E-PROCUREMENT SYSTEM WITH EMBEDDED SUPPLIER SELECTION DSS FOR AN AUTOMOBILE MANUFACTURING INDUSTRY

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ABSTRACT

This paper presents the development of Decision Support System (DSS) to enable the selection of best suppliers in an e-procurement process. The model base of the DSS incorporates the Online Analytical Processing (OLAP) and Analytic Hierarchy Process (AHP) techniques to shortlist and selects the best suppliers in a web environment. The e-DSS process is implemented using ASP and SQL server, for an Indian automobile manufacturing industry. The results obtained for supplier selection is competitive in terms of the quality and lead time of the chosen suppliers.

KEYWORDS

AHP, Decision Support System, E-commerce, E-procurement, Supplier selection, OLAP

1. INTRODUCTION

The Internet allows the supplying of enterprises from the smallest enterprise to largest corporations to establish global presence. Hence, the supplying enterprises now have the opportunity to reach geographically dispersed markets that would otherwise be cost prohibitive to consider. Purchasing enterprises also now have the opportunity to select the best suppliers, by utilizing suppliers' bids on the internet, thus averting time consuming and costly outside sources (middlemen). By best supplier, it means the supplier who can supply the right amount of material at the right time at right price (or cheap), and of the right quality. Hence the choice of suppliers plays an important role in reducing the wastage in the supply chain and hence shows an initiative towards business process improvement.

The increasingly competitive global world markets put industries under intense pressure to find ways to cut material costs to survive and sustain their competitive position in their respective markets. Since a qualified supplier is a key element and a good resource for a buyer in reducing such costs, evaluation and selection of the potential suppliers has become an important component of supply chain management. Hence, development of an effective and rational

supplier selection model is naturally desirable. A review of literature has been made to study the different techniques used for the supplier selection in an procurement/ e-procurement process.

Saman Hassanzadeh Amin et al (2011) have proposed a new framework for supplier management of Internet Service Provider (ISP) on the basis of company's strategy including supplier selection, evaluation, and development. In the first phase, quality function deployment is utilized to rank the best ISPs based on qualitative criteria. Then a Quantitative model is adopted to consider quantitative metrics.

Cemalettin Kubat et al (2010) have integrated AHP, Fuzzy AHP and Genetic Algorithm to determine the best suppliers. Fuzzy set has been utilized to linguistic factor to organize criteria and sub criteria weight, pair wise comparison with fuzzy AHP where it is utilized to organize all factors and which was assigned weighting for related factors. Finally, a hypothetical supplier selection problem was solved by GA algorithm

Ali kokangul et al (2009) have developed an integrated approach of AHP and non-linear integer and multiobjective programming to determine the best suppliers and to place the optimal order quantities among them. This integration based multi-criteria decision making methodology takes into account both qualitative and quantitative factors in supplier selection. While AHP matches item characteristics with supplier characteristics, non-linear integer programming model analytically determines the best suppliers and the optimal order quantities among the determined suppliers.

Jose M.Cruz (2009) have developed a decision support frame work for modelling and analysis of supply chain networks incorporating social responsibility (CSR) and have considered the multi-criteria decision making behaviour of the various decision makers (manufacturers, retailers , and consumers) , which includes the maximization of net return , the minimization of emission, and the minimization of risk.

Ming –Hung Shu et al (2009) have proposed a supplier selection and evaluation problem on the basis of the quality criteria. Here the cpk indexes have been used to evaluate the quality of supplier's product.

Suleyman Ersoz et al (2009) have developed an expert system to give rational decisions in vendor selection in which management and selection of vendors have been examined by considering the various factors like quality, service, speed, cost etc.

Jing-Rung Yu et al (2008) proposed a framework which integrates the Analytic Hierarchy Process and integer programming to rate suppliers' performance regarding incoming raw materials in the context of supplier management and then to allocate periodical purchases.

Wan Lung Ng (2008) proposed a weighted linear program for the multi- criteria supplier selection problem.

Zhiying Liao et al (2007) presented a model on multi-objective stochastic supplier selection model which is a typical non-linear mixed integer combinatorial optimization problem developed to minimize the cost, average quality rejection rate, delivery rate and maximize the flexibility rate.

Manoj kumar et al (2006) have developed and formulated a fuzzy multiobjective integer programming Vendor selection problem that incorporates the three important goals: cost minimization, quality maximization and maximization of on time delivery with the realistic constraints such as meeting the buyer's demand, vendor's capacity, and vendor's quota flexibility.

Ozden Bayazit et al (2005) for the first time discussed a comprehensive application of AHP for a real-world case along with sensitivity analysis to choose the best supplier. They proposed an AHP model to choose the best supplier and place the order quantities among them for a construction company.

Qualitative and quantitative factors used to identify a potential good supplier has been taken from the above stated literature papers. However the literature does not report the implementation of the supplier selection process integrated in an e-procurement process. Also, the use of OLAP technique for multi-criteria decision making for deciding the supplier selection strategies in the early phase of e-procurement is not reported in the literature. Hence, this paper explores the development of Decision Support System (DSS) for the supplier selection process in an E-procurement process, i.e., automatically searching suppliers on the servers, and filtering the data to find the best supplier. By this DSS, an enterprise can seek potential suppliers from all over the world, faster and cheaper. Also, an enterprise can seek suppliers often, for an ongoing project or for future projects. Hence a DSS framework has been developed for supplier selection procedures that enable the enterprise to maintain its key concepts for survival, namely agility and dynamic collaboration.

