

SUPPLY CHAIN MANAGEMENT IN THE TEXTILE INDUSTRY: A SUPPLIER SELECTION MODEL WITH THE ANALYTICAL HIERARCHY PROCESS

Asli Koprulu¹

aslik@ipekyol.com

Process Management Director
Ipekyol Tekstil ve Tic. San. A.S.
Kazım Orbay Cd. 43
Bomonti Sisli
34381 Istanbul Turkey

M. Murat Albayrakoglu

albayrak@bilgi.edu.tr

Coordinator, Business Informatics Program
Istanbul Bilgi University
Kurtulus Deresi Cd. 47 Dolapdere
34440 Istanbul Turkey

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Summary: *The aim of this study is to emphasize the importance the vendor selection problem and its relation to the supply chain strategy and goals. First, the current conditions of the textile or apparel industry are analyzed and the key factors for a successful supply chain considering the globalization of the industry are discussed. An analytical hierarchy process (AHP) model that an apparel company can use for the selection of suppliers is presented and a supplier relationship management (SRM) strategy is created based on the results of the model. In addition, strategic priorities for the supplier selection problem are identified and weights are developed to select the right supplier that fits the company's strategy. Finally, the outcome and the implications of the model for implementation are discussed.*

1. Introduction

In today's world of globalization many apparel retailers are building strong supply chains to gain advantage over their competitors by offering the best value to their customers. The supply-chain management (SCM) has become very critical to manage risk, dynamism, and complexities of global sourcing. A totally integrated supply chain is required for the company to get gain the maximum benefits.

The objectives of the supply chain and the performance measurements need to be understood in order to build the most effective supply chain. Performance measurements provide an approach to identify the success and potential of supply management strategies.

One major aspect of the SCM is to select the right sources of supply in the global business environment that can support corporate's strategy. Contrary to the conventional adversarial relationships, effective SCM in the new competition suggests seeking close relationships in the long term with less number of partners.

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Considering the rapidly changing market conditions and customer seeking the best value, long-term relationships with the vendors became very critical in the apparel industry. Therefore the apparel retailers are looking for the vendors who can provide the best cost in the fastest way. Such a relationship is regarded as partnership since it includes activities such as information sharing, joint product design, or sharing storage spaces.

The purpose of this paper is to emphasize the importance the vendor-selection problem and its relation to the supply-chain strategy. It presents a model, based on the analytical hierarchy process (AHP), that an apparel company can use to select its suppliers, and create a strategy for supplier relationship management (SRM). The framework of the performance measurement is based on quantitative and qualitative measurements.

2. Supply Chain Management (SCM)

A supply chain is characterized by the flow of goods, services, money, and information both within and among business entities including suppliers, manufacturers, and customers. It also includes all types of organizations engaged in transportation, warehousing, information processing, and materials handling. Sourcing, procurement, production scheduling, manufacturing, order processing, inventory management, warehousing, and, finally, customer service are the functions performed throughout the supply chain. The ultimate goal of SCM is to meet customers' demand more efficiently by providing the right product, in the right quantity, at the right location, on the right time, and in the right condition.

As Figure 1 shows, SCM aims four major goals: 1) waste reduction; 2) time compression; 3) flexible response; and 4) unit cost reduction. These goals have been articulated in several contexts associated with SCM, emphasizing the importance of both intra- and inter-firm coordination. (Brewer & Speh, 2000)

