

CHAPTER III

Methodology

The purpose of this study is to examine apparel manufacturers' inventory performance, which is one of the major aspects of supply chain management (SCM). First, apparel manufacturers' level of SCM activity was identified. In addition, how apparel manufacturers' characteristics in terms of product characteristics, production system, fabric supplier, and retail customers are different according to the level of SCM activities and how the four characteristics are related to inventory performance (i.e., level within the type) were identified. This chapter details the procedures for the study in the following sections: (a) hypotheses, (b) research design, (c) sample, (d) instrument, (e) data collection, and (f) data analysis.

Hypotheses

This study is designed to examine how the level of SCM activities are related to selected apparel manufacturers' characteristics and how these characteristics are related to inventory performance. The following hypotheses are proposed.

H1. Apparel manufacturers show different levels of SCM activities.

Based on the literature analysis, the SCM activities can be composed of six dimensions: collaborative partnership, utilization of information technology, flexibility of operations, service and performance measurements, top management commitment, and knowledge of demand characteristics. Each dimension requires specific activities to achieve benefits from the successful SCM. According to Subramanian and Nilakanta (1996), the adoption of innovations is related with a company's environmental, organizational, and individual factors. Implementation of QR program, and computer technology usage in purchasing, design, and manufacturing were found to be different among apparel manufacturers. (Belleau & Didier, 1989; Ko & Kincade, 1998; Priyadarshi, 1996; Sullivan & Kang, 1999). Therefore, Hypothesis One suggests that the level of SCM activities be different among apparel manufacturers.

H2. Apparel manufacturers' company characteristics (i.e., product characteristics, production system, fabric supplier, retail customers) are related to the level of SCM activities.

Company characteristics are varied according to the company's level of innovation adoption, based on the conceptual framework of this study. SCM is the innovation that a company may adopt and four apparel manufacturers' characteristics are the organizational characteristics in the framework. More product variety is a product characteristic required in the apparel industry (Standard & Poor's, 1998). Product variety in apparel is measured in terms of fashion level, which interprets to uncertainty of demand. Fashion level was found to be related to the implementation of QR program in the apparel industry (Ko & Kincade, 1998). SCM allows apparel manufacturers to better serve their customers through improved operational activities (i.e., reduced cycle times, lower inventory levels), while reducing costs; therefore, implementing SCM activities would be related to production of fashion apparel.

Traditional production system such as bundle system and progressive bundle system (PBS) may be less efficient to implement SCM activities due to its nature of high levels of inventory and extended throughput time (Bailey, 1993). On the other hand, modular system, which reduces the throughput time and WIP inventory, enhances the operational flexibility and seeks economies of scope (Berg, Appelbaum, Bailey, & Kalleberg, 1996). Modular system may be related with a high level of SCM activities.

Fabric suppliers and retail customers are adjacent supply chain partners to apparel manufacturers and are the companies with whom apparel manufacturers have direct relationships. The supplier performance is assumed to be a key component for efficient SCM. Recently, suppliers' delivery performance has received more attention from buyers (Artz, 1999). The size and type of retailers with whom apparel manufacturers do the business are found to be related to the manufacturers' managerial decisions in the literature analysis (Kincade & Cassill, 1993; Ko, 1995). And, traditional relationships such as short-term and low-cost oriented adversarial relationships are barriers to

implementing the SCM activities. More collaborative partnership-like relationships, with suppliers or retailers are hypothesized to be found in the apparel manufacturers who show high level of SCM activities. Overall, Hypothesis Two suggests that levels of the SCM activities identified in Hypothesis One be related to the selected apparel manufacturers' characteristics (i.e., product characteristics, production system, fabric suppliers, retail customers).

H3. Apparel manufacturers' company characteristics (i.e., product characteristics, production system, fabric suppliers, retail customers) are related to inventory performance (i.e., level of inventory within the type).

As a company tries to adjust company characteristics to the changing environment when adopting innovation, the company's performance should be distinguished from non-adopter companies' performances. In this study, inventory level within the type will be used as an indicator of a company's performance. The level of inventory held in an apparel manufacturing plant is related to the decisions on the volume and timing of raw material purchasing, production, and delivery (McPherson, 1987).

