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$$\begin{aligned}
 a \quad & \sqrt{\frac{2 \times C_o \times D}{C_h \left[1 - \frac{d}{p}\right]}} = \sqrt{\frac{2 \times 350 \times 55,000}{12 \left[1 - \frac{3500}{4200}\right]}} \\
 & = \sqrt{\frac{38500000}{2}} \\
 & = 4388 \text{ units}
 \end{aligned}$$

$$\begin{aligned}
 I_{\max} &= Q \left(1 - \frac{d}{p}\right) \\
 &= 4388 \times \left(1 - \frac{3500}{4200}\right) \\
 &= 4388 \times 0.16 \\
 &= 731.3
 \end{aligned}$$

$$\begin{aligned}
 TC &= \frac{D}{Q} \times C_o + \frac{I_{\max}}{2} \times C_h \\
 &= \frac{55,000 \times 350}{4388} + \frac{731.3 \times 12}{2} \\
 &= 4386.96 + 4387.8 \\
 &= \pounds 8774.76
 \end{aligned}$$

1

b

1) Factors affecting how much stock to hold include:

Buffer inventory - if an unexpected event causes delays in the process

Re-order point - At what level does the inventory need replenishing

Demand forecast - How much stock is likely to be going out

2) When to order depends on three main aspects which are a part of service levels. These include:

- Total orders received - How many orders have been requested by customers.

- Customers served without delay

- Probability of a stock out

These give the protection level and the service level

3) Major factors affecting what items to hold in stock include:

Make to order - These are often specialised products that aren't made often

Assemble to order - These are part finished items completed beforehand and fully completed on receipt

Made to stock - These are items that are completed before an order and then held in stock until required.

1.

C. Inventory holding costs can be directed into two main areas. These are direct and indirect costs.

Direct costs include:

- Cost of holding in a storage space.
- Damage due to unnecessary handling
- Obsolescence of components
- Shrinkage of material.

Indirect costs include:

- Opportunity cost - Cannot invest in alternatives
- Business risk - loss of sales / ~~or~~ customers
- Incremental costs - Facilities / Transportation.

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$$a) OEE = \text{Availability} \times \text{Quality} \times \text{Performance}$$

$$\text{Availability} = ((10 \times 60) - 30 - 15 - 15 - 30) / 600 \times 100$$
$$= 510 / 600$$

$$= 0.85 \text{ or } 85\%$$

$$\text{Quality} = (37,600 - 380) / 37,600 \times 100$$

$$= \frac{37,220}{37,600}$$

$$= 0.9899 \text{ or } 98.99\%$$

$$\text{Performance} = \frac{37,600}{510} \times 100$$

$$= 0.67 \text{ or } 67\%$$

$$OEE = 0.85 \times 0.9899 \times 0.67$$

$$= 0.5637 \text{ or } 56.37\%$$

2

b Breakdowns - This is a downtime loss and occurs when equipment fails, unplanned maintenance is needed and any other general breakdowns are required.

Reduced speed - This is a clear speed loss that happens due to worn components, operator inefficiencies and rough running are present in equipment.

Start up rejects - This is a quality loss and occurs when rework is required, Scraps are produced and when parts are incorrectly assembled.

Small Stops - This is also a speed loss that occurs when cleaning is needed, the product flow is obstructed and when components are jammed in the process.

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- C. There are many potential benefits when conducting planned maintenance. These include:
- Convenient maintenance completion (Reduces capacity loss)
 - Reduced disruption from any emergency work
 - Less need for overtime to complete emergency work
 - Reduced maintenance costs
 - Stand by equipment is needed less frequently as a result of fewer emergencies.

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A. Value Stream mapping is an essential tool it can aid in many different ways. These can include:

- Describing is going to be affected as a result of collecting the data.
- Forms the basis of an implementation plan which can then be taken further
- Helps to show the source of waste in a process
- Describes how a facility should work to help make the process more flowing.
- Brings together lean tools and techniques to improve the process.
- Helps visualise more than one process level which gives a much better perspective of it.

Value Stream mapping is an extremely diverse and powerful tool that should definitely be used when viewing a process.

4

B. When drawing a current-state map, it should always begin with the customer requirements. This is essential for understanding ~~the~~ their priorities and their highest value.

The next step would be to understand the basic production process. This is the flow of material through the process and only stops when the process is disconnected.

The next step would be to gain data on the process itself. The types of data needed for it to work are Number of people, Scrap rate, uptime, Cycle time and ~~other variations~~ ~~as~~ many more.

It is then important to identify material movements within the process pushed by the product. Push is when the process produces product ~~regardless~~ regardless of the need.

A timeline of the process can then be created from the arrival of the raw material all the way to the customer.

The lead time can then be calculated after counting the total amount of time taken.