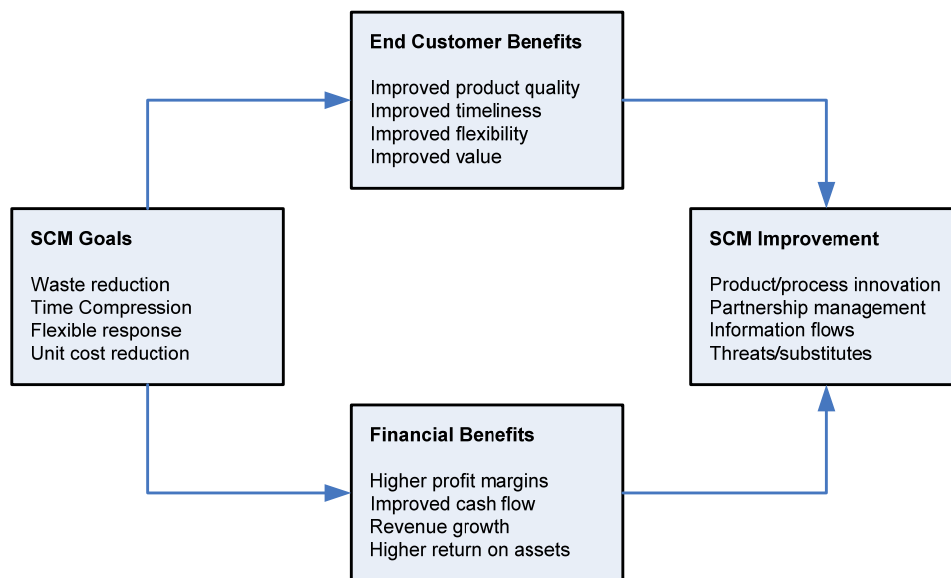


Figure 1. Supply Chain Management Framework (Brewer & Speh, 2000)

Firms practicing SCM seek to reduce waste throughout the supply chain by minimizing duplication, harmonizing operations and systems, and enhancing quality. When production and logistics processes are accomplished in less time, all entities in the supply chain are able to operate more efficiently, and primary result is the reduced inventories throughout the system. Flexible response is in order handling, including how orders are handled, product variety, order configuration, order size, and several other dimensions

means that a customer's unique requirements can be met in a cost-effective manner. Overall, all of these goals help keeping the costs at the minimum for a given value for the customer (Brewer & Speh, 2000).

3. Performance Measurement in the Apparel Industry SCM

According to Chan (2003), the aim of supply chain management is to gain an advantage in terms of customer service and cost over competitors. Traditionally, performance measurement is defined as the process of quantifying the effectiveness and efficiency of action. It plays a critical role in monitoring performance, enhancing motivation and communication, and diagnosing problems. Furthermore, performance measurement helps identifying the success and potential of management strategies, and facilitating the understanding of the situation.

Traditionally, performance measurement is defined as the process of quantifying the effectiveness and efficiency of action. From the management perspective, performance provides the necessary information for feed back to decision makers and process managers. It plays a critical role in monitoring performance, enhancing motivation, facilitating communication, and diagnosing problems.

Performance measures are categorized into two groups; qualitative and quantitative. These measures involve customer satisfaction and responsiveness, flexibility, supplier performance, and costs. There are three types of measures: resources, output, and flexibility. A framework for measuring the strategic, tactical and operational level of performance in a supply chain, which deals mainly with supplier, delivery, customer service, and inventory, and logistics costs, exists.

Customer satisfaction level is an indication of the required standard of service level of a particular company, which is closely related to the whole performance of its supply chain. For different industries, customers look at different measures, such as delivery service, where time is no doubt their major concern; whereas for parts manufacturing, the accuracy of specification may be the most importance consideration. Thus, the weighting of each performance measurement can be different for each industry.

It is common practice for apparel retailers to deal with manufacturers, with centralised buying and considerable negotiation on prices, quality and delivery schedules. However, Popp (as cited in Bruce, Daly & Towers 2004) suggests that in addition, in many chains there is an intermediary, often an import or export agency, acting as a significant figure within the chain. The addition of the intermediary has come about as a result of increasing globalisation within the industry. Globalisation of the textile and clothing supply chain is currently intensifying, with many companies either sourcing components from overseas, or moving manufacturing to countries with lower labour costs. In addition, the fashion industry is characterised by a number of factors, namely a short lifecycle, high volatility, low predictability, and high impulse purchase. (Bruce, Daly & Towers 2004)

