

COMPETITIVE ADVANTAGE THROUGH OPERATIONS SYSTEM AND SUPPLIER NETWORK RESPONSIVENESS

Ashish Thatte, Gonzaga University, USA
thatte@gonzaga.edu

Parag Dhumal, University Of Wisconsin - Parkside, USA
dhumal@uwp.edu

Vikas Agrawal, Jacksonville University, USA
vagrawa@ju.edu

ABSTRACT

This study extends Thatte and Agrawal's (2017) research which found positive effects of operations system responsiveness (OSR) and supplier network responsiveness (SNR) on competitive advantage (CA), and Thatte, Rao, and Ragu-Nathan's (2013) research which found positive relationships between supply chain management (SCM) practices, supply chain responsiveness (SCR), and CA. As such, by utilizing MANOVA, this study analyses how CA is effected by high and low levels of OSR and SNR. The study finds that high levels of OSR create high levels of CA for a firm collectively and individually on price, delivery dependability, product innovation, and time to market. The study also finds that high levels of SNR create high levels of CA for a firm collectively and individually on price and delivery dependability. Useful implications of the findings are drawn and discussed.

INTRODUCTION

Firms are finding it useful to aptly respond to changing customer needs (Huber, 1984; Ward, McCreery, Ritzman, & Sharma, 1998) and supply disruptions (Christopher & Peck, 2004; Lee, 2004) in today's global supply chains. Consistent with Thatte and Agrawal (2017) and Thatte, Rao, and Ragu-Nathan (2013), this research studies the SCR construct from the customer demand perspective, rather than a supply disruption perspective.

Thatte and Agrawal (2017) found OSR and SNR to positively impact CA. Thatte et al. (2013) dealt with large scale instrument validation and hypotheses testing between SCR and CA using structural equation modeling and found positive relationship between SCR and CA, SCM practices and SCR, and SCM practices and CA. This study extends Thatte and Agrawal's (2017) and Thatte et al.'s (2013) studies by examining how CA responds to high and low levels of OSR and SNR, in order to draw implications. Such a dimension level analysis between SCR and CA is lacking in

existing literature and this study aims to fill this research gap by offering insights into these relationships. Such an analysis can contribute towards providing more meaningful research implications.

The relationships among the constructs were tested using MANOVA, using data collected from 294 respondents to a survey questionnaire. The remainder of the paper is organized as follows. Section 2 presents the research framework, definitions, and theory underlying each dimension of SCR and CA. The research questions are identified in section 3. The research methodology and results of data analyses are described in sections 4 and 5 respectively. Section 6 presents the findings and implications of the study, while section 7 concludes the study by offering limitations and directions for future research.

RESEARCH FRAMEWORK

Figure 1 presents the framework being investigated in this research. Thatte et al. (2013) developed the SCR construct and a valid and reliable measurement instrument for SCR through rigorous statistical methodologies, including pretest, pilot-test, confirmatory factor analysis, unidimensionality, reliability, and validation of second-order construct.

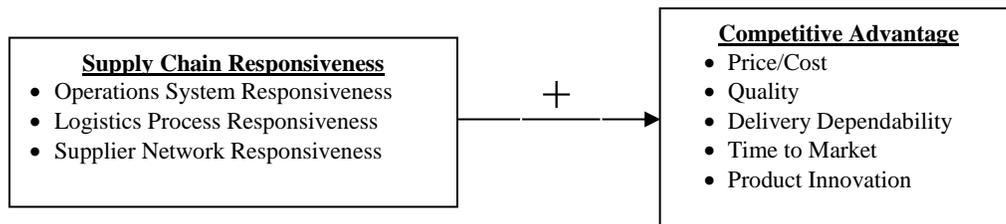


FIGURE 1. RESEARCH FRAMEWORK

Supply Chain Responsiveness (SCR)

SCR is defined as the capability of promptness and the degree to which a supply chain can address changes in customer demand (Duclos, Vokurka, & Lummus, 2003; Holweg, 2005; Lummus, Duclos, & Vokurka, 2003; Prater, Biehl, & Smith, 2001). This responsiveness is aggregate of three first-order constructs operations system responsiveness (OSR), logistics process responsiveness (LPR), and supplier network responsiveness (SNR). SCR is the ability of the supply chain to rapidly address changes and requests in the marketplace (Holweg, 2005), which implies that speed combined with flexibility results in responsiveness (Prater et al., 2001). Thatte et al. (2013) conceptualized and operationalized OSR, LPR, and SNR as three sub-constructs of SCR.

OSR is defined as the ability of a firm's manufacturing system to address changes in customer demand (Thatte et al., 2013). Although it encompasses manufacturing and service operations, this study focusses on firms within the manufacturing industry. In manufacturing operations, it includes the ability to rapidly configure or reconfigure assets and operations of a manufacturing

system in order to cope with consumer trends (Lummus et al., 2003; Wu, 2001), respond to changes in product volume, respond rapidly to unexpected events, effectively expedite emergency customer orders, and an ability to swiftly accommodate special or non-routine customer requests. OSR at each node in a supply chain is an integral component of SCR, since each entity in a supply chain is required to deliver the product or service in a timely and reliable manner, to fulfill customer demands (Duclos et al., 2003; Lummus et al., 2003; Meehan & Dawson, 2002). The items under this category measure the responsiveness associated with a specific node or firm in a supply chain (Duclos et al., 2003; Lummus et al., 2003). Measures used to operationalize the OSR construct are: operations system's ability to – respond rapidly to changes in product volume demanded by customers, effectively expedite emergency customer orders, rapidly reconfigure equipment to address demand changes, rapidly reallocate people to address demand changes, and rapidly adjust capacity to address demand changes.

LPR is defined as the ability of a firm's outbound transportation, distribution, and warehousing system (including 3PL/4PL) to address changes in customer demand (Thatte et al., 2013). These activities include warehousing, packing and shipping, transportation planning and management (Duclos et al., 2003; Lummus et al., 2003; Ricker & Kalakota, 1999), inventory management, reverse logistics, order tracking and delivery. This study focuses on the outbound logistics of the focal firm. The responsiveness in the logistic processes is a vital component in the success of a responsive supply chain strategy (Fawcett, 1992). Fuller, O'Connor, and Rawlinson (1993) suggest that a firm's logistics system is instrumental in creating value for its customers. This value creation for a firm's customers implies ensuring logistics flexibility (Duclos et al., 2003; Lummus et al., 2003) and speed within the supply chain to serve each distinct customer's needs. Responsiveness components in the logistics system include selecting logistics components that accommodate and respond to wide swings in demand over short periods, adjust warehouse capacity to address demand changes, handle a wide range of products, vary transportation carriers, have the ability to pack product-in-transit to suit discreet customers' requirements, and have the ability to customize products close to the customer (i.e. postponement), and do all of these speedily in order to gain a CA. Hise (1995) maintains that the logistics system of a firm needs to be flexible and responsive in order to be able to adjust its logistics resources rapidly for satisfying market needs. It is also important that firms have easy access to and are able to utilize different modes of transportation to be logistically flexible and responsive (Prater et al., 2001). Lummus et al. (2003) present critical logistics process flexibility aspects of a supply chain, which are vital for SCR. These aspects have been adapted for LPR to form its measures: logistics system's ability to - rapidly respond to unexpected demand change, rapidly adjust warehouse capacity to address demand changes, rapidly vary transportation carriers to address demand changes, and effectively deliver expedited shipments.

