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Contingencies for Low Implementation Levels of New Manufacturing Practices

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ABSTRACT

New manufacturing practices, common in many industries, have been underrepresented in the apparel industry. For this industry, the researcher explored what barriers and organizational characteristics exist for firms that have low implementation levels of these new manufacturing practices. Findings show that management's approach or strategy choice for quality management and return on investment had significant relationships to implementation levels of new manufacturing practices. Resources were perceived as a barrier to implementation, and firm size had significant relationships to new manufacturing practices implementation.

Key words: Operation strategy, empirical study, implementation, technology management

1. Introduction

Manufacturers in the apparel industry, as many industries, have operated within a highly competitive business environment. For these firms, profitability has been eroded by rising labor costs, increasing numbers of rivals, and constantly changing customer demands. In addition, apparel manufacturers, in industrialized countries, have aging factories and limited capital. In such countries, the apparel industry has been considered near extinction (Ormerod, 1999). Failure to maintain or rejuvenate the industry has caused extreme economic hardship in some U.S. regions (Crafted with Pride, 2000). Many managers have perceived only two options for the future of their firms: go offshore or go out-of-business. This study examined a third option - manufacturing transformation through implementation of new manufacturing practices. Transforming a business by implementing new practices has been promoted as beneficial for firms in competitive environments (Bordogna, 1996).

The apparel industry has been well documented as existing in a highly competitive market driven by an increasingly demanding customer (e.g., Abernathy et al., 1995; Goldhar et al., 1991). Such a crisis has been stated as an alert mechanism to trigger change (Moosbruker & Loftin, 1998). For these reasons, this industry has fit the image of an industry with potential for transformation through new technology implementation. Although other industries have made major transformations in manufacturing practices, many apparel manufacturers have maintained a traditional stance with a continuation of mass production techniques (Singletary & Winchester, 1998). The crisis-situation in the apparel industry was full-blown by the late 1990s, with competitive stress continuing its pressure. Barriers that may have impeded implementation of new manufacturing practices were suggested and

explored in this study. Lessons learned from this industry may be useful to other consumer-oriented industries (Whiteoak, 1999).

2. Research Background

To achieve transformation from traditional mass production to new agile manufacturing, some firms have implemented a variety of new manufacturing practices including processes, technologies, and techniques. These practices have been studied extensively in numerous industries but not so in the apparel industry. In a review of previous studies (not including apparel), Dean and Snell (1991) grouped new manufacturing practices into three categories: advanced manufacturing technology (AMT), just-in-time (JIT) inventory control, and total quality management (TQM). Singletary and Winchester (1998a) provided a similar review, specific to the apparel industry; however, the study was based on concept not empirical work. They proposed five new manufacturing practices for this industry: JIT, TQM, Quick Response (QR), business process reengineering (BPR), and supply chain management (SCM). The commonality between the lists of JIT and TQM were immediately obvious, and QR paralleled in part numerous computer related AMT practices as listed by Dean and Snell.

The importance of manufacturing transformation through new practice implementation was noted in previous research outside of the apparel industry. Relationship, between manufacturing practices and performance of a firm, was documented in empirical research for industries primarily in SIC codes 34-39 (e.g., heavy machinery) (e.g., Vokurka, & O'Leary-Kelly, 2000; Ward & Duray, 2000). In conflict to these findings, studies also listed failures in competitive positioning with use of new manufacturing practices (Lefley, 1996; Zammuto & O'Connor, 1992). Although new practices were examined for some industries in previous studies, researchers (e.g., Ward & Duray) stated that more, empirical research was needed. In addition, researchers (e.g., Kotha & Swamidass, 2000; Tracey et al., 1999) called for empirical research with samples beyond heavy industries and with fewer geographical limitations.

A single typology of practices across industries was not clearly available from the literature. Various combinations of practices were studied in other industries. For the apparel industry, trade publications and organizations, but not empirical research, provided substantial information and demonstrated benefits of new manufacturing practices. In 1985, new manufacturing practices, such as QR, were introduced into the apparel industry (Hunter, 1990); however, implementation level remained low. Hunter and Valentino (1995), in a conceptual article, noted the contrast between demonstrated benefits of new manufacturing practices and low implementation levels of these practices. Empirical studies showed that after almost 15 years of trade pressure and information about QR, usage rates remain at or below 30% in the apparel industry (e.g., Ko & Kincade, 1998; Sullivan & Kang, 1999).