In the textile industry, sourcing strategies must reflect the performance capabilities of the supply base. In most cases there are a variety of possible vendors that differ in cost, lead times and flexibility of production. Vendors with lowest cost generally offer virtually no flexibility booking capacity and shipment times of several weeks and often require that the total production be allocated relatively evenly throughout the year. More responsive vendors may have shorter lead times and allow greater flexibility vis-a-vis production commitments. Additionally, different vendors may be willing to store limited amounts of finished product prior to delivery for a fee. (Agrawal, Smith & Tsay, 2002)

Retailers tend to leverage a portfolio of two types of vendors: Type 1 vendors are characterized by long lead times, lower unit costs and less flexibility whereas Type 2 vendors offer short lead times, high unit costs and more flexibility. This enables such strategies as exploiting lower cost production for the most predictable segment of demand, while sourcing the more speculative segment via the more flexible, but more costly, vendors. Operationalizing this in multi-product, multi-vendor setting is nontrivial and is further complicated by many production and logistical constraints. (Agrawal, Smith & Tsay, 2002)

Apparel retailers deal with both fashion goods and basic goods to offer product variety to their customers. Basic and fashion goods can be classified based on the volume of production, degree of style variation, and frequency of style changes. For example, fashion goods are hard to forecast the demand; have high fashion level and seasonality, and have varied style change. Basic goods are relatively easy to forecast the demand, have low fashion level and limited seasonality, have a basic garment style that remains constant (Lee & Kincade, 2003). Therefore, the retailer will place the fashion goods with the Type 2 vendor and the basic goods with the Type 1 vendor.

Textile is a sector where quality is one of the key competitive factors, and current competition does not only concern the individual firm but, rather, involves the entire supply chain. Indeed, the quality of the final product that reaches the customer is clearly the result of a chain of successive, inter-linked phases: spinning, weaving, apparel and distribution. In this new competitive environment, quality, but must be a feature of all market segments—basic and fashion—to meet the specific requirements and tastes of all types of customers. Furthermore, quality cannot be restricted to the area of the intrinsic quality of the goods themselves, but must also take even more operational aspects into account in (Romano & Vinelli, 2004).

The fashion industry is beset by problems of volatility, making it difficult to predict fashion trends and consumer demands. Despite recent improvements, traditional forecasting techniques cannot deliver the accuracy required for managing logistics in the fashion market. Hence, forecasting risks could be reduced by being less dependent on forecasts. This can be achieved by shortening lead times, since this allows better response to consumer demand. Speed-to-market has become a fundamentally important way to cope with the increasing demand for fashion variety. (Birtwistle, Fiorito & Moore, 2006)

4. An Analytic Hierarchy Process Model for Vendor Selection

Supplier selection decisions are taken following the creation of a supplier shortlist during the pre-qualification phase of the supplier relationship framework shown in Figure 2. They are complicated decisions since various criteria must be considered in the process. A significant number of quantitative and qualitative supplier attributes should be examined. Assessments should be made using objective and subjective criteria, and trade offs should be established. A strategic approach towards purchasing may further emphasize the need to consider multiple criteria (Onesime, Xiaofei & Dechen, 2004).

The evaluation of vendors is a complicated decision problem, (Chan & Chan, 2004). The complexity comes from: 1) the relative difficulty to conceptualize and structure the numerous components of the evaluation problem into an analytical framework; 2) the nature of the components in this process; some are quantitative whereas others are subjective; and 3) the large number of alternatives as the competition in the marketplace increases.

AHP is a decision making tool that decomposes a complex problem into a multi-level hierarchical structure of objectives, criteria, subcriteria and alternatives. Applications of AHP have been reported in numerous fields such as conflict resolution, project selection, budget allocation, transportation, health care and manufacturing (Wang, Huang & Dismukes, 2005).

The AHP provides a framework to cope with multiple criteria situations involving tangible and intangible, quantitative and qualitative aspects (Saaty, 2000, 2001). It consists of three steps:

1. Decomposing the complex problems into a hierarchy of different levels of elements.
2. Using a measurement methodology to establish priorities among the elements.
3. Synthesizing the priorities of elements to establish the final decision.

First a complex problem is broken down into sub-problems in hierarchical levels, which is a set of criteria or attributes relative to each sub-problem. The top level is the goal, and consists of only one element—the broad, overall objective. Subsequent levels may each have several elements. The elements are to be compared with one another against criterion in the next higher level, but must be of the same magnitude.