Section 2 presents the design details for implementation of the DSS, which enables potential short listing of the good suppliers. Section 3 illustrates the implementation of the e-procurement process with the selected list of suppliers, for the final selection of the best supplier for contract. Section 4 presents the conclusions of the paper.

2. DESIGN AND IMPLEMENTATION OF E-DSS

The electronic Decision Support System (e-DSS) framework shown in Figure 1 first determines the characteristics and requirements of the procurement cycle. The strategic decision making involves the demand analysis, fixing up the procurement horizon and determine the sourcing strategy. Once this is finalized, the buying organization invites all suppliers to participate in the supplier selection bid. Any supplier around the globe can participate in the selection process by registering with the buying organization by providing all the relevant data required. These data's are stored in the supplier's database. The profile submitted by every supplier can be modified/ updated at any point of time in order to show their continuous improvement in terms of quality rating, cost rating, cycle time rating, organization rating, relationship rating, service rating and past performance rating.

The supplier selection process is initiated with the screening of potential suppliers based on the procurement requirement. The screening is based on strategic decisions made such as (i) choosing the supplier of specific geographic location (like local suppliers , regional / national / international suppliers) , (ii) choosing based on the manufacturing strategy (MTO/MTS/MFS) , (iii) choosing the supplier based on their relative performance rating and so on. Once the supplier selection list is finalized, the e-procurement process can then follow.

The user interacts with the interface which is basically a graphical user interface (GUI). Using the GUI the user can key in data and also retrieve data using the 'Data Acquisition System (DAS). It is this DAS that interacts with all the modules of the DSS.

The DAS first interacts with the knowledge database. This is the permanent database that stores all details regarding the suppliers, process details and also the performance data.

The DAS also interacts with the dynamic database. This dynamic database can also be called the temporary database. It is this database from which we can export the data to the SPSS software for OLAP analysis.

The link engine is the engine that establishes the link between the dynamic database and the SPSS database. Once the data is exported to the SPSS database the OLAP analysis can be executed from a command executed by the user.

There is also a dynamic data acquisition module. With the help of this module the user can edit any existing data and append new data to the existing database. This can be useful in the case there is any change in the supplier's performance or parameters. This is usually done by a human expert, who is normally a supplier assessor in the buying organization or by the supplier himself by means of self-evaluation. Apart from all these, the user can store data and retrieve them at any future point.

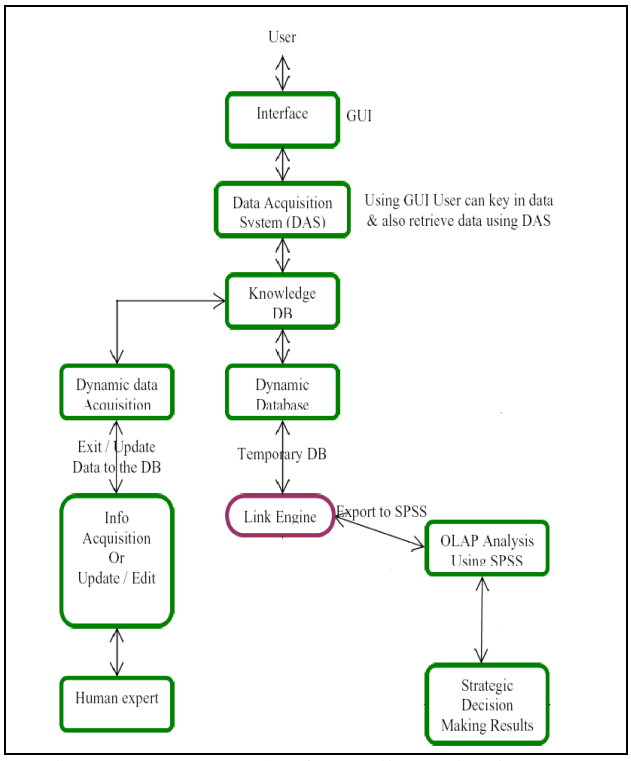

Figure 1 Framework of Supplier Selection DSS

The implementation of DSS is done with ASP.Net as the front end for user interface. Any supplier willing to partner with the buying organization needs to submit their profile which can be updated at any time. This enables continuous monitoring of the supplier improvement towards business process improvement. The buying organization will make use of this supplier database

information to make strategic decisions in selecting the best supplier among the very large list of potential suppliers. The Model View Controller (MVC) pattern of DSS implementation is shown in Figure 2.

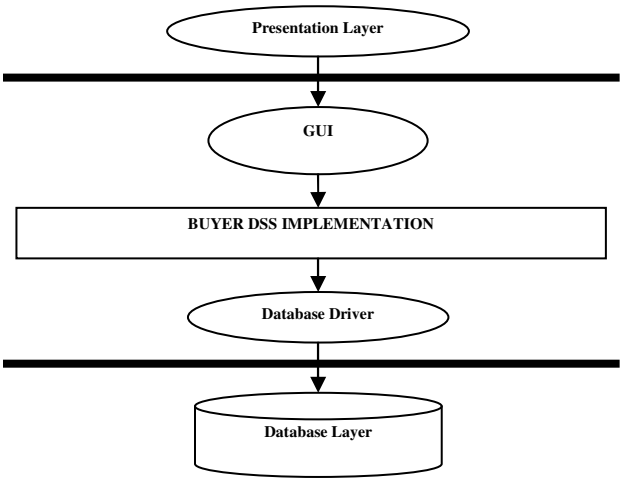

Figure 2 MVC Pattern of DSS Implementation

The structure of the buyer DSS implementation comprises of the following sub-modules. They are described as follows:

(A) Supplier Profile Submission or Update Component

The supplier profile submission or update component is used by the buying organization to get as much information about the supplier. This supplier profile will be stored in their supplier's database from which they can screen the potential suppliers whoever matches their screening criteria. The information provided can be updated by the supplier at any time.

