International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 05 | May 2020 www.irjet.net p-ISSN: 2395-0072

A Survey on Optimization in Procurement Process

Abhinandan H[1], Mamatha T[2]

[1]*UG Student, Dept of CSE, RV College of Engineering, Bangalore, India*
[2]*Professor, Dept of CSE, RV College of Engineering, Bangalore, India*

Abstract - *This paper presents an overview of the various Optimization techniques which are used or proposed for the Procurement Process. For each of the methods that are described are, the method followed for the optimization, the proposal of a mathematical model or the results of the simulation model is presented here. This paper also tries to identify the gap between the proposed methods and their implementation in enterprise or business models. The mathematical model description includes the method followed, the variables used and a quick glance on the results obtained. The survey provided can be used to get a general idea of the various optimization models and the difficulty of implementing them to solve real-life procurement problems.*

Key Words: **Optimization, Procurement, Non-Linear Programming, Mathematical model**

1. INTRODUCTION

Procurement is the process of acquiring the necessary materials needed for a company or enterprise to deliver their products The first step in the process of procurement after the identification of the necessary materials is to get a list of suppliers that will provide them with the materials required. There is a process of decision making involved here as the same material can be offered by different suppliers. It so happens that the procurement of materials from one supplier may come at a lesser price as compared to another supplier but the delivery of those materials is faster when the price is high. Similarly, there are other factors also which an enterprise or a business has to consider during the procurement. Optimization is the process of finding the best scenario which satisfies the company's requirement with the least cost possible.

Among the different Optimization models that exist, there is no single method that can satisfy all the business scenarios. This is because enterprises differ in their needs and the various cost items in the procurement process such as price, transportation cost, raw material cost, etc. vary depending on the region where the business is located. It also fluctuates based on the location of the supplier. From a mathematical point of view, we can say that the multiplication coefficient of the cost items varies among suppliers and regions. All the methods presented here have their own advantages and disadvantages. So depending on the situation, any of them can be used to implement the required business logic.

The structure of this survey paper is as follows. The next section presents the different optimization methods for procurement process. Section 3 presents the challenges faced while implementing these methods to solve real life business problems. Conclusions are discussed in Section 4.

2. OPTIMIZATION METHODS FOR PROCUREMENT

Let us look into the different optimization methods for the procurement process. Each of the methods that is discussed here are applicable to certain industries or based on certain scenarios. For example, the method in [1] is applicable to discrete manufacturing environments, whereas the method in [2] is applicable to the construction industries. So along with the description of the method, the field of application is also discussed.

2.1 Mathematical Models

In [1], an optimization process for a new integrated system which is a combination of procurement and production is discussed. This method is applicable to the discrete manufacturing environments as mentioned in the thesis. A mathematical model is presented here which uses the Non-Linear programming to provide a solution. A business scenario is presented to which the mathematical model is applied and the results are presented. The overview of the scenario is as follows. Consider a firm or an industry that produces five different kinds of ink. The number of warehouses which function as manufacturing workshops are three. The operation time for these workshops is specified. The supply and demand cycle in the form is production lines and the procurement of raw materials is specified.

Variables which will be used in the optimization method includes those for inventory levels of each product i.e the different inks, demand for those products which the company has to meet on a timely basis, variables to keep track of the backlogs, production

rate. Using these variables Optimal Control Problem is obtained which is then converted to Nonlinear programming problem which is then converted into an Unconstrained Optimization problem which was solved using the Genetic algorithm as proposed in [6]. The results indicated that procurement of quantity of any product in the 4th week can be made as late as in the 19th week.

In [3], the role of logistics in the procurement process is described in detail. The method described is applicable to logistics costs in the procurement process. The two different kinds of logistics costs are explained. The first type of cost is the procurement logistic cost and the other is the distribution logistic cost. Ground rent is the cost of storing the materials. The ground cost is the cost of ground per unit multiplied by the total stock for the number of days stored. Similarly, the procurement logistics cost can be calculated as the total number of trucks used multiplied by the cost of renting a truck for a certain time period. The sum of both of these costs is known as the total cost. To optimize this cost, we have to consider two factors - the capacity of the truck and the order frequency. This process of choosing both factors was repeated for all optimal combinations to lead to the best outcome. Cost reduction up to 40% was obtained.