With reference to this case, the main goal is simply to choose the best or most optimum supply chain. At the subsequent levels, the relevant performance measures are listed. These are all the criteria necessary to achieve the goal. (Chan & Chan, 2004)

All available choices are listed and quantified; they are then converted to weights that are used to prioritize a portfolio of alternatives. The weights of each element in each hierarchical level are aggregated to the next level.

Pairwise comparison (different alternatives or attributes) can be used to determine the priorities of each pair of criteria, indicating the strength with which one element dominates another with respect to a higher-level element. It provides a clearer priority for each of the criteria, using a nine point scaling system (see Table 1). It helps to quantify intangible and non-economic factors included in the hierarchies, which make an explicit and informed trade-off among many attributes or criteria possible in selecting the best goal. (Chan & Chan, 2004)

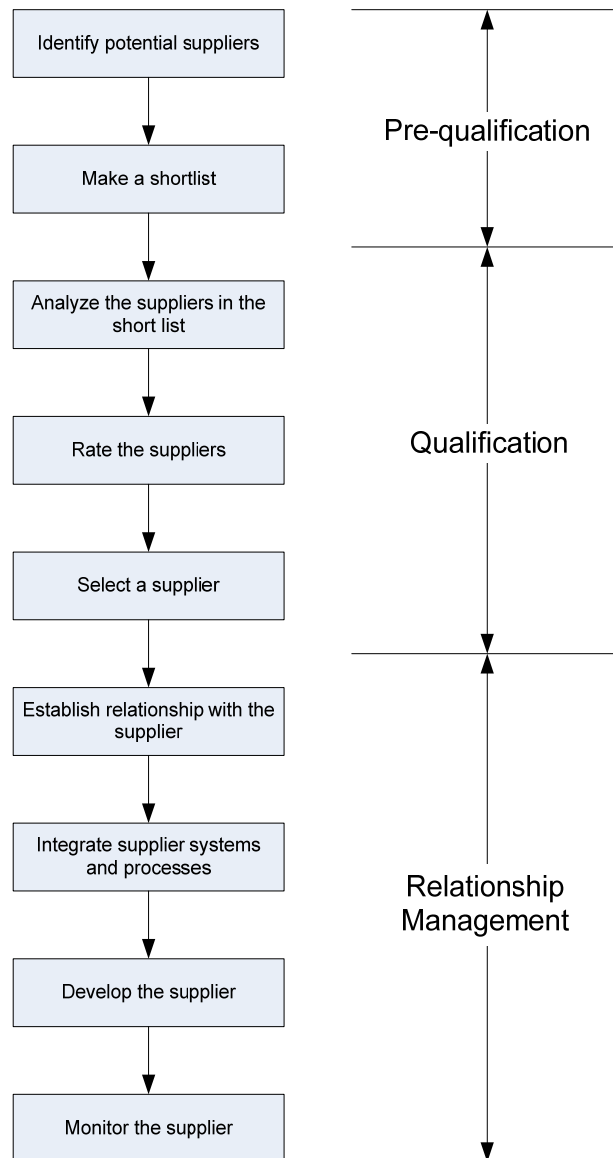


Figure 4. A Model for Supplier Relationship Management (Lash & Janker, 2005)

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Numerical rating	Verbal Judgments of Preferences
9	Extremely preferred
8	Very strongly to extremely
7	Very strongly preferred
6	Strongly to very strongly
5	Strongly preferred
4	Moderately to strongly
3	Moderately preferred
2	Equally to moderately
1	Equally preferred

Table 1. Pairwise comparison Scale for AHP Preferences

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The AHP helps to rank and make decision in a rational and systematic way. Weighting can be changed according to different companies and industries, thus it provides flexibility into the decision process (Chan, 2003). Three features of the AHP differentiate it from other decision-making approaches: its ability to handle both tangible and intangible attributes; its ability to structure the problems, in a hierarchical manner, to gain insights into the decision-making process; and, finally, its ability to monitor the consistency with which a decision maker makes a judgement

