The problems have been translated by students and the english spelling and grammar has not been checked. If you find anything that should be rewritten or reexplained please make me know it, and I will correct it. Pls, if doing so send me an email to jpgarcia@omp.upv.es with the following data: page, paragraph, line how it is now, how should it be

Exampe: page 23
line 215
it says: “I ham”
it should say “I am”

Thanks.

2.1 MERCANONA

Logistics for products of large expending

You work in the department of Logistic of a big distribution enterprise producing products of large expending that has 500 shops in all the national territory.
You have to design the ordering and the distribution of a product (vino italiano espumoso).
It's possible to buy this kind of wine directly in the shops in pallets of 350 bottles each.
Your work is to find the most economic way to transport the bottles to the shops.

You have a central warehouse AC and 5 regional warehouses AR. Each regional warehouse handles 100 shops.
In this enterprise you have 2 options for the ordering:

- *To buy from the central warehouse and to distribute to each shop in a continuous way.*
- *To buy from the regional warehouses with a periodical reordering.*

You have to evaluate all the costs: transport costs, costs of storage.

You have to use this datum:

- *number of weeks in a year: 52*
- *level of service of the client: 99,99%*
- *Time to deliver the product from italy: 2 weeks*
- *Cost of each bottle: 2€*
- *Number of bottles of each pallet: 350*
- *Max number of pallets on each camion: 33*
- *Number of shops: 500*
- *Number of regional warehouses: 5*
- *Number of central warehouses: 1*
- *Request of bottles each week: 12 bottles*
- *Typical deviation of the request for each shop: 5 bottles*
- *Cost for the transport of each camion: 800e for trip*
- *Cost for the transport from AC to the shops: 0,15€*
- *Cost for the transport from AR to the shops: 0,07€*
- *Cost of the storage of each pallet in AC: 210€*
- *" " " AR: 200€*
- *The variation of a sum is the sum of variations*

Solution.

This problem is a double one:

1) the first part is the calculation of the economical lot and the datum of the central warehouse AC. The request is the quantity of the 500 shops. The costs are the ones of the camion.
2) The second part is to calculate the economical period of reordering for each warehouse AR. The request is the quantity of the 100 shops. The costs are the ones of the camion.

***We know that*:**

C_L = 800 €
bottles on each pallet: 350
pallets on each camion: 33
bottles on each camion: 11550
H = 52 weeks
PA = 2 weeks
z = 4

Solution of the first part:

500 shops

$$d = 12 * 500 = 6000$$

$$\sigma = 5\sqrt{500} = 111{,}8$$

$$h = \frac{210}{350} = 0{,}6$$

Lot without restrictions

$$Q = \sqrt{\frac{2CD}{h}} = 28844 bot$$

Lot with restrictions

quantity that goes in a camion = 11.550 bot

SS (security stock)

$$ss = \sigma z\sqrt{PA} = 632{,}4$$

Point of reordering

$$PR = dPA + ss = 6000 * 2 + 632{,}4 = 12633$$

Cost of transport from the factory to AC

$$\left(\frac{D}{11550}\right) * C = 21610{,}2$$

Costs of warehouse in AC

$$h\left(\frac{Q}{2} + ss\right) = 3844{,}8$$

Costs of the transport to the shops

$$(H * d) * 0{,}15 = 46800$$

Total costs

$$74817 \frac{e}{year}$$

Cost of each bottle

$$0{,}24e$$

Solution of the second part:

100 shops

$$d = 6000$$

$$\sigma = 5\sqrt{100} = 50$$

$$h = \frac{200}{350} = 0{,}6$$

Period without restrictions

$$T = \sqrt{\frac{2CH}{hd}} = 11{,}02 weeks$$

Period with restrictions

$$\frac{1}{\sqrt{2}} T = 7{,}79 \leq 2^n T_B \qquad n = 3 \qquad PR = 8 weeks$$

SS

$$ss = \sigma z \sqrt{PA + PR} = 632{,}4$$

Max level

$$N_{max} = d(PA + PR) + ss = 12633$$

Cost of transport from the factory to AC

$$\frac{52}{8}C = 5200$$

Costs of warehouses AR

$$\frac{h*(N_{max} - dPA + ss)}{2} = 3096{,}8$$

Costs of transport to the shops from AR

$$(Hd)*0{,}07 = 4368$$

Total costs for each AR

$$12664{,}8\frac{e}{year}$$

Cost of each bottle

$$0{,}203e$$

2.10 PLANNING REORDERINGS

En enterprise is planning the distribution of the purchase of a product.

The cost of the product is of 800€/pallet and the cost of storage is the 20% of the annual cost.

To transport the product the enterprise has to pay a transport enterprise: 700€/camion plus 30€ for each pallet. The capacity of the camion is of 33 pallets and needs 15 days to transport them.

The request is of 3,5 pallets each week with a typical deviation of 0,5 pallets. The service of the client if the 99%.

To plan the purchase they have to:

a) *decide de PR point (time or reordering)*
b) *plan the Periodical reordering using Tbase = 1*
c) *calculate the cheapest policy.*

3) *In a year you have 52 weeks*

SC %	*z*
-	*1,65*
97,5	*1,96*
99	*2,33*
99,5	*2,58*

Solution.

We know that

D = 3,5 pal/week
Pap = 15 days
Pprev = 1 week (3,5 pal/week)
σ = 0,5
Cl = 700€/camion
Weeks/year = 52
Client service = 99,9%
Z = 2,33
Tb = 1 week
C1 = 800€/pal for purchase
C2 = 30€/pal for transp

REORDERING POINT (PR)

$$Q = \sqrt{\frac{2*700*3,5*52}{0,2*(800+30)}} = 39,18$$ but the camion can transport only 33

$$SS = 2,33*0,5*\sqrt{2} = 1,65$$

$$PR = 3,5*2+1,65 = 8,65$$

PERIODICAL REORDERING (AP)

$$T = \sqrt{\frac{2*700*52}{0,2*(800+30)+3,5}} = 11,19 weeks$$

$$\frac{11,9}{\sqrt{2}} \leq 2^n * 1 \qquad n = 3 \qquad T = 2^3 * 1 = 8 weeks$$

$$N_{max} = 3,5*(2+8)+2,33*0,5*\sqrt{\frac{(2+8)}{1}}$$

SS = 3,68

Nmax = 38,68

TOTAL COSTS

$$Cpr = 700*\left(\frac{3,5*53}{33}\right)+0,2*(800+30)*[1,65+\left(\frac{33}{2}\right)]+3,5*52*800+3,5*52*30 = 157,934$$

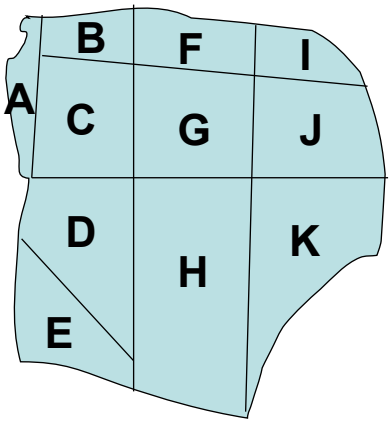
best one..lower costs!

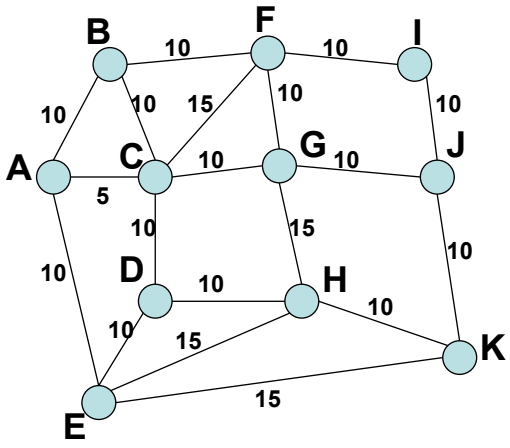
$$Cap = 700*\left(\frac{52}{8}\right)+0,2*(800+30)*[3,68+\left(\frac{35,5*8}{2}\right)]+3,5*52*800+3,5*52*30 = 158,546$$

3.2 NEW SUPERMARKET-CHAIN

A supermarket chain wants to open a new one. They ask you an opinion about where to open it. A person before you analysed the situation.

4) you know how the city is and all the information about the quarters and the demand.





In the table that follows you have the distance in minutes between the centres of the different quarters:

Quarter	X	Y	people	question mil/e	X d	Y d
A	1	5	2000	20	20	100
B	3	6	5000	20	60	120
C	3	5	6000	15	45	75
D	3	3	7000	10	30	30
E	3	2	5000	10	30	20
F	5	7	5000	10	50	70
G	5	5	7000	10	50	50
H	5	3	3000	15	75	45
I	7	7	4000	10	70	70
J	7	5	7000	15	105	75
K	7	3	5000	20	140	60
SUMA	49	51	56000	155	675	715

In the table, X and Y, stand for the centres of each quarter.

The enterprise has shops in the quarters D and K with capacity of selling 16.000 and 24.000 respectively.

5) you can place shops in the quarters A, F and H and it costs 1.000.000, 750.000 and 1.200.000 respectively.
6) Applying the concept of gravity and considering the question served as a negative question, which is the best localization?
7) Considering that the annual costs for the shops are the 50% of the installation cost.

Considering that the question for each centre is the one of the centre itself and the 10% of the other quarters, which is the best option?

8) An enterprise of transports is looking for a partner. At the beginning it is considered that a quarter is covered if the distance from the shop is less than 15 min. The enterprise can help us. Which is the best option?
9) If our mission is to get more people as possible, knowing that a quarter is covered by the centres if the distance is less than 10 min, which is the best option?
10) Knowing that the supplying is daily and that we decide to install a centre in A. Knowing that the security stock is the demand of a day. Which is the cost of storage of each day if we have a annual cost of the 15%, considering 310 days in a year?

- **Applying the method of the centre of gravity, which is the best solution?**
- **Considering costs, which is the best solution?**
- **Having the possibility of working with a distribution company, which is the best solution?**
- **If the objective is to leave the minimum space to the competitor, which is the best solution?**
- **Which is the daily cost of storage?**

Solution

1.

Applying the method of the Centre of Gravity, we have first to calculate the centre of gravity of the actual demand (demand served in D and K).

$$X_G = \frac{\sum_i X_i d_i - 16X_i - 24X_k}{\sum_i d_i - 16 - 24} = 3{,}99$$

$$Y_G = \frac{\sum_i Y_i d_i - 16Y_i - 24Y_k}{\sum_i d_i - 16 - 24} = 5{,}17$$

The nearest is F (5,7)

2.

