EHS402: OPERATIONS AND SUPPLY CHAIN MANAGEMENT (Elective)

VIII Semester B.Tech CSE

Section B4,B5,B6/D,E,F

Lecture Notes

in

O&SCM

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**Prepared and Compiled
by**

Dr. Smt. Padmini.R*
Sri.S.Hemanth Kumar*
Sri.K.Suresh*

***Assistant Professor
Department of Industrial Engineering
GITAM Institute of Technology
GITAM (Deemed to be University)
Visakhapatnam-530045**

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Impact of Uncertainty in Network:
- Globalization and supply chain,
- Risk management in global supply chain
- Demand forecasting in supply chain
- Role of information technology in forecasting.

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The primary purpose of a **supply chain network** design is to assess company policies and programs and to meet targets to accomplish long-term strategic objectives, and most business units or functional areas within a company are impacted by a network design project.

When designing a supply chain the following steps must be followed:

1) Define the business objectives,
2) The project scope must be defined,
3) The form of analyses to be done must be determined,
4) Determine what tools will be used,
5) Finally, Project completion, the best design.

What Creates Real Economic Value?
Business and operations strategy - the formulation of strategies that drive investment, operations, and competitive positioning - is where all value begins.There are five strategic questions that need to be answered:

1. **What** business is the CPG company in and why?
2. **How** should value be added to the business?
3. **What** are the target markets?
4. **What** are the products and why will customers buy from the CPG company?
5. **What** capabilities are needed to assure that the company adds value and differentiates?

How has Globalization impact to supply chain management?
Supply chain management: In commerce, supply chain management, the management of the flow of goods and services, involves the movement and storage of raw materials, of work-in-process inventory, and of finished goods from point of origin to point of consumption. It's the broad range of activities required to plan, control and execute a product's flow, from acquiring raw materials and production through distribution to the final customer, in the most streamlined and cost-effective way possible.

With the advent of globalization, managing supply chain activities has become more complex. Today a company operating in the United States may have its manufacturing facilities in China, Mexico or Taiwan and its customers throughout the world. Many companies in order to manage its global operations may outsource their supply chain activities to third-party organizations around the globe. Outsourcing reduces the supply chain operating cost but when not managed effectively proves otherwise.

Globalization has dramatically changed how manufacturers operate, offering an opportunity to reach new customers in new markets while at the same time exposing firms to greater competition. Meanwhile, raw materials and supplier relationships must now be managed on a global scale. Just as there are benefits and costs of globalization, there are similar pros and cons of a global supply chain. In particular, companies need to manage the related risks.

The Four Driving Forces of the Globalization Process:
a) Global Market Forces
b) Technological Forces
c) Global Cost Forces
d) Political and Macroeconomic Forces

Benefits of a Globalized Supply Chain:

1. **Expanded sourcing opportunities:** A world market offers businesses opportunities to secure a diverse selection of workers, materials, and products. This larger selection of goods and services often means the opportunity to select higher-quality or lower-cost options.
2. **The opportunity to reach new customers in new markets:** Just as globalization offers more materials and laborers, it also offers new customers in new locations with new needs.
3. **More room to grow:** New technologies and a shrinking globe mean that it is easier for companies to grow generally: to produce more, offer more, and sell more. Expanding borders also means expanding businesses and corporations.
4. **More opportunities to save money:** Globalization's biggest benefit is that increases options: options for source materials, options for workers, and options for transportation. More options mean more chances to save on spending and increase profits.

Supply chain risk management (SCRM): is the process of taking **strategic** steps to identify, assess and mitigate the risk in your end-to-end supply chain. A comprehensive approach to SCRM involves the management of all types of risk, for all tiers of supply and for all risk objects (suppliers, locations, ports and more).

Risk is often defined as : RISK = f (Probability, Consequences).
Hence, risk is the combination of the probability of an event and its consequences/impacts.

Risk in the context of supply chains may be associated with the production/procurement processes, the transportation/shipment of the goods, and/or the demand markets.

The five steps

The five steps of global supply chain risk management follow in the footsteps of the classic circular risk analysis paradigm: Identify > Assess and Evaluate > Mitigate > Monitor and Re-assess.

