ENHANCEMENT OF INTELLIGENT STOCKS PLANNING OPTIMIZATION USING DYNAMIC PARAMETERS

NUS National University of Singapore

Department of Industrial and Systems Engineering

IE3100R – SYSTEM DESIGN PROJECT

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Infineon

Introduction

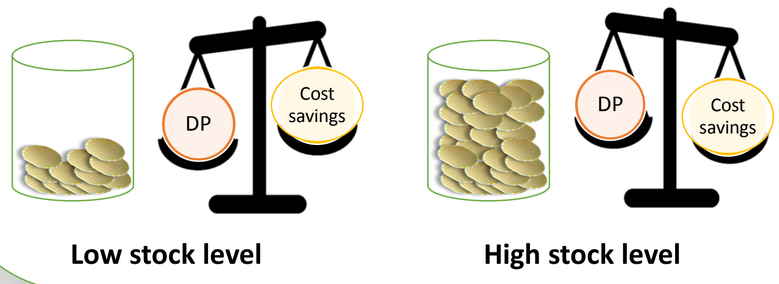
DECISION DILEMMA: LOW COST VS HIGH DP

Stock Level:

The quantity of goods or merchandise kept in the warehouse and available for sale or distribution.

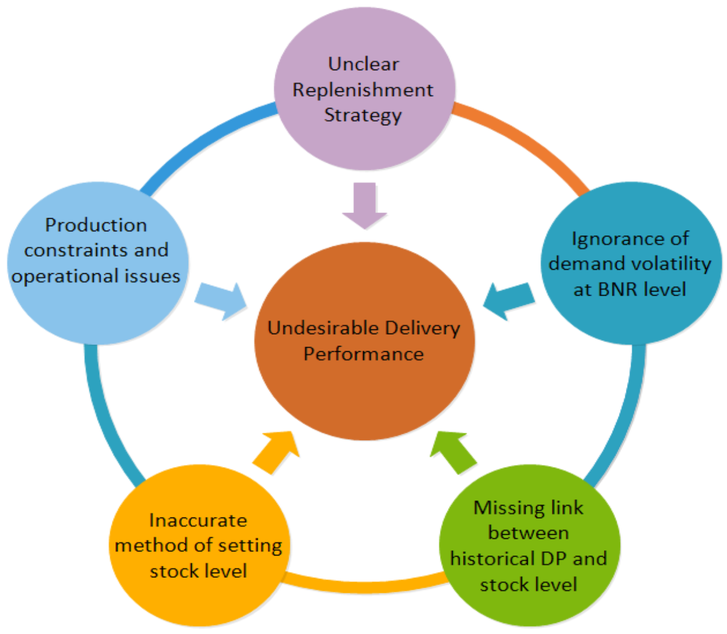
***Delivery Performance (DP)**:*

Key Performance Indicator measurement used in supply chains to measure the fulfilment of a customer's demand to the wish date.

