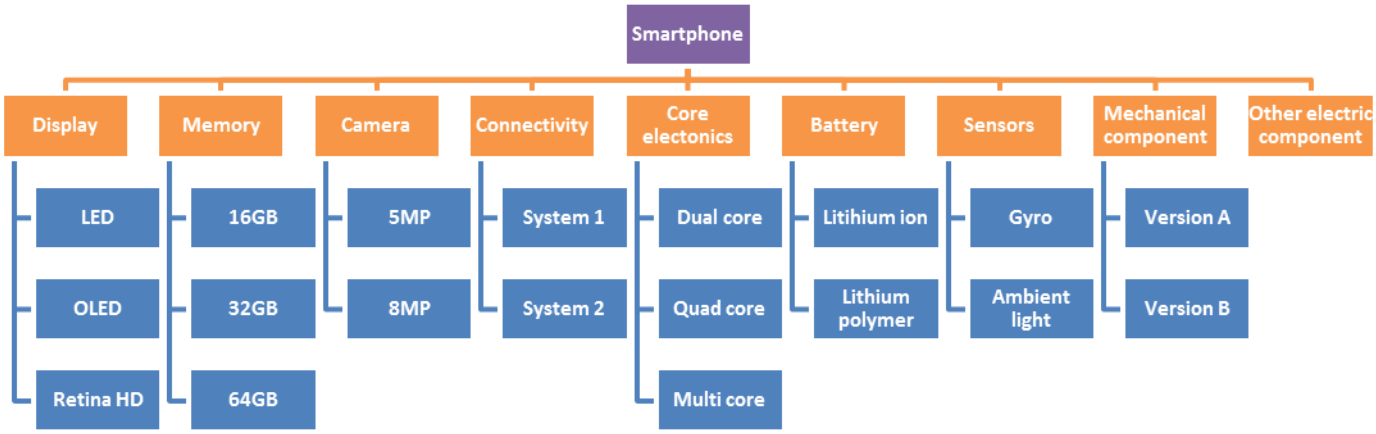
LEAN EXAMPLES AND EXERCISES

An high-tech company designs and develops consumer electronics, computer software, and personal computers in different areas. In the assembling of its smart-phone, the main items can be grouped as followed:

- Display: LED, OLED, Retina HD;
- Memory: 16GB, 32GB, 64GB;
- Camera: 5MP, 8MP;
- Connectivity: system 1, system 2;
- Core electronics: dual core, quad core, multi core;
- Battery: lithium ion, lithium polymer;
- Sensors: gyro, ambient light;
- Mechanical component: type A, type B;
- Other electric component



You are the material manager and it is asked you optimize the inventory and in general the warehouse organization.

In the table 1 there are the data you collected from the system.

Try to carry out and ABC analysis for usage, for average stock and ABC cross analysis.

Item	Consumption $[pieces/year]$	Unit value $[\$/piece]$
LED display	6000	20
OLED display	46500	42
Retina HD display	10500	48
Memory 16GB	14500	8
Memory 32GB	39500	13
Memory 64GB	9500	16
Camera 5MP	45500	16
Camera 8MP	15500	23
Connectivity system 1	18500	5
Connectivity system 2	36500	9
Core electronic dual	5500	40
Core electronic quad	48500	50
Core electronic multi	7000	58
Battery lithium ion	40500	10
Battery lithium polymer	14500	18
Sensors gyro	18500	3
Sensors ambient light	36500	5
Mechanical component version A	9500	20
Mechanical component version B	54500	18
Other electric component	68000	27

Table 1 – Annual consumption data

Solution:

Different methodologies can be adopted in order to obtain a certain selection of the items previously listed. The ABC analysis can be a possible method to support the material management. It is a categorization method which divides the items into three categories in order to identify the items that have a significant impact on the overall inventory cost.