First of all, product characteristics (i.e., fashion goods, basic goods) have a relationship with raw material purchasing, production, and delivery (Fisher, Hammond, Obermeyer, & Raman, 1997). Raw materials for highly seasonal and fashionable goods may need to be ordered once in case the supplier discontinues production of the raw material. Raw materials for basic goods may be ordered continuously because the demand for the basic goods is stable and certain (Tersine, 1988). Suppliers of raw materials of basic goods can provide the materials on a continuous basis. Planned production volume will be different according to the product characteristics. According to U. S. Bureau of the Census's (1996) report on value of manufacturers' inventories by type, average finished goods inventory accounted for 42.8% and average raw material inventory for 36.1% of the total average inventory in women's wear (SIC 233, 234). Average finished goods inventory and raw material inventory of men's wear (SIC 231, 232) accounted for 55.9% and 25.7% of the total average inventory, respectively in 1996. Considering, women's wear represents higher fashion level than men's wear, fashion

goods may be stored as raw materials and produced as close to the selling season as possible, and basic goods are produced and stored as finished goods until delivered.

The level of WIP is closely related to the production system. For example, the bundle system has the highest level of WIP, compared to PBS or modular system (Bailey, 1993). Therefore, production system may be one factor that determines the level of inventory in the apparel manufacturing.

Fabric suppliers' cost offering, delivery performance and characteristics of supplier-buyer relationship will affect the apparel manufacturers' inventory level. For example, if buyers are more cost-oriented, they may place an order in a bulk, which implies high levels of raw material inventory. When suppliers' are not reliable in product quality, timely delivery, and fill rate, apparel manufacturers may need to build higher inventory levels to avoid the potential shortage of raw material. In addition, if the relationship with apparel manufacturers is long-term and collaborative based on trust, and QR-oriented, the apparel manufacturers' inventory performance will be enhanced.

The size of the retail customer may affect inventory levels for an apparel manufacturer. If retailers, who are a big account to apparel manufacturers, want to place more frequent and small-lot orders, apparel manufacturers need to tune their delivery volume and timing to the will of the retailers. The partnership-like relationships between retailers and apparel manufacturers are also considered to have positive a impact on the company's performance in the supply chain (Harrington, 1999). In addition, the type of retailer is found to influence apparel manufacturers' decision on adopting QR programs (Kincade & Cassill, 1993; Ko, 1995). Therefore, Hypothesis Three states that the level within type of inventory held in apparel manufacturers' sites differ based on apparel manufacturers' characteristics (i.e., product characteristics, production system, fabric supplier, retail customers).

H4. Apparel manufacturer' level of SCM activities is related to inventory performance (i.e., level within the type)

This study also focuses on the level of inventory within the type in apparel manufacturing as a measure of inventory performance and an effect of SCM. Although a high level of SCM activities are assumed to reduce the level of inventory, according to the effect of the company's organizational characteristics, the inventory performance among apparel manufacturers may differ. Therefore, how the level of SCM activities alone is related to the level within type of inventory will clarify the effect of the four company characteristics on the inventory performance of the apparel industry.

Assumptions

This study was done based on the following assumptions:

1. Apparel manufacturers have some level of involvement with SCM activities.
2. Apparel manufacturers have knowledge of product characteristics, production system, and have a business relationship with at least one fabric supplier and retailer.
3. Apparel manufacturers have knowledge of their inventory status.

Research Design

This study employed non-experimental quantitative research. Specifically, the design falls into the single cross-sectional design using the mail survey method, which is the most frequently used descriptive research design. Previous studies of similar subjects to this study used the same research design (Kincade, 1988; Ko, 1993; Jones, 1999). This research design requires one sample of respondents and quantitative data analyses with a large and representative sample. The descriptive research was used to test specific hypotheses and make careful descriptions or explore the possible relationships between variables unlike the causal research that is designed to determine cause and effect relationships (Malhotra, 1996).

To increase the internal and external validity, the sampling procedure in this study applied the stratified random sampling technique. Internal validity refers to whether the

variation in dependent variables is really caused by the variation in independent variables (Malhotra, 1996). The extraneous variables that are not included in the study but might affect the dependent variables should be controlled to increase the internal validity.

