Success factors and cost management strategies for logistics outsourcing

George N. Kenyon
Lamar University

Mary J. Meixell
Quinnipiac University

Abstract

Logistics outsourcing has a significant effect on how manufacturing firms produce and deliver products to their customers. Indeed, many manufacturing firms do not own or manage the transportation and warehousing resources used for inbound and outbound shipments from their facilities. Earlier research, however, has cast doubt on the efficacy of outsourcing, as some companies experience favorable performance outcomes while others do not. This research investigates the effects of logistics outsourcing on cost by analyzing empirical data across a wide variety of industries, using data from a survey of manufacturing plant managers. Our analysis indicates that outsourcing logistics activities slightly increased COGS, but the existence of moderating factors suggests interesting new strategies for outsourcing the logistics functions.

Keywords: Logistics, Outsourcing, Manufacturing Strategy, Empirical analysis

INTRODUCTION

The efficiency and effectiveness of the logistics operation has a considerable influence not only on the business performance of manufacturers but also on the customer's perception of the quality of the products and services provided by the plant. If inbound material flows from the supplier are erratic, the firm's internal operation will not be able to sustain their production strategies without a high level of safety stock. Similarly, if the flows of finished goods to the customer are unreliable, the firm's customer base will be dissatisfied. Accordingly, logistics is strategically important in many industries as it is central to achieving competitive advantage (Bowersox, Closs, & Cooper, 2010).

Logistics knowledge is highly specialized and so external logistics organizations, i.e. logistics service providers or 3PL's, are often engaged by firms to provide transportation and warehousing services, and sometimes to guide the development and implementation of best practices (R. Lieb, 2008; Robert Lieb & Bentz, 2005), for both the transportation service itself as well as management of the transportation companies providing the service (Hannon, 2006, 2008). Outsourcing all or part of the logistics function is a popular practice in industry, especially in prominent companies that consider logistics a strategically important function. It has been estimated that over 70% of these firms use a 3PL to manage at least a portion of their logistics activities (Langley, Allen, & Tyndall, 2001).

Firms typically outsource a variety of activities in order to achieve specific objective, which includes reducing costs (Aimi, 2007; Jiang, Frazier, & Prater, 2006; Lau & Zhang, 2006), improving product quality (Bardhan, Whitaker, & Mithas, 2006), improving flexibility (Lau & Zhang, 2006), increasing market coverage (Skjoett-Larsen, 2002), or perhaps to gain ready access to additional capacity (Linder, 2004; Mason, Cole, Ulrey, & Yan, 2002). According to Elliott (2006, p. 22), however, "in most cases the objective of outsourcing is a targeted 20% cost reduction, with actual savings coming from direct labor and variable costs." Yet there is relatively little empirical inquiry into the factors associated with successful cost reduction when outsourcing logistics. Our purpose is to better understand the conditions under which logistics outsourcing is beneficial or detrimental to plant cost performance on a key dimension, the cost of goods sold (COGS).

This paper focuses on three activities that are often outsourced in the supply chain – transportation, warehousing / distribution, and staging / packaging. For a manufacturing plant, transportation involves the shipment of components and raw materials from suppliers to the facility, as well as the shipment of finished goods to warehouses and other customer locations. Warehousing is the storage of components, raw materials and finished goods, while distribution involves the management of goods on the physical path between production and consumption (Coyle, Bardi, & Langley, 2003). Staging may apply to either inbound materials, e.g. kitting of components for a production line, or outbound as in the case of an installation site where materials are needed according to a project schedule. Packaging includes the activities of enclosing finished products for protection while handling in warehouses and transportation vehicles.

This research investigates the relationship between logistics outsourcing and the plant's cost performance through empirical data analysis. In particular, the paper identifies the conditions for which logistics outsourcing improves performance, that is, the main success factors associated with logistics outsourcing. The paper investigates the influence of outsourcing these logistics activities on COGS, which comprises all labor, materials and overhead cost at the plant. In this way, this research adopts a broad view of the impact of outsourcing on cost. The unit of analysis in this study is the manufacturing plant. Additionally, the model investigates eleven moderating factors; structure, strategy, supplier integration, volume and product mix, industry, year, ERP, EDI, TMS, WMS and collaborative forecasting. Four contextual factors were also used in this study; plant age, plant size, type of ownership, and the degree of unionization.

The next section describes the response variables as well as the proposed factors, followed by a discussion of the data and the analysis. Following is a presentation of the results and a discussion of the insight into the underlying process. Finally, the paper is closed with conclusions and recommendations for managers.

SUCCESS IN LOGISTICS OUTSOURCING

The research community has used a variety of theoretical perspectives for investigating the efficacy of outsourcing decisions (Busi & McIvor, 2008). Theories such as Transaction Cost Economics and the Resource-Based View of the firm predict that under the right conditions, the outsourcing of appropriate processes or activities reduces cost (Holcomb & Hitt, 2007; McCarthy & Anagnostou, 2004; McIvor, 2008). TCE argues that firms should consider the cost-benefit tradeoff between internal execution of a process and the external sourcing of the same process as the principle determinant. As such, financial performance metrics are a good measure of the effectiveness of this decision.

