What-If Analysis: Decision-Making Model of Closed Loop Supply Chain under Uncertainty Conditions

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***Abstract*— Decision making is one of the key tasks in managerial outcomes whereby the effect of any decision matters a lot on the strategic dimensions of the organization. In recent years, due to increased environmental concerns, government regulations and natural resource constraints, and the impact of green laws, the supply chain has been attracting increasing attention. Given that the supplier plays an important role in the supply chain, if it is faced with the risk and disruption of the harmful and important impacts on the supply chain, it is necessary to study and study these conditions. Hence, in this paper, the problem of designing a closed loop supply chain network in terms of supply risk is discussed. In any decision, there are multiple perspectives or variables while are closely associated and these variables decide the overall impact on the scenario. For managerial decision making, there are assorted approaches which are used widely including sensitivity analysis, scenario analysis and many others. This research manuscript is focusing on the aspects of what-if analysis and associated decision making models under uncertainty. The manuscript covers the hidden patterns and perspectives which are mandatory to be associated and included in the process of decision making.**

***Keywords*—** *Decision Making, Closed loop supply chain, Uncertainty, Risk, Sensitivity Analysis, What-If Analysis*

1. Introduction

Managerial Decision Making [1] and Risk Avoidance [2] is the key focus in any organization so that the maximum profitability can be achieved with minimum risk factors [3]. The What-If analysis in decision making makes sure and integrates the assorted perspectives so that the risks on different situations can be evaluated and remedial measures can taken [4-8].

2. Literature Review

Faizi, S. et al. (2018) [9] presents the facts that there are enormous uncertainties and risks associated with the traditional multi-criteria decision-making (MCDM) methods. The work develops the effectual approach to cope up with these challenges. The approach developed is Characteristic Objects Method (COMET) and compared with the TOPSIS method with the outcome on the effectiveness of this model.

Basu, P. et al. (2018) [10] analyze the important factors and models for decision making with uncertainty. The work evaluates the models and approaches including max-min analysis, Choquet Expected Utitlity (CEU) for the overall association of decision with the particular outcomes. Dotan, D. et al. (2018) [11] propose two models for the computation of confidence and the probabilistic outcome. These models include post hoc computation and versus online computation. The results from the work present the adaptive mechanism for the effectiveness of decisions under uncertainty. Cleden, D. (2017) [12] reviews the models, frameworks and approaches for the management of project uncertainties and decision outcomes. The work evaluates the models under different perspectives with the analytics on the risk management dimensions.

Fleming, S.M. et al. (2017) [13] presents and works on the general Bayesian framework for self-evaluation of decision making under uncertainties. The approach presents the deep mining towards cognitive factors and outcome associated with the decision making process.

Slawinski, N. et al. (2017) [14] develop and underlines the multi-level framework so that the decisions associated with climate change in the organization can be evaluated effectively with the higher degree of accuracy. The work presents the limitations and implications associated with the framework on different scenarios

Trutnevyte, E. et al. (2016) [15] propose and present the focal points for the analytics of decision making process. These points include multidimensional uncertainties, improvement

progress with the iterations and evaluation of the scenario under different perspectives.

Wu, Z. et al. (2016) [16] presents a performance aware multi-criteria group decision making (MCGDM) approach with the base of fuzzy VIKOR method for the optimization of overall outcome and selection problem.

Wyborn, C. et al. (2016) [17] presents the approach for future-oriented conservation for the combination of capacities and features for the prediction of outcomes in assorted dimensions of the research space. The work finds out the probabilistic parameters so that the risk management can be done effectually.

Empirical Analysis of Models for Decision Making under Uncertainty

In decision making, the perspectives of ambiguity, uncertainty, risk and variability are associated which every manager always willing to reduce. There is diversified set of models and frameworks which are used for decision making under uncertainty. Following is excerpts from the selected high performance models and approaches.

3. Monte Carlo Simulation

The processes of analyzing the objective probability with all the possible permutations of outcome are considered in Monte Carlo Simulation. In this approach, the evaluation of numerical scenarios is done with the integration of planning, risk mitigation and effectual decision. Monte Carlo Simulation is the Stochastic Approach that implements the scoring on the unknown variables and non-deterministic objects with the implementation of probabilities to generate "What-If" on enormous decision flavors.