The AHP approach, as applied to the supplier selection problem, consists of the following five steps:

1. Specify the set of criteria for evaluating the supplier's proposals.
2. Obtain the pairwise comparisons of the relative importance of the criteria in achieving the goal, and compute the priorities or weights of the criteria based on this information.
3. Obtain measures that describe the extent to which each supplier achieves the criteria.
4. Using the information in step 3, obtain the pairwise comparisons of the relative importance of the suppliers with respect to the criteria, and compute the corresponding priorities.
5. Using the results of steps 2 and 4, compute the priorities of each supplier in achieving the goal of the hierarchy.

In this paper, there are three vendors chosen in the suiting category who produce garments for a global apparel company based in the United States (US). Two of its vendors are located in Turkey and the third vendor is located in Egypt. The goal is to select the supplier that can provide the best material aligned with company strategies and is willing to build a collaborative relationship in the long-term. This goal is placed on the first level of the hierarchy. The competitive priorities proposed by Watts are adopted with the addition of "trust" as the criterion in the supplier selection model. Thus, six criteria—namely cost, quality, delivery, flexibility, innovation and trust—are identified to achieve this goal, and constitute the second level of the hierarchy. The third level of the hierarchy involves the subcriteria that are chosen regarding the success factors for the apparel supplier (Chan & Chan, 2004).

There are three important subcriteria which can be considered as *cost* success factors for a textile company. The first one is the *first cost* which is basically composed of the raw material (fabric and trims), the cut-and-sew, packing cost and the vendor's profit. The second one is the *competitiveness of the landed cost*. The landed cost is different than the first cost since other costs are included such as duty fees and transportation. In this case one of the vendors is in Egypt and there is a trade agreement where Egyptian vendors can ship to the US duty-free which brings a big advantage in reducing the costs. The third criterion is the *fixed costs* which can be considered as the development costs that are put with the related vendor.

The *quality* factor is measured in terms of suppliers' ability to provide samples in good quality. In the development and production process there are a lot of samples that are requested from the vendors such as

fit samples, promotional samples, shipment samples etc. It is important for the suppliers that the *quality of the samples* conforms to the buying firm's specifications. The second subcriterion is the *passing rate* of the shipment audits. The third subcriterion is the *returns to the vendor*. Moreover, the conformance of the garments to the firm's standards is being tested before the shipment and the results of the *product integrity (PI) testing* is used as a subcriterion since it measures the quality of the vendor's production capabilities.

Vendor's ability and willingness of submitting the samples and costing to the buying firm is one of the *delivery* success factors that needs to be considered during the vendor selection process. Considering the shortening cycle times in fashion, speed is very important when evaluating the suppliers. This includes both the production *lead time* (cut-to-ship time) and *sampling turn time*. In addition, the *on-time shipment rate* is one of the key success factors which can be quantified very easily through the weekly reports. For each PO, vendor commits a shipment date for a certain quantity. A delay can cause to missed sales and financial loss, and also shipping less quantities than ordered will have the same consequences. The *timeliness of costing and its accuracy* are also important.

Vendor's ability to *change order volumes* and to *change the mix of ordered items* (style, color, size etc.) is very important in the fashion industry. Also vendor's capability of handling *quick response (QR)* orders is an important criterion however especially in the suiting category where the fabrics have long lead times, it is often impossible to implement the QR system. Vendor's *willingness to go to other countries* to make joint ventures or strategic alliances to pursue for trading and cost advantages is another criterion important when widening the vendor base.

One of the *innovation* dimensions is to have an *in-house design team* to support buyer firm with new ideas and details as per the latest market trends. It is important that the vendor has a clear idea about the aesthetics of the buying firm's designer and execute it correctly on the product. Development and prototyping is the initiation of the final product so the sample room capacity of the vendor, and the *speed and quality of sampling* is one important success factor in the vendor selection process. Vendor's capability of thinking upfront to *apprehend market trends* will help the buyer to adopt the right product.