External validity refers to the ability to generalize the findings of the study.

Randomization and stratification in sampling is one method of controlling extraneous variables and of increasing generalizability beyond the sample.

Sample

This study focuses on U.S. apparel manufacturers. The population consists of the apparel manufacturers whose products can be classified as fashion goods or basic goods. Apparel manufacturer classified under SIC 235, 237, 238, and 239 were excluded because the items, which include hats, caps, fur goods, and miscellaneous apparel accessories, are considered not to represent both seasonality and fashionability as well as men's and women's. The sample mainly consists of SIC 231, 232, 233, and 234. The SIC codes 231, 232, 233, and 234 are assigned mainly to manufacturers of men's and women's garments which account for approximately 48.3% in the number of establishments and 60.7% of value of manufacturers' inventories in the apparel manufacturers under SIC code 23 (US Census Bureau, 1996).

The sample companies were selected from purchased directories: The National Register of Apparel Manufacturers, Women & Children's Wear (Marche Publishing, 1998) and The National Register of Apparel Manufacturers, Men & Boys (Marche Publishing, 1997). The source of the population was selected because of its large coverage in terms of the number of apparel manufacturers listed in the directories, which represents approximately 6,500 out of 11,731 U.S. apparel manufacturing companies. The main features of the directories include apparel manufacturers' address, phone/fax numbers, sales volume, employment, and key personnel, listed by state and city, activity, and product category. This information is important in sampling the population and contacting the sample. However, the use of a general directory could result in sampling bias. Listed companies' demographic characteristics may not be representative of the

overall U. S. population of apparel manufacturers in terms of company size and product category. The characteristics of the sample were compared to those of U.S. population to reveal the bias in results due to sample-specific characteristics.

From the data compiled from County Business Patterns (1996), the total number of establishments in the target population of apparel manufacturers is estimated at 11,731. According to Krejcie and Morgan (1970), the suggested sample size for a population of 10,000 is 370 or 3.7 % of the population. In previous studies on apparel manufacturers where a similar data collection method was used to this study, sample sizes ranged from 118 of Priyadarshi's (1996) study to 246 of Lin, Kincade, and Warfield's (1995) study. Response rates ranges from 32.5% (ZuHone & Morganozky, 1995) to 48% (Kincade, Cassill, & Williamson, 1993). These previous studies reported that intensive follow up contacts with respondents increased the response rates. Krejcie and Morgan's (1970) suggestion on the sample size shows a big difference from other previous studies, which focused on one size strata or one state. Sample size for this study was based on Krejcie and Morgan's (1970) suggestion and the predicted response rate was based on the previous studies' experience.

From the list, a stratified random sample of 1,195 apparel manufacturers without location limitation was selected. The list was stratified into four groups by a cross tabulation of size (i.e., number of employees) and SIC code (i.e., SIC 231/232, SIC 233/234) (see Figure 3-1). Stratified sampling is a sampling technique that follows two-steps: partitioning the population into subpopulations and selecting the elements by a random procedure (Malhotra, 1996).

In this study, operational definitions of small and large apparel manufacturers are from data compiled from County Business patterns (US Census Bureau, 1996). Small apparel manufacturer is defined as US apparel manufacturer classified under SIC 231 to 234, with 1 to 19 employees, which accounts for 59.7% of the population. Mediums to large apparel manufacturers are US apparel manufactures who are classified under SIC 231 to 234, with over 20 employees. Sample was stratified by the company size because

apparel manufacturing company is assumed to have differentiating characteristics such as marketing and manufacturing strategies, the level of usage of advanced technologies, and the level of QR adoption (Jones, 1999; Priyadarshi, 1996; Sullivan & Kang, 1999).

The proportion of SIC code stratum to the total population is 21% and 79% respectively (U.S. Census Bureau, 1996). Product category that complies with the different SIC code is known to affect numerous characteristics of manufacturers. For example, according to U.S. Bureau of the Census (1996), capital expenditure for plant and equipment does not parallel the proportion of the establishment between men's wear and women's wear. Apparel manufacturers under SIC 231/232 expend more capital for plant and equipment compared to those under SIC 233/234. Besides, product category may be an indirect variable that is associated with the fashion level. Therefore, to control the effect of extraneous variables and increase the internal validity, stratified sampling was used. Figure III-1 shows the description and the proportion to the total population of each stratum.

