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Journal of Transportation Management

Editorial Policy

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

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

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

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From the Editor...

Welcome to the Winter, 2016 issue of the Journal of Transportation Management, being Vol. 26 No 2! This issue of the *Journal* starts with an article on an assessment of Logistics Management in two Latin American countries, includes an article on better understanding the needs of business parcel shippers, moves on to an article investigating the benefits of contracted vs. in-house maintenance approaches for Air Force aircraft, and concludes with an article on the impact of urban sprawl on journey to work times in the U.S.

The first article examines the logistics strategy typology (Process Strategy, Market Strategy, and Information Strategy) for studying logistics/supply chain management strategy in the context of Peru and Guatemala. The authors find that the typology constructs hold up well in both countries with some similarities and differences in strategic practice in each country. The second article reviews investigates how business parcel shippers select carriers. Survey respondents were asked to evaluate the importance of 17 carrier selection variables in regard to choosing a parcel carrier. Four unique segments were identified based on their carrier selection criteria. The third manuscript examines alternative maintenance strategies for Air Force aircraft and studies the advantages and disadvantages of in-house maintenance as compared to outsourcing these services. The authors conclude outsourced maintenance outperforms organic in-house services based on evaluation of performance on several key target performance and cost metrics. The fourth article reviews the impact of urban sprawl on journey to work times in the U.S. and studies the wisdom of mass transit subsidies and “smart growth” policies. The authors make several public policy recommendations on how to improve public mass transit at the local level.

At the *Journal*, we are continuing to make a number of changes that will improve the visibility of JTM, and improve its position in the supply chain publishing world. These include registering and updating journal information with several publishing guides, placing the journal content with the EBSCO, Gale and JSTOR databases faculty have access to, and placing abstracts of all past journal articles on an open area of the Wayne State University Journal web page. Full journal article PDF's continue to be available to subscribers on the web page at www.business.wayne.edu/gscm.

I look forward to hearing from you our readers with questions, comments and article submissions. The submission guidelines are included at the end of this issue's articles and I encourage both academics and practitioners to consider submitting an article to the Journal. Also included in this issue is a subscription form and I hope you will subscribe personally, and/or encourage your libraries to subscribe.

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AN EMPIRICAL ASSESSMENT OF LOGISTICS/SUPPLY CHAIN MANAGEMENT IN TWO LATIN AMERICAN COUNTRIES

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ABSTRACT

The Bowersox Daugherty (1987) logistics strategy typology (Process Strategy, Market Strategy, and Information Strategy) is an important conceptual framework for studying logistics/supply chain management strategy and its role on logistics/supply chain management outcomes. The purpose of this research is to empirically apply the typology in Peru and compare the findings with the previous research conducted in Guatemala. The three Bowersox/Daugherty dimensions are used to define the construct Overall Logistic Strategy (OLS), and then, the OLS was used to measure Organizational Competitiveness (COMP) through two intervening variables LCE (Logistics Coordination Effectiveness) and CSC (Customer Service Commitment). The results indicate that generally the logistics strategy in Peru is fundamentally similar to Guatemala's. In other words, the direction of the relationships among the conceptualized constructs tested in the SEM model was significant and explained a sizable variation in COMP in both countries. This provided additional support for the robustness of the structural model in different cultural environments. However, some differences are apparent. First, the importance of the three independent variables and three dependent variables appear to be greater to the Peruvian respondents than Guatemalan respondents. Second, on closer inspection Peruvian logistics data indicates relatively greater emphasis on information, coordination, customer service, and relatively less emphasis on cost efficiency, than Guatemalan managers. Managerial insights and suggestions for future research and discussed.

INTRODUCTION

Logistics management is the process of managing material, service, information and capital flows from the source, through the firm and to the customer (Logisticsworld, 2015). It is a critical part of an organization's corporate strategy (Heskett, 1977). One conceptual framework used in studying logistics/supply chain management is the Bowersox/Daugherty (1987) typology, which has been the basis for longitudinal research in the United States and a series of international markets. Collectively these studies have demonstrated that the Bowersox and Daugherty typology is applicable over time in the United States and in several other countries with different cultural backgrounds and economic development levels. As such, these recent empirical studies address the concerns of Luo, Van Hoek, and Ross (2001) who stated that cross-cultural logistics/supply chain management research has lagged in comparison to other business disciplines. The authors believe that the analysis contained in these studies validate the Bowersox/Daugherty typology as an effective model for the study of logistics/supply chain management across cultures.

Considering the speed of the globalization, a firm's ability to manage logistics in cross-country environments has become an important success factor. Although, globalization offers significant opportunities for multi-national corporations (MNCs) to shift their manufacturing and distribution around the world, especially in the developing and emerging markets, global manufacturing strategies may not be effective if not supported by successful logistics strategies. Therefore, we strongly believe that cross-cultural/cross-country logistics studies have significant potential to enrich our understanding of logistics systems and strategies applicable in different national environments. These studies provide in depth logistics knowledge, which can have important international logistics management implications in helping managers to identify similarities, and

would encourage similar strategies, or identify significant differences.

Kohn, McGinnis, and Kara's (2011) recent study reported the role of overall logistics strategy (OLS) on logistics coordination effectiveness, customer service effectiveness, and organizational competitive responsiveness. Using multi-year data collected in the U.S., their findings demonstrated that the Bowersox/Daugherty dimensions had a significant impact on the company's competitiveness through the links of logistics coordination and customer service. The purpose of this study is to explore whether the Bowersox/Daugherty typology is useful for examining logistics strategies in two dissimilar Spanish language countries in Latin America, namely Peru and Guatemala.

The authors postulate that a two-country/cross-cultural study of Guatemala and Peru would furnish an intriguing example of how logistics systems are assessed in two nations through the lens of one common measurement instrument. Furthermore, such a study would provide a strong validation of the dimensionality and the structural relations identified in the recent Kohn, McGinnis, and Kara (2011) study. We emphasize that the differences in each country's geographic size, population size, labor force make-up, infrastructure, and economic systems provide an excellent platform for evaluating the validity of the research instrument, as well as providing insights into logistics strategies and outcomes in these heterogeneous countries.

This current research adopts a perspective that the Bowersox and Daugherty typology provides a strong conceptual framework consistent across countries with regards to salient dimensions of logistics/supply chain management strategy. These dimensions should be coordinated at many levels of the organization to achieve competitive responsiveness regardless of the country's environment. Through this research the authors hope to discover the applicability of logistics/supply chain management strategy and understand the role logistics management

strategy plays in maintaining and enhancing competitive advantage responsiveness in cross-country environments. Using a confirmatory factor analysis and a structural equation model, we assess the validity of three dimensions of the Bowersox and Daugherty typology and their simultaneous relationship to logistics coordination, customer service effectiveness, and overall organizational competitive responsiveness.

This paper is organized into seven sections. The first two sections contain the introduction and literature review and they provide an overview of the conceptual framework for the study and briefly compare selected characteristics of Peru and Guatemala. Sections three and four contain the research methodology and data analysis. The fifth section discusses the similarities and differences in logistics/supply chain management between the two Latin American countries. The sixth section presents a discussion of the results and conclusions. The final section provides implications for logistics/supply chain management practitioners, teachers, and researchers.

LITERATURE REVIEW AND AN OVERVIEW OF PERU AND GUATEMALA

Literature Review

In 1987, Bowersox and Daugherty completed a comprehensive study of logistics integration. Their research focused on three distinctly different logistic management strategy types that firms have used in their decision-making. They are summarized as follows:

- The objective of Process Strategy is to manage flows to gain control over activities that “give rise to cost”. In current terminology they are referred to as “cost drivers”.
- The objective of Market Strategy is to reduce the complexity faced by customers. For example, this strategy may try to provide a single point of

contact for customers that source multiple products from different divisions, or facilities, of the same firm.

- The objective of Information Strategy is to coordinate information flows throughout the channel of distribution to facilitate cooperation and coordination among channel (supply chain in today’s vocabulary) members.

Three studies (McGinnis and Kohn, 1993, Kohn and McGinnis, 1997b, and McGinnis and Kohn (2002) have tested the three components of the Bowersox/Daugherty typology in large U.S. manufacturing firms. The researchers found that process and market strategies were emphasized when logistics strategies were intense. They also determined that both strategies existed at moderate levels when firms used a balanced strategy approach. Additionally, they found that these strategies were present only at low levels when firms used an unfocused strategy. These studies indicate that the three dimensions (logistics process strategy, market strategy and information strategy) together, and referred to as Overall Logistics Strategy (OLS), provide a basis for assessing logistics/supply chain management effects on firm competitiveness. One significant contribution of this research was that the three dimensions of logistics strategy would be more likely to be blended than used separately as Bowersox and Daugherty (1987) originally indicated.

Clinton and Closs’s (1997) research using a sample of 818 U.S. and Canadian firms to assess the significance of the Bowersox/Daugherty typology concluded that there was a clear overlap of the three strategies (process, market, information). This is to be expected because logistics performs the same activities regardless of the overall logistics strategy. In addition, Spillan, Kohn, and McGinnis (2011) concluded that the strategies of small and large U.S. manufacturing firms vary in degree rather than type. Market, Process, and Information strategies were present in both small and large firms. Moreover, the authors concluded that the logistics

strategy outcomes of small and large firms were similar. It was concluded that the Bowersox/Daugherty typology was applicable to United States manufacturing firms regardless of size.

Recent studies have explored the value and suitability of the Bowersox/Daugherty typology in different cultures/countries (McGinnis, Harcar, Kara, and Spillan (2011); McGinnis, Spillan, Kara, and King, D., 2012; and Spillan,

McGinnis, Kara, and Yi (2013). These studies were conducted in China, Guatemala, Ghana, and Turkey. In each case confirmatory factor analysis was used to assess the validity of Overall Logistics Strategy (OLS) using Structural Equation Modeling (SEM) to test the validity of the overall model of OLS-LCE (Logistics Coordination Effectiveness)-CSC (Customer Service Commitment)-COMP (Organizational Competitiveness). In two of

TABLE 1
SELECTED COMPARISONS OF THE PERU AND GUATEMALA

Category	Peru	Guatemala	Source
Area (sq. km/sq. miles)	1,279,996/494,206 (Slightly smaller than Alaska)	108,889/42,042 (Slightly smaller than Tennessee)	<i>Guatemala Central Intelligence Agency World Factbook</i> (www/cia.gov. 2014)
Population	30,147,935 est.	14,647,083 est.	<i>Guatemala Central Intelligence Agency World Factbook</i> (www/cia.gov. 2014)
Percentage of Population Urban	77%	49%	<i>Guatemala Central Intelligence Agency World Factbook</i> (www/cia.gov. 2010)
Make up of Labor Force	Agriculture: 25.8% Industry: 37.5% Services: 56.3%	Agriculture: 13.5% Industry: 23.8% Services: 62.7%	<i>Guatemala Central Intelligence Agency World Factbook</i> (www/cia.gov. 2014)
Gross Domestic Product	\$334 billion est.	\$81.5 billion est.	<i>Guatemala Central Intelligence Agency World Factbook</i> (www/cia.gov. 2014)
Climate	Varied	Tropical	<i>Guatemala Central Intelligence Agency World Factbook</i> (www/cia.gov. 2014)
Railroads (km/miles)	1,907/1,183	332/206	<i>Guatemala Central Intelligence Agency World Factbook</i> (www/cia.gov. 2014)
Paved Roads (km/miles)	18,698/11,602	6,797/4,217	<i>Guatemala Central Intelligence Agency World Factbook</i> (www/cia.gov. 2014)
2013 Public-sector Corruption Index. An indication of domestic public corruption.	38/100: 83 of 177 countries. Higher number > less corrupt.	29/100: 29 of 180 countries.	<i>Transparency International</i> (www.transparency.org)

Websites accessed March 31, 2014.

these countries, China and Ghana, OLS was supported, but support for the overall model was mixed for the Guatemalan data and statistically insignificant for the Turkish data. McGinnis, Spillan,

Kara, and King, (2012) analyzed empirical data collected in Ghana and found that the OLS-LCE-CSC-COMP model was supported. Finally, Spillan, McGinnis, Kara, and Yi, (2013) compared

TABLE 2
SUMMARY OF HOFSTEDE'S CULTURAL DIMENSIONS*

Dimension Name and Brief Description	Example Attributes		Dimension Scores Peru Subjects/ Guatemalan Subjects
	of a Low Score	of a High Score	
Power Distance: The extent that those less powerful accept that power is distributed unequally.	Less concentration of authority, flat organization pyramids, subordinates expect to be consulted.	More concentration of authority, tall organization pyramids, subordinates expect to be told.	64/95
Uncertainty Avoidance: Extent to which members of a culture are comfortable or uncomfortable in unstructured situations.	Company rules may be broken, less resistance to change, acceptance of foreigners as managers.	Company rules should not be broken, more resistance to change, suspicion of foreigners as managers.	87/99
Individualism and Collectivism: The degree to which individuals look after themselves or are integrated into the group.	Employee commitment to organization low, personal relationships prevails over task and company, less control over job and working conditions.	Employee commitment to organization high, task and company prevail over personal relationships, more control over job and working conditions.	16/6
Masculinity and Femininity: The degree "toughness" versus "tenderness" within a culture.	Work to live, managers expected to use intuition, managers hold modest career aspirations.	Live to work, managers expected to be decisive, managers have ambitious career aspirations.	42/37
Pragmatism: <i>How people in the past as well as today relate to the fact that so much that happens around us cannot be explained.</i>	People are normative in their thinking, having concerns for establishing absolute truths. Emphasis is on traditions, less likely to save for the future, and likely to seek quick results.	People are guided by virtues and good examples. Long term orientation, more likely to save, priority on steady growth rather than quarterly profit	25/NA
Indulgence: The extent to which people try to control their desires and impulses, based on the way they were raised.	People have a tendency toward restraint, placing little emphasis on leisure time while controlling gratification of their desires. They perceive their actions are controlled by social norms and indulging themselves is somewhat wrong	People have a tendency toward indulgence, being willing to realize their desires and impulses and enjoying life and having fun. They are likely to place a higher degree on leisure time, act as they please, and spend money as they please.	46/NA

* Adapted from: www.gert-hofstede.com (Accessed May 14, 2014).

Chinese and United States data and found the both the OLS and the OLS-LCE-CSC-COMP were supported.

Peru and Guatemala Comparison

The following narrative briefly compares Peru and Guatemala on selected dimensions of geography, population, economics, infrastructure, and culture. A summary of these dimensions is presented as Tables 1 and 2.

Peru and Guatemala share a similar colonial history. Both countries had established cultures (Peru primarily Andean and Guatemala primarily Maya) until their conquests by Spain in the 16th century. Both gained their independence in the 19th century (cia.gov). Both have struggled with various forms of governance since independence.

Otherwise, the two countries differ. As shown in Table 1, compared to Guatemala, Peru is nearly twelve times as large geographically, has about double the population, has a higher percentage of urban population, has a workforce that is more agricultural and industrial, has a Gross Domestic Product about four times the size of Guatemala's, and has a varied climate (an arid lowland coastal region, the central high sierra of the Andes, the dense forest of the Amazon, with tropical lands bordering Colombia and Brazil) while Guatemala's is tropical. Finally, Peru's public sector is somewhat less corrupt than Guatemala's (www/transparencv.org 2014). An

examination of the two cultures using the Hofstede Cultural Dimensions (www.gert-hofstede.com, 2014) revealed that, except for Power Distance (less concentration of authority in Guatemala) both countries are similar in Uncertainty Avoidance, Individualism/Collectivism, and Masculinity/Femininity.

