

# MENGM0056 - Product and Production Systems

## Scenario 3: FMCG - Bottled Beverage (500 ml)

Hand-out for Group Coursework (2025/26)

**UUID seed:** 36ddb4a1-ecd1-44c6-81e5-d113e4a01c35    **Checksum:** 574ce682f82a

### Purpose

This scenario considers a high-throughput beverage line with volatile demand and despatch congestion. Your task is to propose operational policies that stabilise service level and improve utilisation while controlling changeover losses and inventory.

### Narrative

A 500 ml carbonated soft drink is produced in PET bottles. The line comprises blow-moulding, filling, labelling, case-packing and palletising, with despatch to outbound trucks via limited loading bays. Demand varies with weather and promotions. CIP and changeovers consume valuable capacity. Capital spend is constrained; improvements should focus on scheduling, policies, and parameter changes.

### Entities and flow (fixed structure)

Preforms → Blow-mould → Fill → Cap → Label → Case-pack → Palletise → Despatch.

### Baseline parameters (seeded)

#### Global

Shifts per day	2
Shift length	7.5 h
Base daily demand	2129 cases/day (12 bottles/case)
Daily demand CV	0.123
Number of SKUs	6
On-time despatch target	95%

### Line capacities and availability

Resource	Count	Nominal rate	Availability
Blow-moulder	1	23196 bph	0.914
Filler	1	23651 bph	0.867
Labeller	1	25025 bph	0.928
Case-packer	1	1890 cph	0.937

Palletiser	1	1545 cph	0.91
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## Changeovers and CIP

CIP duration (flavour)	49 min
Additional flavour change operations	17 min
Label-only change duration	15 min
Minimum batch size	715 cases

## Despatch and yard logistics

Loading bays	1
Despatch window	7:00 – 19:00
Mean truck inter-arrival	60 min
Truck service time	57 min
Cases per pallet	84
Pallets per truck	26

## Reliability (downtime parameters)

Resource	MTBF (min)	MTTR (min)
BlowMoulder	534.4	14.6
Filler	419.9	23.0
Labeller	490.7	12.9
Packer	821.2	11.7
Palletiser	937.2	17.7

## Costs

Holding cost	£2.42 /pallet/day
Changeover cost (all-in)	£239.29 /event
Lateness penalty	£300.1 /late truck
Scrap cost (changeover/CIP)	£1.55 /case

## Required KPIs

- Line utilisation by unit (blow-moulder, filler, labeller, packer, palletiser).
- Changeover time and product loss per week; percentage of capacity lost to changeovers/CIP.
- Order lead time distribution and on-time despatch rate (service level).
- Loading-bay utilisation and maximum truck queue length; truck lateness count.
- Finished-goods days-of-cover and average pallets in buffer.

## Techniques to apply

- **Modelling & KPIs:** capacity model, bottleneck identification, changeover loss accounting.
- **Mathematical programming:** shift patterns, SKU sequencing and batch sizing subject to CIP and bay constraints.
- **Uncertainty modelling:** daily demand and truck arrivals; downtime distributions.

- **Simulation:** discrete-event model of the line and despatch yard; evaluate congestion and schedules.
- **Metaheuristic optimisation:** lot-sizing and sequence optimisation with changeover penalties and service-level targets.

## Improvement levers (examples)

- SKU sequencing to group labels and reduce full CIP events; threshold policies for label-only changes.
- Time-of-day despatch smoothing: reserve windows for large orders; dynamic bay assignment.
- Buffer targets before palletiser and before despatch to prevent starvation/blocking.
- Preventive maintenance windows aligned with expected demand troughs.

## Deliverables

1. A report (max 20 sides of A4 including figures and references; appendices unmarked but admissible as evidence).
2. The report should contain a production and despatch plan for one representative week, showing SKU sequence, batch sizes, and expected service level.
3. Model files (e.g., simulation, optimisation) as appendices/evidence.

## Assessment emphasis

Clarity and correctness of the capacity and KPI model; appropriate choice and justification of techniques; quality of experimental design; robustness to demand variability; and persuasiveness of recommendations under operational constraints.

## Data ethics and reproducibility

Report your UUID seed and any random seeds used within tools. Provide enough detail for independent regeneration of your parameter tables.