

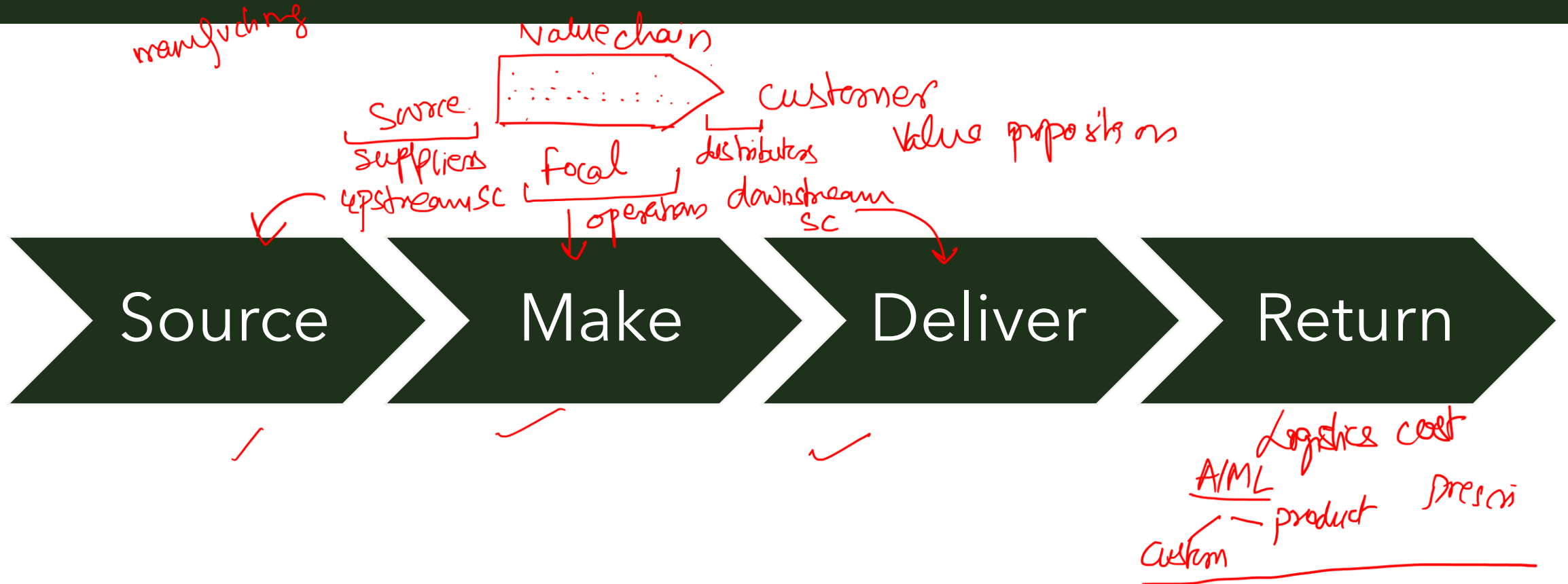
# DTSL: Digital Transformation of Operations

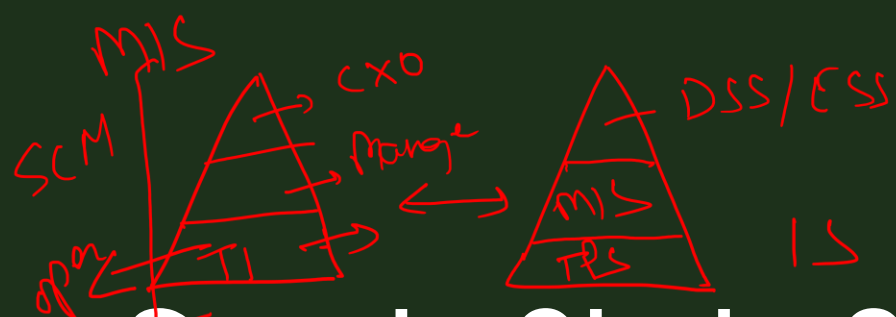
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DTSL EEP

