Part 3 — Templates and Core Relationships

1. Merit Function Template

Purpose

The merit function helps compare multiple process designs (e.g., As-Is vs To-Be) on a single numeric scale that blends time, cost, quality, and automation.

Formula

$$M = \sum_{i=1}^{n} (w_i \times N_i)$$

Where:

- w_i = Weight for criterion i (the importance you assign).
- N_i = Normalized score for that criterion (0 = best, 1 = worst).

Steps

1. **Select criteria:** Pick 3–6 measurable factors.
   - Cost / transaction
   - Average service (lead) time
   - Throughput (orders/hour)
   - Error rate / remakes
   - Automation / digitization level
2. **Normalize values:** Convert everything to a 0–1 scale.
   - For “Lower is Better”:
     $N = \frac{Value - Best}{Worst - Best}$

- For “Higher is Better”:
  N=Best−ValueBest−WorstN = \frac{Best - Value}{Best - Worst}N=Best−WorstBest−Value

3. **Assign weights (sum = 1):**

Criterion	Weight
Cost	0.35
Lead Time	0.25
Throughput	0.20
Errors	0.15
Automation	0.05

4.

5. **Compute Merit:**
   Multiply each normalized score by its weight and add them up.
   The smaller the final value M, the better the design.

Example Interpretation

- **As-Is** M = 0.66
- **To-Be** M = 0.31
  ✅ Conclusion: The To-Be process clearly dominates; it provides higher throughput and lower cost for almost the same investment.

Sentence You Can Copy in Exam

> “A weighted merit function combining cost, lead time, throughput, and error rates was developed. The To-Be process produced a merit score nearly half that of the current system, confirming measurable improvement across all key criteria.”

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2. Timestamp Measurement Table (Process Time Study)

Step	Queued At	Start At	Finish At	Wait Time	Service Time	Cumulative Lead Time
Order Placed	0:00	0:00	0:25	0	25 s	25 s
Payment	0:25	0:25	0:40	0	15 s	40 s
Barista Start	0:40	0:55	1:45	15 s	50 s	1 m 45 s
Pickup	1:45	1:45	1:50	0	5 s	1 m 50 s

How to Read It

- **Wait Time** = Start At − Queued At
- **Service Time** = Finish At − Start At
- **Lead Time** = Final Finish − First Queued
- The step with the **largest average Service Time** or the **longest Queue** is your **Bottleneck**.

Use in Exam

> “Timestamps were recorded at every transition. Average customer lead time reduced from 12 minutes As-Is to 7 minutes To-Be after removing redundant cashier entry and parallelizing drink preparation.”

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3. Efficiency, Productivity, and Bottleneck Relationships

Concept	Definition	In Simple Words	Example
Efficiency	Output per unit of input at a single step.	How little waste a worker or machine produces.	Reducing cashier keystrokes → Faster order entry.
Productivity	Total output per unit of total input for the whole system.	How many completed products or services you deliver overall.	Serving 170 orders/hr instead of 120 → Higher productivity.

Bottleneck	The step with the lowest effective capacity, limiting overall throughput.	The slowest part of the chain that decides how fast everything else can go.	Barista = bottleneck → limit = 1 drink/min per barista.

Key Point: Improving a non-bottleneck step does *nothing* if the bottleneck remains unchanged.

> Example: Making payment faster helps only if the barista can keep up; otherwise, orders just pile up earlier.

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4. Little's Law and Takt Time

A. Little's Law

Work in Process (WIP)=Throughput×Lead Time\text{Work in Process (WIP)} = \text{Throughput} \times \text{Lead Time}Work in Process (WIP)=Throughput×Lead Time

- **Meaning:** The number of units in the system equals how many you complete per hour times how long each stays in the system.
- **Why Useful:** If your lead time increases but throughput stays constant, your system is getting "clogged."

Example:
If Starbucks completes 120 orders/hr (2 orders/min) and average lead time = 6 min:

WIP=2×6=12ordersWIP = 2 \times 6 = 12 ordersWIP=2×6=12orders

So on average, 12 customers are "inside" the system (ordering, waiting, or picking up).

B. Takt Time

Takt Time=Available Production Time (per shift)Customer Demand (per shift)\text{Takt Time} = \frac{\text{Available Production Time (per shift)}}{\text{Customer Demand (per shift)}}Takt Time=Customer Demand (per shift)Available Production Time (per shift)

- It represents the **pace** you must maintain to meet demand without backlogs.

- If your process takes *longer* than takt time, customers queue; if it's *shorter*, resources sit idle.

Example:

- Available barista time = 3600 s/hour.
- Demand = 150 orders/hour.

Takt Time=3600150=24sperorder.\text{Takt Time} = \frac{3600}{150} = 24 s per order.Takt Time=1503600=24sperorder.

If each drink currently takes 40 s, you're behind demand and need more capacity or simplification.

Exam Sentence:

> "Little's Law shows that higher throughput shortens lead time by reducing the number of orders in process. Calculated takt time was 24 s per order, confirming that the As-Is barista step (≈ 40 s) is the bottleneck."

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5. Change-Management Paragraph (always end with this)

> "Successful process redesign is not only technical but also cultural. Employees must understand why the change is beneficial. Training, transparent communication, and phased roll-outs reduce resistance. Cashiers, for example, can be redeployed to customer service or loyalty engagement rather than removed. This ensures morale, consistency, and long-term adoption of the new process."