

Evaluating Supply Chain Performance and Risks through Data Mining

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Abstract

Evaluation of supply chain performance and risks are getting more and more importance day by day in Pakistani aviation industry. Risk management is in fact a process of identifying, analyzing and controlling the any deviation for procurement outcomes from desired results i-e cycle starting from demand requisition till the timely receipt of components of the right quality within the optimal resources at the right cost. In order to complete project deliverables at competitive price in global environment, it is important that identification of risks and timely mitigation of risks should be carried away. By doing these stack holders of supply chain get equal share in profit as per their share in the whole process. The current research is focused on the evaluation of supply chain performance and risks through data mining in procurement process starting from requirement identification, requisition processing, awarding of purchase orders through a tendering process till receipt of right quality ordered goods and their delivery to the end user. Each minor step of complete procurement cycle is being recorded into customized ERP software in the form of records to top management and procurement managers. Data analysis shows the history of risks in supply chain and actions necessary to mitigate these risks. The completion procurement cycle in time and delivery to right item is ultimate target during evaluation of supply chain performance measurement.

I. Introduction

In recent days supply chain management is considered as a source of competitive advantage. Sourcing and procurement managers manage many risks in the competitive business environment. Therefore evaluation of supply chain performance and risk are area of great interest for practitioners. The Pakistan aviation industry requirements for raw material and components are of complex nature and effective supply chain plays a decisive role. Unavailability of a single part can lead to failure of whole assembly. The bulk of these components are imported as Pakistan's local industry can not meet the complete requirement. Pakistani aviation industry has enough trained man power and machinery to meet the requirements of the foreign industries which are looking for cheaper labor areas to outsource their production items. After getting the order the Pakistani aviation industry has to import raw material, mechanical and electronics components. . Most of the managers consider risks of only those events which had already taken place. In today's global world the companies are not facing the traditional risks. Instead the new risks are being confronted to them. In current years where the world has changed into global village, companies are not facing traditional risks; instead new risks are confronted to them. Most risks are part of every activity and one can not avoid them.

Supply chain management is key to make profit for an organization. Supply chain risk management and analysis is the area of study these days and it is getting popularity day by day. There is a need to calculate the internal and external cost of supply chain. Five key risks environment risk, inventory risk, supply risk, capacity risk and information risk and their derivs have been identified [1].Supply chain structure and whole supply chain is interrelated. Its structure maximizes or minimizes the supply chain risk. If the structure is appropriate than it eliminates the effect of risk and makes the whole chain reliable. Improvements in supply chain structure will mitigate the effect of risk, higher risk transfer effects should be avoided and must be replaced by lower risk effects [2].Risk management practices demand that organizations should consider all phases of risk management equally important. Most of the organizations consider only monitoring phase of risk, however, it should be fully incorporated in all phases of risk management [3]. Therefore it is very important for buyer's to not only consider the monitoring phase of the contracts/purchase orders given to vendors but the whole process right from initiation till the maturity of the contracts should be improved to mitigate risk.

This research is focused on decision making and analysis of aviation industry demands and procurement transactions. This industry has comparatively more sound working practices of data collection, its storage and security due to its specific requirements. Aircraft are designed, manufactured, operated and maintained all over the world leaving long trails of data. This data is mandatory to be left in industry archives through out the useful

life of an aircraft. The present research is also focused on determining useful trends to forecast future demands and procurement direction for decision makers and procurement personnel. The variation of data being generated in aviation Industry could assist any researcher to explore wide variety of subject areas from supply chain management, Enterprise Resource Planning (ERP) to operations management. This research is confined their work, only to the price comparison of materials, parts procurement, demand forecasting and vendor supplier relationship. The data was mined from archives of an aircraft manufacturing company.

II. Methodology

The following methodology will be adopted to carry out research.

The present research data would be collected from an aircraft part production company. The company is performing to these major functions:—

- a. Acts as production resource for bigger companies.
- b. Design and manufacture its own aviation products
- c. Procures raw material and components for its own and customer products
- d. Provides turn key solutions of system integration to its customers.

These functions demand the company procurement office to liaise with a lot of in country and international companies and vendors. Its typical procurement process involves the following activities:—

- a. Identification of requirement
- b. Planning for procurement
- c. Demand origination by the department
- d. Research for perspective suppliers
- e. Tendering / bidding process
- f. Evaluation of financial requirements of suppliers.
- g. Award of purchase order to successful bidder on the basis of total cost of ownership.
- h. Receipt and acceptance of deliveries as per purchase order
- i. Timely payment of suppliers

The data is being stored in the ERP system of the aviation industry right from the procurement planning to the receipt and inspection of items. All the above stated activities require a lot of data analysis and decision making at various stages of the process. Incorrect data mining, analysis and decision making can lead to a huge financial losses, delays in production and inability to meet the customer deadlines. A poor or inappropriate product quantity supplied by vendors could also lead to embarrassing situations and poor performance of the integrated system designed/delivered by the company. These aspects call for methodical reviews of available data to meet its own and customer's requirements by the company.