If we consider the benefits, the one that most benefits is A

k. is near to B,C,D :

d) that have a total question of 45.000e
e) annual costs: 0,5 * 1000 = 500 mil/e
f) annual benefits: 310 (20 + 4,5) = 7595

F) is near to B,C,G,I,J :

- that have a total question of 70.000e

- annual cost: 0,5 * 750 = 375e
- annual benefits: 310 (10 + 7) = 5270 mil/e

H) is near to C,D,E,G,J,K:
- that have a total question of 80.000e
- annual costs: 0,5 * 1200 = 600 mil/e
- annual benefits: 310 * (15 + 8) = 7130 mil/e

3.

If we choose A we can cover zone F,G,I
If we choose F we can cover zone A
If we choose H we can cover A,B,F,I

The best solution is F

4.

The solution is again F

5.

The cost of storage of the centre in A is proportional to de demand in A (2,45 mil/e). As we know from the text, the cost of storage is the 15% of the stock plus el security stock that is the daily demand.

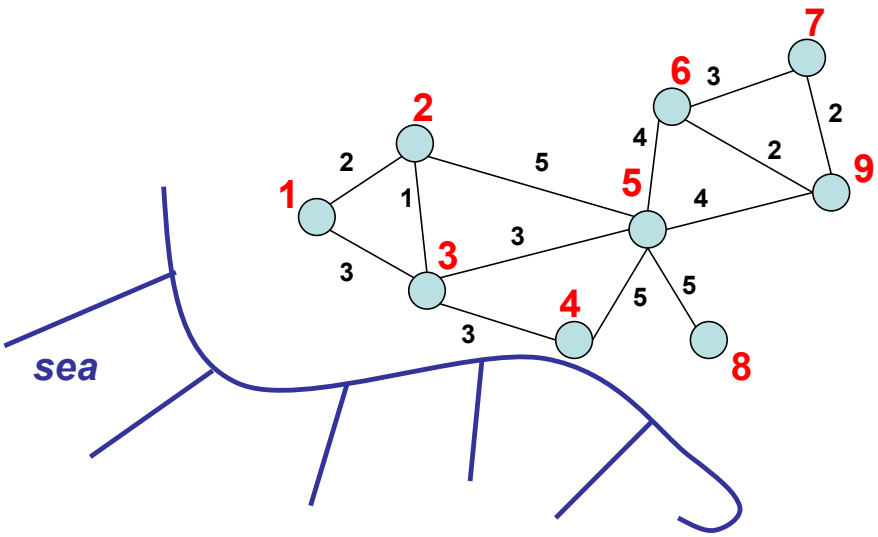
$$\frac{0,15}{310}(12,25 + 24,5) = 17,8€$$

l. THE LORD OF THE RINGS

The Middle Earth is in danger, if we don't destroy the only ring and don't make sure that it falls in Sauro's hands, the evil will capture all the Middle Earth. The reign of the 'dunedain' can't be renewed if the ring isn't destroyed and until it hasn't a legitim rey.

In the last hours news arrived: Sauron is organizing a battle with thousands of monsters. You have to help Aragorn's, Legota's warriors and Gandalf to defend the 9 most important folks of the Middle Earth. You have to decide where to collocate the army knowing that:

- you can't collocate more than an army in each folk
- each army is able to defend the folk in which it is situated and the folks that are not farer than 4 hours.
- In the folks 3 and 7 you can't collocate any armies.
- You have to collocate the minimum number of armies to defend all the folks.
- The monsters aren't able to swim, so you know that they won't come from the sea.



You have to:

g) **How many armies and where?**

h) **Due to an unespected attack of the monster, you have only 2 armies to defend the 9 folks. Knowing the number of the inhabitants of the folks written in the next table, where do you collocate your armies?**

Poblado	1	2	3	4	5	6	7	8	9
Habitants	125	100	150	200	110	50	75	300	125

i) **Which percentage of people can you help?**

SOLUCION.

1)

Populated	Can receive protection from			
1	1	2		
2	1	2	4	5
3	1	2	4	5
4		2	4	
5	2	5	6	9
6		5	6	9
7			6	9
8	8			
9		5	6	9

415

Knowing that you can't collocate an army in 3 and 7

A good solution is to collocate an army in 2,6 and 8 or 2,9 and 8

420

2) you have to see which folk covers the most number of people

Populated						*tot*
1	1	2	3			375
2	1	2	3	4	5	**685**
3						
4		2	3	4		450
5	2	3	5	6	9	535
6	5	6	7	9		360
7						
8			8			300
9	5	6	7	9		360

425

The folks that covers the most number of people is the number 2.

Populated						*tot*
1	all covered					
2	you can't here, you already have					
3	you can't					
4	all covered					
5				6	9	175
6		6	7	9		250
7	you can't					
8			8			**300**
9		6	7	9		250

The second army is collocated in 8 (300 people).

430

The people that are saved are: 685 + 300 = 985, 79,7% of the total (1235).

4.12 Big truck or small truck?

A company buys the products it needs in european pallets (1.2m x 0.8m) with 56 boxes in each one. The daily box demand is 90ut. with a typical deviation of 15 units.

It is supposed that the week has 6 working days, and the year is 52 weeks long. The transport cost deppends on the type of truck used. The pallets can not be piled up.

a) If it is 13,5 m long , this cost is €1000
b) If it is 9,5 m long, €700

Each box has a unitary cost of 25€/unit. Due to the fact that the product has to be kept cold, the storage costs are 35% of price of the stored products. These products expire 30 days after they have left the manufacturing plant.

The level of service has to cover the 99'99%. And the lead time is 3 days.

Define the cheapest reorder point policy, checking that there are not problems due to the expiry.

Suggestions: -Calculate the number of boxes that could be loaded in each type of truck.
-Calculate the optimum batch for each type of supply, taking into account the trucks' limitations. Decide what kind of supplying policy is the best.
- Calculate the security stock and the ROP.
- Check that even in low demand, there will not be expiration problems, and change the previous decisions if necessary.

SOLUTION:

The 13,5 meters long and 2,5m wide truck can carry 33 european pallets, which is 1848 boxes.

On the other hand, the 9'5 meters long truck can only carry 23 pallets, which is 1288 boxes.

For the larger truck:

$$Q = \sqrt{\frac{2 \cdot S.D}{k \cdot Cu}} = \sqrt{\frac{2 \cdot 1000 \cdot 52 \cdot 6 \cdot 90}{0{,}35 \cdot 25}} = 2533{,}27 \text{ boxes}$$

For the smaller one:

$$Q = \sqrt{\frac{2 \cdot S.D}{k \cdot Cu}} = \sqrt{\frac{2 \cdot 700 \cdot 52 \cdot 6 \cdot 90}{0{,}35 \cdot 25}} = 2119{,}6 \text{ boxes}$$

The batch is too large for both trucks, therefore we have to calculate the total cost over possible batchs. We don't take into account the security stock, because it is the same in both cases.

Transport Cost (larger truck)= $1000\frac{52\cdot6\cdot90}{33\cdot56}+0{,}35\cdot25\left(\frac{33\cdot56}{2}\right)=23279€$

Transport Cost (smaller truck)= $700\frac{52\cdot6\cdot90}{23\cdot56}+0{,}35\cdot25\left(\frac{23\cdot56}{2}\right)=20895€$

And as we can see, the cheapest option is using the smaller truck.

The ROP is calculated taking into acount the 3 day long demand plus the security stock.

ROP= $d\cdot L + ss = 90\cdot3 + 4\cdot15\sqrt{3} = 374$ boxes

Max. Stock = $Q + 2\cdot ss = 1288 + 2\cdot4\cdot15\sqrt{3} = 1496$ boxes

During 27=30-3 days (expiration period minus lead time) the demand will be at least the relative to 23 days of low demand. It is 23 days because in 27 days there could be 4 free days (weeks are 6 days long)

$d(27-4)-z\sigma\sqrt{27-4}=1782$ boxes

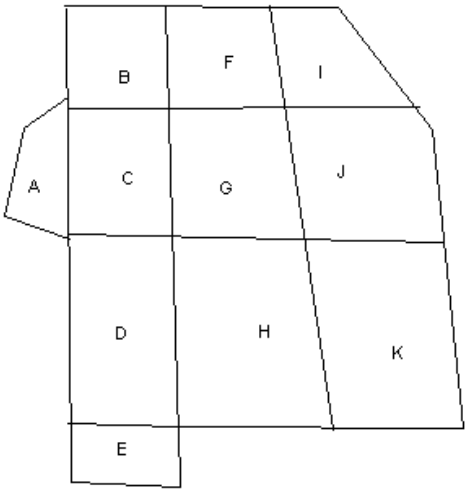
Which is bigger than maximum quantity that could be in stock. Therefore there will not be any expiration problem.

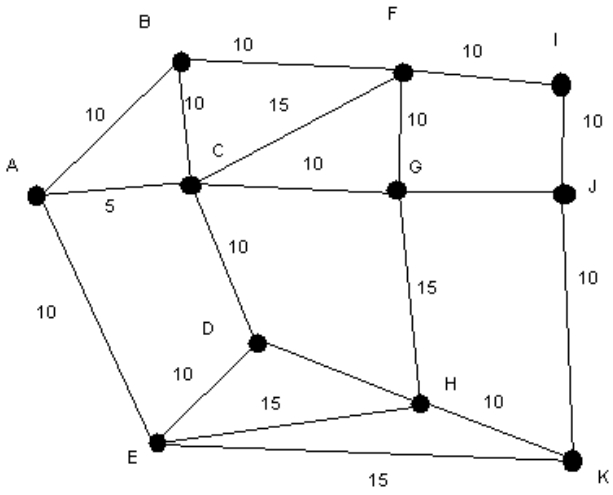
3.2

A supermarket chain wants to opens a new branch. You have to choose the location of this new supermarket. Fortunately, your predecessor was very methodical and defined a working process which is going to help you.

Step 1) City description. Divide the city into districts and evaluate the demand of each one in monetary units, and also define the capacity of each existing shop.

We get this map:





On the map on the right there is the infomation about the distances in minutes between the different districts.

District	X(position)	Y(position)	Population	Demand (thousands €)	X·d	Y·d
A	1	5	2000	20	20	100
B	3	6	5000	20	60	120
C	3	5	6000	15	45	75
D	3	3	7000	10	30	30
E	3	2	5000	10	30	20
F	5	7	5000	10	50	70
G	5	5	7000	10	50	50
H	5	3	3000	15	75	45
I	7	7	4000	10	70	70
J	7	5	7000	15	105	75
K	7	3	5000	20	140	60
Total	49	51	56000	155	675	715

Our company has currently shops in the districts D and K, with sales capacity of €16.000 and €24.000 respectively

Step 2) Looking for available plots to build inmediatly. We have found plots in the districts A, F and H. Building in district A has a cost of €1.000.000, in F €750.000 and in H 1.200.000€.