Contingency theory described a process of adjustment that a firm can undergo as the external environment changes (e.g., George & Jones, 1999; Schroder & Sohal, 1999). This interpretation of contingency theory, when applied to industry as suggested by George and Jones, resulted in the description of a business environment with the following components: competitive strategies, new manufacturing practices, organizational demographics, and other barriers that result in competitive positioning (see Figure 1). Within and among these components are forces that promoted change and those that restricted change. Forces promoting change were activating forces for change and included growth of global competition, increasing rate of technology change, and rising power of the consumer (Miles & Snow, 1994; Nadler, 1992). Many of these activating forces existed for the apparel

industry and led this researcher to expect change within the firms, including implementation of new manufacturing practices. For an uncertain and competitive market, industry membership, as a proxy, was used by Kotha and Swamidass (2000). In application of contingency theory, researchers predicted that firms did have the potential to increase their competitive position through change, implementation, and adjustments to new activities (Nadler & Tushman, 1992; Schilling, 1998).

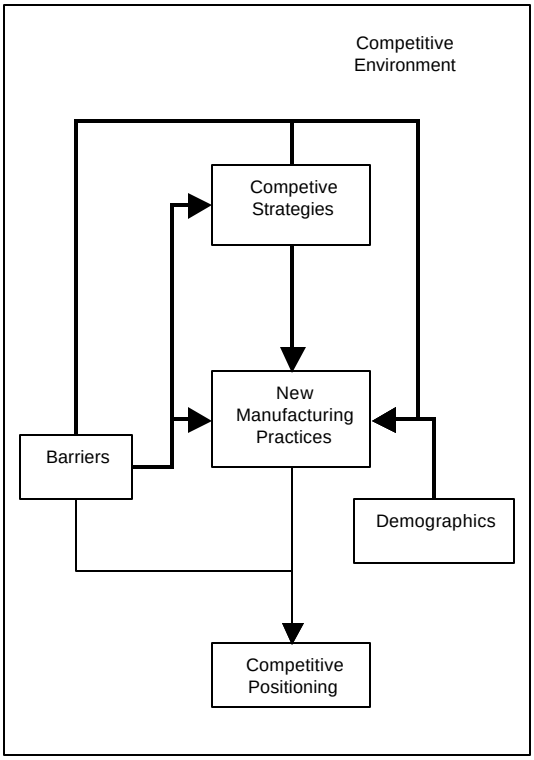


Figure 1. Conceptual Framework using Contingencies for Explanation of Non-implementation of New Manufacturing Practices in a Competitive Environment

Contingency theory further posits that, even in the presence of activating forces, restraining forces became barriers or impediments to change and prevented a firm from adjusting to contingencies (George & Jones, 1999). According to George and Jones, not all firms made internal process changes when receiving activating forces through external environments. External change may be met with resistance and barriers to change within an organization (e.g., Cummings & Worley, 1993; Motwani et al., 1998). Barriers included rigid and mechanistic organizational structures, limited numbers of assets or resources, and restrictive management culture. Such barriers or restraining forces were not merely a reversal of activating forces.

Researchers verified barriers within the trucking and other heavy industries (e.g., Ariss et al., 2000; Crum et al., 1998). One study of barriers included the apparel industry; however, the sample was small and composed of purposively selected manufacturers (Lowson, 1998). That study identified the following: market dependence, lack of market information, shortage of skilled operators, poor training of operators, limited financial resources, lack of management skills, requirements of long

lead times, and short-term outlook. Additional research was needed to generalize this finding. This researcher proposed that barriers could intercede in manufacturing transformation through implementation of new manufacturing practices.

Complexity of the path to improved firm performance was noted by several researchers, and a single strategy did not exist in a vacuum (Kim & Lee, 1993). Implementation of new manufacturing practices was found in other industries to be intertwined within internal as well as external environments (Schroder & Sohal, 2000; Vickery et al., 1999). These business environments included organizational characteristics such as: choice of competitive strategies and organizational demographics. Competitive strategies represented decisions and choices made by manufacturers for modes of operation (Kim & Lee). Specifically, manufacturing strategies included the plans of management to achieve low cost products, increased flexibility, high quality products and service, and improved dependability (Flynn et al., 1999). In addition, differentiation or specialization of product was noted as a manufacturing strategy used in a competitive environment (Berry & Cooper, 1999).

Among organizational demographics, size of firm was noted in research on several industries as important to change and technology implementation (e.g., Schroder & Sohal, 1999; Smith & Reese, 1999). Researchers agreed that in the apparel industry users of new business practices tend to be large sized plants (Kincade & Cassill, 1993; Sullivan & Kang, 1999). Size, however, was not always a change promoting force and could have been a barrier to implementation and profitability. Size in other industries was related with cost, rigid structure, and other barriers (Ariss et al., 2000; Crum et al., 1998).