- Literature review will be carried out in the areas evaluation of supply chain and risk management.
- Public and private sector aviation organizations in Pakistan and abroad will be approached to identify the present risk management practices and evaluation of supply chain.
- Best practices in this area would be collected and would be used for this purpose.
- Aircraft users in country including military and civil organizations will be approached to collect real time data of their requirements from vendors.
- Vendors of these companies will be approached to identify their problems and difficulties.
- Aviation industry in any country normally involves huge diversity of vendors from academia to industry. This research may be spread over manufacturing, maintenance and services or support requirements of the industry.
- The data may be collected through a suitable questionnaire from both the users as well as vendor organizations. It may also be collected through structured and unstructured interviews also and may be of case study and empirical nature
- Data so collected will be analyzed through various statistical tools such as SPSS to arrive at various correlations
- Inferences will be drawn from the statistical results to establish the outcomes of this research which will be the knowledge contribution of this research.
- The findings of this research will be discussed on the basis of past literature in similar areas. This will provide validations of past research as well as any deviations.
- Findings of this application will also add to the knowledge being investigated as a part of this degree requirement.
- Results obtained from projects will be compared with similar results from research conducted in others parts of the world.

- Any other area of knowledge contribution that may emerge as a result of literature review or industrial studies will also be added to the thesis
- Any area advised by the local and Strathclyde supervisor will also be added to the research being conducted
- Finally the results of this research will be published in international journals and conferences with due approval from local and Strathclyde supervisor.

III. Types of Data

The company holds numeric, alpha numeric and text data of a large number of variables in its databases. Some of these variables are as follows:

- a. Requisition no
- b. Requisition date
- c. Description of demanded items
- d. OEM details
- e. In lieu item of demanded item
- f. Data sheet of Demanded item
- g. Last purchase price
- h. Quantity demanded
- i. Purchase requisition form
- j. Tender Enquiry No
- k. Quotes of suppliers
- l. Comparative Statement of suppliers offers
- m. Purchase order number
- n. Order value
- o. Date of order
- p. Delivery period scheduled
- q. Mode of shipment
- r. Payment terms
- s. Date of Receipt of items
- t. In coming inspection as per Purchase order clause
- u. Discrepancies in delivered items
- v. Lot number / batch number of received item
- w. Vendor information
- x. Variation in deliveries
- y. Inspection Note of accepted items
- z. Goods receipt note
- aa. Rejection report in case of non conformance
- bb. Processing of payment

The data is usually held for 8-10 years duration for the purpose of data analysis for short and long term decision making. For present research, data for only two years would be mined for approximately 500 different parts procured in different time periods in these two years. The objective of research is to evaluate the performance of local vendors for procurement of raw materials and components.

IV. Identification Of Supply Chain Risks

Risk management is in fact a process of identifying, analyzing and controlling any deviation for procurement outcomes from desired results i-e cycle starting from demand requisition till the timely receipt of components of the right quality within the optimal resources at the right cost. Supply chain risk is considered to be poor performance of the procurement manager and factor of risk management is considered to be a part of financiers. But in fact supply chain and procurement manager must be fully vigilant with risk in throughout supply chain. The main factor of risk comes in terms of timely delivery and quality and at competitive rates. These aspects are related to the performance of suppliers and also depend upon the evaluation of procurement managers. Project timelines are fully dependent on the output of procurement people. If one can not monitor the risk in terms of unforeseen events than the whole timelines are disturbed and as a result your customer is not satisfied with you. The following are the methods which are being used to mitigate the risk in supply chain.

- Dual Sourcing
- Purchase managers involvement in early stage of project

- Better and close relationship with suppliers
- Fixed price contracts with suppliers.
- Rate Running contracts
- Outsourcing of Risk related components
- Careful negotiations in contract management

To mitigate the risk first of all the need for awareness of procurement and supply related risk among the organizations and member of organizations are required. All these things demand the continuous collection and evaluation of data.

Global sourcing has made it possible for procurement managers in undeveloped countries in Pakistan to become more vigilant and must gather information through the internet and directly contact to OEM's. Competition in aviation industry is also increasing day by day and there is strong debate going on between make or buy decisions. The decision makers are very much interested to reduce the cost of projects. Procurement managers can play active role in it and sourcing plays a very vital part in it. If items and services are made available at best optimal prices and of right quality than it is a competitive advantage to the competitors.