Step3) Applying the gravity centre concept, and taking into account the already served demand as negative demand, where would be the best option of locating it?

Step4) Taking into account that the annual costs of the instalation are 50% of the instalation cost in each year (these ones include the amortization); Taking also into account that the forecasted payments of a given shop in a district are due to the demand of the district and 10% of the demand of the sorrounding districts, what would be the right option?

Step5) A business by catalogue distribution looks for a partner to cover the city. It considers that a district is covered if its distance (measured in minutes) from its geographic centre and the closest distribution centre of other district is less than 15 minutes. This company can complement our facilities with some other of its own, albeit by increasing the investment, our value would be reduced, then what would be the best option for us?

Step6) If our goal was serving as many people as possible in order to avoid other companies infiltrating our market, and admiting that the population of a district is covered if they have one shop in a district closer than 10 minutes... what would be the right option?

Step7) Assuming that the supplying method is the daily one, and the final decision is installing a centre in the district A and assuming as well that the security stock is defined as the daily demand, what would be the daily storage cost if we adopt a storage cost of each monetary unit as 15% considering that a year is 310 days long?

Now you have to calculate:

1.- Applying the gravity centre method, what is the right solution?
2.- Considering costs, what is the right solution?
3.- Bearing in mind the possibility of reaching an agreement with the catalogue company, what is the right solution?
4.- If our goal was to allow the minimum space to our competitors, what would be the right solution?
5.- What is the daily storage cost?

SOLUTION:

13) Applying the gravity centre method, we first need to calclate the gravity centre of the current demand (taking away the served demand in D and K)

$$X_G = \frac{\Sigma X_i d_i - 16X_D - 24X_K}{\Sigma d_i - 16 - 24} = 3{,}99$$

$$Y_G = \frac{\Sigma X_i d_i - 16X_D - 24X_K}{\Sigma d_i - 16 - 24} = 5{,}17$$

The closest district is the district F(5,7)

14) If we bear in mind the benefits, the district which gives more money is A:

xv. Its surrounding districts are B, C and D, which altogether total a demand of €45000
Annual costs= 0,5·1000= 500 (in thousand €)
Annual payments= 310(20+4,5)=7595

F) Its surrounding districts are B, C, G, I and J and D, which altogether total a demand of €70000
Annual costs= 0,5·750= 375
Annual payments= 310(10+7)=5270

H) Its surrounding districts are C,D,E,G,J,K, which altogether total a demand of €80000
Annual costs= 0,5·1200= 600
Annual payments= 310(15+8)=7130

c) In case we want to cover all the map, in order to make it easy for our partner to minimize the number of facilities to install (and maximizing our value, therefore)

If we plant a shop in A, we don't cover F, G and I
If we plant a shop in F, we don't cover A
If we plant a shop in H, we don't cover A, B, F and I

Therefore, the best solution is F

d) If we do not want to allow space to our competitors, the right option is F too, because with the other ones we cover less population.

e) The storage cost of A is proportional to the demand in A (24,5 thousand €). As it was indicated before, the storage cost is 15% of the stock price (the half part of the daily demand) plus the security stock, which is a day demand.

Therefore: $\frac{0.15}{310}(12.25 + 24.5) = 17.8€$

2.2 DISREUSA buys 3 different products A,B and C from its provider . These products have a demand with the following characteristics

	Weekly demand	Typical deviation	Box cost	Box/pallet
A	400	40	15	100
B	300	30	20	50
C	150	30	25	40

Two posibilities are taken into account:

j) Transport costs are paid by DISREUSA. The company has trucks with capacity for 33 pallets with a lead time of 2 weeks and a cost of €700. The company would have a periodic review policy with powers of 2 as period.

k) Transport costs are paid by the provider, increasing the price of each product by 10%. In this case, the review period would be of one day and the lead time of one week.

The storage cost is 25% of the value of the products in the warehouse, and the level of service has to cover the 99'99% (z=4). In the first option, in order to calculate the review period, you can assume that the demand is the sumatory of each individual demand, and the cost of the virtual product is:

$$\text{Cost}=\frac{\sum Cost(i)\cdot Demand(i)}{\sum Demand(i)}$$

In the secod option, there is no transport cost, and it is considered that the week is 5 days long.

SOLUTION:

Calculation of the first option:

$h = k \cdot Cu$

$$T^*=\sqrt{\frac{2\cdot L\cdot H}{k\cdot Cu\cdot d}} \qquad \frac{T^*}{\sqrt{2}} \le 2^2.T_B$$

The virtual demand is: d= 400·15+300·20+150·25 = 15750. And Tb=1

$$T^*=\sqrt{\frac{2\cdot 700\cdot 52}{0.25\cdot 1\cdot 15750}} = 4.3 weeks \qquad \frac{T^*}{\sqrt{2}} = 3.04 \le 2^n T_B = 2^2 = 4 weeks$$

$4\left(\frac{400}{100}+\frac{300}{50}+\frac{150}{40}\right) \approx 52$ which is more than the 33 pallets that the truck can carry.

Therefore the review period has to be reduced to 2 weeks.

The OUL has to be calculated separately:

OUL(A)= $d(T+L)+z\sigma\sqrt{T+L} = 400\cdot4 + 4\cdot40\cdot\sqrt{4}$ =1920 boxes

OUL(B)= $d(T+L)+z\sigma\sqrt{T+L} = 300\cdot4 + 4\cdot30\cdot\sqrt{4}$ =1440 boxes

OUL(C)= $d(T+L)+z\sigma\sqrt{T+L} = 150\cdot4 + 4\cdot30\cdot\sqrt{4}$ =840 boxes

Annual transport cost: 26·700= 18200€
Annual warehousing cost: 0,25(720·15+540·20+390·25)=7837.5€
Annual goods cost: 52·15750= 81900€

Calculation of the second option:

OUL(A)= $d(T+L)+z\sigma\sqrt{T+L} = 400\cdot1{,}2 + 4\cdot40\cdot\sqrt{1{,}2} = 656$ boxes

OUL(B)= $d(T+L)+z\sigma\sqrt{T+L} = 300\cdot1{,}2 + 4\cdot30\cdot\sqrt{1{,}2} = 492$ boxes

OUL(C)= $d(T+L)+z\sigma\sqrt{T+L} = 150\cdot1{,}2 + 4\cdot30\cdot\sqrt{1{,}2} = 312$ boxes

Annual transport cost=0€
Annual warehousing cost: 0,25(216·16,5+162·22+147·26,5)=2755,9€
(216 is calculated as: OULaverage=((400·0,2+176)+176)/2)
Annual goods cost: 1,1(52·15750)=900900€

We can now fill the tables:

Using own transport

Review Period without transport restrictions	4,3
R.Period in power of 2	4
R.Period with transport restrictions	2
OUL measured in boxes of A	1920
OUL measured in boxes of B	1440
OUL measured in boxes of C	840
Annual transport cost	18200
Annual warehousing cost	7837
Annual goods cost	819000
Annual global cost	845037

Using provider's transport

OUL in monetary units of A	656
OUL in monetary units of B	492
OUL in monetary units of C	312
Annual transport cost	0
Annual warehousing cost	2790
Annual goods cost	900900

Annual global cost	903690

And, as we can see, the first option is cheaper than the second one.

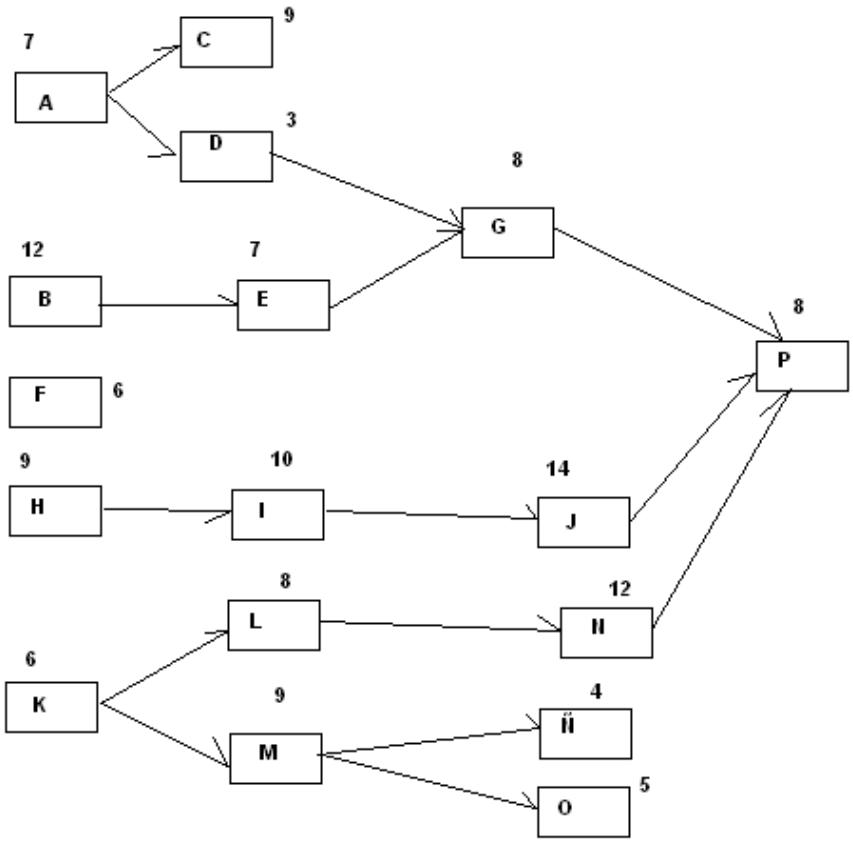
1.2- Two types of engines are built in the same assembly line. The process for both is the same, but in some parts of the line different components are used for each engine. There are 17 tasks, and the details of the order to follow are in the next table. The line works with two different speeds, in the fast shift 1000 engines per hour will be assembled, and in the slow one only 400. Each turn is 455 minutes long.