Empirical evidence suggests, however, that plants do not always experience consistent improvement in financial performance when outsourcing some portion of their operation (Ehie, 2001; Jiang et al., 2006; Kotabe & Murray, 2004). This failure may be due to competitive priorities that emphasize dimensions other than cost or cost alone (i.e. supplier retention, access to additional capacity, etc). A second explanation relates to mitigating and contextual factors, many of which are proposed in the research literature. Krizman (2009) investigated logistics-specific outsourcing based on a survey of companies in the Slovenian market and found that logistics involvement, knowledge sharing, and innovation have a significant effect on outsourcing performance. Hilletofth and Hilmola (2010) investigated the effects of logistics outsourcing on companies in Northern Europe and found that outsourcing of warehousing, IT, and customs brokerage could have impact on some managerial and strategic aspects of supply chains.

The performance of a firm when outsourcing logistics has been investigated using cost-related performance measures, along with operational/channel and relational dimensions in Knemeyer and Murphy (2004) and Deepen, Goldsby, Knemeyer and Wallenburg (2008). Earlier research largely investigates the influence of relational antecedents such as cooperation, communication, trust, opportunistic behavior, prior satisfaction, responsiveness, assurance, and empathy on performance in this domain. In this study, the influence of logistics outsourcing on COGS is investigated, with an extension into the influence of strategy, structure, environment and integration factors on operational and business performance, as proposed in Stock, Greis and Kasarda (1999). Though focused on the effect of logistics on performance, they proposed that practices, such as logistics integration, can interact with strategy and structure choices to affect performance. In this way, logistics plays a vital role in bridging strategy and structure in the creation of a responsive organization.

The structure of an organization, and its alignment with product, has long been a subject of interest in operations management, but has not received as much attention in logistics and supply chain management (Grover & Malhotra, 2003). Early research in operations strategy has investigated the relationship between strategy, structure and performance. From a traditional perspective, production facilities producing numerous, highly non-standardized products, are typically produced at low volumes with labor intensive processes. As product variety diminishes, and/or the degree of standardization between products increase, production volumes can increase, and the degree of automation used in the processing can increase. Certainly the product-process matrix forms an important element of structure in the manufacturing industries, as proposed by Hayes and Wheelwright (Hayes & Wheelwright, 1979) and subsequently adopted into increasingly sophisticated structure models (Devaraj, Hollingworth, & Schroeder, 2001; Kotha & Orne, 1989). Stock, Greis and Kasarda (Stock et al., 1999) incorporated the logistics activities into this framework, and proposed that practices such as logistics integration can interact with strategy and structure choices to affect performance. For these reasons, structure and strategy variables are included in this research in an attempt to capture the influence of product volume and mix, strategy and structure on manufacturing performance when logistics activities are outsourced.

Earlier empirical research also suggests that supply chain integration influences outsourcing success. Integrating processes between a manufacturing plant and its suppliers often leads to improved performance in inventory, product availability and customer retention (Cheung & Lee, 2002; Marshall, McIvor, & Lamming, 2007). But this integration comes with a cost for both manufacturing and service organizations, as coordination drives costs for monitoring and controlling the outsourced activity (Bakos & Brynjolfsson, 1993; Croom, 2001; Dibbern, Winkler, & Heinzl, 2008). Information technologies can, however, facilitate collaboration by reducing integration costs and the risk of quality and delivery failures (Bardhan et al., 2006; Paulraj & Chen, 2007). Supplier integration and enterprise integration, through the adoption of collaborative information technologies, are also included in this research as potential factors that influence outsourcing outcomes.

As such, this research examines performance in logistics outsourcing, in concert with practices that are likely to influence the outcome – strategy, structure and enterprise integration. Here, a product-process variable, a structure variable, along with variables for collaborative practices and information technologies are all integrated into the model.

DATA & ANALYSIS

The data for this analysis were drawn from the annual Census of Manufacturers survey, conducted by the Manufacturing Performance Institute (MPI) in conjunction with the well-known Industry Week (IW) publication. This survey collects plant-level data on manufacturing metrics, management practices, and financial results. The survey is mailed out to approximately 30,000 invited respondents, plant managers and financial officers, and is advertised online and in IW to the general population. Over the four years (2004-2007) of the survey used in this study, the response rate ranged from 1.33% to 6.43% (3.13% overall). These are gross response rates that include all observations, some of which are later excluded as unusable based on missing information. Also, note that IW/MPI does not report on un-deliverable surveys, so the response rates computed here are understated. This would increase the net response rate to approximately 3.5%, as IW found in an earlier survey that 10-15% were either sent to outdated contact information (the individual no longer worked at the plant) or sent to the wrong individual in the plant (Banker, Bardhan, Hsihui, & Shu, 2006).

