers should incorporate all significant variables and associated input and output data in the simulation. It is important to be exhaus-

tive to avoid data representation biases that could occur when variables are omitted. Further, it is important to ensure that enough relevant data will be available to achieve statistical power for the results obtained from the simulation. Finally, the simulation should incorporate statistically accurate probability distributions to represent the input data. Potential sources to obtain input data include company archives with information about inventory policies and transportation lead times, for example. Other sources may include publicly available information like the U.S. Census, which could be very useful in collecting economic activity data, demand volumes, and demand seasonality.

THE PATH FORWARD: USING SECONDARY DATA METHODOLOGIES TO EXPAND THE LOGISTICS AND SUPPLY CHAIN LITERATURE

In this article, we offer a variety of methods through which researchers could use secondary data to advance the field of logistics and supply chain management. We also argue that these secondary data methods hold great promise to advance the current knowledge that exists in the logistics literature.

However, the effectiveness of secondary data methodologies will depend on how well the data match the operationalization of different constructs required for logistics research. If the data do not match the constructs' operationalization, researchers may be compelled to compromise the range of their measurements, pair down the scale and scope of their models, or even limit the breadth of their review of the literature to ground their hypotheses and constructs. Naturally, these compromises may ultimately undermine the rigor of the research studies.

To neutralize these pitfalls, scholars may benefit from combining the use of these methodologies with the use of surveys or case studies. By supplementing secondary data with surveys, for instance, researchers can obtain a richer operationalization of constructs while addressing possible limitations due to common method biases that may be present when surveys are the only source of information. Further, when the scope of study is large, the joint use of these methodologies can offer ways to rigorously test theories in logistics, without requiring excessive amounts of funding. Through secondary data, researchers can also supplement empirical testing done through surveys by doing post hoc analyses to offer additional insights to their research questions. These insights can lead to the formulation of new research questions and the development of more robust research designs that incorporate multiple data sources for the testing of new hypotheses.

Logistics studies can also benefit from using secondary data to validate unexpected results and increase their integrity and internal validity. When researchers find unexpected results, for example, they could use secondary data to evaluate whether the results are caused by spurious relationships. If this is not the case, then, they could use secondary data to reexamine the unexpected results using a series of alternative variables that could capture the originally proposed constructs. Researchers should avoid ad hoc explanations based on conjecture without solid theoretical foundations or empirical observations. The careful design of a validation process based on secondary data can contribute to this effort and enhance the quality of logistics research.

The rigorous use of secondary data methodologies based on archival information obtained directly in the field from industry sources, such as companies and government agencies, will be of great value if it can also provide logistics practitioners with insights that may be better targeted to address managerial applications directly related to the information used for the research. This can strengthen the practical validity of logistics research because managers would be in a position to more easily translate research results into tangible implications for their operations. Moreover, because the results obtained from secondary data are based on information obtained directly from the field, where the practical relevance of the results can be validated, managers can become more engaged in evaluating the practical value of these results. This will certainly challenge logistics scholars to refine their studies in order to make them more substantively rigorous.

By considering the rigorous application of secondary data along with other methodological options available to address future research challenges, scholars will have greater opportunities to conduct groundbreaking research that will greatly advance the logistics and supply chain literature. Limiting the methodological options to those that have been commonly used in the past will only serve to limit the reach of the scholarly work in our field at the expense of the pursuit of more innovative research.

APPENDIX

Authors	Methodology	Main data source
Daugherty et al. (2009)	Survey	Members to the Council of Supply Chain Management Professionals (CSCMP)
Chen et al. (2009a,b)	Survey	Chinese electronic manufacturers

Continued.

APPENDIX (CONTINUED)

