

# Rolling stock spare parts inventory management

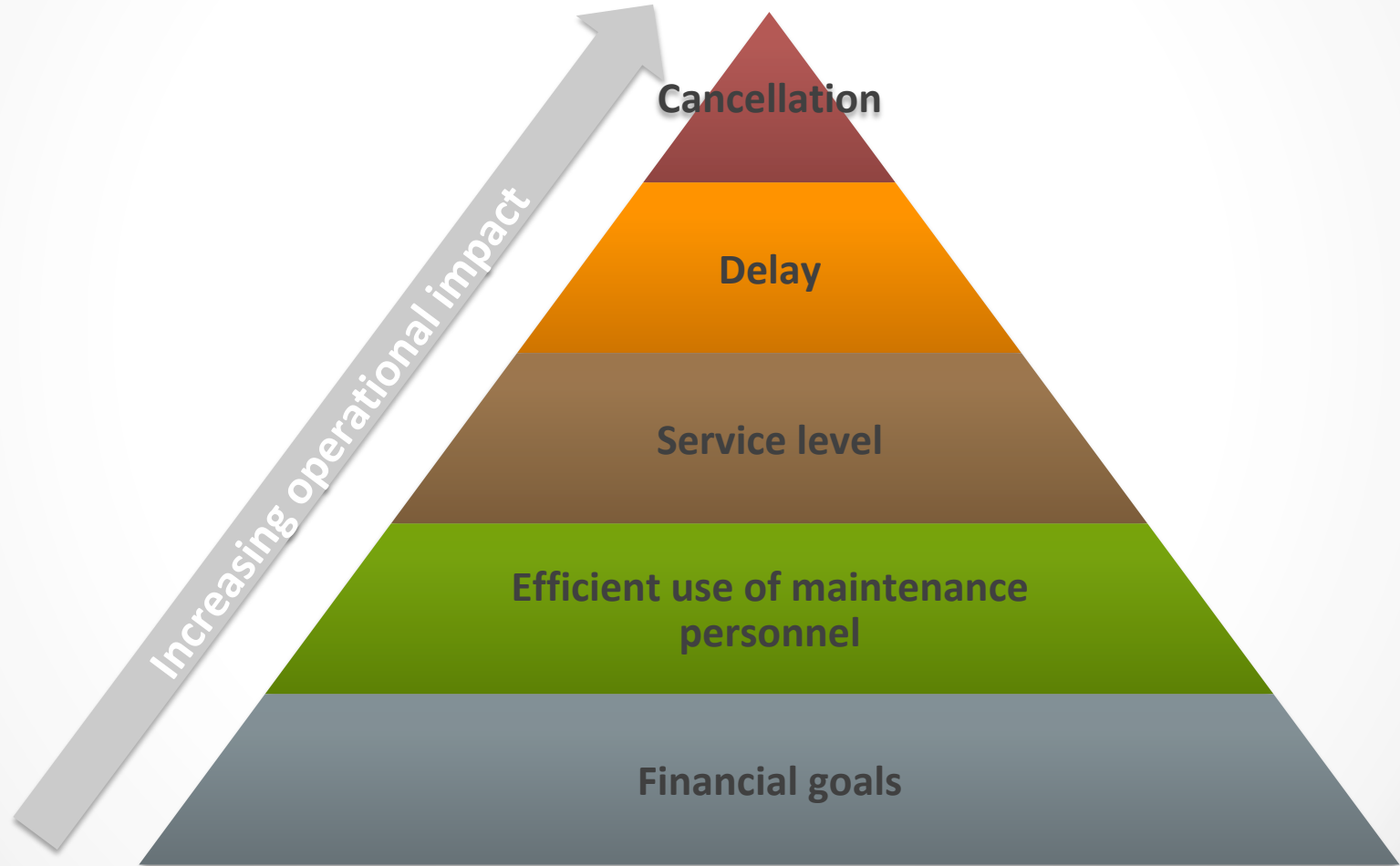
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Provide the highest level of service to customers  
at the lowest total cost

