Gordian
Logistic Experts

Spare Parts Management

- *What's different?* -

Complex SPM environment
Spare parts logistics vs. Production logistics

Parameter	Production logistics	Spare parts logistics
Strategy	Just in Time	Just in Case
Demand pattern	Predictable	Unpredictable
Response	Plannable	Asap
Parts	Limited	15 to 20 times as much
Assortment	Uniform	Many different types of parts
Objective inventory management	Maximise turnover	Effective allocation inventory based on service level
Return logistics	Does not occur	Rotables, defects and scrap
Performance indicator	Stock availability	Uptime of the system
Stock turn	6 to 50 times per year	1 to 4 times per year

Influence of logistics on asset availability

Managing the operational availability of a capital asset*:

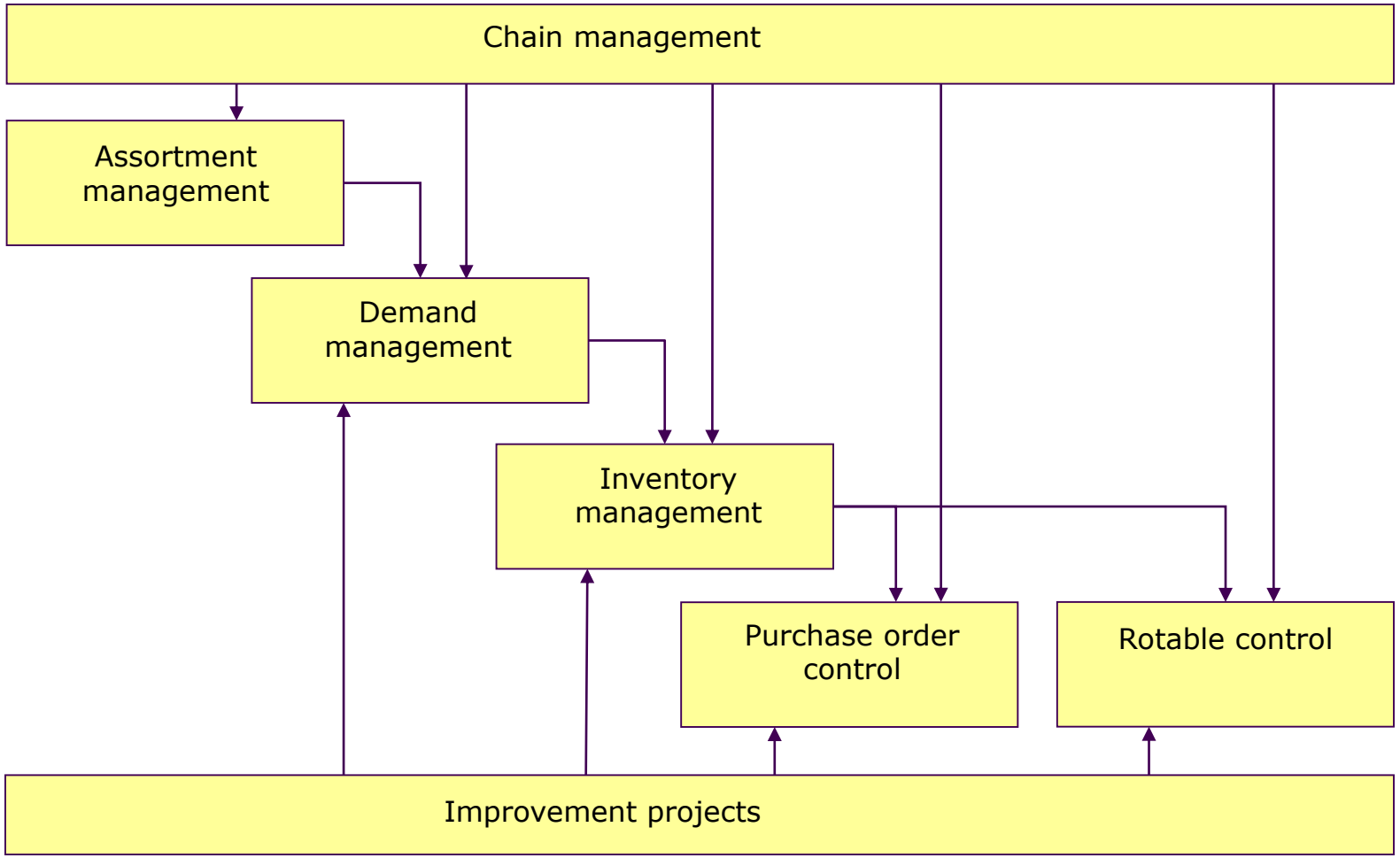
$$\text{Operational availability} = \frac{\text{Mean Time Between Maintenance Actions}}{\text{Mean Time Between Maintenance Actions} + \text{Mean Logistics Delay Time} + \text{Mean Time To Repair}}$$

"# assets waiting for parts"