NEENA PANDEY, IIMV

# Supply Chain Operations Reference Model





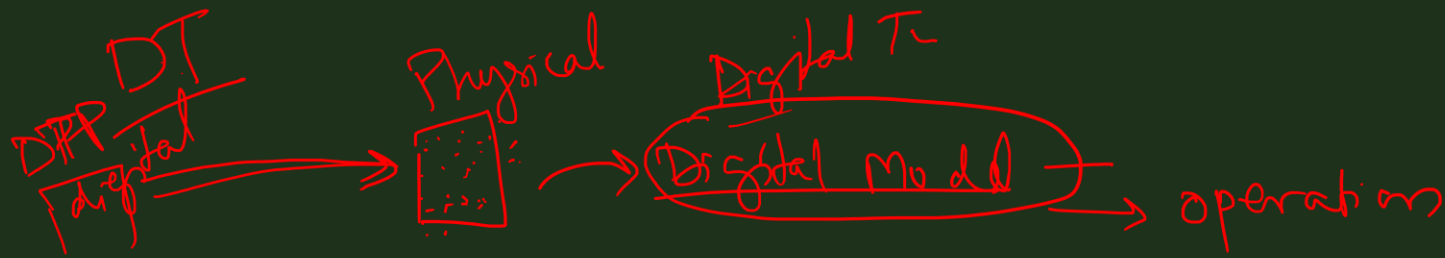
# Supply Chain Operations Reference Model

	Strategic	Tactical	Operational
Source	<ul style="list-style-type: none"> <li>Whom to source from?</li> <li>Measuring the efficiency of Supply Chain</li> </ul>	<ul style="list-style-type: none"> <li>Regular/Spot contracts - with whom</li> <li>What kind of contracts</li> </ul>	<ul style="list-style-type: none"> <li>Materials requirement planning</li> <li>Inventory replenishment</li> </ul>
Make	<ul style="list-style-type: none"> <li>Location of plants</li> <li>Product-line mix at plants</li> </ul>	<ul style="list-style-type: none"> <li>Product line rationalization</li> </ul>	<ul style="list-style-type: none"> <li>Workforce scheduling</li> <li>Manufacturing, Order tracking, &amp; Scheduling</li> </ul>
Deliver	<ul style="list-style-type: none"> <li>Location of distribution centres</li> </ul>	<ul style="list-style-type: none"> <li>Inventory policies at locations</li> </ul>	<ul style="list-style-type: none"> <li>Vehicle routing</li> </ul>
Return	<ul style="list-style-type: none"> <li>Location of return centres</li> </ul>	<ul style="list-style-type: none"> <li>Reverse distribution plan</li> </ul>	<ul style="list-style-type: none"> <li>Vehicle routing</li> </ul>

# Digital Transformation

- Digital Capability: Technology & their Use cases
  - Industry 4.0
  - Blockchain
  - AI/ML
- Leadership Capability
  - Digital Vision; Business Process Reengineering & Change Management;
  - Digital Governance



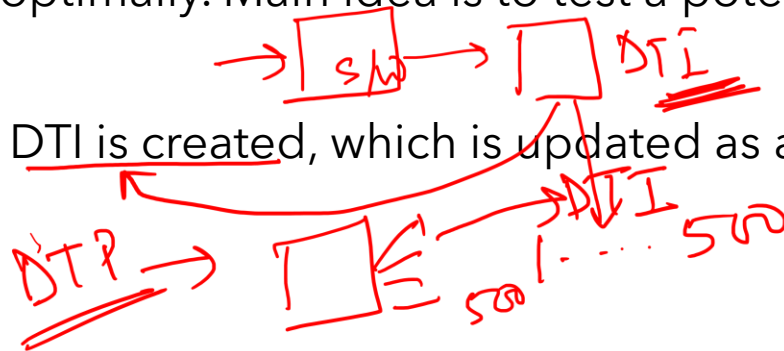


# Internet of Things: Digital Twins

- Product Lifecycle Management
  - Four phases of a system - creation, production (manufacture), operation (sustainment and support), and disposal
  - Each system consisted of two systems: the physical system that has always existed and a new virtual system that contained all information about the physical system
  - Requirement: Real space, Virtual space, the link for information flow from virtual space to real space and virtual sub-spaces
  - Digital Model of a Real Object *Physical*
    - Sensors placed on an actual object and connected to the Internet
    - Sensors transfer data to a cloud database in real-time to update the object's digital twin