The variables used are:

- usage value
- average stock value

where:

$$Usage\ Value = C \cdot v \ [\$/period]$$

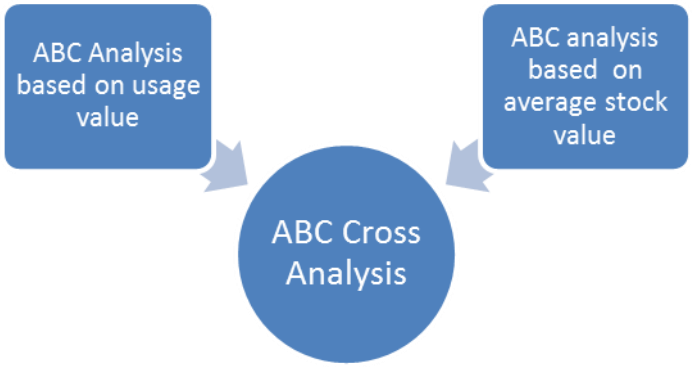
$$Average\ Stock\ Value = \bar{S} \cdot v \ [\$/period]$$

C = consumption during period of analysis $[pieces/period]$

v = unit value $[\$/piece]$

$\bar{S}$ = average stock during period of analysis $[pieces/period]$

The simultaneous use of both analyses allows to obtain an ABC cross analysis.



With the use of the ABC Cross Analysis it is possible to have more significant information and address the resources to the most fruitful item in terms of stock optimization.

ABC Analysis based on usage value

Considering the data illustrated in table below, an ABC analysis based on the usage value can be performed adopting as thresholds for each group the following limit values (for example):

$$v_A = 70\%, v_B = 90\%.$$

Item	Consumption $[pieces/year]$	Unit value $[\$/piece]$
LED display	6000	20
OLED display	46500	42
Retina HD display	10500	48
Memory 16GB	14500	8
Memory 32GB	39500	13
Memory 64GB	9500	16
Camera 5MP	45500	16
Camera 8MP	15500	23
Connectivity system 1	18500	5
Connectivity system 2	36500	9
Core electronic dual	5500	40
Core electronic quad	48500	50
Core electronic multi	7000	58
Battery lithium ion	40500	10
Battery lithium polymer	14500	18
Sensors gyro	18500	3
Sensors ambient light	36500	5
Mechanical component version A	9500	20
Mechanical component version B	54500	18
Other electric component	68000	27

A calculation of usage value of items can be obtained through this figure. In other words with a product between the yearly consumption and the unit value we are answering to this question: **"For which components the company spends the highest amount of money?"**

The calculation is performed in the table 2.

Item	Consumption $[pieces/year]$	Unit value $[\$/piece]$	Usage value $[\$/year]$
LED display	6000	20	120000
OLED display	46500	42	1953000
Retina HD display	10500	48	504000
Memory 16GB	14500	8	116000
Memory 32GB	39500	13	513500
Memory 64GB	9500	16	152000
Camera 5MP	45500	16	728000
Camera 8MP	15500	23	356500
Connectivity system 1	18500	5	92500
Connectivity system 2	36500	9	328500
Core electronic dual	5500	40	220000
Core electronic quad	48500	50	2425000
Core electronic multi	7000	58	406000
Battery lithium ion	40500	10	405000
Battery lithium polymer	14500	18	261000
Sensors gyro	18500	3	55500
Sensors ambient light	36500	5	182500
Mechanical component version A	9500	20	190000
Mechanical component version B	54500	18	981000
Other electric component	68000	27	1836000

Table 2 – Usage Value of components

Once you have performed the previous evaluation, the materials can be structured in a diminishing order through their usage value. A calculation of the total accumulated value and the percentage of this value is necessary perform in order to conclude the analysis.