Influenced by spare parts and tools

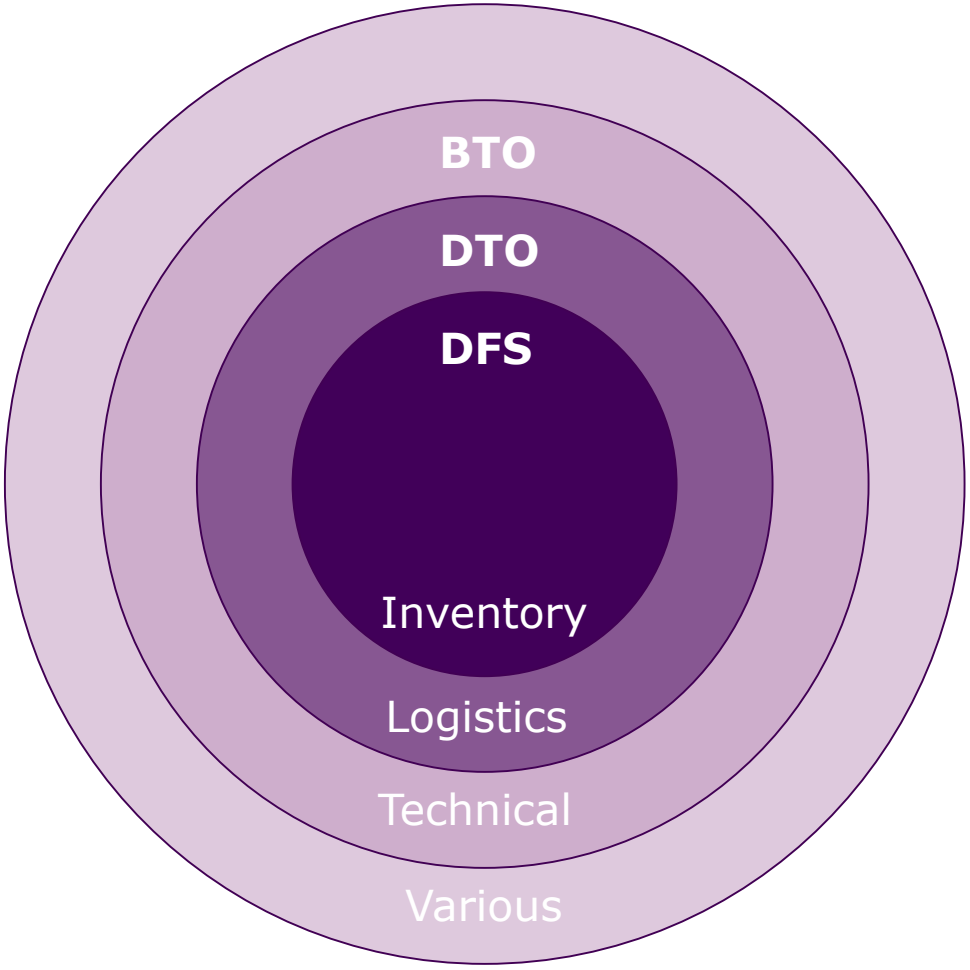
* Several definitions exist

Spare parts management framework



Assortment strategy (1)

Assortments:



Collection of assortments

Technical assortment

Assortment that potentially will be used for maintenance (configuration items)

Logistics assortment

Assortment of regular used **or** at least plannable demand (not necessarily on the shelf)

Inventory assortment

Assortment for which stock is needed from client/operations or economical perspective

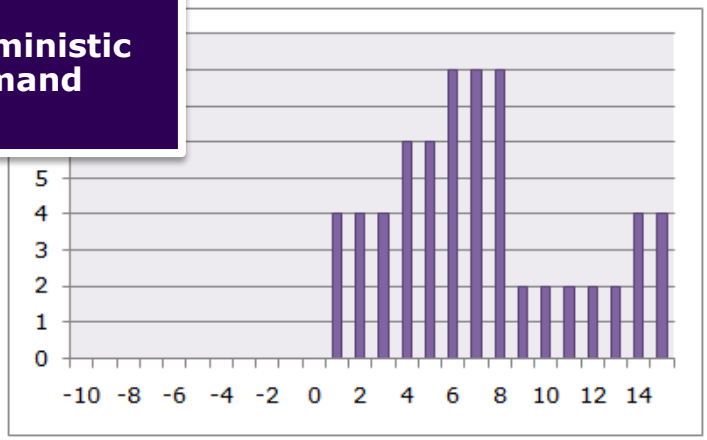
Assortment strategy (2)

Assortment strategy	Description	Technical data known	Purchase data known	Inventory data known	Time spent
BTO = Buy **T**o **O**rder	Assortment not active, from a logistics perspective	✓	-	-	5%
DTO = Deliver **T**o **O**rder	Logistics assortment which IS NOT held in stock (non stock items)	✓	✓	-	15%
DFS = Deliver **F**rom **S**tock	Logistics assortment which IS held in stock (stock items)	✓	✓	✓	80%

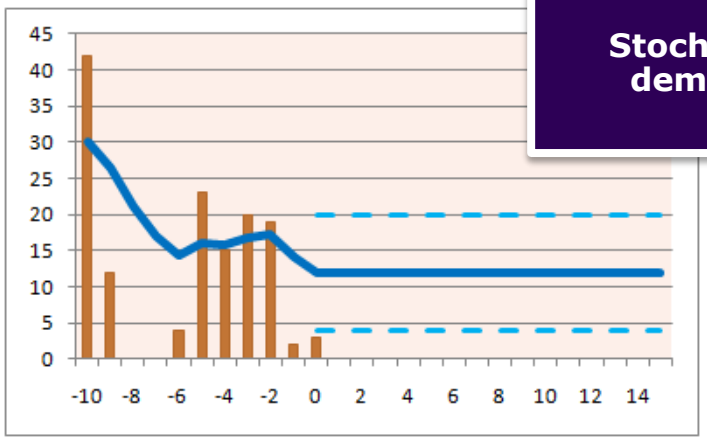
Introduction inventory control

The inventory control model we use depends on the underlying demand characteristics. We distinguish:

Deterministic demand



Stochastic demand



Deterministic demand:

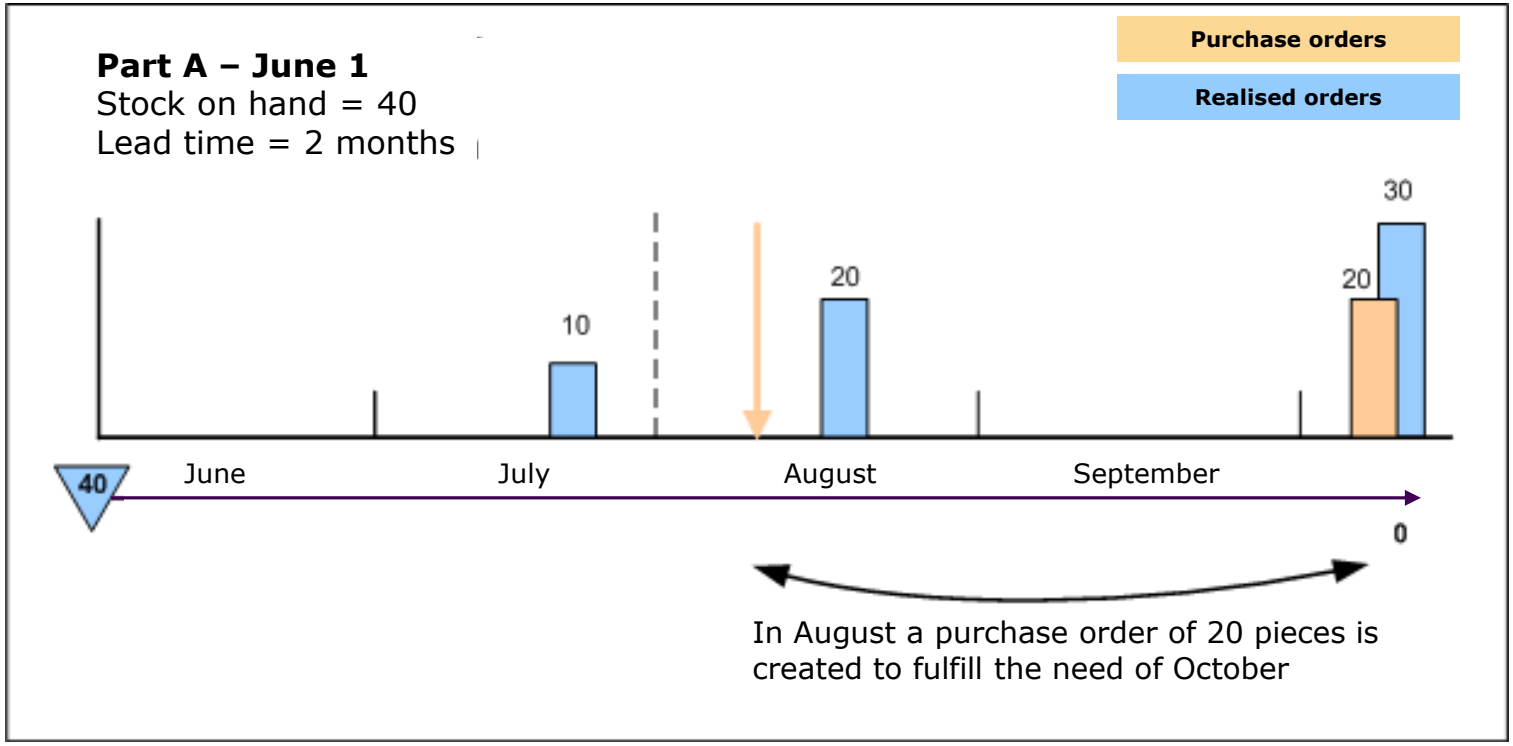
- Demand is known
- Assumption: no deviation in demand
- Mainly planned maintenance (or production demand)