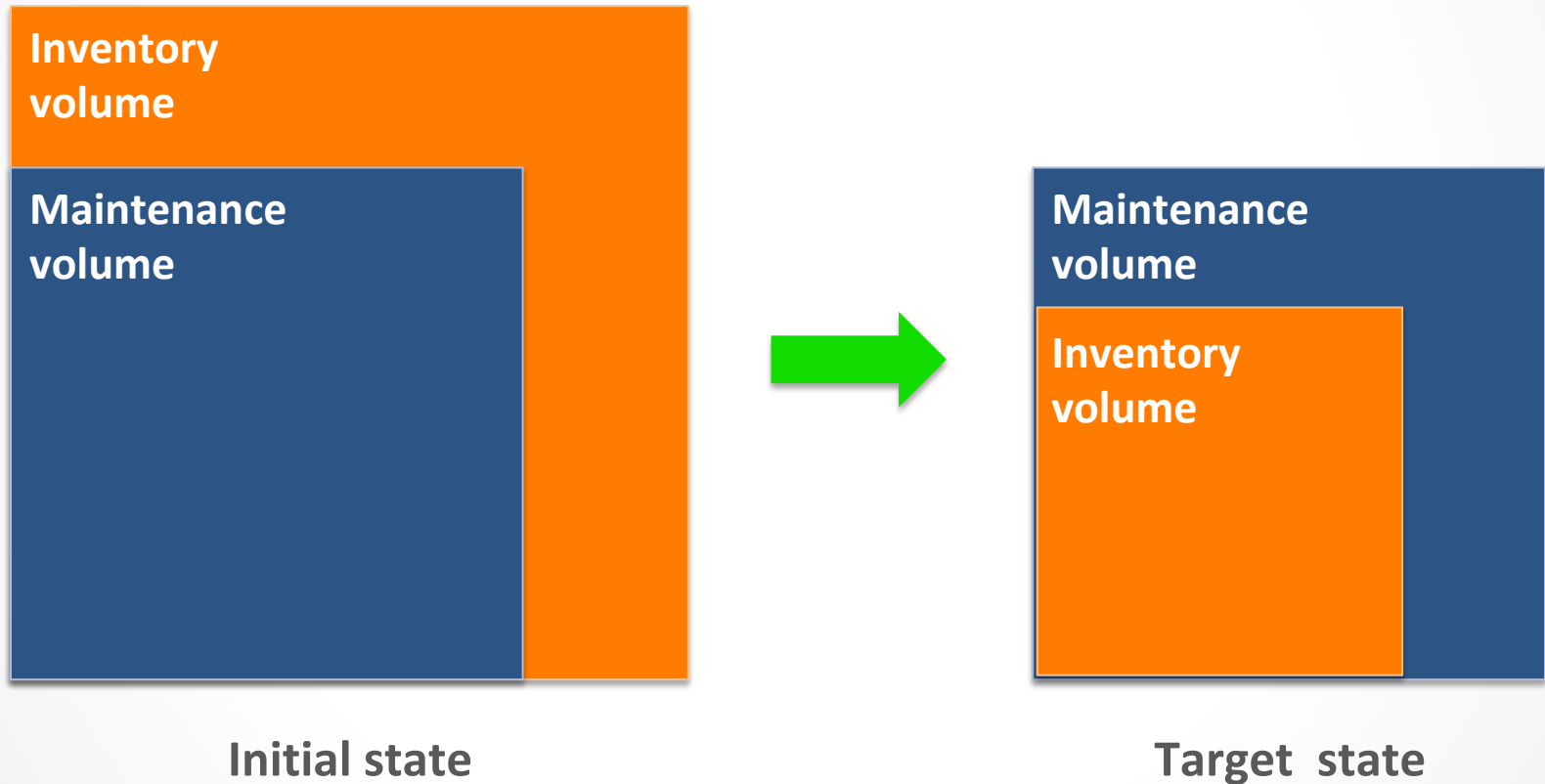
# Goals of inventory management

- Provide the highest possible level of service to end customers at the lowest total cost.
- Prevent delays and cancellations.
- Maintain a high state of readiness with trains free of maintenance issues.
- Ensure part availability to the maintenance function, optimize preventive maintenance and reduce the impact of stoppages.
- Conflicting financial and operational goals
  - Inventory fill rate (EOQ)
  - Minimum Equipment List
  - Efficient use of maintenance personnel