In their world they call it:
- Risk Identification
- Risk Assessment and Evaluation
- Selection of Risk Management Strategies
- Implementation of Risk Management Strategies
- Mitigation of Supply Chain Risks

Types of Risks
- Supply Risks – disruption of supply, inventory and schedules
- Operational Risks – breakdown of operations, changes in technology
- Demand Risks – variations in demand
- Security Risks – theft, sabotage, terrorism, counterfeiting, infrastructure breakdown
- Macro Risks – economic shifts, recession, hike in wages, variation in exchange rates
- Policy Risks – actions and sanctions of governments, shifts in legislation
- Competitive Risks – uncertainty about competitors' moves and actions
- Resource Risks – uncertainty about resource availability

SUPPLY CHAIN RISK MANAGEMENT- DRIVERS OF RISKS

Disruptions	■ Natural disaster ■ Labor dispute ■ Supplier bankruptcy ■ War and terrorism ■ Dependency on a single source of supply as well as the capacity and responsiveness of alternative suppliers
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Disruptions	- Natural disaster - Labor dispute - Supplier bankruptcy - War and terrorism - Dependency on a single source of supply as well as the capacity and responsiveness of alternative suppliers
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Risk Management – Drivers of Risk
Risk Management Strategies

- Avoidance – exiting a market (or product) or delay entering a market (or product)
- Postponement – delay commitment of resources to maintain utmost flexibility
- Speculation – assuming risk to gain competitive advantage
- Hedging – globally dispersing your portfolio of suppliers, customers and facilities
- Control – vertical and lateral integration of suppliers and business partners
- Transferring/sharing risk – outsourcing, offshoring, contracting
- Security – identifying unusual movements and protecting against unwanted penetration

Following best practices for supply chain risk management:
1. Automate processes involved in supplier risk management (SRM) to collect, analyze and manage supplier information.
2. Include supplier performance information in your analysis for insight into potential financial issues.
3. Identify red flags that may indicate problems and use technology to automate their early detection.
4. Integrate SCRM platforms with procurement and supply chain management (SCM) software systems including software for spend visibility, e-sourcing, purchase-to-pay, contract management and compliance.
5. Provide dashboards that track and report on supply risk metrics to give the executive team access to real-time observations into risk factors.

SCRM may require collaboration and coordination among an organization's sales, marketing, production, development, procurement, finance and IT departments.

Why Do Companies Need to Forecast?

Demand forecasting supports corporate-wide planning activities

Level of Forecast	Purposes	
Strategic(years)	Business planning Capacity planning	
Tactical (quarterly)	Brand plans Financial planning/budgeting Sales planning Manpower planning	*Operational Forecasts*
Tactical (months/weeks)	Short-term capacity planning Master planning Inventory planning	
Operational(days/hours)	Transportation planning Production scheduling Inventory deployment	

Forecasting
A integrated approach is driven by a stakeholder organization that is chartered with driving commitment and accountability to "single number"consensus-based forecasts

Integrated Approach
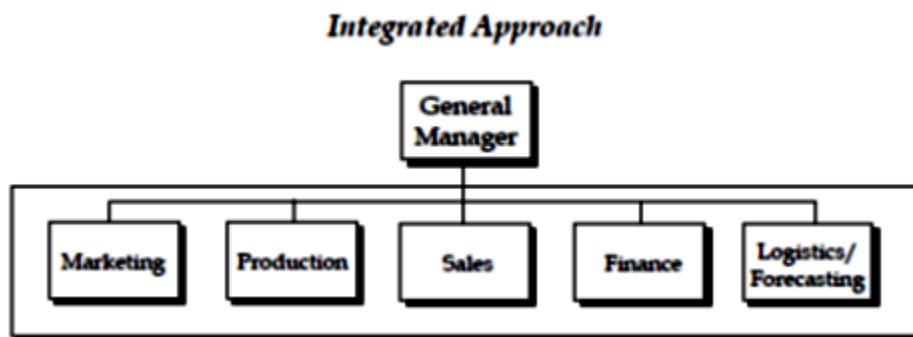
- Forecast administration driven by a stakeholder
- Stakeholder responsible for getting input from others
- Responsible for driving to a reconciled consensus forecast
- Less important which function is stakeholder, but usually marketing or operations

SUMMARY OF PROS AND CONS OF PUTTING THE FORECASTING FUNCTION IN EACH TYPE OF DEPARTMENT

Department	Objectivity	Business Understanding	Quantitative Skills	Organizational Skills
Standalone Forecasting	Objective, but not impacted by demand	No direct contact wih customers	High Level	High level of discipline
Marketing	Objective, but some bias from performance goals	Very good understanding of future customer needs	Low Level	Moderate level of discipline
Production, Operations and Logistics	Objective and impacted by demand	Little direct contact with customers	High Level	High level of discipline
Sales	Bias from sales goals and commissions	Highest level of contact with customers	Low Level	Less interest in running structured, routine processes
Finance	Objective, but some bias from budgeting and not impacted by demand	No direct contact with customers	High Level	High level of discipline
Strategic Planning	Objective, but not impacted by demand and view is too long-term	No direct contact wih customers	High Level	High level of discipline

After gathering information about various aspects of the market and demand from primary and secondary sources, an attempt may be made to estimate future demand. A wide range of forecasting methods are available to the market analyst. These may be divided into three categories: qualitative methods, time series projection methods, and casual methods.