Overall, the two countries are similar in having been Spanish colonies for about three centuries, share the Spanish language, do not differ greatly in terms of culture, and differ modestly in terms of public sector corruption. However, the two countries differ in geographical size, population size, size of GDP, level urbanization, work force make up, climate and infrastructure.

From a logistical point of view, we can also view the relationship of Guatemala and Peru through the lens of the logistics performance index. This index scores countries on their logistics performance according to six factors. These factors are important in evaluating the effectiveness of each country in terms of their overall logistical performance annually. The six factors include customs, infrastructure, international shipments, logistical competence, tracking and tracing, and timeliness. Both countries have very similar scoring records for the year ending 2014. The Logistics Performance Index in Table 3 summarizes a comparison of logistical performance scores. Very little variation exists between Guatemala and Peru.

TABLE 3
LOGISTICS PERFORMANCE INDEX (LPI)

Country	Year	LPI Rank	LPI Score	Customs	Infrastructure	Int. Shipments	Log. Competence	Tracking and Tracing	Timeliness
Guatemala	2014	77	2.80	2.75	2.54	2.87	2.68	2.68	3.24
Peru	2014	71	2.84	2.47	2.72	2.94	2.78	2.71	3.30

The scorecards demonstrate comparative performance—the dimensions show on a scale (lowest score to highest score) from 1 to 5 relevant to the possible comparison groups—of all countries (world), region and income groups. (Source: World Bank, 2014).

The authors believe that Peru and Guatemala would provide a good basis for comparing logistics/supply chain management strategies between two countries in a region that shares characteristics in the areas of history and culture but differ in many ways as described above.

Objectives of the Study:

One gap in this stream of cross-cultural logistics strategy research has been a lack of comparisons between countries in one geographical-cultural area. The authors were able to gather information in Peru, which could then be compared with previously gathered data from Guatemala. If the results from the two countries were similar then the authors thought that they would have more confidence in generalizing the Bowersox/Daugherty typology to the Latin-American region. Conversely, if the results from Peru and Guatemala were dissimilar then it would be concluded that the Bowersox/Daugherty model was not robust in that region.

Therefore, our interest in this study is to explore whether the Bowersox/Daugherty typology is a useful instrument for examining logistics strategies in two dissimilar Spanish language countries located in Latin America. The authors postulate that a two-country study of Guatemala and Peru would furnish an intriguing example of how logistics systems are assessed in two nations through the lens of one common measurement instrument. Furthermore, such a study would provide a strong validation of the dimensionality and the structural relations identified in the recent Kohn, McGinnis, and Kara (2011) study. We emphasize that the differences in each country's geographic size, population size, labor force make-up, infrastructure, and economic system provides an excellent platform for evaluating the validity of the research instrument, as well as providing insights into logistics strategies and outcomes in these heterogeneous countries.

METHODOLOGY

Measures and Questionnaire Development

To conceptualize the factors of our research model, we used two sets of scales adapted from the McGinnis, Kohn, and Spillan (2010) study. In the first set the overall logistics strategy of the companies was measured on three dimensions; *process strategy*, *market strategy* and *information strategy*. The second set focused on three dependent variables; *logistics coordination effectiveness*, *customer service effectiveness*, and *company/division competitiveness*. Respondents were requested to determine their level of agreement with three statements for process, market and information strategies for their company /division, for three statements regarding logistics coordination effectiveness, customer service effectiveness, and for four statements regarding company/division competitiveness on a five point -type scale (1 = definitely agree, 5=definitely disagree).

Data Collection

To collect data in Peru, the authors used the McGinnis and Kohn survey. Articles based on this instrument are found in McGinnis and Kohn (1993), Kohn and McGinnis (1997a), and later cited work. A bilingual associate translated the instrument into Spanish. Back translation was completed to check any discrepancy in addition to potential translation errors. One of the co-authors trained 27 students by explaining to them the purpose of the survey, what its contents were, how to complete the survey and how to respond to questions from the respondents. After the training, the students conducted face-to-face and e-mail interviews with representatives from small companies located in nine major regional centers in Peru. The students interviewed company representatives from 300 companies and received 138 usable responses. We believe that the respondents are a reasonable sample of Peruvian businesses involved in business logistics.

In Guatemala, as reported by McGinnis, Spillan, and Virzi (2012), one of the co-authors worked through the Ministry of Economics to collect data. Ministry of Economics staff was trained to

administer the survey. After the training was complete, the Ministry of Economics staff conducted face-to-face interviews with representatives from midsize and large companies located in nine major regional centers in Guatemala, providing a sample across a large geographic area and a substantial cross-section of the Guatemalan business sector.

The authors decided that the Peruvian and Guatemalan data were collected in a manner that enables a defensible basis for a comparison of logistics/supply chain management strategies in the two countries. The three independent variables and three dependent variables used in this research are presented as Table 4. Included in Table 4 are the items for each variable and the scale reliabilities in Peru and Guatemala. Previous research (Kohn and McGinnis, 1997b) has concluded that the six variables are valid when studying logistics strategy using logistics managers in manufacturing firms.

ANALYSIS AND RESULTS

The first step was to check the construct reliabilities. For purposes of comparison the results from the Peru survey and the previously gathered data for Guatemala (McGinnis, Spillan, and Virzi, 2012) are shown as Table 4. The alpha coefficients for reliability for the three independent variables (Process Strategy, Market Strategy, and Information Strategy) were higher for the Peru respondents. In the case of Process Strategy, the alpha for Peru was significantly higher (0.725) than for Guatemala (0.524). The alphas for the dependent variables varied between the two countries. For Logistics Coordination Effectiveness and Customer Service Commitment, Guatemala's alpha was higher (0.733 versus 0.684 and 0.634 versus 0.430 respectfully) while Peru's alpha for Company/Division was higher (0.752 versus 0.532) than Guatemala's. Overall, the authors concluded that the reliability of the six variables was adequate for further analysis.

Although some of the reliability scores were below the suggested levels (0.70) in the literature, in general we can make a case that these scores are satisfactory for testing and validating the structure reported in Kohn, McGinnis, and Kara (2011). Alpha is not a good indicator of unidimensionality and low levels of alpha can be attributed to the sample homogeneity (Bernardi 1994) and do not put the results in question. Usually 0.70 is desired but Schmitt (1996, p. 351) states that "...use of any cutoff value is shortsighted." Accordingly, when a measure has other desirable properties, the low alpha scores may not be a major impediment to its use (Schmitt, 1996). In addition, as coefficient values are relatively receptive to the number of items in the constructs, particularly when constructs have fewer than 10 items, as in the case in this research, it is common to find coefficient alphas around 0.50 (Pallant, 2007). For instance, almost all alphas reported in Rojas-Mendez and Davies (2005) study was below the cutoff suggested in the literature. The scale items used in our study have been previously used in several studies in the literature; have been considered as having sufficient content validity (Kohn and McGinnis, 1997a), and possessing adequate levels of reliability. All constructs have been previously described and discussed by Keller et al. (2002). Previous studies that used these scales also reported low alpha scores (Kohn, McGinnis, and Kara, 2011).

Based on the findings shown in Tables 3 and 4, the authors concluded that a comparison of modeling the Peru data using the Bowersox/Daugherty typology, and comparing those results with the previously modeled Guatemalan data (McGinnis, Harcar, Kara, and Spillan, 2011), would provide insights into differences and similarities of logistics/supply chain management strategies between two Latin American economies.

Table 5 provides further insights into the two data sets. First, the Kaiser-Meyer-Olkin measure of sampling adequacy (KMO-MSA) (Kaiser, 1970) and Bartlett's test for sphericity was conducted for

TABLE 4
INDEPENDENT AND DEPENDENT VARIABLES¹

Scales/Items*	Reliability Coefficients	
	Peru	Guatemala
Scale 1: Process Strategy (PROCSTR)		
1. In my company/division, management emphasizes achieving maximum efficiency from purchasing, manufacturing, and distribution.	0.725	.524
2. A primary objective of logistics in my company/division is to gain control over activities that result in purchasing, manufacturing, and distribution costs.		
3. In my company/division, logistics facilitates the implementation of cost and inventory reducing concepts such as Focused Manufacturing and Just-in-Time Materials Procurement		
Scale 2: Market Strategy (MKTGSTR)	.684	.624
1. In my company/division, management emphasizes achieving coordinated physical distribution to customers served by several business units.		
2. A primary objective of logistics in my company/division is to reduce the complexity our customers face in doing business with us.		
3. In my company/division, logistics facilitates the coordination of several business units in order to provide competitive customer service.		
Scale 3: Information Strategy (INFORSTR)	.816	.739
1. In my company/division, management emphasizes coordination and control of channel members (distributors, wholesalers, dealers, retailers) activities.		
2. A primary objective of logistics in my company/division is to manage information flows and inventory levels throughout the channel of distribution.		
3. In my company/division, logistics facilitates the management of information flows among channel members (distributors, wholesalers, dealers, retailers).		
Logistics Coordination Effectiveness (LCE)	.684	.733
1. The need for closer coordination with suppliers, vendors, and other channel members has fostered better working relationships among departments within my company.		
2. In my company logistics planning is well coordinated with the overall strategic planning process.		
3. In my company/division logistics activities are coordinated effectively with customers, suppliers, and other channel members.		
Customer Service Effectiveness (CSE)	.430	.634
1. Achieving increased levels of customer service has resulted in increased emphasis on employee development and training.		
2. The customer service program in my company/division is effectively coordinated with other logistics activities.		
3. The customer service program in my company/division gives us a competitive edge relative to our competition.		
Company/Division Competitiveness (COMP)	.752	.532
1. My company/division responds quickly and effectively to changing customer or supplier needs compared to our competitors.		
2. My company/division responds quickly and effectively to changing competitor strategies compared to our competitors.		
3. My company/division develops and markets new products quickly and effectively compared to our competitors.		
4. In most of its markets my company/division is a (1=very strong competitor, 5=very weak competitor).		

*Scales: 1 = Strongly Agree, 2 = Agree, 3 = Neither Agree nor Disagree, 4 = Disagree, 5 = Strongly Disagree. See COMP-4 for that variable's scale.

¹Adapted from: McGinnis, Michael A., Jonathan W. Kohn, and John E. Spillan (2010), "A Longitudinal Study of Logistics Strategy: 1990-2008," *Journal of Business Logistics*, Vol. 31, No. 1, pp. 217-235.

the 2 data sets. In addition the mean scores for the constructs in both countries were assessed. The value of KMO-MSA was 0.845 for the Peruvian sample and 0.900 for the Guatemalan sample indicating the data were appropriate for factor analysis. All KMO results were above 0.50, which is the minimum cut off for factor analysis. Additionally all levels of significance for Bartlett's test for sphericity are less than 0.000. KMO results along with the Bartlett results indicate the data is suitable for factor analysis. Finally, the average values for five of six variables of the Peru data were numerically lower (stronger agreement) than for Guatemala, however, none of the averages of the six variables differed by an amount that was significant (alpha = 0.05).

Confirmatory Factor Analysis

To confirm the underlying factor structure, the authors conducted CFA on all datasets using AMOS. We assessed the goodness of the fit of the models using various fit indices used in previous studies, including the χ^2 statistic, normed fit index (NFI), non-normed fit index, (NNFI), comparative fit index (CFI) goodness of fit index (GFI); standardized root mean, square residual (SRMR); and root mean square error of approximation (RMSEA). The two-step approach suggested by Anderson and Gerbing (1988) was used to first examine the measurement model and then the structural model. In the measurement model, the hypothesized relationship between the 9 logistics strategic orientations and the three first order factors were examined to understand how well the relationships fit the data. In the structural model, we examined the relationship between the three first

TABLE 5
AVERAGE VALUES OF INDEPENDENT AND DEPENDENT VARIABLES:
GUATEMALA FIRMS* AND PERU FIRMS**

Latin American Countries Studies		
Constructs	Guatemala	Peruvian
Independent variables		
PROCSTR	2.227	1.899—lower***
MKTGSTR	2.067	2.046—lower
INFOSTR	2.078	2.220—higher
Dependent Variables		
LCE	2.035	1.969—lower
CSE	2.125	1.783—lower
COMP	2.129	2.069—lower
KMO Measure of Sampling Adequacy	0.900	0.845
Bartlett's test of sphericity	0.000	0.000

*N = 179; **N = 138

*** Adapted from Adapted from: McGinnis, Michael A., John E. Spillan, and Nicholas Virzi (2012), "An Empirical Study Comparing Guatemalan and United States Logistics Strategies," *International Journal of Logistics Management*, Vol. 23, No. 1, pp. 77-95.

*** Scales: 1 = Strongly Agree, 2 = Agree, 3 = Neither Agree nor Disagree, 4 = Disagree, 5 = Strongly Disagree. See COMP-4 for that variable's scale

**** A "lower" value indicates more strongly agree than the Guatemalan data. None of the differences were significant at alpha =0.05.

order factors (PROCSTR, MKTGSTR, and INFSTR). The findings supported the underlying factor structure of the 19 items with correlated factors.

The results of the estimation of the first order factor model (Figure 1) revealed very strong results for all datasets used as indicated by several different measures (χ^2 GUATEMALA =48.65, and χ^2 PERU= 43.81). As suggested by McGinnis, Kohn, and Kara (2011), we allowed two

of the error terms to be correlated. The figures of GFI and CFI, were all larger than or equal to for all three countries (GFI GUATEMALA=0.944; CFI GUATEMALA=0.942; GFI PERU=0.937; CFI PERU=0.953).

The normalized chi-square (chi-square/degrees of freedom) of the CFA model was smaller than the recommended value of 3.0; the RMR was smaller than 0.05, and the RMSEA were smaller than or

FIGURE 1
FIRST ORDER CONFIRMATORY FACTOR ANALYSIS
(GUATEMALA AND PERU)

very close to 0.08 (RMSEA GUATEMALA=0.08 and RMSEA PERU=0.078). Although χ^2 value for two of the datasets were significant, due to the sensitivity of this measure, it was not considered a major concern since the other fit indices showed strong model fit. Accordingly, the results showed that all loadings in the model were significant, leading us to conclude that the relationships between the items and latent factors were confirmed by the three datasets obtained from different countries.

Structural Equation Models

The structural model was used to test the hypotheses of all six factors tested in the measurement model. The hypothesized structural models for three datasets are shown in Figure 2 and 3. Inspection of these exhibits revealed that all linkages were significant and the directions of relationships were as hypothesized for the Guatemala and Peru datasets. The model fits for both datasets were good and above the acceptable levels mentioned in the literature (See Figure 2 and 3).

Overall, both Guatemala and Peru datasets supported the hypothesized relationship directions and strength of the hypothesized relationships. Figures 2 and 3 also display standardized coefficients for the linkages, and r^2 values for the variables. Finally, the values for Chi-square (193.616 AND 166.511), p-value (0.000), GFI (0.866 and 0.875), CFI (0.910 and 0.904), and RMSEA (0.08 and 0.072) indicate a good model fit for both datasets. As we discussed earlier, the Overall Logistics Strategy (OLS) construct is a second-order construct and its three dimensions (MKTGSTR, INFOSTR, and PROCSTR) are first-order factors measured by their respective indicators. Overall, both Guatemala and Peru data supported the hypothesized relationship directions and strength of the hypothesized relationships. The other three data sets (1990, 1994, and 2008) supported the directions of the hypothesized relationship directions and provided faint to modest support of the strength of the model's relationships.

DISCUSSION AND CONCLUSIONS

While Peru and Guatemala share similar histories regarding colonialism, and then independence from Spain; and generally share similar cultures, there are substantial differences regarding the two countries' geographic size, size of economy, make-up of their populations, climate, and infrastructure. These differences suggest that business practices, including logistics/supply chain management strategies, could differ substantially between the two countries. However, the results presented in this research suggest that the logistics/supply chain management strategies of the two countries share more similarities than differences.