The survey's respondents come from a host of different industry segments as defined by the North American Industry Classification System (NAICS), and span twelve different industry supply chain groups. Table 1 in the Appendix shows the participation level for each NAICS category for each of the four years of data used in this study (2004-2007) as compared with the 2002 US Census Bureau figures. This comparison suggests that the MPI sample is largely representative of the U.S. Census Bureau data, but somewhat over-samples electric, metal, chemical, and transportation-related plants and under-samples print, apparel, and furniture-related plants. Earlier research has derived useful results concerning the influence of practices and technologies on manufacturing performance from this database (Bardhan, Mithas, & Lin, 2007; Shah & Ward, 2003; Stratman, 2007; Ward & Zhou, 2006; Watson, Blackstone, & Gardiner, 2007).

This survey contains over a hundred variables that pertain to how the responding plant structures its operation and utilizes its capacity, equipment, information technology, human resources, and supply chain. The primary dependent financial performance variable is COGS = the plant's cost of goods sold as a percentage of plant revenue (Range: 0 to 110). The primary independent variables of interest in this study are the logistics outsourcing variables – i.e. whether or not the plant retained the operation and/or management of its transportation activities (OUTTRANS), warehousing and distribution activities (OUTWRHS), and its staging and packaging activities (OUTPKG), or if these functional activities were outsourced (response is limited to either Yes or No).

There are several moderating variables included in this study, which establish the conditions that hypothetically influence success when outsourcing logistics. A key moderating variable is strategy, which is defined using the strategic priorities variables captured in the survey. The IW/MPI survey asked each respondent to identify the "three objectives that best describe the focus of your market strategy," from a list of the following: low cost, high quality, fast delivery, innovation, product variety, customization, service and support, and total value. Cluster analysis was then used to classify respondents into four strategic groupings, consistent with earlier classification schemes in the literature (Olson, Slater, & Hult, 2005): Prospectors, Analyzers, Low Cost Defenders, and Differentiated Defenders.

The model also includes a structure variable to capture context relating to continuous improvement programs in the plant and market conditions. This variable is defined using the following IW/MPI variables: Who the final products are shipped to, Agile, Total Quality Management (TQM) systems, Degree of Supplier Integration, Degree of Customer Integration, Supplier Relations, Customer Relations, Percentage of Overseas Sales, and the Percentage of Imports. Again, cluster analysis was used to group the respondents into organizational groupings defined as; Narrow Hierarchy Structure, Narrow Market Structure, Narrow Network Structure, Wide Hierarchy Structure, Wide Market Structure, and Wide Network Structure.

The product volume and mix (VOLMIX) variable is used here as a proxy measure for the amount of logistics work at each respondent plant. VOLMIX also provides definition on the processing strategy used by the plant; capturing to some degree the manufacturing cycle time difference between the various production strategies. VOLMIX also serves as a proxy measure for the amount of logistics work at each respondent plant. The competitive environment component of the model is defined using the variable "YEAR" to capture environmental effects related to contextual impacts associated with each of the years that data was collected. The

"IND" variable signifies industry, and is used to capture impacts associated with specific value-chains used by manufacturing plants to distribute/market their products and services.

The last two moderating variables relate to whether or not information is readily shared and processes are integrated across enterprise lines, using the survey items that represented the degree of supplier integration (SUPP-INT), and those IT systems used by the respondents, such as, enterprise resource planning (ERP), electronic data interchange (EDI), collaborative planning and forecasting (FORECAST), transportation management systems (TMS), and warehouse management systems (WMS).

Finally, the context variables that define the basic structure of the plant were also used. These variables include; the type of ownership (PUBLIC) of the plant, the age (AGE) of the plant, the degree of unionization (UNION) in the plant, and the size (EMPLOYEE) of the plant. Table 2 in the Appendix shows the results of the ANOVA analysis of this data. Due to size, the output shown were restricted to only the main effects and the significant interactions (@ 0.10) involving the principle variable being studied.

RESULTS & DISCUSSION

The results of the ANOVA analysis on the main effects are shown in Table 2 in the Appendix. Of the three outsourcing variables, only transportation outsourcing was found to have a significant effect on overall COGS (Pr>0.0344), with the mean value of COGS for plants who retain transportation in-house at 62.4% of revenue versus those who outsource at 64.2%. One explanation for this result is the tactic that firms use to increase profit margins through the lowering of operating expenses. When plants outsource activities, the SG&A portion of operating expenses (OE = Selling, General and Administrative (SG&A) expenses + COGS) may be shifted into COGS via the procurement contract. On the other hand, neither OUTWRHS nor OUTPKG were found to have a significant effect on overall COGS, with Pr>F values of 0.4858 and 0.5518 respectively. Table 2 (Appendix) also identifies variables that were found to influence overall COGS independent of outsourcing, specifically AGE, IND, STRUCTURE, STRATEGY, PUBLIC, UNION, VOLMIX, and FORECASTING were all significant relative to COGS.

The analysis also points to significant interactive effects associated with the outsourcing of all three logistics-based activities. Interestingly, the analysis showed that OUTTRANS tends to benefit larger plants (> 500 employees), but has little or no impact on smaller plants (see Figure 1 in the Appendix). Large plants may provide enough volume to the carrier to alter their cost structure, providing more negotiating power than small plants. Large plants also are most likely serve more diverse markets, which adds enough complexity to require higher levels of expertise than may exist within a small or medium size plant.