Empirical studies in other industries showed that manufacturing strategies co-existed with all other processes and technologies in the firm (e.g., Cagliano & Spina, 2000; Koste & Malhotra, 1999; Pagell & Krause, 1999). The co-existence needed to be harmonious and compatible for profitable transformation. Based on the explanation of needed co-existence within potential contingency reactions, the relationship among barriers, implementation levels of new manufacturing practices, competitive strategies, and organizational demographics were examined, and the following questions were proposed. When forces existed within the environment for change activation why did manufacturers in the apparel industries not implement new manufacturing practices? What barriers and other variables were related with a firm's low implementation level of new manufacturing practices? To explore these research questions, the following operational hypotheses were proposed:

Hypothesis 1. *Implementation levels of new manufacturing practices decrease as levels of competitive strategies decrease.*

Hypothesis 2_a. *Levels of competitive strategies decrease as barrier levels increase.*

Hypothesis 2_b. *Implementation levels of new manufacturing practices decrease as barrier levels increase.*

Hypothesis 2_c. *Implementation levels of new manufacturing practices decrease as competitive strategies decrease and barrier levels increase.*

Hypothesis 3. Implementation levels of new manufacturing practices were increased by competitive strategies, decreased by perceived barriers, and moderated by demographics.

3. Methods

An empirical study was conducted in two parts: (a) two pilot studies, with apparel manufacturers not in the final sample, for questionnaire development and (b) mailed survey, with apparel manufacturers across three U.S. states, for data collection. The sample for the pilot studies and mailed survey was selected from state listings of manufacturers in the code of SIC 23 (now

noted by NAICS 3152), which primarily represented the cut and sew aspects of the apparel industry (U.S. Census Bureau, 2001). Three U.S. states (i.e., XXXXX, XXXXX, XXXXX) were selected because they ranked among the top ten states for number of apparel manufacturers within the state. Their exact ranking relative to each other and other states has varied over the years, but XXXXX and XXXXX consistently ranked as XXX or XXX among the 50 states. The sample was stratified by size as noted by number of employees (i.e., small [1-49], medium [50-499], large [500+]). A random selection was made within the strata within states with equal numbers in each stratum as available within the state's population.

For the pilot studies and mailed survey, contact was made directly to plant managers by name. From the researcher's apparel industry experience, plant managers were the best personnel to respond to a questionnaire. This industry has been a very 'hands on' industry with many family-owned and managed businesses. Plants were selected that were strategic business units (SBUs) (i.e., plants with managers able to make independent decisions). When the independence of a plant was not confirmed by the researcher from the listing or previous experience with the plant, the plant office was contacted directly. The first survey mailing to 384 managers resulted in 32 nondeliverables. A second mailing and follow-up telephone calls encouraged returns and confirmed out-of-business status for 5% of remaining firms.

Final usable returns were obtained from 107 SUBs (adjusted n= 334) for an adjusted return rate of 32%, comparable to return rates of similar surveys: 24.1% (D'Souza & Williams, 2000) and 37% (Ward & Duray, 2000). Nonresponse bias was estimated in the following ways: demographics of nonrespondents were compared visually to respondents and demographics of early respondents were compared statistically to late respondents. Response time, based on date of survey returns relative to requested return date, was the basis for tagging, as early or late respondents. On visual examination, nonrespondents did not differ from respondents. Comparing early and late respondents (i.e. response time) indicated no significant relationship between response time and firm size (X^2=2.36, p=.80); customer size (X^2=3.22, p=.36); or product type (X^2=.38, p=.95).

The final questionnaire was a two-page, two-sided instrument, with four parts: competitive strategies, new manufacturing practices, barriers, and demographics. Questionnaire development proceeded through the following stages: (a) competitive strategies and barriers variables were generated from the first pilot test, (b) manufacturing practices and demographics were generated from the review of literature, and (c) validity of all variables was confirmed with a second pilot test and literature. For the first pilot study, respondents were similar to the target respondents and were drawn from a stratified sample of 150 apparel manufacturers (not in the final sample). Responding managers, willing to do an in-depth telephone interview, represented 15 plants (response rate = 10%). With open-ended questions, managers were asked to list competitive strategies and barriers that they perceived important to their firms. Content analysis of the telephone transcripts was used to determine the final lists, which represented strategy and barrier items identified by more than 50% of the managers. The second pilot test was conducted with five additional plant managers and two industry consultants.

