Analysis of Supplier Relationship Management Model Using AHP

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***Abstract*— There has been a perennial talk on how each function in supply chain adds up to overall efficiency of the company and its process. There is an increase in growth in outsourcing in various sectors which led to the discussion of selecting the right suppliers which has become increasingly critical to a firm's business success. An enterprise performance largely depends on the performance and relationship of its customer–suppliers in the value chain which has increased when compared to what happened in the past. Good customer–supplier relationships is imperative for any organization to respond to dynamic and unpredictable changes. The latest trend has been the formulation of effective Customer Relationship Management (CRM) and Supplier Relationship Management (SRM). There has been only specific focus towards individual domains and lack of research when it comes to an integrative approach in SRM. So, the prime objective of this research is to analyze the criterions of Supplier Relationship Management and its sub-functions such as Supplier Selection, Supplier Assessment and Procurement of materials from the selected suppliers and formulate an overall model, thereby, proposing a framework for SRM. This paper researched, assessed and analyzed previous work related to integration of SRM and conducted a case study based on the Analytical Hierarchy Process (AHP) with a field study. This study particularly shows that differential effects of SRM components and its capabilities that exists, which are specified to the characteristics of any business environment in combination with the firm's strategic choices.**

Keywords: Supplier relations, Purchasing, Buyer-seller relationships, Supplier relationship evaluation.

I. INTRODUCTION

Over a decade, the emergence of supplier relationship management (SRM) has seen significant changes and development in Supply Chain Management. SRM has been viewed as "The way" for firms to capture additional value and boost their performance from the supply chain function. SRM is the development of a well-worn perspective towards continuous improvement of performance and value – a process recognized as a perennial process that focuses towards value for money. The globalization has brought customers closer to the organizations and in order to maintain the diversification of customer needs, the efficiency of Supply Chain Management has become the apex when it comes to importance. The supply chain function start with purchasing and the efficiency of the whole SCM depends on the purchasing strategy as the purchasing strategy and cost directly attribute to the total costs incurred during manufacturing process. So, organizations have started to focus their strategy towards efficient Supplier Relationship Management (SRM) in order to meet the value expected by the customers. Supplier Relationship Management consists of sub-functions such as purchasing strategy, supplier selection and collaboration, and supplier assessment and development. The starting point for describing SRM is recognition that the various interactions and communications with suppliers are not distinct and independent – instead they are unambiguous and usefully thought of as comprising a relationship. It should be organized in a systematized fashion across functional and business unit touch-points, and throughout the relationship lifecycle. However, much research has been conducted on each of these sub-functions solely and exclusively. In order to understand the whole concept of SRM, the managers of each sub-function have to be well educated about the whole concept of SRM and the sub-functions. This helps them to understand how each sub-function influence the other and the important criteria in each department in order to provide a good end result. Here, this paper formulates and propose a model for SRM integrating/clubbing all the sub-functions consists of purchasing strategies, supplier consideration and selection, collaboration in product development and production activities, and assessing the suppliers and performance evaluation. The seamless of this SRM system is a collaboration of SRM with systems such as Enterprise Resource Planning (ERP), Warehousing Management System (WMS) and Strategic Planning System. The motive of this paper is to study the overall concept of SRM in order to understand the how important a supplier is to a company and how purchasing and other components of SRM affects the overall effectiveness of the supply chain unit, thereby, the overall performance of the organization. This paper provides a clear comprehension of the meaning and viewpoint of SRM which will improve collaboration between partners (both external and internal) and possibly stress the adoption of SRM concepts and technologies.

This paper is structured as follows. Section 2 provides a detailed review of the literature. In Section 3, this paper elaborates the processes of the framework for an integrative/collaborative SRM system. In Section 4, a case study is conducted. Finally, the study is concluded in Section 5.