Another second order effect was identified for OUTTRANS with UNION, as depicted in Figure 2 in the Appendix. In this case, a lower level of unionization tends to increase COGS when outsourcing transportation, while plants with the highest levels of unionization (over 50%) have no impact. The analysis revealed a three way interaction with OUTTRANS, EMPLOYEE and UNION, and showed that unionization in large plants appears to have a detrimental effect on costs when outsourcing the transportation functions, while small to midsized plants either benefited from, or were not impacted by OUTTRANS. This effect is most likely due to a lack of logistics expertise, or the lack of ability to focus expertise on logistics activities.

Another observed effect is that OUTTRANS has a sizeable detrimental effect on plants with high volume and high product mix, and beneficial effect on plants with high volume and low product mix (see Figure 3 in the Appendix). Increases in mix require numerous experts focused on the unique needs of multiple marketplaces. Outsourcing under these conditions would necessitate higher levels of coordination and synchronization, a situation that is more difficult to achieve with outsourced transportation. This also relates to the complexity of production in high mix environments, and the need for transportation to be flexible and sometimes fast. Transportation contracts are often negotiated to minimize cost, however, which could produce a detrimental result in a high mix plant.

Another interesting interaction occurs when both OUTPKG and OUTTRANS are retained in-house, which our analysis shows will tend to decrease COGS and provide a beneficial condition (see Figure 4 in the Appendix). The model allowed for investigation of three-way interactions here as well and see that this result holds only for for small plants (<500 employees), and for plants with low volume and low mix production. For plants with high volume and high mix, OUTWRHS tends to decrease COGS. This may be explained by observing that small plants may not have the same level of diversity in their marketplaces as large plants, thus minimizing the affect of product mix on the retention of the staging and packaging functions.

Although the main effect of the OUTWRHS on COGS was not significant, there are several significant interactive effects that bear consideration. First, the analysis shows that OUTWRHS tends to benefit larger plants (> 500 employees), but has little or no impact on smaller plants as illustrated in Figure 5 in the Appendix. This is similar to the effect observed to transportation, and again, perhaps the scale of the large plants provide enough volume to the service provider to alter their cost structure, providing more negotiating power for larger plants than for small plants. Another likely reason is the geographic diversity of their marketplaces for large plants, which may make the ownership of warehousing and the personnel to manage them excessively costly when contrasted to outsourcing.

The analysis also suggests that the OUTWRHS for plants with a lower amount of unionization (< 25%) receive benefits in COGS. Higher levels of unionization may add additional levels of complexity to the organization and job/work methods that could drive costs up as shown in Figure 6 in the Appendix. Another second order effects suggest that publicly held plants tend experience a serious penalty in COGS when outsourcing of warehousing and distribution activities. Also, plants with either high production volume and high product mix, or low production volume and low product mix plants benefit in COGS when warehousing and distribution activities are outsourced. Finally, when plants that are relatively new (<5 years) engage in OUTWRHS, they tend to experience an increase in COGS; otherwise, the effect is neutral.

Although the main effect of OUTPKG on COGS was not found significant, again here there were a number of interactive effects. An analysis of the structure variable with this type of outsourcing shows that narrow hierarchy and wide network structures tend to benefit in COGS from the OUTPKG, as in Figure 7 in the Appendix. This may very well relate to the tendency for narrow hierarchies to be very rigid, and for wide network structures to have geographically diverse marketplaces. Yet, staging and packaging functions need to be flexible in order to deal with changing customer demands. Organizationally, this flexibility when outside of the normal organizational structure would benefit Narrow Hierarchies. From a structural standpoint, for the wide network, asset management and customer service can be focused on the requirements of various regions.

The interaction analysis also showed that OUTPKG tends to improve COGS when there is either no supplier integration or extensive supplier integration – the case of some supplier integration with OUTPKG however leads to an increase in COGS (see Figure 8 in the Appendix). This result perhaps relates to whether the plant outsources inbound or outbound packaging and staging. If inbound packaging and staging is outsourced, supplier integration is important, and perhaps is more easily managed with the service provider as an intermediary. If outbound, supplier-facing integration has less of an impact. Another explanation could be that plants that outsource their staging and packing activities with no supplier integration are most likely doing so with a full set of specifications in a relatively stable market, while those with extensive integration are in a relatively unstable/dynamic marketplace. Unfortunately, the survey does not provides us with this level of insight.

Interestingly, the usage of WMS tends to lower COGS when OUTPKG, as depicted in Figure 9 in the Appendix. The increased data sharing that is enabled by a WMS allows for increased coordination leading to enhanced efficiencies and thus lower costs. Other interactions includes plant age, where plants between 5 years of age and 20 years tend to benefit in COGS from the OUTPKG. Finally, publicly held plants tended to experience an improvement in COGS through the OUTPKG.