(B) Supplier Self – Evaluation Component

Supplier selection criteria are an important issue in the supplier selection process. A self evaluation form is framed based on the study of factors affecting supplier selection and given to the suppliers to provide input to the buying organization in-order to help the buying organization to better understand their business practices and standards. Formulation of the self - evaluation criteria's & the factors influencing each decision criteria towards understanding of the supplier, as collected from the automobile industry is given in Appendix 1. This form has to be submitted by the supplier during their participation in the supplier's selection bid. The supplier has to evaluate/rate himself based on many criteria's such as the cost, quality, cycle time, organization standards, past performance, relationship with other organizations and service level. Based on the evaluation their performance is recorded and will be monitored by the Supplier assessment team of the buying organization. This evaluation data provided by the supplier will be used by the buying organization to make strategic decisions. The validity of the information provided will be assessed by a team from the buying organization, after which the supplier will be considered for the selection process. The supplier can update their rating as and when they update their business standards/ practices. This helps the buying organization to keep track of the supplier performance improvement or monitor the continuous improvement of the supplier which aids towards TQM.

The supplier is rated based on the information provided by them. The overall supplier performance is calculated based on the average of the ratings obtained in terms of: Quality, Cost, Relationship, Organization, Service, Cycle time and Past performance rating.

The supplier can update the self-evaluation procedure as and when they show an initiative towards business improvement. The performance rating thus calculated by this process is used to continuously monitor the improvement of the supplier towards its business improvement initiatives.

The supplier self-evaluation form shown in Fig 3 is used to evaluate the supplier performance based on the data submitted by them. The authenticity and validity of the information provided by the supplier will be verified by the supplier assessment team (SAT). The supplier is evaluated in terms of Cost, Quality, Service, Past Performance, Relationship, Organization and Cycle time are evaluated. The supplier rating is evaluated as per the information provided by the supplier.

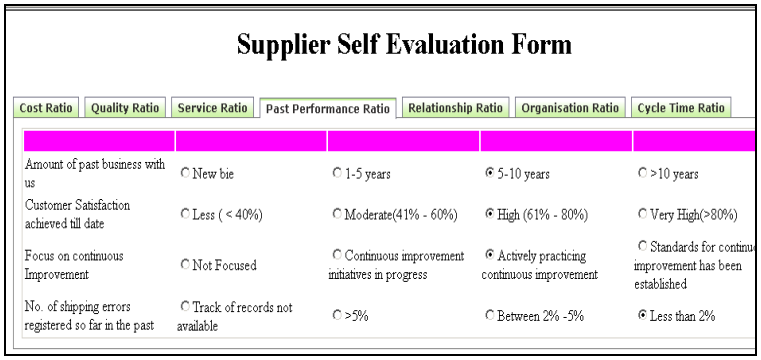

Figure 3. Supplier self evaluation component.

(C) OLAP Using SPSS

Multidimensional OLAP using SPSS is used for making strategic decisions. The possible dimensions of supplier selection decisions are the Location (Local, Regional, National, International), Manufacturing strategy (MTS, MTO, MFS, etc.), Type of product. In all cases, the performance rating is taken into account as the quantitative measure used for the decision making process. The ODBC connectivity is interfaced with the SPSS software for the OLAP analysis.

OLAP databases are referred often as "cubes" since they have a multidimensional nature. Each result of querying, browsing, and summarizing can be viewed and stored as a separate cube. A cube is a visual representation of a multidimensional table and has just three dimensions: rows, columns and layers. OLAP cubes are very flexible because they allow the user to move information between these three dimensions. OLAP cubes are easy to create and manipulate. Since they provide insight into various aspects of data, these tools also represent data mining technology. Figure 4 shows the OLAP cube for the decision making process with three dimensions: The supplier, location and product.

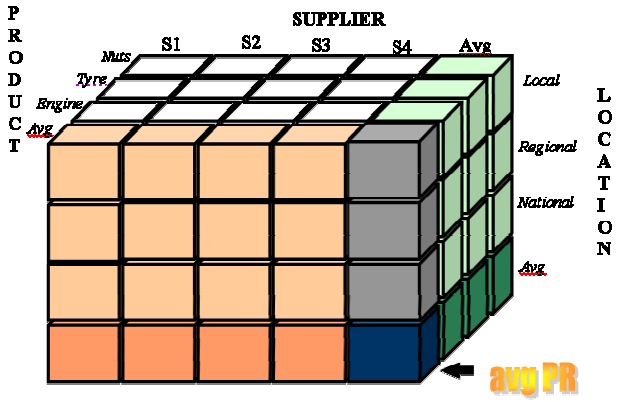

Figure 4 Data cube construction for Supplier selection process

With this cube creation, an OLAP analysis can be performed to make decisions. If the OLAP cube gives a higher performance rating for local suppliers (High mean value of performance rating for suppliers whose location type="local") as compared to others (Regional, national, international) then, the decision of supplier selection favours the choice of selecting local suppliers. Similarly, OLAP can be used to find out which product performance is good, so as to bring in focus to other products whose performance is not up to the expected level.