SNR is defined as the ability of a firm's major suppliers to address changes in the firm's demand (Thatte et al., 2013). The ability of firms to react quickly to customer demand is dependent on the reaction time of suppliers to make volume changes. A key to responsiveness is the presence of responsive and flexible partners upstream and downstream of the focal firm (Christopher & Peck, 2004). Supply chain networks must be ready to react to any ripple effects due to supply disruptions as well (Walker, 2005). In order to have a CA, organizations need to meet the changing needs of customers by being able to rapidly supply products, including any demand changes in terms of product volume, mix, product variations, and new product introductions. Meeting these needs

requires responsiveness in the supply chain at various stages from the raw materials to finished products to distribution and delivery. Supplier networks are the essential building blocks of a flexible system and their flexibility is an important ingredient of being responsive to customers (Holweg & Pil, 2001; Slack, 1991). In order to be responsive, organizations should be able to select suppliers who can add new products quickly and have suppliers make desired changes. Fisher, Ramen, and McClelland (2000) found that for short lifecycle products, such as fashion apparel, retailers are most successful if they can work with suppliers who can provide initial shipments of product based on forecasts, but then rapidly increase production to the right style, color, size, etc. based on actual sales. Several studies (e.g. Choi & Hartley, 1996) suggest that supplier selection based on product development capabilities, rapid deployment capabilities or product volume flexibility positively impact the delivery time of new products. Holweg (2005) found that the lack of supplier network flexibility hampered its customer's responsiveness capability. Supplier network flexibility (Slack, 1991) and thus SNR (Thatte et al., 2013) is an important part of SCR. The measures of SNR used in this study are: major suppliers' ability to - change product mix in a relatively short time, consistently accommodate the firm's requests, provide quick inbound logistics to the firm, and effectively expedite emergency orders.

Competitive Advantage (CA)

CA is defined as the "capability of an organization to create a defensible position over its competitors" (Li, Ragu-Nathan, Ragu-Nathan, & Rao, 2006, p. 111). CA comprises of distinctive competencies that sets an organization apart from competitors, thus giving them an edge in the marketplace (Tracey, Vonderembse, & Lim, 1999). CA traditionally involved the choice regarding the markets in which a firm would compete, defending market share in clearly defined segments using price and product performance attributes (Day, 1994). Competition in today's global economy depends on anticipating and quickly responding to changing market needs. Porter's approach to CA centers on a firm's ability to be a low-cost producer in its industry, or to be unique in its industry in some aspects that are popularly valued by customers (Porter, 1991). Most managers agree that cost and quality will continue to remain the CA dimensions of a firm (D'Souza & Williams, 2000). Wheelwright (1978) suggests cost, quality, dependability and speed of delivery as some of the critical competitive priorities for manufacturing. 'Time' has been argued to be a dimension of CA in other research contributions (viz. Stalk, 1988; Vesey, 1991; Zhang, 2001). There is widespread acceptance of time to market as a source of CA (Holweg, 2005). Price/cost, quality, delivery dependability, and time to market have been consistently identified as important competitive capabilities (Skinner, 1985; Tracey et al., 1999; Vokurka et al., 2002; White, 1996). In a research framework, Koufteros, Vonderembse, and Doll (1997) describe competitive pricing, premium pricing, value-to-customer quality, dependable delivery, and product innovation as the five dimensions of competitive capabilities. These dimensions were further described and utilized in other contributions as well (Cleveland, Schroeder, & Anderson, 1989; Koufteros, Vonderembse, & Doll, 2002; Li et al., 2006; Rondeau, Vonderembse, & Ragu-Nathan, 2000; Safizadeh, Ritzman, Sharma, & Wood, 1996; Tracey et al., 1999; Vickery, Calantone, & Dröge, 1999). CA has been operationalized in existing literature (Koufteros et al., 1997; Zhang, 2001) and the measures have been adopted in this study with minor modifications. Based on the study of Koufteros (1995),

Zhang (2001), and Li et al. (2006) and as used in Thatte et al. (2013) this study uses price, quality, delivery dependability, product innovation, and time to market as the five dimensions of CA.

RESEARCH QUESTIONS

This study aims at answering the following research questions: (1) Are there significant mean differences in CA of a firm, as measured by a combination of price, quality, delivery dependability, product innovation, and time to market, for high and low OSR / SNR? (2) Are there significant mean differences in CA of a firm based on 'price', for high and low OSR / SNR? (3) Are there significant mean differences in CA of a firm based on 'quality', for high and low OSR / SNR? (4) Are there significant mean differences in CA of a firm based on 'delivery dependability', for high and low OSR / SNR? (5) Are there significant mean differences in CA of a firm based on 'product innovation', for high and low OSR / SNR? and (6) Are there significant mean differences in CA of a firm based on 'time to market', for high and low OSR / SNR?

RESEARCH METHODOLOGY

This study adopts the SCR instrument developed by Thatte et al. (2013) and the CA instrument developed by Zhang (2001) and Koufteros et al. (1997). The items for these instruments are listed in Appendix B. The unit of analysis in this study is a firm since SCR is dependent on the individual operating firms within a supply chain. Past studies (ex: Swafford, Ghosh, & Murthy, 2006) have used similar unit of analysis. Also a study that encompasses the entire supply chain domain, from raw materials through production/assembly at multiple stages/organizations, through delivery via diverse distribution channels, would be complex, time consuming, and costly.

Large-scale data collection was conducted using a web-based survey grounded on methods of Dillman (2000). E-mail lists were purchased from The Council of Supply Chain Management (CSCMP), Rsateleservices.com, and Lead411.com. Seven SIC codes were covered in the study: 22 "Textile Mill products", 23 "Apparel and other Textile Products", 25 "Furniture and Fixtures", 34 "Fabricated Metal Products", 35 "Industrial Machinery and Equipment", 36 "Electrical and Electronic Equipment", and 37 "Transportation Equipment." The lists were limited to organizations with more than 100 employees as these organizations were most likely to engage in SCM initiatives. Since the focus of this study is SCM, the target respondents were the operations / manufacturing / purchasing / logistics / materials / supply chain – vice presidents, directors, and managers, as these personnel were deemed to have the best knowledge of the supply chain area. The respondents were asked to refer to their major suppliers or customers when answering the questionnaire. The final version of the questionnaire was administered by e-mail to 5,498 target respondents. To ensure a reasonable response rate, the survey was e-mailed in three waves.