# Goals hierarchy in transportation systems inventory management



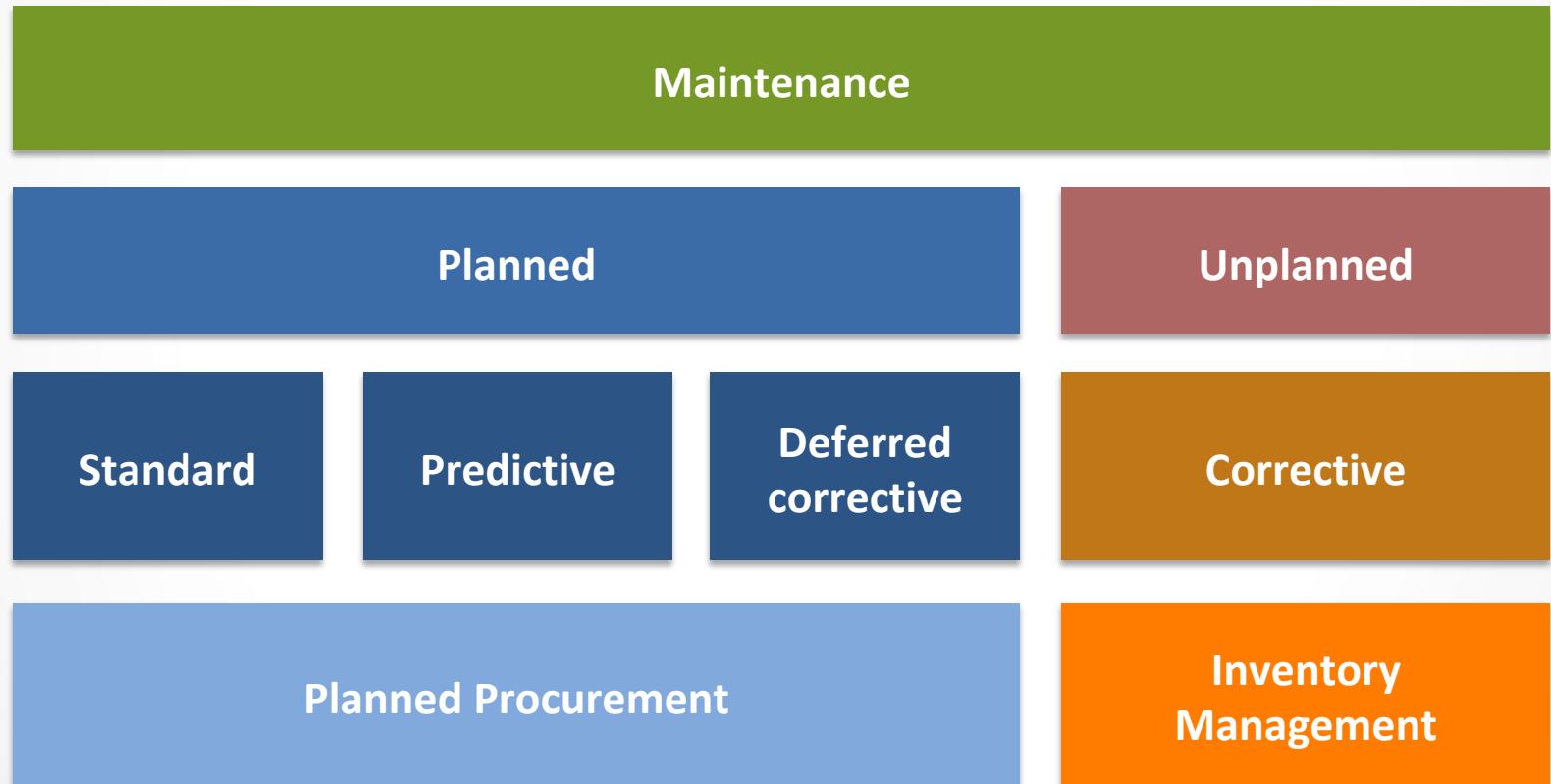
# Efficient spare parts management



# Rules for efficient SPM

- Champion preventive maintenance
- Eliminate process flaws along the Supply Chain
- Segment the spare parts portfolio
- Evaluate spare parts criticality
- Forecasting is key to spare parts management
- Use special methods for intermittent demand items and emergencies.
- Consider the whole life cycle of the equipment.
- Implement an appropriate information system for spare parts and maintenance inventory management.

# Enhance preventive maintenance



# Eliminate process flaws in the Supply Chain

## Forecast

- What will we need? When? Where?
- Typical process flaws:
  - Substantial uncontrolled spend spread across multiple sites and categories.
  - Duplicate SKUs, some being used only on certain equipment and/or location.
  - Unpredictable demand with high % of items turn less than once every two years.
  - A "just in case" mindset, buying more than is needed.
  - A large number of vendors, including many local vendors at individual sites.
  - Spot buys of unplanned purchases.
  - Data management challenges — myriad number of specs, part numbering, systems, Excel files and more.

# Eliminate process flaws in the Supply Chain

## Need identification

- Generated by planned and un-planned maintenance.
- Typical process flaws:
  - No direct responsibility of maintenance engineers/technicians for “their” items and spare parts levels.



# Eliminate process flaws in the Supply Chain

## Requisition

- Formalization of identified need, to make it visible to relevant stakeholders.
- Typical process flaws:
  - Requisition created by someone else than the technician who had identified the need.
  - Creation of the requisition may not be necessary in the process. This is the case for low value, sporadic items. Emergencies.
  - The requisition could be automated for planned maintenance based on adjusted forecast.