Overall, logistics/supply chain management strategies are not greatly affected by substantial geographic, size of economy, population, and climate differences between Peru and Guatemala. These findings are not inconsistent with the findings of other cross-cultural research cited earlier. If confirmed by subsequent research, the findings reported here suggest that logistics/supply chain management strategies may be similar in other Spanish speaking Latin American countries.

The research reported in this manuscript offers opportunities for additional research in Latin America and within other regions of the world. For example, little is known about logistics/supply chain management strategy among countries in South East Asia, the European Union, Japan, and India. Perhaps further research would either further confirm the value of the Bowersox/Daugherty typology or facilitate the development of alternate frameworks that would be applicable across cultures and economies.

The author's summary of both countries fit the OLS→LCE→CSC→COMP model that has been previously tested longitudinally in the United States and cross culturally in Guatemala, Turkey, Ghana, and China. Two conclusions that can be drawn from this research are (a) logistics/supply

FIGURE 2
SEM FOR OVERALL LOGISTICS STRATEGY AND COMPETITIVENESS FOR
GUATEMALA DATA

Chisquare=193.616, p-value=.000, GFI=.866, CFI=.910, RMSEA=.080

FIGURE 3
SEM FOR OVERALL LOGISTICS STRATEGY AND COMPETITIVENESS FOR PERU
DATA

Chisquare=166.511, p-value=.000, GFI=.875, CFI=.904, RMSEA=.072

chain management strategy in Peru is comparable to that found in previous research and (b) both Peruvian and Guatemalan logistics/supply chain management strategies both fit the OLS→LCE→CSC→COMP model well. Additional comparisons reported in the Appendix A show similar, but not identical, patterns of logistics/supply chain management strategies in Peru and Guatemala. In both countries 40-45% of the logistics/supply chain management strategies were Intense, 42-47% of the strategies were Moderate, and 11-13% of the strategies were Passive. The results of this second research approach reinforce the previously stated findings that Peruvian and Guatemalan logistics/supply chain strategies, while not identical, are similar.

When the authors compared the results of Peruvian respondents to the Guatemalan respondents the differences were exhibited in two different ways. First, the means of independent and dependent variables were somewhat lower (Scale: 1 = Strongly Agree to 5 = Strongly Disagree), indicating that the Peruvian respondents placed greater importance on all independent and dependent variables, on average, than did the Guatemalan respondents. The differences in this could be because of the type of managers completing the survey or the perception of logistics that exist among the respondents that were interviewed. The authors decided that these differences did not substantially affect the results shown in Tables 3 and 4. Second, Process Strategy - PROCSTR (focus on controlling costs) was generally considered to be less important (higher average) than Market Strategy – MKTGSTR (management of logistics activities to reduce complexity faced by customers) and Information Strategy – INFOSTR (focus on managing activities to achieve greater inter-organizational coordination and collaboration throughout the channel). This contrasts with the findings of Peruvian logistics managers where PROCSTR was generally more important than MKTGSTR, and MKTGSTR was less important than INFOSTR. A possible explanation for the

difference in the relative order may be due to the perception of supply chain management operations and support services among Peruvian managers when compared with Guatemalan managers. Greater emphasis might be placed on hard measures of performance (PROCSTR). However, the supplemental analysis shown in Appendix A reinforces the authors' conclusion that logistics/supply chain strategies in the two countries are similar.

Overall, the study of logistics strategy in Peru suggests that the approach is fundamentally similar to Guatemala's. In other words, the direction of the relationships among the conceptualized constructs tested in the SEM model were significant and explained a sizable variation in COMP in both countries, which provided additional support for the robustness of the structural model in different cultural environments. However, some differences are apparent. First, the importance of the three independent variables and three dependent variables appear to be stronger to the Peru respondents than Guatemalan respondents. Second, on closer inspection Peruvian logistics data places relatively greater emphasis on information (INFOSTR), coordination (LCE), customer service (CSC), and relatively less emphasis on cost efficiency (PROCSTR) and (MKTGSTR), than Guatemalan managers. Possible reasons include (a) information technology and communication along with fewer competitors may reduce the need to emphasize cost control, and (b) more sophisticated information systems can facilitate better communication, coordination, and customer responsiveness in more sophisticated communication economies. The authors believe that (a) may be the determining reason, since the Peruvian economy ranks 61 on the Global Competitiveness Index, while Guatemala ranks 86 on the same study (World Economic Forum, 2013).

RESEARCH IMPLICATIONS

The results of the analyses and country comparisons in this manuscript provide insight into logistics

strategy in two similar cultures but different economies. A comparison of the results from the Peru and Guatemala data suggest that logistics/supply chain management strategies do not differ substantially. This enabled the authors to make some generalizations regarding Peruvian and Guatemalan logistics/supply chain management strategies.

First, because the two economies are substantially different, the Bowersox/Daugherty typology appears to be an appropriate framework for comparative logistics research. Second, the relationships among the independent variables (PROCSTR, MKTGSTR, and INFOSTR) and the dependent variables (LCE, CSC, and COMP) were similar.

Differences between the findings in Peru and Guatemala studies may be due to size of the economy, size of population and manager's perceptions of logistics and supply chain differences. This suggests that future comparative logistics research should include an understanding of other contributing factors such as size of economy and management perception differences.

For logistics/supply chain management faculty, this research suggests that logistics frameworks, such as the Bowersox/Daugherty typology should not be considered as absolute. Rather, logistics frameworks should be considered as concepts that are likely to vary somewhat with the size of the economy, the nature of the economy (agricultural, industrial, post-industrial), and the culture of the population.

For logistics practitioners, these findings suggest that logistics strategies should consider whether an ethnocentric (do things the way we do it in our country), polycentric (tailor the logistics systems to be unique for each country where business is transacted), or geocentric (a logistics system that blends the needs of each country where business is conducted) approach is appropriate. Each of these approaches may be appropriate in different

situations. The crucial aspect is to consider these three options, and their respective advantages and disadvantages.

For researchers, the Bowersox/Daugherty typology appears to be one framework that can be useful when conducting comparative logistics research. The authors believe that this typology could be a useful tool for understanding logistics strategies in different countries. Further research should continue to assess the value of the Bowersox/Daugherty typology for comparative logistics research and examine differences, and the cause of differences, of logistics strategies between countries or economies.

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APPENDIX A

The purpose of the Appendix is to compare the cluster analysis of Peruvian logistics strategies with a previous assessment of Guatemalan logistics strategies.

Three independent variables were cluster analyzed to ascertain whether Peruvian logistics strategies were homogenous, and if not in what way were they heterogeneous. SPSS 16.0's Two Step Cluster was used in this step. As shown in Table A-1, three logistics clusters, named Intense Logistics Strategy (N=57),

Moderate Logistics Strategy (N=65), and Passive Logistics Strategy (N=16) were identified. As shown in Table A-1, the means of Process, Market, and Information strategies (PROCSTR, MKTGSTR, and INFOSTR respectively) were significantly different, $\alpha < 0.05$, among the three logistics strategy clusters. Post hoc tests did not identify any pairing of independent variables. Post hoc analysis did not identify pairing of dependent variables. Within Clusters 1, 2, and 3 there were no pairs of PROCSTR, MKTGSTR, or INFOSTR that were significant at $\alpha < 0.05$ using the paired t-test of variables. Overall, the means of PROCSTR, MKTGSTR,

and INFOSTR were significantly different at $\alpha < 0.05$.

As a comparison, a similar analysis of Guatemalan data was adapted from McGinnis, Spillan, and Virz (2012) and is presented as Table A-2. Using the same criteria for Intense, Moderate, and Passive Logistics Strategies, it was observed that the percentages of Peru/

Guatemala respondents categorized as Intense Logistics Strategy (41.3/44.1%), Moderate Logistics Strategy (47.1/42.5%), and Passive Logistics Strategy (11.6/13.4%) were similar. The differences in percentages, ranging from 1.8% to 4.6%, did not suggest an underlying difference between logistics/supply chain management strategies between the two countries

TABLE A-1
RESULTS OF CLUSTER ANALYSIS OF INDEPENDENT VARIABLES
PERU RESULTS

Cluster*	PROCSTR Mean/Standard Deviation**	MKTGSTR Mean/Standard Deviation	INFOSTR Mean/Standard Deviation	Paired t-test of Variable Means
1. Intense Logistics Strategy N = 57 41.3%	1.3801/0.33593 High	1.6433/0.46658 High	1.7544/0.48192 High	No variable pairs significant <0.05, 2-tailed test.
2. Moderate Logistics Strategy N = 65 47.1%	2.1333/0.41999 Medium	2.1333/0.28137 Medium	2.3436/0.36309 Medium	No variable pairs significant <0.05, 2-tailed test.
3. Passive Logistics Strategy N = 16 11.6%	2.7917/0.65405 Low	3.1250/0.69788 Low	3.3750/0.88506 Low	No variable pairs significant <0.05, 2-tailed test.
Combined N=138	1.8986/0.63758	2.0459/0.62158	2.2198/0.70394	No variable pairs significant <0.05, 2-tailed test.
Significance***	0.000	0.000	0.000	

*Cluster Classification:

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

Moderate Logistics Strategy: Values of PROCSTR, MKTGSTR, and INFOSTR = 2.000 to 2.999.

Passive Logistics Strategy: One or more values of PROCSTR, MKTGSTR, or INFOSTR = 3.000 or greater.

**Scales: 1 = Strongly Agree through 5 = Strongly Disagree.

***Variable means tested using Duncan post hoc test.

Next, the means of dependent variables Logistics Coordination Effectiveness (LCE), Customer Service Commitment (CSC), and Company/Division Competitiveness (COMP) were tested for significant differences among the three logistics strategy clusters. As shown in

Table A-3, LCE, CSC, and COMP were each significantly different, $\alpha < 0.05$, among the clusters.

Post hoc analysis did not identify pairing of dependent variables. Within Clusters 1, 2, and 3

TABLE A-2
RESULTS OF CLUSTER ANALYSIS OF INDEPENDENT VARIABLES
GUATEMALA RESULTS¹

Cluster*	PROCSTR Mean/Standard Deviation**	MKTGSTTR Mean/Standard Deviation	INFOSTR Mean/Standard Deviation	Paired t-test of Variable Means
1. Intense Logistics Strategy N = 79 44.1%	1.7426/0.41671 Highest	1.4895/0.35740 Highest	1.5063/0.40240 Highest	PROCSTR significant <0.05, 2-tailed test from MKTGSTTR and INFOSTR.
2. Moderate Logistics Strategy N = 76 42.5%	2.4430/0.61917 Medium	2.219/0.42760 Medium	2.2061/0.56560 Medium	PROCSTR significant <0.05, 2-tailed test from INFOSTR.
3. Passive Logistics Strategy N = 24 13.4%	3.1389/0.51935 Lowest	3.3194/0.54266 Lowest	3.5556/0.63449 Lowest	PROCSTR significant <0.05, 2-tailed test from INFOSTR.
Combined N=179	2.2272/0.71319	2.0670/0.74063	2.0782/0.82917	PROCSTR significant <0.05, 2-tailed test from MKTGSTTR and INFOSTR.
Significance***	0.000	0.000	0.000	

NOTE: Percentages do not add to 100 due to rounding

*Cluster Classification:

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

Moderate Logistics Strategy: Values of PROCSTR, MKTGSTR, and INFOSTR = 2.000 to 2.999.

Passive Logistics Strategy: One or more values of PROCSTR, MKTGSTR, or INFOSTR = 3.000 or greater.

**Scales: 1 = Strongly Agree through 5 = Strongly Disagree.

***Variable means tested using Duncan post hoc test.

¹Exhibit A-2 was adapted from McGinnis, Spillan, and Virzi. (2012)

there were no pairs of LCE, CSC, or COMP that were significant at $\alpha < 0.05$ using the paired t-test of variables. Overall the means of LCE, CSC, and COMP were significantly different at $\alpha < 0.05$. The following paragraphs discuss the findings based on the analysis. An inspection of LCE, CSC, and COMP in the three clusters for both countries found that the values

for Intensive Logistics Strategy differed very little. However, in all three strategies the data indicated that CSC was substantially more important (lower average values) in Peru with differences of LCE and COMP being slight.

These results were consistent with the results of previous Guatemalan data shown in Table A-4

TABLE A-3
RESULTS OF CLUSTER ANALYSES:
WITH DEPENDENT VARIABLES
PERU RESULTS

Cluster*	LCE Mean/Standard Deviation**	CSC Mean/Standard Deviation	COMP Mean/Standard Deviation	Paired t-test of Variable Means
1. Intense Logistics Strategy N = 57 41.3%	1.6842/0.45172	1.5439/0.40645	1.7807/0.48658	No variable pairs significant < 0.05 , 2-tailed test.
2. Moderate Logistics Strategy N = 65 47.1%	2.0103/0.44084	1.8718/0.41538	2.1577/0.55299	No variable pairs significant < 0.05 , 2-tailed test.
3. Passive Logistics Strategy N = 16 11.6%	2.8125/0.94256	2.2708/0.64657	2.7344/0.7771	No variable pairs significant < 0.05 , 2-tailed test.
Combined N=138	1.9686/0.62379	1.7826/0.49923	2.0688/0.62911	No variable pairs significant < 0.05 , 2-tailed test.
Significance***	0.000	0.000	0.000	

*Cluster Classification:

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

Moderate Logistics Strategy: Values of PROCSTR, MKTGSTR, and INFOSTR = 2.000 to 2.999.

Passive Logistics Strategy: One or more values of PROCSTR, MKTGSTR, or INFOSTR = 3.000 or greater.

**Scales: 1 = Strongly Agree through 5 = Strongly Disagree.

***Variable means tested using Duncan post hoc test.

Overall, Peruvian logistics can be summarized as grouping into three distinct overall strategies. This result is not inconsistent with earlier in the United States (McGinnis, Kohn, and Spillan, 2010), Guatemala (McGinnis, Spillan, and Virzi, 2012), and China (Spillan, McGinnis, Kara, and

Liu Yi (2013). Based on the analysis presented in this appendix the authors concluded that logistics/supply chain management strategies in Peru are not fundamentally different than those observed in Guatemala and in other countries studied in previous similar research.

TABLE A-4
RESULTS OF CLUSTER ANALYSES:
WITH DEPENDENT VARIABLES
GUATEMALA RESULTS¹

Cluster*	LCE Mean/Standard Deviation**	CSC Mean/Standard Deviation	COMP Mean/Standard Deviation	Paired t-test of Variable Means
1. Intense Logistics Strategy N = 79 44.1%	1.6582/0.62012	1.7468/0.57044	1.7563/0.43111	No variable pairs significant <0.05, 2-tailed test.
Moderate Logistics Strategy N = 76 45.2%	2.1096/0.61677	2.2193/0.69826	2.2993/0.75169	No variable pairs significant <0.05, 2-tailed test.
2. Passive Logistics Strategy N = 24 13.4%	3.0417/0.92372	3.0694/0.83971	2.8125/0.68465	No variable pairs significant <0.05, 2-tailed test.
Combined N = 179	2.0354/0.80066	2.1248/0.79162	2.1285/0.71910	No variable pairs significant <0.05, 2-tailed test.
Significance***	0.000	0.000	0.000	

*Cluster Classification:

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

Moderate Logistics Strategy: Values of PROCSTR, MKTGSTR, or INFOSTR = 2.000 to 2.999.

Passive Logistics Strategy: One or more values of PROCSTR, MKTGSTR, or INFOSTR = 3.000 or greater.