As far the *trust* between the company and its suppliers is considered, the dimensions of *customer service* include the vendor's ability of handling complaints, following up the orders etc. The *financial stability* is strongly expected from the vendors as they are required to buy raw materials, open the letter of credits (L/Cs) and so on. When evaluating the vendors, the *in-house production capacity* is always preferred; the usage of subcontractors increases the risk in the production process. The reliability of the vendor increases with in-house activities including cutting, sewing, washing, embroidery, printing, and packing. Exchange of sensitive information among partners brings the issue of *confidentiality* into attention. The compliance issues have been a very important matter in the late 90's, as the largest retailers went globally for sourcing; the attention of public was into the sweatshops in the developing countries where the workmanship is much cheaper. Therefore firms created independent audit departments to ensure that the workers at the suppliers work in proper conditions which are standardized in the certifications as well in order to establish and improve *social responsibility*.

All these criteria and subcriteria that are listed above can be put in the hierarchical tree as shown in Figure 6. The criteria and subcriteria used in these two levels of the AHP approach of pairwise comparison of elements in each level with respect of every parent element located one level above. A set of global priority weights can then be determined for each of the subcriteria with weights of all parent nodes above it.

The nine-point scale as suggested by Saaty is used to assign pairwise comparisons of all elements at each level of the hierarchy. As suggested by Saaty, the geometric mean approach, instead of the arithmetic approach, is used to combine the individual pairwise comparison matrices to obtain the consensus pairwise comparison matrices for the entire team. In the Mediterranean sourcing office of the company, the merchandise managers and merchandisers of the related category were questioned using this approach.

In order to construct the model, Web-HIPRE, an AHP program at www.hipre.hut.fi, was use to determine and calculate the normalized weights. This software has been designed to support hierarchy design, construction, and implementation for decision making models and problem solving. It is based on the

software called HIPRE +3 developed at Helsinki University of Technology (Mustajoki and Hamalainen, 2000). As per the survey results, the program normalized the weight of each criterion (cost, quality, delivery, flexibility, innovation and trust) and the results show that the quality is the most important criterion whereas the innovation is the least important one.