Task	Previous Task	Length	Engine A	Engine B
A	-	7	comp1	comp1
B	-	12		
C	A	9		
D	A	3		
E	B	7	comp2	comp3
F	-	6		
G	D,E	8		
H	-	9		
I	H	10		
J	I	14	comp4	2xcomp4
K	-	6		
L	K	8		
M	K	9		
N	L	12		
Ñ	M	4		
O	M	5		
P	G,N,J	8		
	Total	137		

Using the criterium of assigning first the longest task as primary rule, and the most number of following tasks as second rule:

l) How many work stations do we need in the fast shift?
m) Which station is the G task in the fast shift in?
n) Where is the P task in the fast shift?
o) What is the percentage of free time on the idlest work station?
p) How many workstations are needed in the slow shift?
q) Which station is the G task in the slow shift in?
r) What is the eficiency difference between the fast and the slow shift?
s) If you balance manually the line once again, in the slow shift, keeping all the characteristics, what is the maximal speed you can get?

SOLUTION:



Fast shift:

C= $\frac{455 \cdot 60}{1000} = 27'3$ sec N= $\frac{137}{27'3} = 5'01 \approx 6$ E%= $\frac{137}{6 \cdot 27'3} = 0'836$

Fast Shift				
Station	Task	Time	Rest of time	Possible Task
1	B	12	15,3	A,**B,**F,H,K
	H	9	6,3	A,E,F,**H**,K
	K	6	0,3	A,E,F,I,**K**
2	I	10	17,3	A,E,F,**I**,L,M
	J	14	3,3	A,E,F,L,M,**J**
3	M	9	18,3	A,E,F,L,**M**
	L	8	10,3	A,E,F,**L**,Ñ,O
	A	7	3,3	**A,**E,F,Ñ,O,N
	D	3	0,3	C,**D,**E,F,Ñ,O,N
4	N	12	15,3	C,E,F,Ñ,O,**N**
	C	9	6,3	**C,**E,F,Ñ,O
	F	6	0,3	E,**F**,Ñ,O
5	E	7	20,3	**E**,Ñ,O
	G	8	12,3	**G**,Ñ,O
	P	8	4,3	**P**,Ñ,O
	Ñ	4	0,3	**Ñ**,O
6	O	5	22,3	**O**

The percentage of freetime of the most idle station is:

725

%FreeTime=100- $\frac{5 \cdot 100}{27'3} = 81'68\%$ or $\frac{22'3 \cdot 100}{27'3} = 81'68\%$

The duration of the O activity is 5 sec. And the idlest workstation is the number 6.

Slow shift:

$$C=\frac{455\cdot 60}{400}=68'25 \qquad N=\frac{137}{68'25}=2'007\approx 3 \qquad E\%=\frac{137}{3\cdot 68'25}=0'669$$

Workstation	Task	Time	Free time	Possible tasks
1	B	12	56,25	A,**B**,F,H,K
	H	9	47,25	A,E,F,**H**,K
	I	10	37,25	A,E,F,K,I
	J	14	23,25	A,E,F,K**,J**
	A	7	16,25	**A**,E,F,K
	C	9	7,25	E,F,K,**C**,D
	E	7	0,25	**E**,F,K,D
2	K	6	62,25	F,**K**,D
	M	9	53,25	F,D,L,**M**
	L	8	45,25	F,D,**L**,Ñ,O
	N	12	33,25	F,D,Ñ,O,**N**
	F	6	27,25	**F**,D,Ñ,O
	O	5	22,25	D,Ñ,**O**
	Ñ	4	18,25	D,**Ñ**
	D	3	15,25	D
	G	8	7,25	G
3	P	8	60,25	P

Manual rebalancing of the slow shift (Cycle time=46seg)

Workstation	Task	Time	Free time	Possible tasks
1	B	12	34	A,B,F,H,K
	H	9	25	A,E,F,H,K
	I	10	15	A,E,F,K,I
	J	14	1	A,E,F,K,J
2	A	7	39	A,E,F,K
	C	9	30	E,F,K,C,D
	E	7	23	E,F,K,D
	K	6	17	F,K,D
	M	9	8	F,D,L,M
	L	8	0	F,D,L,Ñ,O
3	N	12	34	F,D,Ñ,O,N
	F	6	28	F,D,Ñ,O
	O	5	23	D,Ñ,O
	Ñ	4	19	D,Ñ,O
	D	3	16	D,Ñ,O
	G	8	8	G
	P	8	0	P

With this rebalancing we can get $\frac{455\cdot 60}{46}$ =594 engines

In order to rebalance the slow shift, we have added the idle times of each workstation (0.25+7.25+60.25=67.75sec). This idle time was divided by the three stations (67.75/3=22.58sec). Then, we could say that the time of each station could be reduced in 22,58 sec. The new cycle time was 45.67 (68.25 – 22.58 = 45.67). With that time, we could start rebalancing the line, trying that all

the activities that we put in each station have a total time close to 45.67. In our case, we achieve a cycle time of 46sec, which is quite good because any cycle time under 50sec.

745 Box position calculation

In the fast shift, we have many more engines than in the slow one, therefore we have to calculate it for this case.

750 455min = 7.58 hours → 1000engines/7.58 hours = 131,926 ≈132

Kind of component		Engines/h	hours without replacing	nº of comp./eng.	needed components until new reposition		comp/box	boxes	superior aproximation
	1	132	2	1		264	10	26,4	27
	2	132	2	1		264	20	13,2	14
	3	132	2	1		264	10	26,4	27
	4	132	2	2		528	30	17,6	18

2.1. MERCANONA. (JANUARY 00-01).

Logistics for products of great consumption.

You are working for the logistics department of a distribution company of great comsumption products, with 500 shops distributed by the whole national territory.

You've been said to design the provisioning system and the distribution of a determined import product (Italian frothy wine). This wine is bought directly from the warehouses in packs of 350 bottles each. Your work is to establish the most economic way to make the bottles get to the racks.

Your distribution system considers a central store and 5 regional stores. Each of the regional stores supplies 100 shops.(for solving the problem it will be assumed that all the shops are equal).

In your company basically exist two provisioning alternatives:

A) Buying to the supplier from the central store (CS), service from this one to every shop of the goods needed in a continuos way. The shopping in the central store is made following the method of the reorder point.

B) Buying to the supplier from the regional store (RS), service from this one to every shop of the goods needed in a continuos way. The shopping from the regional store is made by periodic provisioning, with periods in powers of two on a basic period of one week.

It is a question of evaluating on total costs (costs of transport from the supplier to the store, of the storage including the security store and the costs of transport from the store to the shop) which of both options is better. For solving it, it is necessary to refill the attached form to pass it to your hierarchic Superior.

The basic information used is below:

- Number of weeks per year: 52 weeks
- Level of service to the customer: 99,99% (z=4)
- Delivery time from Italy: 2 weeks
- Unitary cost per bottle: 2€
- Number of bottles each pack: 350
- Maximum number of packs that fit in a truck: 33
- Total number of shops: 500
- Total number of regional stores(RS): 5
- Total number of central stores(CS): 1
- Weekly average demand of each shop: 12 bottles

- Standard deviation of the weekly demand of every shop: 5 bottles
- Cost of every truck from Italy: 800€ per trip
- Cost of transport of each bottle from the CS to the shop: 0,15€
- Cost of transport of each bottle from the RS to the shop: 0,07€
- Annual cost of storage of each pack in the CS: 210€
- Annual cost of storage of each pack in the RS: 200€
- The variance of a sum is the sum of the variances($\sigma^2_t = \Sigma_t \sigma^2$)

Report of provisioning

MERCANONA

Procedure A:

Economic lot of buying not having in account restrictions of transport (in sale units)	
Economic lot of buying having in account restrictions of transport (in sale units)	
Security stock in the central store	
Reorder point	
Maximum level expected in the store	
Annual cost of transport from the supplier	
Annual cost of transport to the shop	
Annual cost of storage	
Total cost of supplying	
Repercutible cost of supply for unit of sale	

Procedure B:

Economic period of buying from every regional store without having in account neither restrictions of transport nor politics in power of two with period weekly based	
Economic period of buying from every regional store having in account restrictions of tranport and politics of power of two with period weekly based	
Security stock in every regional store	
Maximum level until where you can ask in every review	
Maximum level of stock expected in the store	
Total annual cost of transport from the supplier	
Tatal annual cost of transport to the shop	
Total annual cost of storage	
Total annual cost of supplying	
Repercutible cost of supply by unit of sale	

Introduction to the resolution

The raised problem is actually a double problem:

The first part consists on calculating the economic lot of the shopping, and its parameters associated for the central store. The information of the demand is relative to 500 shops. The costs of launching are relative to the cost of the truck.

The second part of the problem consists on calculating the economic period of reprovisioning for each regional store. The information of the demand is relative to 100 shops. The costs of launching are relative to the cost of the truck.

General information:

Bottles per pack= 350 packs per truck= 33 bottles per truck=11550
H= 52 weeks $C_{L=}$800€ L=2 weeks z = 4

Solution to the first part

Key data:

500 shops. d=12*500 =6000 $\sigma_d = 5*(500)^{1/2}$=111’8 h=210/350=0’6€

Lot without restrictions $Q = \sqrt{\frac{2*C_L*d*H}{h}} = \sqrt{\frac{2*800*6000*52}{0'6}} = 28844$ bottles

Lot with restrictions: quantity that holds in the truck: 11550 bottles

Security Stock: ss = z*σ*√ L =4*111’8*√ 2= 632’4

Reorder point: ROP =d*L+ss =6000*2+632’4= 12633

Transport costs from the factory to the CS: D=H*d

$$\frac{D}{11550} * C_L = \frac{52 * 6000}{11550} * 800 = 21610'4$$

Costs of store in CS $h * \left(\frac{Q}{2} + ss \right) = 0'6 * \left(\frac{11550}{2} + 633 \right) = 3844'8$

Costs of transport to the shop: (H*d)*0’15 =52*6000*0’15= 46800

Total costs = 74817 €/year

Costs per bottle = 0’24 €

(Maximum level expected in the store = Q + SS)

Solution to the second part

Key data:

100 shops. d = 12*100= 1200 σ_d=5*(100)$^{1/2}$=50 h =200/350= 0’57€

S=C_L*H Q=T*d

Period without restrictions $T = \sqrt{\frac{2 * S}{h * d}} = \sqrt{\frac{2 * 800 * 52}{0'57 * 1200}} = 11'02$ weeks

Period with restrictions and by period in powers of two on a basic period of one week:

$$\frac{1}{\sqrt{2}} T = 7'79 \leq 2^n T_B \rightarrow n = 3 \rightarrow T = 8 \text{ weeks}$$

Security stock: $ss = z * \sigma * \sqrt{L + T} = 4 * 50 * \sqrt{10} = 632'4$

Maximum level: OUL =d*(L+T) + ss= 1200*10+632’4= 12633

Costs of transport from the factory to each RS 52/8 * C_L = 5200

Costs of store for RS

$$h*\left(\frac{OUL-d*T+ss}{2}\right)=0'57*\left(\frac{12633-2400+633}{2}\right)=3096'8$$

Costs of transport to the shop by RS (H*d)*0’07= 52*1200*0’07= 4368

915 Total costs for each RS =12664’8 €/year

Costs per bottle =0’203 €

(Maximum level expected in the store = Q + SS)

920

Procedure A:

Economic lot of buying not having in account restrictions of transport (in sale units)	28844
Economic lot of buying having in account restrictions of transport (in sale units)	11550
Security stock in the central store	632’4
Reorder point	12633
Maximum level expected in the store	29476’4
Annual cost of transport from the supplier	21610’4
Annual cost of transport to the shop	46800
Annual cost of storage	3844’8
Total cost of supplying	74817
Repercutible cost of supply for unit of sale	0’24

925

Procedure B:

Economic period of buying from every regional store without having in account neither restrictions of transport nor politics in power of two with period weekly based	11’02
Economic period of buying from every regional store having in account restrictions of tranport and politics of power of two with period weekly based	8
Security stock in every regional store	632’4
Maximum level until where you can ask in every review	12633
Maximum level of stock expected in the store	29476’4
Total annual cost of transport from the supplier	5200
Total annual cost of transport to the shop	4368
Total annual cost of storage	3096’8
Total annual cost of supplying	12664’8
Repercutible cost of supply by unit of sale	0’203

2.4. MERCANONA II. (JANUARI 02-03)

Logistics for products of great consumption.