# Digital Twins

- Definition
  - A set of virtual information constructs that fully describes a potential or actual physical manufactured product from the micro atomic level to macro geometric level
  - Digital Twin Prototypes (DTP) & Digital Twin Instance (DTI) → *Operation.*
  - In DTP, various tests or simulations can be conducted in the creation phase to ensure that the real object can be built optimally. Main idea is to test a potential real object's action and operation in the real world
  - During production, DTI is created, which is updated as and when the real object changes



# Digital Twins in Operations

- Use Cases
  - To identify and address current issues with a real object
  - Can leverage ML to identify patterns in the streamed data to optimize the real object's performance
  - Insights gathered from data is passed back to the actual object - for product improvement
  - Example: GE, Tesla, Bayer Crop Science

# Advantages of Additive Manufacturing

- Design Freedom: Create complex geometries that are impossible with traditional methods.
- Cost-effectiveness: Ideal for low-volume production and prototyping
- Reduced waste: Uses only the material needed for production
- Customization: Allows for highly customized products like medical implants
- Rapid-prototyping: Shortens the design-to-production cycle

# Applications of Additive Manufacturing



- Aerospace - Lightweight components and complex geometries
- Healthcare - Custom prosthetics, implants, and dental products.
- Automotive - Rapid prototyping and small-batch production.
- Consumer Goods - Customized jewelry, footwear, and fashion accessories.
- Construction - Printing entire buildings or structural components.

# Impact of Industry 4.0 on Operations

- Efficiency Gains
  - Automation reduces manual errors and speeds up processes
- Cost Reduction
  - Optimized resource utilization
  - Predictive maintenance saves costs
- Customization
  - Mass customization (personalized) capabilities
- Real-time Insights ✓
  - Enhanced decision-making

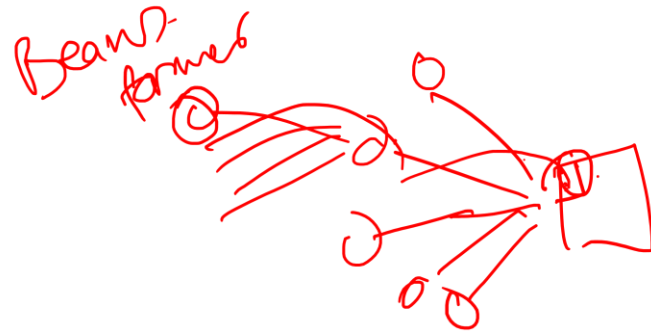


# Challenges in Adopting Industry 4.0

- High Initial Investment
  - Technology implementation
- Data security concerns   Healthcare
  - Data breaches and cyber attacks
- Skill Gaps in Workforce
  - Upskilling to handle advanced technologies
- Integration with Legacy Systems
  - Integration with new technologies

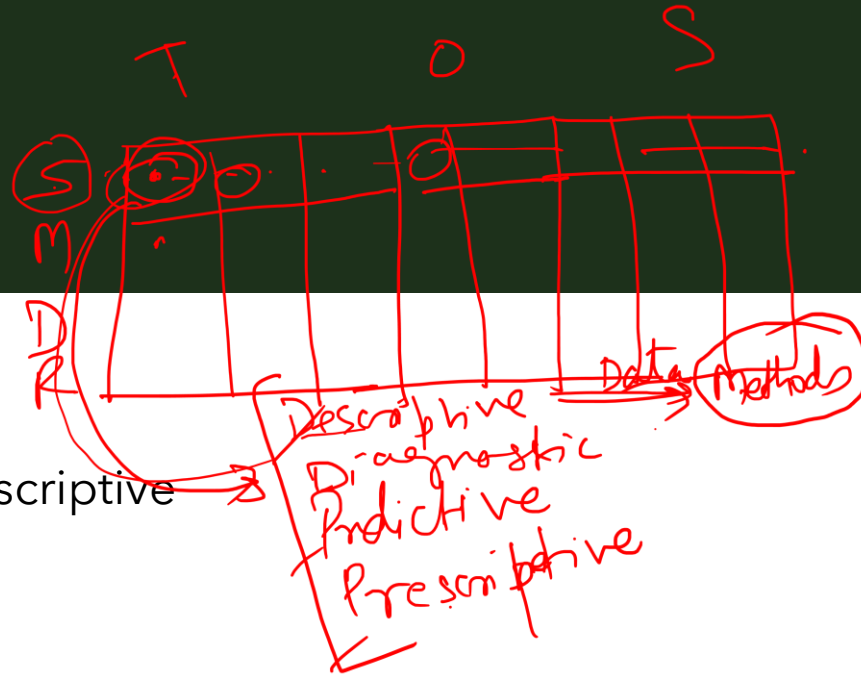
# Blockchain Usecase in Operations: Smart Contracts