# Eliminate process flaws in the Supply Chain

## Requisition approval

- Requisition should reflect needs and respect budget.
- Typical process flaws:
  - How often are RFOs approved? Who approves?
  - Is RFO approved by means of IS workflow or by signing a paper copy?
  - Alternatively, are both ways needed?
  - After RFO is approved, the issued order must be approved again.
  - Too many approvers, complicated approval procedure and hierarchy of responsibilities.
  - Approving on high levels of management.

# Eliminate process flaws in the Supply Chain

## Procurement

- PO placement to an approved supplier
- Typical process flaws:
  - Insufficient information available to procurement.
  - Poor spare parts identification – the buyer hardly knows what should be bought, additional communication with maintenance technician is needed.
  - Missing or incomplete procurement specification in the IS.

# Eliminate process flaws in the Supply Chain

## Reception

- Ensure the right goods are received and compliant to specifications.
- Typical process flaws:
  - Problems with missing (undelivered) documentation for the received material (certificates, declarations).
  - Only “paper-based” archiving of spare parts documentation.
  - Problems to find documentation when needed.

# Eliminate process flaws in the Supply Chain

## Warehousing

- Store parts at the right place in the right conditions
- Typical process flaws:
  - Insufficient identification of spare parts in the warehouse.
  - Problems with finding items stored in the warehouse.
  - Inventory count discrepancies, physical stock different from information system data.
  - Non-real value of stock in the information system.
  - Existence of out-of-system stocks.

# Eliminate process flaws in the Supply Chain

## Issuance

- Issue the right quantity of the required parts at the adequate point of use
- Typical process flaws:
  - Wrong parts, wrong quantity, wrong spot
  - Slow spare part issues in case of sudden need.
  - Parts withdrawn and not accounted for in the system.