Imagine that you are working for a distribution company of products of great consumption. The increase of the demand in the last months has allowed increasing the number of shops until a total of 750, even the number of regional stores is still 5 (150 shops per store).

One year ago you were asked about a report of the provisioning politics of an Italian frothy wine. The time has passed and the demand of that product has changed. Nowadays the average demand of the product is 20 bottles per week in each shop, with a standard deviation of 5 bottles. Due to this change of the demand, in the company, you are asked to check the provisioning politics that you proposed last year.

After visiting the wine manufacturer, you discover that nowadays it is possible to transport the wine in a vat truck of 25000liters if you have the technology to bottle it in the arrival. The transport from Italy of the mentioned truck costs 1.000€ per trip. The litre of wine in this conditions cost 1€.

You have a supplier with the technology to bottle, because they already work with other products of the same characteristics (german beers and Asturian cider), then you visit the bottler and he says that he can bottle whatever if he is paid.

Then, the new options that will have to be compared with the previos ones are:

- The bottler buys wine in abundance to the Italian supplier and this one sends it to him with the vat truck. After bottling it, the bottler stores in his own warehouse the bottles and distribute them to the regional stores when they demand it, in packs of 350 bottles.

- Every 2 weeks our company buys wine in abundance from Italy. The vat truck takes the wine to the bottler. After bottling it, the bottler sends to every regional store the corresponding bottles. For example, every 2 weeks, every regional store indicate its needs; This needs are added and then the wine is demanded to the Italian supplier. This one sends the truck to the bottler that bottles and serves it directly to each store.

Evaluate together both alternatives and try to know which the cheapest one is.

In total, it will be necessary to pay: 1) the wine, 2) the vat truck, 3) the preparation of the bottle machines, the stopper and the etiquettes. 5) Refilling process, 6) the storaging costs, 7) the costs of transport up to the regional stores, 8) the costs of transport up to the shops.

A condition imposed by the bottler is that, once the vat truck is received, he bottles the whole wine that is inside; otherwise it can be a mess.

With the first alternative every epigraph has the following cost.

C) Price of the wine: 1€/liter
D) Vat truck: 1000€/trip
E) Costs for preparing the machines: 300€ per launching
F) Bottle, stopper and etiquettes: 0,5 €/bottle
G) Refilling process: 0,3 €/bottle

H) Costs of storaging in the bottler: 20 €/(pack*year)
I) Costs of storaging in the regional store: 0,4 €/(bottle*year)
J) Costs of transport to the regional store: 50 €/pack
K) Costs of transport to the shop: 0,07 €/bottle

With the second alternative every epigraph has the following cost.

16) Price of the wine: 1€/liter
17) Vat truck: 1000€/trip
18) Costs for preparing the machines: 300€ per launching
19) Bottle, stopper and etiquettes: 0,5 €/bottle
20) Refilling process: 0,3 €/bottle
21) Costs of storaging in the regional store: 0,4 €/(bottle*year)
22) Costs of transport to the regional store: 500 €/pack
23) Costs of transport to the shop: 0,07 €/bottle

It would be worthwhile to complete the report for helping you taking a decision.
The used key data is the following:

- Every bottle will hold ¾ liters.
- Every truck will hold 25000 liters
- The packs can't be piled up
- Week per year: 52 weeks
- K = 0,2
- Level of service to the client: 99,99% (z = 4)
- Number of bottles per pack: 350
- Total number of shops: 750
- Total number of regional stores(RS): 5
- Delivery time of the vat truck from Italy: 2 weeks
- Production lead time of the bottles since the truck comes: 1 week
- Delivery time from the bottler to the regional store: 2 days
- Weekly average demand of every shop: 20 bottles
- Standard deviation of the weekly demand of every shop: 5 bottles
- The truck that transport from the bottler to the stores is 11 meters long and 2,3 meters wide.(22 packs per truck)
- One week means 6 days
- The variance of a sum is the sum of the variances($\sigma^2_t = \Sigma_t \sigma^2$)

General information:

Weekly accumulated demand for all the shops in liters of wine	

Procedure A:

Shopping lot in liters of wine in the vat trauck	
Security stock in the bottler (in bottles)	
Reorder point of the bottler (in bottles)	
Annual cost of transport supplier-bottler-store-shop	
Reorder point in each store (in bottles)	
Annual cost of storaging in the regional stores	

Annual cost of storaging in the bottler	
Annual cost in products launchings	
Total costs of supplying (including the materials costs and excluding the price of the wine)	
Supplying cots per bottle (excluding the price of the wine)	

1025

Procedure B:

Maximum level of reference in every regional store	
Transport costs Italy-bottler-store-shop	
Average level of packs in each store	
Annual cost of storaging in regional stores	
Annual cost of storaging of the bottler	
Annual cost in products launchings	
Total costs of supplying (including the materials costs and excluding the price of the wine)	
Supplying cots per bottle (excluding the price of the wine)	

1030

SOLUTION

The number of liters of wine sold weekly is of: 20 * 750bottles * ¾ = 11250

Option A

The bottler buys the wine in the vat truck and bottles all of it simultaneously. Later it is sent to the Regional Store when it is needed.

The economic lot measured in liters is:

$$Q = \sqrt{\frac{2*(1000+3000)€*11250 liter/week*52 weeks/year}{20\frac{€}{pack*year}*1\frac{pack}{350 bottles}*1\frac{bottle}{3/4 liters}}} = 141290 liters$$

Where the costs of launching include: the 1000€ of transport and the 300€ for the preparation of the machinery. The costs of storaging are on the packs to which every lot gives place.
The truck only holds 25000liters.

The security stock must cover the irregularity of 750 shops for 3 weeks (which is the time that late since we ask for the truck until we have it bottled).

$$ss = z*\sigma *\sqrt{750}*\sqrt{3} = 949 bottles$$

The reorder point must cover the demand during 3 weeks for 750 shops.
ROP =d*L + ss= 3*750*20 + ss=45949
d=demand rate per period
L=lead time

The annual cost of the transport is calculated adding the cost of every section: importation of the vat truck of 25000liter, plus the transport to the regional store of 15000 packs of 350 bottles each, plus the transport to the shop of 15000.

$$\text{Annual\_cost\_trasport} = \frac{11250*52}{2500}*1000+\frac{15000*52}{350}*50+15000*52*007 = 189428\ €$$

In the store it is necessary to have a safety stock that covers the irregularities during the term of provisioning (that are 2 days).

$$SS_{RS} = z*\sigma *\sqrt{150}*\sqrt{\frac{2}{6}} = 141$$

And therefore the reorder point must be:

$$ROP_{RS} = 20*150*\frac{2}{6}+SS_{RS} = 1141$$

In the regional stores it will be asked pack by pack and therefore the cost of storage is calculated this way, for every regional store

$$Cost\_store_{RS} = 0'4*\left(\frac{350}{2}+SS\right) = 126'6$$

In the bottler, the annual cost of storage is calculated this way:

$$Bottler\_storing\_costs = \frac{20}{350} * \left(\frac{25000 * 4/3}{2} + SS_{Bottler} \right) = 1006'6$$

The number of launching productions is the number of trucks that have to be asked, so the associated cost is:

$$Annual\_cost\_launching = \frac{11250 * 52}{25000} * 300 = 7020$$

The total costs of supplying include the costs of transportation (189428), plus the costs of storage (1638), plus the costs of the labels and the filling (624000), plus those of the launching production (7020).

Costs_of_storage = 5*126'6 + 1006'6 = 1638

Cost_labels_filling = (0'5 + 0'3)(€/bot)*20*750(bot)*52 = 624000

Total_costs =189428+1638+624000+7020=822086

The costs per bottle are 1'053€/bottle of that 0'8€ correspond to raw material and direct work and 0'203€ correspond to costs tied to the logistic system.

Option B

In the second system, the provisioning term for each regional store is 3'33 weeks.

$S=C_L*H$ $\quad$ $Q=T*d$ $\quad$ $T = \sqrt{\frac{2*S}{h*d}}$

The weekly average demand is 20 bottles per shop, but we indicate our needs every 15 days (40bottles):

$$T = \sqrt{\frac{2*1300*52}{0'4*40*750}} = 3'3 weeks$$

The maximum level that has to cover the demand during this time plus the reviewing period:

$$N\max = 20*150*5'3 + 4*5*\sqrt{150}*\sqrt{5'33} = 16555$$

The transport costs from Italy to the shop are those of transporting 26 vats (one every fortnight; 52weeks/2) plus freight every fifteen days 5 trucks to every RS (because there are 5 RS), and then take every bottle to the shop. This supposes 132600€ per year.

$$Trasport\_costs = 26*1000 + \frac{52*6}{15}5*500 + 52*15000*0'07 = 132600€$$

The average level of packs in every regional store is: d * T + SS

1500 * 2 + 4 * 5 * √150 * √5'3 = 3564 bottles = 10'2 packs

The annual costs of storaging in the regional stores is = $h*N_{averag}$ =1426€

The annual cost of storaging in the bottler is = 0 (because he doesn't store anything)

The annual costs of launching are 300€ every 15 days: 7800€/year (300 * 26)

The total costs of supplying are 771531€, what supposes a cost of 0'99€/bottle.