<u>Stratum 1</u> Small SIC 231 & 232 7.6%	<u>Stratum 2</u> Medium to large SIC 231 & 232 12.9%
<u>Stratum 3</u> Small SIC 233 & 234 52.1%	<u>Stratum 4</u> Medium to large SIC 233 & 234 27.4%

Figure III-1. Sample Stratum Description

Instrument

A mail questionnaire was designed to document the relationship between SCM activities, apparel manufacturers' characteristics, and the level within type of inventory management in U.S. apparel manufacturers. The questionnaire consists of questions regarding the following variables: the SCM activities of six dimensions, apparel manufacturers' characteristics (i.e., product characteristics, production system, fabric suppliers, retail customers), and inventory performance (i.e., selected performance indicators for raw material purchasing, production, delivery). The questions used in the questionnaire were adopted and compiled from the previous study of SCM, QR, inventory management, and apparel manufacturing (Artz, 1999; Droge & Germain, 1998; Germain & Droge, 1998; Jones, 1999; Kanakadurga, 1994; Kincade, 1988; Ko, 1993). The example of the instrument is attached in the Appendix E.

SCM Activities

Respondents were assessed for their level of agreement with 26 statements that characterize the SCM activities in six dimensions (Question I). Those six dimensions are partnership, information technology, operation flexibility, performance measurement, management commitment and leadership, and demand characterization. Each dimension consists of four to five activity statements with the total of 26 questions identified through literature analysis. For each activity, six-point items with endpoints of *not at all* (0) and *very high* (5) were used. In compiling the contents into a specific scale, examples of activities specific to the apparel industry were adopted from Ko and Kincade's (1998) study of QR technologies. Table III-1 summarizes the contents and sources of the items under six dimensions.

Table III-1

Measurements Contents of SCM Activities

Dimension	Measurement Activities	Source
Partnership	<ul style="list-style-type: none"> • Consolidation in supplier base • Collaboration with suppliers and customers in forecasting and production planning • Active information and relevant technology sharing • Conversion to long-term relationship with suppliers and customers 	Cooper & Ellram(1993), Higginson & Alam(1997), Johnson(1998), Jones & Riley(1985), Kincade & Cassill (1993)
Information technology	<ul style="list-style-type: none"> • Use of computer-to-computer communication • Use of EDI • Use of POS data communication • Use of bar-coding 	Alber & Walker(1997), Copacino(1998), Higginson & Alam(1997), Jones & Riley(1985), Kincade & Vass (1998), Sabath (1995)
Operation flexibility	<ul style="list-style-type: none"> • Ability of volume flexibility • Ability of product flexibility • Ability of delivery flexibility • JIT practice 	Alber & Walker(1997), Cooper & Ellram(1993), Johnson(1998)
Performance measurement	<ul style="list-style-type: none"> • Establishment of performance measurements with customers and suppliers 	Johnson(1998), Sabath (1995), Vass (1995)
Management commitment and leadership	<ul style="list-style-type: none"> • Top management's awareness of benefits • Top management's desire to change 	Higginson & Alam(1997), Vass (1995)
Demand characterization	<ul style="list-style-type: none"> • Knowledge of demand pattern • Aligning supply capabilities with demand cycles • Applying the uncertainty in demand to operational decisions 	Alber & Walker(1997), Copacino(1998), Priyadarshi (1996)

Company Characteristics

This section measured the four company characteristics to examine the relationship with the SCM activities and with inventory performance. Those four characteristics are product characteristics, production system, fabric suppliers, and retail customers.