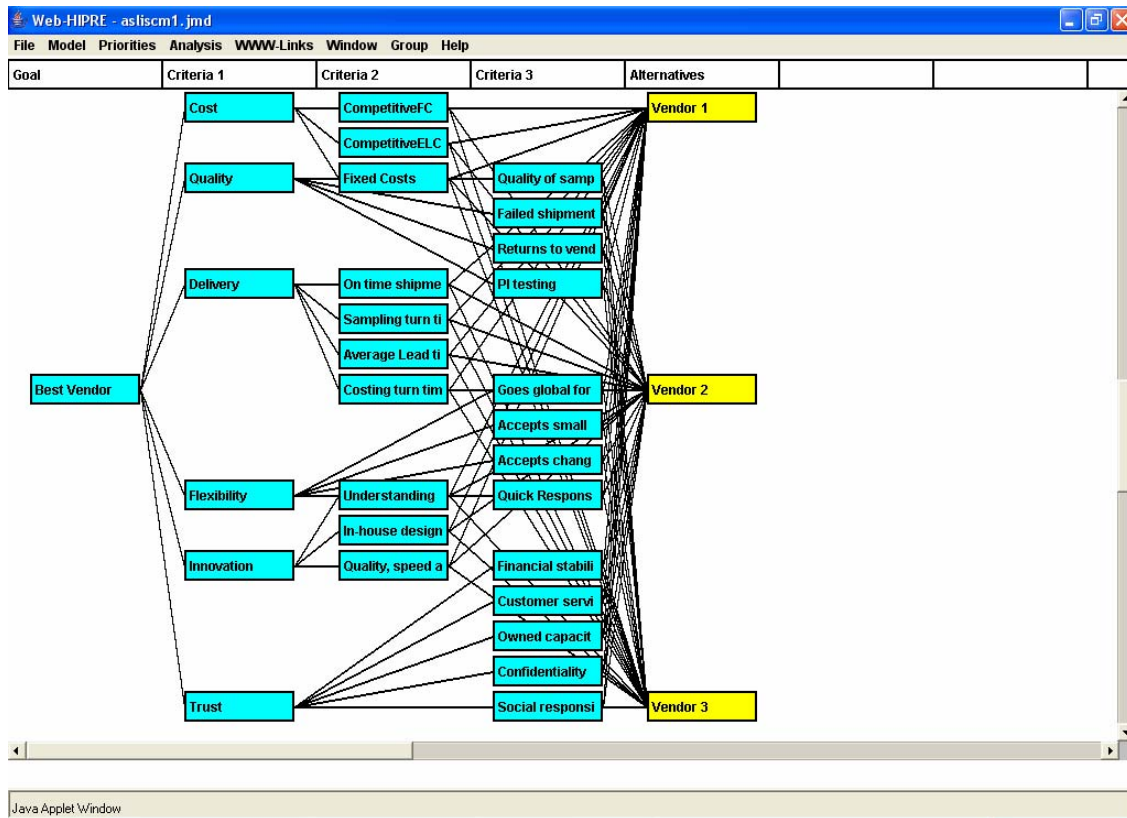


Figure 6. AHP Model for the Selection of Best Vendor

After computing the normalized priority weights for each pairwise comparison matrix, the next phase is to synthesize the solution for the supplier selection problem. The normalized local priority weights of criteria and subcriteria from third phase are combined together with respect to all successive hierarchical levels to obtain the global composite priority weights of all subcriteria used in the third level of the AHP model.

5. Results and Discussions

After calculating the weights of each criterion of second level, they are arranged in Figure 7. The result shows that the quality, delivery and trust are the most important strategic priorities to be considered in the supplier selection problem for suiting category, representing more than 65 per cent of the the total weight. Since the suits category is mostly high-end products with the most expensive fabrics and the best fit, the quality is very important in the supplier selection decision. The vendors are expected to be equipped with most sophisticated machinery and the know-how to produce this high-quality products is very important during both development and production stages.

Delivery and trust have almost the same importance: 0.204 against 0.197. The on-time shipment in the correct quantity rate is very critical in evaluating the vendor's performance in delivery whereas the customer service is the most important factor when evaluating the trust criteria. It is interesting that the cost has less weight than the delivery and trust. However considering the strength of the suiting vendors in this region comparing with the other competitors in Far East or South America, the cost has a less weight when

giving the supplier decision. The cost will definitely have more importance in other apparel categories where there are a lot of global competitors capable of offering the same product.

The flexibility factor is ranking as fifth factor followed by innovation as last. It has a quite small importance in the weighting which can be explained that the suiting category is a more rigid category depending on the fabric lead times. There is mostly very expensive Italian fabric used in this category not allowing so many changes during the season. Once a fabric is booked for a style, unless you can carry the liability you cannot decrease the quantity as the fabric mills are not willing to make these changes or it is not feasible to change the color or the quality. In our case, the category is men's suits where the numbers of styles are limited and the innovation mostly depends on fabric development. Therefore there are not many expectations from the garment supplier. The most important factor is the sampling lead time and quality of the samples which has the weight of 68 per cent.

Eventually Vendor 1 is the strongest vendor followed up by Vendor 2 and Vendor 3. Figure 8 helps to explain the strengths and weaknesses of each vendor considering the criteria. Accordingly, although Vendor 1 is ranking third in the cost, it is still chosen as the best vendor since the weight of quality, delivery and trust are quite strong for this supplier. There is a visible trade-off of cost against quality, delivery and trust.