Another important factor which is worth mentioning is sources of inventory. Inventory management is always point of concern for decision makers. Here and import 80-20 rule comes into play i-e 20% of total inventory costs 80% of remaining inventory. Like many parts used in aviation industry is of high value. These parts are used in low quantities as well and can be procured as a single line item. While the remaining 80% parts cost 20% of the inventory. Therefore these parts are procured in higher quantities due to heavy operating costs involved in it i-e FCA charges, freight charges, export documentation charges, export permission documents, clearance charges in importing country and again inland transportation charges in the importing country. These all charges are associated with every items procured from overseas. This requires quantities to be procured from overseas supplier in minimum ordering quantity (MOQ) and getting quantity discounts as well. The entries in these databases allow you to make various decisions to enhance the efficiency and effectiveness of supply chain.

Obsolescence is a two way knife and always is point of concern for management in countries like Pakistan. The technology is changing so quickly that there is a need risk in inventory management as well. If huge quantity of items is stocked, and suddenly design changes than stocking of those parts is a big risk to financial portion of project. On the other hand if you don't stock and item becomes obsolete by the manufacture or alternative of these items not sourced than it is also a big risk.

V. Dual Sourcing

In order to mitigate risk dual sourcing is very important for aviation industries in Pakistani environment. Companies can not totally rely on the incumbent suppliers due to their quality issues and failing to meet timelines. As most of items are to be imported from overseas and if there is delay in any one of them the whole assembly line is disturbed by it. Therefore it is necessary that in data bases must have complete record of every item like OEM's authorize distributor, sales offices around the world, data sheets, in lieu item for this item. This can be achieved if you have maintained item coding for each item along with necessary information. Data mining help you for dual sourcing as well. As ERP databases have record of all the previous purchase and also for the comparative statements made on the basis of quotes obtained from these venders. In case of a certain supplier fail to deliver the item these data basis help in decision making and timely arrangement of items from the other source.

VI. RESULTS

Data mining of transactions revealed many long unsolved problems. It highlighted certain loop holes in the procurement process which were later solved on the basis of results obtained from analysis of data. Some examples are given below:

- (i) Complaints of supplier on timely payments

Payment to suppliers against delivered goods was a area which was always highlighted by suppliers. According to condition of purchase order, payment was to be made after inspection of goods at the company site. A certain supplier dealing in the supply of raw material for manufactured parts always complained for delayed payment.

As every step of whole procurement process was being stored in the ERP system so a report was generated for the average time taken by the company to make payments to its vendors which is shown in the fig (i)

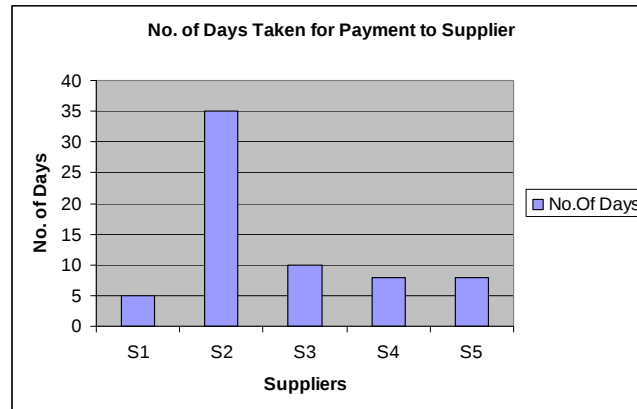


Figure 1: Average number of days taken in payment to different suppliers

This graph showed that it always took quite longer time to Supplier S2 and his complaint was seemed to be genuine. Further investigation was carried out on this matter. As the payment was also bound to the inspection of items, another study was carried out for the average time taken in inspection of various kind of items which is shown in fig (ii).

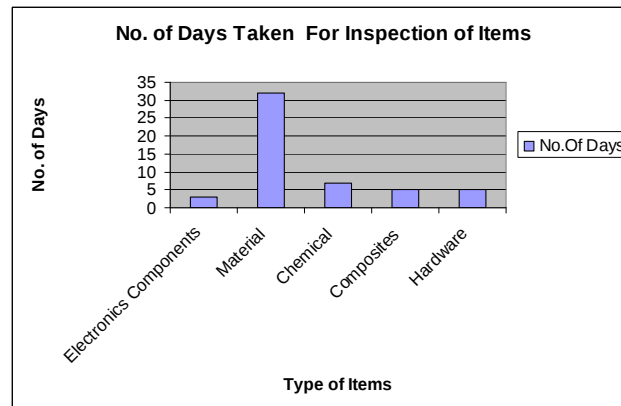


Figure 2: Average number of days taken for inspection of different kind of items

This graph showed that raw material inspection took longer time. Further investigation showed that as material was to be inspected / tested against the material test reports and certificate of conformance which took too much time. On the basis of this data an inspection procedure was made for the testing and inspection of materials and a time line of one week was fixed for them which solved the long outstanding complaint of supplier.

