**MRP (Material Requirement Planning)**

**<Experiment result & analysis>**

**※ Answer the following questions. Please show calculations if necessary, and answer the questions in detail.**

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| 1. Compare the changes in production policy for Item C and D when Lot sizing Rule is [lot-for-lot] or when it is [fixed order quantity].  Following the Lot-for-Lot policy, the quantity to be ordered or produced is equal to the exact net requirements for each period. It results in varying order quantities, but it minimizes holding costs because there are no excess inventories. Simultaneously, it can lead to many orders with varying sizes, which can increase ordering costs.  In the case of the Fixed Order Quantity policy, the quantity of orders are predetermined, often based on economic order quantity calculations. This rule can result in holding some inventory for future periods, thus increasing holding costs. Yet, it typically reduces the frequency of orders, which can decrease ordering costs.  [ Item C ]    For the Lot-for-Lot policy, it is observable that planned order releases exactly match net requirements for each period, leading to no excess inventory. The order releases fluctuate according to the net requirements, potentially leading to higher ordering costs due to multiple small orders.  Under the FOQ policy, planned order releases are in fixed quantities of 1500 units, leading to inventory holding when the fixed quantity exceeds the net requirements. It is observable that there are projected on-hand inventories throughout the planning horizon. Orders may not be required every period, which reduces ordering frequency but increases holding costs due to excess inventory.  [ Item D ]    In the case for Lot-For-Lot policy, similar to Item C, the order releases exactly match the net requirements, with no excess inventory carried over. This can result in many small orders, which may increase ordering costs but avoid holding costs.  Under the FOQ model, planned order releases are in fixed quantities of 1400 units and do not match the net requirements. Although this policy leads to reduced order frequencies, this method results in excessing inventory holding that are carried over from previous large orders throughout the planning horizon.  -  Both items show a similar trend under LFL, where order releases are as per the exact requirement. Under FOQ, both items reflect larger but less frequent order releases, which led to increased inventory levels. In summary, LFL minimizes holding costs by avoiding excess inventory but may increase ordering costs, whereas FOQ simplifies ordering but may lead to higher inventory holding costs. The decision between these two approaches depends on the cost balance between ordering and holding, as well as the predictability and variability of the demand for each item.  (end of question 1)  2. When demand is changing as shown in the Table below, compare the two Lot Sizing Rules for Item C  and D: [lot-for-lot] and [fixed order quantity]. Find out which is more sensitive and analyze the reason.     |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **Week** | 2 | 7 | 11 | 12 | 17 | | **Demand** | 100 | 150 | 120 | 100 | 90 |   Sensitivity can be evaluated in terms of how each lot sizing rule responds to changes in demand and the resulting effects on inventory levels, ordering frequency, and costs.  The following MRPs for item C and item D is recalculated based on the changed demand of the Table. The calculation process can be seen in the excel file.  [Item C]    [Item D]    Lot-for-Lot is more sensitive to demand changes because it matches orders to demand without any buffer, leading to more frequent adjustments in order quantities and potential for stockouts if demand is underestimated. On the contrary, FOQ is less sensitive on a period-to-period basis due to the buffer inventory, but over time, it may lead to inefficiencies due to overstocking, especially if demand decreases consistently or is less than the fixed order quantity. It is noticeable that the planned order release time and quantity changed entirely for Lot-for-Lot policy, whereas the FOQ policy even managed to reduce its order frequency.  In conclusion, LFL is more sensitive to demand variability, which can be an advantage in terms of reducing holding costs but a disadvantage if it leads to frequent changes in orders or stockouts. FOQ reduces sensitivity to demand changes and can stabilize the production schedule, but it risks incurring higher inventory holding costs and reduced responsiveness to drops in demand.  (end of question 2)  3. Explain what nervousness is for MRP system, and discuss why it occurs.  In Material Requirements Planning (MRP) systems, a phenomenon known as nervousness occurs when minor demand fluctuations precipitate widespread and often unwarranted adjustments throughout the entire supply chain. These ripples can lead to a cascade of changes, from the constant reordering of components to sweeping alterations in production schedules and shifts in purchasing strategies.  Such nervousness can have detrimental consequences. On one hand, it may inflate operational costs due to the need for frequent rescheduling, increased inventory holdings, waste of resources, and inefficient management of labor. On the other hand, nervousness can harm customer satisfaction; overreactive changes to the system can result in missed delivery deadlines and failures to complete orders, reducing customer trust.  Nervousness could occur for several reasons.  Firstly, volatility in customer demand is a major driver of nervousness in MRP systems. MRP systems are essentially demand-driven, which means adjusting production schedules and ordering materials according to predicted customer requirements. If actual demand deviates from these predictions, the system will have to adjust orders and schedules accordingly, even for small differences. This is particularly problematic when MRP systems do not have a mechanism to distinguish between significant demand changes that require action and small fluctuations that are within the normal variance range.  Second, variability in lead time add to the complexity even further. If lead times are long or inconsistent, the MRP system must plan further into the future, which essentially makes decisions based on less accurate predictions. This uncertainty can lead the system to order too quickly or too little. The former can lead to overstock and increased retention costs, while the latter can lead to production delays and missed customer deadlines. Moreover, if the provider is unreliable or if lead times are not delivered well, the MRP system's response to changes in demand can become more irregular.  Lastly, the design of some MRP systems can exacerbate nervousness. Systems that lack flexibility or the ability to quickly adapt to new information can struggle to cope with the dynamic nature of their supply chains. Strict MRP systems overreact to minor changes, allowing them to apply broad changes across the board instead of adjusting their targets.  (end of question 3)  4. Despite the nervousness of the MRP system, many manufacturers producing different number of parts use the MRP to manage the system efficiently. Consider ways to reduce the nervousness of the MRP system.  1) Improved demand forecasting techniques:  Increasing the accuracy of demand forecasts is critical. Companies can develop more reliable forecasts by incorporating advanced statistical models that take into account historical sales data, seasonal fluctuations, and current market trends. Regular updates of these forecasts can reflect the latest market conditions and consumer behavior patterns, reducing the likelihood of unexpected demand fluctuations that can disrupt the supply chain. These approaches should be dedicated to data analysis, and machine learning algorithms can be used to predict future demand more accurately.  2) Implementation of Safety Stock and Buffer Inventories:  Setting safety stock levels for critical items is a proven way to buffer the volatility of supply and demand. This includes calculating the optimal amount of inventory to keep for each item, taking lead times, demand volatility, and inventory exhaustion costs into account. Beyond simple safe inventory, applying the Demand-Based Material Requirements Planning (DDMRP) principle allows for strategic deployment of inventory buffers throughout the supply chain. These buffers act as shock absorbers that seamlessly handle fluctuations in supply and demand before creating widespread disruption.  3) Lead Time Reduction and Management:  Shorter and consistent lead times allow for faster response to changes in demand, eliminating the need for large safe inventories. Implementing safe lead times, a buffer period that adds to a supplier's lead time, can provide increased security against supply chain disruptions.  4) Frozen Planning Horizons:  A frozen planning horizon policy, in which production plans cannot be changed within a period of time before production begins, can significantly increase stability. This allows production teams to prepare for upcoming runs without the risk of last-minute changes, thereby increasing resource utilization and reducing waste. The duration of the frozen horizon must be carefully set to balance flexibility needs and operational stability needs in response to market changes.  (end of question 4) |