# Eliminate process flaws in the Supply Chain

## Consumption

- Parts are used to maintain the corresponding asset and put it back into operations.
- Typical process flaws:
  - Issued spare parts are not consumed in fact. What happens then?
  - Consumption of external material even when the part is on stock (Maverick buying).

# Eliminate process flaws in the Supply Chain

## Back flow

- Warehouse returns and refurbished parts.
- Typical process flaws:
  - Refurbished parts returned to warehouse while new are bought.
  - Accounting price of refurbished items is much higher (or lower) than the non-realistic value of items on stock.
  - Problematic or impossible returns of parts issued but not consumed.
  - Insufficient control of parts dismantled from the maintained asset (the information system has no information about these).



# Segment SP portfolio: Inventory classification and characteristics

- Rotable: Part that can be economically restored repeatedly to a fully serviceable condition.
- Repairable: Same as rotatable with the difference of a higher scrap rate.
- Expendable: Single use with 100% scrap rate.
- Recoverable: A repairable with a high scrap rate or an expendable that can be repaired sometimes with a process.
- Consumable: used in time with 100% scrap rate.

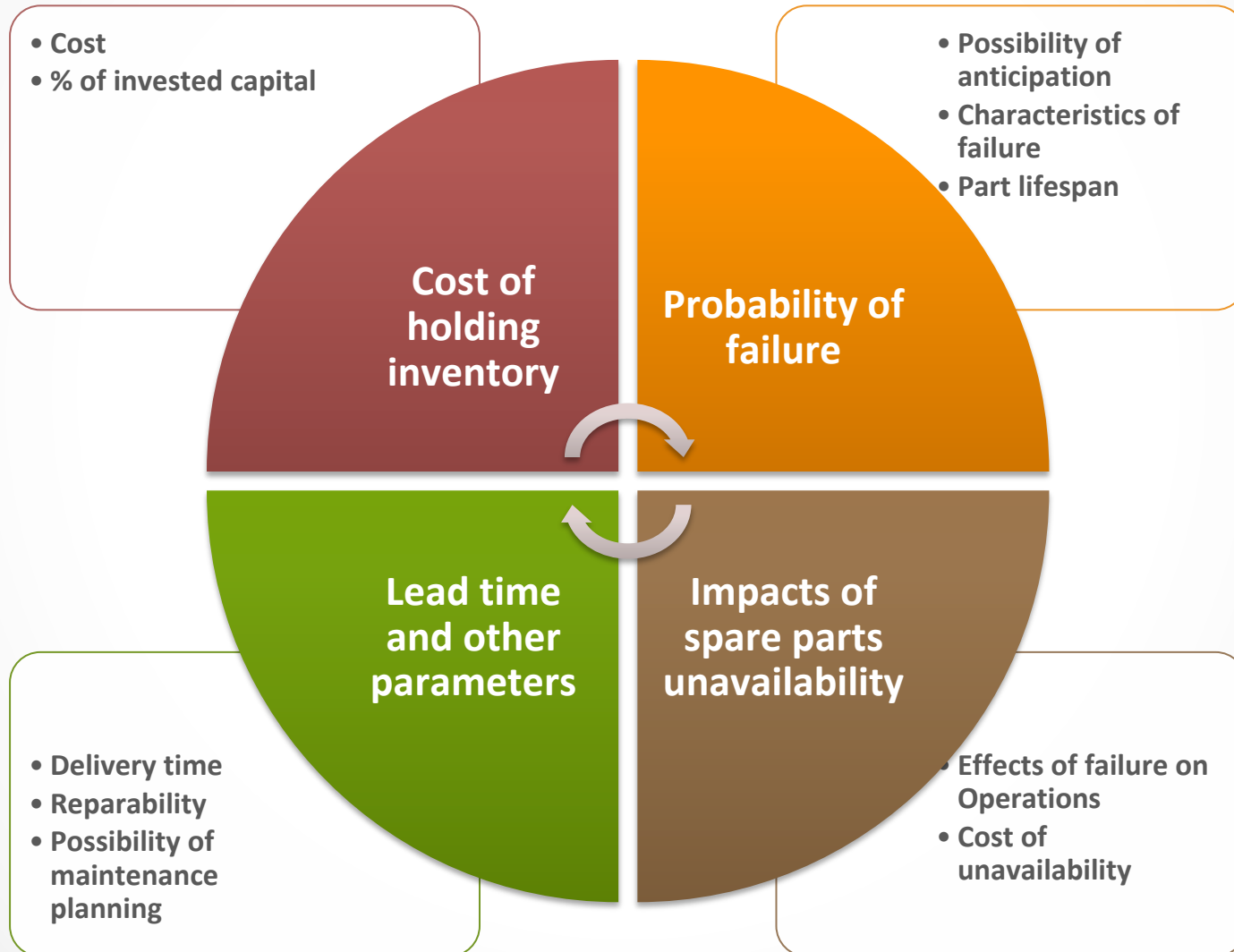
# Inventory classification and characteristics