From the Performance Level of all the "n" suppliers, Multidimensional OLAP is performed using SPSS for making strategic decisions. The OLAP operations such as Slice and Dice shown in Figure. 5 are done on the OLAP cube. The slice operation performs a selection on one dimension of the given cube resulting in a sub cube. The dice operation defines a sub cube by performing a selection on two or more dimensions. OLAP is an approach to quickly provide the answer to analytical queries that are dimensional in nature. OLAP is technology that uses a multidimensional view of aggregate data to provide quick access to strategic information for further analysis. It allows fast and efficient analysis of data by turning raw data into information that can be understood by users and manipulated in various ways. So OLAP technique is used for multidimensional analysis of supplier's performance and determines the criteria for procurement process.

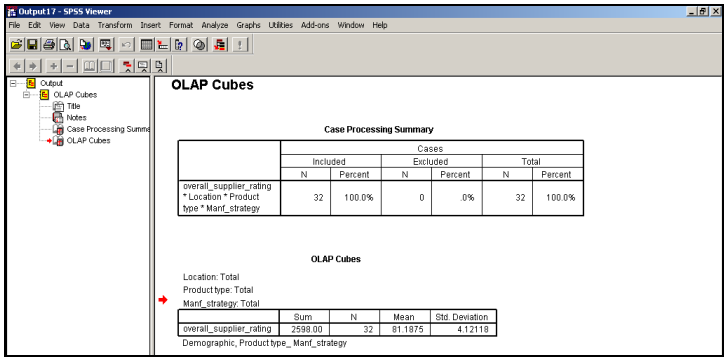

Figure 5 OLAP operations in SPSS

(D) Screening & Short-Listing of Suppliers

The filtering process is based on the selection strategies decided by the Decision authorities, such as based on the attributes such as: Manufacturing strategy and location as shown in Figure 6. The

results of the screening module are used to rank the suppliers as shown in Figure 7. The Operations Research based Analytic Hierarchic Process (Saaty, 2000) is used for ranking among supplier alternatives. The results of selecting the best "n=4" suppliers for the chosen criteria quality, cost, service, delivery and environment are shown in Figure. 8.

