



Capacity Planning and Analysis

MIB2307 Operations Management

Dr. Nalin Simasathiansophon

Learning Objectives

By the end of this lesson, students will be able to:

1

Define Capacity Types

Distinguish between design, effective, and actual capacity with real-world examples.

2

Calculate Key Metrics

Apply standard formulas to compute capacity utilization and efficiency rates.

3

Identify Bottlenecks

Analyze process flows to locate constraints that limit overall system throughput.

4

Compare Capacity Strategies

Evaluate lead, lag, and average strategies across different business contexts.

5

Sustainability Lens

Assess capacity decisions through environmental responsibility and ethical frameworks.

What is Capacity?

Core Definition

Capacity is the maximum output rate or service capacity that an operation, process, or facility can achieve per unit of time. Strategic capacity management enables firms to make vital decisions about **maximizing attainable output** within any given period. (Heizer et al., 2024)

Why It Matters

Capacity sets the ceiling on revenue potential. Too little capacity means lost sales; too much means wasted resources. Getting it right is central to competitive operations strategy.

Three Types of Capacity

1

Design Capacity

Maximum output under **ideal conditions** – the theoretical upper limit.

 Hotel: 500 rooms available

2

Effective Capacity


Expected output given **realistic constraints** – maintenance, scheduling, quality standards.

 Hotel: 450 rooms bookable

3

Actual Output

Real output achieved – always \leq **effective capacity** due to breakdowns, absenteeism, etc.

 Hotel: 380 rooms occupied

Measuring Capacity



Capacity Utilization

Formula:

$$\text{Utilization} = (\text{Actual Output} \div \text{Design Capacity}) \times 100\%$$

Example: Factory design capacity = 200 units/day. Actual output = 160 units/day.

$$\rightarrow \text{Utilization} = 160 \div 200 \times 100\% = \mathbf{80\%}$$

-   Higher utilization = better asset use, but running at 100% leaves **no buffer** for maintenance or unexpected demand surges.



Capacity Efficiency

Formula:

$$\text{Efficiency} = (\text{Actual Output} \div \text{Effective Capacity}) \times 100\%$$

Example: Effective capacity = 180 units/day. Actual output = 162 units/day.

$$\rightarrow \text{Efficiency} = 162 \div 180 \times 100\% = \mathbf{90\%}$$



-   Efficiency measures performance against **realistic expectations** — a more actionable operational benchmark than utilization alone.

Capacity Strategies

Organizations must choose **when** to add capacity relative to demand. Each strategy carries distinct risk and reward trade-offs suited to different industries and growth contexts.

01 — Lead Strategy



Add capacity **before** demand arrives to stay ahead of the market.

-  Never miss demand; first-mover advantage
-  Risk of excess capacity and higher costs

Best for: High-growth markets, technology, hospitality expansion

02 — Lag Strategy



Add capacity **only after** demand is proven and sustained.

-  Lower financial risk; lean, disciplined investment
-  May lose customers due to shortages

Best for: Stable industries, capital-intensive operations

03 — Average (Match) Strategy

Build in **small increments** that closely track demand trends.

-  Balanced risk exposure; moderate capital outlay
-  Requires accurate, ongoing demand forecasting

Best for: Moderate growth, mature markets

Bottleneck Analysis

What Is a Bottleneck?

A **bottleneck** is the operation or resource in a process with the **lowest capacity**, which limits the throughput of the entire system. No matter how efficient other stations are, the bottleneck determines total output.

System Output = Output of the Bottleneck Operation

Goldratt's **Theory of Constraints (TOC)** prescribes a disciplined cycle:

1. Identify the bottleneck
2. Exploit it—maximize its output
3. Elevate it—add resources if needed
4. Repeat for the next constraint

Process Flow Example (units/hour)

Station	Capacity	Status
Station A	120 u/hr	Available
Station B	80 u/hr ⚠	BOTTLENECK
Station C	100 u/hr	Available
Station D	95 u/hr	Available

System output is limited to 80 units/hour. How to address it:

- Add resources to Station B
- Reduce downtime (a machine is out of action) at the bottleneck
- Offload work to non-bottleneck stations
- Redesign the overall process flow

The Capacity Planning Process

Effective capacity planning is not a one-time event — it is a **continuous, iterative cycle** of forecasting, measuring, analyzing, and adapting as business conditions evolve.



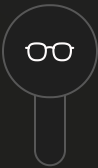
Step 1—Forecast Demand

Analyze historical data and market trends to project future demand levels with accuracy.



Step 2—Measure Current Capacity

Assess design, effective, and actual capacity across all key resources and processes.



