



KS SUPPLY CHAIN FUNDAMENTALS

08 Aggregate Planning

SS 2025



PLM Institute of
Production and
Logistics Management

Learning goals

After this lecture you should be able to...

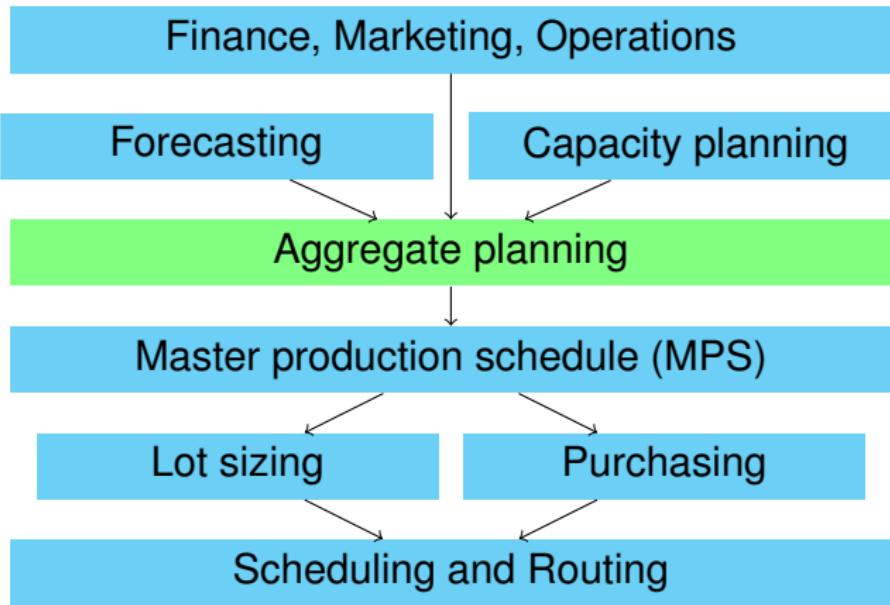
- ... explain what aggregate planning is and why it is used.
- ... use simple spreadsheet-based techniques.
- ... understand the connection of aggregate planning and further planning steps.

Literature

Stevenson, WJ: Operations Management. McGraw-Hill Education Ltd; latest edition - Chapter 11

Acknowledgements: icons are by fontawsome (latex) or by Pixelmeetup from www.flaticon.com

Planning hierarchy



The concept of aggregation

- “Big-picture approach.
- Focus on groups of similar goods and services.
- Capacity is usually calculated as operating hours/machine hours per period.
- Planning horizon: 3-18 months.
- Supply chain partners should be included to reduce the possibility of time- and material-related problems.

Example TV sets of varying sizes  (40, 46, 55 inches) → aggregate planning considers the “aggregated” product TV and does not distinguish different versions.

Different strategies

Match supply and demand!

- **Demand strategies:** Adjust demand through price adjustments and advertising (Marketing).
- **Capacity strategies:** Change capacities such that demand can be met (Operations Management).
- **Mixed strategies:** use both.

Aggregate planning

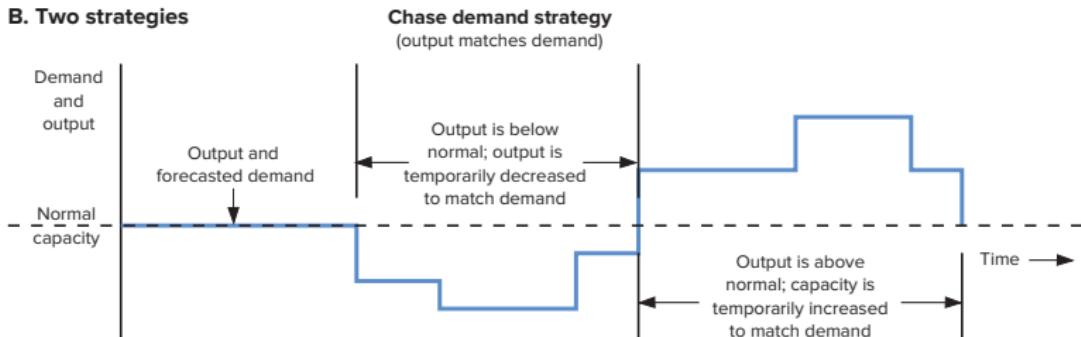
- also known as “Sales and Operations Planning”
- Goal: Minimize costs for the entire planning horizon and cover the forecasted demand.
- Required Information:
 - Production rate
 - Workforce (number of workers/divisions)
 - Overtime (planned)
 - Machine capacity level
 - Subcontracting
 - Backlog (demand carried over from the last period)
 - Inventory on hand (planned inventory at the end of the period)

