IJCEM International Journal of Computational Engineering & Management, Vol. 21, Issue 6, November 2018
ISSN (Online): 2230-7893
www.IJCEM.org

Innovative Heuristics Modeling for Dynamic Supply Chain Risk Management

Radhakrishnan Perumalsamy[1] and Jeyanthi Natarajan[2]

[1] Business Department, Emirates College for Management and Information Technology, Dubai ,United Arab Emirates

[2] Mathematics Department, Sri G.V.G. Visalakshi college, Udumalpet, India

Abstract

Organizations of all types are increasingly carrying out business operations to accomplish their business objectives. Efficient and effective risk analysis and management significantly improves the organization's competitive edge as well as enhances ultimate service provided to the customer. Escalating events around the world have increased the awareness of how detrimental risk can be to the business. Supply chain risk assessment and mitigation involve critical processes that must be implemented to address major supply chain risk. Efficient supply chain risk analysis and management is a complex process in our effort to deal with the complexity of managing risk as it happens in its different forms from multiple sources. In this paper, an optimization methodology utilizing the Particle Swarm Optimization algorithm is proposed to generate essential predictive analytics to maintain dynamic supply chain risk analysis and management towards effective business performance management.

Keywords: Risk analysis, Supply Chain Risk Management, Performance Management, Particle swarm optimization.

1. Introduction

Competitiveness in today's global marketplace depends heavily on the ability of a firm to handle the challenges of reducing lead-times and costs as well as increasing customer service levels. All these factors have driven business organizations to move towards dynamic supply chain management [1].All business experience some degree of uncertainty, and some uncertainties can create risks to achieving the business objectives. The successful management of these risks is therefore critical to business success .Risk management is designed as a preventive process to ensure that negative consequences are minimized. Awareness about the importance of explicit consideration of risks and the implementation of an effective risk management process are required for effective risk management. The effective management of the supply chain and associated risks has become unavoidable these days to increase business effectiveness levels [2][3].

Senior managers need to establish policies and procedures as well as a thorough understanding of risk management to ensure that all risks have been considered and properly addressed before allowing operations to proceed past critical decision point[6]. The task of managing business performance can be a major challenge for organizations to execute tasks in alignment with planned progress as well as in alignment with profit, cost, time and scope considerations. . Risk Factor Scoreplays a vital role in the in finding out the deviations and hence gives an inference for suitable risk mitigation strategies to control anticipated deviations from established objectives. Therefore, skillful managers are need of the hour to manage the entire supply chain in a systematic approach.[7].

Supply chain risk management has been on the agenda for most organizations because of significantly impact on key fiscal metrics due to supply chain disruption. supply chain risk assessment and mitigation are viewed as critical processes that must be implemented to address major supply chain risk. The supply chain should be monitored for any disruption and alert mechanism should be smart enough to alert on the events that impact the business[5].

Particle Swarm Optimization (PSO) is a stochastic global optimization algorithm and the robust performance of the proposed method over a variety of difficult combinatorial optimization problems has been proved. In accordance with PSO, either the best local or the best global individual affects the behavior of each

IJCEM International Journal of Computational Engineering & Management, Vol. 21, Issue 6, November 2018
ISSN (Online): 2230-7893
www.IJCEM.org

individual in order to help it fly through a hyperspace The ability pf the particles to remember the best position that they have seen is an advantage of PSO. An evaluation function that is to be optimized evaluates the fitness values of all the particles [4].

2. Model

An organization may have more supply chain risk factors involved during execution of its business operations. The following major types of Logistics and Supply chain risks are identified as having the potential to cause serious consequence on the business:

Demand risk: due to variation in demand based on seasonality, new product launch etc.,;

Supply risk : due to disruption in supply sides;

Operational risk : due to technical and non technical changes;

Competitive risk : due to aggressive competition;

Security risk: due to infrastructure and information security lapse;

Macro-economic risk: due to economic and business cycle;

Policy risk : due to changes in national and international trade policies;

Reputational risk: due to adverse or misconduct leading to breach of trust with customers;

Corporate risk: due to serious fraud or crime;

Sustainability risk: due to shortage or depletion of essential resources;

These risks are represented as R1, R2,……………., R10 with scores between 0 (lowest risk) to 100 (highest risk);We assume the organization is dealing with 5 product lines

Then for each product i and each period j, Total Risk Factor Score: TRFij is calculated as follows:

Total Risk Factor Score: TRFij= W1 TR1 +W1 TR2,…………….,+W10 TR10;

where

TRi = Σ rij ;i represents risk type and j represents supply chain partner index

(TRi is normalized to 100);

Wi is the weightage attached for each type of risk;

A database consisting of the Total Risk Factor Score: TRFij data values is created for each product and for each period.