The key areas of implementations for Monte Carlo Simulation includes Financial Risk Predictions, Stock Market Analysis, Software Testing, Military and Defense, Optimal Transportation, Pricing and Revenue, Frauds Investigation, and many others

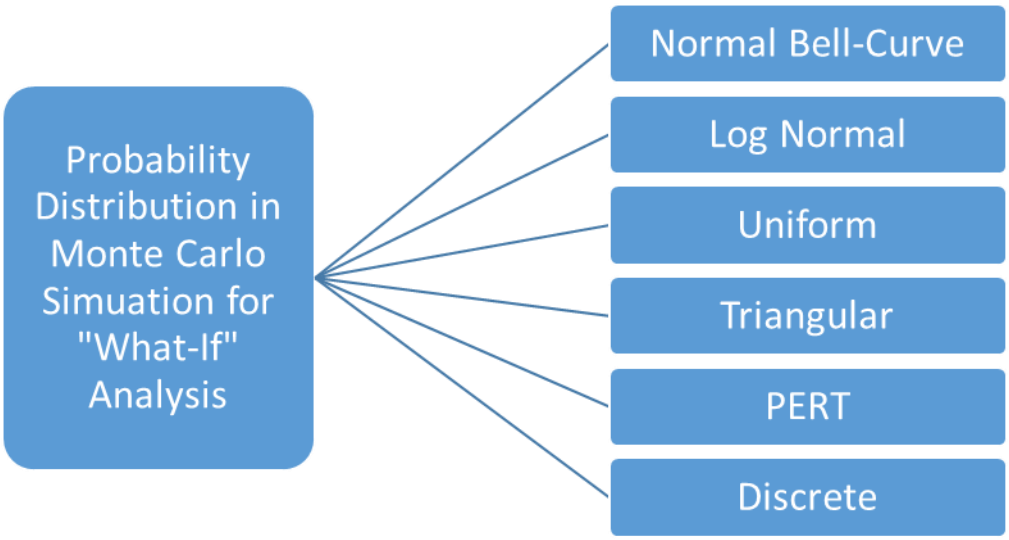

Figure 1. Probability Distribution in Monte Carlo Simulation for "What-If" Analysis

Using probability distribution approaches, the decision making is quite effectual in Monte Carlo Simulation. The advantages and key features of Monte Carlo Simulation as compared to "Single Point Estimation" Analysis include the graphical outcome with the Probability Factors of Risks and Possible Output. In addition, Monte Carlo Simulation makes it easy to associate and integrate the inputs with its overall impact on the bottom-line output. Monte Carlo Simulation enables and assist the decision makers and business analysts to analyze the relationship between the variables and inputs. The overall correlation and integration of multiple inputs can be foreseen in the approach of Monte Carlo Simulation.

4. Sensitivity Analysis

Sensitivity Analysis or "What-If Simulation" is the approach for prediction of the outcome from a decision having a specific set of variables.

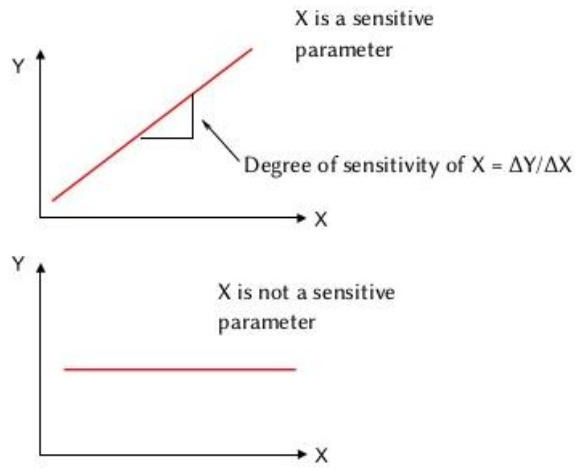

Figure 2. Sensitivity Analysis

The decisions are generally evaluated in deep before actual implementation; still the decisions are having uncertainties. There are many inputs and variables which indirectly affect the overall outcome from the decision. A sensitivity analysis is the approach to evaluate and identifies the ways by which different values and scores of independent variable affect the dependent variable with the specific set of assumptions.