**Scales: 1 = Strongly Agree through 5 = Strongly Disagree.

***Variable means tested using Duncan post hoc test.

¹Table A-4 was adapted from McGinnis, Spillan, and Virzi. (2012)

PARCEL SHIPPING: UNDERSTANDING THE NEEDS OF BUSINESS SHIPPERS

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ABSTRACT

Research on carrier selection addresses how shippers choose carriers. To date, this extensive research stream has not adequately addressed a known and significant shipping segment: business parcel shippers. In this research, input from 374 business parcel shippers was captured and analyzed using Maximum Difference Scaling. The respondents were asked to evaluate the importance of 17 carrier selection variables in regard to choosing a parcel carrier. The overall results indicate that delivery promises, transit times, rates, pick-up promises, and tracking are the most important attributes when a parcel shipper makes a carrier selection. In addition, the results of attribute importance were used to classify the parcel shippers into four unique segments.

INTRODUCTION

The parcel shipping market, which is commonly characterized as shipments of up to 150 pounds (Burks et al., 2004), has grown substantially over the last decade. Data from the Commodity Flow Survey, issued by the U.S. Census Bureau in conjunction with the U.S. Department of Transportation, reveals that in the ten year period from 2002 to 2012, the parcel mode of transportation grew by 59% to nearly \$1.6 trillion worth of goods shipped between U.S. businesses (2013; 2010). Comparatively, over the past 25 years, the parcel shipping industry has greatly outperformed the less-than-truckload (LTL) industry in terms of growth (Jindel, 2010).

Three primary factors have driven the substantial growth of the parcel shipping industry. First, U.S. retail e-commerce sales grew by 406% to \$224 billion between 2002 and 2012, greatly expanding the need for parcel shipping (U.S. Department of Commerce, 2013). Second, changes to manufacturing and inventory processes have created increased volume of smaller, more frequent parcel deliveries. Finally, parcel carriers have increased their maximum shipment weights from 70 pounds to 150 pounds

and developed pricing innovations to convert LTL freight (Haber 2013; Jindel 2010).

Although the parcel shipping market has grown substantially, academic research on this topic has not. Carrier selection research is one of the most researched topics in logistics (e.g., McGinnis, 1979; Abshire & Premeaux, 1991; Voss et al., 2006). Yet, in this wide stream of research, business parcel carrier selection has received almost no attention. This dearth of research is a problem for a number of reasons. First, the size and growth of the parcel shipping market is substantial. Second, academic research has suggested that carrier selection is specific to the mode (truckload or TL, LTL, etc.), as each mode's customers likely have their own unique needs (Kent et al., 2001). Without a better understanding of the specific needs of parcel shippers, parcel carriers cannot develop the best service solutions for their customers.

The purpose of this research study is to examine the preferences and characteristics of business parcel shippers. More specifically, the study will answer the following questions:

1. What is the relative importance of carrier selection variables that business parcel shippers consider when choosing a parcel carrier?
2. Based on the importance of selection variables, can business parcel shippers be segmented according to the importance of these variables?

To pursue answers to these research questions, a brief literature review of parcel shippers and carriers is presented. Next is a discussion of the research design and method employed in this study, followed by a presentation of the results. This is followed by the discussion and implications. Finally, future research and study limitations are presented.

LITERATURE REVIEW

At the outset of the study, a literature review of parcel markets was undertaken to understand the respective requirements of parcel shippers and capabilities of parcel carriers. This effort revealed a dearth of parcel research relative to the number of studies focusing on LTL and TL transportation. Within the parcel sector, the research highlights the growing demand for parcel transportation. Less attention has been paid to shipper needs or carrier service offerings.

Parcel Shipping Demand Drivers

Shipping methods are often dictated by a firm's operational strategies and the purchasing practices of buyers. In the case of parcel shipping, changes in the way goods and services are produced and distributed contribute to the growing importance of this method. In particular, the adoption of lean inventory principles, the use of just-in-time (JIT) manufacturing and customized mass production, and the dramatic growth of e-commerce activity are key contributors to the growth of parcel shipping (Morlok et al., 2000).

In a lean operating environment, excessive inventory is considered waste (Liker, 2004; Vokurka and Lummus, 2000). A major

challenge is the trade-off between decreased inventory levels due to small batch sizes and increased transportation costs resulting from frequent deliveries (Chen and Saker, 2010). To lower total cost in a lean operation, managers must allow for trade-offs between inventory, material handling, storage, transportation, etc. Thus, managers are likely to ship smaller batches using parcel carriers or work with freight forwarders and consolidators (Myerson, 2012).

Arcelus and Rowcraft (1993) highlighted the link between the JIT manufacturing movement and an increased need for parcel shipments. JIT is an order pull system based on actual demand and consumption that attempts to minimize inventory levels and shorten lead times. As a result, smaller, more frequent orders are required and firms become much more reliant on rapid replenishment and expedited delivery, capabilities that parcel carriers excel in. Similarly, one-off production of personal computers, footwear, and clothing drives direct delivery to end users (Andrews, 1998). Again, parcel shipping is a logical delivery solution.

The evolution of consumer buying practices has led to significant growth in parcel shipping activity. Christopher Jr. (2011) notes that e-commerce has been the fastest growing trade sector since 1999 and was largely unaffected by the global economic downturn. At the height of the recession in 2009, e-commerce activity actually increased, allowing many parcel carriers to remain profitable (Andrews, 2011). US retail e-commerce sales reached \$263 billion in 2013 and will continue to increase at an annual rate of 13.7% through 2017, when sales are expected surpass the \$440 billion mark (emarketer, 2014). This growth has driven demand for parcel transportation, to the point of taxing the carriers' network capacity during peak holiday demand (Stock, 2013).

Although heavy attention has been given to the rapid growth of business-to-consumer (B2C) e-commerce activity, it is a fraction of business-to-business (B2B) e-commerce activity. Laudon

and Traver (2012) expect a \$1.1 trillion increase in B2B e-commerce sales, rising from \$3.3 trillion in 2011 to \$4.4 trillion in 2015. This growing B2B activity is further driving demand for parcel shipping service and is leading to rate increases in the form of higher minimum charges (Burnson, 2014).

Finally, changing retail strategies are fueling parcel transportation's growth. Subscription based services like Amazon Prime allow consumers and small businesses to place small orders without incurring charges for second day delivery (Anderson, 2014). A strategic shift to smaller store sizes with lower in-store SKU variety drives the need for home delivery of SKUs that are offered only online (Gustafson, 2014). And, liberal e-commerce return policies with free shipping lead to high return rates which Sarkis et al. (2004) estimate at greater than 30%.

Parcel Shippers' Needs

Recent research purports to show the need for carriers to focus on shipper's most important needs (e.g., Dobie 2005). Understanding shipper needs is a key prerequisite for carriers to develop, implement, and refine customer driven strategy (LeMay, 1986; Coulter et al., 1989 Lambert et al., 1993). Despite the growing activity and importance of the parcel shipping market, the literature review yielded only two research studies that specifically focused on the needs of parcel shippers.

Ding, et al. (2005) developed a fuzzy multi-criteria decision-making model to support the selection of suitable Taiwanese courier service providers. Six primary criteria were included: speed and reliability; freight rates; safety; sales staff; service and convenience; and, carrier considerations. Thirty sub-criteria of interest to parcel shippers were used by this model to systematically appraise and rank four parcel carriers.

Lin and Lee (2009) identified seven factors that are important in choosing parcel carriers when

firms and consumers are selling products in an online environment. The researchers found that the following factors were important when choosing a parcel carrier:

- On-time, tracking, and quick response,
- Fare rate and freight loss,
- Security and reputation,
- Personnel courtesy and quality,
- Equipment, package, and flexible service,
- Diversified service,
- Promotion and reputation.

These studies took important steps in identifying parcel shipping customers as a known and unique segment of the transportation market. The current research seeks to extend the prior research and further answer questions regarding the needs of parcel shippers.

Parcel Carriers' Capabilities

Much academic literature has been focused on various motor carrier markets, including LTL (Jarrah et al., 2009; Lin et al., 2009; Barcos et al., 2010; and Hernandez et al., 2011) and truckload (TL) (Kent and Smith, 2005; Ergun et al., 2007; Liu et al., and 2010; Pai, 2011). However, many distinct differences exist for motor carriers that operate in the parcel environment that necessitates independent study of this market segment.

Parcel shipping has been hailed by Morlok et al. (2000) as a major element of the U.S. transportation system that is essential to modern commerce. From a service standpoint, these authors state that parcel carriers are at the forefront of modern transportation services. Parcel carriers are industry leaders due to their differentiated time-definite service options, intermodal service, in-transit visibility, and data integration with the management systems of customers.

Parcel carriers also have an order processing advantage over other motor carriers. FedEx Ground receives more than 95 percent of all packages via electronic manifest. When

manifests are communicated electronically, parcel carriers gain knowledge of shipments early and create more efficient loads. Additionally, parcel carriers have advantages in terms of accurate billing. Finally, parcel carriers capture the dimensions and weight of every package, whereas LTL carriers typically rely on customer input for weight and classification (Jindel, 2010).

Given the current state of the parcel shipping literature, additional study is warranted. The current study will extend the knowledge base by investigating the alignment of parcel carrier capabilities with the needs of parcel shippers. Poor alignment can result in resources being wasted on unneeded service elements while important service attributes go unfulfilled.

METHODOLOGY

Maximum difference scaling (MD) is a discrete choice survey method that asks survey respondents to choose the most and least important items from a set of options. MD allows a large number of items to be traded off against each other in an efficient manner, which is independent of any rating scale bias. Additionally, MD produces a needs based segmentation, allowing priorities to be estimated for any subgroup (Cohen, 2003). Given these capabilities, it is well suited to the research objectives of this parcel shipping study. MD is gaining attention from academic researchers and practitioners (e.g., Cohen and Orme, 2004; Garver, 2009; and, Williams et al., 2011). Another study identified MD as the method that delivered the most valid results when conducting importance research (Chrzan and Golovashkina, 2006). Moreover, Garver et al. (2010) recommend MD as it has key distinct advantages over other methods, particularly rating scales. Traditional rating scales do not force choices, thus respondents may be free to select everything as important for example.

Research Process

Variables

To determine the appropriate attributes for parcel carrier selection, the carrier selection literature was thoroughly reviewed. Next, the researchers met with industry experts to make sure that the relevant attributes were identified and that these attributes were phrased appropriately. This process resulted in a final list of attributes that is aligned with the logistics academic literature, yet also has relevance to logistics professionals.

Once the list of attributes was developed, the researchers chose to include five attributes per MD survey question, a common MD best practice (Chrzan and Patterson, 2006). The next step in the MD experimental design stage was to determine the overall number of MD survey questions that should be presented to study respondents. Following the guidelines put forth by Garver et al. (2010), each research participant was asked 11 questions. The experimental design plan in the current study led to each attribute being shown approximately three times each to survey respondents.

The actual MD survey questions were developed after the experimental design plan was created, with each question containing the following instructions:

“Please consider how important different attributes are when selecting a parcel carrier. Considering only these 5 features, which is the Most Important and which is the Least Important?”

For each of the 11 MD questions, the research respondents were asked to select the “most important” and the “least important” attribute.

Data Collection

Data for this study were collected from a business research panel. Members of the panel came from a leading market research firm called MarketTools. The choice to use an online panel as a data source follows numerous other supply chain and logistics researcher’s use of this

approach (e.g., Autry et al. 2008; Jack et al. 2010; Richey et al. 2010; and, Grawe et al. 2011).

When using online panels as a data source, researchers have taken a series of additional steps to validate knowledge and skills of respondents (e.g., Autry et al., 2010) and this study implemented those as well. First, MarketTools, was hired to provide the online panel. Second, filter questions were added to the survey in order to screen out panelists who did not fit the appropriate respondent profile. Figure 1 demonstrates how these individuals were eliminated from the respondent pool. As a result,

only logistics practitioners with extensive parcel shipping knowledge and buying influence are included in the final data set for analysis.

Data Cleansing

Four hundred twenty (420) completed surveys were collected. However, after excluding respondents with incomplete surveys, respondents lacking the necessary expertise, or those respondents who incorrectly answered embedded trap question, 374 valid and complete surveys were retained for analysis. When conducting MD research, a minimum of 100 data points are recommended

**FIGURE 1
PARTICIPANT SCREENING PROCESS**

SCREENING CRITERIA

(Garver, et al., 2010). The final data set greatly exceeds this benchmark.

Data Analysis

Sawtooth software (7.0) was used to collect and analyze the MD data. Specifically, Hierarchical Bayes estimation was implemented to study the MD data. A MD study provides results which can be used to derive need-based segments, which is one of the objectives of the current study (Orme, 2005; Orme, 2005b; Garver, 2009; Garver et al, 2010).

RESEARCH RESULTS

General properties of the sample will first be discussed, then the MD results will be presented. followed b

segments identified using latent class cluster analysis. Then, results from classification trees, ANOVA, and cross-tabulation analysis will be presented to describe the nature of each segment.

MD Parcel Selection Attribute Importance Results

A common practice in MD research is to rescale Hierarchical Bayes analysis results so that the importance scores assigned to all attributes sum to 100 points, with higher scores reflecting greater importance of the attribute. This means that the importance scores of one attribute should be interpreted in relative, not absolute, terms (e.g., an importance score of 10 is greater than 5, but not twice as great). Table 1 contains

TABLE 1
PARCEL CARRIER SELECTION ATTRIBUTE IMPORTANCE

Parcel Carrier Selection Attributes	MD Score	Cumulative MD Score	Rank
Delivers shipments when promised	15.8	15.8	1
Transit time (speed)	12.1	27.9	2
Competitive rates	11.8	39.7	3
Picks up shipments when promised	11.5	51.2	4
Effective tracking systems	10.6	61.8	5
Availability of service	8.9	70.6	6
Ability to adjust to customer's needs	5.5	76.2	7
Invoice accuracy	5.2	81.4	8
Overall reputation of carrier	4.5	85.9	9
Security practices	4.0	89.9	10
Damage record	2.5	92.4	11
Financial stability	2.1	94.5	12
Website usefulness	1.8	96.3	13
Claims processing	1.5	97.8	14
Sustainability practices	0.8	98.5	15
Relationships with carrier personnel	0.8	99.3	16
Information sharing capabilities	0.7	100.0	17

the MD mean importance scores for the parcel carrier selection attributes.

Several observations should be made about Table 1. First, there is discrimination among the different parcel carrier selection attributes (Garver et al, 2010; Williams et al, 2011), with importance scores ranging from 0.68 to 15.77 (Table 1). Second, the scores of the six attributes having the greatest importance scores sum to 70.6, which means these collectively account for just over 70% of the total importance in parcel carrier selection by customers. Third, four attributes having greatest importance in parcel carrier selection – Delivers shipments When Promised (15.77), Transit Time (speed) (12.14), Competitive Rates (11.78), and Picks-up Shipments When Promised (11.46) – account for 51% of the total importance of attributes that influence the choice of parcel carriers by shippers.

Fourth, several attributes that have received much attention from practitioners and academics received relatively low importance scores. Specifically, security practices (4.0) and sustainability (.8) were ranked 10th and 15th, respectively, in terms of their importance in the parcel carrier selection process, while information sharing (.7) was the least important to business customers.

Finally, while mean responses are of some assistance in interpreting empirical results, they can be misleading (Garver, 2009; Garver et al., 2010; Williams et al., 2011). Garver (2010) suggested that researchers should examine need-based segments (if they exist) in order to truly understand customers in the marketplace. Accordingly, this analysis was next undertaken, the results of which are reported below.