For competitive strategies, the pilot tests resulted in the following five strategies: *differentiation, employee empowerment, flexibility, investment determination, and quality management.* For the mailed questionnaire, structure of these questions was multiple-choice with three or four fixed responses. Responses represented levels of strategy adoption in an ordinal set from traditional to agile manufacturing activities. A stair-step or levels approach represented

stages of transformation from mass to agile production (Bordogna, 1996). Participants in the second pilot test suggested the use of proxies for differentiation and flexibility because rating levels would not be meaningful or managers would tend to over-estimate the plant's position. For *differentiation*, the proxy was number of style changes in product line. For *flexibility*, the proxy was seasonality of product, which was measured by numbers of weeks for product life cycle. For *employee empowerment,* response levels ranged from workers require supervision to empowered employees. For *investment determination*, levels ranged from no ROI or ROI was not a factor to long-term ROI even with a short-term loss. For the *quality management* question, response levels ranged from a traditional final inspection to a world class or total quality management (TQM) approach.

To check validity of the competitive strategies, comparison to known variables from other industries was used. These strategies were found in numerous previous studies: *differentiation* (e.g., Goldhar et al., 1991; Kincade & Cassill, 1993; Ko & Kincade, 1998; Subramanian & Nilakanta, 1996), *employee empowerment* (e.g., Giffi et al., 1990, Nadler & Tushman, 1992), *flexibility* and *quality management* (e.g., Cummings & Worley, 1993; Kim & Lee, 1993, Ko & Kincade; Lin et al., 1994), and *investment determination* (e.g., Bessant & Haywood, 1986; Hayes et al., 1988). The second pilot test participants confirmed that the list represented both manufacturing and management strategies, and considered the list to be recognized by the term, competitive strategies.

For the new manufacturing practices, a list was used that was developed from previous research (Kincade, 1995) and has been used by other researchers in this industry (e.g., Sullivan & Kang, 1999). From the first pilot study, no additions were made, but two items were dropped from Kincade's list. The final list included: automated sewing operations, bar coding of products (finished garments), customer involved with product planning, EDI-confirmation orders with customer, EDI-confirmation with suppliers, elimination of redundant testing, garment design done by CAD, overhead conveyor for materials handling, receive retail POS information, reduction of inventory size, reduction of wait time for inventory, scan bar coding of supplies (fabric rolls), share product information with customer, short cycle production, and small lot fabric orders. The new manufacturing practice items were compared with and found similar to listings for various industries (e.g., automotive components, fabricated metals) (e.g., Ariss, et al., 2000; Tracey et al., 1999). Based on suggestions from the second pilot test, the list was divided into three groupings for ease of reading (i.e., planning, production, distribution). For the questionnaire, the grouped practices were structured as stems with a choice of intervals for percentage of implementation level (i.e., 0, 25, 50, 75, 100). Plant managers were asked to select the percentage that corresponded to the firm's implementation for each practice.

For validity and generalizability, the scales were factored using principle components factor with varimax rotation. Three factors were retained that included 13 of the 15 practices (see Table 1). PoS (point-of-sale) data and UPS usage (overhead conveyor systems) loaded on a fourth factor that was not retained. No missing values existed in this section of the questionnaire. The three factors were titled *computer technologies*, *partnerships*, and *JIT-production*. Factors were then compared to factors in previous studies about other industries. With a few differences, these factors paralleled manufacturing factors identified by previous researchers as follows: c*omputer technologies* (e.g., Dean & Snell, 1991; Kotha & Swamidass, 2000; Zammuto & Connor, 1992), *partnerships (e.g.,* Dean & Snell), and *JIT-production* (e.g., Dean & Snell; Golhar & Stamm, 1991; Kotha & Swamidass).

Table 1. New Manufacturing Practices: Results of Factor Analysis

Factors	Item	Mean	S.D.	Loadings	Eigenvalue	Cronbach's alpha	Percentage of Variance
Computer technologies					4.75	.79	36.54%
	EDI with customer	29.72	34.18	.80			
	Bar code on product	41.75	44.94	.79			
	EDI with supplier	20.75	28.13	.73			
	CAD	21.23	36.15	.71			
	Bar code on supplies	14.15	32.00	.54			
Partnerships					1.99	.78	15.31%
	Elimination of testing	30.14	33.07	.77			
	Plan with customer	38.32	32.45	.72			
	Share information	46.96	39.11	.70			
	Reduction - wait time	38.55	29.40	.61			
JIT-production					1.17	.65	9.00%
	Automated sewing	29.91	25.80	.67			
	Reduction - inventory	39.49	29.94	.66			
	Small lot orders	41.36	28.54	.66			
	Short cycle production	45.32	33.32	.46			

Note: New Manufacturing Practices implementation scale had intervals of 0, 25, 50, 75, 100%.

