EGT2
ENGINEERING TRIPOS PART IIA

Module 3E10
OPERATIONS MANAGEMENT FOR ENGINEERS

CRIB

QUESTION 1:

(a) Order Qualifiers are the minimum requirements CollabSpace must meet for customers to consider using the service:

- **Convenience of location**: The workspace is in a business district with no other coworking spaces nearby.
- **Amenities**: High-speed internet, coffee, printing, and meeting rooms are essential to attract professionals.
- **Affordability and flexibility**: Offers day passes, monthly memberships, and private office bookings to suit diverse customer needs.
- **Welcoming environment**: A modern, professional interior with spaces for focused work, collaboration, and networking.
- **Community and networking opportunities**: Events like guest speaker sessions, workshops, and networking are unique offerings that foster a sense of community, making CollabSpace more attractive than traditional offices or other coworking spaces.

Order Winner is what makes CollabSpace stand out and convinces customers to choose it over alternatives:

- The order winner is **Location** being the only facility of its kind in the vicinity.

(b) Structural Decisions:

1. **Capacity**: Seating for up to 30 members with workstations having a one-hour average turnover time.
2. **Location**: Strategically placed in a business district with limited coworking options nearby.
3. **Facility Design**: Modern interior with separate zones for quiet work, collaboration and meetings.
4. **Technology**: Use of high-speed internet and IT support for smooth operations.

Infrastructural Decisions:

1. **Workforce and Organisation**: A small team with specific roles (receptionists, coordinators, IT technicians), but multi-skilled to add flexibility. Limited hierarchy.
2. **Policies and procedures:** Staff trained in health and safety, operations and customer service.
3. **Quality management** – not mentioned, could be a concern

Alignment with Strategy: The structural and infrastructural decisions align well to support the strategy of creating a convenient, welcoming and professional coworking space. However, there is room for improvement in scaling capacity and managing workload during peak times, especially Fridays and Saturdays.

(c) Capacity Utilization

Assumptions:

- Peak demand = 30 members/hour (maximum capacity).
- Staff roles remain fixed during a peak hour.

Employee Utilisation:

	Check-in at Reception	**Receive Workstation and Clean**	**Maintain Amenities**
Role	**Receptionists**	**Co-ordinators**	**Technicians**
Task time	3	4	6
Peak demand	30	30	30
Worker capacity - customers per hour	20	15	10
Number of workers	2	3	3
CollabSpace capacity - customers per hour	40	45	30
Capacity utilisation	75%	67%	100%

Bottleneck

Bottleneck: The bottleneck is with the IT technicians, as their utilisation is the highest at 100%. This is over the manager's threshold of 80%.

Recommendations for addressing utilisation

- **Balance the Line:** Utilise the cross-training of staff to allow facility coordinators and receptionists to assist with minor technical issues during peak hours. This can help distribute the workload more evenly and prevent bottlenecks.

	Check-in at Reception	**Receive Workstation and Clean**	**Maintain Amenities**
Role	**CollabSpace Multi-taskers**		
Task time	13		
Peak demand	30		
Worker capacity - customers per hour	4.6		
Number of workers	8		
CollabSpace capacity - customers per hour	36.9		
Capacity utilisation	81%		

- **Flexible Scheduling:** Adjust staff schedules to ensure that more employees are available during peak hours, especially on Fridays and Saturdays when demand is highest.
- **Streamline Technical Support:** Implement a ticketing system to prioritise and manage technical issues more efficiently.
- Or **Increase Staffing:** Hire an additional IT technician to reduce the workload and prevent burnout.
- **Other sensible suggestions**

(d) Technology for Efficiency and Effectiveness

1. **Self-Check-In System**: Kiosks or mobile apps for member check-in and workstation assignments.
2. **Booking and Payment Platform**: Online system for day pass purchases, meeting room reservations, and membership management.
3. **Automated Scheduling**: Use workforce management software to optimise staff shifts and assignments.
4. **Smart Workstations**: Equip desks with sensors to monitor occupancy and enable real-time space allocation.
5. **Virtual Community Platform**: Host events, workshops, and networking opportunities online to extend CollabSpace's reach.
6. **IT Support Automation**: Implement chatbot systems or AI-driven help desks for resolving basic technical issues.