CONCLUSIONS

This research investigates the effects of logistics outsourcing on plant level COGS. We draw on plant-level performance data collected by the IW/MPI Census of Manufacturers survey, and build statistical models to aid in understanding the degree to which firms benefit from this type of outsourcing practice, as well as the conditions under which it is most likely to fail or succeed. Only OUTTRANS had a first order effect on COGS. The tendency for COGS to increase perhaps best relates to the SG&A portion of operating expenses shifting into COGS via the procurement contract. The influences of OUTWRHS and OUTPKG on COGS were in the second and third order effects. These interactions related to several of the moderating factors in the study; STRUCTURE, SUPP-INT, VOLMIX, and WMS had limited effect on plant performance when outsourcing. There were also interactions relating to all four contextual factors - AGE, EMPLOYEE, PUBLIC, and UNION.

This research contributes to the understanding of the conditions that support success when outsourcing logistics. A key finding is that first order effects are few, so moderating and contextual factors are paramount to success in manufacturing cost performance. From a practical standpoint, this study identifies success factors for logistics outsourcing that are both moderating (i.e. organizational structure, product volume and mix, and the degree of supplier integration) and contextual (i.e. age, size, unionization, and ownership type). Most of the effects are second and third order, which means that there are few easy answers to success factors when outsourcing logistics. Plant managers would do well to avoid those limited conditions that drive costs while seeking the combination of conditions that create a sweet spot in their own operation.

The limitations of this research that limit the degree of generalizability of results include its focus on; U.S. manufacturing and on overall COGS. Future research could include investigation into the components of COGS, as discussed in (Hilletofth & Hilmola, 2010). Similarly, future research might include other measures as prescribed in the balanced scorecard perspective, including finance, customer, internal business processes and learning & growth (Weimer & Seuring, 2009).

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Appendix

Table 1: NAICS Composition of Respondents to the IW/MPI Census of Manufacturer's Survey

NAICS Category	2004		2005		2006		2007		Total		2002 US Census Bureau
	Freq	Pct	Freq	Pct	Freq	Pct	Freq	Pct	Freq	Pct	
311 – Food Related	35	5.31%	16	2.47%	30	3.84%	20	4.73%	141	4.10%	7.66%
312 – Beverage Tobacco	6	0.91%	1	0.15%	3	0.38%	3	0.71%	17	0.49%	0.87%
313 – Textile Fabrics	17	2.58%	10	1.54%	3	0.38%	5	1.18%	48	1.39%	1.14%
314 – Textile Mill	2	0.30%	5	0.77%	3	0.38%	4	0.95%	16	0.46%	2.13%
315 – Apparel Accessory	2	0.30%	7	1.08%	4	0.51%	1	0.24%	22	0.64%	3.64%
316 – Leather Etc	0	0.00%	1	0.15%	0	0.00%	2	0.47%	4	0.12%	0.44%
321 – Wood Products	7	1.06%	16	2.47%	18	2.30%	16	3.78%	80	2.32%	4.91%
322 – Paper	20	3.03%	19	2.93%	18	2.30%	17	4.02%	97	2.82%	1.59%
323 – Print Related	10	1.52%	16	2.47%	23	2.94%	10	2.36%	73	2.12%	10.80%
324 – Petroleum & Coal	1	0.15%	3	0.46%	2	0.26%	3	0.71%	15	0.44%	0.66%
325 – Chemicals	57	8.65%	43	6.63%	64	8.18%	39	9.22%	263	7.64%	3.81%
326 – Plastics & Rubber	29	4.40%	42	6.47%	39	4.99%	13	3.07%	186	5.41%	4.45%
327 – Nonmetals & Mineral	11	1.67%	25	3.85%	22	2.81%	8	1.89%	84	2.44%	4.82%
331 – Primary Metal Mfg	32	4.86%	33	5.08%	44	5.63%	23	5.44%	199	5.78%	1.73%
332 – Fab. Metal Products	102	15.48%	125	19.26%	105	13.43%	62	14.66%	502	14.59%	17.60%
333 – Nonelec. Machinery	110	16.69%	99	15.25%	160	20.46%	68	16.08%	600	17.44%	8.17%
334 – Computer & Elect.	60	9.10%	58	8.94%	61	7.80%	52	12.29%	299	8.69%	4.56%
335 – Elec. Eq., Appl. & Cmpnt.	33	5.01%	36	5.55%	38	4.86%	16	3.78%	172	5.00%	1.86%
336 – Transportation Eq.	58	8.80%	41	6.32%	66	8.44%	29	6.86%	269	7.82%	3.56%
337 – Furniture etc	26	3.95%	11	1.69%	22	2.81%	9	2.13%	96	2.79%	6.34%
339 – Misc Mfg	41	6.22%	42	6.47%	57	7.29%	23	5.44%	258	7.50%	9.26%
Total	659	100%	649	100%	782	100%	423	100%	3441	100%	100

Table 2: ANOVA Analysis Results

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	906	543909.0604	600.3411	1.93	<.0001
Error	826	257473.9298	311.7118		
Corrected Total	1732	801382.9902			