The response rate was calculated based on the number of click-throughs the emailing generated and total number that was converted to a completed survey. After three waves of emailing a total of 714 click-throughs were generated and 294 completes were obtained to provide a good response

rate of 41.18%. Response rate based on the click-throughs may represent a better measure for email surveys, since bulk emails sent out in this manner are treated as spam by respondents' organizations' email program and may never be retrieved or viewed by the target respondent. Since it is highly difficult to track this information accurately, a more appropriate measure would be to base the analysis on the number of people who have visited the site and have had an opportunity to review the request and purpose of this study, and then may have declined to complete the survey based on any number of reasons. 11% of the respondents are CEO/President, 45% are Vice Presidents, 25% are Directors, and 19% are titled as Managers. Thus 81% of the respondents (CEOs, VPs, and Directors) are high-level executives, implying a high reliability of the responses received, as these executives have a wider domain (job responsibility) and administrative knowledge. This is consistent with past survey-based research studies in SCM (ex: Frohlich & Westbrook, 2002). The areas of expertise were 11% executives (CEOs/Presidents), 12% purchasing, 22% SCM, 18% distribution/transportation/logistics, 20% manufacturing/production, 10% materials, and 7% belong to other category such as sales. Thus the respondents' domains cover all key functions across the supply chain ranging from purchasing, to manufacturing, to sales, to distribution. Also, since 33% of the respondents have been with the organization for over 10 years and 21% have been at their organization between 6-10 years, implies that majority of the respondents have a comprehensive view of their firm's supply chain program.

This research did not investigate non-response bias directly since the email lists had only names and email addresses of individuals without the organizational details. This research compares those subjects who responded after the first e-mailing wave and those who responded to the second/third wave. The succeeding waves of survey were considered to be representative of non-respondents (Armstrong & Overton, 1977; Lambert & Harrington, 1990). Similar methodology has also been used in prior SCM empirical research (Chen & Paulraj, 2004; Handfield & Bechtel, 2002; Li, Rao, Ragu-Nathan, & Ragu-Nathan, 2005). Chi-square tests (χ^2 statistic) were used to make the comparisons. No significant difference in industry type (based on SIC), employment size, and respondent's job title was found between these two groups (i.e. $p > 0.1$, when testing the null hypotheses: there is no significant difference in distribution of responses across SIC codes/employment size/job title between groups). Further, Chi-square tests of independence were also performed to observe if the distribution of responses across SIC codes, employment size, and respondent's job title is independent of the three waves when considered independently. No significant difference in industry type (based on SIC), employment size, and respondent's job title was found between each of the three groups / waves.

RESULTS

Thatte et al. (2013) found SCR to have a direct positive impact on CA of a firm and confirmed the assertion in literature that a responsive supply chain in terms of an organization's operations system, logistics and distribution processes, and suppliers could provide firms with CA on cost, quality, delivery dependability, product innovation, and time-to-market dimensions. This study builds on Thatte and Agrawal's (2017) study which found OSR and SNR dimensions of SCR to be significant in predicting CA on a composite basis. The data analysis utilized MANOVA to study how CA and its dimensions are impacted with high and low levels of OSR and SNR can provide

additional insights into improving CA and its constituents by means of OSR and SNR. Thatte and Agrawal's (2017) study which utilized regression analyses did not find support for impact of OSR or SNR on CA dimensions, with the exception of 'delivery dependability.' This section aims at understanding if the measures of CA when considered collectively and individually, significantly differ for high and low levels of SCR dimensions.

MANOVA has several advantages over ANOVA (analysis of variance) (Tabachnick & Fidell, 1996). First, by measuring several DVs instead one, the chances of discovering what actually changes as a result of the differing treatments or characteristics, and any interactions, improve greatly. Thus, we improve our chances of uncovering these effects by including the measures of CA in the analysis. A second advantage is that, under certain conditions, MANOVA can reveal differences that separate ANOVAs might not (Stevens, 1992; Tabachnick & Fidell, 1996). There are several available test statistics for MANOVA, including Wilks' Lambda (λ), Pillai's Trace, Hotelling's Trace, and Roy's Largest Root. The most commonly used is the Wilks' Lambda. Wilks' λ ranges from zero to one. The smaller the value of λ , more is the evidence for treatment effects or group differences (Stevens, 1992).

Thatte and Agrawal (2017) found OSR and SNR as two significant dimensions of SCR that predict CA. Thus for conducting MANOVA only OSR and SNR have been considered as two distinct independent variables (IVs). The dependent variables (DVs) are the five dimensions of CA (viz. price, quality, delivery dependability, product innovation, and time-to-market). The results of MANOVA shall answer the research questions presented in section 3.

This study follows the data analysis procedure for MANOVA as outlined by Mertler and Vannatta (2016). First, we evaluate Box's Test. If homogeneity of variance-covariance is assumed, we utilize Wilks' Lambda statistic when interpreting the multivariate tests. If the assumption of equal variances is violated, we use Pillai's Trace. Second, once the multivariate test statistic has been identified, we examine the significance (F-ratios and p-values) of factor interaction, which is necessary if two or more IVs are included. Third, we examine the significance of each factor's main effect by utilizing the F-ratios and p-values. If the results are significant, we proceed to the next step. If results are not significant, we stop data analysis. Fourth, we examine the univariate tests (ANOVAs) of individual DVs. If any tests are significant, we proceed to the next step. If tests are found to be not significant, we stop data analysis. Fifth, we perform Roy-Bargman stepdown F-test to support the results of ANOVA (Hair, Anderson, Tatham, & Black, 1998). Finally, we examine post hoc tests for the individual DVs.

Thatte and Agrawal (2017) found OSR to be the first SCR dimension to predict CA on a composite basis. We therefore perform a one-way MANOVA with OSR as IV, with high and low categories, and the five dimensions of CA as quantitative DVs. We utilize the OSR scale developed by Thatte et al. (2013), which was a 5-point Likert scale measured from 1 (not at all) to 5 (to a great extent). We define the "high" category as a score of 4 or 5, and "low" category as a score of 3 or below. It is desired that the DVs that are entered in the MANOVA analysis be correlated (Hair et al., 1998; Mertler and Vannatta, 2016). Therefore, before proceeding with the multivariate tests, Pearson correlation was performed to determine if the DVs are significantly correlated. Table 1 shows the Pearson correlation results.