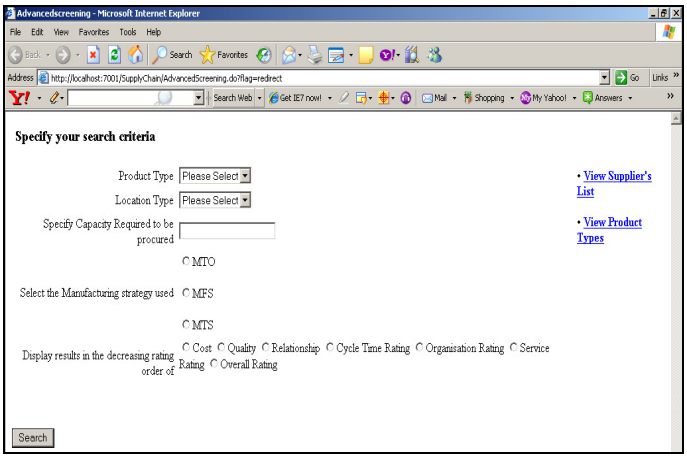

Figure 6 Supplier screening module

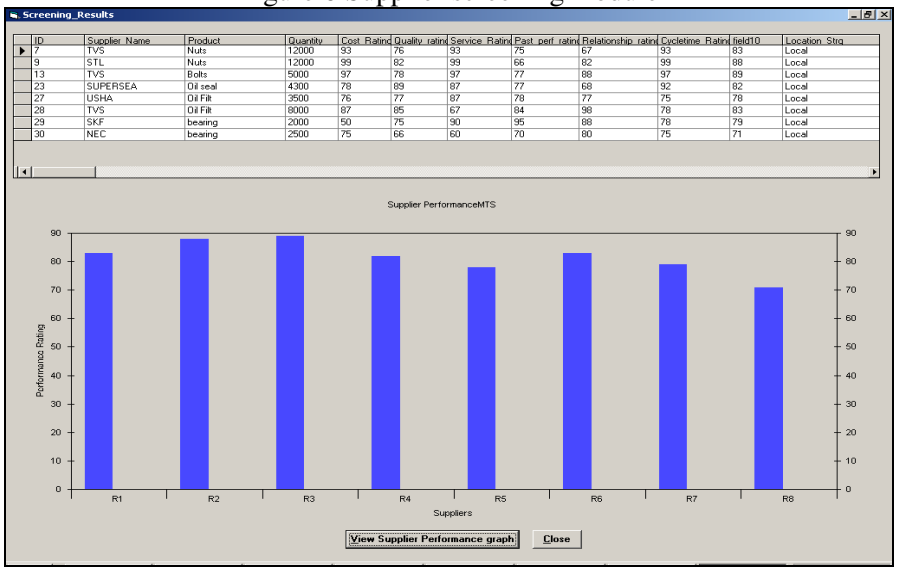

Figure 7 Supplier Screening Component

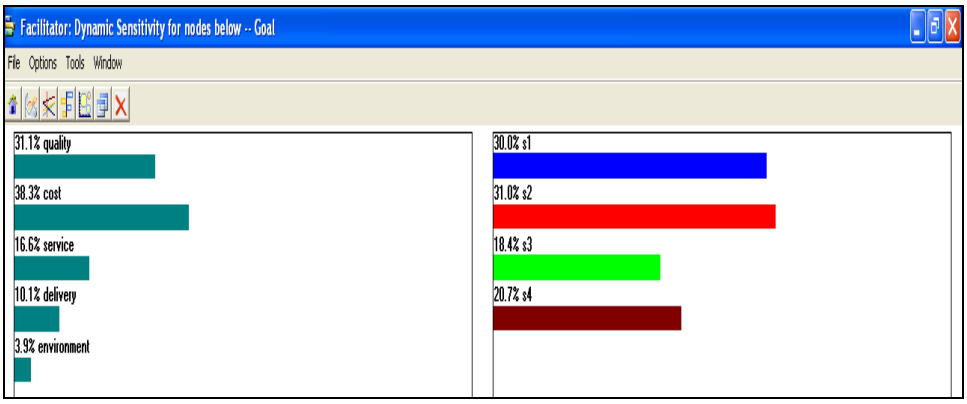

Figure 8 Priorities of the Supplier with respect to Criteria

3. E-Procurement Implementation

Finally, after choosing the top "n" suppliers, the e-procurement process shown by the sequence diagram in Figure 9 is implemented using the ASP and SQL Server in an intranet server.

Once the manufacturing industry submits its procurement requirements (E-requirements) to the DSS agent (web agent), the potential suppliers are selected as discussed above and the Request for Proposal (E-RFP) is sent to those potential suppliers as shown in Figure 10.

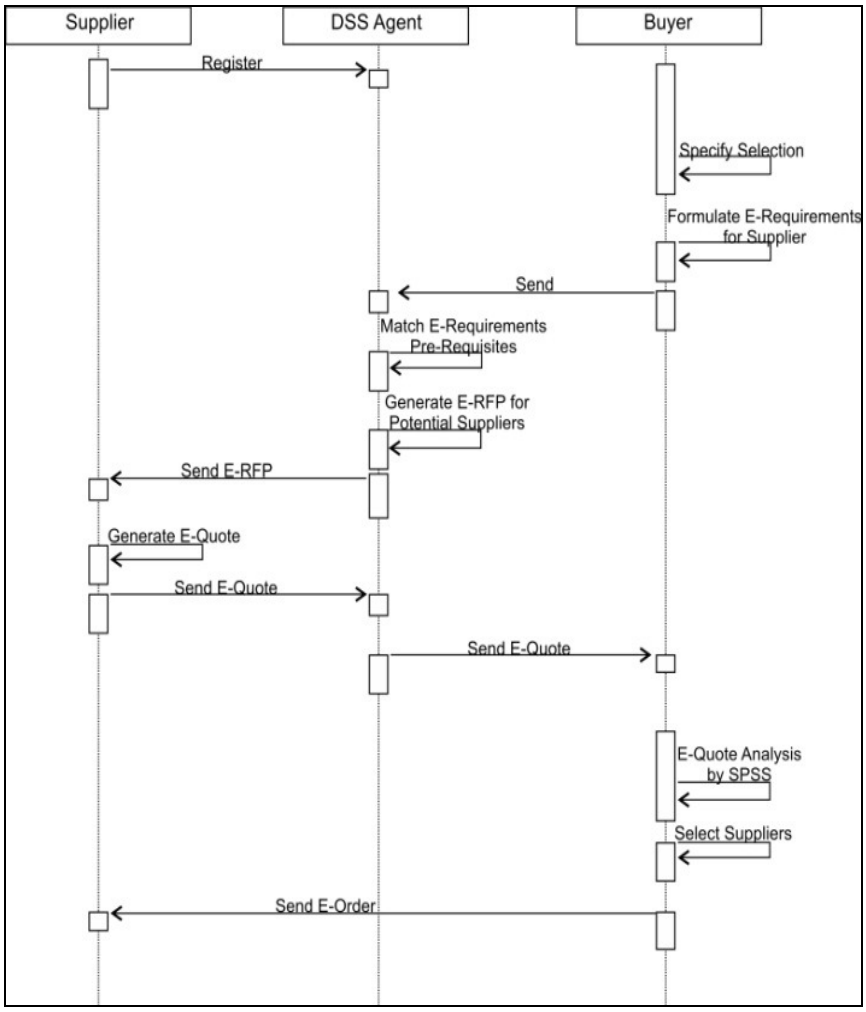

Figure 9 E-procurement sequence diagram

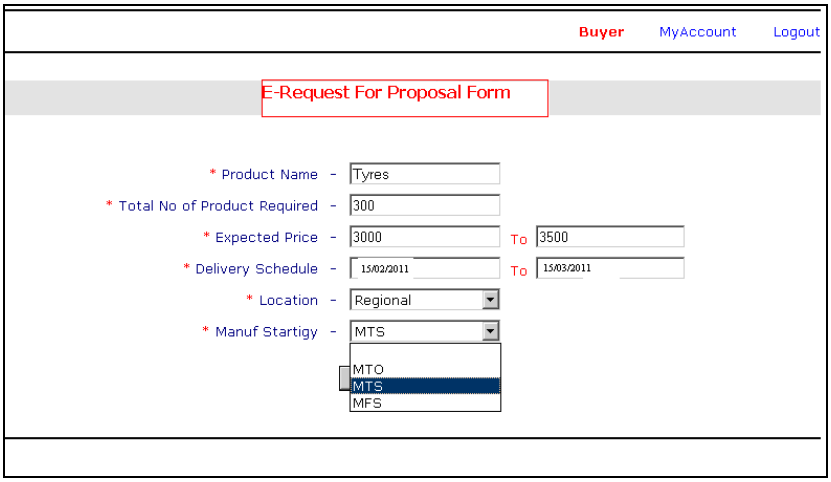

Figure10 E-RFP sent to the supplier

Upon receipt of the e-RFP, the supplier prepares the quote and submits the e-quote back to the DSS agent as shown in Figure 11.

