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IFB

Simulation Model for Evaluating Supply Chain Profit Under Stochastic Conditions of IFB Appliances Ltd.

Course: Management Decision Science using Excel

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Thank you sir, for your guidance and support throughout the course

FORE School of Management

1. Introduction

Introduction IFB Appliances Ltd. finds itself operating in the Indian consumer durables industry, where profitability is very much related to the supply chain's efficiency and resilience. The company is confronted by multiple sources of uncertainty, including volatile customer demand, fluctuations in raw material prices, labour cost variability, supplier reliability issues, foreign exchange exposure due to imported components, and rising sustainability and regulatory pressures.

The uncertainties impact the operational performance and cost structures with effects on the overall financial outcomes. Conventional deterministic planning models use fixed assumptions and single-point estimates, failing to capture the intrinsic variability of real-world supply chains. Models like this often underestimate risk and give limited insight into adverse scenarios. This project thus adopts a Monte Carlo simulation approach for assessing the multi-tier supply chain profitability of IFB Appliances under stochastic conditions. The simulation involves the induction of randomness across operational, financial, and sustainability-related variables to describe probability distributions of profit outcomes. The objective was to estimate expected profitability, downside risk, key drivers of profit variability, and managerial insights that can support informed, risk-aware, and decision-making.

2. Model Description and Logic

The simulation model is developed using Microsoft Excel and estimates supply chain profit over a defined short-term planning horizon. The model reflects IFB Appliance's procurement, production, and distribution activities and converts uncertain operating conditions into financial outcomes through a structured and transparent logic.

For each simulation iteration, random values are generated for all stochastic input variables based on their assigned probability distributions. These inputs determine procurement costs, labour expenses, production effectiveness, realized customer demand, sustainability-related costs, and the occurrence of operational disruptions. Revenue is calculated as the product of realized demand and selling price, adjusted for quality defects and supplier failures that reduce saleable output. Total cost includes raw material procurement, labour costs, logistics and lead-time penalties, currency exchange impacts, and sustainability-related costs arising from carbon pricing, energy consumption variability, and waste generation rates.

Profit for each iteration is calculated as:

Profit = Total Revenue – Total Cost

This project uses Monte Carlo simulation to effectively evaluate the supply chain's profitability for IFB Appliances Ltd., especially when things are uncertain. By looking at operational, financial, and sustainability-related risks, the model gives us a realistic and full picture of potential profit issues.
While the supply chain is generally profitable, it faces some real variability which are Unpredictable demand, supplier reliability issues, and fluctuating costs.

This simulation-based approach helps the managers make better decisions. It moves away from simple, fixed assumptions and provides smart, probability-based insights instead, helping us build a supply chain that's stronger, more sustainable, and financially sound.

3. Assumptions and Probability Distributions

To ensure clarity and tractability, several simplifying assumptions are made. All stochastic input variables are assumed to be independent. The planning horizon is assumed to be short enough that no major structural changes occur in the supply chain. Unfulfilled demand resulting from supplier disruptions or quality issues is treated as lost sales rather than backorders. Cost relationships are assumed to be linear, while capacity constraints are implicitly reflected through supplier failure and defect rate variables.

Table 1: Stochastic Inputs and Probability Distributions

Variable	Distribution	Business Rationale
Part Cost Variability	Normal	Reflects market-driven raw material price fluctuations
Demand Uncertainty	Normal	Reflects demand variability around an expected mean
Labour Cost Variability	Triangular	Captures minimum, most likely, and maximum labour cost scenarios
Supplier Failure Probability	Bernoulli	Models occurrence of supplier disruptions
Defect Rate / Quality Variation	Uniform	Represents random quality outcomes
Lead Time Delay	Triangular	Represents minimum, most likely, and maximum delivery delays
Exchange Rate Fluctuation	Lognormal	Captures asymmetric foreign exchange risk
Carbon Price Variability	Normal	Reflects uncertainty in carbon pricing and regulation
Energy Consumption Variability	Normal	Represents operational energy usage fluctuations
Sustainability Event Penalty	Bernoulli	A random event where firm incurs financial losses due to regulations, or compliance failure

Sustainability-related stochastic factors such as **carbon price variability**, **energy consumption variability**, and **Sustainability penalty event** are incorporated. These factors directly affect total cost through regulatory compliance requirements, energy expenses, and waste handling penalties.