The next method of optimization is applicable to the transport industry. In [4],the integer programming method is used to optimize the procurement of vehicles for public transport. The existing method of transportation in the paper had problems balancing the supply and demand cycle for the system. This lead to the reduction of public interest to use the system. The problem here is treated as a linear programming problem. The required data was collected was from standard sources which include the routes, the time when the demand was high, the average number of passengers, the various costs, etc. Jensen library was used to solve the problem. Four constraints were applied to this problem. The results included the optimum number of vehicles for each route, the operation time and helped to save much cost of the system.

In [8], we look at the optimization methods for the process of timber procurement. The one more factor to consider for timber procurement in addition to the general factors as it can damage the timber. The different stages include the felling of trees and loading them, transportation, unloading, storage which is done at a terminal yard. The rules for the evaluation of a procurement plan for timber are stated. The four rules are Authoritative, observable, measurable and independent. Based on these rules, five criteria were formulated and weightage was assigned to each criteria based on a survey from specialists. A Mathematical model was formed using these weights as coefficients for a linear programming problem subject to several constraints. The results indicated the best season to carry out the procurement process in that region which was winter.

2.2 Modelling and Simulation

The method in [2] is used to optimize the storage cost of the construction materials. Storage is also an important step in the procurement process. If there is no proper planning for the storage of materials, it can lead to huge damage costs especially the construction materials. An optimization method is provided both for the storage and procurement of the materials. Since the location of the industry, as well as the suppliers, are fixed, the main cost factor considered here is the storage cost. Procurement volume, which is the amount of materials needed and the storage cost are treated as variables that need to be optimized. To optimize this problem, as it is a non-linear programming problem, MATLAB was used. The result of this optimization is a graph which shows the stock amount with the progress of the construction project. This method is applicable to construction projects.

In [5], procurement plan for the multi-tier supply chain is discussed. The Multi-tier supply chain is the one where a buyer acquires the materials a supplier who has already purchased those materials from yet another supplier. The buyer is called as a retailer. So both the retailer and supplier must be involved in the planning for procurement of the materials based on the risk involved. It is assumed that the demand of the retailer is a Gaussian distribution. The multi-tier supply chain is simulated using the simulator proposed in [7]. The simulator is used to estimate the recovery time for an industry or business once there is a disruption in the supply chain. So the retailer wants to reduce his recovery time and also the cost. The accepted range values for risks and cost must by agreeable by all parties involved in the multi-tier supply chain.

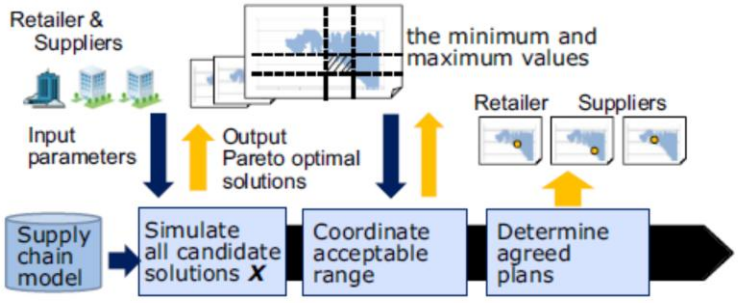

Fig -1: Simulation of Multi-tier Supply chain as constructed in [5]

2.3 Other Methods

The methods before proposed a mathematical model and simulations give proof of the suggested optimization method for the procurement process. In [9], rather than proposing an optimization method, a framework is presented which contains several components such as items, procurement rules, suppliers, etc. Optimization here is achieved by finding the initial values for the decision variables. To perform the optimization, the simulation model is automatically compiled into AMPL is a mathematical programmable model. The framework is proposed for the Java programming language. A problem is presented in the form of a case study which is then programmed and solved using the proposed framework. To solve the optimization problem which was converted into an AMPL model, the ILOG CPLEX library by IBM was used. To solve the proposed problem, it took 17 seconds.

3. CHALLENGES FACED IN IMPLEMENTING THE OPTIMIZATION METHODS

The methods proposed for optimization during the procurement process ranged from mathematical models, simulation models and even frameworks for common programming languages. In spite of so many optimization methods which are cited here and the numerous other ones, the preferred method is still the manual decision making where the buyers or retailers take the decision based on their needs. From this, we understand that there is a gap between the proposed models and applying these models to solve real-life business problems. Here are some of the factors which are responsible for this gap.