1. **Qualitative methods**
The important qualitative methods are as follows.

1. *Jury of executive opinion method:* Very popular in practice, this method calls for the pooling of views of a group of executives on expected future sales and combining them into a sales estimate.
2. *Delphi method:* This method involves converting the views of a group of experts, who do not interact face – to – face, into a forecast through an iterative process.

2. **Time series projection methods**
These methods generate forecasts on the basis of an analysis of the historical time series. The important time series projection methods are as follows:

1. *Trend projection method:* Very popular in practice, the trend projection method involves extrapolating the past trend onto the future.
2. *Exponential smoothing method:* In exponential smoothing, forecasts are modified in the light of observed errors.
3. *Moving average method:* According to this method, the forecast for the next period represents a simple arithmetic average or a weighted arithmetic average of the last few observations.

3. **Casual methods:**

More analytical than the preceding methods, causal methods seek to develop forecasts on the basis of cause – effect relationships specified in an explicit, quantitative manner. The important methods under this category are as follows:

1. *Chain ratio method:* A simple analytical approach, this method calls for applying a series of factors for developing a demand forecast.
2. *Consumption level method:* Useful for a product that is directly consumed; this method estimates consumption level on the basis of elasticity coefficients, the important ones being the income elasticity of demand and the price elasticity of demand.
3. *End use method:* Suitable for intermediate products, the end use method develops demand forecasts on the basis of the consumptions coefficient of the product for various uses.
4. *Leading indicator method:* According to this method, observed changes in leading indicators are used to predict the changes in lagging variables.
5. *Econometric method*: Perhaps the most sophisticated forecasting tool, the econometric method involves estimating quantitative relationship derived from economic theory.

Quantitative Approaches of Forecasting

Most of the quantitative techniques calculate demand forecast as an average from the past demand. The following are the important demand forecasting techniques.
- Simple average method: A simple average of demands occurring in all previous time periods is taken as the demand forecast for the next time period in this method. (Example 1)
- Simple moving average method: In this method, the average of the demands from several of the most recent periods is taken as the demand forecast for the next time period. The number of past periods to be used in calculations is selected in the beginning and is kept constant (such as 3-period moving average). (Example 2)
- Weighted moving average method: In this method, unequal weights are assigned to the past demand data while calculating simple moving average as the demand forecast for next time period. Usually most recent data is assigned the highest weight factor. (Example 3)
- Exponential smoothing method: In this method, weights are assigned in exponential order. The weights decrease exponentially from most recent demand data to older demand data. (Example 4)
- Regression analysis method: In this method, past demand data is used to establish a functional relationship between two variables. One variable is known or assumed to be known; and used to forecast the value of other unknown variable (i.e. demand). (Example 5)

Error in Forecasting
Error in forecasting is nothing but the numeric difference in the forecasted demand and actual demand. MAD (Mean Absolute Deviation) and Bias are two measures that are

used to assess the accuracy of the forecasted demand. It may be noted that MAD expresses the magnitude but not the direction of the error.

Example 1
Simple Average :
A XYZ television supplier found a demand of 200 sets in July, 225 sets in August & 245 sets in September. Find the demand forecast for the month of October using simple average method.

The average demand for the month of October is

$$SA = \left(\frac{D1 + D2 + D3}{3}\right)$$
$$= \left(\frac{200 + 225 + 245}{3}\right)$$
$$= 223.33$$
$$\approx 224 \text{ units}$$

Example 2
Simple Moving Average :
A XYZ refrigerator supplier has experienced the following demand for refrigerator during past five months.

Month	Demand
February	20
March	30
April	40
May	60
June	45

Find out the demand forecast for the month of July using five-period moving average & three-period moving average using simple moving average method.

$$MA_n = \frac{\sum_{i=1}^{n} Di}{n}$$

For five period average (i.e. n = 5)

$$MA_5 = \frac{20 + 30 + 40 + 60 + 45}{5}$$
$$= 29 \text{ units}$$

For three period average (i.e. n = 3)

$$MA_3 = \frac{40 + 60 + 45}{3}$$
$$= 48.33$$
$$\approx 49 \text{ units}$$

Example 3
Weighted Moving Average Method :
The manager of a restaurant wants to make decision on inventory and overall cost. He wants to forecast demand for some of the items based on weighted moving average method. For the past three months he experienced a demand for pizzas as follows:

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Month	Demand
October	400
November	480
December	550

Find the demand for the month of January by assuming suitable weights to demand data.