II. LITERATURE REVIEW

A Supplier Relationship Management (SRM) is discipline that strategically and coherently strategizes all the interactions with a third-party organization, which supplies goods and services in order to attain maximum value out of the transaction. An SRM system strategically aims towards collaboration with suppliers and well-established supplier network and relationship, so that a company can develop a new product competitively and produce goods effectively. Accordingly, functions such as formulating the purchasing strategy, supplier selection, supplier evaluation and collaboration, and supplier management have been widely studied. The following section examines how these functions acts as input to SRM, which has been presented in the literature. The literature review goes in 4 phases and as follows:

A. Formulating the purchasing strategy:

Chandra and Kumar et al, (2000) states that Purchasing strategies can be grouped into two distinct types. 1) Competitive approach- the approach based on competition between suppliers where buyers can obtain goods for the minimum price. 2) Cooperative approach- the approach where a strategic relationship is formed between supplier and buyer leading to cooperation with one another to achieve a long-term goal. The other commonly used model for formulating the purchasing strategy as stated by Olsen and Ellram et al., (1997) is purchasing portfolio model where the products are categorized upon the attributes and accordingly distinctive approach are formulated for strategic implications. Gelderman and van Weele et al (2002) pointed out that many have engineered portfolio models and modified according to their needs but on the whole, it has been Kraljic Model that acts as the base for all these models. Eisenhardt and Martin (2000) et al explains that organizational capabilities helps a firm to seize opportunities or mitigate threats from tumultuous environments, they can enhance the firm's competitive (and survival) prospects to a great extent (Eisenhardt and Martin, 2000). The objective for a strategic purchasing is to reduce the cost of procurement. As purchasing acts as the stepping-stone to the whole supply chain, the preparation of it has to be taken as high importance.

B. Supplier Selection:

Supplier Selection is important which decides many factors of the whole supply chain management. Najla Aissaoui et al (2006) mentions that most of the existing literature focuses only on the buyer's side and the trend of selecting a right supplier has been inclined towards artificial intelligence approaches such as case-based and neural network systems. Monczka et al (2009) put forth his discussion that there is no solitary source when it comes to purchasing strategy and it cannot be applied to all purchasing requirements. Therefore, the purchasing strategy used for procuring any material or service is highly shaped and altered during the supplier selection process. Ustun and Demirtas et al, (2008) explains the two kinds of decisions that affects the overall decision-making. One being that suppliers can be evaluated and assessed by more than one criterion and the next being that each and every supplier has a unique specialty and therefore, criterions vary from one to another. Confining to one supplier brings in risks of over dependence and in the other hand, multiple sourcing lead to management issues.

Weber et al (1991) proposed that the important factor that has to be taken care while selecting a supplier is the identification of the right criteria for the assessment of the supplier and Schniederjans and Garvin et al, (1997) added that right techniques and tools has to be employed in order to make the process effective. Aiter et al (2011) stated that the most common evaluation criterions are the expertise in the process, business process and practices followed and risk factors. Lisa M Ellram et al (1990) describes that the trend in selection is towards a strategic point of view, which brings in win-win situations to both supplier and buyer. Wang et al. (2004) expresses that for lean supply chain the criteria such as low price and high quality are considered whereas swiftness, flexibility and quality of the material should be considered for an agile supply chain. In recent times, supplier selection is inclined towards a strategic or towards long-term relationship. This helps in integrating with the manufacturing process, thereby, bringing down the cost involved. Some of the popular methods in selecting supplier are using Analytical Hierarchy Process and Analytical Network Process. The recent trend has been the adoption of fuzzy approach along with AHP in order to mitigate the limitation in the portfolio and other models.

C. Supplier Performance Evaluation and Management:

Evaluation of Supplier is the process of measuring the performance of the supplier and its capability to meet the demands. Wagner and Krause et al (2009) discussed that the goal of relationship is to improve a supplier's capabilities, functionalities and degree of knowledge transfer from the buyer to the supplier firm is subdued by the magnitude of human interactions. William Ho *, Xiaowei Xu, Prasanta K. Dey et al (2009) observed that price is not the most widely adopted criterion, instead, the most popular criterion used for evaluation of supplier performance is quality, followed by delivery, price. Saleeshya et al (2012) says that the analysis of the results of AHP and ISM methodologies provide the industry an insight on how the supply chain can be made more agile. Raghuram et al (2016) stresses on responsiveness in supply chain being a differentiator in the supply chain and helps in competing with other supply chains in the market.

D. A collaborative/integrated approach:

There has been many research conducted in the field of SRM but they were mostly focused towards either supplier selection or supplier evaluation. The research on overall SRM has been very limited. K.L. Choy (2002) et al designed a SRM model using neural network approach but focused towards select and benchmark potential suppliers. S.H. Ghodsypour (1996) et al devised an integrated system linking AHP and linear programming for decision support system for supplier selection only.