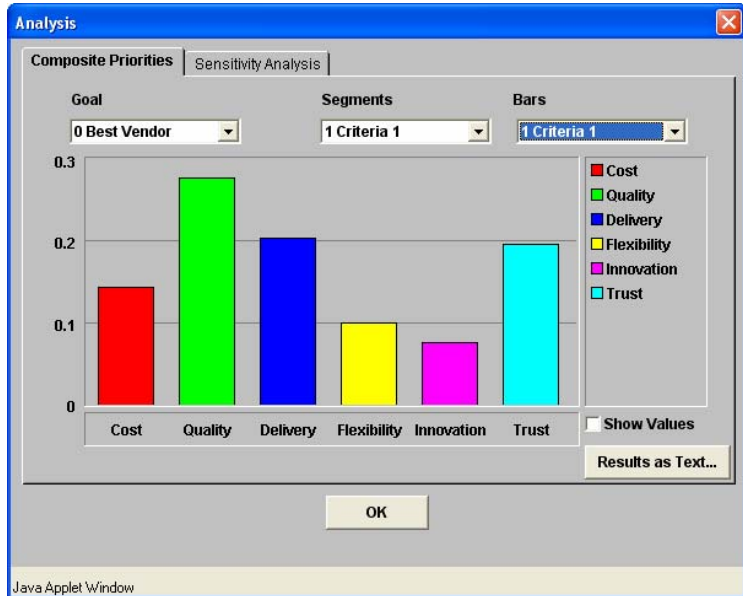


Figure 7. The Rank of the Criteria that Effect the Best Vendor Decision

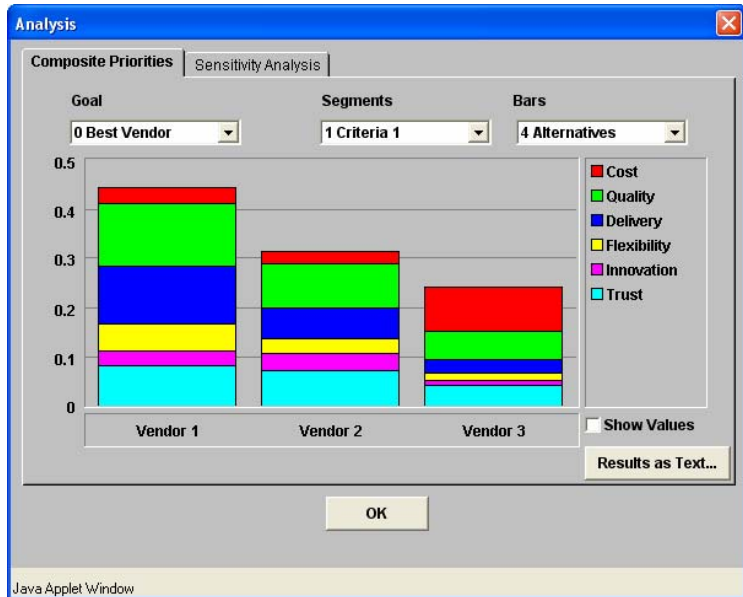


Figure 8. Summary for Rating of Vendor 1, 2 and 3

6. Conclusion

Suppliers are viewed as critical resources for the textile/apparel retailers. They have to be managed to derive the maximum potential in the supply chain, and the selection of the supplier is the most critical task in the supply management. In this study, six strategic priorities were identified as the criteria, and the

priority measures as the subcriteria, and then an AHP-based model was formulated to select the best supplier. After finding the global priority weights, they can be used to determine the final composite priority weights of supplier occupying the last level of hierarchy.

Using the AHP model, the criteria for vendor selection are clearly identified and the problem is structured systematically. This enables decision makers to examine the strengths and weaknesses of the supplier by comparing them with respect to appropriate criteria and subcriteria. Moreover, the use of proposed AHP model can significantly reduce the time and effort in decision making. However we noticed that the weights will need to be fine tuned for the apparel categories other than suiting since the priorities will change definitely. A future work can be conducted for other categories. AHP can be widely used when making decisions regarding the qualitative aspects of a problem.

However, Web-HIPRE provides the opportunity to incorporate hard data into the model. In fact, this feature helps decision makers use the model for monitoring the performance of the existing supplier portfolio as well. This, in turn, can be used to negotiate further contracts in different segments with the existing vendors, given the data and their current capabilities.

Finally it is proven in this work that AHP is a very practical tool that helps the stakeholders to gain a clear idea of selecting the best vendor considering all the aspects of the business which need to be aligned with the company strategy and goals. The regular usage of this tool will also help for checking the plans and ensure that there is no deviation from set-up goals.

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