$$WMA = \sum_{i=1}^{n} C_i D_i$$

$C_i = $ Weights for Periods
$D_i = $ Demand for Periods
Let $C1 = 0.25, C2 = 0.3, C3 = 0.5$
∴ $WMA = C1D1 + C2D2 + C3D3$
$= 0.25 * 400 + 0.3 * 480 + 0.5 * 550$
$= 100 + 144 + 275$
$= 519$ units

Example 4
Exponential Smoothing :

One of the two wheeler manufacturing company experienced irregular but usually increasing demand for three products. The demand was found to be 420 bikes for June and 440 bikes for July. They use a forecasting method which takes average of past year to forecast future demand. Using the simple average method demand forecast for June is found as 320 bikes (Use a smoothing coefficient 0.7 to weight the recent demand most heavily) and find the demand forecast for August.

$$F_t = \alpha D_{t-1} + (1 - \alpha) F_{t-1}$$

where $\alpha = $ Smoothig Coefficient
$D_{t-1} = $ Actual Demand for Recent Period
$F_{t-1} = $ Demand Forecast for Recent Period
$F_t = $ Forecast of Next Period Demand
for July :
$= 0.7(420) + (1 - 0.7)320$
$= 294 + 96$
$= 390$ units
for August :
$= 0.7(440) + (1 - 0.7) 390$
$= 308 + 117$
$= 425$ units

Example 5
Regression Analysis :

Farewell Corporation manufactures Integrated Circuit boards(I.C board) for electronics devices. The planning department knows that the sales of their client goods depends on how much they spend on advertising, on account of which they receive in advance of expenditure. The planning department wish to find out the relationship between their clients advertising and sales, so as to find demand for I.C board.

The money spend by the client on advertising and sales (in dollar) is given for different periods in following table :

Period(t)	Advertising (X_t) $\$(1,00,000)$	Sales (D_t) $\$(1,000.000)$	D_t^2	X_t^2	X_tD_t
1	20	6	36	400	120
2	25	8	64	625	200
3	15	7	49	225	105
4	18	7	49	324	126
5	22	8	64	484	176
6	25	9	81	625	225
7	27	10	100	729	270
8	23	7	49	529	161
9	16	6	36	256	96
10	20	8	64	400	120
Σ	211	76	592	4597	1599

$$b = \frac{n(\Sigma X_t D_t) - (\Sigma X_t)(\Sigma D_t)}{n(\Sigma X_t^2) - (\Sigma X_t)^2}$$

$$= \frac{10(1599) - (211)(76)}{10(4597) - (211)^2}$$

$$= \frac{15990 - 16036}{45970 - 44521}$$

$$= \frac{-46}{1449} = -0.0317$$

$$a = \Sigma D_t - b \Sigma X_t$$

$$= \frac{76 - (-0.0317)211}{10}$$

$$= 8.268$$

Relationship between future sales F_t and advertising cost X_t is

$$F_t = a + bX_t$$

$$= 8.268 - 0.0317 X_t$$

Role of information technology in forecasting:

Without information technology, it would not be possible to plan demand for hundreds and thousands of product items and communicate the demand plan to the supply organization. Most was simply too time-consuming to gather information on customers' buying intentions, integrate this information with marketing and sales plans, and perform statistical forecasting.

Information technology, in the words of cultural has the power to change the world with unexpected speed and in unprecedented detail. Speed and detailed information are just what is needed for demand management. Today, software applications can statistically forecast hundreds of items in minutes. Sales orders and demand schedules can be communicated via electronic data interchange (EDI) and the Internet in real time. Retail companies can share point-of-sale information with their trading partners—daily, if desired. Salespeople can sit in their customers' offices and look up product availability, specifications, and pricing on their companies' information systems, using hand-held devices known as personal data acquisition (PDA) tools.

The increasing usage of demand forecasting for businesses can largely be attributed to the advancing application of computational technology. Unlike the conventional statistical practices for demand forecasting, the new IT driven technique have come to bear greater accuracy, increased productivity, and posses greater potentiality in uncovering market opportunities, with an efficient synchronization of demand and supply.

Examples of some firms which provide demand and forecasting solutions

Blue Ridge	➢ Blue Ridge unique forecasting solution helps retailers and distributors capitalize on richer, customer transaction data to generate precise supply chain planning recommendations
Causometrix	➢ Provides cloud-based SaaS applications for demand planning and inventory replenishment and the necessary tools for the associated collaborative planning
Demand Foresight	➢ Helps optimize inventory, increase customer satisfaction, reduce capital investment, and increase profits by using their own forecasting technology
Demand Management	➢ Delivers the powerful demand planning and inventory planning functionality that an organization needs to increase their visibility into their supply chain processes
Demand Link	➢ Provides next-generation demand planning and high accuracy forecasting systems for retailers
E2open	➢ Enables supply chains to better plan, execute and collaborate