Identification of Parcel Need-Based Segments

Latent Class Cluster Analysis (LCCA)

Latent class cluster analysis (LCCA) was used to determine whether meaningful, unique need-based segments exist in the sample used in this study. Research over the last decade has shown

that LCCA has distinct advantages over more traditional methods of cluster analysis (Vermunt and Magidson, 2005). Research has shown that LCCA has improved predictive capabilities over more traditional clustering techniques (Vermunt and Magidson, 2003).

Furthermore, LCCA assists researcher by supplying researchers with fit statistics that guide the selection of the appropriate number of segments. Finally, LCCA provides probabilities of segment membership, which is helpful in determining how well the technique has worked in segmenting the market (Garver, et al., 2008)

The researchers employed Latent Gold 4.0 to conduct the analysis. Each of the 17 MD parcel carrier selection attributes was entered into LCCA as continuous attributes to develop the segmentation results. Garver, et al. (2008) suggest that most segmentation studies examine up to five segments, since it is difficult for most practitioners to focus on more than five segments. With this in mind, the researchers ran the following cluster analysis models for consideration evaluation: a one cluster, a two cluster model, and so on. In total, six different models were evaluated (up to a six cluster solution).

The researchers used the random seed default in the program, which randomly selects ten different starting points for each analysis. This procedure overcomes the potential limitation of LCCA models to produce a local solution as opposed to a global maximum.

Number of Segments - Evaluation and Selection - LCCA

The first goal of this analysis was to determine if need-based segments of parcel carrier customers exist, or whether the marketplace of parcel carrier customers is homogeneous in terms of the importance attached to the parcel carrier selection attributes. If the sample is homogeneous, then the interpretation of mean (overall) importance scores is valid. However, if need-based segments do exist, the first goal is to

determine the appropriate number of need-based segments. Selecting the appropriate number of segments is a critical task in LCCA.

Accordingly, the latent class model evaluation strategies identified by Garver, et al. (2008) were adapted for LCCA in this study. Similarly, the following “best practices” for determining the appropriate number of segments within LCCA were followed (Vermunt and Magidson, 2005):

- 1) Goodness of fit measures
- 2) Misclassification error
- 3) Theoretical knowledge, expertise, and researcher judgment.

Goodness of fit Measures

The BIC is the most popular goodness of fit measure for assessing LCCA models (Arunotayanun and Polak, 2011), especially when the data are sparse, the situation for most logistics research studies (Garver et al., 2008). One reason for this popularity is that the BIC measure simultaneously explains model fit while accounting for model parsimony. Typically, a model with a lower BIC value is preferred over one with a higher BIC value (Guerrero, Egea, and Gonzalez 2007; Wen, et al., 2012).

The researchers first specified and analyzed several models, estimating a 1, 2, 3, 4, 5, and 6-

segment model, using the 1-segment model as the baseline. If the 1-segment model has the lowest BIC score, then there is evidence that the parcel carrier market is homogeneous with respect to the importance placed on parcel carrier selection attributes. Table 2 provides critical results for evaluating model fit and selecting the appropriate number of segments.

Based on the goodness of fit measure, the 6-segment model is most appropriate as it has the lowest BIC value (17435). In contrast, the BIC measures for the 1, 2, and 3 segment models are significantly higher than that of the 6-segment model, yet the BIC scores for the 4 and 5-segment model are relatively close.

The classification errors provide strong support for a 4-segment model. By definition, a 1-segment model will have no classification errors. However, as the number of segments increase, so does the probability of classification errors. For example, all else being equal, a 4-segment model should have a higher classification error than a 3-segment model. However, in this study, the 4-segment model actually has fewer such errors relative to the 3-segment model. Additionally, the 5 and 6-segment models have relatively high classification errors, relative to 4-

TABLE 2
LATENT CLASS SEGMENT EVALUATION SELECTION

Number of Segments	BIC	Classification Error
1 Segment Model	32111	0
2 Segment Model	29154	0.0162
3 Segment Model	28382	0.0268
4 Segment Model	28026	0.0265
5 Segment Model	27848	0.0415
6 Segment Model	27804	0.0436

segment model. Assessing classification errors lend strong support for a 4-segment model.

The fit indices and the classification errors result in a conflict concerning the appropriate number of segments. Thus, the researchers relied upon guidelines put forth by Garver, et al. (2008) as well as theoretical judgment to determine the appropriate number of segments.

From a practical standpoint, Garver et al. (2008) suggest limiting the number of segments to five or less segments. Aligned with practitioner guidelines, firms often have trouble on comprehending, understanding, and focusing on more than five segments.

From a theoretical standpoint, the 4-segment model has clearer theoretical implications for academic researchers and practitioners. After examining the 4 and 6-segments models the 6-segment model does not provide true theoretical differentiation among the segments. More specifically, the 6-segment does not truly show different segments, and the results are redundant. In addition, the 4-segment demonstrates more parsimony, a goal of all scientific endeavors. With this in mind, in addition to the classification errors, the 4-segment model was selected as most appropriate.

For the 4-segment model, each of the clusters was of substantial size and the parameter estimates demonstrate that each cluster has a unique and meaningful nature, because the values are significantly different across the other segments. The MD scores for the 4-segment model will now be explained.

Parcel Need-Based Segment Results: Unique and Different Segments

At this time, differences among segments will be discussed first, followed by the actual size of each segment. Finally, attribute importance scores for each segment will be discussed, which will demonstrate the nature of each segment.

Unique and Different Segments

Before the segment attribute importance scores are discussed, it is important to demonstrate that the four need-based segments are unique and significantly different from one another. To accomplish this goal, the Wald statistic is used within LCCA. As can be seen in Table 3, all of the 17 MD attributes show a significance level for the Wald statistic, which suggests that these 17 attributes are significantly different across the four segments and that these attributes are meaningful predictors ($p < .05$) of driving segment membership. Essentially, each of the 17 attributes has a significantly different attribute importance score across the four segments.

In addition to the Wald statistics and related p -values, R^2 values indicate the amount of variance that is explained by each parcel carrier selection attributes for each of the four different segments. The R^2 values are a guide to suggesting which attributes are most important in determining segment membership. For example, the top five attributes that are the most important attributes to determine segment membership include:

- sustainability practices,
- transit time,
- financial stability,
- website usefulness, and
- information sharing capabilities.

Table 4 summarizes the importance scores for each attribute for each segment.

Overall View of the Segments

Segment 1: The Essentials Segment

Segment 1 tends to focus on those critical attributes that are the foundation of parcel services. Segment 1 places the most importance on the following attributes.

- Delivers shipments when promised
- Transit time (speed)
- Competitive rates
- Picks up shipments when promised
- Effective tracking systems
- Availability of service

In addition, Segment 1 places significantly more importance on these attributes than other parcel carrier segments. Segment 1 is the most price sensitive segment, yet also placing the highest priority on transit time speed.

Segment 2 – Dependability Segment

While Segment 2 places high priority on the basics of parcel carrier shipping services

(delivered when promised, transit time, etc.), this segment is different from other segments because they place more importance on the following attributes:

- Availability of service
- Ability to adjust to customer's needs
- Invoice accuracy
- Overall reputation of carrier
- Security practices
- Damage record

TABLE 3
SIGNIFICANT DIFFERENCE FOR MD PARCEL
CARRIER SELECTION ATTRIBUTES

	Wald	p-value	R²
Sustainability practices	166.3	0.000	0.45
Transit time (speed)	174.6	0.000	0.34
Financial stability	99.8	0.000	0.32
Website usefulness	168.0	0.000	0.29
Information sharing capabilities	92.9	0.000	0.29
Claims processing	113.3	0.000	0.25
Delivers shipments when promised	62.2	0.000	0.24
Security practices	114.1	0.000	0.22
Damage record	81.5	0.000	0.19
Relationships with carrier personnel	40.4	0.000	0.16
Competitive rates	49.3	0.000	0.12
Invoice accuracy	47.5	0.000	0.11
Effective tracking systems	41.8	0.000	0.10
Ability to adjust to customer's needs	43.3	0.000	0.09
Picks up shipments when promised	29.8	0.000	0.09
Overall reputation of carrier	17.1	0.001	0.04
Availability of service	9.1	0.028	0.03

Relative to other segments, Segment 2 places the highest amount of importance on issues that attest to the parcel carrier's overall dependability: availability of service, ability to adjust to customer's needs, invoice accuracy, and overall reputation of the carrier. In essence, Segment 2 is defined by these differentiating

attributes that engender customer trust in the carrier's important capabilities.

Segment 3 – Tech Segment

Segment 3 is very similar to segment 1, yet one key difference can be noted. Examining similarities first, Segment 3 places significantly

TABLE 4
SEGMENT IMPORTANCE SCORES

Parcel Carrier Selection Attributes	Segment 1	Segment 2	Segment 3	Segment 4
Delivers shipments when promised	16.7	15.7	16.5	13.2
Transit time (speed)	15.0	11.1	13.1	7.0
Competitive rates	13.9	10.1	12.9	9.2
Picks up shipments when promised	12.7	11.0	12.0	9.0
Effective tracking systems	11.9	9.5	11.2	9.1
Availability of service	9.4	9.4	8.2	7.8
Ability to adjust to customer's needs	5.4	7.0	3.3	5.8
Invoice accuracy	4.6	6.8	3.7	5.7
Overall reputation of carrier	3.4	5.3	4.7	5.3
Security practices	1.8	4.8	3.4	7.5
Damage record	1.5	3.5	1.6	3.9
Financial stability	0.9	2.3	1.2	5.4
Website usefulness	1.5	0.2	4.7	1.5
Claims processing	0.8	2.1	1.0	2.5
Relationships with carrier personnel	0.2	0.2	1.2	2.4
Sustainability practices	0.2	0.6	0.4	2.8
Information sharing capabilities	0.2	0.4	0.7	1.9
SIZE OF SEGMENT (%)	34%	29%	20%	17%

higher importance on the following attributes, which is consistent with segment 1:

- Delivers shipments when promised
- Transit time (speed)
- Competitive rates
- Picks up shipments when promised
- Effective tracking systems

In addition, Segment 3 places significantly higher importance on “usefulness of the website” (4.7). Thus, given the significantly higher importance placed on tracking and website, the researchers conclude that this segment is more information driven.

Segment 4 – Balanced Segment

Segment 4 is very different from the other segments. First, Segment 4 possesses more balance in the importance placed on a wide number of parcel carrier selection attributes. Second, they place significantly more importance than the other segments on the following attributes:

- Overall reputation of carrier
- Security practices
- Damage record
- Financial stability
- Relationships with carrier personnel
- Sustainability practices
- Information sharing capabilities

Three observations can be noted. First, Segment 4 places much more importance on image related attributes such as overall reputation, financial stability, and track record of damage. Second, this segment places much more importance on recent trends such as sustainability and security. Finally, this segment is more information focused, placing higher importance on relationship with carrier personnel and information sharing capabilities.

DISCUSSION

The results indicate that business parcel shippers consider the following attributes to be most important when choosing a parcel carrier: delivers shipments when promised, transit time, and competitive rates. While not significantly

important to all parcel shippers, a number of attributes were important in determining segment membership, such as sustainability practices, information sharing capabilities, and website usefulness. Latent class cluster analysis identified four different business parcel shipper segments that were based on the importance attribute of discernible variables. The resulting four-segment model, with its unique nature, was the most theoretically sound and parsimonious model of all models tested.

While there are significant differences in attribute importance, the results also indicate commonalities across segments. For example, the six most important attributes (delivers shipments when promised, transit time, competitive rates, picks up shipments when promised, effective tracking systems, and availability of service) are generally the most important attributes to each segment. However, concerning the six most important attributes, there are significant differences in the level of importance across the segments. Hence, the parcel shipping business should not be viewed as a single homogeneous market. Certain attributes are significantly more important to various segments that emerged among parcel shippers.

The Essentials Segment (Segment 1) focuses on basic performance considerations: delivering when promised, transit time, competitive rates, picks ups, tracking, and service availability. It is interesting to note that The Essentials is the most price sensitive segment, yet also places the highest priority on transit time.

Relative to other segments, the Dependability Segment (Segment 2) places the highest amount of importance on dependability concerns: availability of service, ability to adjust to customer’s needs, invoice accuracy, and overall reputation of the carrier. Likewise, the Dependability Segment places significantly more importance on their shipments being secure and damage free.

The Tech Segment (Segment 3) resembles The Essentials except that The Tech Segment places greater emphasis on website usefulness. Thus, given the significantly higher importance placed on website, the researchers conclude that this segment might be more driven by technology and information.

Regarding the Balanced Segment (Segment 4), this segment places much more importance on image related attributes such as overall reputation, financial stability, and track record of damage. The segment membership also places much more importance on recent trends such as sustainability and security. Finally, the Balanced Segment is more information-focused, placing higher importance on relationship with carrier personnel and information sharing capabilities.

CONCLUSIONS

The findings in this research provide several valuable contributions to transportation literature. Parcel carriers transport a considerable volume of high value goods each year. Due to the growth and complexity of the parcel sector, carriers must have a greater understanding of business shipper needs in order to be successful. This includes the ability to objectively segment parcel customers into logical groups.

Latent class analysis is a quantitative approach that is useful in finding patterns of heterogeneity “related to characteristics of the choice situation and characteristics of the shipper” (Arunotayanun and Polak, 2011, p. 147) to identify segments of shippers (i.e., customers) that share a common logistics service profile. Latent class cluster analysis results stemming from this research categorized parcel shippers into four distinct segments and identified six important attributes (delivers when promised, transit time, competitive rates, picks up when promised, effective tracking, and service availability) that emerged among the different shipper segments. Academics and practitioners using the more common practice of treating

shippers as a homogeneous entity would have obscured these results.

Second, the empirical findings support the view that a one-size-fits-all (single segment) supply chain strategy cannot adequately meet all customer needs and expectations (Anderson et al., 1997). In addition, the findings illustrate opportunity for carriers (managers) to move beyond conventional service segments by taking a quantifiable need-based approach in understanding and managing shippers. Results indicate that there are segments of parcel shippers, like the Balanced Segment above, that are not as sensitive to time as other shipper segments, so perceptive carriers would benefit by designing an efficient logistics service operation that is reputable and secure and utilizes sustainable practices like consolidation to best serve customers.

These results are consistent with Barratt’s (2004) assertion that:

“If customers can be segmented by way of their buying behaviour and service needs, then separate supply chains can be designed to meet the specific needs of the various customer segments. Each supply chain will require a different strategy and a different culture to support that strategy” (Barratt, 2004, p. 34).

Carriers that accurately identify shipper segments can provide a “portfolio of services” that correctly meets the specific needs of each segment (Anderson et al., 1997). By predicting shipper desires and behaviors and placing shippers into optimal segments, carriers can adjust their marketing strategy, clarify their marketing message, and align their logistics operations to better target and serve each segment. Better aligned services have the potential to reduce operating costs and increase profit margins.

Third, recent research in logistics/supply chain management has called for using innovative, advanced research methods and statistical

methods. This study attempted to answer that call in several ways. First, maximum difference scaling (MD) was used to advance our understanding of the importance of a broad set of variables in terms of carrier selection. These results were then subjected to latent class cluster analysis and then to decision tree analysis. As a result of this multi-method analysis, the story that emerges from the data is different from prior research in this topic area. This represents an important step forward in understanding how shippers select motor carriers. Future research should examine logistics service models using MD attribute importance scores and latent class analysis to more accurately identify and address the unique needs of critical customer segments.

Future research is also needed to corroborate the different segments that manifested in this research. Furthermore, identifying additional attributes and descriptors for the different segments would provide better understanding of parcel shipper segments. The segment descriptors are key parcel carrier marketers being able to target different marketing mixes to each target segment, so further research is needed to better describe the demographic characteristics of each of these business segments. Other sectors of transportation service, namely truckload and LTL, might also consist of need-based shipper (customer) segments. Previous research has generally assumed that these sectors are homogenous, whereas this research and others like it (e.g., Arunotayanun and Polak, 2011) that examine shipper preferences suggest further investigation into possible heterogeneity.