After going through previous research work, the conclusion is that most of them where focused towards selection and evaluation view, in addition to discussing about the problems in selection and purchasing. The objective of any SRM is towards achieving a mutual benefit between a supplier and a buyer and inclination towards long-term relationship with

mutual growth. In order to achieve this, a collaborative/integrated SRM is needed which is discussed in coming sections.

III. METHODOLOGY

This is a structured method in organizing and analyzing complex decision. (Thomas L Saaty 1970). This system helps in decision makers converging to the best decision corresponding to the goal and the understanding of the problem. By segregating the factors in a hierarchy framework, it is easy to comprehend sub-problems which can be analyzed independently. A numerical weight often called as priority is derived allowing it to compare the importance with the other factors. Pairwise comparison is a structured procedure of comparing factors/criterions in pairs in order to decide which of each criterion is a preferable one, or which has a substantial amount of quantitative advantage, or whether two entities share identical preference. The method of pairwise comparison is used in the scientific study of preferences, attitudes, voting systems, social choice, and public choice. The Analytic Hierarchy Process is a method for decision making tool where there are handful number of choices but each has a number of trait and some of those traits are difficult to formalize.

IV. ANALYSIS

A. Supplier Relationship Management Framework:

This is a proposed framework where we collaborate functions of SRM in to a single entity. Once it is integrated, the supplier selection is based on the purchasing strategy, which changes the overall scenario of the selection process. The selection of the supplier contributes to the company's performance and will be evaluated to monitor the progress towards long-term relationship.

This framework consists of sub-functions namely purchasing strategy, Supplier selection and supplier assessment and collaboration. This framework acts like a loop model where feedback comes in to action. The loop is to make sure there is continuous improvement and adjusting the whole framework depending upon the feedback from customer and evaluation of the supplier.

SRM is a whole set of process. It consists of

- Strategies for purchasing
- Selection of suppliers
- Collaborate with the suppliers
- Assessment of performance of the supplier

B. Strategies of purchasing:

Using the Kraljic model, the strategies for purchasing are formulated. Factors affecting the cost are the number of units purchased, the total purchase cost and the quality of the product. Factors that influence risk are the number of suppliers for that particular material, the availability, and the substitutions. Depending upon the risk and the type of the material to be procured, the approach towards strategizing is differentiated namely co-operative approach and competitive approach.

1.- *Defining the approach (P1):*

Competitive approach is adopted when there are ample alternatives in the market and the availability of the material. The trust factor is only on the supplier side and there is no commitment in this kind of approach. This approach focuses mostly on price bargain.

Cooperative approach is adopted when there are few alternatives in the market. This approach is used for when procuring special and strategic materials. The balance of power is mutual here and the transaction frequency is recurrent. The important factor that runs this approach is mutual truth and win-win situation.

On the whole, competitive approach is used for low supply risk items whereas cooperative approach is used for high supply risk items. Cooperative approach needs detailed analysis of supplier and the capability before fixing on to a supplier.

2.- *Analysis of supplier (P2):*

Generally, a supplier is analyzed by criterions such as price, on-time delivery, and quality. But these are the basic criterions for analyzing any supplier. In addition to these, there are other criterions that decide the cooperative approach such as financial and economic status, performance, and technological, organizational, cultural. These are often called as factors that influence priority suppliers.

C. Supplier Selection:

Supplier selection is the process by which an organization identifies, evaluate, and contract with suppliers. It is the activity of handpicking a supplier to acquire the essential materials to support the process and outputs of organizations. Choi and Hartley et al (1996) explains that the selection process relies on many assessment techniques, which includes both qualitative and quantitative methods.

First, the material to be procured is to be finalized and then, the suppliers who can provide that material is collected and formed as a database. Then, using the criterions selected in the purchasing strategy, the list of suppliers is selected (in case of competitive approach) or a single supplier (in case of cooperative approach). After the suppliers are selected, the suppliers are ranked using AHP. Finally, the list of suppliers for different materials is selected according to the score in accordance to the criteria.

When it comes to cooperative approach, long term relationship comes into picture and for this, either a new supplier can be developed into one or efforts can be made to extend the relationship with existing supplier. In both the cases, the criterions remain the same. An incentive based contract for example is one of the common method used to monitor the performance and motivation towards better performance.

