Pareto analysis-simplified

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What is it ?

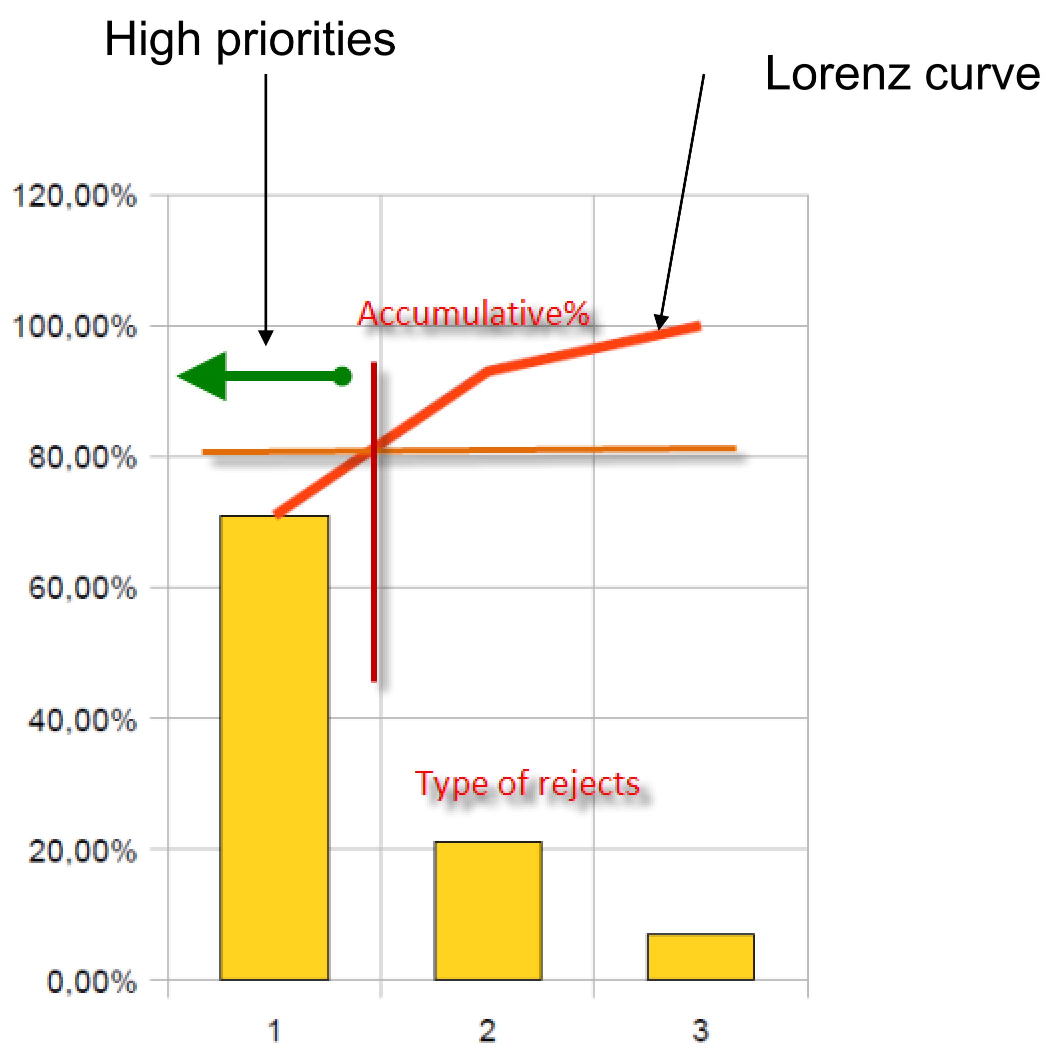
- tool to specify priorities
- which job have to be done earlier than the others
- which rejects must be solved firstly
- which product gives us the biggest revenues
- 80|20 rule

How to construct Lorenz Curve and Pareto chart

- list of causes (type of rejects) in %
- table where the most frequent cause is always on the left side of the graph

Reject	Type	Importance	Importance (%)	Accumulative (%)
1	Bad size	10	71%	71 %=71%
2	Bad material	3	21 %	92%=71%+21%
3	Rust	1	8%	100 %=92%+8%

Pareto chart



Use of PA in Inventory Management

- ABC analysis = Always Better Control
- Use in Selective Inventory Control based on different criteria :
  - VALUE ($\sum(Annual\ demand\ * Unit\ price)$- ABC
  - CRITICALITY (Vital, Essential, Desirable) = VED
  - USAGE FREQUENCY (Fast, Slow, Non moving) = FSN

Statements I.