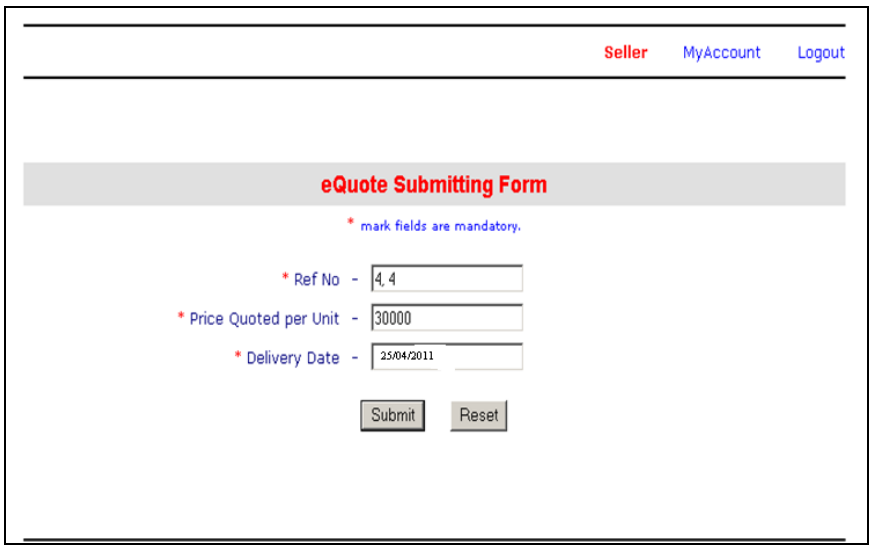

Figure11 E-quote submitted by the suppliers to the Web agent.

The e-Quotes are then forwarded to the buying organization/ procurement managers. Upon receipt of the e-quotes from the top "n" selected suppliers, the procurement team selects the best convincing supplier by summarizing and reviewing the e-quotes by SPSS analysis and then finally sends the e-order to the selected supplier.

4. CONCLUSIONS

The stand-alone DSS developed is flexible and set up in a modular structure suitable for a multi-user, inter-company usage. The DSS selects key suppliers based on the company's core process requirements (Decision support strategies) and standardized selection criteria. This is done by the standard Operations research tools such as the OLAP and AHP. The supplier screening process is done by means of evaluation and short-listing procedures. The purchasing process is then initiated with this selected list of potential suppliers. The short listed suppliers are ranked by the Analytic Hierarchical Processing technique. The DSS finally recommends this list of short listed suppliers for the e-procurement process.

5. REFERENCES

[1] Alev Taskin Gumus, Ali Fuat Guneri, Selcan Keles, Supply chain network design using an integrated neuro-fuzzy and MILP approach: A comparative design study, Expert Systems with Applications, DOI: 10.1016/j.eswa.2009.05.034, 2009.

[2] Ali Fuat Guneri, Atakan Yucel , Gokhan Ayyildiz, An integrated fuzzy-lp approach for a supplier selection problem in supply chain management, Expert Systems with Applications, Vol. 36 Issue 5, DOI: 10.1016/j.eswa.2008.12.021, 2009.

[3] Ali Kokangul and Zeynep Susuz, Integrated analytical hierarchy process and mathematical programming to supplier selection problem with quantity discount, Applied Mathematical Modelling, Vol. 33, Issue 3, pp: 1417-1429, 2009.

[4] Amir Sanayei, S. Farid Mousavi, M.R. Abdi and Ali Mohaghar, An integrated group decision-making process for supplier selection and order allocation using multi-attribute utility theory and linear programming, Journal of the Franklin Institute, Vol. 345, Issue 7, pp: 731-747, 2008.

[5] Cemalettin Kubat and Baris Yuce, A hybrid intelligent approach for supply chain management system, Journal of Intelligent Manufacturing, DOI: 10.1007/s10845-010-0431-2, 2007.

[6] Davidrajuh, R. (2003) Modeling and implementation of supplier selection procedures for e-commerce initiatives. Industrial Management & Data Systems, 103(1): p. 28-38.

[7] Jing-Rung Yu, Chao-Chia Tsai, A decision framework for supplier rating and purchase allocation: A case in the semiconductor industry, Computers and Industrial Engineering, Vol. 55 Issue 3, DOI: 10.1016/j.cie.2008.02.004, 2008.

[8] Jose M. Cruz: The impact of corporate social responsibility in supply chain management: Multicriteria decision-making approach. Decision Support Systems 48(1), pp: 224-236, 2009.

[9] Journal of Systems Science and Systems Engineering, Vol. 15, Number 2, pp: 217-231, 2005.

[10] Manoj Kumar , Prem Vrat , R. Shankar, A fuzzy goal programming approach for vendor selection problem in a supply chain, Computers and Industrial Engineering, v.46 n.1, p.69-85, 2006.

[11] Ming-Hung Shu, Hsien-Chung Wu , Quality-based supplier selection and evaluation using fuzzy data, Vol. 57 Issue 3, DOI: 10.1016/j.cie.2009.04.012, 2009.