In conclusion, while it is still of practical importance to pay close attention to shipment type (letter, packets, parcels, freight), volume, weight, route (e.g., residential, rural), haul length, and transit time; some shippers are more profitable than others as they are generally more willing to pay for high customer service that fulfills specific needs. This study has illustrated that parcel shippers are not homogenous. Rather, four distinct parcel shipper segments emerged based on specific needs expressed by the shippers.

Identifying and understanding these customer segments may provide carriers with an advantage in negotiations with shippers who value service characteristics beyond cost. Furthermore, shipper needs may change over time, just as the business environment can change (e.g., JIT, Hours of Service, and home delivery), causing carriers to adjust their strategy and approach (Meixell et al, 2008). Consequently, supply chain executives and leaders must understand shipper segments to provide optimum customer service that continues to meet if not exceed shipper needs and expectations.

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ORGANIC OR CONTRACT SUPPORT? INVESTIGATING COST AND PERFORMANCE IN AIRCRAFT SUSTAINMENT

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ABSTRACT

Over the past 15 years, the United States Air Force (USAF) has shifted toward utilizing more Contracted Logistics Support (CLS) and away from organic maintenance in their aircraft fleets. Given operating and support costs comprise 53-65% of total life-cycle costs for USAF aircraft, understanding the implications of these sustainment decisions is imperative. Utilizing a maintenance cost per flying hour metric and performing regression analysis, we find the maintenance strategy decision (CLS, mixed, or organic) is the most significant driver. We then examine performance metrics in relation to two established aircraft availability targets. Analysis of variance reveals statistically significant differences between maintenance strategies, with CLS outperforming organic in relation to the targets.

INTRODUCTION

The decision to vertically integrate capability into a firm or contract-out for that capability is a fundamental economic question all large companies must answer. The economics discipline frames a theoretical answer through the *theory of the firm* with Ronald Coase's contribution in this area undergirding the literature (Coase, 1937). After visiting Ford Motor Company, Coase pondered why certain activities occurred within the firm (e.g. Ford built their own steel mills) rather than being purchased from the market. His answer revolutionized economists' understanding of why companies are created and the factors that determine their size and scope. Coase explains that there are costs to using the price mechanism (i.e. markets). These costs, commonly referred to as transaction costs, are the costs incurred by buyers and sellers in making an economic exchange. Thus, transaction costs are often *the* costs that matter in determining whether or not to make an activity internal to the firm (Coase, 1937).

The United States Air Force (USAF) is confronted with this strategic decision for each individual aircraft platform it owns. Complicating matters, the fundamental question of whether to build in-house or purchase in markets is relevant in all stages of a product's life-cycle: from development to production to operations and sustainment. Decisions to use the market for one stage of the life-cycle do not necessarily lead to the same decision in a subsequent phase. For example, production of a platform may be through the market mechanism, while sustainment of that same platform may be organic. This research focuses solely on the operations and support phase of the life-cycle for the USAF fleet of aircraft. Specifically, the focus of this paper is on the decision to provide aircraft maintenance organically or by Contractor Logistics Support (CLS).

While the underlying decision to conduct maintenance organically or through contracted support confronts all businesses from Southwest Airlines to FedEx, the unique aspects of Air Force aircraft is more clearly understood in the transaction cost framework detailed by Oliver Williamson. Williamson introduces the concept of "asset specificity" as a determinant of

transaction costs (Williamson, 1981). Asset specificity is the extent to which investments made to support a particular transaction have a high value to that specific transaction and are not easily converted for other uses. The implication is a supplier may bid in a competitive environment for the rights to produce something. However, once the contract is awarded, the high degree of asset specificity changes the nature of the market environment from a competitive market to a de facto bilateral monopoly (a bilateral monopoly is defined as one supplier; the monopolist, and one purchaser; the monopsonist). Williamson argues that higher degrees of asset specificity raise transaction costs (Williamson, 1981). Given the unique nature of Air Force aircraft, it can be argued that there is high asset specificity in their maintenance. For example, the investments in equipment to maintain composite materials on a stealth aircraft are unlikely to be easily converted to commercial aircraft use.

This research analyzes organic maintenance support in comparison with CLS costs in Air Force aircraft. It seeks to determine whether one maintenance approach is more expensive than the alternative through regression analysis. However, considering cost alone removes the ability to truly assess value. As assessment of performance output allows the Air Force to understand if the dollars they spend produce the results they need to perform their mission. Analysis of Variance (ANOVA) assessment provides comparisons of performance metrics to determine statistical differences in maintenance strategy performance.

BACKGROUND AND LITERATURE REVIEW

The life-cycle of USAF aircraft consists of four stages: research and development, procurement, operating and support, and disposal. Historically, researchers have focused on issues associated with the research and development or procurement stages of the life cycle. However,

smaller defense budgets and recent legislation, such as the Weapon System Acquisition Reform Act of 2009, has highlighted the importance of total life-cycle cost analysis. Subsequent research determined that operating and support costs for USAF aircraft consist of 53-65% of the total life-cycle costs (Jones et al., 2014). See Figure 1. With platforms such as the joint strike fighter projected to cost over \$1 trillion for operations and support, analysis of maintenance strategy decisions is needed (GAO, 2014).

The Air Force has a continuum of choices when determining the optimal strategy for maintaining and sustaining its fleet of aircraft. See Figure 2. On one end is the fully vertically integrated option – referred to as organic maintenance. Air Force organic maintenance occurs at three government run “depots” called Air Logistics Centers (ALCs)¹. On the other end of the continuum is the market mechanism, referred to as Contractor Logistics Support (CLS), where all maintenance activity is conducted through a contractual relationship with private industry. In between either extremum is a mix of varying combinations of both organic and CLS maintenance.

Both organic and CLS maintenance strategies have benefits. Organic maintenance provides a guaranteed source of supply and endows the Air Force with complete control over when and how the maintenance is completed (Boito et. al, 2009). CLS offers the potential for lower costs due to market competition and possible economies of scale when the Original Equipment Manufacturer (OEM) is also selected to perform the sustainment function (Boito et. al, 2009). It is important to understand the Air Force sustainment strategy decision occurs at the individual aircraft platform level (e.g. B-2, C-17, F-22), rather than a single decision for the entire Air Force enterprise. These sustainment strategy decisions originate early in the program life-cycle with significant long-term operational and cost implications.

FIGURE 1
NOTIONAL AIRCRAFT LIFE-CYCLE

FIGURE 2
MAINTENANCE STRATEGY CONTINUUM

Historically, public-sector organic depots originated in the late 1930s and early 1940s to meet the need for weapon system maintenance as the private sector was fully utilized in producing new military equipment. This paradigm of primarily private sector military production of equipment and public sector maintenance of military systems continued through the Cold War (Heivlin, 1993). The 1984 National Defense Authorization Act set in motion legislative activism and a change in the underlying sustainment strategy of Air Force platforms. The 98th Congress passed 10 USC 2464 which mandates a “core logistics capability” be maintained that is government owned and operated. The “core” requirement is intended to ensure sufficient organic competency and resources for contingency

and other emergency requirements (Solis, 2009). Subsequent legislation in 10 USC 2466 sets the limit for the amount of depot-level workload that can be performed by non-governmental personnel. While the initial 1988 legislation capped non-governmental maintenance at 40 percent, more recent legislation has raised the threshold to what is now commonly referred to as the 50/50 rule. Specifically, the 50/50 rule stipulates that a maximum of 50 percent of funds available in a given fiscal year can be used for contracted maintenance work (10 USC 2466, 2005).

¹ Total Air Force aircraft maintenance is comprised of depot, intermediate, and flight line (unit level) maintenance. Flight line maintenance is excluded from this analysis.

In addition to the legislative actions discussed above, decisions by the Department of Defense have affected organic aircraft maintenance capabilities. Program Budget Decision (PBD) 720 reduced total Air Force end strength manpower numbers by 40,000 personnel from 2006-2009. The aircraft maintenance career field took particularly large reductions with an approximately 9,000 person reduction (Drew et al., 2008). This reduction equates to approximately 11% of the total aircraft maintainer manning.

Figure 3 displays the longitudinal trajectories of total Air Force aircraft by maintenance type. For the purposes of this study, aircraft are categorized as either organic, contractor or mixed. Categorization of organic or contractor occurs when greater than 80 percent of the dollars are allocated to the specific type. Any combination less than 80 percent is categorized as “mixed.” There is a clear shift over the last 20 years from an Air Force enterprise predominately organically maintained to one more dependent on contracted maintenance. This trend leads to two investigative questions. First, which

maintenance type costs the Air Force more? Second, which approach provides greater value to the Air Force?

MODEL DATA

The Air Force Total Ownership Cost (AFTOC) database provides operations and support data on Air Force aircraft platforms dating back to 1996. The Office of Secretary of Defense, Cost Analysis and Program Evaluation (OSD-CAPE) office provides broad policy guidance and executive oversight to the AFTOC system (DoD, 2014). OSD-CAPE promotes standardization of operations and support cost data collection through a published Cost Element Structure (CES) in its *Operating and Support Cost Estimating Guide*. Cost data for this analysis is extracted from AFTOC for the period 1996-2014 for those elements related to maintenance as defined in the OSD-CAPE guidance. See Table 1 for a list of the aircraft platforms by maintenance type.

Logistics Installations and Mission Support – Enterprise View (LIMS-EV), maintained by

FIGURE 3
AIR FORCE TOTAL ACTIVE INVENTORY CATEGORIZED BY MAINTENANCE STRATEGY

TABLE 1
AIRCRAFT PLATFORMS

CLS		Mixed	Organic	
F-117	TU-2	B-2	B-1	EF-111
F-22	C-12	UC-26	B-52	MC-130E
F-35	C-17	UV-18	A-10	MC-130H
E-8	C-20	EC-130H	F-15	MC-130P
MC-12	C-21	EC-130J	F-16A	MC-130W
RC-135	C-22	MC-130J	F-16B	NKC-135
RC-26	C-26	WC-130	F-16C	AT-38
U-2	C-27	T-41	F-16D	T-37
E-4	C-32	TC-135	F-4	T-38
E-9	C-37	TE-8	HH-60	TG-10
U-28	C-38	TG-15	MH-53	TG-12
WC-135	C-40	TG-4	MH-60	TG-14
T-1	C-9	TG-7	TH-53	TH-1
T-3	KC-10	C-130H	UH-1	C-130E
T-43	MQ-1	C-130J	E-3	C-135
T-51	MQ-9	CV-22	OC-135	C-141
T-6	RQ-4	HC-130	AC-130H	C-5
TC-130			AC-130U	KC-135
			AC-130W	KC-46
			EC-130E	LC-130
			EC-135	

Headquarters Air Force Logistics, provides flying hour data for each mission design series (MDS) in the Air Force enterprise. Flying hour data is combined with maintenance cost to create a total maintenance cost per flying hour metric for each aircraft platform. This metric is used as the dependent variable in the regression analysis.

The age of an aircraft can have a significant effect on maintenance costs. There are a multitude of studies examining the age effect (Kamins (1970), Hildebrandt and Sze (1990), Kiley (2001)). Pyles (2003) is the most comprehensive study completed on Air Force aircraft aging effects. Pyles found that late-life maintenance requirements generally exhibit increased growth as aircraft age. Dixon (2006) tested similar hypotheses as Pyles. Dixon, however, differs from Pyles in several ways. First, Dixon examines real dollars through the cost per flying hour dependent variable (rather than man-hours or requirements). Second, Dixon utilizes a different dataset as he analyzes commercial aircraft and then draws inferences for USAF aging aircraft. Dixon concludes that while

there are significant aging effects early on, after year 12 the age effect is only 0.7 percent and not statistically significant from zero (Dixon, 2006).

Data on age of aircraft is also collected from LIMS-EV. Figure 4 shows that the average age of organically maintained aircraft has increased significantly over the past 15 years. Thus, age of aircraft is utilized as a control variable in the model.

The remaining data, to include Total Active Inventory (TAI), number of sorties, number of landings, and availability metrics, is also collected from LIMS-EV.

ANALYSIS AND DISCUSSION

The analytic approach seeks to first determine whether the maintenance strategy chosen (i.e. organic or CLS) is a driver of total maintenance costs. The naïve approach of comparing simple averages of maintenance costs per flying hour by maintenance strategy is rejected as other variables (e.g. technology, age of aircraft, etc.)

FIGURE 4
AVERAGE AGE OF AIR FORCE FLEET CATEGORIZED
BY MAINTENANCE STRATEGY

are influential. Thus, multiple regression is utilized to answer the first question.

Finding a maintenance strategy to be more expensive does not, in itself, make it an undesirable choice. Instead, the output derived from the approach must be taken into account. Thus, the second stage of our research examines performance metrics. The literature reveals Aircraft Availability (AA) as the traditional performance metric analyzed. AA is defined as the mission capable hours divided by the total hours possessed. AA has been studied extensively since it became the cornerstone metric of internal Air Force logistics fleet evaluations (Rainey et. al, 2011). While Air Force agencies have therefore examined AA and its predecessor mission capable (MC) rates, we argue that AA is not the true metric of interest. The AA calculation gives a raw availability metric. But the

real value to the Air Force is in meeting established targets, not a raw value of the AA metric.

The Air Force tracks two availability targets called the “standard” and “attainable.” The “standard” is aircraft platform unique and represents the percentage of the aircraft fleet that is required to be available at any time to meet mission requirements. AA Standards are updated once a year based on the following formula:

Where S_o – number of sorties needed to complete all aircrew contingency operations, S_t – number of training mission requirements, F_{do} – days available to fly, F_{dt} – number of days available during the fiscal year to execute the flying training mission, T_u

$$\left[\frac{[S_o]}{F_{do}} \right] + \left[\frac{(S_t)}{F_{dt} \times T_u \times (1 - a)} \right] + G + S + A + R = OR \text{ (Operational Requirement)}$$

– turn rate, α – attrition rate, G – ground schedule requirement, S – spare requirement, A – alert requirement, and R – reserve requirement (Air Force Instruction 21-103, 2012)

The “attainable” metric represents the realistic availability of individual aircraft platforms given the resources that have been allocated to that platform. *The proper statistics of interest is therefore the ratio of AA to Standard and AA to Attainable, not AA itself.* It answers the question “which maintenance type hits closer to the established target?” Deviating below the ratio is undesirable as aircraft are not available to meet mission requirements. On the other hand, exceeding the ratio is also undesirable as resources are not being properly allocated. We conduct ANOVA analysis to test the mean differences for each maintenance strategy.

Stage 1: Regression Model

The first investigative question is whether the maintenance approach (organic or CLS) is a driver of costs per aircraft tail. If the approach is found to be a driver, then we investigate which maintenance strategy is more expensive. To analyze maintenance costs per flying hour, we relate measures of activity with maintenance costs over time using Ordinary Least Squares (OLS) multiple regression analysis.

The dependent variable is Total Maintenance Cost per Flying hour for platform i in year j . The cost data from AFTOC is normalized with Office of Secretary of Defense inflation indices to a Base Year 2014 dollar. The initial regression model violates the underlying OLS assumption of homoskedasticity (constant variance). To correct this, the dependent variable is transformed with the natural log.

Independent variables are based on a review of the literature and subject matter experts in the USAF. An explanation for their inclusion in the model is as follows:

Age of Aircraft_{ij} – The literature review finds age of aircraft as a theoretically important explanatory variable. Figure 4 demonstrates the age profile of organically, CLS, and mixed maintenance strategy as a function of time. As the figure indicates, organically maintained aircraft are older on average than CLS maintained aircraft and the enterprise as a whole is getting older.