TABLE 1. PEARSON CORRELATIONS FOR CA DIMENSIONS

	Price	Quality	Delivery Dependability	Product Innovation	Time to Market
Price	1	0.180**	0.222**	0.069	0.207**
Quality	0.180**	1	0.214**	0.108	0.078
Delivery Dependability	0.222**	0.214**	1	0.030	0.230**
Product Innovation	0.069	0.108	0.030	1	0.238**
Time to Market	0.207**	0.078	0.230**	0.238**	1

** Correlation is significant at 0.01 level

Results show some correlation between price, quality, delivery dependability, product innovation, and time to market. Since some correlation is observed, we proceed with the MANOVA tests. MANOVA was conducted utilizing the multivariate procedure in SPSS. The Box’s Test presented in Table 2 tests the null hypothesis that the observed covariance matrices of the DV are equal across groups. The results show that the test is not significant, indicating that homogeneity of variance-covariance is fulfilled, $F(15, 242285.4) = 1.498$, $p = 0.096$, subsequently needing a Wilks’ Lambda test statistic to interpret MANOVA results.

TABLE 2. BOX’S TEST OF EQUALITY OF COVARIANCE MATRICES FOR OSR

Box’s M	22.914
F	1.498
df1	15
df2	242285.4
Sig.	0.096

The Wilks’ Lambda multivariate test is presented in Table 3. MANOVA results indicate that the combined DV of price, quality, delivery dependability, product innovation, and time to market, significantly differs for high and low levels of OSR (Wilks’ $\lambda = 0.858$, $F(5, 288) = 9.527$, $p = 0.000$, partial $\eta^2 = 0.142$). However, the multivariate effect size, η^2 , is small, which reveals low strength in associations.

TABLE 3. WILKS’ λ MULTIVARIATE TEST OF SIGNIFICANCE FOR OSR

Test	Value	F	Hypothesis df	Error df	Sig. (p)	Partial Eta Squared
Wilks’ Lambda	0.858	9.527	5	288	0.000	0.142

Since the multivariate test was significant, we examine the univariate ANOVA results of individual DVs as presented in Table 4. As recommended by Tabachnick and Fidell (1996), ANOVA results are interpreted using a conservative alpha level of $\alpha = 0.01$ (i.e. 0.05/5) to counteract the potential of an inflated type I error rate which can be caused due to multiple ANOVAs.

ANOVA results indicate that the CA of a firm based on price ($F(1, 292) = 9.637, p < 0.01$, partial $\eta^2 = 0.032$), delivery dependability ($F(1, 292) = 16.085, p < 0.001$, partial $\eta^2 = 0.052$), product innovation ($F(1, 292) = 16.568, p < 0.001$, partial $\eta^2 = 0.054$), and time-to-market ($F(1, 292) = 20.421, p < 0.001$, partial $\eta^2 = 0.065$), significantly differs for high and low levels of OSR. Although significant group differences were found for these four DVs, the effect sizes are small, indicating that a small proportion of variance in the individual abilities of a firm to compete based on price, delivery dependability, product innovation, and time to market, is accounted for by OSR. The ability of an organization to compete based on quality does not significantly differ for high and low levels of OSR ($F(1, 292) = 0.095, p = 0.759$, partial $\eta^2 = 0.000$).

TABLE 4. ANOVA SUMMARY TABLE FOR OSR

Source	DV	Sum of Squares	df	Mean Square	F	Sig. (p)	Partial Eta Squared
OSR	Price	7.812	1	7.812	9.637	0.002	0.032
	Quality	0.030	1	0.030	0.095	0.759	0.000
	Delivery Dependability	7.434	1	7.434	16.085	0.000	0.052
	Product Innovation	11.313	1	11.313	16.568	0.000	0.054
	Time to Market	13.092	1	13.092	20.421	0.000	0.065

Roy-Bargman stepdown F test, as presented in Table 5, was performed to support the results of ANOVA and to check for significance of group differences while allowing DV inter-correlation. This test will assure that the effect of OSR on individual DVs is not due to the inter-correlation effect between the DVs, but by itself. Results show that four variables – price ($F(1, 292) = 9.637, p < 0.01$), delivery dependability ($F(1, 290) = 12.443, p < 0.001$), product innovation ($F(1, 289) = 16.342, p < 0.001$), and time to market ($F(1, 288) = 6.810, p = 0.01$) have unique differences across high and low levels of OSR, indicating that the four dimensions of CA are not so highly correlated with each other that there are no unique differences in each of them after the effects of the other three are accounted for.

TABLE 5. ROY-BARGMAN STEPDOWN F TESTS FOR OSR

Variable	Between-Groups Mean Square	Within-Groups Mean Square	Stepdown F	Degrees of Freedom		Significance of Stepdown F
				Between	Within	
Price	7.812	0.811	9.637	1	292	0.002
Quality	0.019	0.306	0.062	1	291	0.804
Delivery Dependability	5.386	0.433	12.443	1	290	0.000
Product Innovation	11.116	0.680	16.342	1	289	0.000
Time to Market	4.035	0.593	6.810	1	288	0.010

Result suggests that, the level of OSR has significant separate effects on CA based on price that are unrelated to the CA of a firm based on delivery dependability, product innovation, and time to market. Similarly, results also show that: the level of OSR has significant separate effects on CA based on delivery dependability that are unrelated to the CA based on price, product innovation, and time to market; level of OSR has significant separate effects on CA based on product innovation, that are unrelated to CA based on price, delivery dependability, and time to market; level of OSR has significant separate effects on CA based on time to market, that are unrelated to CA based on price, delivery dependability, and product innovation. Thus the results suggest that high and low levels of OSR, both collectively as indicated by MANOVA and individually as shown by ANOVA and Roy-Bargman stepdown F tests significantly differ on price, delivery dependability, product innovation, and time to market.

TABLE 6. MEANS AND STANDARD DEVIATIONS FOR CA DIMENSIONS BY OSR

	OSR	Mean	Std. Deviations
Price	Low	3.25	0.92
	High	3.58	0.89
Delivery Dependability	Low	4.04	0.71
	High	4.37	0.66
Product Innovation	Low	3.63	0.87
	High	4.04	0.79
Time to Market	Low	2.94	0.80
	High	3.37	0.80

Table 6 presents the means and standard deviations for price, delivery dependability, product innovation, and time to market by high and low levels of OSR. The means are significantly different for high and low levels of OSR, indicating that organizations can compete based on price,

delivery dependability, product innovation, and time to market, to a greater extent if they have high levels of OSR. The results thus suggest that OSR has a positive impact on CA in terms of a firm's ability to compete based on price, delivery dependability, product innovation, and time to market, but not on its ability to compete based on quality.

Since Thatte and Agrawal (2017) found SNR to be the second dimension of SCR to predict CA on a composite basis, a one-way MANOVA is performed with SNR as IV, with high and low categories, and price, quality, delivery dependability, product innovation, and time to market dimensions of CA as five quantitative DVs. We utilize the SNR scale developed by Thatte et al. (2013), which was a 5-point Likert scale measured from 1 (not at all) to 5 (to a great extent). We define the "high" category as a score of 4 or 5, and "low" category as a score of 3 or below.