D. Collaboration Planning:

Collaboration is where the purchasing team links up with other department inside the company along with the suppliers. This is done use Information Technology that links all the functions within the company and the suppliers as well. Collaboration is where the suppliers come into picture on decision-making at the buyer's side. This can happen either during product development or during the production stage. Collaboration during product development is the highest degree of communication when it comes to collaboration.

E. Structure of Collaboration:

For an effective collaboration, supplier and the buyer need to share roles and profits in order to achieve a win-win situation. Including the supplier at an early stage in the product development process and nurturing effective interaction with a concurrent engineering system can achieve effective collaboration. The criteria for supplier selection are: product, process, production, quality, trust, design expertise, communication, and innovativeness. In addition to these, there has to be a cohesive internal collaboration. Collaboration at the production stage fosters lean manufacturing by providing materials to the buyer at the right place and at the right time. This is done in order to meet the customers' demands, as the demand in the market is erratic. This adds up to the flexibility component. The intangible yet important criterions at the collaboration level that decide the overall relationship are collaboration activities, commitment, confidence, financial sharing, communication, and sharing of information.

F. SRM architecture:

When it comes to collaboration/integration, Information Technology is mandate. When it comes to collaboration, this system plays a crucial role in improving the overall effectiveness. It helps in collaborating marketing, purchasing and production inside the company and logistics, transport, purchase order when it comes to collaborating with supplier. Sharing of information between departments inside the company as well as sharing real time information with suppliers simultaneously is needed. In accordance to these systems, planning and scheduling is linked in order to share the information in real time.

The reason for integration is to bring in the real-time experience in order to mitigate any discrepancies. To elaborate on this, let us take a situation. Warehouse Management system notifies the purchasing team when there is a low stock in the inventory. This notification helps them to place an order in the supplier portal where the supplier is connected and as soon as the order is placed, the supplier is intimated along with the inbound logistics team who has to take care of transportation. Now, the supplier checks the planning schedule and accordingly determines the quantity and point of delivery. This is how information system links up and collaborates all the functions in real-time (Appendix Figure 1).

G. Assessment and Evaluation of Supplier:

Supplier evaluation is an activity used in business for evaluating and validating potential suppliers through quantitative assessment. The purpose of supplier evaluation is to certify a portfolio of suppliers and to segment best in class suppliers there is available.

The strategic materials for production/manufacturing is selected and sorted out. Then, the performance of the supplier is measured and with the results, the supplier is evaluated. The materials are sorted out strategically using the basic portfolio model (Kraljic) depending upon the risk and supply factors. Accordingly, the suppliers are checked using factors such as financial stronghold, performance, and use of technology, organizational, and strategic factors. The strength of the relationship is described by characteristics of the relationship, responsiveness and communication, cooperation degree.

Finally, the supplier is evaluated by the supplier capability, promises and performance over the period of time. According to this, the suppliers are categorized as Green Suppliers, Yellow Suppliers and Red Suppliers where green stands for excellent, yellow and red for good and bad respectively. The criterions are as follows:

Overall Capabilities: Systems, quality, technological capability, financial stronghold, reputation, organization, production capacity, and communication/responsiveness

Performance standards: Quality, cost, and leads time and on-time delivery

The collaborative factors: Includes mutuality among them, cooperation, commitment, faith, disputes, approach towards conflict resolution, and compliance

H. Supplier Development:

The process that enhances the supplier's performance is Supplier Development. The recent trend has been that the buying organization is condensing the supplier base and revamps the performance of the existing suppliers.

We define four groups of development programs:

(1) The principal group- constructing long term trust relationship and motivated by incentives

(2) The collaboration group that reinforces and improve the cooperation to increase mutual benefits;

(3) The maintenance group maintains the existing state of affairs and pushes towards a mutual benefit;

(4) The improvement group focuses on the supplier via inspections and improvement activities;

Feedback System:

This system helps in recording the feedback from customers and suppliers based on implementation and evaluation and thereby helping in continuous improvement of the overall system, process, communication and manpower. This continuous improvement helps in nurturing the overall relationship and inclines towards collaboration. This framework helps in improving the overall process in SRM by reengineering the SRM, checking whether the strategies are implemented correctly, evaluation of the overall system inherited and assessment of the overall work. Finally, the system is improved in order to attain mitigate errors and inclination towards better relationship and work efficiency.