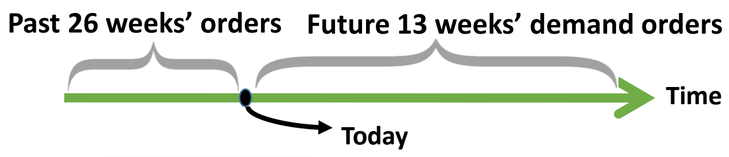


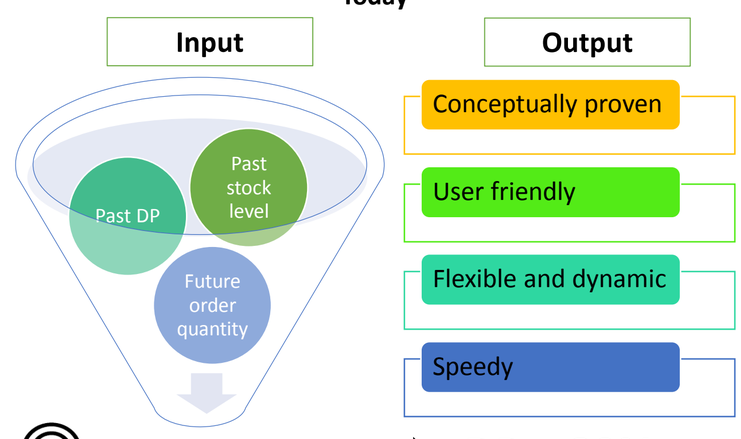
Low stock level — High stock level

PROBLEM IDENTIFICATION



OBJECTIVES





Future stock level ➡ DP = 80%

Methodology

Delivery Performance

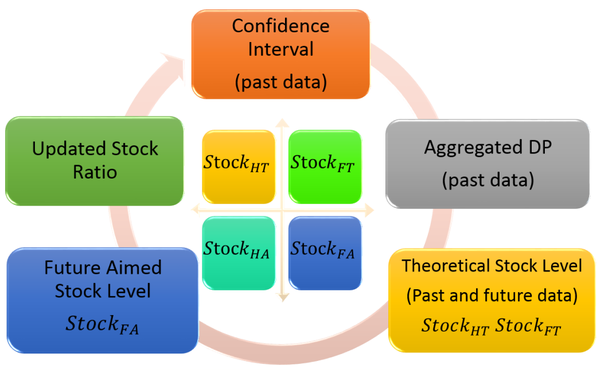
If $Demand_{t,p} + Backlog_{t-1,p} > 0$ **then**

$$DP_t = min(\frac{max(0, Inventory_{t,p} - Backlog_{t-1,p})}{Demand_{t,p}}; 1)$$

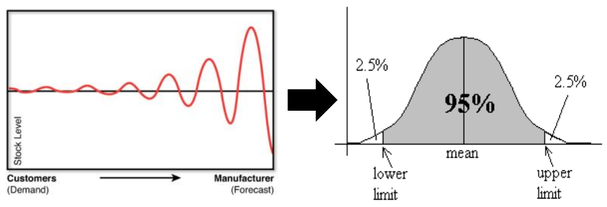
Else $DP_t = NULL$

t: *week that DP is calculated,*
p: *product identifier*

Revising the stock ratio



Step 1: Fit a 95% Confidence Interval for the future 13 week's demand

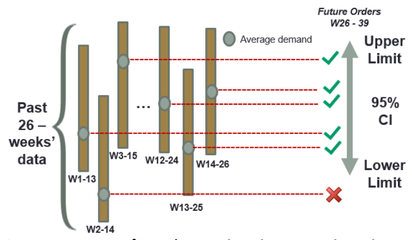


Future orders are prone to uncertainty

- **Cancellations**
- **Reduction in order quantity**
- **Additional orders / top-ups**

- Mean = Average future demand
- Lower/Upper Limit = $Mean \pm Z_{0.25}\ (Standard\ Error)$

Step 2: Using confidence interval, historical demand data and DP to determine the aggregate DP



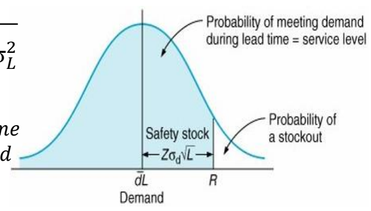
- **Moving Average (MA)** method is used to best capture the demand volatility
- **Aggregate DP** is the average of all the DP values in the matched moving average

Step 3: Using aggregate DP to obtain theoretical stock level, for both future and actual demand

Theoretical Stock Level:

$$ss = z_\alpha * \sqrt{E(L)\sigma_D^2 + (E(D))^2\sigma_L^2}$$

$a = Delivery\ Performance$
$E(L) = Expected\ value\ of\ Lead\ Time$
$E(D) = Expected\ value\ of\ Demand$
$\sigma_D^2 = Variance\ of\ Demand$
$\sigma_L^2 = Variance\ of\ Lead\ Time$