An appropriate optimization methodology is designed accordingly as illustrated in figure 1 to move towards dynamic supply chain risk analysis and management.

IJCEM International Journal of Computational Engineering & Management, Vol. 21, Issue 6, November 2018
ISSN (Online): 2230-7893
www.IJCEM.org

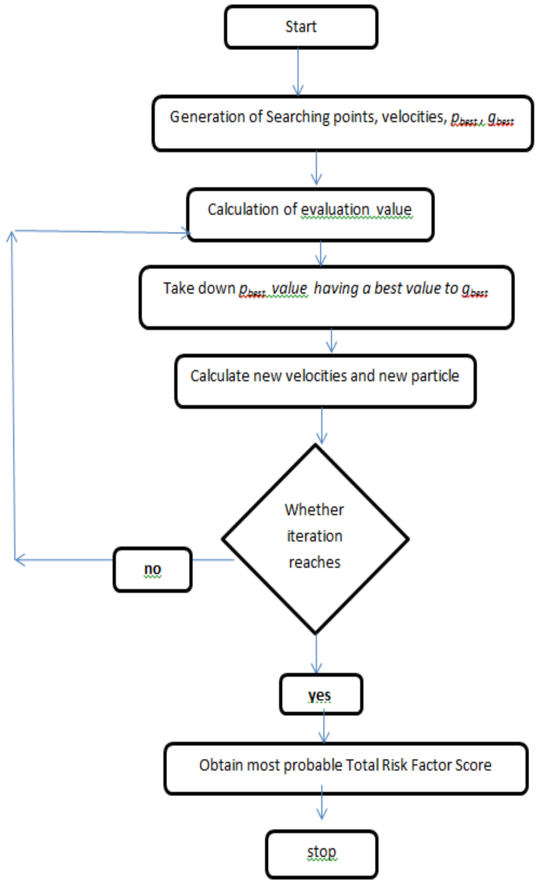

Fig. 1Particleswarm optimization methodology

The PSO methodology is outlined below.

In PSO, the potential solutions, called particles follow the current optimum particles to fly through the problem space. Every particle represents a candidate solution to the optimization problem. The best position visited by the particle and the position of the best particle in the particle's neighborhood influence its position. Particles would retain part of their previous state using their memory. The particles still remember the best positions they ever had even as there are no restrictions for particles to know the positions of other particles in the multidimensional spaces. An initial random velocity and two randomly weighted influences: individuality (the tendency to return to the particle's best previous position), and sociality (the tendency to move towards the neighborhood's best previous position) form each particle's movement .PSO uses individual and group experiences to search the optimal solutions. Nevertheless, previous solutions may not provide the solution of the optimization problem. The optimal solution is deformed by adjusting certain parameters and putting random variables. The ability of the particles to remember the best position that they have seen is an advantage of PSO. An evaluation function that is to be optimized evaluates the fitness values of all the particles. For every individual particle, a comparison is made between its evaluation value and its . The indicates the best evaluation value among the . This serves as an index that points to the best individual generated so far.

As an initialization step the individuals of the population including searching points, velocities, and are initialized randomly but within the lower and upper bounds.

IJCEM International Journal of Computational Engineering & Management, Vol. 21, Issue 6, November 2018
ISSN (Online): 2230-7893
www.IJCEM.org

The individuals of the population including searching points, velocities, and are initialized randomly but within the lower and upper bounds of the CR values which have to be specified in advance.

Determination of Evaluation function

f(i) = - $\log\left(1-\frac{n_{occ}(i)}{n_{tot}}\right)$; $i = 1,2,3,\ldots,n$

This formulated function is used to capture the most probable suppler selection index levels from the data base as well as the convergence criteria for stopping the algorithm.