[12] Keshavamurthy B.N. , Mitesh Sharma and Durga Toshniwal, efficient support coupled frequent pattern mining over progressive databases, International journal of database management systems, Vol.2, No. 2, pp:73 – 82, May 2010.

[13] Paul Humphreys, Ronan McIvor, Felix Chan , Using case-based reasoning to evaluate supplier environmental management performance , Expert Systems with Applications, Vol. 25(2),pp:141-153, 2003.

[14] Qinghua Zhu, Joseph Sarkis and Kee-hung Lai, Initiatives and outcomes of green supply chain management implementation by Chinese manufacturers, Journal of Environmental Management, Vol. 85, Issue 1, pp: 179-189, 2007.

[15] Saman Hassanzadeh Amin, Jafar Razmi, Guoqing Zhang, Supplier selection and order allocation based on fuzzy SWOT analysis and fuzzy linear programming, Expert Systems with Applications, DOI: 10.1016/j.eswa.2010.06.071, 2011.

[16] SPSS tutorial available at: www.spss.com

[17] Süleyman Ersöz, Mustafa Yüzükırmızı, A Kürşad Türker, Burak Birgören, Vendor Selection in Supply Chain Management, Management Science / Operations Research, Vol.: 1, Issue: 2, pp: 61-67, 2009.

[18] Thomas L Saaty, Fundamentals of the Analytic Hierarchy Process. RWS Publications, 4922 Ellsworth Avenue, Pittsburgh, PA 15413, 2000.

[19] Wan Lung, Ng, An efficient and simple model for multiple criteria supplier selection problem, European Journal of Operations Research, 186 (3), pp: 1059 – 1067, 2008.

Evaluation criteria		Business Process Improvement Initiatives			
Criterion	Factor	1	2	3	4
C O S T	Price of the product	Fixed cost	Variable cost as per the trend.	Customer centric.	Customer centric and as well open to negotiations.
	Logistics cost (Based on distance between the supplier and the production unit)	Very high due to greater distance between the supplier facility and the manufacturing unit.	Moderate (due to the nominal distance between the supplier & production unit) & not negotiable.	Moderate (due to the nominal distance between the supplier & production unit) but, negotiable.	Less due to less distance of the supplier facility nearer to the manufacturing unit.
	After sales service cost	Fixed cost	Variable cost as per the trend.	Customer centric.	Customer centric and as well open to negotiations.
	Quality Performance (e.g. ISO 9000 accreditation)	No such Quality performance accreditations.	Initiatives are being made towards the registration of ISO 9000 accreditations.	The Quality system is registered to ISO 9000 or SSQA, but Internal & External Quality measurements are not documented.	The Quality system is registered to ISO 9000 or SSQA. Internal & External Quality measurements available
	Control of product quality	Not focused.	Formal process for the disposition of non-conforming material is not well thought-out still.	Rejected or suspect material is adequately identified and segregated from production.	In-process defects and suppliers identified defects are analyzed in a timely manner to detect and eliminate potential causes on nonconforming product. Results of final inspection are documented, tracked and trended for improvement.

Q U A L I T Y	Quality Objectives	No real consistent approach and deployment	Informal procedures only	Acceptable procedures, but not understood by all employees involved	Quality objectives and responsibilities are clearly stated, widely distributed and understood throughout the organization.
	Traceability	No system or procedures in place	Informal procedures only	A formal Lot control system is under development. Not yet deployed.	A Lot Control System or equivalent is in effect that provides traceability of the product through the manufacturing process to the raw material or other purchased material.
	Results & Reliability	Not well thought out still	Informal procedures are used to ensure quality.	Industry standard practices are used to assure quality, but results are not traced back to ensure quality plan.	Results & Reliability are traceable to the quality plan
	Delivery lead time for JIT products.	More than 3 days	+- 3 days	+- 2 days	+-1 day
	Delivery lead time for LCL products.	>8 days	+- 6-8 days	+- 4-6 days	+-3 days
	Development Speed.	No real consistent approach to improve the speed of development.	Informal procedures are adopted to improve speed of development.	Acceptable procedures are used to improve the development speed, but the procedures are not understood by all employees involved	A complete system is in place to improve the development speed. It is understood by all employees involved and correctly applied
	Visitation to supplier facilities	Less	On-demand	Periodic	Very frequent
	Desire for business	Moderate , Short Term	Moderate , Long term	High, Short Term	High, Long Term
	Business references	Less than 30	At least 30	At least 60	More than 100
	Suppliers customer base	Locally distributed	Regionally distributed	Nationally distributed.	Globally distributed