Product characteristics. This study used the product line characteristics construct for the product characteristics. One open-ended question is used for respondents to divide their product line into two groups, fashion goods and basic goods, and describe the proportion of each type of goods to the total production in percentage (Question II-1). This question was devised based on the recent trend that apparel manufacturers are dealing with multiple product lines of fashion goods and basic goods. In Priyadarshi's study (1996), demand uncertainty was used to measure product characteristics. Fashion goods and basic goods used in this study were defined to be different in ease of forecasting, fashion level and seasonality in demand pattern, and frequency of style change based on Priyadarshi's research instrument (1996). In detail, fashion goods refer to products of which the demand is hard to forecast due to high fashion level and seasonality and have quite varied style changes season by season. Basic goods refer to products of which the demand is relatively easy to forecast due to low level of fashion level and seasonality and have the basic garment style that repeats frequently.

Production system. One multiple-choice question was presented to respondents to select the major production system they use (i.e., bundle system, PBS, UPS, modular system) (Question IV-2). This question was compiled from Kanakadurga's (1994) research instrument and an additional choice of UPS was added to the original question.

Fabric suppliers. Respondents were asked to evaluate the suppliers' cost- offering and delivery performance (Question V-4). Delivery performance questions were formed by adopting four questions from Artz's (1999) study. These questions were asked to address the quality of products, satisfaction with the delivery performance of the supplier, on-time delivery, and defect rate of the product on six point scale with endpoints of *not at all* (0) and *very high* (5). Also, respondents were asked to indicate the most appropriate description of the nature of their relationship with fabric suppliers on a six-point scale (Question V-5). These questions were based on the definition of partnership and compiled from previous studies (Cooper & Ellram, 1990; droge & Germain, 1998).

Retail customers. Major retail customers' type was asked with a multiple-choice question, which was adopted from a previous study (Ko, 1993) (Question IV-3). Retailer types are department stores, specialty stores, mass merchandisers/discounters, small independent stores, direct mail, and others. *Direct mail* was added by the author because this type of retailer is growing fast (Diamond, 1993). The extent of cost orientation and ownership by the respondent, and size relative to the respondent's company are asked to address the retail customers' characteristics (Question IV-4, V-1). These items were included because the typical classification of retailers' type is not mutually exclusive. Extent of the attributes mentioned in this questionnaire has been found to be different according to the type or size of retailers. The same questions that address the nature of relationship with fabric suppliers were asked again to describe the relationship with retail customers as well (Question V-2).

Inventory Performance

In this section, questions were developed to obtain the level of inventory within the type. The level of raw material inventory was measured on four open-ended scales by asking the following: (1) how many weeks of raw materials inventory were kept on hand (Question III-3), and (2) what is the typical order lead-time for raw material from order placement to order receipt (Question III-8). The former question was adopted from Sterling and Lambert's (1979) study of methodology for assessing logistics operating systems and the latter question was from Droge and Germain's (1998) study of JIT impact on inventory level.

Weeks of raw material is a traditionally used inventory measurement throughout many industries, called weeks of supply (WOS), or equivalently, days of supply (Tersine, 1991). WOS indicates the expected time to exhaust a raw material's current on-hand inventory (Question III-3). To calculate the weeks of inventory, the following formula is used: weeks of inventory = on-hand inventory/weekly requirements rate (Pena, Beaumarigage, & Nelson, 1997). Raw materials for the apparel products include fabrics, threads, and a variety of components such as zippers, embroidery, and binding. In this

study *fabric* was used as a representative of the raw material because fabric costs account for about 80% of material costs (Tyler, 1991).

The level of WIP was measured on open-end scales by asking the average production lot size in pieces (Question III-4). In addition, in Question III-8, respondents were asked to indicate shop lead-time in days (time span from shop order release to the order completion). The production lot size and the rate of operation overlapping are directly connected to the production system (i.e., bundle system, PBS, UPS, modular system) that is distinguishable by the WIP level (Kanakadurga, 1994). And reducing the WIP level is associated with the reduction of shop lead-time (Tersine, 1991).