- Blockchain-based programs to assess the status of a transaction and automatically take actions - Self-executing contracts with predefined rules coded into blockchain
- Automatically enforce terms without intermediaries
- Major Benefits
  - ~~Trustless Execution~~ ✓
  - Transparency ✓
  - Cost efficiency ✓
  - Security ✓



# AI/ML

- Types of Analytics
  - Descriptive, Diagnostic, Predictive, and Prescriptive
- Artificial Intelligence / Machine Learning
  - Supervised & Unsupervised Learning
  - A Few Methods: Linear Regression, Logistic Regression, Decision Trees, Clustering
- Use Cases for Operations & Supply Chain Management (OSCM)



# Types of Analytics: Descriptive

- Descriptive Analytics
  - Descriptive statistics summarize and describe the main features of a dataset; To answer: “What happened?”
  - Used to provide insights into the data distribution for easier interpretation of complex data
  - Some of the numerical measures are: Mean, Median, Range, Standard deviation, Skewness
  - Graphs: Frequency distribution; Box plot, Scatter Plot
- Use cases in OSCM
  - Inventory Performance analysis: Insights into stock levels, turnover rates, and slow-moving items
  - Demand Trends and Forecasting: Analyzes historical sales data to understand demand patterns across regions, seasons, or product categories
  - Transportation and Logistics Monitoring; Cost Analysis

# Types of Analytics: Diagnostic

- Diagnostic analytics delves deeper into data to identify root causes of trends, anomalies, or events.
- Investigates historical data to uncover the reasons behind observed outcomes or trends
- To answer questions like "Why did this happen?"
- Key Techniques:
  - Data visualization; Correlation; ~~Root Cause analysis~~; Anomaly detection;
- Use Cases in OSCM: Remain same as descriptive analytics

log → fraud Six → 87gn  
→ 1 batch

# Types of Analytics: Predictive

- Predictive analytics uses historical data, machine learning, and statistical models to forecast future outcomes
- Extracts patterns from historical data; Applies different techniques to make predictions
- Key Methods
  - Regression Analysis: Linear & Logistic Regression
  - Classification Models - Categorizes data into predefined classes; e.g., Decision Trees
  - Time Series Analysis - Forecasts trends over time
  - Clustering - Group data points based on similarity for better predictions
  - Neural Networks - Advanced models for complex relationships, to enhance prediction accuracy

# OSCM Applications: Predictive & Prescriptive

## Applications - In OSCM - Predictive

- Forecasting demand for inventory planning; Predictive maintenance to reduce equipment downtime;
- Demand Forecasting; Delivery time prediction; Returns Management

## Applications - Operations & Supply Chain Management - Prescriptive

- Supply Chain: Optimize delivery routes and inventory management
- Production Planning: Allocate resources efficiently to maximize output
- Portfolio Optimization: Select a set of projects or investments to maximize returns under budget constraints

LTV → 20 →  
 LTV → 1/1kale  
 Predict → Predict →

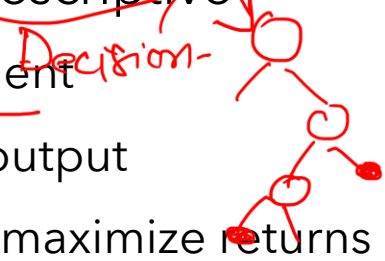
UPS Min perform. Max eff  
 Linear program  
 ante program  
 Min cost

Prescript → Do this

constraints - Max Profit  $3x_1 + 2x_2 + \dots$   
 data → objective func  
 $x_1 \leq 100$   
 $x_2 \leq 500$   
 constraints