- ABC analysis divides an inventory into three categories :
  - "A items" with very tight control and accurate records
  - "B items" with less tightly controlled and good records
  - "C items" with the simplest controls possible and minimal records.

Statements II.

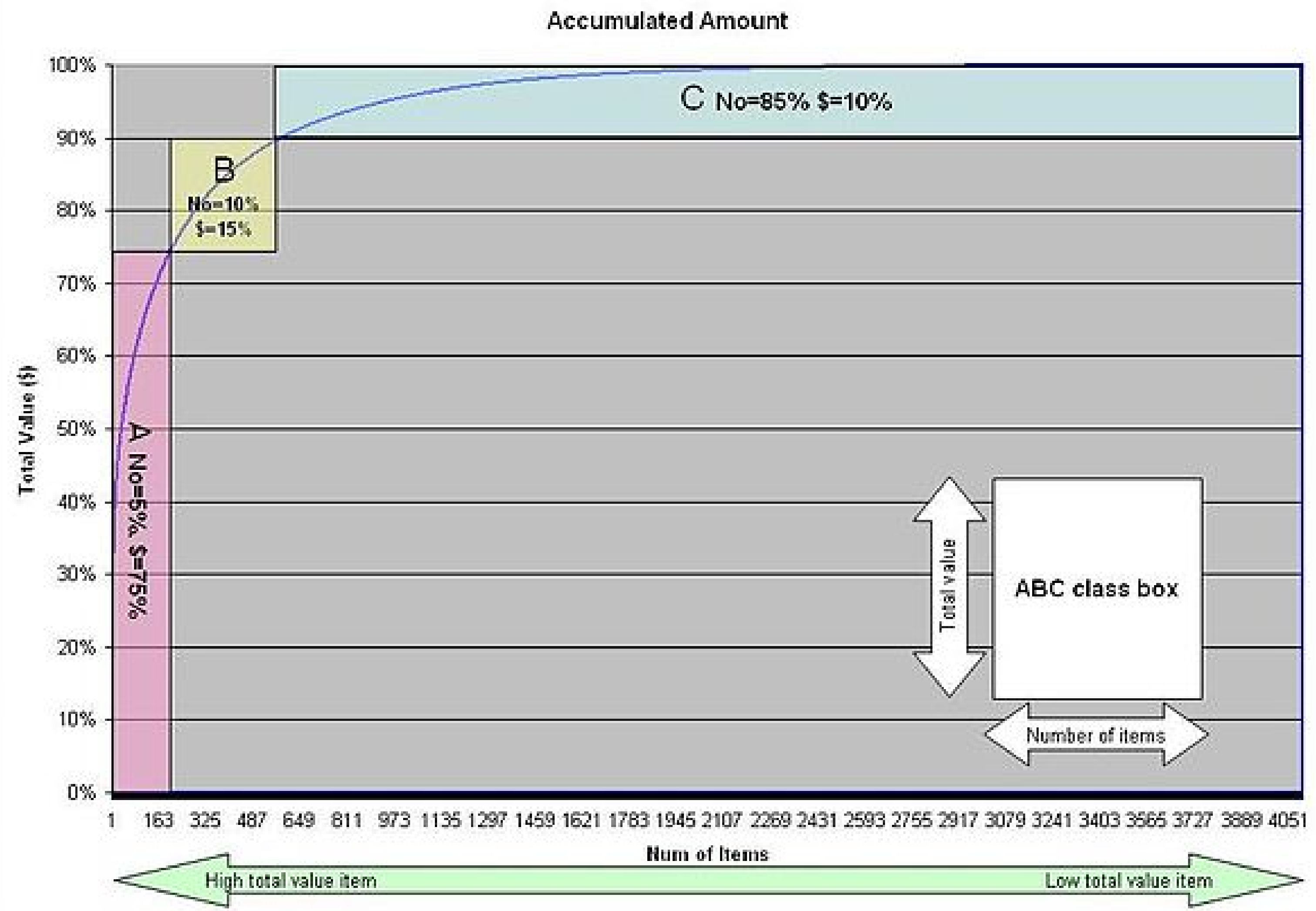
- The ABC analysis suggests, that inventories of an organization are not of equal value
- The inventory is grouped into three categories (**A, B, and C**) in order of their estimated importance.

Example of possible allocation into categories

- **A'** items – 20% of the items accounts for 70% of the annual **consumption** value of the items.
- **'B'** items - 30% of the items accounts for 25% of the annual **consumption** value of the items.
- **'C'** items - 50% of the items accounts for 5% of the annual **consumption** value of the items

Beware that **20+30+50=100** and **70+25+5=100**

Example of possible categories allocation-graphical representation (4051 items in the stock)



ABC Distribution

Minor difference from distribution mentioned before !!