Stochastic demand:

- Uncentainty in demand is expressed in a mean and standard deviation
- Mainly corrective demand, failure rate is difficult to predict

Demand driven planning

Deterministic demand: demand is known in advance or can be postponed and should be fulfilled "just in time".



Demand driven planning

Material Requirements Planning (MRP)

Requirements MRP:

- Set lead times
- Required materials are included in Bill Of Material (BOM)
- Requirements are known in advance, at least before the length of the lead time.

Application MRP:

- Parts with known requirements from planned maintenance jobs
- "Buy-to-order" and "deliver-to-order" parts
- Non critical parts for which the repair of a defect can be postponed long enough

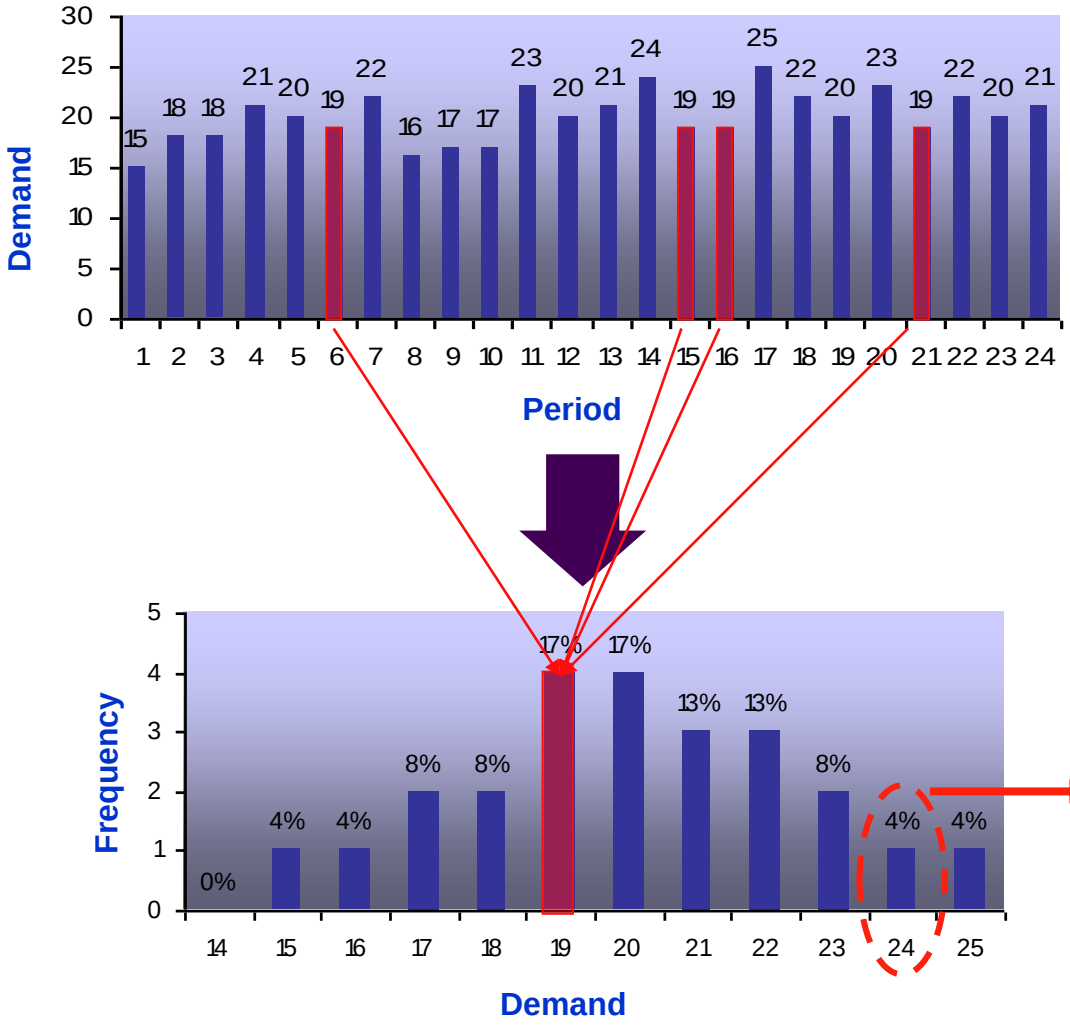
	MRP Level 0																				
	Safety stock	8																			
	On hand	80																			
	Order policy	Discrete																			
	MOQ	50																			
	Lead time	3																			
	Period		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
MPS	Forecast		25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
MPS	Orders		0	0	10	0	0	40	25	5	40	0	0	0	0	0	0	0	0	0	0	0
MPS	Gross reqs		25	26	27	28	29	40	31	32	40	34	35	36	37	38	39	40	41	42	43	44
MRP	Scheduled receipts		0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MRP	Projected stock on hand	80	55	49	22	-6	-35	-75	-106	-138	-178	-212	-247	-283	-320	-358	-397	-437	-478	-520	-563	-607
MRP	Planned stock	80	55	49	22	44	15	25	44	12	22	38	53	17	30	42	53	13	22	30	37	43
MRP	Net reqs		0	0	0	14	0	33	14	0	36	20	5	0	28	16	5	0	36	28	21	15
MRP	Planned order receipts		0	0	0	50	0	50	50	0	50	50	50	0	50	50	50	0	50	50	50	50
MRP	Planned order release		50	0	50	50	0	50	50	50	0	50	50	50	0	50	50	50	50	#N/B	#N/B	#N/B
MRP	ATP		80	100	90																	