Platform_i – Platform is incorporated as a fixed effect in the regression model. It is a proxy variable for technology. There are likely to be significant maintenance cost differences based on the technology of the aircraft platform. For example, the sophisticated composite materials required for the F-22 is significantly more costly to maintain than the relatively simple materials of an A-10.

Average Total Active Inventory_{ij} - Economic theory postulates that there are potential economies of scales (lower average costs) as the quantity of aircraft maintained increases. This variable controls for this effect.

Year_j - Year is modeled as a fixed effect in the regression model. It covers 19 years from 1996-2014, with 1996 utilized as the year of comparison. Even with the data normalized for inflation, it is still necessary to control for other year to year changes.

Percent CLS_{ij} – Percent CLS is calculated using AFTOC data. It provides the percentage of the platform that is CLS maintained, where 1 is fully CLS maintained, 0 is fully organically maintained, and numbers in between represent the mixture. *This is the crucial independent variable in the model.* Its significance (or lack thereof) in the model is the rosetta stone to answering the first research question concerning the costs of the maintenance strategies.

Other independent variables were considered in the model. These variables included number of landings, number of sorties and stealth technology. Multivariate correlation plots (and

TABLE 2
REGRESSION MODEL VARIABLES

Attribute	Variable	Type of Variable	Hypothesized Sign
Fleet Size	Avg. Total Active Inventory	Direct	-
Age	Avg. Age of Aircraft Fleet	Direct	+
Technology	Platform Type	Indirect/Proxy	N/A
Support Type	Percent CLS	Direct	unknown
Time Series	Year	Direct	N/A

VIF va

between the Landings, Sorties, and TAI independent variables. As a result, the landings and sorties variables were removed from the model. Table 2 summarizes the final set of independent variables, their attributes, the type of variable, and the *a priori* hypothesized sign of the coefficients. The hypothesized signs of the coefficients are theoretical, based upon the literature review.

The final form of the regression model is the following:

$$\ln(\text{Cost}_{ij}/\text{FH}_{ij}) = \beta_0 + \beta_1 \text{Age}_{ij} + \beta_2 \text{Platform}_i + \beta_3 \text{Total Aircraft Inventory}_{ij} + \beta_4 \text{Year}_j + \beta_5 \text{Percent CLS}_{ij} + \varepsilon_{ij}$$

where β are the coefficients to be estimated, i is the platform, j is the year, and ε is a standard residual term. The initial dataset contained 1111 data points. A data scrub and Cook's D analysis for influential data points resulted in removal of 13 data points for a final model with 1098 valid data lines.

Next, the models underlying OLS assumptions of normality, constant variance, and independence are verified. Two diagnostics are utilized to check for normality. First, a histogram of the studentized residuals is plotted to analyze the normality assumption with a normal curve imposed over the histogram. Second, the Shapiro-Wilk test is used as a quantitative diagnostic to evaluate the Goodness of Fit of the Normal Distribution. The constant variance assumption is verified with both a visual examination of the residual by predicted plot and also through the Breusch-Pagan test.

Model results are displayed in Table 3. Percent CLS is found to be highly significant with a positive coefficient sign. The interpretation is that as platforms move toward contracted logistics maintenance and away from organic maintenance the costs increase. Additionally, percent CLS has the highest standard beta indicating it is the most powerful explanatory variable. This is the first key finding of the research.

Results from other independent variables in the model provide further insights. The negative coefficient on average TAI demonstrates economies of scale. As the fleet size increases the average cost per unit decreases. These results are consistent with economic theory. The age of aircraft coefficient is positive indicating that as aircraft age, the sustainment costs increase. This empirical finding is consistent with the aging literature (Pyles, 2003). Finally, the platform variable is found to be significant. Platform is used as a fixed effect in the model and a proxy for technology. Thus, technology is correlated with an increased cost per flying hour.

Stage 2: Performance Analysis

Determining that a maintenance strategy is a driver of costs does not necessarily mean that past sustainment decisions were not in the best interest of the USAF. The performance achieved by the various approaches must also be considered. For USAF aircraft, availability is the primary performance characteristic associated with maintenance. Rather than analyzing raw availability, we evaluate the maintenance strategy's ability to

TABLE 3
PARAMETER ESTIMATES

Term	Estimate	Std Error	t Ratio	Prob> t	Std Beta
Intercept	8.4187221	0.213904	39.36	<.0001	0
Avg. Age of Aircraft Fleet	0.2378726	0.034224	6.95	<.0001	0.193578
Avg. Total Active Inventory	-0.05965	0.025988	-2.30	0.0219	-0.08458
Percent CLS	1.1479219	0.113405	10.12	<.0001	0.404605
Platform Type	various			significant	
Year	various			significant	
SUMMARY OF FIT					
RSquare	0.84461				
RSquare Adj	0.83139				
Root Mean Square Error	0.47983				
Observations	1098				

meet the two USAF specified targets for each platform. These targets are the “standard” and the “attainable”. As discussed previously, the “standard” represents the percentage of the aircraft fleet that is required to be available at any time to meet mission requirements while the “attainable” metric is the resource constrained target. LIMS-EV contains the unique platform target data for both the “standard” and “attainable” metrics. The range of data, by platform, for the “standard” is 30%-90% and for the “attainable” is 30%-100%. It is malapropos to assess availability in the global sense as is often the proclivity amongst USAF leaders and analysts. Hypothetically, if aircraft “A” has a standard target of 55% and meets this with an AA rate of 55%; and aircraft “B” has a standard target of 75% but fails to meet this with an AA rate of 65%: how does averaging these AA rates to a global statistic give the USAF any indication that they are meeting their sustainment goals? Thus, a better performance parameter is to evaluate the availability of platforms in relation to their established targets. Specifically, we

calculate this performance parameter through two ratios:

$$\% \text{ Aircraft Available}_i / \text{Standard Target } \%_i$$

Equation (1)

$$\% \text{ Aircraft Available}_i / \text{Attainable Target } \%_i$$

Equation (2)

where i represents individual aircraft platforms.

First, data is delineated into three groups: organic, mixed, and CLS as previously shown in Table 1. Next, Analysis of Variance (ANOVA) is utilized to compare the confidence intervals associated with the mean of each maintenance approach for the metric in Equation 1. We will refer to this as the Standard ratio. ANOVA analysis demonstrates all three maintenance types are statistically different from one another with regard to their ability to meet the Standard target (see Table 4). The lack of any overlap in the 95% confidence intervals demonstrates statistical differences between the organically, mixed, and CLS maintained groups. The CLS maintenance approach provides the greatest performance as it’s mean of 0.9469 is closest to the ideal of 1.0. The

TABLE 4
ANOVA RESULTS: STANDARD RATIO

	Mean	Lower 95% CI	Upper 95% CI	Standard Dev.
CLS	0.9469	0.9377	0.9562	0.2138
Mixed	0.8602	0.8370	0.8833	0.2426
Organic	0.9160	0.9072	0.9247	0.2095

organic approach is the next best and the mixed approach lags significantly behind either of the other two.

Similarly, ANOVA analysis is conducted to compare the confidence intervals associated with organic, mixed, and CLS aircraft maintenance for the Attainable metric ratio as delineated in Equation 2. See Table 5. Organic and CLS aircraft maintenance are found to be statistically different with regard to their ability to meet established Attainable targets. However, the mixed maintenance group is not statistically different from either CLS or organic aircraft maintenance. The variance of the mixed group is quite large and may be partly due to the smaller sample size in this group. Interestingly, CLS again provides the highest mean ratio of all three groups.

Thus, we conclude that in regards to both standard and attainable ratios, CLS and organic maintenance strategies are statistically different.

CONCLUSION

There has been a recent shift in USAF aircraft maintenance strategies away from organic maintenance and towards CLS aircraft maintenance. Program Budget Decision 720, which reduced the USAF organic maintenance capability, accelerated the shift from 2006-2009. One reason for this shift was the theory that CLS would result in cost savings through increased competition. The findings of this research indicate that the policy decision to conduct aircraft maintenance organically, mixed, or by CLS has significant implications. We find that maintenance strategy is not only a driving factor, but is actually correlated as the most significant factor in aircraft

maintenance costs. Thus, the policy decisions on which maintenance strategy to pursue are extremely important.

The empirical findings in USAF aircraft maintenance that CLS costs more than organic maintenance refutes one of the initial claims cited in the literature (Boito et al, 2009) that introducing contractor maintenance should reduce costs through competition. While not definitive, we suggest that the counterbalancing effect is likely to be asset specificity. There are large unique costs to conducting maintenance for USAF aircraft. These costs do not transfer easily to other uses – hence there is a high degree of asset specificity. Economic transaction cost theory would postulate that due to the large transaction costs associated with high asset specificity, it would be more beneficial to provide the service organically (vertically integrate). Thus, we suggest the asset specificity phenomenon outweighs the benefits of competition. In this study, CLS is found to be more expensive than organic maintenance for USAF aircraft.

Cost, however, is only one side of the coin. The value inherent from the outcomes of the maintenance strategy must also be considered. Value, for USAF aircraft, manifests itself in aircraft availability to fly missions. More specifically, the penultimate valued performance is achieving the availability target established for individual USAF platforms. Our “standard” and “attainable” ratios model this value. The performance analysis provides several findings. First, the mixed approach to aircraft maintenance performs worse than either organic or CLS. The mixed standard ratio mean is more than five percent lower than organic and nine

TABLE 5
ANOVA RESULTS: ATTAINABLE RATIO

	Mean	Lower 95% CI	Upper 95% CI	Standard Dev.
CLS	1.0301	1.0218	1.0384	0.1811
Mixed	1.0187	0.9938	1.0436	0.2377
Organic	1.0084	1.0005	1.0163	0.1810

percent lower than CLS. Thus, the mixed approach provides the least amount of performance and should be employed as a last resort. Second, CLS and organic maintenance performance ratios demonstrate that the two approaches provide statistically significant performance differences. CLS average performance outperforms organic by over three percent for the *standard* ratio. The *attainable* ratio performance results are more complicated. Both organic and CLS achieve, on average, above the ideal ratio of 1.0. CLS maintains a higher mean value than organic for the *attainable* ratio. Recall that the attainable target takes into account availability of aircraft given the resources allocated. This naturally leads back to PBD 720 and the cutting of maintenance manpower. Our *attainable* ratio performance analysis shows that when resources are taken into account, organic can perform very well. Thus, USAF decision makers should take this into account when considering future PBD 720 type decisions.

In summary, we have found that the decision to sustain aircraft organically or through CLS contracts is the most significant driver behind USAF operating and support costs per flying hour. In addition, given that operating and support costs account for a historical average of 53-65% of the total aircraft life-cycle costs, the maintenance strategy decision has profound effects (Jones et al., 2014). Assessment of “standard” ratio calculations via ANOVA reveals CLS maintenance strategy is providing greater performance than organic. Additionally, the ANOVA reveals both CLS and organic strategies perform, in the aggregate, above targets for the “attainable” ratio and that their means are statistically different. This indicates the importance of appropriately resourcing across the enterprise to achieve necessary mission requirements.

DISCLAIMER: The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the United States Air Force.

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THE IMPACT OF URBAN SPRAWL ON JOURNEY TO WORK TIMES FOR MASS TRANSIT AND ALL OTHER COMMUTERS IN THE UNITED STATES: A RESEARCH NOTE

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ABSTRACT

As government budgets get tighter, there has been considerable public outcry about the continued investment in public mass transit systems and their financial viability. Amid this outcry, a number of studies have been conducted to determine which factors influence the use and efficiency of publicly-funded mass transit systems. These factors include population density and less sprawl (or greater urban compactness). However, their impact on mass transit usage is somewhat contradictory in that the heavy concentration of populations in the urban area and greater compactness is believed to increase mass transit usage due to a bigger number of potential passengers. In fact, greater compactness and greater transit ridership have played a role in lengthening the journey to work for most commuters and thus discouraged the use of mass transit systems. Thus, some questioned the wisdom of mass transit subsidies and “smart growth” policies. To attempt to answer this question and avoid any further confusion, this paper examines how urban sprawl affects the journey to work commute time of mass transit riders and other commuters throughout the United States after controlling for variables such as the volume of ridership, local per capita income, the presence of a local rail transit system, and local weather. The findings for this research note defy some conventional wisdom and point to several public policy recommendations on how to improve public mass transit at the local level. For instance, we find that greater urban compactness can be turned into a mass transit advantage if mass transit riders can use a commuter rail option.

INTRODUCTION

Public transportation (hereafter, mass transit)¹ has been a popular subject of scientific inquiry for the past few decades due to its role in enriching some people’s lives by increasing their mobility and access to employment, shopping, medical care, educational resources, and recreational activities. Though being considered important public goods, undisciplined investment in mass transit has been criticized and is under constant scrutiny. Thus, considerable efforts have been made to understand what makes mass transit more useful and to determine which factors influence the efficient utilization of mass transit. These efforts will help policy makers develop ways

to better allocate their limited financial resources to the improvement of mass transit services. Those efforts that were published in the scholarly literature reveal the following:

1. Greater housing and population density (less “sprawl”) usually lead to greater mass transit ridership (e.g., Ewing et al 2003, Lin and Yang 2009, O’Sullivan 2012).
2. Greater ridership, in turn, has the benefit of reducing traffic congestion for lower occupancy vehicles such as automobiles, and helps reduce other negative externalities such as air pollution and traffic noise/accidents if less cars travel the

roadways due to greater mass transit usage (Ewing et al 2003, O'Sullivan 2012²² The analysis by Winston and Langer (2006) argues that most of the road construction undertaken to reduce traffic congestion yields fewer benefits than costs.

3. On the other hand, beyond a certain point, it is possible that greater population and housing density can cause greater traffic congestion, and thereby increase, not decrease commute times for both mass transit riders and private vehicle users. Therefore, it is often difficult to predict the effect of greater density (or less sprawl) on commute times in general (Levinson and Kumar 1997, Prud'homme and Lee 1999, O'Sullivan 2012, Dries and Rietveld 2013), although Ewing and Hamidi (2010) show that less sprawl is associated with shorter drive times for commuters on average.
4. The reduction in externalities and the fact that mass transit serves a disproportionate number of low income commuters and disabled travelers are often used as justifications for subsidies to mass transit as many mass transit agencies fail to operate at a surplus or break even (Parry and Small 2009, O'Sullivan 2012), although those with greater ridership usually operate with greater financial and operating efficiency (Nolan, Ritchie, and Rowcraft 2001, O'Sullivan 2012, Min and Lambert 2015). Some, however, contend that federal subsidies generate inefficiencies with regard to operating expenses (Nolan, Ritchie, and Rowcraft 2001), and O'Sullivan (2012) notes that transit subsidies could be better targeted with more appropriate investment and clearer performance goals in mind.
5. Because greater ridership is associated with denser development, policies favorable toward mass transit often have also gone hand in hand with those

favoring "smart growth" urban policies—policies that promote denser residential and commercial development along with mixed use and mixed income zoning and land usage (Ewing et al 2003, Handy 2005). Su and DeSalvo (2008) found that taxes and subsidies were likely targeted for mass transit systems in high density urban areas, whereas those areas that encouraged private auto use to one extent or another had greater degrees of urban sprawl.