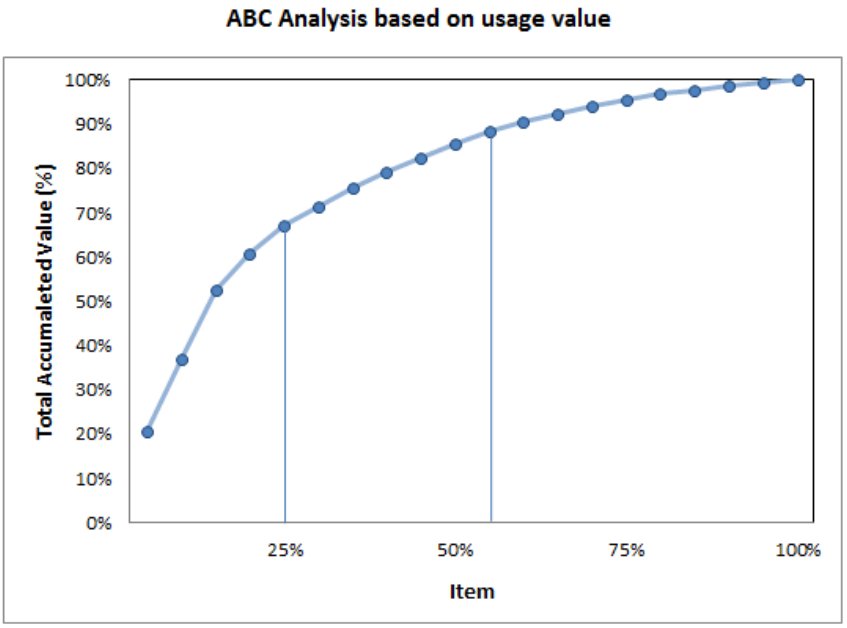
In other words, by sorting from the highest, you have immediately an idea on which component are the more important (in terms on money) in your yearly cash flow.

To calculate the accumulate value a simple spreadsheet is strongly recommended.
The result is showed in Table 3.

Item	Usage value $[\$/year]$	Total accumulated value $[\$/year]$	Total accumulated value %
Core electronic quad	2425000	2425000	20,5%
OLED display	1953000	4378000	37,0%
Other electric component	1836000	6214000	52,5%
Mechanical component B	981000	7195000	60,8%
Camera 5MP	728000	7923000	67,0%
Memory 32GB	513500	8436500	71,3%
Retina HD display	504000	8940500	75,6%
Core electronic multi	406000	9346500	79,0%
Battery lithium ion	405000	9751500	82,5%
Camera 8MP	356500	10108000	85,5%
Connectivity system 2	328500	10436500	88,3%
Battery lithium polymer	261000	10697500	90,5%
Core electronic dual	220000	10917500	92,3%
Mechanical component A	190000	11107500	93,9%
Sensors ambient light	182500	11290000	95,5%
Memory 64GB	152000	11442000	96,8%
LED display	120000	11562000	97,8%
Memory 16GB	116000	11678000	98,7%
Connectivity system 1	92500	11770500	99,5%
Sensors gyro	55500	11826000	100%

Table 3 – Total Accumulated Value and Accumulated Percentage

According to these values: $v_A = 70\%$ and $v_B = 90\%$, the items belonging to group A are 25%, another 30% constitute group B and 45% of items are part of group C. A summary of the analysis is shown in following table.



How can the material manager (you) use these data?

Mainly these data could suggest to try to have a discount on the 25% of the pieces that represent the 70% of the annual usage. It should be clear that spending resources in having 5% of cost reduction on OLED display in better than the same on the component memory 16 GB.

Another use could be linked to the logistic. It should be better to have the most used component close to the point of use in the assembly line or in the most comfortable place in the warehouse. In this way the wastes of the "excess of movement" and "excess of transportation" will be reduced.

ABC Analysis based on average stock value

Now let us focus the inventory situation from a different point of view. Considering the data illustrated in table 4, an ABC analysis based on the average stock value can be performed adopting as thresholds for each group the following limit values: $v_A = 70\%$, $v_B = 90\%$.

Item	Average stock $[pieces/year]$	Unit value $[\$/piece]$
LED display	2220	20
OLED display	5580	42
Retina HD display	892,5	48
Memory 16GB	580	8
Memory 32GB	3436,5	13
Memory 64GB	332,5	16
Camera 5MP	1365	16
Camera 8MP	620	23
Connectivity system 1	4625	5
Connectivity system 2	1496,5	9
Core electronic dual	715	40
Core electronic quad	4850	52
Core electronic multi	1540	58
Battery lithium ion	1498,5	10
Battery lithium polymer	4567,5	18
Sensors gyro	6475	3
Sensors ambient light	11680	5
Mechanical component version A	1710	20
Mechanical component version B	7085	18
Other electric component	1700	27

Table 4 – Average Stock of components

A calculation of average stock value of items can be obtained through these tables.