For the barriers section in the questionnaire, the list, as developed from the first pilot test, included seven barriers: high cost of equipment, lack of capital funds, lack of trained employees, poor communication with customers, customers in bankruptcy, uncertainty in sales volume, and unclear consumer market. The list contained many theorized barriers identified by previous authors (e.g., Cummings & Worley, 1993; Shaw, 1992). In the questionnaire, these items were structured as stems with interval responses of 1 (no barrier), 2, 3 (some barrier), 4, 5 (major barrier). Wording was confirmed in the second pilot test and was estimated to represent the effect barriers had on operational outcomes.

The seven barrier items were factored with principle components and varimax rotation. Three factors emerged and titled as follows: *customer barriers*, *resource barriers*, and *market information barriers* (see Table 2). All factors were retained because of confirmation by literature, pilot studies, and exploratory nature of the study. Parallels were made between these factors for the apparel industry and results from other industries: *customer barriers* (George & Jones, 1999; Shaw, 1992), *resource barriers* (Shaw), and *market information barriers*, (Crum et al.; George & Jones) as barriers. The presence of these barriers supported the proposition that restraining factors as well as activating factors were involved in change (George & Jones).

Table 2. Barriers: Results of factor analysis

Factors	Item	Mean	S.D.	Loadings	Eigen value	Cronbach's alpha	Percentage of Variance
Customer barriers					1.97	.39[a]	28.14%
	Uncertain sales volume	3.67	1.04	.87			
	Customers in bankruptcy	2.71	1.17	.72			
Resource barriers					1.36	.52	19.43%
	High cost of equipment	2.78	1.07	.75			
	Lack capital funds	2.45	1.29	.75			
	Lack trained employees	3.68	1.23	.62			
Market information barriers					1.21	.43 [a]	17.29%
	Poor communication w/ customers	2.28	1.01	.89			
	Unclear market	2.92	1.22	.75			

Note: [a] Pearson Correlations were used for the two factors that contain only two items.
The scale for barriers was interval with 1=no barrier, 2, 3=some barrier, 4, 5=major barrier.

Demographic questions were multiple-choice with fixed responses. Selection was based on the technology innovation literature (e.g., Rogers, 1983) and on manufacturing literature (e.g., Kim & Lee, 1993; Kincade & Cassill, 1993). Demographic questions included three variables: (a) size of the firm (i.e., number of employees, annual sales), (b) customer characteristic (i.e., size of customer), and (c) product information (i.e., price point). In the final analysis, firm size was characterized only by number of employees because number of employees and annual sales were highly correlated.

For data analysis, Hypothesis 1, 2a, and 2b were tested with multiple linear regression. Hypothesis 2c and 3 were tested with forward selection regression to

determine the variables most significant in the relationships. Multicollinearity was a consideration when using multiple and other forms of linear regression. The explanatory variables for the study were examined for correlation with Pearson's correlation coefficients. No pair of variables had a correlation value higher than .41. This level of correlation was not considered a problem for this type of research (Hair et al., 1998, Malhotra, 1996). Additional collinearity diagnostics were conducted using features in SAS, and the highest resulting condition index number in any of the regression models was only 19.79. The *SAS OnLine DocV8* (2000) stated that condition index numbers of 30 or more indicated moderate to strong collinearity; therefore, the level for this study was considered low. Although some relationship between variables was to be expected because of their context in the research model, multicollinearity was not considered a serious limitation. However, potential and unexplained relationships may have hindered the predictor affect of variables in explaining their relative importance to dependent variables (Malhotra).

4. Results

Five competitive strategies were examined for relationships to three factors for new manufacturing practices (i.e., one regression model for practice factor). The three regression models were significant (see Table 3). A plant manager's perception of strategic positioning was significantly related to the manager's perception of implementation levels for new manufacturing practices. Hypothesis 1 was supported.

Table 3. Competitive Strategies as Explanatory Effects on Implementation Levels of New Manufacturing Practices (H1)

	Computer technologies	Partnerships	JIT-Production
R^2	.1675	.1617	.1130
F-value	3.66**	3.51**	2.32*
	F-value	F-value	F-value
Differentiation	-.07	-.30	.56
Employee empowerment	.43	1.14	-.06
Flexibility	-.83	-.41	-1.85
Investment determination	3.05**	2.31*	1.66
Quality management	2.51**	2.99**	1.91

* = $p<.05$, ** = $p<.01$

A low or traditional level of strategies was related to the lack of implementation of the *computer technologies* factor. Low levels of the *investment determination* and *quality management* strategies were statistically significant with low levels of the *partnership* factor. Low levels of the p*artnership* factor were associated specifically with short-term ROI expectations for investment and with mass production attitudes about quality (i.e., use of only final inspection). The competitive strategies, as a group, were also statistically significant with implementation of the *JIT-production* factor; however, no individual strategy was significant at the 0.05 level.