TABLE 7. BOX'S TEST OF EQUALITY OF COVARIANCE MATRICES FOR SNR

Box's M	12.003
F	0.784
df1	15
df2	207776.9
Sig.	0.697

The assumption of homogeneity of variance-covariance is tested within MANOVA. Box's Test presented in Table 7 is found to be not significant and indicates that homogeneity of variance-covariance is fulfilled, $F(15, 207776.9) = 0.784, p = 0.697$. Wilks' Lambda test statistic is thus used in interpreting the MANOVA results.

The Wilks' Lambda test is presented in Table 8. MANOVA results indicate that the combined DV of price, quality, delivery dependability, product innovation, and time to market, significantly differs for high and low levels of SNR (Wilks' $\lambda = 0.914, F(5, 288) = 5.428, p = 0.000, \text{partial } \eta^2 = 0.082$). However, the multivariate effect size (η^2) is small and which implies that a small proportion of the variance in CA dimensions is accounted for by SNR.

TABLE 8. WILKS' λ MULTIVARIATE TEST OF SIGNIFICANCE FOR SNR

Test Name	Value	F	Hypothesis df	Error df	Sig. (<i>p</i>)	Partial Eta Squared
Wilks' Lambda	0.914	5.428	5	288	0.000	0.086

ANOVA results were interpreted using $\alpha = 0.01$ to counteract the potential of an inflated Type I error rate as discussed earlier. Table 9 exhibits ANOVA results for SNR. The results indicate that CA of a firm based on price ($F(1, 292) = 8.105, p < 0.01, \text{partial } \eta^2 = 0.027$), delivery dependability ($F(1, 292) = 18.784, p < 0.001, \text{partial } \eta^2 = 0.060$), and time-to-market ($F(1, 292) = 7.044, p < 0.01, \text{partial } \eta^2 = 0.024$), significantly differs for high and low levels of SNR. Although significant

group differences were found for these three CA dimensions, the effect sizes are small, indicating that a small proportion of variance in the individual abilities of a firm to compete based on price, delivery dependability, and time to market, is accounted for by SNR. The results suggest that the ability of an organization to compete based on quality ($F(1, 292) = 6.249, p = 0.013$, partial $\eta^2 = 0.021$) and product innovation ($F(1, 292) = 0.650, p = 0.421$, partial $\eta^2 = 0.002$) does not significantly differ for high and low levels of SNR.

TABLE 9. ANOVA SUMMARY TABLE FOR SNR

Source	Dependent Variable	Sum of Squares	df	Mean Square	F	Sig. (<i>p</i>)	Partial Eta Squared
SNR	Price	6.604	1	6.604	8.105	0.005	0.027
	Quality	1.926	1	1.926	6.249	0.013	0.021
	Delivery Dependability	8.606	1	8.606	18.784	0.000	0.060
	Product Innovation	0.468	1	0.468	0.650	0.421	0.002
	Time to Market	4.718	1	4.718	7.044	0.008	0.024

Roy-Bargman stepdown F test summarized in Table 10 shows that only two of the three significant variables from ANOVA results – price ($F(1, 292) = 8.11, p < 0.01$) and delivery dependability ($F(1, 290) = 12.193, p < 0.001$), have unique differences across high and low levels of SNR. ‘Time to market’ was found to be not significant ($F(1, 288) = 1.91, p = 0.168$), which implies that the effect of SNR on ‘time to market’ is due to the inter-correlation effect between the DVs, and not by itself. Thus, results indicate that only CA based on price and delivery dependability significantly differs for high and low levels of SNR.

TABLE 10. ROY-BARGMAN STEPDOWN F TESTS FOR SNR

Variable	Between-Groups Mean Square	Within-Groups Mean Square	Stepdown F	Degrees of Freedom		Significance of Stepdown F
				Between	Within	
Price	6.604	0.815	8.105	1	292	0.005
Quality	1.255	0.301	4.163	1	291	0.042
Delivery Dependability	5.283	0.433	12.193	1	290	0.001
Product Innovation	0.152	0.718	0.198	1	289	0.657

Time to Market	1.151	0.603	1.910	1	288	0.168
----------------	-------	-------	-------	---	-----	-------

The result suggests that level of SNR has significant separate effects on CA of a firm based on price that are unrelated to the CA based on delivery dependability and time to market. Similarly, the level of SNR has significant separate effects on CA based on delivery dependability that are unrelated to the ability of an organization to compete based on price and time to market. Thus the results suggest that high and low levels of SNR, both collectively and individually, significantly differ on price and delivery dependability.

TABLE 11. MEANS AND STANDARD DEVIATIONS FOR CA DIMENSIONS BY SNR

	SNR	Mean	Std. Deviations
Price	Low	3.25	0.90
	High	3.56	0.91
Delivery Dependability	Low	4.02	0.68
	High	4.37	0.67

Table 11 presents the means and standard deviations for price and delivery dependability by high and low categories of SNR. The results point out that the means are significantly different for high and low levels of SNR indicating that SNR has a positive impact on the ability of organizations to compete based on price and delivery dependability, but not on their ability to compete based on quality, product innovation, or time to market. The following section discusses the findings, implications, and contributions of this research.

FINDINGS AND IMPLICATIONS

The study found that CA of a firm differs significantly, collectively based on its dimensions, viz. price, quality, delivery dependability, product innovation, and time to market, for high and low levels of OSR. This implies that firms may be able to improve their overall competitive position based on price, quality, delivery dependability, product innovation, and time to market, by having in place a responsive operations system in terms of the five measures of OSR set forth in Appendix B. This finding supports Thatte and Agrawal’s (2017) findings about the positive relationship between OSR and CA. The study also found that CA of a firm differs significantly individually based on price, delivery dependability, product innovation, and time to market, for high and low levels of OSR. This effect is reinforced through the finding that high and low levels of OSR were found to significantly differ on price, delivery dependability, product innovation, and time to market. These findings imply that firms can achieve CA exclusively based on price or delivery dependability or product innovation or time to market, if they are more operationally responsive in terms of each of the five measures of OSR as presented in Appendix B. The study found that responsiveness of a firm’s operations system had no effect on the firm’s ability to compete based on quality, implying that CA of a firm based on quality is independent of and unaffected by the responsiveness of its operations system.