R-Square	Coeff Var	Root MSE	COGS Mean
0.678713	27.90827	17.65536	63.26212

Source	DF	Anova SS	Mean Square	F Value	Pr > F
year	3	1235.00107	411.66702	1.32	0.2664
age	3	3014.39984	1004.79995	3.22	0.0221
EDI	1	923.47239	923.47239	2.96	0.0856
Employees	4	2851.12419	712.78105	2.29	0.0585
ERP	1	691.32045	691.32045	2.22	0.1368
Forecast	1	3657.96693	3657.96693	11.74	0.0006
Ind	11	25927.07461	2357.00678	7.56	<.0001
OutTrans	1	1415.00175	1415.00175	4.54	0.0334
OutPkg	1	111.77357	111.77357	0.36	0.5495
OutWrhs	1	153.33714	153.33714	0.49	0.4833
public	1	2924.67935	2924.67935	9.38	0.0023
Strategy	3	4973.53981	1657.84660	5.32	0.0012
Structure	5	10178.88988	2035.77798	6.53	<.0001
Supp_Int	2	283.45821	141.72910	0.45	0.6348
TMS	1	1086.45432	1086.45432	3.49	0.0623
Union	5	3742.57596	748.51519	2.40	0.0356
VolMix	3	5832.45482	1944.15161	6.24	0.0003
OutTrans*Employees	4	4149.09620	1037.27405	3.33	0.0102
OutTrans*Union	5	5636.02132	1127.20426	3.62	0.0031
OutTrans*VolMix	3	2428.89796	809.63265	2.60	0.0512
OutPkg*age	3	2511.15965	837.05322	2.69	0.0456
OutPkg*public	1	1579.76373	1579.76373	5.07	0.0246
OutPkg*Structure	5	6594.99057	1318.99811	4.23	0.0008
OutPkg*Supp_Int	2	3399.57738	1699.78869	5.45	0.0044
OutPkg*Union	3	2137.47641	712.49214	2.29	0.0774
OutTrans*OutPkg	1	1388.11863	1388.11863	4.45	0.0351
OutWrhs*age	3	2093.56674	697.85558	2.24	0.0823
OutWrhs*Employees	4	6206.67089	1551.66772	4.98	0.0006
OutWrhs*public	1	1230.58777	1230.58777	3.95	0.0473
OutWrhs*Union	4	3753.92545	938.48136	3.01	0.0176
OutWrhs*VolMix	3	2216.15716	738.71905	2.37	0.0693

Figure 1. Interaction between plant size and transportation outsourcing

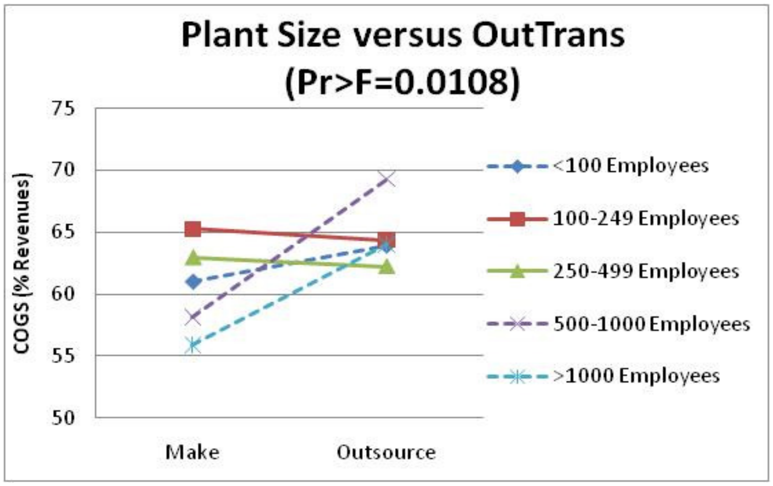


Figure 2. Interaction between unionization and transportation outsourcing

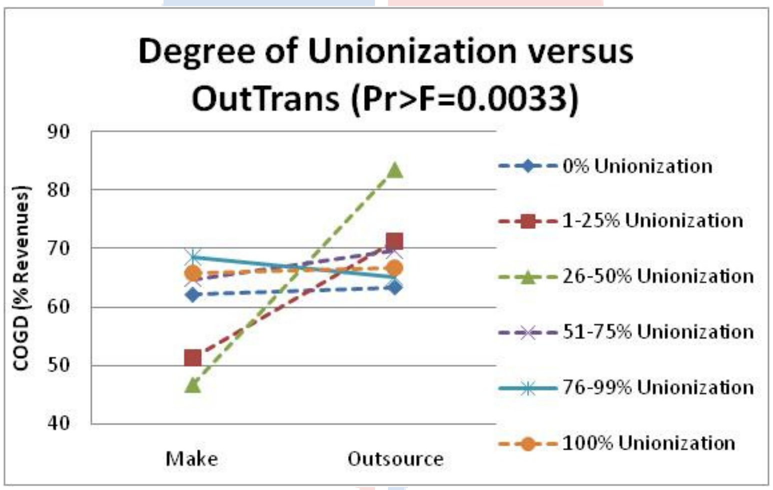


Figure 3. Interaction between plant volume and mix and transportation outsourcing