The *quality management* strategy and the *flexibility* strategy approached significance ($p < .10$).

To examine the relationship of barriers to competitive strategies (H2a), five statistical models were built, one for each strategy. Barriers were only related significantly to one strategy, *quality management* (see Table 4). Increases in barriers were associated with increases in the *quality management* strategy, which was different from the predicted relationship of increased barriers hypothesized as related to decreased strategy levels. Very limited statistical support, which also lacked practical interpretation, was found for Hypothesis 2a in this analysis. In addition, a very small R^2 was associated with this model, which indicated the need for identification of other variables to explain the variance. Hypothesis 2a was not supported.

Table 4. Barriers as Explanatory Effects on Competitive Strategies (H2a)

	Differentiation	Employee Empowerment	Flexibility	Investment Determination	Quality Management
R^2	.0264	.0157	.0515	.0086	.0803
F value	.85	.50	1.70	.27	2.73*
	F-value	F-value	F-value	F-value	F-value
Resource barriers	.53	-1.18	.47	-.17	-.81
Customer barriers	-1.52	.31	-1.71	-.42	1.85
Market information barriers	-.41	-.15	-1.16	.85	1.82

*= $p<.05$, ** = $p<.01$

In the examination of barriers and new manufacturing practices, the three barriers factors approached significance ($p < .10$) with one of the three factors for new manufacturing practices (i.e., *computer technologies)* (see Table 5). Hypothesis 2b was partially supported. Implementation of the new manufacturing practices within *computer technologies* was negatively related to a perception that the *resource barriers* factor was a major barrier for firms. Other barriers (i.e., *customer barriers, market information barriers)* were not statistically significant with the implementation of *computer technologies.* Although a statistical model was significant, a very small R^2 was associated with that model. The *partnerships* and *JIT-production* models were not significant. Although barriers were perceived by a majority of responding managers to be 'some what' to 'major' barriers to their firm, these factors showed limited to no statistical relationship to implementation of new manufacturing practices.

Table 5. Barriers as Explanatory Effects on Implementation Levels of New Manufacturing Practices (H2b)

	Computer technologies	Partnerships	JIT-Production
R^2	.0690	.0052	.0014
F value	2.52	.18	.05
	F-value	F-value	F-value
Resource barriers	-2.50**	.56	-.34
Customer barriers	-.81	-.53	.12
Market information barriers	.20	.11	.17

* = $p<.05$, ** = $p<.01$

To examine the combined effect of competitive strategies and barriers on implementation of new manufacturing practices, three regression models were used and found to be significant (see Table 6). Hypothesis 2c was supported. In the first model, two strategies (i.e., *investment determination strategy, quality management strategy*) and one barrier (i.e., *resource barriers*) significantly contributed to the implementation level of *computer technologies*. Three of eight predictor variables were significant, which indicated that some aspects of firms had more association with or a larger role in changes than other aspects. In the second model, two strategies (i.e., *quality management, investment determination*) and no barriers significantly contributed to variance in implementation of *partnership* practices. *Flexibility* was significant on an individual basis with *JIT-production* but not in the presence of the barriers. In the third model, *JIT-production* was also significantly predicted by *flexibility*. A firm with higher flexibility in the product line had lower levels of new manufacturing practices in *JIT-production*. The finding contrasted to higher implementation levels of firms with lower flexibility.

Table 6. Competitive Strategies and Barriers as Explanatory Effects on Implementation Levels of New Manufacturing Practices (H2c)

	Computer technologies		Partnerships		JIT-Production	
R^2	.2115		.1444		.0480	
F value	8.32**		7.93**		4.79*	
	F-value	Partial R^2	F-value	Partial R^2	F-value	Partial R^2

Investment determination	11.15**	.0951	5.82*	.0529	- [a]	-
Quality management	7.08**	.0633	9.56**	.0914	- [a]	-
Resource barriers	6.27*	.0532	- [a]	-	- [a]	-
Flexibility	- [a]	-	- [a]	-	4.79*	.0480

* = $p<.05$, ** = $p<.01$

Note: [a]No other variable met the .05 significance level for entry into the model.