QUESTION 2:

(a)

Component Model	**1**	**2**	**3**	**Total**
Annual demand in units (D)	1500	1800	2100	5400
Setup costs (S)	5000	10000	16000	31000
Holding costs per unit (H)	500	500	500	1500
	173.2	268.3	366.6	808.1
Economic Order Quantity (EOQ)	**173**	**268**	**367**	**808**
Annual setup cost	43,353	67,164	91,553	202,070
Annual holding cost	43,250	67,000	91,750	202,000
Annual inventory cost	**86,603**	**134,164**	**183,303**	**404,070**

(b) Assumptions the EOQ Model applied to the InnoChip case:

1. Constant Demand

Assumption: The EOQ model assumes that demand is steady and predictable.

Context at InnoChip:

- Demand for microchips is fairly stable (125, 150, and 175 units per month for models 1, 2, and 3, respectively). This assumption is reasonably valid for InnoChip since the demand figures are relatively consistent.
- However, unexpected fluctuations in demand could occur due to changes in orders from the computer manufacturer, challenging the assumption.

2. Constant Lead Time

Assumption: The time between placing and receiving an order is fixed.

Context at InnoChip:

- Lead times for parts may vary as they are sourced from multiple vendors.

3. No Stockouts

Assumption: The EOQ model assumes stockouts (inventory shortages) do not occur.

Context at InnoChip:

- To ensure no stockouts, InnoChip keeps buffer inventory between each process step. This aligns with the assumption, as there is a focus on maintaining continuous production.

- However, reliance on multiple vendors delivering at random times could result in material shortages, contradicting the assumption.

4a. Fixed Setup Costs

Assumption: Setup costs per production run are constant and do not change with volume or other factors.

Context at InnoChip:

- InnoChip's setup costs for models 1 (£5,000), 2 (£10,000), and 3 (£16,000) are provided and appear consistent for each model. This aligns with the assumption.
- However, these costs could vary over time due to operational adjustments, such as changes in labour or material costs, which may challenge the assumption of fixed setup costs.

4b. Fixed Holding Costs

Assumption: The holding cost per unit is constant over time and does not vary with inventory levels.

Context at InnoChip:

- The holding cost of £500 per unit per year applies consistently across all models, supporting the assumption.
- However, holding costs might increase if InnoChip uses high-rise shelving, as the operations manager is considering, or if additional inventory handling expenses arise.

5. Single Product Focus

Assumption: EOQ calculations are done for one product at a time, assuming no interaction between products.

Context at InnoChip:

- InnoChip produces three different models, but each has its own EOQ calculation. This assumption holds true as long as the models are treated independently.
- However, shared resources (e.g., labor, machines) among models could cause interactions, complicating the application of the EOQ model.

6. Instantaneous Replenishment

Assumption: Inventory is replenished instantaneously as soon as an order is placed or production begins.

Context at InnoChip:

- InnoChip's production process involves multiple stages (preparation, assembly, inspection, baking, packaging), making it impossible to replenish inventory instantaneously.
- This assumption is invalid in this case, as production and setup time will introduce delays in replenishment.

The EOQ model provides a useful approximation for managing inventory at InnoChip, but real-world complexities like production delays, supply chain variability and shared resources require more nuanced consideration.

(c)

1. **Installing an MRP System**:

   Contradicts Lean: Although MRP systems can help reduce overproduction and inventory by aligning production with end demand, more associated with a Push-production system

   Reason: The monthly demand is stable enough to be considered repetitive, which means that a 'lean' pull system is more appropriate

2. **Adding Inspectors:**

   Contradicts Lean: Focus on inspection adds cost and resources instead of addressing root causes of quality issues.

   Reason: Lean emphasises "building quality in" rather than inspecting defects later.

3. **Setting Up a Rework Line**:

   Contradicts Lean: Rework is a form of waste. Effort should be directed toward preventing defects initially – Jidoka.

   Reason: Lean focuses on error-proofing (poka-yoke) and eliminating defects.

4. **High-Rise Shelving for Inventory**:

   Contradicts Lean: Encourages excess inventory, which goes against the lean goal of minimising waste. Better to consider introducing Kanban.

   Reason: Lean underpinned by just-in-time (JIT) systems to reduce inventory levels.

5. **Keeping Two Days of Inventory**:

   Contradicts Lean: Excess inventory ties up capital and creates waste.

   Reason: Lean emphasizes flow and production based on actual demand.

(d) Importance:

Eliminating waste improves efficiency, reduces costs and enhances product quality. Waste detracts from value creation and ties up resources that could be better utilised. Waste hides problems.