$n_{occ}(i)$ is the number of occurrences of the particle in the record set

n_{tot} is the total number of records that have been collected from the past or total number of data present in the record set.

n is the total number of particles for which the fitness function is to be calculated.

For every individual, a comparison is made between its evaluation value and its p_{best} .The g_{best} indicates the most excellent evaluation value among the p_{best} . This g_{best} is an index that points to the best individual generated so far.

Subsequently the adjustment of the velocity of each particle a is as follows:

$$v_{new}(a,b) = w * v_{cnt}(a) + c_1 * r_1 * [p_{best}(a,b) - I_{cnt}(a,b)] + c_2 * r_2 * [g_{best}(b) - I_{cnt}(a,b)]$$

where, $a = 1,2,\ldots,N_p$ (Number of particles)

$b = 1,2,\ldots,d$ (Dimension of the particle)

This is done to diversify the search space as well as to intensify the search towards better feasible solutions

Here, $v_{cnt}(a)$ represents current velocity of the particle, $v_{new}(a,b)$ represents new velocity of a particular parameter of a particle r_1, and r_2 are arbitrary numbers in the interval $[0,1]$, c_1 and c_2 are acceleration constants (often chosen as 2.0), w is the inertia weight that is given as

$$w = w_{\max} - \frac{w_{\max} - w_{\min}}{iter_{\max}} \times iter$$

where,

$w_{\max}$ and $w_{\min}$ are the maximum and minimum inertia weight factors respectively that are chosen randomly in the interval $[0,1]$. Also and are the minimum and maximum limit for velocities respectively

$iter_{\max}$ is the maximum number of iterations

$iter$ is the current number of iteration

Such newly obtained particle should not exceed the stated limits. This would be checked and corrected before proceeding further as follows,

If $v_{new}(a,b) > v_{\max}(b)$,then $v_{new}(a,b) = v_{\max}(b)$

if $v_{new}(a,b) < v_{\min}(b)$,then $v_{new}(a,b) = v_{\min}(b)$

Then, as per the newly obtained velocity, the parameters of each particle is changed as follows

$$I_{new}(a,b) = I_{cnt}(a,b) + v_{new}(a,b)$$

Then the parameter of each particle is also verified whether it is beyond the lower bound and upper bound limits. If the parameter is lower than the corresponding lower bound limit then replace the new parameter by the lower bound value. If the parameter is higher than the corresponding upper bound value, then replace the new parameter by the upper bound valueThis is to be done for the other parameters as well.

This process will be repeated again and again until the evaluation function value is stabilizing and the algorithm has converged towards optimal solution.

3. Results

The analysis based on PSO for predicting project risk factor has been implemented in the platform of MATLAB .As stated, the detailed information about the TRFij values for each product for each period is captured in the database. The sample data having this information is given in the Table 1.

IJCEM International Journal of Computational Engineering & Management, Vol. 21, Issue 6, November 2018
ISSN (Online): 2230-7893
www.IJCEM.org

Table 1: A sample data of total risk factor scores

PI	TRF1	TRF2	TRF 3	TRF 4	TRF 5
1	10	8	8	6	15
2	7	4	5	24	12
3	3	8	7	14	5
4	9	6	21	3	5
5	12	9	34	15	25
6	15	12	27	2	14

As initialization step of the PSO process, therandom individuals and their corresponding velocities are generated. Table 2 describes two random individuals.

Table 2: Initial random individuals

TRF1	TRF2	TRF 3	TRF 4	TRF 5
10	8	8	6	15
7	4	5	24	12

Similarly, Table 3 represents random velocities which correspond to each particle of the individual.