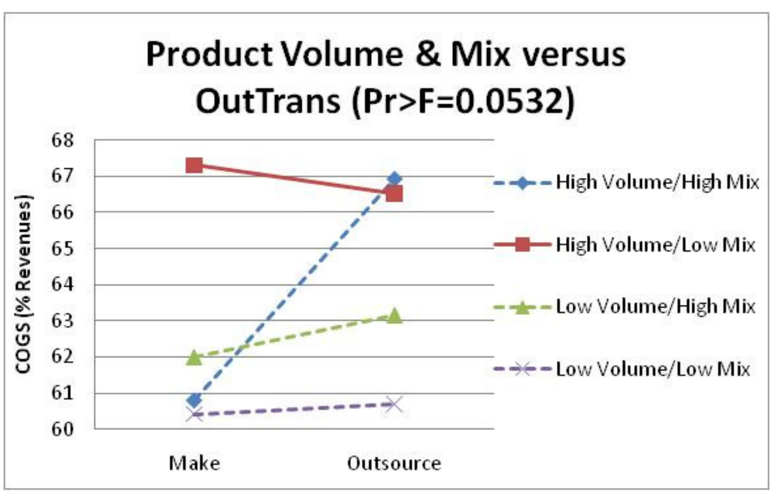


Figure 4. Interaction between packaging outsourcing and transportation outsourcing