4. Simulation Output and Results

The simulation generates a distribution of profit outcomes reflecting the uncertainty embedded in IFB Appliances' supply chain. Key descriptive statistics obtained from the simulation are summarised below.

Table 2: Simulation Output – Descriptive Statistics

Metric	Profit (₹)	Revenue (₹)
Maximum	24,991,213	25,000,000
Average (Mean)	12,486,221	12,500,000
Minimum	–13,763	0
Standard Deviation	17,677,647	17,677,670
Probability of Loss	9.56%	--

The **average profit of ₹ 12.49 million** represents the long-run expected profitability of the supply chain under uncertainty. The **maximum profit of ₹ 24.99 million** tells us the best-case scenarios characterised by strong demand, stable costs, and minimal disruptions. The **minimum profit of - ₹13,763** indicates that loss-making outcomes are possible but limited in magnitude, suggesting relatively strong downside protection.

The high standard deviation highlights substantial variability around the mean, confirming that profit outcomes are highly sensitive to changes in demand, costs, and disruptions. Importantly, the **probability of loss is only 9.56%**, implying that fewer than one out of ten scenarios result in a loss. On the revenue side, the close alignment between revenue and profit variability indicates that demand uncertainty is the primary driver of financial performance, while cost structures determine the extent to which revenue is converted into profit.

5. Sensitivity Analysis

Sensitivity analysis is conducted to identify the variables that exert the greatest influence on profit variability. The analysis indicates that demand uncertainty is the most critical driver of profitability, as revenue responds directly to fluctuations in market demand. Supplier failure probability and part cost variability also have a significant impact, as disruptions and cost increases simultaneously raise expenses and reduce realised sales.

Table 3: Sensitivity Analysis – Key Drivers of Profit

Variable	Impact on Profit
Demand Uncertainty	Very High
Supplier Failure Probability	High
Part Cost Variability	High
Carbon Price Variability	Moderate
Energy Consumption Variability	Moderate
Sustainability Penalty	Low to Moderate

Sustainability-related factors, particularly carbon pricing and energy consumption variability, show a moderate but meaningful influence on profitability. Waste generation rates and sustainability-related penalties exhibit relatively lower individual sensitivity; however, their combined effect contributes to overall cost variability and regulatory risk. These findings help management prioritise risk mitigation efforts toward the most influential sources of uncertainty.

6. Managerial Insights and Decision Implications

The simulation provides several actionable insights for IFB Appliances.
First, profitability should be evaluated based on risk rather than just expected profit. While average profitability is strong, variability shows the need to manage downside risk.

Second, managing demand risk is a key priority. Investing in better forecasting, smoothing demand, and flexible production planning can greatly reduce profit fluctuations. Third, building supplier resilience is crucial. Diversifying suppliers, using multiple sources, and having backup plans can lessen the financial impact of supplier disruptions.

Furthermore, risks related to sustainability directly affect finances. Investing in energy efficiency, reducing waste, and managing emissions can lower cost fluctuations and serve as long-term tools for risk management, not just compliance measures. Overall, the simulation shows how useful Monte Carlo analysis can be for budgeting, scenario planning, and long-term supply chain strategy.

7. Conclusion

This project uses Monte Carlo simulation to effectively evaluate the supply chain's profitability for IFB Appliances Ltd., especially when things are uncertain. By looking at operational, financial, and sustainability-related risks, the model gives us a realistic and full picture of potential profit issues.

While the supply chain is generally profitable, it faces some real variability which are Unpredictable demand, supplier reliability issues, and fluctuating costs.

This simulation-based approach helps the managers make better decisions. It moves away from simple, fixed assumptions and provides smart, probability-based insights instead, helping us build a supply chain that's stronger, more sustainable, and financially sound.