Step 3—Identify Gaps

Compare projected demand with current capacity to quantify surplus or deficit clearly.





Step 4—Evaluate Alternatives

Consider options: expand capacity, subcontract, improve process efficiency, or manage demand.



Step 5—Select & Implement

Choose the strategy best aligned with financial constraints and long-term strategic goals.

  Capacity plans must be **regularly reviewed**—market conditions, technology, and competitive landscapes shift constantly.

Expanding & Adjusting Capacity

Organizations have a wide toolkit of options for responding to capacity gaps. The time horizon determines which levers are available and appropriate.

⚡ Short-Term Options

- Overtime & extra shifts
- Hire temporary / part-time staff
- Subcontracting / outsourcing
- Cross-train existing employees
- Reduce product variety (focus)

📅 Medium-Term Options

- Hire and train new permanent staff
- Add equipment & machinery
- Lease additional facilities
- Redesign process for efficiency
- Implement scheduling optimization

🏗️ Long-Term Options

- Build or expand facilities
- Acquire competitor's capacity
- Enter new strategic partnerships
- Invest in automation & technology
- Develop new geographic locations



Sustainable Capacity Planning

CLO 4 – ETHICS & ENVIRONMENTAL RESPONSIBILITY

Capacity decisions are never purely operational. Every expansion has environmental, social, and community consequences that responsible managers must proactively assess and mitigate.



Environmental Impact

Capacity expansions must account for **carbon emissions, energy consumption, water usage, and land use**. Conduct environmental impact assessments before scaling operations – regulatory and reputational risks are significant.



Worker Welfare

Increasing output must never exploit workers. Ensure **fair wages, safe working conditions, and reasonable hours** – especially critical in global supply chains where oversight may be limited.



Circular Economy

Design capacity for **reuse, remanufacturing, and recycling**. Avoid building overcapacity that drives resource waste, product obsolescence, and unnecessary landfill contributions.



Community Impact

New facilities affect local communities through **traffic, noise, employment, and land values**. Meaningful stakeholder engagement in capacity planning builds trust and reduces social opposition.

Case Study: SiamAuto Co., Ltd.

Scenario

SiamAuto produces **1,200 engine components/day** (Design cap: 1,600/day; Effective cap: 1,400/day). A major Japanese OEM client now requires **1,500 units/day** starting next quarter. Adding a third shift would require hiring 45 workers but raises concerns about **increased night-time energy consumption** and worker wellbeing.

Current Performance Analysis

Metric	Calculation	Result
Current Utilization	$1,200 \div 1,600 \times 100\%$	75%
Current Efficiency	$1,200 \div 1,400 \times 100\%$	85.7%
Required Output	Client target	1,500 u/day
Capacity Gap	$1,500 - 1,400$	100 u/day shortfall

Discussion Questions

1

Capacity Strategy Choice

Which capacity strategy – **Lead, Lag, or Average** – would you recommend for SiamAuto? Justify your choice with reference to the data provided.

2

Ethical Implications

What are the **ethical implications** of adding a third shift regarding worker wellbeing, fatigue risk, and increased energy consumption?

3

Alternative Options

Beyond adding shifts, what **other capacity options** – process redesign, automation, subcontracting – should management explore to close the 100-unit gap?

Key Takeaways

→ Capacity Defined

Capacity = maximum output rate; measured through **utilization** (vs. design) and **efficiency** (vs. effective capacity).

→ Three-Tier Hierarchy

Always remember: **Design** ≥ **Effective** ≥ **Actual Output** — each level introduces real-world constraints.

→ Strategy Trade-offs

Lead, Lag, and Average strategies offer different risk-reward profiles suited to specific growth stages and industries.

→ Bottleneck Principle

System throughput equals bottleneck throughput. Use **Goldratt's TOC** — identify, exploit, elevate, repeat — to systematically improve.

→ Sustainability Integration

Ethical capacity planning integrates **environmental impact, worker welfare, circular economy thinking**, and community responsibility.

References

Heizer, J., Render, B., & Munson, C. (2024). *Operations management: Sustainability and supply chain management* (14th ed.). Pearson Education.

Stevenson, W. J. (2021). *Operations management* (14th ed.). McGraw-Hill Education.

Krajewski, L. J., Malhotra, M. K., & Ritzman, L. P. (2022). *Operations management: Processes and supply chains* (13th ed.). Pearson Education.

Slack, N., Brandon-Jones, A., & Burgess, N. (2022). *Operations management* (10th ed.). Pearson Education.

Goldratt, E. M., & Cox, J. (2014). *The goal: A process of ongoing improvement* (30th anniversary ed.). North River Press.