V. CASE STUDY

This is a case study conducted in a company T (for confidentiality purpose). The aforementioned proposed framework was applied with respect to the shaping purchasing strategies, supplier selection, supplier relationship performance measurement and assessment, and development of supplier. A specific material has been chosen as the base of this study. This material is used as an important part in manufacturing of switches.

A. Planning the purchasing strategy:

The Kraljic Portfolio method is used in formulating the purchasing strategies. Depending upon the number of suppliers available, the supply risk is determined. This part is a strategic part, so, there has to be high risk.

B. Selection of Supplier:

The criterions for supplier selection in this case study are price, quality and on-time delivery where quality being the important criteria as it decides the performance of the overall product. The company has an incoming quality team that inspects the quality of the material in terms of the material strength, appearance. Delivery time decides the effectiveness of JIT and the inventory level.

Supplier Relationship Assessment:

C. Supplier evaluation:

The supplier is evaluated in terms of their capability, the performance and Relationship. These factors can be classified into:

1. Performance evaluation – quality, cost, lead time and on-time delivery
2. Capability evaluation – management and the technology inherited
3. Relationship evaluation – responsiveness and degree of collaboration

D. Finding the weight for each criterion:

A survey was carried out in the company to determine the relative weight of each criterion. The survey was carried out and analyzed by production team, quality team and procurement team. Applying the pairwise comparison, the judgments were determined with the help of Saaty's scale (1970). The judgment was verified using the consistency ratio (CR). After the pairwise comparison is developed from the Saaty's scale, the matrix is normalized to sum to 1.0 or 100 %. Then, the priority or relative weight is obtained from the normalized matrix (Appendix Table 1, Table 2 and Table 3).

VI. RESULTS

Results from these table shows the total supplier score and they are as follows: Company A- 87.84; Company B-96.36; Company C-92.5; Company D-90.39; Company E- 83.79. According to the results, Company B is an excellent supplier and thus, placed as Green Supplier (type of supplier who does not have to go through incoming quality). Companies A, C and D form a group of supplier list that has the potential to enhance its performance and join the green supplier group. These companies have to work on its collaboration techniques and strategies in order to equip themselves as the top-tier supplier. Company E has the lowest score among these and have to initiate programs to improve the overall relationship and methods inherited in the organization. This proposed system provides each of the suppliers' suggestions and recommendations so that they can enhance their performance level.

VII. CONCLUSION

This proposed SRM system helps a company to understand how the supplier links up with respect to the buyer's expectation and helps in achieving an optimum purchasing price, improvement in collaboration, delivering high quality products. This proposed framework explains how to initiate the purchasing function and establishing its strategies, the selection of the supplier, the methods of collaboration, the assessment of supplier and the development of supplier relationship and the feedback system in order to implement the concept of continuous improvement. Information technology is adopted to interlink the departments inside the company as well as with the suppliers and form a basis for a long-term relationship with the suppliers. The feedback system helps in monitoring the overall progress of the implemented SRM framework and points out the improvement areas in order to enhance the overall plan, system and its process.

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Appendix

Table 1

	Price	Quality	On-Time Delivery	Innovation	Collaboration	Management
Price	1	¼	3	3	4	2
Quality	4	1	3	2	4	2
On-Time Delivery	1/3	1/3	1	1	1	1/3
Innovation	1/3	½	1	1	1	½
Collaboration	¼	¼	1	1	1	1/3
Management	½	½	3	2	3	1

$$\mathrm{Si} = \sum_{j=1}^{6} \mathrm{Aij} * \mathrm{wj} \ \ where\ i = 1,2,..5$$

[1] Lambda max value = (6.3942+6.9051+6.2187+6.2021+6.1900+6.1617)/6
[2] =>6.6453
[3] Consistency Index CI = lambdamax-n/(n-1)
[4] CI=0.0690
[5] Consistency Ratio = CI/RI
[6] RI for 6*6 matrix is 1.24
[7] CR = 0.0690/1.24
[8] CR = 0.055 which is less than 0.1 or 10% (acceptance value)

Table 2

	Price	Quality	On-Time Delivery	Innovation	Collaboration	Management	Priority/weight Matrix B
Price	0.150	0.088	0.250	0.300	0.285	0.317	0.2416 or 24%
Quality	0.625	0.353	0.250	0.200	0.285	0.317	0.3383 or 34%
On-Time Delivery	0.052	0.117	0.083	0.100	0.071	0.052	0.0791 or 8%
Innovation	0.052	0.176	0.083	0.100	0.071	0.079	0.0935 or 9%
Collaboration	0.039	0.088	0.083	0.100	0.071	0.052	0.0821 or 8%
Management	0.078	0.176	0.250	0.200	0.214	0.158	0.1793 or 17%