Maintenance impacting SPM

Types of maintenance

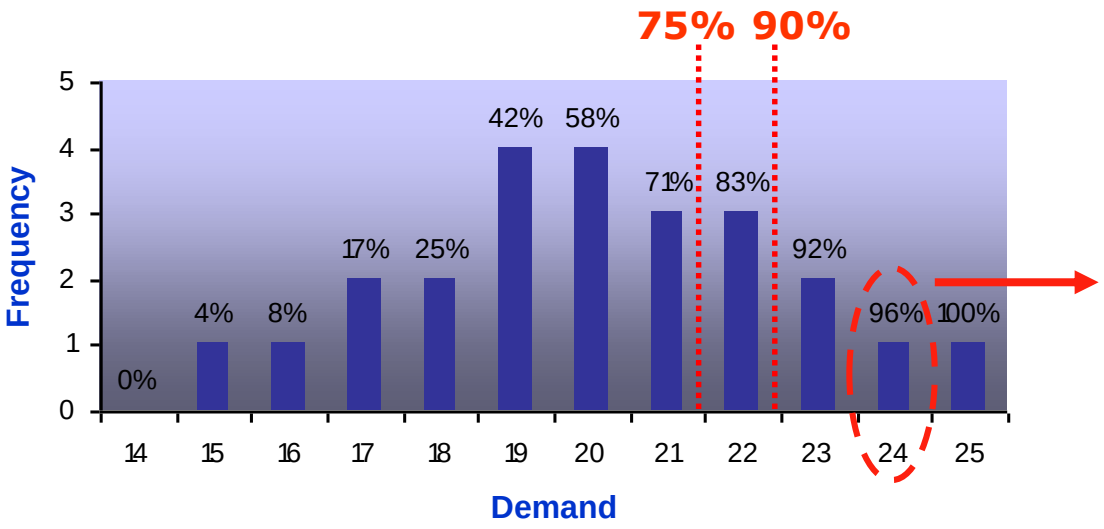
Types of maintenance	Maintenance & spare parts management strategy
Preventive maintenance	▪ Plan maintenance as much as possible ahead ▪ Standardize maintenance as much as possible incl. required parts ▪ Deliver to Order (DTO), unless economically feasible
Corrective maintenance	▪ Deliver from Stock (DFS) ▪ Make adequate supply decisions by an adequate prediction ▪ Differentiate in service levels based on criticality and cost
Modifications/ Turnarounds	▪ Plan the entire project, including ordering items ▪ Separate incidental demand and regular demand
Component maintenance	▪ Good coordination between maintenance and stock control ▪ Deliver from Stock (DFS)

Demand frequency distribution (1)



Shows the probability of a future request of 24 pieces in the next period = 4%

Demand frequency distribution (2)



Shows the probability of a future request of 24 pieces or less in the next period = 96 %

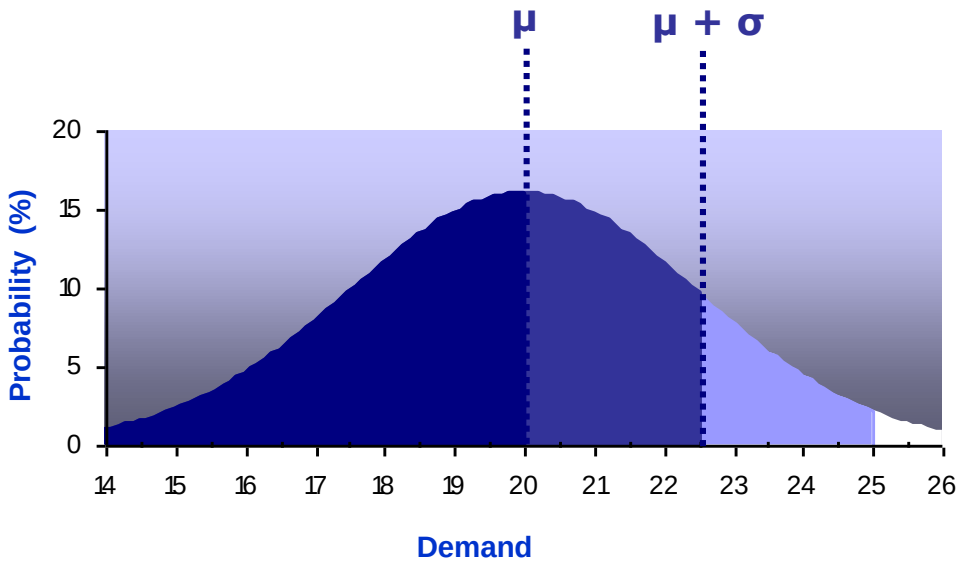
- To achieve a stock availability of 75%, 22 pieces must be put on stock! (lead time = 1 period)
- To achieve a stock availability of 90%, 23 pieces must be put on stock! (lead time = 1 period)

How can we approximate this demand statistically?

Normal demand distribution

Example

We would like to have a service level of 90%, what stock level do we need?