Sources of Waste in InnoChip (any three)

InnoChip exhibits several types of waste, commonly referred to as the **"7 Wastes of Lean"**. Below are the specific wastes identified in InnoChip's operations:

1. Overproduction

InnoChip builds up inventory at the start of the month to ensure buffer stock is available. This leads to excess production that may not align with actual demand. This ties up capital, increases holding costs and risks obsolescence of microchips.

2. Inventory

Inventory is held in carts between process steps, with inventory turns occurring only twice per year. High inventory levels lead to increased storage costs, holding costs and potential waste from outdated or defective parts.

3. Defects

Scrap rates are about 10% per production run, indicating significant defects during manufacturing. Reworking or discarding defective units wastes materials, labour, and machine time, increasing overall costs.

4. Waiting

Employees rely on having two days' worth of inventory before starting work at a workstation. Maintenance is performed "as needed," which could result in equipment downtime. Idle time for workers and machines reduces productivity and delays production flow.

5. Motion

With 40 part numbers sourced from about 100 vendors delivering at random times, excessive movement may occur during part handling and retrieval. Increased labour time spent searching for, organising or moving parts instead of focusing on value-adding activities.

6. Transportation

Parts are multiply sourced and delivered from various vendors at irregular intervals. Unnecessary transportation between suppliers and InnoChip adds costs and delays.

7. Overprocessing

The operations manager plans to add three inspectors and set up a rework line to address defects. Focusing on inspection and rework rather than preventing defects creates redundant activities that do not add value.

QUESTION 3:

(a) The main consequence of placing inventory in the supply chain as a decoupling point is that it creates independence between processes. The advantage of independence between operations (areas, processes) is that it can maximise the local utilisation and efficiency of the equipment and staff. Each batch of work-in-progress inventory joins a queue awaiting its turn in the schedule for the next processing stage. This allows each operation to be set to the optimum processing speed (cycle time), i.e., de-coupling inventory creates the opportunity for independent scheduling.

A disadvantage of independence is that local optimisation creates "island of excellence" that not necessarily contribute ot the overall flow in the value chain. Another disadvantage is that Finished Goods Inventory (FGI) can decouple the value chain from customer demand. That is, the downstream value chain (dealers, retailers) will want to sell what they have in stock, rather than supply what the customer wants.

(b) Outsourcing refers to the obtainment of goods or services from an external supplier company, whereas offshoring refers to the practice of basing some of a company's processes overseas to take advantage of lower costs. The two concepts are not mutually exclusive or inclusive.

Pros of outsourcing

- Focus on core competencies
- Harness lower labour cost at supplier
- Access to technology
- Stable and predictable financial planning in fee-for-transaction services
- Less investment risk