Figure 1

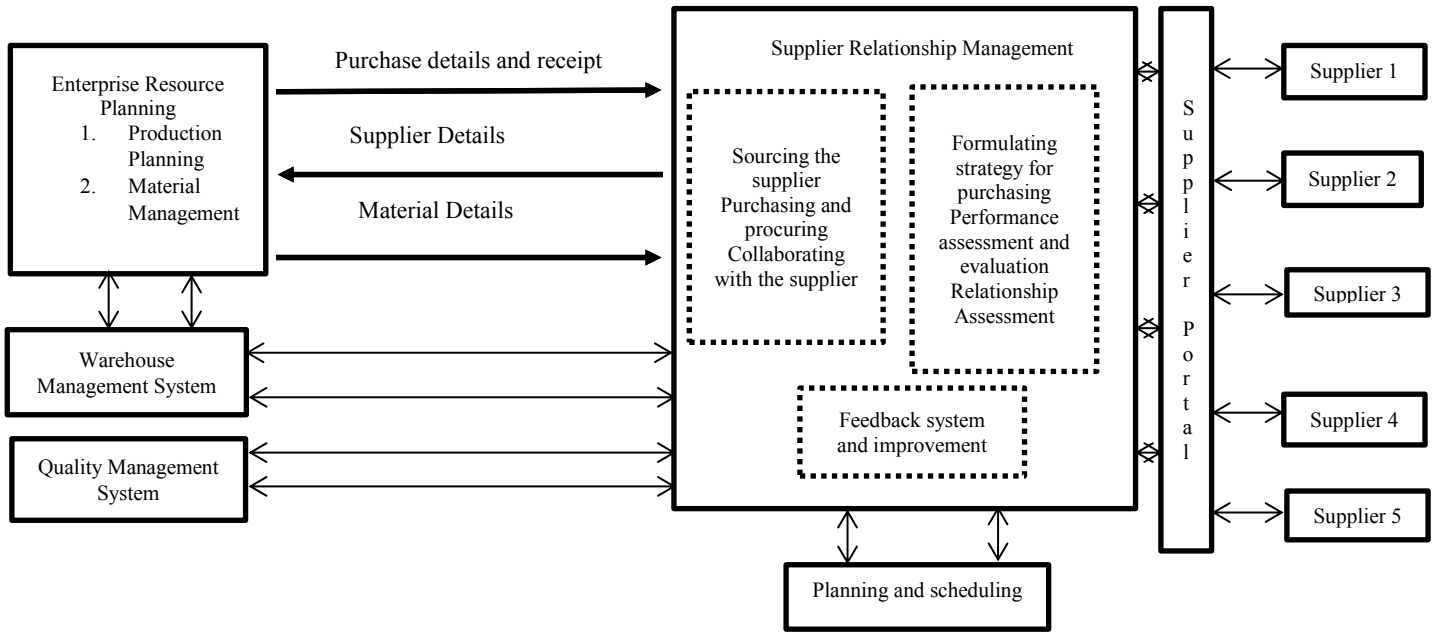

Table 3

Suppliers		Firm 1	Firm 2	Firm 3	Firm 4	Firm 5
Price (24.6)	Aij	97.6	96.1	100	81.5	90
	Aij*wj	24	23.6	24.6	20	22.14
Quality (33.83)	Aij	75.6	100	91.3	95	62.3
	Aij*wj	25.57	33.83	30.88	32.1	21
On-Time Delivery (7.91)	Aij	84.6	90	85.3	87	92
	Aij*wj	6.69	7.11	6.74	6.88	7.27
Innovation (9.35)	Aij	91	87	85	85	89
	Aij*wj	8.5	8.13	7.94	7.94	8.32
Collaboration (8.21)	Aij	95.4	98.7	92	89.5	100
	Aij*wj	7.83	8.1	7.55	7.34	8.21
Management (17.93)	Aij	85.1	87	82.5	90	94
	Aij*wj	15.25	15.59	14.79	16.13	16.85
Total Supplier Score		87.84	96.36	92.5	90.39	83.79