For Infineon, cycle time follows the planning cycle, therefore $\sigma_L^2 = 0$

$$ss = z_a * \sqrt{E(L)} * \sigma_D^2$$

	SS_{HT}	SS_{FT}
z_a	Aggregated DP	Target DP
σ_D^2	Past data	Future data

Step 4 Given a Target DP, calculate the theoretical future stock

$$\frac{stock_{HA}}{stock_{HT}} = \frac{stock_{FT}}{stock_{FA}}$$

Assumption: ratio of discrepancies due to natural variation such as capacity constrains & operations issues remain constant)

$stock_{HA}$ = Average Historical Demand * Cycle Time * Old Stock Ratio

$stock_{FT} = SS_{FT} + Average\ Future\ Demand$

$stock_{HT} = SS_{HT} + Average\ Historical\ Demand$

Then: $stock_{FA} = \frac{stock_{HT}}{stock_{HA}} * stock_{FT}$

Step 5 From the actual (targeted) stock level, obtain the stock ratio

$$New\ stock\ ratio = \frac{Stock_{FA}}{Average\ Future\ Demand\ *\ Cycle\ Time}$$

Self-Learning Mechanism

Simulation

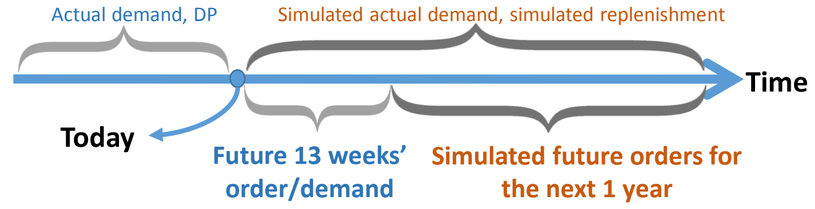
Objective

To evaluate the performance of the proposed methodology against the base methodology across various products with varying demand patterns.

Model Input and Output

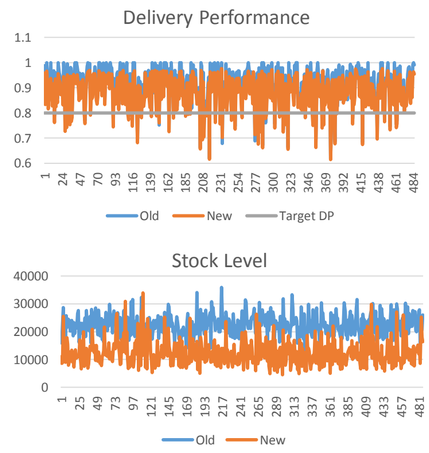
Historical Demand and DP
Forecast Accuracy
Historical Stock Ratio
➡ Simulation ➡
Average Stock Level
Average DP

Horizon



Results

PRODUCT WITH VOLATILE DEMAND



PRODUCT WITH STEADY DEMAND

Findings

Proposed methodology achieves DP nearer to target DP with lower stock levels on average for both types of products. However, there is a higher variance of results.

Conclusion

KEY ASSUMPTIONS

- Demand for products is normally distributed
- Random errors will exist throughout different products at different periods (past manufacturing conditions will persist into the future)
- Future orders reflect the seasonal patterns implicitly
- For replenishment strategy, there is a lower probability for goods with steady demand to dip into stocks as compared to goods with volatile demand
- Forecast for the future orders are generally accurate

FUTURE DIRECTION

- As each product has different demand patterns, set individual ratio for each specific product
- Keep track of and enhance forecast accuracy, especially last minute order cancellations and added orders
- Keep track of replenishment strategy such as how often to replenish and how often target stock is changed
- Take into consideration inventory cost
- Enhance the visibility of the data across different departments to allow ease of exchange of information

PROJECT ACHIEVEMENT

- The new methodology introduced for calculation of stock ratio has proven reasonable, effective and successfully meets the project's objective
- From the simulation results, the new methodology proposed produces delivery performances closer to the target delivery performance of 80%
- Lower stock level is achieved on average for both steady and volatile demand products