Item	Average stock [$pieces/year$]	Unit value [$/piece]	A.S. value [$/year]
LED display	2220	20	44400
OLED display	5580	42	234360
Retina HD display	892,5	48	42840
Memory 16GB	580	8	4640
Memory 32GB	3436,5	13	44674,5
Memory 64GB	332,5	16	5320
Camera 5MP	1365	16	21840
Camera 8MP	620	23	14260
Connectivity system 1	4625	5	23125
Connectivity system 2	1496,5	9	13468,5
Core electronic dual	715	40	28600
Core electronic quad	4850	52	252200
Core electronic multi	1540	58	89320
Battery lithium ion	1498,5	10	14985
Battery lithium polymer	4567,5	18	82215
Sensors gyro	6475	3	19425
Sensors ambient light	11680	5	58400
Mechanical component version A	1710	20	34200
Mechanical component version B	7085	18	127530
Other electric component	1700	27	45900

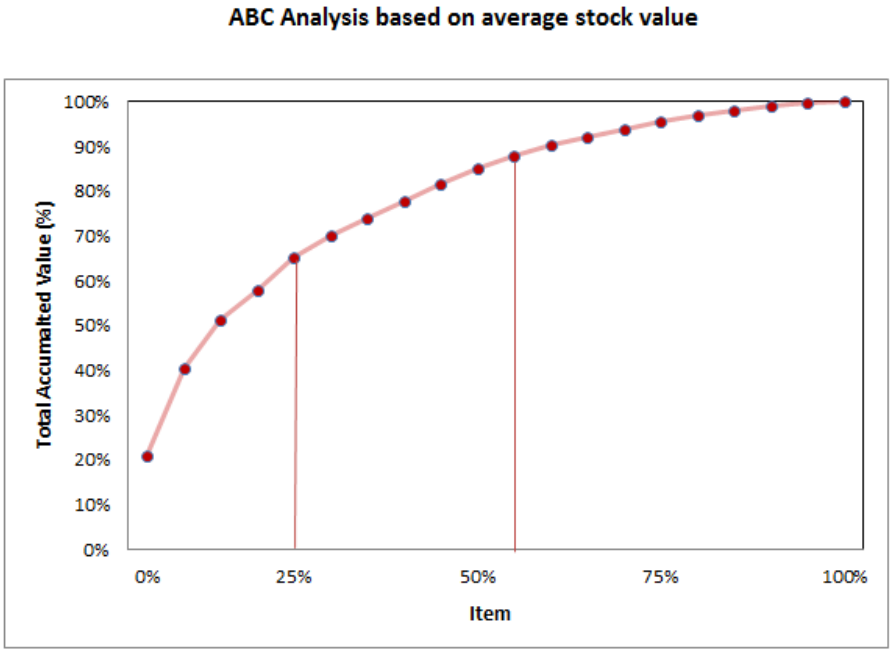
As previously shown the items can be structured in a diminishing order through their average stock value, and then calculate the total accumulated value and the percentage of this value.

Item	A.S. value [pieces /year]	Total accumulated value [$/piece]	Total accumulated value %
Core electronic quad	252200	252200	21,0%
OLED display	234360	486560	40,5%
Mechanical component B	127530	614090	51,1%
Core electronic multi	89320	703410	58,5%
Battery lithium polymer	82215	785625	65,4%
Sensors ambient light	58400	844025	70,2%
Other electric component	45900	889925	74,1%
Memory 32GB	44674,5	934599,5	77,8%
LED display	44400	978999,5	81,5%
Retina HD display	42840	1021840	85,0%
Mechanical component A	34200	1056040	87,9%
Core electronic dual	28600	1084640	90,3%
Connectivity system 1	23125	1107765	92,2%
Camera 5MP	21840	1129605	94,0%
Sensors gyro	19425	1149030	95,6%
Battery lithium ion	14985	1164015	96,9%
Camera 8MP	14260	1178275	98,1%
Connectivity system 2	13468,5	1191743	99,2%
Memory 64GB	5320	1197063	99,6%
Memory 16GB	4640	1201703	100%

A calculation of stock value of items can be useful to answer to this question:

”**For which components the company stocks the highest amount of money?”**

According to these values: $v_A = 70\%$ and $v_B = 90\%$, class A items are 25%, class B items are 30% and 45% of items are part of group C.