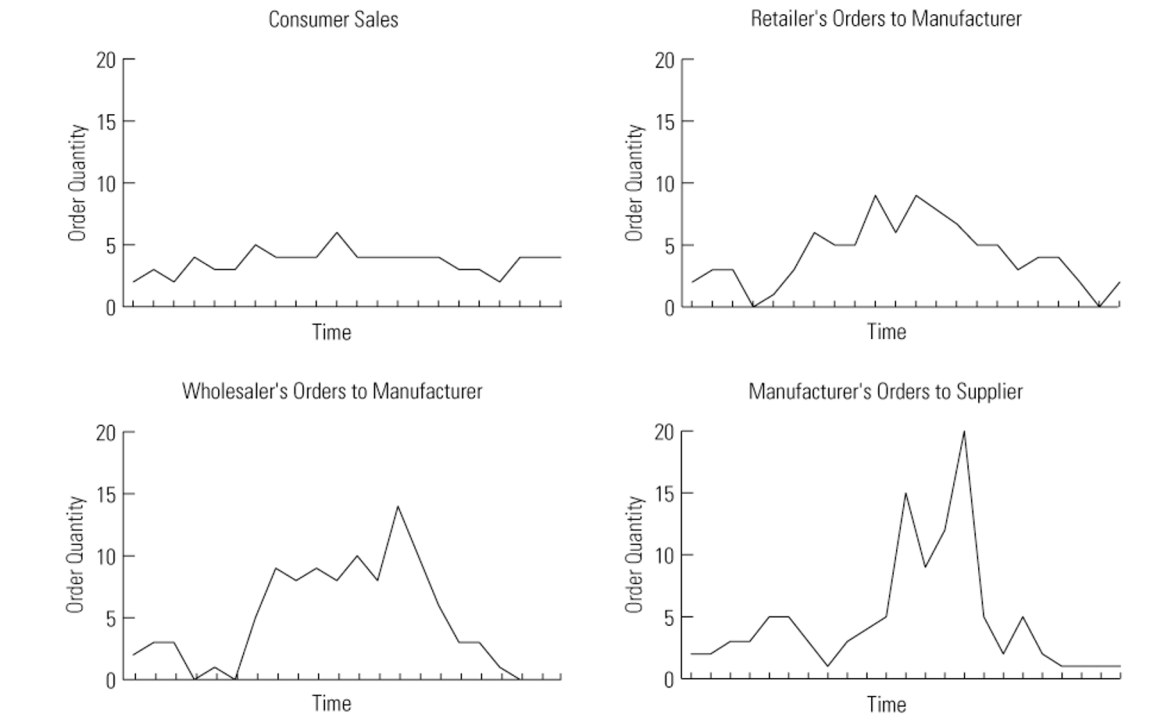
Cons of outsourcing

- Loss of control over process
- Limited ability to improve processes
- Risk of opportunistic behaviour of supplier
- Loss of human capital and tacit knowledge

The risks are similar for offshoring; one the human capital and tacit knowledge is lost, it would be hard to bring the process back in-house, as the capability has been lost! However, in offshoring, the company may face more disruptions and may be affected by other risks, such as geopolitical risks.

(c) The bullwhip is an amplification of demand in a multi-tier system, which leads to dynamic distortions in supply chains, and in turn, to high inventories and stock-outs, and poor capacity utilisation at al tiers. The higher up in terms of tiers, the worse these become.

Figure 1 Increasing Variability of Orders up the Supply Chain



It is caused by uncertainty in the first place (on the demand side), and then amplified by delays and hand-offs or decision tiers:

Forecast Variations

- Demand forecast inaccuracies along chain
- No visibility of actual consumer demand.
- Promotions – result in forward buying to benefit from lower prices

Poor Communications

- Lack of communication and coordination up and down the supply chain
- Long lead times (for material and information flow)

Inappropriate Decisions

- Decisions made locally (by one business) not globally (by the whole supply chain)
- Conservative decision-making
  - Managers are generally risk-averse
  - Risks are usually not symmetric – stockout hurts

Limited Response Capabilities

- Order batching – larger orders result in more variance
- Capacity Limits

Global supply chains are longer, and thus the longer lead-time will mean that it is much less likely to quickly adjust to changes. As a result, it will have to hold more buffer stock, and is more prone ot stock-outs, obsolescence, etc.

(d) Customisable cases are innovative products due to:

- **High demand uncertainty**: Trends and consumer preferences for customization can change rapidly.
- **Short product life cycles**: Designs may go out of fashion quickly.
- **High variety**: Different designs, materials, and personalization options add complexity.

DEMAND

SC OBJECTIVES	FUNCTIONAL PRODUCTS [predictable, few changes, low variety, low margin, long	INNOVATIVE PRODUCTS [unpredictable, many changes, high variety, high margin, short LT …]
EFFICIENT SUPPLY CHAIN [Low cost, high use, low inv.]	LEAN SUPPLY CHAIN	mismatch
RESPONSIVE SUPPLY CHAIN [Fast response, low throughput, flex suppliers]	mismatch	AGILE SUPPLY CHAIN

Examples: designer jeans, sugar, mobile phones, tissues, bananas, fighter aircraft

Source: Adapted from Fisher MC, 1997, What is the right supply chain for your product?, HBR, Mar-Apr, 105-116

According to Fisher's model, innovative products require a **responsive supply chain**, which focuses on flexibility, speed, and responsiveness rather than cost efficiency. This means:

- Short lead times and quick response to changing consumer demands.
- Maintaining excess capacity and buffer stock of raw materials.
- Investing in technology like print-on-demand or modular design for agility.
- Leveraging close supplier relationships to ensure quick adaptability.

Despite its benefits, implementing a responsive supply chain for customisable phone cases presents several challenges:

1. Responsiveness often increases costs due to expedited shipping, buffer inventory, and flexible production methods.
2. Forecasting is difficult because customer preferences constantly change.
3. Managing a network of suppliers who can deliver materials quickly without delays is challenging.
4. Customisation can slow down manufacturing and fulfillment processes.

Solutions like digital printing, AI-driven forecasting, modular processes and modular products can help create an agile, cost-effective supply chain.