Authors	Methodology	Main data source
Lai (2009)	Survey	Supplier organizations reporting on their relationship with a terminal operator
LeBlanc et al. (2009)	Analytical Modeling	Not applicable
Stock and Mulki (2009)	Survey	Members to the Warehousing Education and Research Council (WERC)
Kaufmann et al. (2009)	Case Study	Fifteen German manufacturers
Mello and Flint (2009)	Theory Development	Not applicable
Voss et al. (2009)	Survey	Members of the American Purchasing Society (APS) and the Institute for Supply Management (ISM)
Ross et al. (2009)	Analytical Modeling	Simulation
Boyer et al. (2009)	Analytical Modeling	Simulation
Cantor et al. (2009)	Survey	The 1,025 largest motor carriers in United States
Acharya et al. (2009)	Archival	Reports published by the Agricultural Marketing Service at the U.S. Department of Agriculture
Chen et al. (2009a,b)	Theory Development	Not applicable
Greer and Ford (2009)	Delphi Study	Managers participating in change management seminars sponsored by a large industrial coalition
Zacharia et al. (2009)	Survey	Institute for Supply Management (ISM) members and contacts from a university's supply and value chain center
Hofer et al. (2009)	Survey	Customers to a large Latin American-based third-party logistics provider
Schoenherr (2009)	Literature Review	Not applicable
Defee et al. (2009)	Survey	Supply chain managers participating in executive education courses
Srinivas (2009)	Theory Development	Not applicable
Teo and Lai (2009)	Survey	Employees in companies listed in the Singapore 1000 Directory
Shapiro and Wagner (2009)	Analytical Modeling	Not applicable
Saldanha et al. (2009)	Survey (On-site) and Simulation	On-site primary data collection and expert interviews and secondary data summarization from the literature and Port Import Export Reporting Service (PIERS) data for simulation model parameters
Chapman and Ellinger (2009)	Archival	Publications at 10 different supply chain management and logistics journals
Kovacs and Tatham (2009)	Theory Development	Not applicable
Trautrims et al. (2009)	Case Study	Chilled juice category at one UK retailer and one of its major suppliers
Richey et al. (2010)	Survey	Members to APICS, the Council of Supply Chain Management Professionals (CSCMP), and the Institute for Supply Management (ISM)
Pettit et al. (2010)	Theory Development	Not applicable
Torres and Maltz (2010)	Analytical Modeling	Simulation based on North Electronics (NE), the Mexican subsidiary of a multinational auto parts supplier, is the manufacturer anchoring the supply chain we analyze in detail
Fugate et al. (2010)	Survey	Members to the Council of Supply Chain Management Professionals (CSCMP)
Kros and Nadler (2010)	Survey	Members to the Council of Supply Chain Management Professionals (CSCMP); Institute for Supply Management (ISM) website; and the Association for Operations Management (APICS)

Continued.

APPENDIX (CONTINUED)

Authors	Methodology	Main data source
Ellinger et al. (2010)	Survey	Site managers employed by the 200 largest logistics service provider organizations listed in Who's Who in Logistics: Armstrong's Guide to Global Supply Chain Management
Vogt (2010)	Field Research	On-site interviews and reviews of processes at multiple cross-dock facilities in different countries and in a variety of industry segments
Yang et al. (2010)	Analytical Modeling	Simulation
Nachtmann et al. (2010)	Analytical Modeling	Simulation
Smith and Mentzer (2010)	Survey	Members to the Council of Supply Chain Management Professionals (CSCMP) and the Warehousing Education and Research Council (WERC)
Eroglu and Knemeyer (2010)	Archival	Data collected from a multinational firm operating in the quick service restaurant industry
Cantor et al. (2010)	Archival	Articles published from 1987 to 2007 at seven major logistics and transportation journals
McGinnis et al. (2010)	Survey	Members to the Council of Supply Chain Management Professionals (CSCMP)
Cahill et al. (2010)	Survey	Members to the Council of Supply Chain Management Professionals (CSCMP)
Chen et al. (2010)	Survey	Manufacturing companies listed in a Chinese industry directory
Zsidisin and Wagner (2010)	Survey	Convenience sample of supply management professionals employed at five different organizations
Galbreth and LeBlanc (2010)	Analytical Modeling	Not applicable
Randall et al. (2010)	Theory Development	Not applicable
Christoph et al. (2010)	Archival	*Journal of Business Logistics* articles and cited references from BSC database
Haines et al. (2010)	Analytical Modeling	Not applicable
Atwater et al. (2010)	Archival	Federal Motor Carrier Safety Administration (FMCSA) Form M annual-report data for Class I and II motor carriers from 1999 through 2003
Bell and Girffis (2010)	Analytical Modeling	Not applicable
Ashenbaum and Terpend (2010)	Survey	Purchasing managers with membership in the Institute for Supply Management (ISM)
Keller et al. (2010)	Survey	Members of the Warehousing Education and Research Council (WERC)
Davis et al. (2010)	Survey	Retailer customers of a manufacturer of consumer durable goods
Williams and Waller (2010)	Archival	Data from a large consumer packaged goods' supplier that competes in multiple grocery categories
Hofmann and Kotzab (2010)	Theory Development	Not applicable
Naslund et al. (2010)	Theory Development	Not applicable
Wagner and Kemmerling (2010)	Archival	Articles published from 1998 to 2007 in the *International Journal of Physical Distribution* and *Logistics Management (IJPDLM), Journal of Business Logistics (JBL),* and *Transportation Journal (TJ)*

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