The level of finished goods inventory was measured on open-ended scales by asking the following: (1) the ratio of excess and surplus finished goods inventory to total production of finished goods (Question III-5), (2) service level in percentage (Question III-6), (3) annual inventory turnover ratio (Question III-7), and (4) delivery lead-time to retail customers (Question III-8). According to Tersine (1991), excess and surplus inventories refer to the inventories that are produced over the required amount and of which demand is discontinued respectively. These types of inventory are known to be costly to hold and should be removed from the system. Therefore, the level of unnecessary inventories such as excess and surplus inventories can be used to compare the efficiency of the inventory management among manufacturing companies. On-time delivery rate was measured to assess respondents' delivery performance to retailers' order by asking them write their performance in percentage. Inventory turnover ratio is obtained by dividing the sales by the average inventory for a given period (Branam, 1984). Usually, a high turnover ratio is associated with the low level of inventory and recommended to be desirable (Tersine, 1991).

Three lead-time questions were asked by presenting the illustration that depicts the inventory flow from material acquisition to product shipment (Question III-8). This illustration was adopted and modified from Tersine (1991, p.16). The same questions regarding the level of inventory by the type were asked for fashion goods and basic

goods respectively in the assumption that most apparel manufacturers deal with both product line categories and different inventory performance would be found in ordering fabrics, producing and delivering finished garments.

Besides the detailed inventory performance measures specified above, respondents were assessed their expectation level of improvement in inventory performance as a result of SCM activity. To be more specific, expectation measures were measured by averaging the five expectation scores which assessed their expectation level of improvement in five inventory performance measures (i.e., fill rate, order lead-time, on-time delivery rate, turnover ratio, overall inventory level) (Question I-2). Basic assumption of this measure is that respondents who are aware of the benefits of SCM might be more active in implementing SCM activities.

For demographics information, two open-ended questions were used to ask companies' size and annual total production volume (Question IV-4). In addition, SIC code was asked to describe the profile of the respondents (Question IV-1). A multiple-choice question was presented.

Reliability and Validity of the Instrument

To check the construct validity of the SCM activity items, factor analysis with a varimax rotation was done to test whether all 26 items load on six dimensions as specified. A priori determination was used to determine the factor numbers. Eigen value of each factor was compared with the results of a priori labels. Items that loaded higher than .6 (i.e., correlation value between variables and factors) on one factor and lower than .4 on other factors were accepted (Jones, 1999; Kincade & Vass, 1998 Malhotra, 1996). The most commonly used Cronbach's alpha (internal consistency method) were addressed to check reliability of the scales for the SCM activities (see Question I-1 to I-5) and the other Likert-type statements used to measure the relationship with fabric supplier and retail customers, respectively (see Question V-2, V-3). Cronbach's alpha value of 0.7 is known to be adequate for internal consistency (Leedy, 1997).

Overall, developing the questionnaire from questions previously used in industry research and based on literature analysis enhances construct validity of this study. In addition, to increase face validity, major terms (i.e., fashion goods, basic goods) in the question was accompanied with the definition in the instrument (e.g., Question II). In the pilot test, the expert panel including college professors of clothing and textiles and management science departments and six apparel manufacturers who were excluded from the final sample reviewed the questionnaire and recommended changes to clarify and eliminate ambiguous meanings in instructions and questions (Fowler, Jr., 1993; Jones, 1999; Lin, Kincade, & Warfiled, 1995).

Data Collection

Data were collected following the self-administered mail survey method as suggested by Dillman and Christenson (1974) and Hoinville and Jowell (1977). Self-administered mail survey has the advantages of relatively low cost and easy access to widely dispersed samples (Fowler, 1993). Questionnaires were mailed to a stratified random sample of 1,195 apparel manufacturers listed in the purchased directories, The National Register of Apparel Manufacturers, Women's and Children's Wear (Marche Publishing, 1998) and The National Register of Apparel Manufacturers, Men's and Boys Wear (Marche Publishing, 1997). The questionnaire was addressed to the plant manager or inventory planner who was assumed to be in charge of all the activities of developing, executing, and delivering the product line. These people were also assumed to be aware of the general characteristics of the company.