In Hypothesis 3, strategy and barrier variables were examined collectively along with several demographic variables (i.e., firm size, customer size, product price) to determine those with the largest contributions to the variance in implementation of new manufacturing practices. Three regression models, one for each factor of the new manufacturing practices, were built using the forward selection method. Two models met the 0.05 criteria (see Table 7), and Hypothesis 3 was supported. The collection of variables within the firm's domain (i.e., competitive strategies, barriers, demographics) was significantly related to the implementation of *computer technologies* and *partnerships*. Two variables, one strategy (i.e., *quality management*) and one demographic (i.e., firm size) were significant both for *computer technologies* and for *partnership*. For *computer technologies*, firm size was the over-riding variable for the variance in this factor. Firm size, as measured by its R^2, accounted for over one-third of the variance in *computer technologies* (see Table 7). The *quality management* strategy contributed a much smaller but significant variance. For *partnerships*, the *quality management* strategy and firm size contributed equal but small amounts of variance, as measured by the R^2. No variables met the criteria of 0.05 significance level for entry into a model with *JIT-production.*

Table 7. Competitive Strategies, Barriers, and Demographics as Explanatory Effects on Implementation Levels of New Manufacturing Strategies

	Computer technologies		Partnerships	
R^2	.4043		.1784	
F value	29.52**		9.44**	
	F-value	Partial R^2	F-value	Partial R^2
Firm size	6.03*	.3521	9.25**	.0874
Quality management	7.62**	.0522	9.40**	.0910

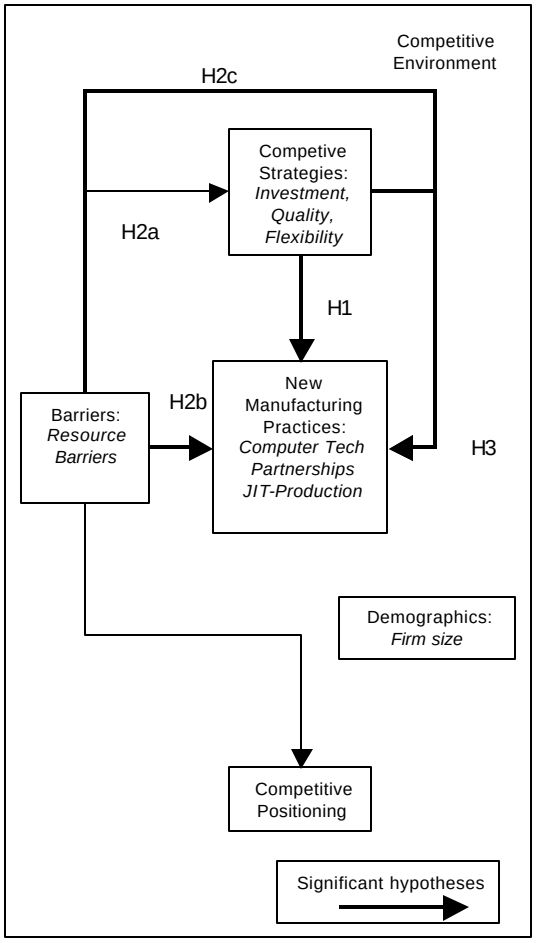
* = $p<.05$, ** = $p<.01$

5. Discussion

This research used a systemic and contingent view of manufacturing organizations and examined barriers to and organizational structure for low implementation levels of new manufacturing strategies. Traditional modes of competitive strategies were expected to relate to low implementation levels of new manufacturing practices (H1). This expectation was supported for the three new manufacturing factors and for three of the five strategies

(see Figure 2). The finding was similar to strategy-to-manufacturing practices as reported in other industries (e.g., Berry & Cooper, 1999; Tracey et al., 1999), and provided support to the contingency theory that competitive strategies were closely related to the processes, technologies and activities used in manufacturing (e.g., Vokurka & O'Leary-Kelly, 2000).

Figure 2. Research Results with Conceptual Framework for Explanation of Non-implementation of New Manufacturing Practices in a Competitive Environment



The relationship between *investment determination* and *computer technologies* was anticipated because implementation of new manufacturing practices, included in this factor, often required purchase of equipment. An *investment determination* strategy of long-term ROI would be needed to justify large initial investment for purchase of equipment (Ariss et al., 2000; Bessant & Haywood, 1986). The study verified that firms with short-term ROI expectations had low implementation levels of new manufacturing practices. In another signification relationship, the *quality management* strategy of respondents was at the lowest or final inspection only level when *computer technologies* implementations were also low. At the higher or total quality management (TQM) level, plant mangers perceived significantly higher implementation levels of the *computer technologies* manufacturing

practices in their plants. In this study, lacking a long-term view of investment and maintaining a traditional vision of quality management were indicative of low implementation levels of new manufacturing practices. In contrast, strategies of empowerment and flexibility, identified as activating forces for implementation of new manufacturing practices in previous research for other industries, were not significantly related to new manufacturing practices in this study.