Basic capacity strategies (1)

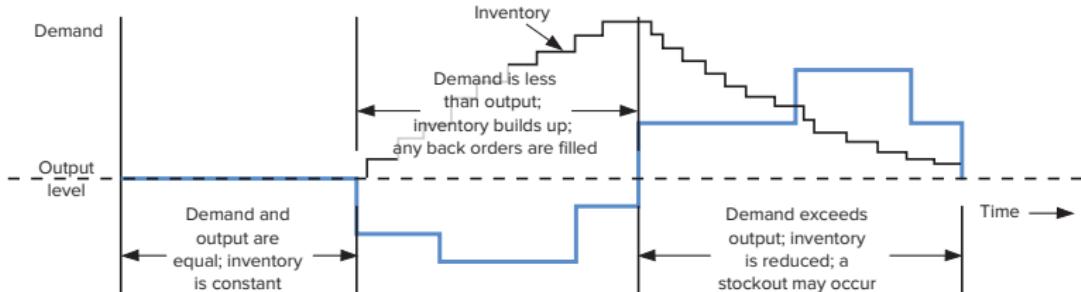
- **Level Strategy** (Emancipation): production rate/work force is kept constant
 - Advantages: stable work force and production rate
 - Disadvantages: higher inventory costs
- **Chase Strategy** (Synchronization): Capacities are adjusted to match demand requirements over the planning horizon.
 - Advantages: Investment in inventory is kept low
 - Disadvantages: Cost of adjusting output rates and workforce levels.
- Using a combination of decision variables (e.g., via LPs)

Basic capacity strategies (2)

B. Two strategies



Level output strategy



Trial-and-error techniques (spreadsheets)

- Plot demand
- Determine capacity
- Choose between level/chase or mixed strategies
- Optimization via linear programming possible (\rightarrow KS Operations and Supply Chain Management)

General approach

1. **Determine demand** for each period (e.g., forecasting)
2. **Determine capacities** (regular time, overtime, subcontracting) for each period
3. **Identify** company or departmental **policies** (e.g., safety stock)
4. **Determine** unit **costs** for regular time, overtime, subcontracting, holding inventories, back orders, layoffs, and other relevant costs.
5. **Develop alternative plans** and compute the cost of each.
6. If satisfactory plans emerge, **select** the one that **best** satisfies objectives. Otherwise, return to step 5.

Calculations: work force and inventory level

W_t Number of workers in a period

H_t Number of new workers at the start of the period (hired)

L_t Number of laid-off workers at the start of period

t Period (e.g., $t = 1$ November, $t = 2$ December, ...)

$$W_t = W_{t-1} + H_t - L_t$$

(Number of workers in period t = Number of workers in period $t - 1$ + hired workers - laid-off workers)

I_t Inventory at the end of period t (units)

P_t Production in period t

D_t Demand in period t (units)

$$I_t = I_{t-1} + P_t - D_t$$

(Inventory at the end of period t = Inventory at the end of period $(t - 1)$ + Production in period t - Demand in period t)

$$\text{Average inventory} = \frac{I_{t-1} + I_t}{2}$$

Calculations: Costs

Costs for a period = Production cost + Hire/lay-off cost + Inventory cost + Backorder cost