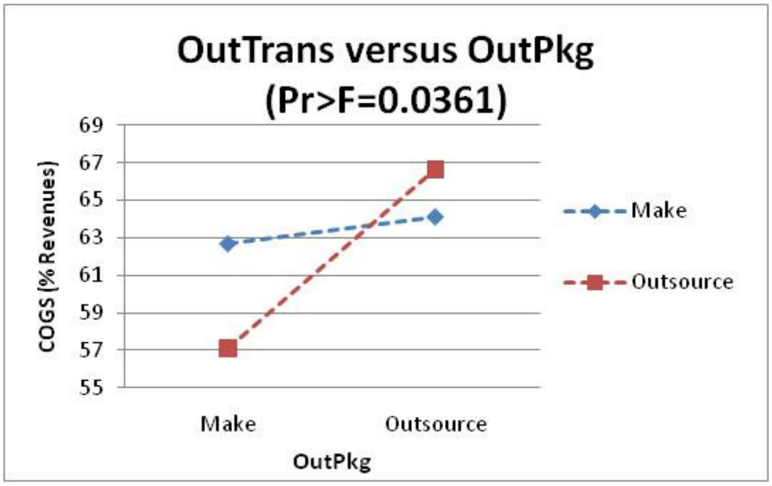


Figure 5. Interaction between plant size and warehousing outsourcing

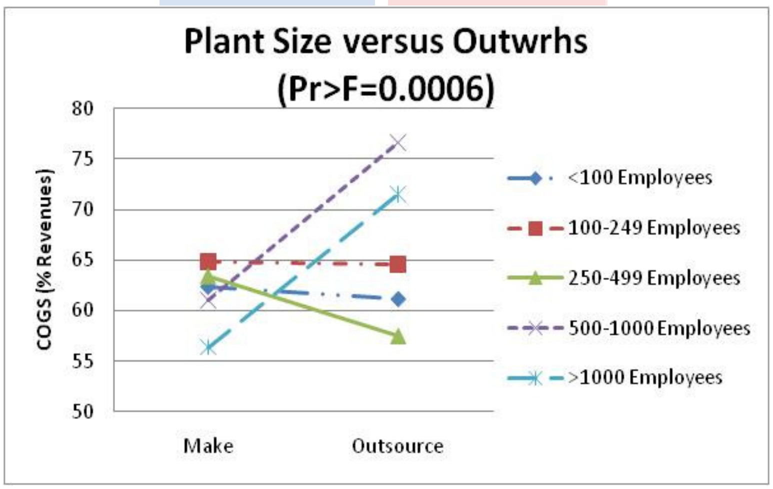


Figure 6. Interaction between unionization and warehousing outsourcing

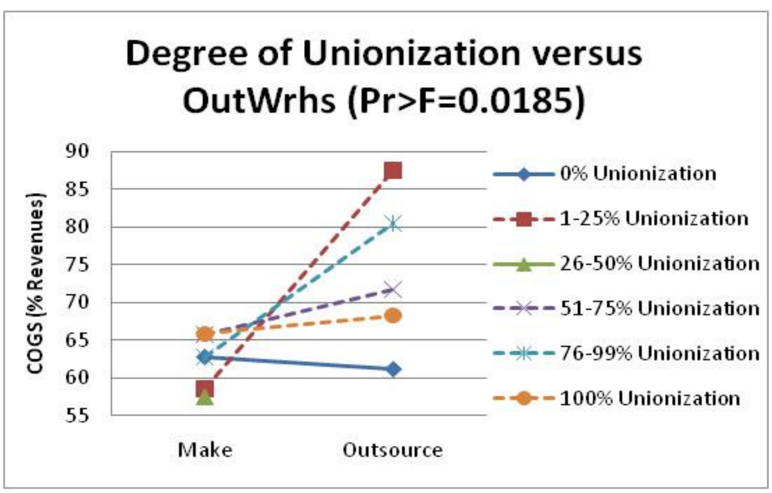


Figure 7. Interaction between structural alignment and packaging outsourcing

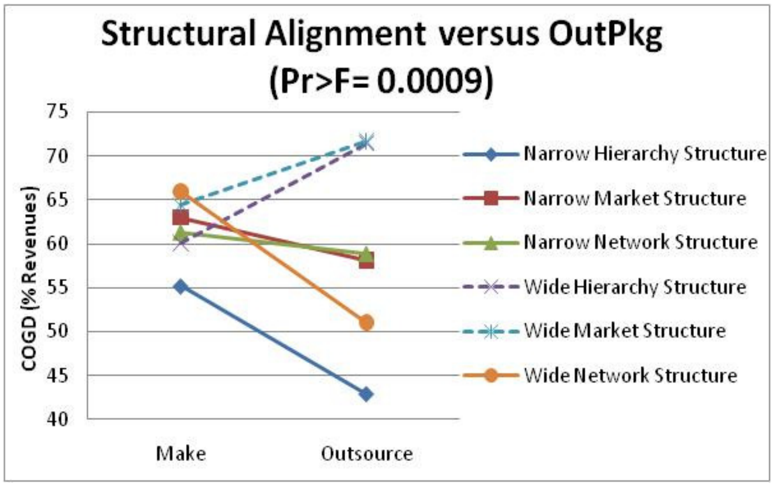


Figure 8. Interaction between supplier integration and packaging outsourcing

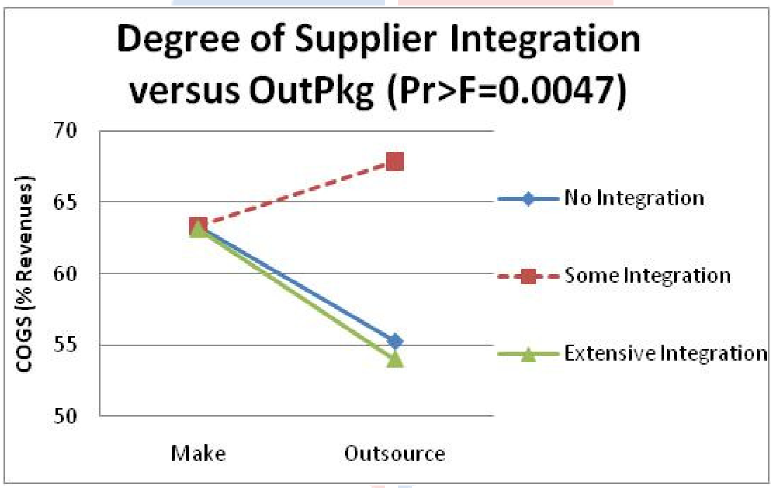
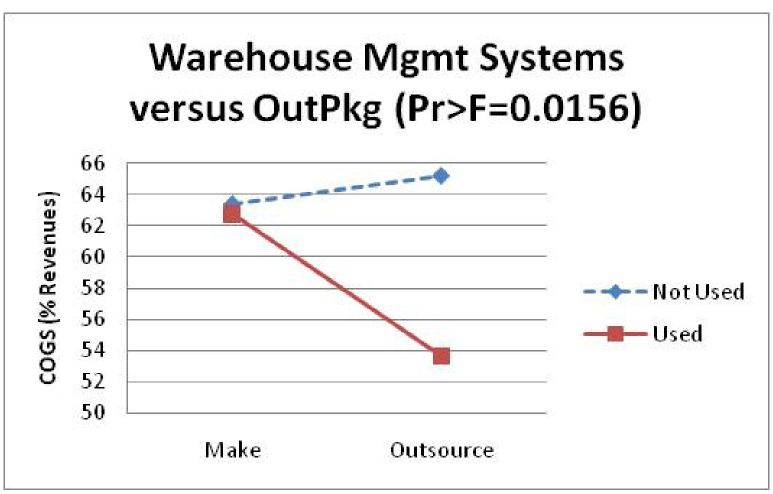


Figure 9. Interaction between WMS and packaging outsourcing



Authors' Biographic Summaries:

Dr. George N. Kenyon is an Associate Professor of Operations Management at Lamar University. He received his B.S. in Technology from the University of Houston, an M.S. in Management Science from Florida Institute of Technology, and a Ph.D. in Business Administration from Texas Tech University. Dr. Kenyon has extensive industry experience in engineering, manufacturing, business planning, and supply chain management. Dr. Kenyon's research has been published in several noted journals such as; *Quality Management Journal, Journal of Marketing Channels, and the International Journal of Production Economics.*

Dr. Mary J. Meixell is an Associate Professor of Management at Quinnipiac University in Hamden, CT. She earned a B.S. in Civil Engineering from Penn State University, an M.S. in Transportation from Massachusetts Institute of Technology, and a Ph.D. in Industrial Engineering from Lehigh University. Dr. Meixell has a noteworthy industry background in production planning and logistics operations. Her research has appeared in journals that include *IEEE Transactions in Engineering Management, the International Journal of Production Research, and Transportation Research*.