(ii) Procurement Manager's involvement

Another important factor which results in late deliveries of items arises when purchase managers are not fully involved in early stage of project. The technical managers are not aware of the problems of sourcing and shipping of items. Early involvement may lead to lot of cost saving in project finances as well. Data analysis shows that technical managers are unaware of the international business and time involved in it. Requisitions are forwarded to procurement managers at very late time, which resulted in late initiation of procurement process. Date mining helped in assessing the average time taken for the items from demand initiation to the receipt of items. When data was collected for most of late deliveries it is found that technical managers were expecting that item to be reach in normal 4-6 weeks but when asked from OEM ,it was found that OEM's have orders around the globe and item can not be supplied to Pakistan within this time period. On the basis of this data the procurement managers were involved in the procurement process at an early stage.

VIII. Rate Running Contracts

In order to reduce risk the organization must have better relationship with the suppliers. Suppliers should be treated as partners to organization and should be given full confidence and response like solving queries, design discussions and timely payments. Research showed that, those suppliers which have better relationship with buyers are performing well. A good way of mitigating risk is by doing fixed price contract with the suppliers. Contract is made one time at the start of a financial year and order is placed according to forecasted demand for the whole year. The prices are made fixed and supplier supplies the items for the given quantities whole year regardless of price escalation. But this contract is suitable only for limited commodities and for items of daily use or consumables only.

IX. Findings

Present research lead to the following findings:

- (a) Data mining is key process for any organization in order to stay competitive.
- (b) In the present study very limited data mining benefits were shown, in order to gain maximum utilization it is required that a detailed analysis in which there should be involvement of human resource from company and a trained data miner.
- (c) Supplier performance measurement must be done on gradual basis and those with poor performance must be put outside the metrics.
- (d) Every party involved in the process must be made stake holder in on way or the other.
- (e) Strategic relationship with the suppliers should be built so that they also get confidence and become part of the organization.
- (f) Data mining techniques must be applied regularly on the data available in the databases and for this human resource must be trained for it.
- (g) Cost saving can not be achieved just by replacing old suppliers with new suppliers, but can only be achieved by maintaining or improving supplier's performance
- (h) Cost, delivery, service and quality should be performance parameters for supplier's evaluation

X. Conclusion

Huge portion of total cost is being spent on procurement in aviation industry environment. In order to stay competitive data mining techniques must be used to save money, achieve better operational performance and mitigate risk. Cost saving should be achieved while maintaining or improving supplier's performance. The results can not be achieved just by replacing old suppliers with new supplier's and doing trade off on the basis of performance standards. Every transaction must be recorded like receipt, inspection, warranty days, delivery time which leads us to apply data mining techniques and getting desirable results.

XI. References

- [1] Syaripah Ruzaini Syed Aris, Noor Habibah Arshad, Mohamed, Azlinah "Risk Management Practices in IT Outsourcing Projects", Information Technology, 2008, ITSIM2008, International Symposium on Volume 4, Issue 2, pp. 1-8, 2008.
- [2] Xiaoxia Jia; Xizhao Zhou "The risk identification and monitoring of electronic business" Services Systems and Services Management, 2005. Proceedings of ICSSSM apos;05. 2005 International Conference on Volume 1, Issue, pp. 805-808, 2005
- [3] Cunlu Zhang Peiqing Huang "Supply Chain Risk by Structure " Service Operations and Logistics, and Informatics, 2006, SOLI '06 pp. 300-303, 2006.
- [4] Liping Liu Jianhua Ji Tijun Fan Lili Qi Zhe Wu " Risk Management in Chemical Industry Supply Chain" Service Operations and Logistics, and Informatics, 2006, SOLI '06, pp. 415-418, 2006.
- [5] Qi Luo," Advanced Knowledge Discovery and Data Mining", International workshop on Knowledge Discovery and Data Mining IEEE, pp. 3 – 5, 2008.
- [6] Robinson, N.; Shapcott, M "Data mining information visualisation - beyond charts and graphs " Information Visualisation, 2002. Proceedings. Sixth International Conference on 10-12 July pp. 577 – 583, 2002.

- [7] Hamid R. Nemati, Christopher D. Barko “ Key Factors for achieving organizational data-mining success”, Industrial Management & Data Systems, Vol. 103, Issue 4, pp. 282-292, 2003.
- [8] Cathering Ma, David C. Chou, David C. Yen “ Data warehousing, technology assesment and management”, Industrial Management and Data Systems, Vol. 100, Issue 3, pp. 125-135.