Tot_costs = transport+store+launching+labels&filling

Tot_costs = 132600 + 5*1426 + 7800 + 624000 = 771531 €

The provisioning report that has been requested to you will be:

General information:

Weekly accumulated demand for all the shops in liters of wine	11250

Procedure A:

Shopping lot in liters of wine in the vat trauck	11250
Security stock in the bottler (in bottles)	949
Reorder point of the bottler (in bottles)	45949
Annual cost of transport supplier-bottler-store-shop	189428
Reorder point in each store (in bottles)	1141
Annual cost of storaging in the regional stores	632
Annual cost of storaging in the bottler	1006’6
Annual cost in products launchings	7020
Total costs of supplying (including the materials costs and excluding the price of the wine)	822088
Supplying cots per bottle (excluding the price of the wine)	1’05

Procedure B:

Maximum level of reference in every regional store	16555
Transport costs Italy-bottler-store-shop	132600
Average level of packs in each store	10’2
Annual cost of storaging in regional stores	1426
Annual cost of storaging of the bottler	0
Annual cost in products launchings	7800
Total costs of supplying (including the materials costs and excluding the price of the wine)	771531
Supplying cots per bottle (excluding the price of the wine)	0’99

3.1. PAPERS (JULY 00-01)

PAPERS is a Valencia's company that distribute newspapers every morning to the kiosks of Valencia's city. This company has divided Valencia into 8 neigborhoods, as the following:

	B1	B2	B3	B4	B5	B6	B7	B8
Number of kiosks	20	40	30	45	50	35	30	40

Papers has the intention of renting two commercial places to attend the possible emergencies caused by the increasing sales during the day, they have decided to attend by bicycle service that won't last more than 15 minutes in getting to each neighborhood. The average times that are needed for moving from a neighborhood to another is the following:

Neighborhood	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	0	25	10	30	40	15	40	10
2		0	25	20	40	30	60	45
3			0	10	30	15	15	35
4				0	15	10	25	20
5					0	20	10	20
6						0	15	25
7							0	20
8								0

t) **Where will be located the commercial places for maximizing the number of attended kiosks?**

u) How would you represent the problem for solving it by a mathematical programming?

SOLUTION

1- Where will be located the commercial places for maximizing the number of attended kiosks?

	B1	B2	B3	B4	B5	B6	B7	B8
Number of kiosks	20	40	30	45	50	35	30	40

Fulfillment of the restrictions of the time of service:

Neighborhood	1	2	3	4	5	6	7	8
1	Yes	NO	YES	NO	NO	YES	NO	YES
2	NO	YES	NO	NO	NO	NO	NO	NO
3	YES	NO	YES	YES	NO	YES	YES	NO
4	NO	NO	YES	YES	YES	YES	NO	NO
5	NO	NO	NO	YES	YES	NO	YES	NO
6	YES	NO	YES	YES	NO	YES	YES	NO
7	NO	NO	YES	NO	YES	YES	YES	NO
8	YES	NO	NO	NO	NO	NO	NO	YES

Applying the method of the partial covering:

Neighborhood	1	2	3	4	5	6	7	8	Total
1	20	--	30	--	--	35	--	40	125
2	--	40	--	--	--	--	--	--	40
3	20	--	30	45	--	35	30	--	160
4	--	--	30	45	50	35		--	160
5	--	--		45	50	--	30	--	125
6	20	--	30	45	--	35	30	--	160
7	--	--	30	--	50	35	30	--	145
8	20	--	--	--	--	--	--	40	60

Wherefrom there are obtained the possible candidates for the first location: neighborhoods 3, 4 and 6.

Mathematically, these 3 generate the same maximum number of attended kiosks (160), what means that the problem has a multiple solution. Thus, for selecting the second candidate for being a neighborhood where to locate the comercial place, this 3 options will have to be solved: locate the first solution in neighborhood 3, 4 and 6.

Localization in neighborhood 3:

Neighborhood	1	2	3	4	5	6	7	8	Total
1	--	--	--	--	--	--	--	40	40
2	--	40	--	--	--	--	--	--	40
3	20	--	30	45	--	35	30	--	**160**
4	--	--	--	--	50	--	--	--	50
5	--	--	--	--	50	--	--	--	50
6	--	--	--	--	--	--	--	--	0
7	--	--	--	--	50	--	--	--	50
8	--	--	--	--	--	--	--	40	40

So the second localization would be in the neighborhood 4, 5 or 7 with the same total valuation of 210 kiosks attended (160+50)

Localization in neighborhood 4:

Neighborhood	1	2	3	4	5	6	7	8	Total
1	20	--	--	--	--	--	--	40	60
2	--	40	--	--	--	--	--	--	40
3	20	--	--	--	--	--	30	--	50
4	--	--	30	45	50	35	--	--	**160**
5	--	--	--	--	--	--	30	--	30
6	20	--	--	--	--	--	30	--	50
7	--	--	--	--	--	--	30	--	30
8	20	--	--	--	--	--	--	40	60

So the second localization would be in the neighborhood 1 or 8 with the same total valuation of 220 kiosks attended (160+60)

Localization in neighborhood 6:

Neighborhood	1	2	3	4	5	6	7	8	Total
1	--	--	--	--	--	--	--	40	40
2	--	40	--	--	--	--	--	--	40
3	--	--	--	--	--	--	--	--	0
4	--	--	--	--	50	--	--	--	50
5	--	--	--	--	50	--	--	--	50
6	20	--	30	45	--	35	30	--	**160**
7	--	--	--	--	50	--	--	--	50
8	--	--	--	--	--	--	--	40	40

So the second localization would be in the neighborhood 4, 5 or 7 with the same total valuation of 210 kiosks attended (160+50)

Then the best solution will be: neighborhood 4 and 1 or the neighborhood 4 and 8 with a maximum number of attended kiosks of 220.

2- How would you represent the problem for solving it by a mathematical programming?

Objective Function:

$$\text{Max. } F(x_i) = 20\lambda_1+40\lambda_2+ 30\lambda_3+45\lambda_4+50\lambda_5+35\lambda_6+30\lambda_7+40\lambda_8$$

Restrictions:

$$x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 = 2$$
$$x_1 + x_3 + x_6 + x_8 \geq \lambda_1$$
$$x_2 \geq \lambda_2$$

$$x_1 + x_3 + x_4 + x_6 + x_7 \geq \lambda_3$$
$$x_3 + x_4 + x_5 + x_6 \geq \lambda_4$$
$$x_4 + x_5 + x_7 \geq \lambda_5$$
$$x_1 + x_3 + x_4 + x_6 + x_7 \geq \lambda_6$$
$$x_3 + x_5 + x_6 + x_7 \geq \lambda_7$$
$$x_1 + x_8 \geq \lambda_8$$
$$x_i = \{0,1\} \quad i = 1, ..., 8$$
$$\lambda_i = \{0,1\} \quad i = 1, ..., 8$$

...where x_i indicates the possible location of a kiosk in the neighborhood i.

2.8. PECAJU STAMPINGS II (JANUARY 04-05)

"El PECAJU stamping" is a company that fabricates metallic parts for cars. They frabricate 5 metallic pieces (truthfully they fabricate 500, but the problem would be too long to be solved with all the information) that are supplied to their final customer. Your boss has assigned you to design a system of provisioning based in politics of power of two, with one day based.

The information of each product is attached below:

PRODUCT	Daily demand	Standard desviation
XS51 AA	300	100
XS51 EB	200	50
XS51 IC	500	300
XS51OD	800	300
XS51 UE	400	200

Since the production of a piece starts until this piece is available, one day is needed. The costs for having the machinery ready are 300€ per piece.

For applying the known formulas of management of stocks you need to know the storaging costs. Asking for the above mentioned costs, the manager of production indicates you that he does not have these costs of storage.

> "*An average global stock is fixed to me. For example 5 days of stock. Then I add up the daily demand of every product, multiply it by 5 and the number that goes out for me is what I want to have. If I have more than that, then I have overstock, if I have less than that, then I have lack of stock*."

As you don't know how to continue for obtaining the costs of storage, you decide to send a mail to your Productive and Logistics System Design's teacher, to see if he can help you. The answer is more or less what comes below:

> "*You have to work at first, as if you were going to use the management of reorder point. Consider a value of z equal to 6 (6-sigma). Asume that h, the cost per storage unit, is a variable equal for all the products. Calculate for each product the Average Level of Stock (depending on h). The sum of the average levels of stock have to be of 5 days of production (or what they fix you). Calculate h, and with this h calculated, then you can calculate your politics of management of stocks for powers of 2. Good luck and regards*."

This way, and though you have not understood the half of it, you decide to set to work:

a) **(1 point)** Establish, depending on h, the formula of the Average Level of Stock for the first product.

b) **(2 points)** Define the value of h for having 5 days of average stock, applying the politics of

management for point of order, including security stocks.

c) **(1 point)** Which would be the value of h if the stock levels would be reduced to 3 days?

d) **(2 points)** Define the periods of reviewing for each product in powers of two.

e) **(2 points)** Define the maximum levels of stock up to refill for each one of the products. Considering z = 6.

f) **(2 points)** Which will be the real value of the average stock? Why is this discrepancy happening?

SOLUTION

a) Establish, depending on h, the formula of the Average Level of Stock for the first product.

$$Naverage = \frac{\sqrt{\frac{2*S*d}{h}}}{2} + SS = \sqrt{\frac{300*300}{2}} * \sqrt{\frac{1}{h}} + 6*\sigma * \sqrt{1} = 212'13 * \sqrt{\frac{1}{h}} + 600$$

b) Define the value of h for having 5 days of average stock, applying the politics of management for point of order, including security stocks.

$$\sum Naverage = \sum_i \left(\sqrt{\frac{300*d_i}{2}} * \sqrt{\frac{1}{h}} + 6*\sigma_i \right) = 5\sum_i d_i$$

$$\left(\sqrt{\frac{300}{2}} \sqrt{\frac{1}{h}} \left(\sqrt{300} + \sqrt{200} + \sqrt{500} + \sqrt{800} + \sqrt{400} \right) \right) + 6*(100 + 50 + 300 + 300 + 200) =$$

$$= 5*(300 + 200 + 500 + 800 + 400)$$

$$\sqrt{\frac{1}{h}} * \sqrt{150} * 102'1 + 5700 = 11000$$

$$h = \left(\frac{\sqrt{150} * 102'1}{5300} \right)^2 = 0'055 € / unit / day$$

c) Which would be the value of h if the stock levels would be reduced to 3 days?

$$\sum Naverage = \sum_i \left(\sqrt{\frac{300*d_i}{2}} * \sqrt{\frac{1}{h}} + 6*\sigma_i \right) = 3\sum_i d_i$$

$$h = \left(\frac{150*102'1}{900} \right)^2 = 1'93 € / unit / day$$

d) Define the periods of reviewing for each product in powers of two.