Data collection procedures were adopted and slightly modified from previous research on apparel manufacturers (Jones, 1999; Ko, 1993; Priyadarshi, 1996). In the first mailing, the questionnaire was sent with (1) the cover letter that informed an overview of the aim of the survey, assurance of the confidentiality, identification of the researchers, and the sponsoring university, (2) a self-addressed stamped return envelope, and (3) a courtesy card that respondents could receive the summary of the findings of the study and

they could participate in the incentive program. For the incentive of participating in the survey, a drawing was done. Out of respondents who replied, two respondents had a chance to win \$200. Intensive follow-ups and the incentive program were used to increase the response rate (Hoinville & Jowell, 1978). After the sending the questionnaire, a follow-up postcard was sent to the sample one week later, thanking those participants who replied and stressing the importance of cooperation to non-respondents. To non-respondents, the follow-up letter emphasized both the urgency and the importance of a response with a replacement questionnaire, another return envelope and courtesy card. To decrease the non-response bias, telephone-interview was done with a random sample of non-respondents. The characteristics of non-respondents were described to compare with those of respondents and the reason for non-response were identified so that the survey results could be adjusted to account for non-response. All data collection materials were attached in the Appendix.

Data Analysis

To test the model in Figure 1-1, four research hypotheses were built. Based on the research hypotheses, detailed null hypotheses are presented in this section. Statistical methods such as cluster analysis, factor analysis, ANOVA, chi-square, correlation, and regression were used to test the null hypotheses that state no relationship between variables. Based on the results of statistical analyses the null hypotheses were rejected or failed to reject. A probability of $p > 0.05$ was used to determine significance for each testing. Data were analyzed using the SPSS 8.0 program. If at least one variable was found to be significant, the hypothesis was rejected.

Before testing the null hypotheses, descriptive statistics were used for all variables to describe the mean, frequency, percentage, and correlation of each value of the response as well as to profile the respondents' demographic characteristics (i.e., firm size, manufacturer type) and to explore the preliminary relationships between variables.

H1₀. Levels of SCM activities among apparel manufacturers are not different.

To test this null hypothesis, hierarchical cluster analysis and factor analysis were employed. First, agglomerative hierarchical cluster analysis were used to cluster apparel manufacturers into k number of relatively homogenous groups based on levels of SCM activities. Squared Euclidean distance measure, the most commonly used measure of similarity (Malhotra, 1996), and Ward's method, one type of clustering procedures to minimize the within-cluster variance, were employed. The group number, k, was determined based on the relative sizes of the clusters. Another hierarchical cluster analyses with a reduced sample that consisted of randomly selected respondents were done to assess the reliability and validity of the results of the cluster analysis as Malhotra (1996) suggested. This cluster analysis method was based on previous research in creating typologies (Jones, 1999; Shim & Kotsiopulos, 1993).

Next, a factor analysis was used to compare the SCM activity level among the clusters. Factor analysis could abstract the reliable items that could significantly explain the variance of each factor. After the SCM dimensions were abstracted, to explain significant characteristics of each classified cluster in terms of SCM dimensions, ANOVA and a post hoc test (i.e., Tukey test) were used by identifying the mean differences of the SCM dimensions identified by factor analysis. According to Howell (1997), Tukey test is the favorite pair-wise test to compare mean differences used in many studies. Each SCM dimension score was obtained by dividing the summation of the scores assigned to each activity question by the number of the questions under the corresponding dimension.

H2a₀. The levels of SCM activities do not differ based on apparel manufacturers' product characteristics.

Product characteristic was measured on the continuous scale that indicates the ratio of fashion goods and basic goods to the total products produced by apparel manufacturers respectively. ANOVA and Tukey test were employed to see the mean difference of product line characteristics between SCM activity levels.

H2b₀. The levels of SCM activities do not differ based on apparel manufacturers' production system.

Production system was measured on the categorical scale (i.e., bundle system, PBS, UPS, modular system, others). Chi-square, ANOVA, and Tukey test were used to evaluate whether SCM activity levels are different among apparel manufacturers who adopt different production systems.

H2c₀. The levels of SCM activities do not differ based on apparel manufacturers' fabric suppliers.

Fabric suppliers in this study were measured based on three variables: cost offering, delivery performance, and the nature of the relationship with the fabric suppliers. Four Likert-type questions were adopted from Artz (1999) study. The delivery performance score was obtained by dividing the sum of three scores by three. The nature of the relationships (i.e., adversarial vs. partnership-like, short-term vs. long-term, QR-oriented vs. non-QR-oriented) with the fabric supplier were the average formed by dividing the sum of three question scores by three. For these two aspects (i.e., delivery performance, relationship), ANOVA, Tukey test, and correlation analysis were used to identify any significant relationships with SCM activity levels.