μ = 20.04

σ = 2.51

Service level (%)	90
k-factor	1.28

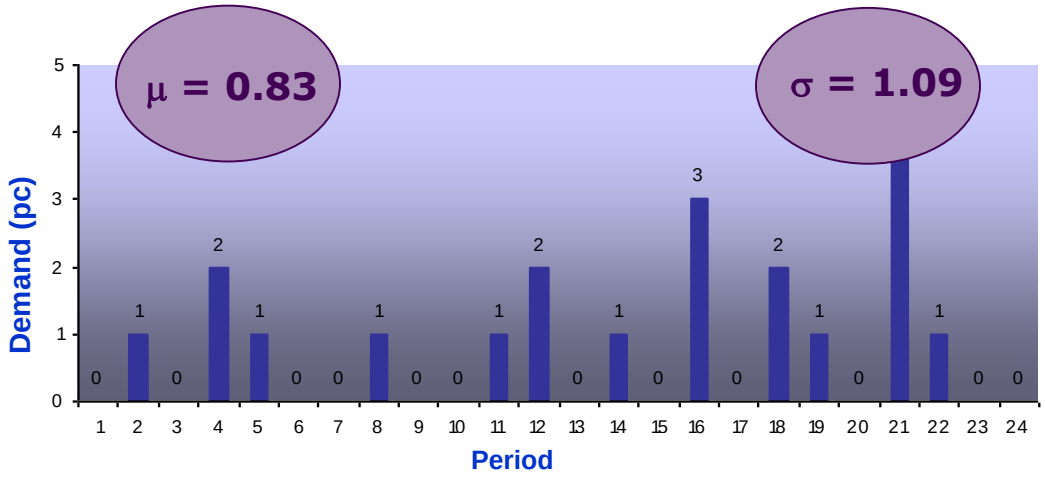
Stock level = μ + k * σ

= 20.04 + 1.28 * 2.51

= 23.25

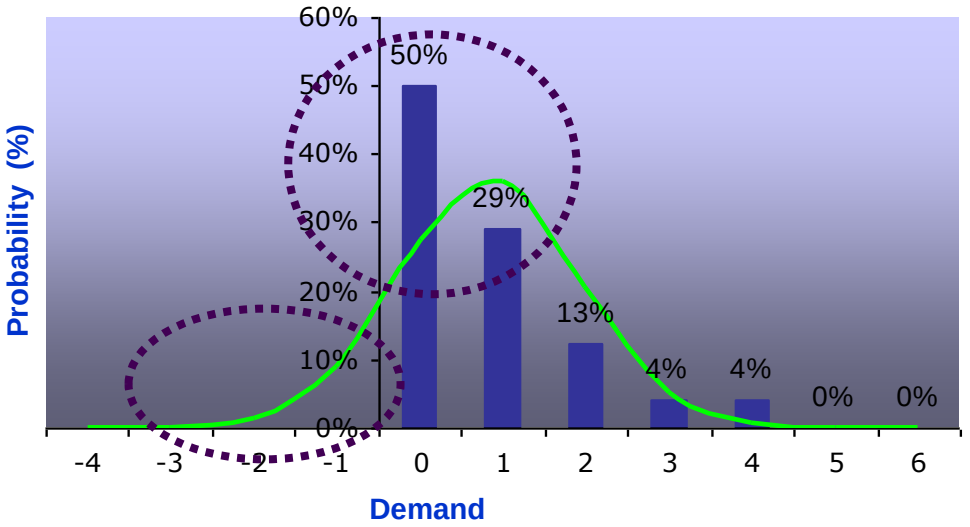
By using the normal distribution, the stock level should be **23.25 pieces** in order to achieve a service level of 90%.

Application normal distribution (1)



The normal distribution does not always fit the actual demand best

Problem areas:

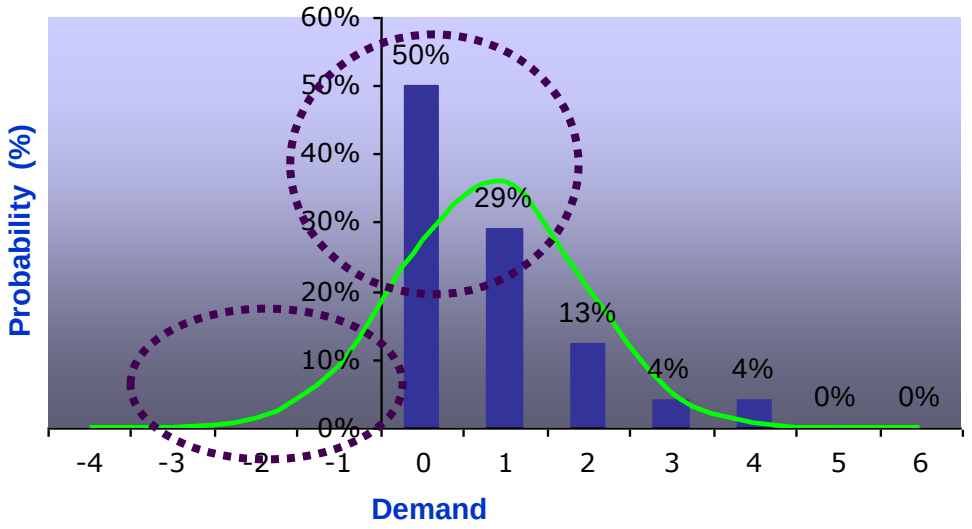


Application normal distribution (2)

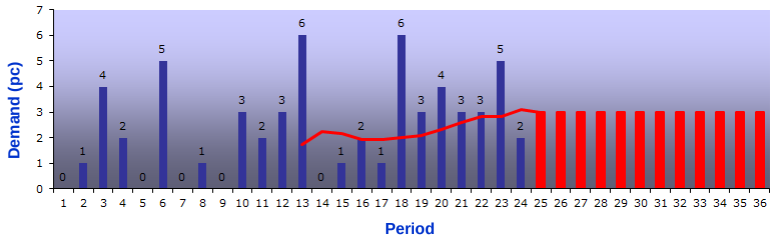
Normal distribution is well applicable if we have:

- Many hits (> 12 per year, is steady)
- OR few periodes with zero demand
- OR high stock availability (> 90%)
- OR σ / μ < 1

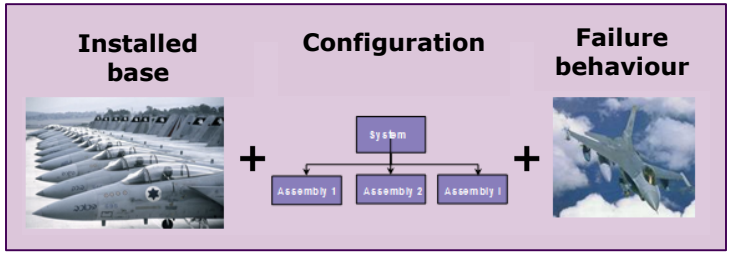
If these criteria are not met, the normal distribution does not fit well. Especially for slow movers!