In the literature there have been arguments on both direct as well as inverse relationship between responsiveness and cost/price. The results of this study support Randall, Morgan, and Morton's (2003) argument about an inverse relationship, implying that firms with more responsive supply chains will be more adaptive to demand fluctuations and will handle this uncertainty at a lower cost / price due to the shorter lead time. Suggestions for future research to support this finding are summarized in the following section. Yusuf, Adeleye, and Sivayoganathan (2003) found high correlation between responsiveness and time to market, dependability, product innovation, and quality. This research partially supports Yusuf et al.'s (2003) findings, as there was no support for the impact of OSR on the ability of a firm to compete based on quality.

Also, the study finds that CA of a firm differs significantly, collectively based on its dimensions, viz. price, quality, delivery dependability, product innovation, and time to market, for high and low levels of SNR. This implies that firms may be able to improve their overall competitive position on all its five dimensions, by having in place a network of responsive suppliers in terms of the four measures of SNR as exhibited in Appendix B. This finding supports Thatte and Agrawal's (2017) findings about the positive relationship between SNR and CA. The study also found that CA of a firm differs significantly individually based on price and delivery dependability, for high and low levels of SNR. This effect is again reinforced through the finding that high and low levels of SNR significantly differ on price and delivery dependability. These findings imply that firms can achieve CA solely based on price or delivery dependability, if they have a network of responsive suppliers in terms of each of the four measures of SNR as set forth in Appendix B. The study found that responsiveness of a firm's network of suppliers had no effect on the firm's ability to compete based on quality, product innovation, or time to market, implying that CA of a firm based on quality, product innovation, or time to market, is independent of and unaffected by the responsiveness of its supplier network.

The findings from this research may encourage practitioners and firms to boost their OSR and SNR so as to improve the different facets of a firm's CA. The findings provide evidence to practitioners that by improving the responsiveness of a firm's operations system as measured by the five measures of OSR exhibited in Appendix B, firms may improve their capability to compete simultaneously on price, quality, delivery dependability, product innovation, and time to market as well as individually on price, delivery dependability, product innovation, or time to market. The study also suggests that by forming partnerships with responsive suppliers as measured by the four measures of SNR presented in Appendix B, organizations may increase their capability to compete simultaneously on price, quality, delivery dependability, product innovation, and time to market as well as individually on price or delivery dependability. This study also provides a research framework and insight for future research in the area of OSR, SNR, and CA.

LIMITATIONS AND FUTURE RESEARCH

This research has extended past research in several ways, by building on theoretical and empirical studies. Although this research has contributions from both theoretical and practical point of views, it also has some limitations, which are described below and which may be addressed in future research.

The individual respondents (high-level executives from purchasing, operations, materials, and logistics functions) in an organization were asked to respond to complex SCM issues dealing with all the participants along the supply chain, including upstream suppliers and downstream customers. However, no person in an organization is in charge of the entire supply chain. Therefore, the use of single respondent may generate some measurement inaccuracy. In addition, this study was limited to the industries (SIC codes – 22, 23, 25, 34, 35, 36, 37) used for this research. This could limit generalizability of results to other industry types. Future research may extend or replicate the study for other industry types to enhance generalizability. Future research may apply multiple methods of obtaining data. The use of single respondent to represent intra or inter-organization wide variables may generate some inaccuracy, more than the usual amount of random error (Koufteros, 1995). Future research could seek to utilize multiple respondents from each participating organization in an effort to enhance reliability of research findings. Future research may test the relationships across countries. Thus SCR dimensions impacting CA in different countries can be compared and country-specific SCM issues can be identified.

Additionally, future research may develop additional dimensions of SCR such assembly responsiveness and inbound logistics responsiveness and study their impact on CA. Future research may study SCR and its dimensions at the supply chain level. Observing a complete supply chain, it may be interesting to investigate the various SCR components across supply chains operating in different industries (e.g. electronic and computer, heavy machinery manufacturing, fashion and apparel, and consumer goods) and their role in creating CA. Further, to confirm the inverse relationship between responsiveness and cost/price found in this research, future research can study this relationship in greater detail. Finally, canonical correlation analyses may be used in future studies to test the simultaneous relationship between the various dimensions of SCR and CA. Such an analysis may provide additional insight into and easy interpretation of the various relationships pertaining to CA of a firm, and may enhance the quality of this research from a methodological standpoint.

REFERENCES

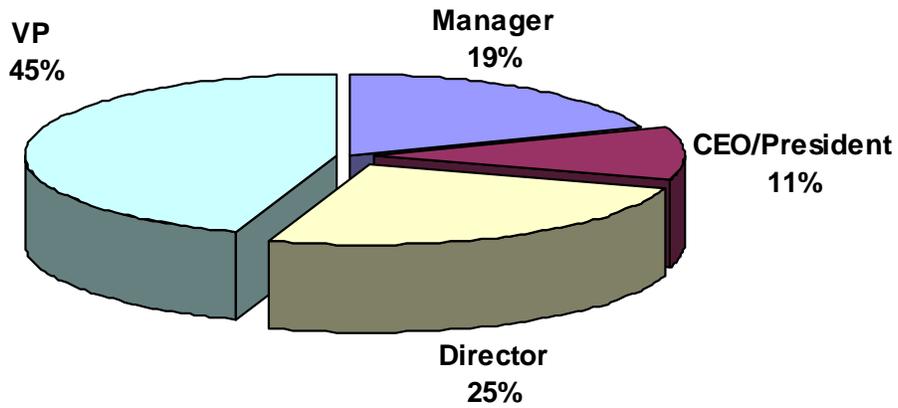
- Armstrong, J. S., & Overton, T. S. (1977). Estimating nonresponse bias in mail surveys. *Journal of Marketing Research*, 14(3), 396-402.
- Chen, I. J., & Paulraj, A. (2004). Towards a theory of supply chain management: The constructs and measurements. *Journal of Operations Management*, 22(2), 119-50.
- Choi T. Y., & Hartley J. L. (1996). An exploration of supplier selection practices across the supply chain. *Journal of Operations Management*, 14(4), 333-343.
- Christopher, M., & Peck, H. (2004). Building the resilient supply chain. *International Journal of Logistics Management*, 15(2), 1-13.
- Cleveland, G., Schroeder, R. G., & Anderson, J. C. (1989). A theory of production competence. *Decision Science*, 20(4), 655-668.
- D'Souza, D. E., & Williams, F. P. (2000). Toward a taxonomy of manufacturing flexibility dimensions. *Journal of Operations Management*, 18(5), 577-593.