Production cost

| | |
|---------------|---|
| regular | unit cost (c_R) \times units produced in regular time |
| overtime | unit cost (c_O) \times units produced in overtime |
| subcontracted | unit cost (c_S) \times units produced by subcontractors |

Workforce

| | |
|-------------|--|
| Hire cost | per worker (c_H) \times new workers |
| Layoff cost | per worker (c_L) \times laid-off workers |

| | |
|-----------|---|
| Inventory | Carrying cost per unit (h) \times Average inventory |
|-----------|---|

| | |
|-----------|--|
| Backorder | Backorder cost per unit (c_B) \times Number of backordered units |
|-----------|--|

Example

A company produces several models of skateboards and it is about to prepare the aggregate plan for the next six periods. They have compiled the following information:

| Period | 1 | 2 | 3 | 4 | 5 | 6 | Sum |
|------------------------|-----|-----|-----|-----|-----|-----|------------|
| Forecast demand | 200 | 200 | 300 | 400 | 500 | 200 | 1800 |

They now want to evaluate a plan that calls for a constant rate of regular-time output, mainly using inventory to absorb the uneven demand but allowing some backlog. Overtime and subcontracting are not used.

$$c_R = 2 \text{ EUR/Skateboard} \quad c_O = 3 \text{ EUR/Skateboard}$$

$$c_S = 6 \text{ EUR/Skateboard} \quad h = 1 \text{ EUR/Skateboard}$$

$$c_B = 5 \text{ EUR/Skateboard}$$

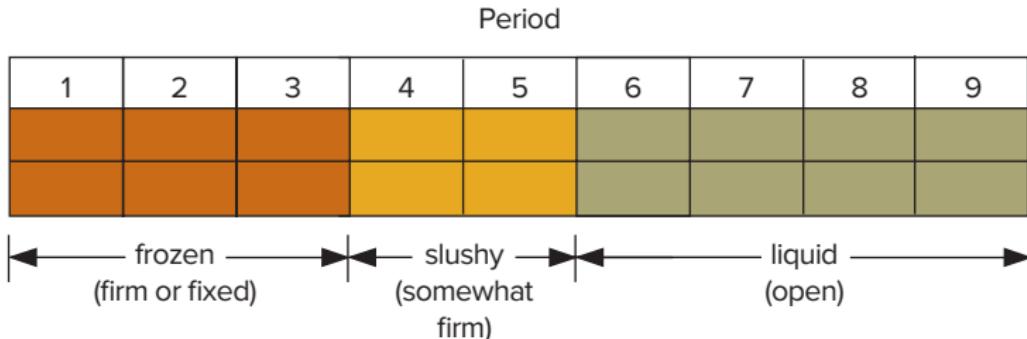
Constant (level) output rate: 300 skateboards per period ($1800/6 = 300$).

Beginning and ending inventory should be zero. There are 15 workers available who can produce 20 skateboards per period each.

Alternative: only 14 workers (280 skateboards per period), with the possibility of overtime.

Master Scheduling

1. Disaggregation of the “aggregated” product
2. Break-down of the aggregated plan into short-term production quantities as well as time-based requirements.
3. Rough-cut capacity planning to check for the feasibility of the master schedule.
4. Time fences divide a scheduling time horizon into three phases.
5. Already includes lot sizing.



Summary

- Aggregate planning focuses on the medium-term planning of the production, where choices on capacities (e.g., workforce) are being made.
- Aggregate means that planning is not done for single days or products, but rather for, e.g., product groups per month. Aggregation may be done based on time (e.g., months), objects (product groups), or location (groups of regions/countries).
- Different strategies can be chosen (chase, level, mixed).
- Planning can be done using “Trial-and-Error” or linear programming.
- Aggregate planning is the basis for master scheduling.