MENGM0056 - Product and Production Systems
Scenario 3: FMCG - Bottled Beverage (500 ml)

Hand-out for Group Coursework (2025/26)

UUID seed: 7198090e-2a3a-44d2-aa88-8fa81074ce55 **Checksum:** b1af0efdbf10

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	2259 cases/day (12 bottles/case)
Daily demand CV	0.234
Number of SKUs	5
On-time despatch target	95%

Line capacities and availability

Resource	Count	Nominal rate	Availability
Blow-moulder	1	23425 bph	0.828
Filler	1	21465 bph	0.858
Labeller	1	24088 bph	0.868
Case-packer	1	1744 cph	0.924

Palletiser	1	1596 cph	0.943

Changeovers and CIP

CIP duration (flavour)	35 min
Additional flavour change operations	24 min
Label-only change duration	9 min
Minimum batch size	556 cases

Despatch and yard logistics

Loading bays	1
Despatch window	7:00 – 18:00
Mean truck inter-arrival	58 min
Truck service time	60 min
Cases per pallet	84
Pallets per truck	25

Reliability (downtime parameters)

Resource	MTBF (min)	MTTR (min)
BlowMoulder	694.0	26.9
Filler	461.8	19.0
Labeller	576.6	9.2
Packer	487.1	10.2
Palletiser	790.9	17.5

Costs

Holding cost	£1.47 /pallet/day
Changeover cost (all-in)	£252.2 /event
Lateness penalty	£354.49 /late truck
Scrap cost (changeover/CIP)	£1.25 /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. 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.