Considering $T = \sqrt{\frac{2*C_L}{h*d}}$ and rounding to powers of two

Product	Demand	T	Pow-of-2
XS51 AA	300	5’99359222	8
XS51 EB	200	7’34062133	8
XS51 IC	500	4’64261657	4
XS51 OD	800	3’67031067	4
XS51 UE	400	5’19060312	4

e) Define the maximum levels of stock up to refill for each one of the products. Considering z = 6.
The maximum level is Nmax=d*(T+L)+SS

XS51 AA	4500
XS51 EB	2700
XS51 IC	6525
XS51 OD	8025
XS51 UE	4683

f) Which will be the real value of the average stock? Why is this discrepancy happening?

The real value of the average stock is 18000, nearly 50% superior to the expected one. This fact is because we have got the security stocks in periodic provisioning, but the h value is calculated supposing that we are working by the reorder point method. The most effective way to solve this problem is increasing the value of h, until the stock gets to the expected level.

2.1.MERCANONA (January 00-01)

Logistic for great consumption products.

You work in the Logistic department of a great consumption products' firm, with more than 500 shops located in the whole national territory.

You have been told to design the supplying and distribution system of a specific imported product (italian sparkling wine). This wine is directly bought in the cellars in trowels of 350 bottles each. Your job consists in finding the cheapest way of conveying the bottles to the shop's shelves.

Your distribution system consists in a central warehouse and 5 regional warehouses. Each regional warehouse supplies 100 shops. (For this problem we will consider that all the shops are the same). In your firm merely exist two alternatives for the supply.

24) Buying to the supplier from the central warehouse (CW), service from this one to each shop of the required merchandise in continuous mode. The purchase in the central warehouse is realized following the Reorder point method.
25) Buying to the supplier from the regional warehouse (RW), service from this one to each shop of the required merchandise in continuous mode. The purchase from the regional warehouse is realized with a periodic review, with power periods-of-two on a basic period of one week.

It's about evaluating on total costs (costs of transport from the supplier to the warehouse, from the warehouse, including the security warehouse and transport costs from the warehouse to the shop) which one, from these two, is the best alternative. For this, the attached form has to be filled to transmit it to your hierarchic superior.

The basic data used are the following ones:

v) Number of weeks of the year: 52
w) Service level: 99% (z=4)
x) Term of delevery from Italia: 2 weeks
y) Unit bottle cost: 2€
z) Number of bottles per trowel: 350
aa) Maximum number of trowels fitting in one truck: 33
bb) Total number of shops: 500
cc) Total number of regional warehouses (RW) :5
dd) Total number of central warehouses (CW) :1
ee) Average weekly demand of each shop: 12 bottles
ff) Standard deviation of the weekly demand of each shop: 5 bottles
gg) Cost of each truck from Italia: 800€ per travel
hh) Transport cost of each bottle from CW to the shop: 0,15€
ii) Transport cost of each bottle from RW to the shop: 0,07€
jj) Annual warehousing cost of each trowel in the CW: 210€
kk) Annual warehousing cost of each trowel in the RW: 200€
ll) The variance of a sum is the sum of the variances ($\sigma_T^2 = \sum_i \sigma^2$)

Supplying information: MERCANONA

Procedure A

Purchasing economic lot without taking into account transport restrictions (in selling unities)	
Purchasing economic lot taking into account transport restrictions (in selling unities)	
Security stock in the central warehouse	
Reorder point	
Maximum hoped level in the warehouse	
Annual transport cost from the supplier	
Annual transport cost to the shop	
Annual cost of warehousing	
Annual cost of supplying	
Repelible supplying cost per selling unit	

Procedure B

Economic periodic review from each regional warehouse without taking into account transport restrictions or two-power policies	
Economic periodic review from each regional warehouse taking into account transport restrictions and two-power policy with a weekly period basis	
Security stock in each regional warehouse	
Maximum level at which ask in each Revision	
Maximum stock level hoped in the warehouse	
Total annual transport cost from the supplier	
Total annual transport cost to the shop	
Total annual cost of warehousing	
Total annual cost of supplying	
Repelible supplying cost per selling unit	

Introduction to answers
This problem is, in reality, a double problem:

The first part is about figuring out the purchasing economic lot, and the asociated parameters for the central warehouse. The demand data concern 500 shops. The launching costs are related to the truck's cost.

The second part of the problem is about figuring out the economical review period of supplying for each regional warehouse. The demand data concern 100 shops. The launching costs are related to the truck's cost.

General Data:
CL=800€ bottles per trowel=350 trowels per truck=33
Bottles per truck=11550 H=52 weeks TD=2 weeks z=4

Answer to the first part

Basic Data:

500 shops. d=12*500=6000 $\sigma_d = 5\sqrt{500} = 111,8$ $h = \frac{210}{350} = 0,6€$

Lots without restrictions $Q = \sqrt{\frac{2*CL*D}{h}} = \sqrt{\frac{2*800*52*6000}{0,6}} = 28844 botellas$

Lots with restrictions: the quantity that fits in the truck: 11550 bottles

Security stock: $s = z*\sigma*\sqrt{TD} = 4*111,8*\sqrt{2} = 632,4$

Reorder point : P=d*TD+s=6000*2+632,4=12633

Transport costs from factory to CW : $\frac{D}{11550}*CL = 21610,4$

Warehousing costs in CW : $h(\frac{Q}{2}+s) = 0,6(\frac{11550}{2}+633) = 3844,8$

Transport costs to the shop (H*d)*0,15=52*6000*0,15=46800
Total costs=74817€/year
Cost per bottle=0,24€

Answer to the second part

Basic data:

100 shops. D=12*100=1200 $\sigma_d = 5\sqrt{100} = 50$ $h = \frac{200}{350} = 0,57$

Periods without restrictions $T = \sqrt{\frac{2*CL*H}{h*d}} = \sqrt{\frac{2*800*52}{0,57*1200}} = 11,02 weeks$

Period withs restrictions and by periods of two-power with a period basis of one week:

$\frac{1}{\sqrt{2}}T = 7,79 \leq 2^n T_B \rightarrow n = 3 \rightarrow RP = 8 weeks$

Security stock : $s = z*\sigma*\sqrt{TD+RP} = 4*50*\sqrt{10} = 632,4$

Maximum level: Nmax=d*(TD+RP)+s=1200*10+12633

Transport costs from factory to eqch CW $\frac{52}{8}*CL = 5200$

Warehousing costs for RW

$h\left(\frac{N\max - d*TD+s}{2}\right) = 0,57\left(\frac{12633-2400+633}{2}\right) = 3096,8$

Transport costs to th shop for RW (H*d)*0,07=52*6000*0,15=46800
Total costs=74817€/year
Costs per bottle=0,24€

1.2.Engine assembly line (January 01-02)

An engine assembly line assembles 2 types of engines. The operations are always the same for both of them, the differences are in the use of the diffent components in some operations.

In the design of one part of the line take place 17 tasks, with the relationships of anteriority shown in the following table.The line will work in 2 turns with different velocity for each of them. In the quicker one 1.000 engines will be constructed during one turn and in the slowest 400 per turn. Each turn is of 455 minutes.

Task	Preceeding	Duration	Engine A	Engine B
A	-	7	comp1	comp2
B	-	12		
C	A	9		
D	A	3		
E	B	7	comp2	comp3
F	-	6		
G	D,E	8		
H	-	9		
I	H	10		
J	I	14	comp4	2xcomp4
K	-	6		
L	K	8		
M	K	9		
N	L	12		
Ñ	M	4		
O	M	5		
P	G,N,J	8		
	Total	**137**		

Using the criteria of assigning first the task with highest duration as principal rule and the highest number of depending tasks as second rule.

mm)How many stations are needed in the quicker turn?
nn) In which station is the task G in the quicker turn?
oo) In which station is the task P in the quicker turn?
pp) What is the percentage of idle time of the most idling station?
qq) How many stations are needed in the slower turn?
rr) In which station is the task G in the slower turn?
ss) What is the difference between the efficiency of the quicker turn and the slower one?
tt) If the line is re-balanced manually, in the slower turn, keeping the anteriority relationships, what is the maximum velocity the line can reach?

The proportion of engines is even unknown for designing the system so that they are made in any proportions. Only in 3 tasks components are added. In task A is added one unity of the component 1 in each engine. In task E in added one unity of the component 2 in A engines and one unity of component 3 in B engines. In the task J is added one unity of component 4 in A engines and two unities of component 4 in B engines.

The input system has to be designed, therefore you have to indicate what is the number of boxes with which the filler has to be charged to garanty the supplying. The logistic department has told you that every 2 hours will come the filler to supply with more boxes of each component.

The boxes in which are given each component have different capacities. Indeed, the component 1

box contains 10 unities, and so has component 3. The component 2 boxes have a capacity of 20 unities. Finally, the boxes containing component 4 have a capacity of 30 unities.

i)How many positions will we need for the component 2's boxes?
j)How many positions will we need for the component 4's boxes?

Solution:

Considering the table's data, the task diagram has this following form:

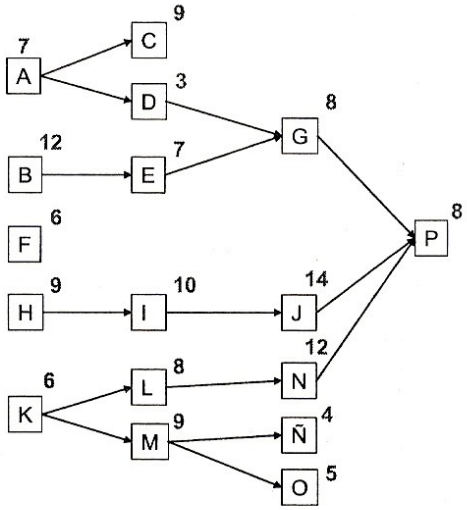


Figure 1.Task Diagram

Quicker turn:

$C = \frac{455,60}{1000} = 27,3$	$N = \frac{137}{27,3} = 5,01 \cong 6$	$E\% = \frac{137}{6.27,3} = 0,836$

Quicker turn:

			27,3	
Station	Activity	Time	Remaining T.	Possibles
1	B	12	15,3	A,**B**,F,H,K
	H	9	6,3	A,E,F,**H**,K
	K	6	0,3	A,E,F,I,**K**
2	I	10	17,3	A,E,F,**I**,L,M
	J	14	3,3	A,E,F,L,M,**J**
3	M	9	18,3	A,E,F,L,**M**
	L	8	10,3	A,E,F,**L**,Ñ,O
	A	7	3,3	A,E,F,Ñ,O,N
	D	3	0,3	C,**D**,E,F,Ñ,O,N
4	N	12	15,3	C,E,F,Ñ,O,**N**
	C	9	6,3	**C**,E,F,Ñ,O
	F	6	0,3	E,**F**,Ñ,O
5	E	7	20,3	**E**,Ñ,O
	G	8	12,3	**G**,Ñ,O
	P	8	4,3	**P**,Ñ,O
	Ñ	4	0,3	**Ñ**,O
6	O	5	22,3	**O**

The percentage of idle time of the more idling station is calculate like this:

$$\%IdelTime = 100 - \frac{5,100}{27,3} = 81,68\%$$ or like this $$\frac{22,3.100}{27,3} = 81,68\%$$

(5 is the length of ativity "O")
...taking into account that the more idling station is the n°6, as it can be seen in the preceeding table.