The need to understand the barriers faced by firms when implementing new manufacturing practices directed the examination of Hypotheses 2. Although an array of barriers was noted as present by most managers, only *resource barriers* significantly predicted implementation of new manufacturing practices (see Figure 2). Human and financial resources, as represented in the *resource barriers* factor, were noted by several authors to be barriers to change (Ariss et al., 2000; Hunter & Valentino, 1995). Although authors (e.g., Ariss et al.) reported that the traditional financial barriers have become less important as technology usage has become more common, this research showed that for managers in this study *resource barriers*, both financial and human, remained barriers to implementation for new manufacturing practices. The *customer barrier* factor was not statistically significant, in contrast to previous concepts and findings. Previous authors have stated that uncertainty about a firm's customers and sales potential was related to low implementation levels of new technology (e.g., Lowson, 1998; Miles & Snow, 1994). Assumptions about an industry should not be made without empirical testing, and additional explanations of these findings should be examined in future research.

Within the conceptual view of a systemic and contingency-based organization, forward selection regression was used to examine the relationship of demographics, barriers, and competitive strategies with implementation of new manufacturing practices (H3). In a pure organic form freely reactive to contingencies, interaction would exist among all parts; however, in this study, only two variables (i.e., *firm size* and *quality management*) were statistically significant with implementation of two new manufacturing practices, *computer technologies* and *partnership*. *Small firms* and low levels of *quality management* were associated with low implementation levels of new manufacturing practices. In addition, a short-term ROI for *investment determination* and 'major' levels of *resource barriers* were significant in separate regression models. With these findings, an explanation of the final model was that traditional relationships with financial resources and size continued to exist in this industry.

Strategies and barriers not significantly related to *partnership* practices were also noted. As proposed by previous authors in case studies or conceptual articles (e.g., Abernathy et al., 1995; Hunter & Valentino, 1995), the researcher assumed that the *customer barriers* would be related to *partnership* practices, but this result was not found. In addition, *flexibility* and *differentiation* were often noted as important strategies in a competitive environment (e.g., Lin, Kincade, & Warfield, 1994; Ward & Duray, 2000), but these strategies were not significant with *computer technologies* or with *partnership* implementation, in the presence of barriers.

In this study, variables were verified by pilot study participants and have validity based on previous research, but the researcher acknowledges that new manufacturing practices, barriers, and competitive strategies may not be comprehensive for all industries or manufacturers. These limitations may affect generalizability of findings. In addition, the listings were kept short to reduce questionnaire length for return rate. Inclusion of multiple variables versus a workable and industry receptive questionnaire was a difficult and limiting decision. Common method bias may have been a limitation. Predictor and dependent

variables collected from the same respondents may have created biases inherent in one or more variable variables.

6. Conclusions

The continued strength of *resource barriers* in inhibiting implementation of new manufacturing practices was noted in this study. The typology of the apparel industry has become di-polar with many small firms (less than 50 employees) and a few very large firms (over 1000 employees). For most apparel firms, profit margins have been traditionally small, and price competition has been extremely strong. Case studies have indicated that one penny per wholesale price of an item can keep a customer or lose a customer. Cost competition has been compounded by the high number of small firms. Credit and financial support has not been readily available for these firms. Small firms cannot easily grow to large firms just to improve their implementation of new manufacturing practices. Further research in financial resources would be needed to identify ways of assisting firms to become more competitive. Additional research would be needed to determine if variation in industry, or limitations of the study, contributed to the conflict with previous findings on *flexibility* and *empowerment*, and to determine what activating forces could assist apparel manufacturers in making transformation change.

This study provided a baseline for additional research in the apparel industry. Three barriers were identified and noted as 'some what' to 'major' barriers by the responding managers in the survey; however, clear answers were not revealed for what these barriers predict or how they might prevent implementation of new manufacturing strategies in the apparel industry. Additional research would be needed to search for other barriers to implementation. Responses showing continuation of traditional practices, and evidence of these as predictors of low implementation levels of new manufacturing practices, gave indication that qualitative aspects of organizations should be explored. Organizational factors, such as organizational culture, group cohesiveness, and individual insecurity, were suggested by George and Jones (1999) as possible impediments to change. These factors have been difficult to define but were being explored in other industries, and should be examined for the apparel industry.

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