In the meantime, mass transit subsidies and smart growth policies have been criticized as being as inefficient as the externalities they are supposed to address. The basic arguments against transit subsidies and smart growth policies are that they defy market principles (i.e., market forces should mostly determine transportation modes and urban development while subsidies encourage inefficiencies) and that the negative externalities that transit and planned development are supposed to address are not as great or as overwhelming as estimated (Nolan, Ritchie, and Rowcraft 2001, O'Toole 2000, 2001, 2006, 2010, Cox 2013). Moreover, the non-scholarly literature (O'Toole 2001, 2006, 2010, Cox 2013) contends that smart growth policies can only result in greater traffic congestion and longer commute times for all travel journeys despite companion policies that promote greater mass transit usage and service delivery. Cox (2013) argues that any reductions in harmful emissions in metro areas have come about mainly because more fuel efficient and environment-friendly automobiles (e.g., bio-fuel, hybrid) have been put on the road over the last few decades rather than due to mass transit, and that most of the benefits of the subsidies of mass transit accrue to a mere six urban areas in the United States out of over 300 metropolitan areas. That is to say, Cox (2013) argues that there have been some doubts about the role of mass transit in alleviating any traffic congestion and air pollution.

To ease these doubts, this research note examines the past premises that greater urban

compactness (or less sprawl) causes longer commutes (using journey to work times as a proxy) and that some form of rail (light or heavy) transit is effective in alleviating congestion by shortening journey to work times for mass transit riders.

This note proceeds as follows. The next section details the research methods employed for the analysis of transit data obtained from the United States. After that, a section discusses the key findings of the statistical data analysis, which in turn is followed by a concluding section which outlines the important implications of this paper's findings, summarizes the limitations of the current research, and makes suggestions for future research, while recommending plausible policy guidelines.

RESEARCH METHODOLOGY

To answer research questions raised in the prior section, we gathered secondary data mostly from public sources such as 2012, five-year estimates, American Community Survey (<http://www.census.gov/acs/www/>), the US Bureau of Transportation Statistics (BTS), and a compactness index developed by Ewing and Hamidi (2010). These data were analyzed using least squares regression analysis. In the proposed three regression models, the following variables were used as dependent variables to measure average commute times for 845 metro area counties in the U.S.³

1. The natural log⁴ of the average journey to work time in minutes for all commuters in the county⁵ (Ln Overall Average hereafter).
2. The natural log of the average journey to work time in minutes for public transit riders in the county⁶ (Ln Public Transit Average hereafter).
3. The natural log of the ratio of the average journey to work time in minutes for public transit riders in the county to the average journey to work time in minutes for all

commuters in the county (Ln Ratio hereafter).⁷

To predict the three dependent variables described earlier, we used the following dimensions as independent variables.

1. Climate (Weather). This is a dummy variable where states in the northeastern, midwestern, and northwestern parts of the US (coded as 1s) are classified as states having a greater chance of heavier snow precipitation than other states (coded as 0s).

2. Rail transit. Using data from the US BTS, counties were noted as having some type of mass transit service featuring light and/or heavy rail (US Bureau of Transportation Statistics, 2010). For the purposes of this paper it was important to highlight the effects of rail transportation since it receives higher subsidies, which is part of the criticism of smart growth and transit subsidy policies.

3. Natural log of the percentage of the work force not working at home and using public transit for the journey to work (Ln Public Tran Ridership). This is used as a way to see if greater ridership leads to longer journeys to work on average due to more frequent stops to collect and release a greater number of passengers than would otherwise be the case (O'Sullivan 2012).

4. Natural log of a compactness index (Ln Compactness Index). This is the natural log of a sprawl or compactness index developed by Ewing et al (2010), and is an improvement over one developed by Ewing and others earlier (Ewing et al 2003). The compactness index uses principal components analysis at the census tract level of urban population density, housing density, job density, road connectivity, and the degree of mixed land usage. It draws upon data from various sources and gives a score to counties, metro areas and urbanized areas according to their degree of compactness

(or lack of sprawl). The greater the score, the greater the compactness (or less sprawl).⁸

The compactness index and the percentage of the workforce using mass transit are strongly correlated. The mass transit and urban economics literature note that historically greater urban density leads to the formation and expansion of mass transit services and greater ridership, especially in the densest parts of urban areas (O'Sullivan 2012). As long as a certain population density is maintained along transit routes, the services for a certain level of ridership will continue to be offered in spite of the development of possible operating losses and competition from other forms of transportation (O'Sullivan 2012). As time goes by, since some commuters prefer mass transit to other forms of transportation, or can only afford mass transit, many choose to locate their residences as closely as possible to transit lines since proximity to those lines reduce walking and waiting times (Mohring costs) of using mass transit (O'Sullivan 2012). This in turn leads to greater ridership. Hence, greater density leads to greater mass transit services, which in turn could lead to more commuters' willingness to locate close to the transit stops and lines, and then this in turn could lead to even greater density. Therefore, although originally greater urban density leads to mass transit services and a certain level of ridership, it is later difficult to distinguish whether ridership is a function of density, or if density is a function of ridership. For this reason, both were used as separate independent variables since the variance inflation factors for these variables were not greater than 5.0, a value which indicates no signs of multicollinearity (Studenmund 2005).⁹

It was found in models employing path analysis that density or compactness was often used as a predictor of ridership (Golob 2003). For this paper, since it is often hard to determine how the two interact, they were used as separate independent variables in the least squares models.

5. Natural log of county's per capita income, 2010 (Ln Per Capita Income). This is used to see if average journey to work times are higher or lower according to levels of per capita income in a county. The hypothesis is that if mass transit is an inferior good (O'Sullivan 2012), then higher per capita income should be associated with less mass transit usage, which would cause greater congestion, and therefore average journey to work times should be longer, all else held constant.

RESULTS AND DISCUSSIONS

Table 1 shows the descriptive statistics for the variables used in the three models developed. Around 60% of the counties were in states that were in the northern top half of the US, only around 7% had some form of rail transit. Overall public transit ridership as a percentage of all of those who commute to work was fairly low at only a little over 2%, and average mass transit commute times were almost twice those of overall commute times.

Robust standard errors were used for all three models because Breusch-Pagan test results showed some evidence of heteroscedasticity for the first model (Koenker 1981). In Table 2, all independent variables show statistical significance (p-values < 0.05), and the Ln Compactness Index is a negative predictor of overall commute times whereas greater ridership is associated with longer average commute times. The presence of rail transit and higher per capita income cause longer commute times, on average. Perhaps higher income may be indicative of greater preferences for private automobile use among those who commute to work, which could lead to greater traffic congestion, and the presence of rail transit does not appear to offset this. For the climate variable, the northern counties tend to have shorter commute times on average, so a higher

TABLE 1
DESCRIPTIVE STATISTICS

Variable	Mean	Standard Deviation
Climate	0.61	0.49
Rail	0.07	0.33
Compactness Index	102.62	25.81
Overall Avg. Journey to Work Time in Minutes	24.39	4.95
Public Trans Avg. Journey to Work Time in Minutes	41.99	17.74
Ratio Public to Overall Average	1.72	0.60
Per Capita Income	\$27,142.00	\$6283.00
Public Trans Ridership Pct.	2.31	5.55

TABLE 2
LEAST SQUARES REGRESSION, LN OVERALL AVERAGE JOURNEY TO WORK TIME FOR ALL COMMUTERS

Dependent Variable: Ln Overall Average Journey to Work Time for All Commuters				
Linear regression		Number of observations = 845		
F(5, 839) = 22.36				
Prob > F = 0.0000				
R-squared = 0.1245				
Root MSE = 4.6387				
	b	Robust SE	t-score	p-value
Climate	-1.06	0.33	-3.24	0.00
Rail	2.90	0.83	3.48	0.00
Ln Public Tran Ridership	0.54	0.20	2.70	0.01
Ln Compactness Index	-6.19	2.15	-2.89	0.00
Ln Per Capita Income	6.66	0.96	6.91	0.00
Constant	-14.44	9.73	-1.48	0.14

probability of encountering snow and ice is not a factor in impeding commute times to work, which could be due to such parts of the country being better prepared for inclement weather.

In Table 3, neither the presence of rail transit nor compactness has any impact on mass transit average commute times, although higher income causes longer commute times. Greater mass transit ridership is associated with longer commute times on average, since it leads to

more frequent and longer stops on average. The northern counties also tend to have shorter mass transit commute times on average. This finding is the same as that of the previous model.

In comparing mass transit to overall commute times by using a ratio of the two (Table 4), climate and per capita income are not good predictors of the ratio. The compactness index also does not work, yet the presence of rail transit is associated with lower ratios (i.e., the mass transit times make only a smaller portion

TABLE 3
LEAST SQUARES REGRESSION, LN PUBLIC TRANSIT
AVERAGE JOURNEY TO WORK TIME

Dependent Variable: Ln of Public Transit Average Journey to Work Time				
Linear regression				
Number of observations = 845				
F(5, 839) = 21.21				
Prob > F = 0.0000				
R-squared = 0.1217				
Root MSE = .40056				
	b	Robust SE	t-score	p-value
Climate	-0.07	0.03	-2.49	0.01
Rail	-0.05	0.03	-1.38	0.17
Ln Public Tran Ridership	0.10	0.02	5.25	0.00
Ln Compactness Index	-0.12	0.12	-1.00	0.32
Ln Per Capita Income	0.39	0.07	5.63	0.00
Constant	0.30	0.90	0.33	0.74

TABLE 4
LEAST SQUARES REGRESSION, LN RATIO OF PUBLIC TRANSIT AVERAGE
JOURNEY TO WORK TIME TO THE AVERAGE JOURNEY TO WORK TIME FOR
ALL COMMUTERS

Dependent Variable: Ratio of Public Transit Average Journey to Work Time to Overall Average Journey to Work Time for All Commuters				
Linear regression				
Number of observations = 845				
F(5, 839) = 11.64				
Prob. > F = 0.0000				
R-squared = 0.0857				
Root MSE = .36777				
Dependent Variable: Ratio of Public Transit Average Journey to Work Time to Overall Average Journey to Work Time for All Commuters				
	b	Robust SE	t-score	p-value
Climate	-0.02	0.03	-0.85	0.40
Rail	-0.17	0.04	-4.34	0.00
Ln Public Tran Ridership	0.08	0.02	4.68	0.00
Ln Compactness Index	0.14	0.12	1.17	0.24
Ln Per Capita Income	0.11	0.06	1.62	0.11
Constant	-1.23	0.87	-1.41	0.16

of overall commute times) on average. However, the high volume of ridership tends to increase mass transit commute times.

CONCLUDING REMARKS AND POLICY IMPLICATIONS

Recently the Obama Administration signed into law a broad \$41.6 billion program of tax breaks that would retroactively raise the monthly mass-transit subsidy to \$250 per month per rider for 2014 (Heckman, 2014). Although this law intends to increase mass transit ridership, ease traffic congestion, and conserve energy; there is no funding in place to honor this subsidy. Since its funding is often tied to government tax policy, the mass transit subsidy has become controversial legislation. To ease controversy over this legislation, this research note tested the validity of arguments against mass transit subsidies or “smart growth” policies and then discovered that such arguments had no empirical evidence to support them. To elaborate, in the first regression model, compactness is actually associated with lower average journey to work times, and has neither positive nor negative impacts on mass transit commute times or the ratio of mass transit to overall average commute times. The critics mentioned above indicate that greater compactness usually leads to more congestion and subsequently longer commute times on average, but this conjecture is not verified by our test results. Greater transit ridership is associated with longer journey to work times, on average, which is probably related to traffic congestion, but in the last model, the presence of rail transit actually closes the gap between mass transit commute times and overall commute times. However, in the first model, rail transit is associated with longer average overall commute times, so the ultimate impact of rail transit is indeterminate.

In all three models, greater per capita income is associated with longer commute times, on average, hinting that due to mass transit being an

inferior good, residents in higher income areas tend to drive their own vehicles more and thereby cause more traffic congestion which, in turn, leads to longer commute times. In other models developed for this study, the percentage of families living in poverty in the counties was used as an independent variable, and was a good predictor of the three independent variables and had a negative coefficient. The ridership percentage was also usually a good predictor and had a positive coefficient. Hence, the poorer the community, the shorter the average commute times for community residents regardless of their greater use of mass transit services.

It is also apparent that the northern counties have lower overall and public transit journey to work times on average than the southern counties. These counties also typically had the greatest compactness index numbers on average as well. Areas which have lower average journey to work times, thanks to their lower level of sprawl, tend to be more productive probably because commuters in those areas have more time to work in that they experience less tardiness in arriving to work and subsequently enjoy less wasted time for their work. This finding is congruent with that of the study conducted by Prud’homme and Lee (1999) who observed that the northern counties tended to be more productive than southern counties.

Despite some refreshing findings that were summarized above, this note is confined by several limitations. For instance, since the adjusted r-squared values for the models are low, much of the variation in the dependent variables remains unexplained. This paper’s conjecture that greater income in an area is associated with greater auto ownership and usage needs to be verified further using alternative statistical models with mediating variables (e.g., parking cost/time and limit, auto accident/theft risk). Also, given that the economic theory (e.g., O’Sullivan 2012) confirming that mass transit is considered an inferior good is pretty strong, a more direct variable needs to be

developed and employed within the models other than just per capita income.

Although some prior studies conducted by Parry and Small (2009) and Ewing and Hamidi (2010) presented evidence in favor of mass transit subsidies and the benefits of compact urban environments, some critics still argue against mass transit subsidies and more compact urban planning for their perceived lack of freedom of choice over commute options. Also, those critics overlook the negative consequences of automobile transportation externalities and the urban sprawl externalities. In fact, they suggest that mass transit and more compact urban development can cause longer commute times due to more traffic congestion. However, the results of this note do not support those assertions.

(Endnotes)

¹ Most mass transit entities in the U.S. are public or non-profit organizations (O'Sullivan 2012).

² The analysis by Winston and Langer (2006) argues that most of the road construction undertaken to reduce traffic congestion yields fewer benefits than costs.

³ When using metro area level data, the composite index had no connection to any of the commute times. The Pearson correlation coefficients were all below 0.08. This may be because on a regional level, for example, some counties may have heavy rail, light rail, and bus mass public transit services whereas others may have only bus service. For this reason, the public, mass transit commute time for a metro area may not reflect a typical commute time for most commuters. For example, the public transit average journey to work time for the New York metro region is 51 minutes whereas for Manhattan (New York County) it is around 35 minutes. Because of such great dispersion possible among several counties in coming up with a

metro level average, county average commute times are used/

⁴ Log models, especially double log models of interval data, tend to offer the best fit for models predicting dependent variables denoting time (Lambert and Meyer 2006 and 2008, Lambert, Min and Srinivasan 2009, Lambert, Srinivasan and Katirai 2012).

⁵ Does not include those who work from home.

⁶ Does not include usage of any type of taxis or private sector transit services.

⁷ The ACS does not separately calculate an average time for all those traveling to work except for those using public transit. There is only an overall trip time and then different trip times for different modes of transportation.

⁸ This exploratory paper only looks at county level data. A follow up paper using metro and urbanized area data is planned, which would permit the employment of the Ewing and Hamidi metro area sprawl index as well as a traffic congestion index developed by the Texas A&M Transportation Institute (<http://mobility.tamu.edu/ums/>). Unlike the findings of other research, a quadratic form of this variable did not work well in the models developed, which does not indicate some type of peak in density or compactness with relation to commute times. That is, there was no evidence of a decreasing commute times and then increasing times as density became greater.

⁹ It was found in models employing path analysis that density or compactness was often used as a predictor of ridership (Golob 2003). For this paper, since it is often hard to determine how the two interact, they were used as separate independent variables in the least squares models.

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MANUSCRIPT SAMPLE**A FRAMEWORK FOR EVALUATING SUPPLY CHAIN PERFORMANCE**

Terrance L. Pohlen, University of North Texas

ABSTRACT

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

INTRODUCTION

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

Table 1 about here

Developing and Costing Performance Measures

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

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

REFERENCES

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

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