- The first factor is related to the field of application of the proposed optimization models. For example, in [1], the method is applicable to discrete manufacturing environments, [3] the proposed model was for the logistics part of the procurement, [2] is applicable to the storage of the construction materials. In [5], the procurement plan for a multi-tier supply chain is proposed which might have a broader scope of application. In addition to the fields, while solving the optimization problems certain conditions and environments are controllable which are not true for real-life problems.
- The second factor is related to the number of variables required for modelling the procurement problem to be optimized. For real-life business problems, the number of variables is huge in number. For example, consider a phone manufacturing industry. It might be manufacturing almost 20 different kinds of mobile phones, the parts required for each phone will be different and so the suppliers also based on the location of where the manufacturing takes place. Considering other factors such as inventory for each part of each phone, the production demand, the production rate, the demand rate, the storage costs, etc we might get around 200 or more variables to form the equation. Adding the constraints also for this optimization, it becomes a complex problem even for computers.
- The third factor is related to transforming the obtained mathematical model to a programmatic one so that it does not need to be solved manually. For this, the most preferred method is the CPLEX library which is supported by many programming languages. We need to be familiar with this library and transform the problem in such a way that its complexity and runtime are as minimum as possible. This is also another optimization problem.
- The fourth factor is the presentation of the optimization results. Once the results for the optimization of a procurement problem are obtained, the visualization of those values is also important. For example, instead of providing a statement like the costs in the procurement process have decreased by 50%, we can show a graph or a table, which compares the previous costs to the optimized costs. Implementing visualization along with the comparison of old costs or data gives a clear picture of the benefits of the method to the industry or the enterprise.
- The fifth factor is related to the formulation of a mathematical model for the given optimization problem. The procurement problem must first be converted into a nonlinear programming model for which constraints must be applied. If the results obtained from the method do not produce a noticeable cost reduction, say after solving the problem, we get 1-5% savings, the time spent on formulation would not be productive. There is a risk involved here which the industry or business must be willing to take.

4. CONCLUSION

In this paper, several optimization methods for the procurement process were discussed along with the results that they produced. All the models achieved good results for the proposed area of application. The challenges faced in implementing the numerous optimization methods to solve real-world procurement problems were also discussed. The methods discussed here will be helpful for industries looking to implement these methods and get a broad overview of these methods.

REFERENCES

[1] H. Cao, Y. Chai and Y. Liu, "Method for Procurement-Production Strategy Optimization in Discrete Manufacturing Environments," 2011 Fourth International Joint Conference on Computational Sciences and Optimization, Yunnan, 2011, pp. 740-744.
[2] J. Chen, W. Liu, W. Lin and L. Xu, "Optimization Simulation of Construction Projects Materials Procurement and Storage Cost," 2008 4th International Conference on Wireless Communications, Networking and Mobile Computing, Dalian, 2008, pp. 1-4.
[3] K. Kamei and K. Tanaka, "An Optimization System for Procurement Logistics Including both the Cost of Ground Rent and the Cost of Procurement Logistics," 2011 21st International Conference on Systems Engineering, Las Vegas, NV, 2011, pp. 334-336..
[4] D. A. R. Wulandari, "Implementation of integer programming in decision support system for operational optimize procurement of public bus transport distribution (Case study: Trans Jogja)," 2017 4th International Conference on Computer Applications and Information Processing Technology (CAIPT), Kuta Bali, 2017, pp. 1-7.
[5] M. Samejima, "A Simulation-Based Process of Consensus Building on Procurement Plan under Disruption Risk in Multi-tier Supply Chain," 2016 5th IIAI International Congress on Advanced Applied Informatics (IIAI-AAI), Kumamoto, 2016, pp. 904-907.
[6] D. E. Goldberg, Genetic algorithm in search, optimization and machine learning. Reading, MA: Addison Wesley, 1989..
[7] M. Mori, R. Kobayashi, M. Samejima, and N. Komoda, "Cost-benefit analysis of decentralized ordering on multi-tier supply chain by risk simulator," Studies in informatics and control, vol. 23, no. 3, pp. 229–239, 2014
[8] C. Dong and L. Wang, "Optimization of timber procurement and logistics," 2010 International Conference on Logistics Systems and Intelligent Management (ICLSIM), Harbin, 2010, pp. 1949-1952.
[9] M. Al-Nory and A. Brodsky, "Unifying simulation and optimization of strategic sourcing and transportation," 2008 Winter Simulation Conference, Miami, FL, USA, 2008, pp. 2616-2624.
[10] D. Ghose, G. Kesa, V. Varanasi, S. Raina and M. Abraham, "Covering Optimization Through Mathematical Model for Decision Making Support in Material Procurement," 2018 8th International Conference on Intelligent Systems, Modelling and Simulation (ISMS), Kuala Lumpur, Malaysia, 2018, pp. 43-48.