Classification	Characteristics		
	Scrap Rate	Financial	Life-cycle
Rotable	Negligible	Asset, held on books until surplus or scrap	Indefinite
Repairable	Between 0% and 100%		Persists until scrap
Expandable	100% One-time use		Consumed at time of use
Consumable	100% several time use	Expensed at time of use	Consumed over time

# Evaluate spare parts criticality

- Criticality is a measure of risk in spare parts supply chain.
- Traditional risk assessment techniques apply.
- Risk level = likelihood of occurrence x Impact
- For spare parts:  
    Probability of failure x Cost of down time x lead time
- To be compared with Total Holding Cost
- Risk control in such case consist in applying different inventory management rules: Holding stock or not, Min-Max, with or without safety stock at an appropriate level, VMI, ...

# Evaluate spare parts criticality



# Spare parts forecasting

- Spare parts forecasting always turns out to be a subtle balance of quantitative methods and common sense.
- Sources for spares provisioning data are numerous:
  - Data from OEM's.
  - Operational data from another user with the same or similar fleet/equipment.
  - Data from an MRO partner for spares provisioning and repair/overhaul.
  - Data from industry experts or consultants.
- Age of the fleet/equipment is a key driver.

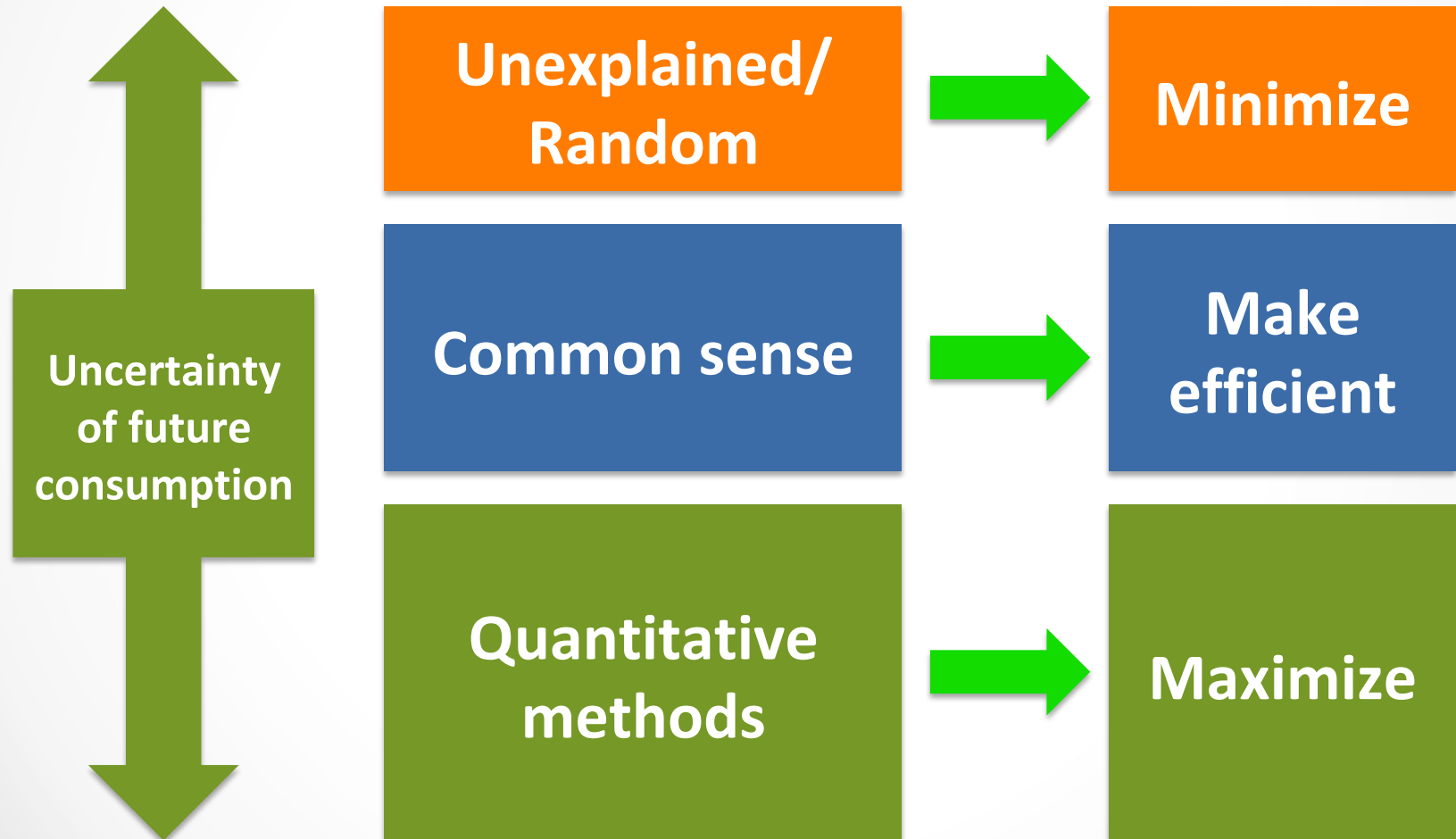
# Spare parts forecasting

**Quantitative  
methods**

**Common  
sense**



# Spare parts forecasting



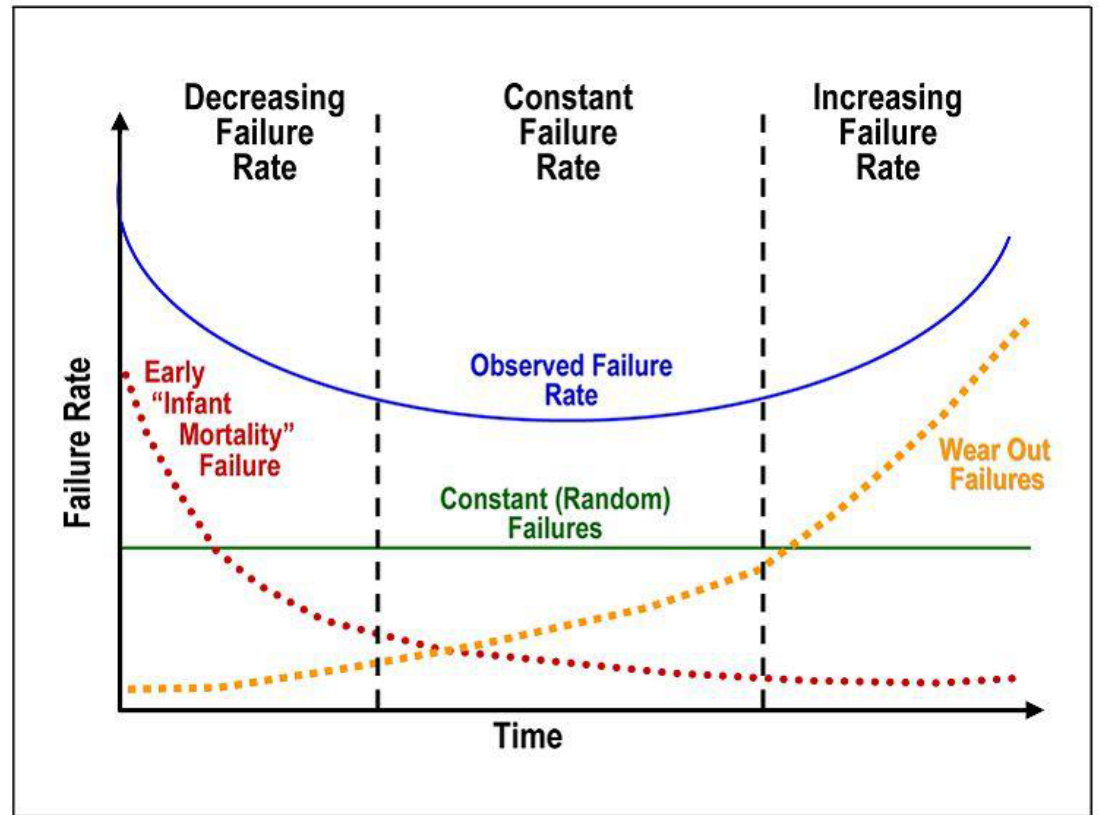
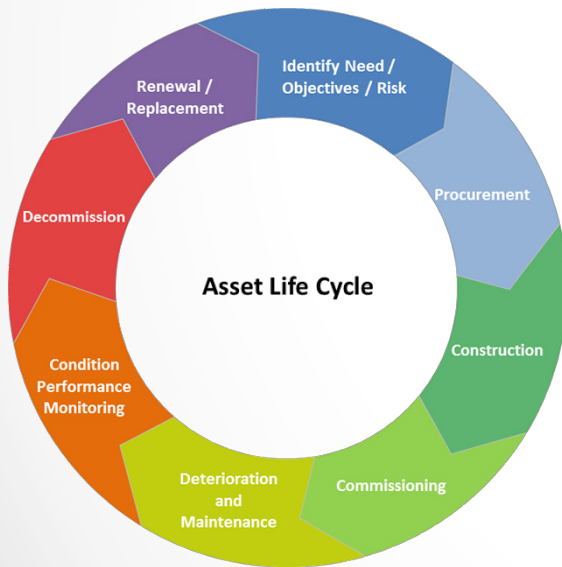
# Special methods for intermittent demand items and emergencies

- Continuously assess where intermittent demand items could be found and possibly secure relationships with pre-approved vendors.
- Make provision for emergency buying with special approval process/Threshold.
- Enforce regularization after the fact to ensure appropriate control levels.
- Ensure to maintain an up-to-date specific set of pre-approved emergency vendors.
- Consider the use of P-cards for low value standard items.



# Consider the whole life cycle of the equipment

## New vs. aging fleet



# Inventory performance metrics

- Inventory Performance Metrics are important because they will allow to gauge the performance of IMS.
- A properly designed set of metrics will allow diagnosis of inventory issues and identification or evaluation of possible areas of improvements.
- Like any system, IMS will benefit from a robust continuous improvement process.
- Metrics will serve to place an objective measurement on planning performance and part delivery processes.
- ERP implementation will provide an appropriate information system for spare parts and maintenance inventory management.

# Inventory performance metrics

- Service Levels: Delays and cancellations attributed to parts availability. Stoppage events and Elapsed time to recovery.
- Fill Rate = Number of Filled Requests for Parts/Total Parts Requests.
- Backorders
- Inventory turnover
- Inventory turns per year for each component
- Repair Turn Around Time or TAT of each component
- Scrap Rates of each component
- Replenishment Lead Times
- No Fault Found Rates

# Thank you

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Questions?

Next steps