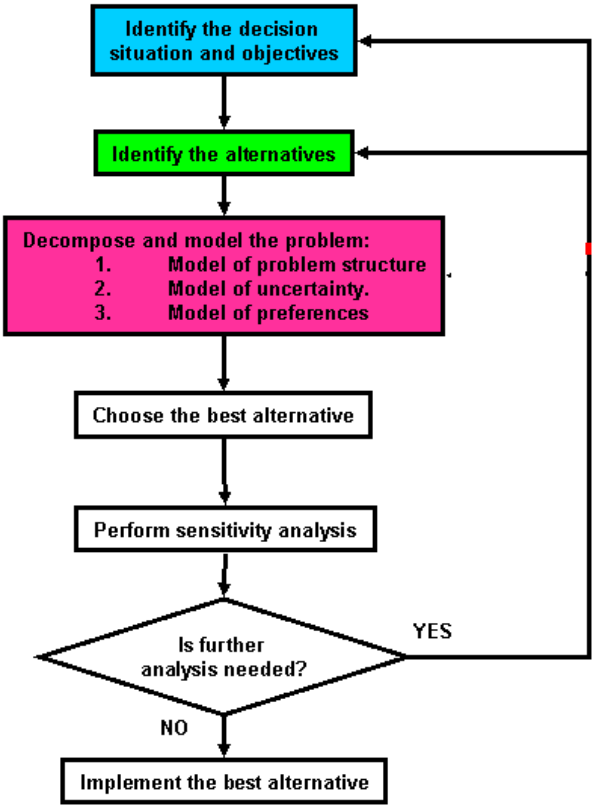

Figure 3. Perspectives of Sensitivity Analysis

The applications and uses of sensitivity analysis includes the following

- Assistance in decision making
- Prior assessment of the risk associated
- Prediction of the outcome from the decision using What-If dimensions
- Assist in appropriate, informed and strategic decisions
- Identification and Evaluation of the errors and pitfalls in the model
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Stochastic Supply chain management in Scenario Analysis

Integrative decision making is key to effective supply chain management. As contrast to sensitivity analysis, the scenario analysis is used to evaluate the decision in the light of current scenario. The analyst imaging and understand the situation or scenario of a particular risk like market crash, bankruptcy etc. and then predict the outcome and perform the decision making. In scenario analysis, the possible future outcomes and events are predicted with the expected results and by this way the projection of future is done.

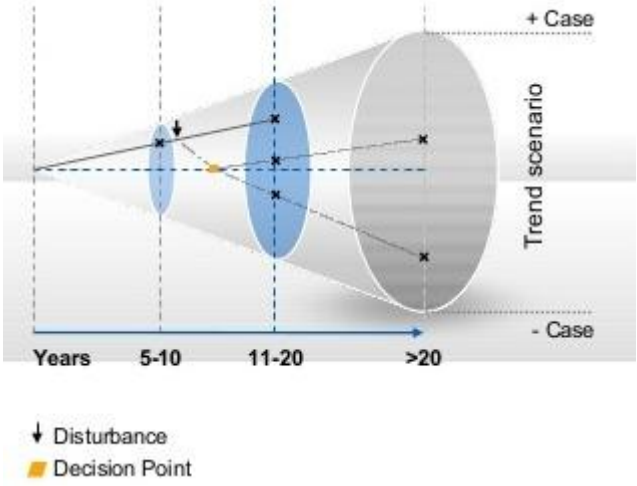

Figure 4. Scenario Analysis

The business analyst or decision maker usually generates different possibilities or outcomes from the overall scenario. These can include Pessimistic, Expected and Optimistic. Based on these possible outcomes, the overall strategy is defined to cope up with the future outcomes. There exist many limitations and disadvantages with this approach. The decision rule is quite difficult to present with accuracy as there is no mechanism for identification of risk compensation. In addition, only the stand-alone or independent risks are evaluated rather than overall multi-dimensional variables.

Supply chain connecting suppliers to customers consists of several important sectors with respect to Industrial Management such as production and sales planning, transportation, and inventory management. It is important to do appropriate decision making for not only the whole of supply chain but also each sector. Each sector has various random and ambiguous conditions. In order to represent these uncertain conditions and to obtain the appropriate decision, the sectors for supply chain management are formulated as stochastic.

5. Conclusion

There are assorted approaches and models developed for managerial decision making with minimum risk factors, still this area is under research as the actual outcome from the decision can be seen only after the implementation of the decision. In this research manuscript, the risk management models and related aspects are presented which work on the assorted perspectives of the decision. For the scope of future work, the novel and effectual models can be developed with the evaluation of different direct and indirect variables for higher degree of accuracy and predictions.

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