Overview demand forecasting

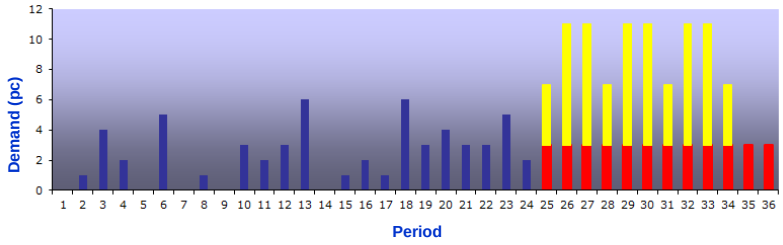


Demand forecasting based on demand history



Demand forecasting based on engineering information

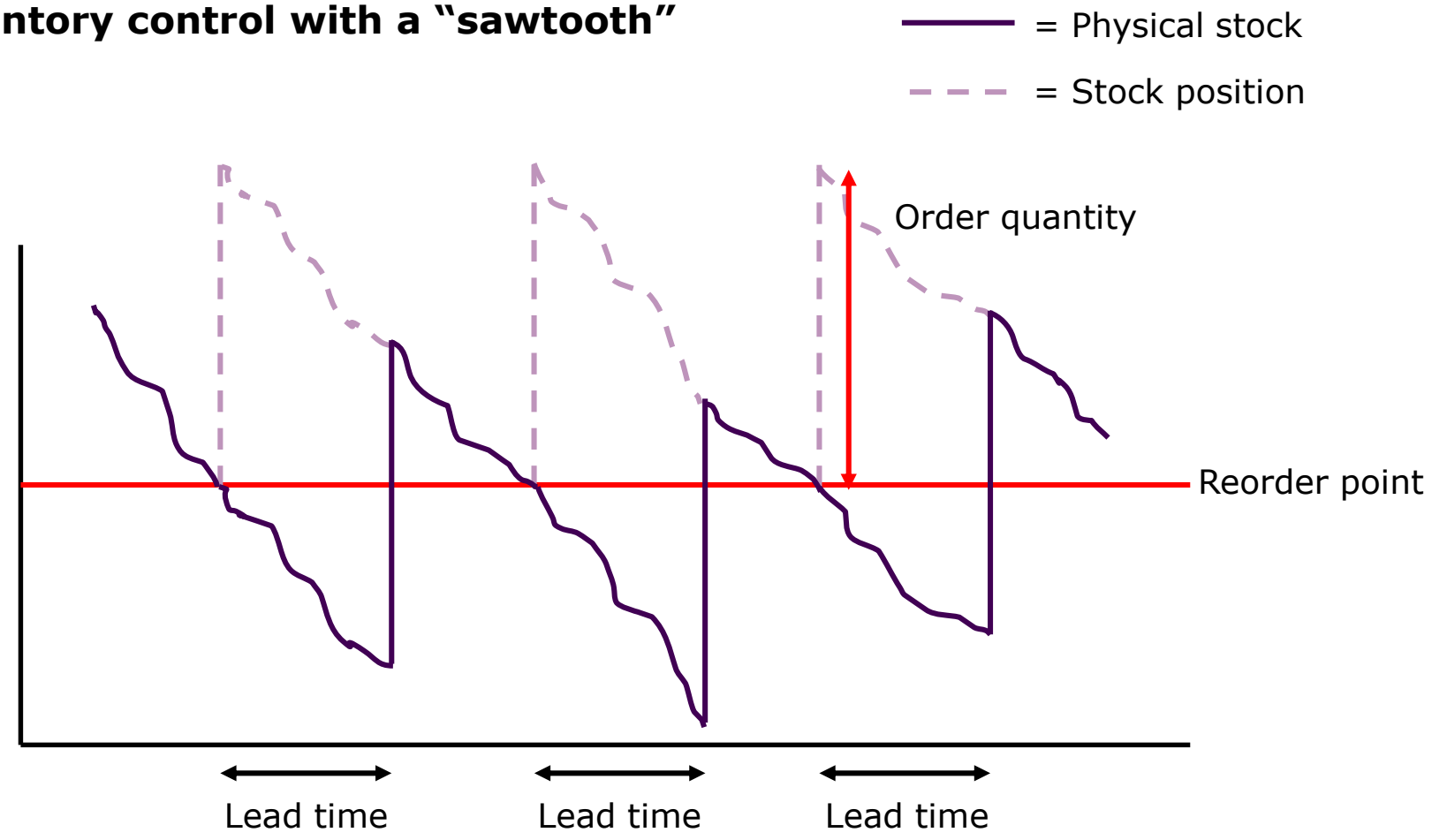
Demand forecasting based on planned maintenance



Combined demand forecasting

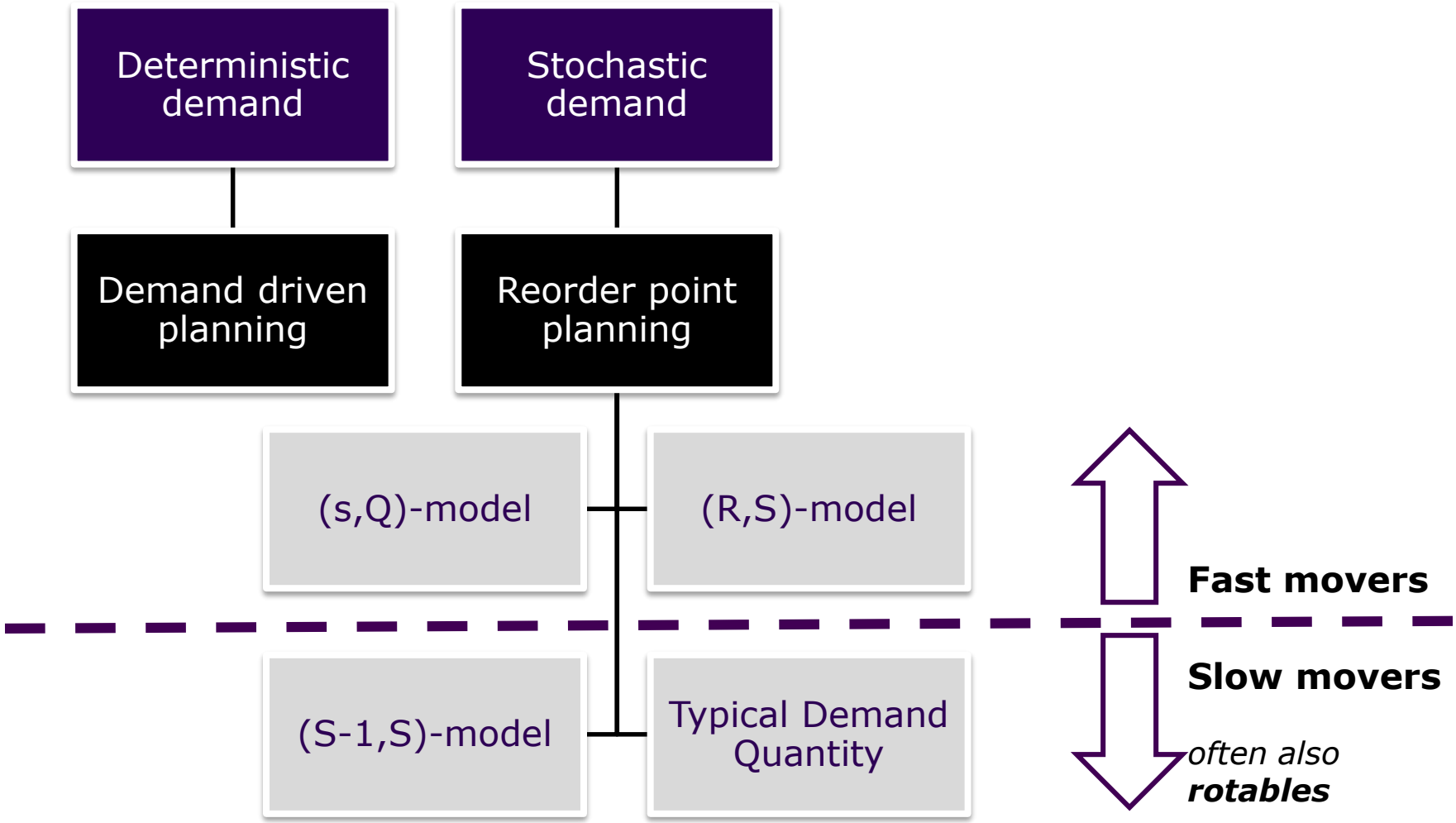
Reorder point planning (1)

Inventory control with a "sawtooth"



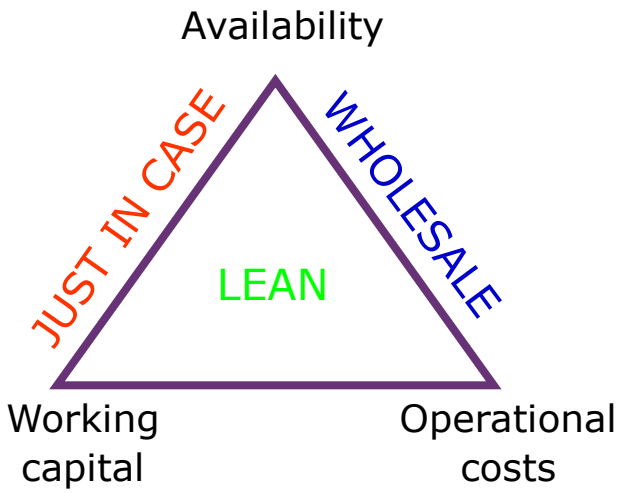
Reorder point planning (2)