ABC class	**Number of items**	**Total amount required**
A	10%	70%
B	20%	20%
C	70%	10%
Total	**100%**	**100%**

Objective of ABC analysis

- Rationalization of ordering policies
  - Equal treatment

    OR
  - Preferential treatment

See next slide

Equal treatment

Item code	Annual consumption (value)	Number of orders	Value per order	Average inventory
1	60000	4	15000	7500
2	4000	4	1000	500
3	1000	4	250	125

TOTAL INVENTORY (EQT) **8125**

1. Value per order= Annual consumption/Numer of orders

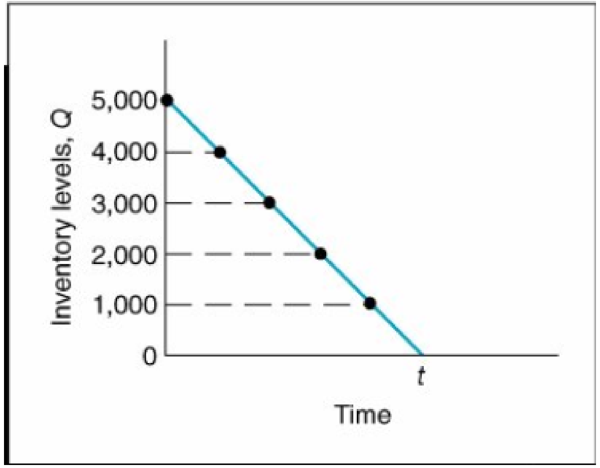
2. Average inventory = Value per order/2 see next slide which is taken from EOQ simplified presentation

Carrying cost (will be presented next slide)

Average inventory (carrying) cost =

To verify this relationship, we can specify any number of points values of Q over the entire time period, t , and divide by the number of points. For example, if Q = 5,000, the six points designated from 5,000 to 0, as shown in shown figure, are summed and divided by 6:

$$\text{average inventory} = \frac{5{,}000 + 4{,}000 + 3{,}000 + 2{,}000 + 1{,}000 + 0}{6} = 2{,}500$$