Looking at the table and graph it should be clear that the 25% of the items represent the 70% of the stock.

How can the material manager (you) use these data?

Mainly these data could be useful to address the resources to investigate if the amount of stock of the more important items are in the right amount or not.

Then, if some of them are consumables, they could try to reduce the usage for piece.

Finally, the company should address on the 25% of the items the resources to promote the “just in time” in partnership with the supplier.

ABC cross analysis

There is a way to have a very complete set of information in order to prioritize the items to focus on and having good results in terms inventory management. This method is called ABC Cross Analysis.

ABC cross analysis integrates the information of the two previous analyzes. It leads to items classification in more classes, so as to perform a more detailed analysis. in particular the items are prearranged in a matrix that defines the following classes: AA, AB, AC, BA, BB, BC, CA, CB, CC.

			Consumption						Tot	
			A		B		C			
Stock	A	*Items*	3	15%	1	5%	1	5%	5	25%
		A. stock value	614090	51,1%	89320	7%	82215	7%	785625	65,4%
		Usage value	5359000	45,3%	406000	3%	261000	2%	6026000	51,0%
	B	*Items*	1	5%	2	10%	3	15%	6	30%
		A.stock value	45900	3,8%	87514,5	7%	137000	11%	270414,5	22,5%
		Usage value	1836000	15,5%	1017500	9%	492500	4%	3346000	28,3%
	C	*Items*	1	5%	3	15%	5	25%	9	45,0%
		A.stock value	21840	2%	42713,5	4%	81110	7%	145663,5	12,1%
		Usage value	728000	6%	1090000	9%	636000	5%	2454000	20,8%
	Tot	*Item*	5	25,0%	6	30%	9	45%	20	100%
		A.stock value	681830	56,7%	219548	18,3%	300325	25,0%	1201703	100%
		Usage value	7923000	67,0%	2513500	21,3%	1389500	1,7%	11826000	100%

A summary of the analysis is shown in following table.

Category	Items
AA	**Core electric quad – OLED display – Mechanical component B**
AB	**Core electronic multi**
AC	**Battery lithium polymer**
BA	**Other electric component**
BB	**Memory 32GB - Retina HD display**
BC	**Mechanical component A - LED display - Sensors ambient light**
CA	**Camera 5MP**
CB	**Battery lithium ion - Camera 8MP - Connectivity system 2**
CC	**Core electronic dual - Connectivity system 1 - Sensors gyro - Memory 64GB - Memory 16GB**

To carry out this analysis you have to use spreadsheet with pivot or you can do it manually by starting with the items of the first analysis and comparing the classification with the second diagram.

Questions to stimulate conversations:

Which items are better managed?
Which items show inconsistencies?
What are the most critical areas?
How the system can be improved?
Which management methods would you use for each class?

Let us explain in detail the meaning of the classes:

		Consumption		
		A	**B**	**C**
Stock	**A**	**Core electric quad OLED display Mechanical component B**	**Core electronic multi**	**Battery lithium polymer**
	B	**Other electric component**	**Memory 32GB Retina HD display**	**Mechanical component A LED display Sensors ambient light**
	C	**Camera 5MP**	**Battery lithium ion Camera 8MP Connectivity system 2**	**Core electronic dual Connectivity system 1 Sensors gyro Memory 64GB Memory 16GB**

Each individual class can be managed through a specific management method.
The classes collocated along the main diagonal show an equilibrated system. The classes over the main diagonal are managed in *an inefficient way*. On the other hand the classes below the main diagonal are managed in a *more efficient way*.

AA class:

This category is characterized by a current management system (high consumption corresponds to high stock). However, a valuation for a more efficient system could be taken into consideration.

AC class:

This category is critical due to the of a risk of high stocks and low consumption. Warehouse management of these items must be checked again and improved.

CA class:

This category represents the best conditions for these items which are managed through an efficient system. No intervention is needed for these products, but it necessary to control the out of stock.

AB, BA, CB, BC classes:

These categories are in intermediate situations. These items could be shifted diagonally along the matrix with opportune management solutions.