RELATIONSHIP	Management contribution towards continuous improvement	Not much serious till now	Informal practices are adopted to manage defect prevention & aid in continuous improvement	Industry standard procedures of defect prevention & continuous improvement are available, but not used regularly.	Formal defect prevention techniques towards continuous improvement are well formulated & used regularly.
	Expectation of continuity.	At least 1 year & above.	At least 5 years & Above	Long term. At least 10 years & Above	Long Term. At least 15 years & above
	Conformance to the customer requirements.	Not focused	Informal practices are being followed to determine the acceptability of finished goods to customer requirements.	Development of tools & techniques to determine the acceptability of finished goods to customer requirements are under progress.	Statistical techniques & other formal procedures are used in determining the acceptability of finished goods to customer requirements.
	Ability to maintain commercial relationship	Moderate. Short-term	Moderate. Long-term.	Very High. Focused on Customer satisfaction to improve our commercial relationship.	Very High. Focused on Customer satisfaction & as well willing to make alliance if desired by our major customers.
	Supplier availability for warranty claims & after sales services.	Available within a short span of time (around a few weeks) on demand/ on call by the customer.	Available within a short period (a few days) on demand/on call by the customer.	Available immediately (few hours) On demand / on call by the customer.	24*7 customer supports along with the immediate availability (few hours) on demand/on call by the customer.
	Industrial relations	New bee	Not much established industrial relations.	Moderately established industrial relationship.	Well Established industrial relationship.
	Risks Management	Not much focused.	Informal methods of risk management are being practiced.	The company has an adequate risk management programmes, but employee training on risk management is not provided.	The company has an adequate risk management program as well as provides employee trainings on risk management.

	Competitiveness	Follows traditional approaches in product development.	Moderate level of competency is imposed in the product developments.	The company is effective in working with the customer to make products more competitive.	Adopts different strategies like concurrent engineering to compete the best in the market. A well formed tracking system is used to measure improvements in manufacturing capabilities.
	Future Technology (e.g. Investment in R&D)	Not focused	Focus towards investment in R&D is under review by the top management decision makers.	Improvement & investment in establishment of the R&D is under progress.	Well established R&D is available.
	Reduction of waste management	Not focused	Informal Procedures of waste reduction are followed	The system of waste reduction is under construction.	A system is in place to identify and eliminate waste in all areas of the company
	Geographic location	Local	Regional	National	International
	Equipment maintenance	Equipment maintenance is carried out through informal procedures.	Only a few equipments are maintained through comprehensive maintenance programmes.	A comprehensive Preventative Maintenance program exists for all equipments, but not widely used always.	A comprehensive Preventative Maintenance program exists for all equipments and is strictly practiced.
	Environmental performance (e.g. ISO 14001 certification)	Concern for environmental practices are not focused	Environmental practices are planned to be imposed shortly.	Environmental concern practices are followed strictly but certifications are not available	Environmental concern practices are followed strictly. The organization is registered to ISO 14001
	Safety programmes	Not focused	Informal methods for safety considerations are being practiced.	The company has an adequate safety program, but does not keep track of the incident rates.	The company has an adequate safety program as well as track and publish/display incident rates.
	Human Resource practices	No real consistent procedure	Informal procedures only	Complete procedures under development	Formal industry standard practices are followed.

ORGANIZATION	Supplier management	Not focused.	Informally carried out	System is used, but no documentation procedures.	A supplier Audit /Survey System is in place with proper documentation control
	Training for the personnel within the organization	No separate training modules conducted for the personnel.	Informal learning procedures are adopted by the personnel.	Personnel are trained initially before put to work in a particular department.	Personnel are trained in the policies and procedures of their operations and departments periodically
	Production facilities & Capacities	Small scale facilities	Decision making under progress to expand production facilities.	Expansion of Production facilities under construction	The facility has the required manufacturing capabilities, including personnel, equipment, processes, etc. to sufficiently meet the demand of the customer.
	Position in the industry & Reputation	Newbie	Not much established	Moderately decent reputation	Very high recognition & and listed in the fortune reputed industries listing.
	Performance history	No system or procedure has been established yet	Informal procedures are used to track performance history	The performance tracking system is under development	A tracking system is used to measure improvements (metrics) in manufacturing based on performance history.
	Physical size/growth	Irregular (Subject to fluctuations in increase & decrease)	Constant	Linearly increasing	Exponential increase.
	Technological capabilities	Never change to new technologies	Slow starter to new technologies	Moderately adapt to new technologies	Always stay in pace with the bleeding edge of technology.
	Innovativeness	Less	Moderate	Somewhat high. Employees are motivated with rewards for trying new innovations.	Very high. A separate R&D team is focused in bringing out new innovations.
	EDI/ Internet Capability	Not available	Under development	Existing, but not yet used	Widely used

S E R V I C E	Reaction to immediate demand	Can't respond	Can try to respond.	Moderate	High volume flexibility.
	Ability to modify product	Not possible	Can try	Moderate	High flexibility to mix product facility is available.
	Supply variety	Not possible	Can try	Moderate flexibility can be introduced in supplying variety.	Very high potential to supply variety is available
	Technical support	Less	Moderate.	Strong. A separate technical support team is available in office.	Very strong. A separate technical team is available in office with 24*7 supports.
	After sales services (e.g. Warranties & Claim policies)	Less	Moderate	High.	Very high. Warranties and claim policies are given with the product aiming towards the highest degree of customer satisfaction.
	Delivery frequency	Less	Moderate.	High.	Very high.
PAST BUSINESS RELATION-SHIP	Amount of past business with us	New bee	1-5 years	5-10 years	>10 years
	Customer Satisfaction achieved till date.	Less (< 40%)	Moderate (41% - 60%)	High (61% - 80%)	Very High (>80%)
	Focus on continuous Improvement	Not Focused	Continuous improvement initiatives in progress	Actively practicing continuous improvement	Standards for continuous improvement have been established.
	No. of shipping errors registered so far in the past	Track of records not available.	>5%	Between 2% -5%	Less than 2%
	No. of complaints registered.	Track of records not available.	>5%	Between 2% -5%	Less than 2%

Appendix 1: Formulation of the self - evaluation criteria's & the factors influencing each decision criteria towards understanding of the supplier.