H2d₀. The levels of SCM activities do not differ based on apparel manufacturers' retail customers.

Retail customers in this study were measured based on four aspects: relative size of the retailers, nature of the relationship with the retailers, and type. The size and the nature of the relationship with the retailers were measured on six-point Likert-type scale. The nature of the relationships (i.e., adversarial vs. partnership-like, short-term vs. long-term, QR-oriented vs. non-QR-oriented) with the retailer will be averages by dividing the sum of three question scores by three. For these four aspects (i.e., retailer size, relationship with retailers), ANOVA, Tukey test, and correlation analysis were used to identify any significant relationship with SCM activity levels. The type of retailers (i.e., department store, specialty chain store, mass merchants/discounters, small independent stores, others) was measured on the categorical scale. Chi-square, ANOVA, and Tukey

test were used to evaluate the relationships with SCM activity levels. Three additional Likert-type questions were used to describe the retailer characteristics. In the current study, the retailer type was defined based on the merchandise mix. The type of retailer is sometimes determined by cost orientation and ownership by the manufacturer (Donnellan, 1996; Jarnow & Dickerson, 1997; Rabolt & Miller, 1997). Therefore, cost orientation of retail customers and ownership by the manufacturer were additionally analyzed to fully describe the relationship with the type of retail customers

H3a₀. Apparel manufacturers' product characteristics are not related to their inventory performance of fashion goods and basic goods in terms of level within type.

A pair of eight detailed inventory performance questions and one expectation measure to profile the inventory levels by the type were asked on the continuous scale (i.e., two for raw materials, two for WIP, and the remaining four for finished goods inventory). The relationship between the four apparel manufacturers' characteristics and inventory levels within the type of each product category were evaluated using correlation analysis, ANOVA, Tukey test, and multiple regression analyses. Correlation analysis was used to examine the relationship between product characteristics and inventory performance measures.

A pair of detailed inventory performance questions was asked based on the product characteristics (i.e., fashion goods vs. basic goods). Matched sample t-test was used to evaluate the mean differences of inventory levels within type between product category. The results of the matched sample t-test were expected to reveal how differently apparel manufacturers deal with the product characteristics in planning raw material purchasing, production, and shipment within a company.

H3b₀. Apparel manufacturers' production system, fabric suppliers, fabric suppliers, retail customers) are not related to their inventory performance of fashion goods and basic goods in terms of level within type.

Chi-square analysis was used to see the relationship between SCM activity clusters and production system. Both variables were measured on categorical scale. ANOVA and Tukey test were used to examine mean differences of inventory performance measures between production system.

H3c₀. Apparel manufacturers' fabric supplier characteristics are not related to their inventory performance of fashion goods and basic goods in terms of level within type.

H3d₀. Apparel manufacturers' retail customer characteristics are not related to their inventory performance of fashion goods and basic goods in terms of level within type.

A multiple-regression was used to identify the relationship between chain partners (i.e., fabric suppliers, retail customers) and inventory performance measures. In the regression, predictors are fabric suppliers, and retailer customers, and criterion is eight-inventory performance measures and one expectation measure. To diagnose the effect of multicollinearity, VIF (Variance Inflation Factor) was calculated. As the variance inflation factor increases, so does the variance of the regression coefficient, making it an unstable estimate. Large VIF values are an indicator of multicollinearity.

H4₀. Apparel manufacturers' level of SCM activities is not related to their inventory performance of fashion goods and basic goods in terms of level within type.

ANOVA, Tukey test, and multiple regression were used 17 times to evaluate the direct relationship between the SCM activity level and inventory performance for all 17 inventory questions. ANOVA and Tukey test were used to examine the mean difference of 17 inventory performance measures among SCM activity clusters identified by through the cluster analysis. Multiple regression was used to see the relationship with SCM activity level and inventory performance measures. In this analysis, predictor is SCM activity level. Regression analysis was used to reveal which specific SCM activity dimension, would influence the inventory performance in the apparel industry.