- Day, G. S. (1994). The capabilities of market-driven organizations. *Journal of Marketing*, 58(4), 37-52.
- Dillman, D. A. (2000). *Mail and internet surveys: The tailored design method*. New York, NY: John Wiley & Sons Inc.
- Duclos, L. K., Vokurka, R. J., & Lummus, R. R. (2003). A conceptual model of supply chain flexibility. *Industrial Management & Data Systems*, 103(6), 446-456.
- Fawcett, S. E. (1992). Strategic logistics in coordinated global manufacturing success. *The International Journal of Production Research*, 30(5), 1081-1099.
- Fisher M. L., Raman A., & McClelland A. S. (2000). Rocket science retailing is almost here: Are you ready? *Harvard Business Review*, 78(4), 115-124.
- Frohlich, M. T., & Westbrook, R. (2002). Demand chain management in manufacturing and services: Web-based integration, drivers and performance. *Journal of Operations Management*, 20(6), 729-745.
- Fuller, J. B., O'Connor, J., & Rawlinson, R. (1993). Tailored logistics: The next advantage. *Harvard Business Review*, 71(3), 87-98.
- Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate data analysis* (5th ed.). New York, NY: Macmillan Publishing Company.
- Handfield, R. B., & Bechtel, C. (2002). The role of trust and relationship structure in improving supply chain responsiveness. *Industrial Marketing Management*, 31(4), 367-382.
- Hise, R. T. (1995). The implications of time-based competition on international logistics strategies. *Business Horizons*, 38(5), 39-46.
- Holweg, M. (2005). An investigation into supplier responsiveness: Empirical evidence from the automotive industry. *The International Journal of Logistics Management*, 16(1), 96-119.
- Holweg, M., & Pil, F. K. (2001). Successful build-to-order strategies start with the customer. *MIT Sloan Management Review*, 43(1), 74.
- Huber, G. P. (1984). The nature and design of post-industrial organizations. *Management Science*, 30(8), 928-951.
- Koufteros, X. A. (1995). *Time-based manufacturing: developing a nomological network of constructs and instrument development* (Doctoral Dissertation). University of Toledo, Toledo, OH.
- Koufteros, X. A., Vonderembse, M. A., & Doll, W. J. (1997). Competitive capabilities: measurement and relationships. *Proceedings Decision Science Institute*, 3, 1067-1068.
- Koufteros, X. A., Vonderembse, M. A., & Doll, W. J. (2002). Examining the competitive capabilities of manufacturing firms. *Structural Equation Modeling*, 9(2), 256-282.
- Lambert, D. M., & Harrington, T. C. (1990). Measuring nonresponse bias in customer service mail surveys. *Journal of Business Logistics*, 11(2), 5-25.
- Lee, H. L. (2004). The triple-A supply chain. *Harvard Business Review*, 82(10), 102-113.
- Li, S., Ragu-Nathan, B., Ragu-Nathan, T. S., & Rao, S. S. (2006). The impact of supply chain management practices on competitive advantage and organizational performance. *Omega*, 34(2), 107-124.
- Li, S., Rao, S. S., Ragu-Nathan, T. S., & Ragu-Nathan, B. (2005). Development and validation of a measurement instrument for studying supply chain management practices. *Journal of Operations Management*, 23(6), 618-641.
- Lummus, R. R., Duclos, L. K., & Vokurka, R. J. (2003). Supply chain flexibility: Building a new model. *Global Journal of Flexible Systems Management*, 4(4), 1-13.

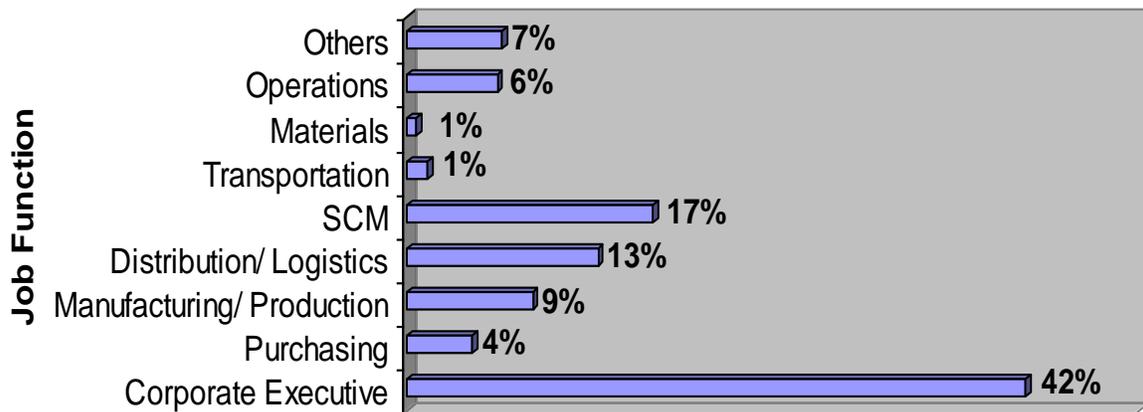
- Meehan, S., & Dawson, C. (2002). Customer responsiveness: Getting it fast and right through impatience and intolerance. *Business Strategy Review*, 13(4), 26-37.
- Mertler, C. A., & Vannatta, R. A. (2016). *Advanced and multivariate statistical methods: Practical application and interpretation*. New York, NY: Routledge Publishing.
- Porter, M. E. (1991). Towards a dynamic theory of strategy. *Strategic Management Journal*, 12(8), 95-117.
- Prater, E., Biehl, M., & Smith, M. A. (2001). International supply chain agility-tradeoffs between flexibility and uncertainty. *International Journal of Operations & Production management*, 21(5/6), 823-839.
- Randall, T. R., Morgan, R. M., & Morton, A. R. (2003). Efficient versus responsive supply chain choice: An empirical examination of influential factors. *Journal of Product Innovation Management*, 20(6), 430-443.
- Ricker, F., & Kalakota, R. (1999). Order fulfillment: The hidden key to e-commerce success. *Supply Chain Management Review*, 11(3), 60-70.
- Rondeau, P. J., Vonderembse, M. A., & Ragu-Nathan, T. S. (2000). Exploring work system practices for time-based manufacturers: Their impact on competitive capabilities. *Journal of Operations Management*, 18(5), 509-529.
- Safizadeh, M. H., Ritzman, L. P., Sharma, D., & Wood, C. (1996). An empirical analysis of the product-process matrix. *Management Science*, 42(11), 1576-1591.
- Skinner, W. (1985). *The taming of the lions: How manufacturing leadership evolved, 1780–1984*. In K. B. Clark, R. Hayes, & C. Lorenz (Eds.), *The uneasy alliance: Managing the productivity-technology dilemma* (pp. 63-110). Boston, MA: The Harvard Business School Press.
- Slack, N. (1991). *The manufacturing advantage: Achieving competitive manufacturing operations*. London: Mercury Books.
- Stalk, G. (1988). Time--the next source of competitive advantage. *Harvard Business Review*, 66(4), 41-51.
- Stevens, J. (1992). *Applied multivariate statistics for the social sciences*. NJ: Lawrence Erlbaum.
- Swafford, P. M., Ghosh, S., & Murthy, N. (2006). The antecedents of supply chain agility of a firm: Scale development and model testing. *Journal of Operations Management*, 24(2), 170-188.
- Tabachnick, B. G. & Fidell, L. S. (1996). *Using multivariate statistics*. New York, NY: Harper Collins College Publishers.
- Thatte, A., & Agrawal, V. (2017). Exploring supply chain responsiveness effects on competitive advantage of a firm. *Quarterly Review of Business Disciplines*, 4(3), 211-228.
- Thatte, A. A., Rao, S. S., & Ragu-Nathan, T. S. (2013). Impact of SCM practices of a firm on supply chain responsiveness and competitive advantage of a firm. *Journal of Applied Business Research*, 29(2), 499-530.
- Tracey, M., Vonderembse, M. A., & Lim, J. S. (1999). Manufacturing technology and strategy formulation: Keys to enhancing competitiveness and improving performance. *Journal of Operations Management*, 17(4), 411-428.
- Vesey, J. T. (1991). The new competitors: They think in terms of speed-to-market. *Academy of Management Executive*, 5(2), 23-33.
- Vickery, S., Calantone, R., & Dröge, C. (1999). Supply chain flexibility: An empirical study. *Journal of Supply Chain Management*, 35(2), 16-24.