$x_1, x_2$  model → LR LR

$x_1 =$   
 $x_2 =$



4- $x_1$   
 $x_2$   
 $x_3$   
 $x_4$   
 Max return:  $4x_1 + \dots$   
 constr  $x_1 \leq 500$   
 $x_1, x_2, \dots, x_4$

100

# OSCM Applications: Methods-based

- Linear Regression

- Demand Forecasting - historical sales data, economic conditions, marketing spend, festival season
- Inventory Optimization - predicting optimal reorder quantities based on past consumption rates and supplier delivery times
- Transportation Cost Analysis - dependent on factors like distance, fuel price, shipment weight etc.

- Logistic Regression

- Classification of suppliers as reliable and unreliable - on-time delivery rates, defect rates, compliance metrics
- Product return estimation - based on customer profile, order history, product features etc.
- Equipment failure Prediction - whether a machine will fail or not in a given time period - usage hours, and operating conditions (temperature, vibrations, etc.)

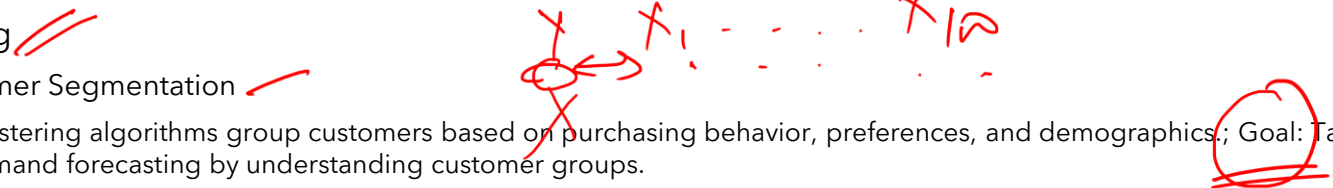



Handwritten notes and formula:

Time →

Data →

$$D = f(\text{sales}, \text{inflat}, \text{GDP}, \text{MS} + \text{fest-months})$$
$$D = 0.8XS - 0.4I + 0.53XAD9$$

# OSCM Applications: Methods-based

- Decision Trees
  - Supplier evaluation and selection - based on criteria like cost, quality, delivery time, reliability
  - Helps decide which products to continue, discontinue, or launch based on sales trends, customer feedback, and profitability
- Clustering 
  - Customer Segmentation 
    - Clustering algorithms group customers based on purchasing behavior, preferences, and demographics; Goal: Tailored marketing strategies for each segment; Improved demand forecasting by understanding customer groups.
  - Supplier Segmentation 
    - Suppliers can be grouped based on reliability, cost, lead time, or quality.; Goal: Identifies strategic suppliers; Helps allocate resources and prioritize key partnerships.
  - Warehouse Optimization 
    - Clustering groups products frequently ordered together for storage optimization; Goal: Reduces picking time; Improves warehouse space utilization
  - Risk Management
    - Clustering identifies suppliers, products, or regions with similar risk profiles (e.g., delays, geopolitical risks).; Goal: Proactive risk mitigation strategies, Enhances supply chain resilience.
  - Product Recommendation
    - Groups similar products together based on purchase history, enabling effective cross-selling and upselling strategies; Goal: Increased revenue per customer; Improves customer satisfaction

# Choosing the Right Algorithm

- Nature of the problem
- Availability of Data - Labeled/Unlabeled, Volume, Quality, Dimensionality, Structured/Unstructured
  - Algorithms like SVM may be sensitive to noise, while tree-based methods handle noisy data better
- What kind of prediction - Is the outcome variable categorical or continuous?
- Computational Resources
- Domain Knowledge
- Performance Requirements - Accuracy
- Interpretability
- Scalability



# References

- <https://www.youtube.com/watch?v=reUZRyXxUs4> - How AI Could Empower Any Business, Andrew Ng
- Digital Twins
  - <https://www.youtube.com/watch?v=nn7XxINRGcs>
  - [https://www.researchgate.net/publication/307509727\\_Origins\\_of\\_the\\_Digital\\_Twin\\_Concept](https://www.researchgate.net/publication/307509727_Origins_of_the_Digital_Twin_Concept)