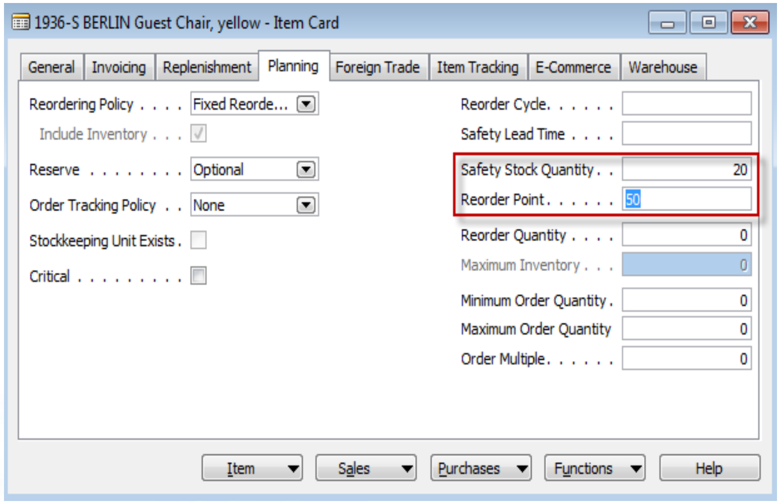


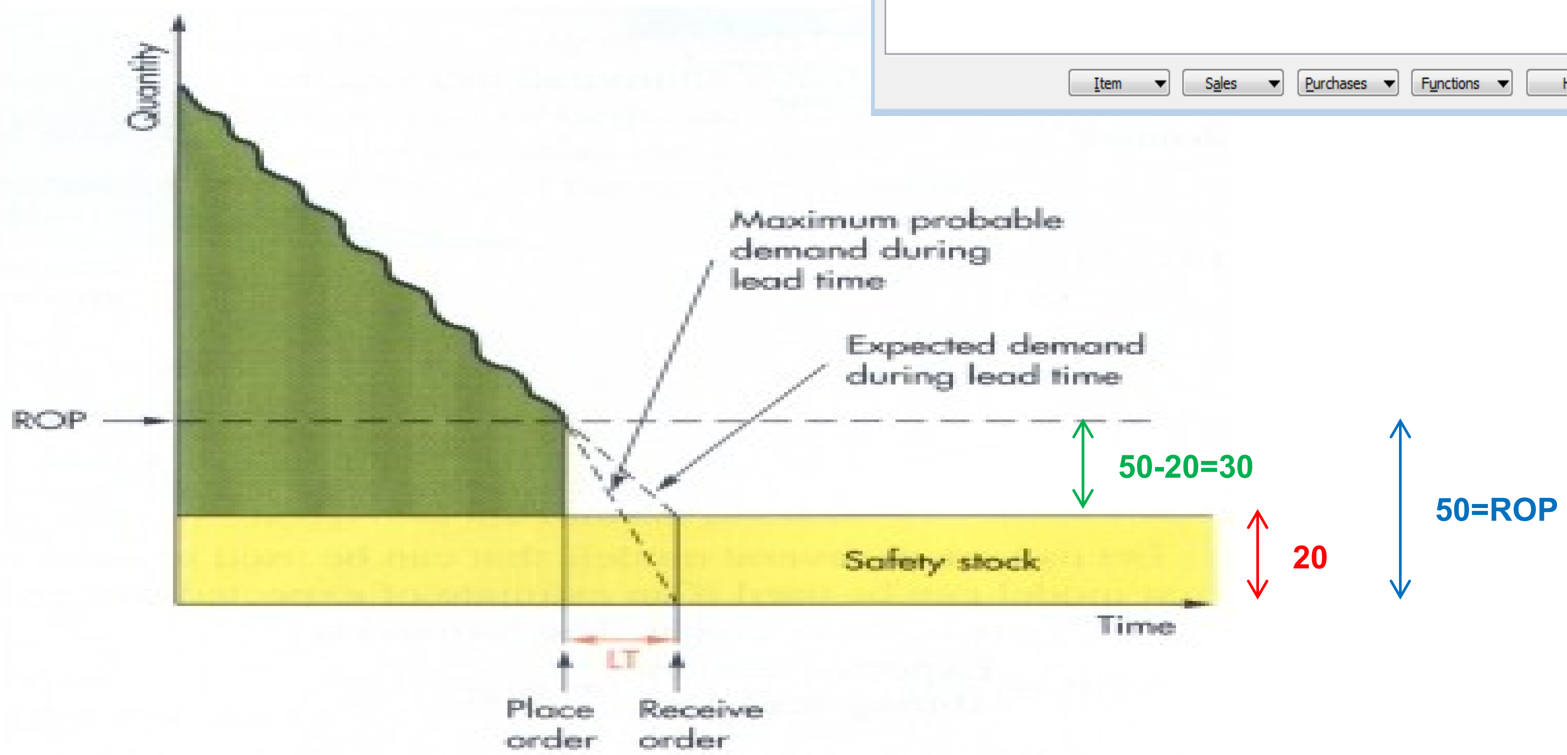
Preferential treatment

Item code	Annual consumption (value)	Number of orders	Value per order	Average inventory
1	60000	8	7500	3750
2	4000	3	1333	666
3	1000	1	1000	500

Determination of the Reorder Point (**ROP**)

- **ROP**=expected demand during lead time + safety stock





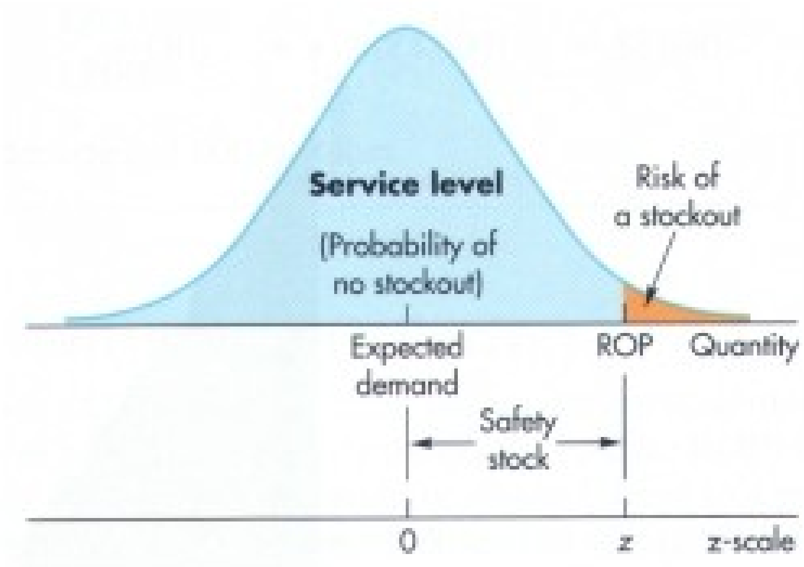
Determination of the Reorder Point (ROP)