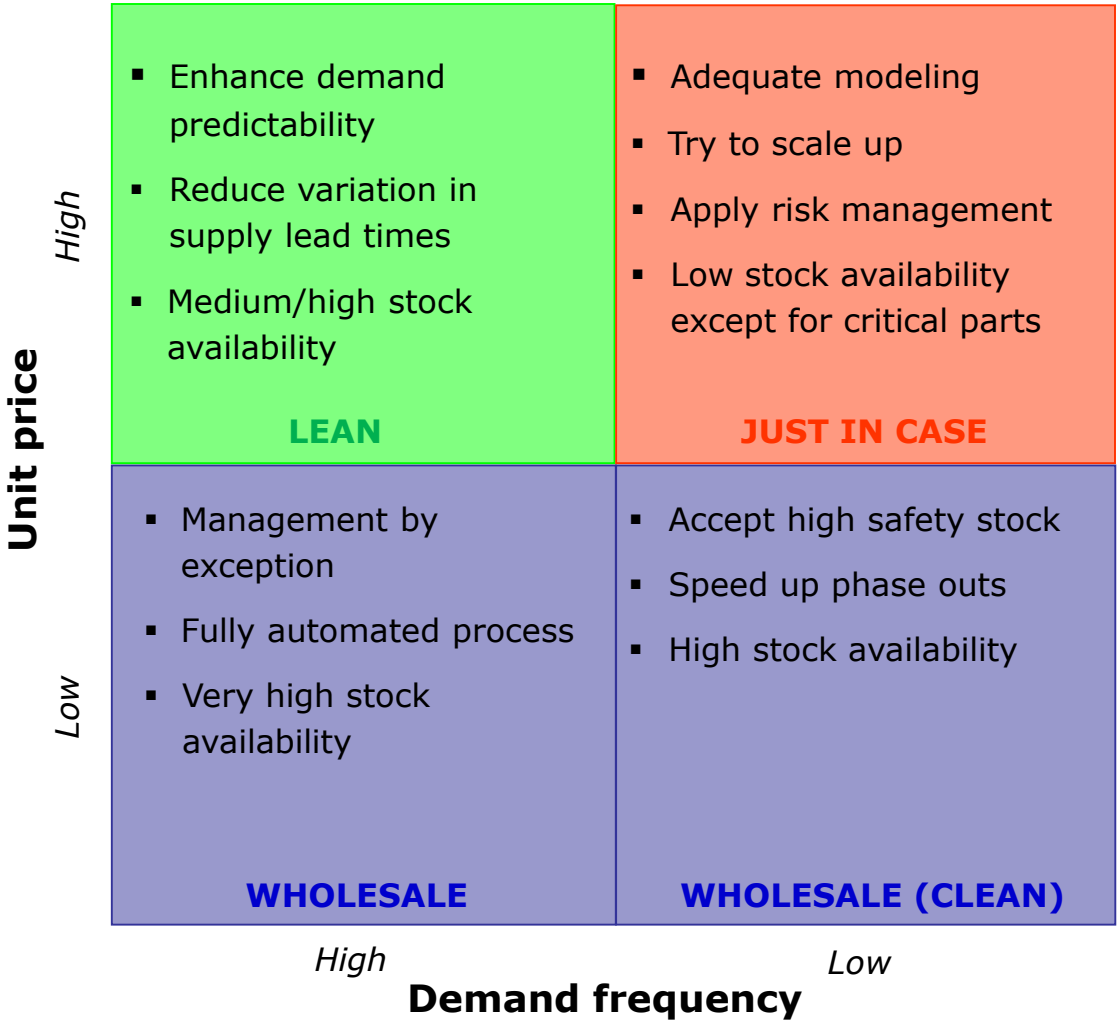
Inventory models



Assortment strategy

Spare parts management strategies

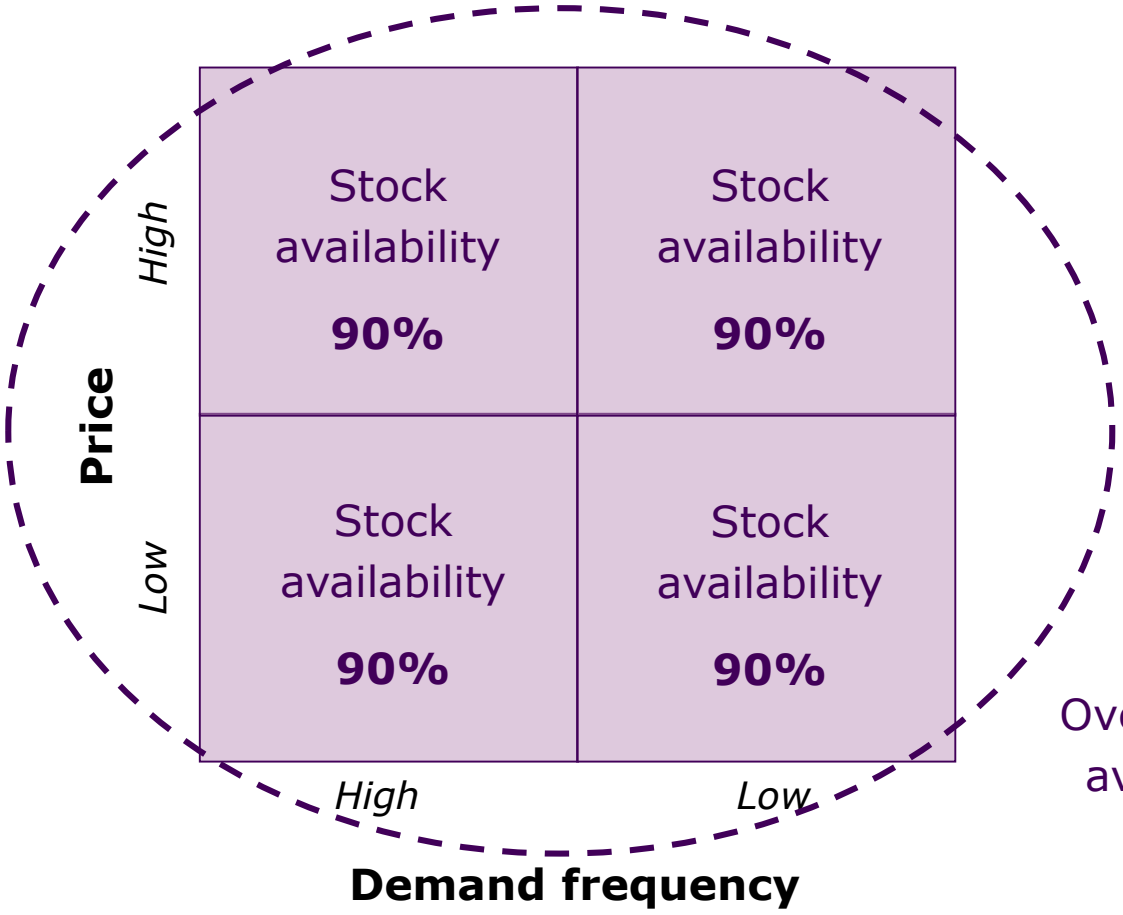




Classification & differentiation (1)