Table 3: Initial Random velocities

TRF1	TRF2	TRF 3	TRF 4	TRF 5
0.1298	0.1298	0.1298	0.1298	0.1298
0.0376	0.0376	0.0376	0.0376	0.0376

The simulation run on a huge database of past records showing evaluation function improvement at different levels of iteration is as shown in Table 4

Table 4:Simulationresult

Number of iterations	Evaluation function value
50	0.3684
80	0. 4554
150	0.6547
200	0. 5522

The final individual obtained after satisfying the convergence criteria is given in Table 5

Table 5: database format of Final Individual

TRF1	TRF2	TRF 3	TRF 4	TRF 5
5	7	15	8	22

4. Discussions

The final individual thus obtained represents the most emerging pattern for the risk levels, providing essential information towards mitigation strategy. If the organization imposed the maximum threshold risk limits as 10%, then, product lines 3 and 5 have exceeded has maximum threshold risk level calling for mitigation efforts to bring down the risk levels to the acceptable threshold risk limits. Here, based on the intensity, the priority is to mitigate the risks of Product line 5 followed by Product line 3. The risk levels of other product lines 1,2 and 4 are within the permissible threshold limits and does not call for any mitigation initiatives by the organization for the forthcoming period.

Based on the risk score, suitable risk mitigation strategies for the respective risks are to be worked out so as to move towards effective business performance optimization. The main purpose of risk identification and analysis is to prepare for risk mitigation. Mitigation includes reduction of the likelihood that a risk event will occur and/or reduction of the effect of a risk event if it does occur. The organizations should discuss the importance of risk mitigation planning and describes approaches to reducing or mitigating supply chain risks.

Conclusion

Of late, supply chain is being exposed to more and more risk due to evolving supply chain practices like Low cost country sourcing, Lean and just-in-time which have changed both the nature and level of supply chain risk. To be successful, organizations need to accept risk as a key element of the ongoing management of the business operations. Risk analysis for effective and efficient performance management is an important component of business management. Risk Factor Score plays a vital role in the in finding out the intensity of risk level and hence gives an inference for suitable risk mitigation strategies to control anticipated risks. To tackle the complexity in predicting the emerging risk, an innovative and efficient approach based on Particle Swarm optimization algorithm using MATLAB is proposed that is aimed at predicting the most probable risk for the forthcoming period necessitating intervention with remedial risk mitigation strategies to control the risks so as to move towards effective business performance optimization.

References

[1]Sarmiento, A. Rabelo, L. Lakkoju, R. Moraga, R., Stability analysis of the supply chain by using neural networks and genetic algorithms , Proceedings of the winter Simulation Conference, 2007, pp. 1968-1976.

[2]Meredith Jack R., Mantel, Samuel J., and Shafer Scott M . Project Management – A Managerial Approach.John Wiley & Sons. 2016

[3]Beamon BM, Supply chain design and analysis: models and method, International Journal of Production Economics,1998, Vol: 55, No. 3, page: 281–294.

IJCEM International Journal of Computational Engineering & Management, Vol. 21, Issue 6, November 2018
ISSN (Online): 2230-7893
www.IJCEM.org

[4]Joines J.A., &Thoney, K, Kay M.G, Supply chain multi-objective simulation optimization, Proceedings of the 4th International Industrial Simulation Conference, 2008,, Palermo, pp. 125- 132.

[5]Sustainable logistics and supply chain management, David B Grant etal., Kogan page, 2017

[6]H. Lu, "Dynamic Population Strategy Assisted Particle Swarm Optimization in Multi objective Evolutionary Algorithm design," IEEE Neural Network Society, IEEE NNS Student Research Grants 2002, Final reports 2003.

[7]Ling-Feng Hsieh, Chao-Jung Huang and Chien-Lin Huang, "Applying Particle Swarm Optimization to Schedule order picking Routes in a Distribution Center", in proceedings of Asian Journal on Management and Humanity Sciences,2007, vol. 1, no. 4, pp: 558- 576.

First Author Dr.P.Radhakrishnan has professional experience spanning 3 decades and has held pivotal positions in Business Schools and been responsible for the Academic, Administrative and Leadership role for Business Administration and Research Programs in Management. He has published widely in International Journals and Conference proceedings in the area of Business Analytics & Optimization He has many awards to his credit for outstanding performance, achievements and significant contributions to higher education and innovation research

Second Author Dr..N.Jeyanthi has about 3 decades of professional experience in the area of Mathematics and Optimization Techniques. She holds a Ph.D. degree in the interdisciplinary area of Mathematics and Management. She has published widely in International Journals and Conference proceedings with a focus on mathematical modeling and optimization towards effective business Management.