(home study)

- **ROP =** expected demand during lead time + $z^* \sigma_{dLT}$

where **z** = number of standard deviations and

$\boldsymbol{\sigma_{dLT}}$ **=** the standard deviation of lead time demand and $z^* \sigma_{dLT}$ =Safety Stock



Example

(home study)

- The manager of a construction supply house determined knows that demand for sand during lead time averages is **50** tons.
- The manager knows, that demand during lead time could be described by a normal distribution that has a mean of 50 tons and a standard deviation of 5 tons
- The manager is willing to accept a stock out risk of no more than 3 percent

Example-data

(home study)

- **Expected lead time averages** = 50 tons.
- $\boldsymbol{\sigma}_{\mathbf{dLT}}$ = 5 tons
- **Risk** = 3 % max
- **Questions :**
  - What value of **z** (number of standard deviation)is appropriate?
  - How much safety stock should be held?
  - What reorder point should be used?

Example-solution

(home study)

- **Service level =**1,00-0,03 (risk) =0,97 and from probability tables you will get z= +1,88

See next slide with probability table

Probability table

STANDARD NORMAL DISTRIBUTION: Table Values Represent AREA to the LEFT of the Z score.

Z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.50000	.50399	.50798	.51197	.51595	.51994	.52392	.52790	.53188	.53586
0.1	.53983	.54380	.54776	.55172	.55567	.55962	.56356	.56749	.57142	.57535
0.2	.57926	.58317	.58706	.59095	.59483	.59871	.60257	.60642	.61026	.61409
0.3	.61791	.62172	.62552	.62930	.63307	.63683	.64058	.64431	.64803	.65173
0.4	.65542	.65910	.66276	.66640	.67003	.67364	.67724	.68082	.68439	.68793
0.5	.69146	.69497	.69847	.70194	.70540	.70884	.71226	.71566	.71904	.72240
0.6	.72575	.72907	.73237	.73565	.73891	.74215	.74537	.74857	.75175	.75490
0.7	.75804	.76115	.76424	.76730	.77035	.77337	.77637	.77935	.78230	.78524
0.8	.78814	.79103	.79389	.79673	.79955	.80234	.80511	.80785	.81057	.81327
0.9	.81594	.81859	.82121	.82381	.82639	.82894	.83147	.83398	.83646	.83891
1.0	.84134	.84375	.84614	.84849	.85083	.85314	.85543	.85769	.85993	.86214
1.1	.86433	.86650	.86864	.87076	.87286	.87493	.87698	.87900	.88100	.88298
1.2	.88493	.88686	.88877	.89065	.89251	.89435	.89617	.89796	.89973	.90147
1.3	.90320	.90490	.90658	.90824	.90988	.91149	.91309	.91466	.91621	.91774
1.4	.91924	.92073	.92220	.92364	.92507	.92647	.92785	.92922	.93056	.93189
1.5	.93319	.93448	.93574	.93699	.93822	.93943	.94062	.94179	.94295	.94408
1.6	.94520	.94630	.94738	.94845	.94950	.95053	.95154	.95254	.95352	.95449
1.7	.95543	.95637	.95728	.95818	.95907	.95994	.96080	.96164	.96246	.96327
1.8	.96407	.96485	.96562	.96638	.96712	.96784	.96856	.96926	.96995	.97062
1.9	.97128	.97193	.97257	.97320	.97381	.97441	.97500	.97558	.97615	.97670

Example-solution

(home study)

- **Service level =**1,00-0,03 =0,97 and from probability tables we have got : z= +1,88
- **Safety stock = z * σ_{dLT}** = 1,88 * 5 =9,40 tons
- **ROP** = expected lead time demand + safety stock = 50 + 9.40 = **59.40 tons**
- ***For z=1 service level =84,13 %***
- ***For z=2 service level= 97,72 %***
- ***For z=3 service level = 99,87% (see six sigma)***

ABC and **VED** and service levels

A items should have low level of service level (0,8 or so)

B items should have low level of service level (0,95 or so)

C items should have low level of service level (0,95 to 0,98 or so)

D items should have low level of service level (0,8 or so)

E items should have low level of service level (0,95 or so)

V items should have low level of service level (0,95 to 0,98 or so)

Matrix

High cost of stockout

decreasing ↑

	V	E	D
A	0.80	0.75	0.6
B	0.95	0.90	0.85
C	0.99	0.97	0.95

→ decreasing

Resource : https://www.youtube.com/watch?v=tO5MmOBdkxk
Prof. Arun Kanda (**IIT**), 2003