Differentiating stock availability

Situation WITHOUT differentiated stock availability



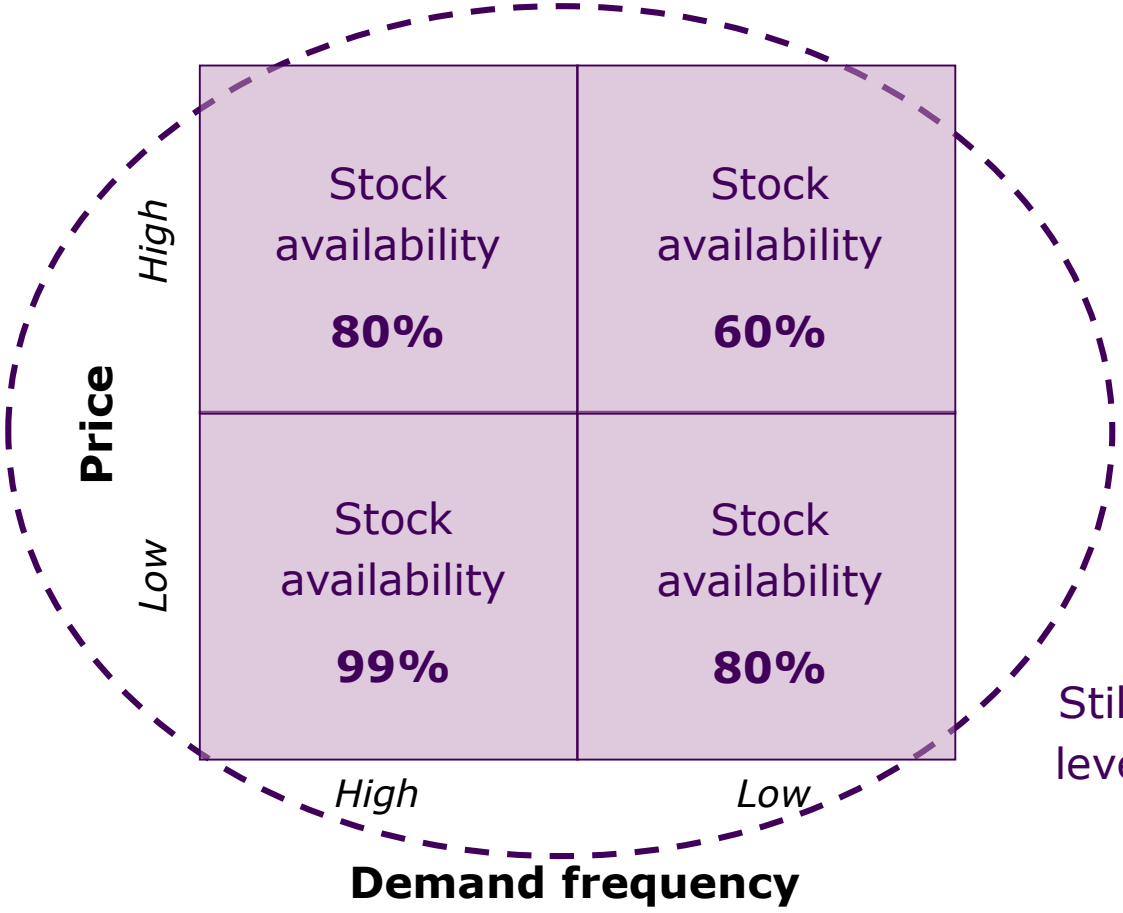
Overall stock availability

90%

Classification & differentiation (2)

Differentiating stock availability

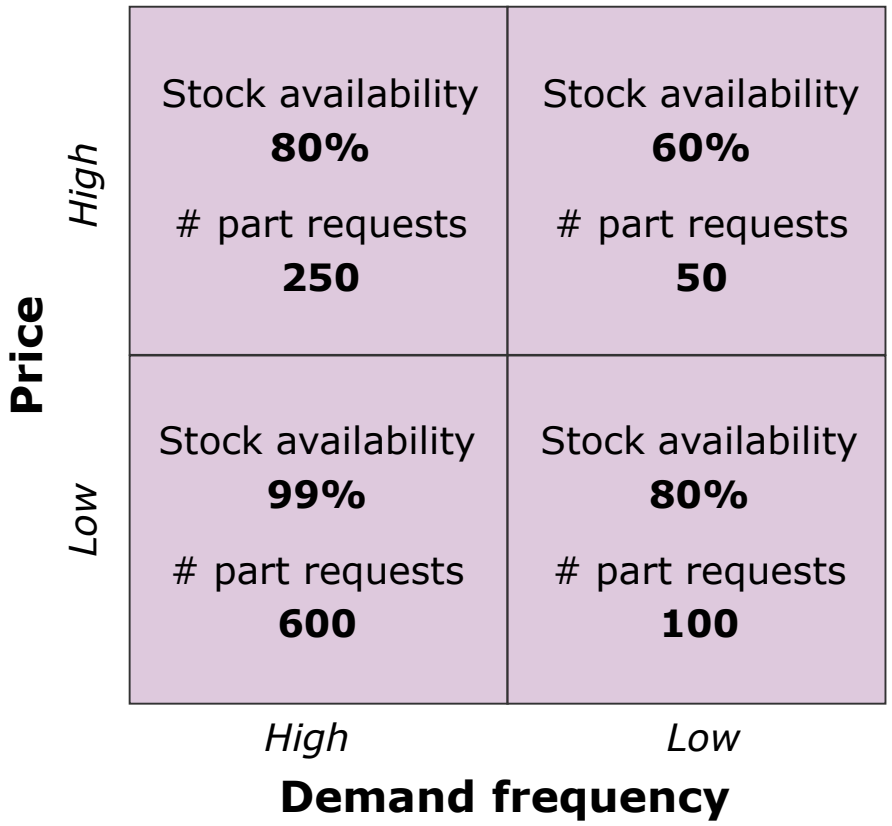
Situation WITH differentiated stock availability



Still a service level of 90%?

Classification & differentiation (3)

Differentiating stock availability



What is the overall stock availability?

Stock availability$_{overall}$ =

((600 * 99%) + (100 * 80%) +

(250 * 80%) + (50 * 60%)) / 1000

= 904 / 1000

= **90.4%**

An overall stock availability of 90% can be achieved by differentiating, using less working capital.

KPI Management