- Vokurka, R. J., Zank, G. M., & Lund III, C. M. (2002). Improving competitiveness through supply chain management: A cumulative improvement approach. *Competitiveness Review: An International Business Journal*, 12(1), 14-25.
- Walker, W. T. (2005). *Supply chain flexibility*. ASCET Supply Chain White Paper.
- Ward, P. T., McCreery, J. K., Ritzman, L. P., & Sharma, D. (1998). Competitive priorities in operations management. *Journal of Operations Management*, 29(4), 1035-1046.
- Wheelwright, S. C. (1978). Reflecting corporate strategy in manufacturing decisions. *Business Horizons*, 21(1), 57-66.
- White, G. P. (1996). A meta-analysis model of manufacturing capabilities. *Journal of Operations Management*, 14(4), 315-331.
- Wu, B. (2001). A unified framework of manufacturing systems design. *Industrial Management & Data Systems*, 101(9), 446-469.
- Yusuf, Y. Y., Adeleye, E. O., & Sivayoganathan, K. (2003). Volume flexibility: The agile manufacturing conundrum. *Management Decision*, 41(7), 613-624.
- Zhang, Q. (2001). *Technology infusion enabled value-chain flexibility: A learning and capability-based perspective* (Doctoral Dissertation). University of Toledo, Toledo, OH.

APPENDIX A1. RESPONDENTS BY JOB TITLE



APPENDIX A2. RESPONDENTS BY JOB FUNCTION



APPENDIX B. INSTRUMENT FOR SUPPLY CHAIN RESPONSIVENESS AND COMPETITIVE ADVANTAGE

Supply Chain Responsiveness*

Please circle the number that accurately reflects the extent of your supply chain's current level of responsiveness.

Operations system responsiveness (OSR)

- OSR1 Our operations system responds rapidly to changes in product volume demanded by customers
- OSR2 Our operations system effectively expedites emergency customer orders
- OSR3 Our operations system rapidly reconfigures equipment to address demand changes
- OSR4 Our operations system rapidly reallocates people to address demand changes
- OSR5 Our operations system rapidly adjusts capacity to address demand changes

Logistics process responsiveness (LPR)

- LPR1 Our logistics system responds rapidly to unexpected demand change
- LPR2 Our logistics system rapidly adjusts warehouse capacity to address demand changes
- LPR3 Our logistics system rapidly varies transportation carriers to address demand changes
- LPR4 Our logistics system effectively delivers expedited shipments

Supplier network responsiveness (SNR)

- SNR1 Our major suppliers change product mix in a relatively short time
- SNR2 Our major suppliers consistently accommodate our requests
- SNR3 Our major suppliers provide quick inbound logistics to us
- SNR4 Our major suppliers effectively expedite our emergency orders

Competitive Advantage*

Please select the number that accurately reflects the extent of your firm's competitive advantage on each of the following.

Price/Cost (PC)

- PC1 We offer competitive prices
- PC2 We are able to offer prices as low or lower than our competitors

Quality (QL)

- QL1 We are able to compete based on quality
- QL2 We offer products that are highly reliable
- QL3 We offer products that are very durable
- QL4 We offer high quality products to our customers

Delivery dependability (DD)

- DD1 We deliver customer orders on time
- DD2 We provide dependable delivery

Time to market (TTM)

- TM1 We are first in the market in introducing new products
- TM2 We have time-to-market lower than industry average
- TM3 We have fast product development

Product innovation (PI)

- PI1 We provide customized products
- PI2 We alter our product offerings to meet client needs
- PI3 We cater to customer needs for “new” features

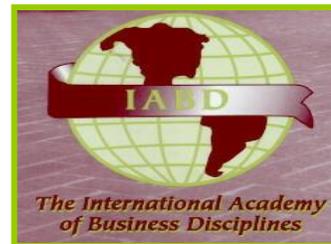
* All items are measured using a 5-point Likert scale measured from 1-not at all to 5-to a great extent

APPENDIX C. CHARACTERISTICS OF THE SURVEYED ORGANIZATIONS

1.	Organizations that have embarked upon a program aimed specially at implementing "Supply Chain Management" (294).	
	Yes:	63.27% (186)
	No:	36.73% (108)
	Average length of implementation: 4.15 years	
2.	Primary production system (283)	
	Engineer to Order	10.60% (30)
	Make to Order	35.69% (101)
	Assemble to Order	20.85% (59)
	Make to Stock	32.86% (93)
3.	Industry – SIC (278)	
	Textile mill Products (SIC 22)	0.00% (0)
	Apparel and Other Textile Products (SIC 23)	1.44% (4)
	Furniture and Fixtures (SIC 25)	2.52% (7)
	Fabricated Metal Products (SIC 34)	10.43% (29)
	Industrial Machinery and Equipment (SIC 35)	10.07% (28)
	Electrical and Electronic Equipment (SIC 36)	39.57% (110)
	Transportation Equipment (SIC 37)	9.35% (26)
	Other	26.62% (74)
4.	Number of employees (291)	
	1-50	4.12% (12)
	51-100	6.87% (20)
	101-250	12.03% (35)
	251-500	12.37% (36)
	501-1000	8.59% (25)
	Over 1000	56.01% (163)
5.	Annual sales in millions of \$ (278)	
	Under 5	2.52% (7)
	5 to 10	3.60% (10)
	10 to <25	7.19% (20)
	25 to <50	8.99% (25)
	50 to <100	6.83% (19)
	>100	70.86% (197)



*Journal of
International Business
Disciplines*



Volume 13, Number 1

May 2018



Published By:

Eastern Washington University and the International Academy of Business Disciplines
All rights reserved

ISSN 1934-1822

WWW.JIBD.ORG