Slower turn:

$$C = \frac{455,60}{400} = 68,25 \qquad N = \frac{137}{68,25} = 2,007 \cong 3 \qquad E\% = \frac{137}{3.68,25} = 0,669$$

Slower turn

			68,25	
Station	Activity	Time	Remaining T.	Possibles
1	B	12	**56,25**	A,**B**,F,H,K
	H	9	47,25	A,E,F,**H**,K
	I	10	37,25	A,E,F,K,**I**
	J	14	23,25	A,E,F,K,**J**
	A	7	16,25	**A**,E,F,K
	C	9	7,25	E,F,K,**C**,D
	E	7	0,25	**E**,F,K,D
2	K	6	**62,25**	F,**K**,D
	M	9	53,25	F,D,L,**M**
	L	8	45,25	F,D,**L**,Ñ,O
	N	12	33,25	F,D,Ñ,O,**N**
	F	6	27,25	**F**,D,Ñ,O
	O	5	22,25	D,Ñ,O
	Ñ	4	18,25	D,Ñ
	D	3	15,25	**D**
	G	8	7,25	**G**
3	P	8	**60,25**	**P**

Manual rebalancing of the slower turn:

One possible solution can be:

Slower turn manually rebalanced (Tcycle=46s)

Station	Activity	Time	Remaining T.	Possibles
1	B	12	**34**	A,**B**,F,H,K
	H	9	25	A,E,F,**H**,K
	I	10	15	A,E,F,K,**I**
	J	14	1	A,E,F,K,**J**
2	A	7	39	**A**,E,F,K
	C	9	30	E,F,K,**C**,D
	E	7	23	**E**,F,K,D
	K	6	17	F,**K**,D
	M	9	8	F,D,L,**M**
	L	8	0	F,D,**L**,Ñ,O
3	N	12	34	F,D,Ñ,O,**N**
	F	6	28	**F**,D,Ñ,O
	O	5	23	D,Ñ,O
	Ñ	4	19	D,Ñ
	D	3	16	**D**
	G	8	8	**G**
	P	8	0	**P**

With this manual rebalancing we can reach: $$\frac{455,60}{46} = 594 engines$$

To do the manual rebalancing of the slower turn the global times of each station have been summed

up (0,25+7,25+60,25=67,75).This total global time is now distributed between the 3 stations (67,75/3=22,58s). Then, in a theorical and exact way, we can say that each stations' time can decrease by 22,58s. The theoretical and exact cycle time would be of 40,67s (68,25-22,58=40,67). Now we can begin with the manual rebalancing, trying to do that the activities that we put in each station sum up a time close to this one. Logically, it's about theory. For this case we have reached a cycle time of 46s. It can be realized by different balances, in general, all the ones below 50s are considered good.

Determining the boxes' positions:

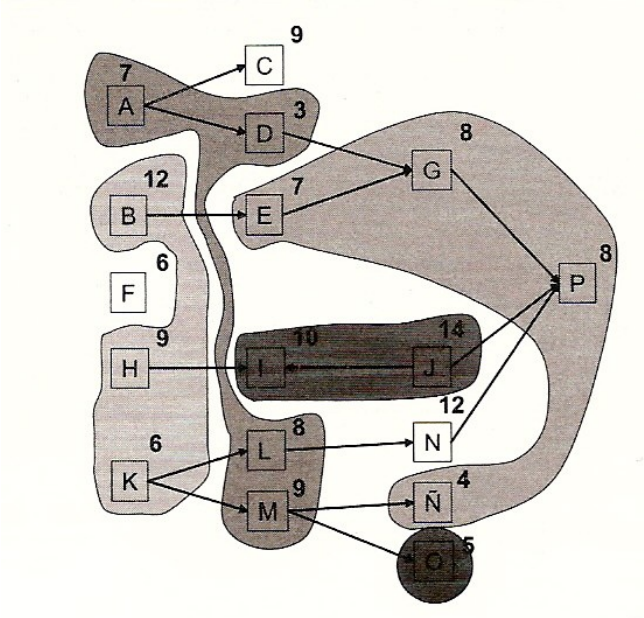
As in the rapid turn are made more engines than in the slower one (1000 comparated to 400), the components' boxes' zones have to be dimensioned for this turn (which is the worst case concerning the components' consumption).

455min = 7,58 hours =>1000 engines/7,58 hours = 131,926~132 engines/hour.

Comp. type	Engines/hour	hours without filling	N° comp./engine	Total necessary comp. Until new filling	Comp./box	Boxes	Upper rounded value
1	132	2	1	264	10	26,4	27
2	132	2	1	264	20	13,2	14
3	132	2	1	264	10	26,4	27
4	132	2	2	528	30	17,6	18

(the dimensionnement always has to be done for the worst case)

N.B.: the graphic groupment of activities in stations for the quicker turn would be:



2.10. Planning the supply

A distribution firm is planning the purchase of a specific product.

The product has a purchasing cost of 800€/paleta. We assume that the warehousing cost of this product is 20% per year.

To transport it, a transporting firm has to be hired and their transporting costs are 700€ for each truck plus 30€ for each transported trowel. The truck has a capacity of 33 trowels and a fortnight is needed to do the travel and being able to deliver the wanted material.

The estimated demand of the product is 3.5 trowels per week with a standard deviation of 0.5 trowels and the service level desired is 99%.

<u>To be able to suitably plan the purchase you have to:</u>

uu) Define the supplying policy with a Reorder Point. (4points)
vv) Define the periodic review supplying policy with the power of two policies using the Tbase=1. (4points)
ww) Calculate what is the cheapest policy considering all the possible costs.(2points)

Other data:
Considering that a year has 52 weeks.

SC(%)	Zsc
95	1,65
97,5	1,96
99	2,33
99,5	2,58

ANSWER:

D=3.5 trowels/week
Pap=2weeks (1 fortnight)
Pprev=1week (3,5 trowels/week)
σ=0.5
Cl=700€/truck
Weeks/year=52
Service level=99%
Zsc=2,33
Tb=1week

Other costs:
C1=800€/trowel asociated with the purchase
C2=30€/trowel asociated with the transport
Cwareh.=0.2

REORDER POINT

$$Q = \sqrt{\frac{2*700*3,5*52}{0,2*(800+30)}} = 39,18$$ (2 points)

But, as in the truck only can fit 33 trowels (39,18>33), the real economic batch size becomes 33 trowels.

$$s = 2{,}33*0{,}5*\sqrt{\frac{2}{1}} = 1{,}65$$

$$p = 3{,}5*2* + 1{,}65 = 8{,}65$$ (2points)

PERIODIC SUPPLYING

$$T = \sqrt{\frac{2*700*52}{0{,}2*(800+30)*3{,}5}} = 11{,}19 weeks$$ (2points)

$$\frac{11{,}19}{\sqrt{2}} \le 2^{n}*1 \Rightarrow n=3 \Rightarrow T = 2^{3}*1 = 8 weeks$$

$$N\max = 3{,}5*(2+8) + 2{,}33*0{,}5*\sqrt{\frac{2+8}{1}}$$

s=3,68 Nmax=38,68 (2 points)

TOTAL COSTS

Ct=Clauching+Cwarehousing+Cpurchasing+Ctransport

$$Crp = 700*\frac{3{,}5*52}{33} + 0{,}2*(800+30)*(1{,}65+\frac{33}{2}) + 3{,}5*52*800 + 3{,}5*52*800 + 3{,}5*52*30$$

Crp=157,934

$$Cprs = 700*\frac{52}{8} + 0{,}2*(800+30)*(3{,}68+\frac{3{,}5*8}{2}) + 3{,}5*52*800 + 3{,}5*52*30$$

Cprs=158,546

The Reorder point offers lower costs. (2 points)

3.3. The Lord of the Ring

The fight for the Middle-Earth has began...

The Middle-Earth is in danger: if the Unique Ring isn't destructed and avoids it to fall in Sauron's hands, the Evil would seize all the beings of the Middle-Earth. Moreover, the fallen Kingdom of the Dunedain won't be possible to rebuilt up until the Ring is destructed and a legitimate heir (able not to succumb to the power of the Ring) would be recognized King.

In the last hours, some members of the Ring Community, survivors of the big fight of the Helm's abyss have been informed, from the Ents (inhabitants of the Fangorn's forest) that Saruman, subject of the evildoer Sauron, is preparing a big counter-offensive with thousands of Orcs. You must help the soldiers Aragorn and Legolas, and the mage Gandalf to prepare the defense of the 9 most important towns of the Middle-Earth. For them, you have to decide in which towns of the following map you have to place the Elfs' detachments, considering that:

xx) you can't put more than one detachment in each town,
yy) each detachment can protect the town in which it is placed and any town located at 4 hours or less,
zz) in the towns 3 and 7 there are no sufficient infrastructure to lodge an Elfs' detachment,
aaa) You have to use the fewest number of Elfs' detachment to protect the 9 towns, so as to maintain the major part of the troops in the Rohan's valley, forced step to the complete invasion of the Middle-Earth from the Mordor, and
bbb) The orcs can't swim, that's why we can discard any attack in the open sea.

Map: Situation of the 9 most important towns of the Middle-Earth.

Questions:

26) Quantity and localisation of the Elfs' detachments (5points)
27) An unexpected attack from the Orcs in the north zone, in the environs of Angmar, forces the Elfs to retreat. Now they only have 2 detachments to protect 9 towns! Where would you locate them to defend the most important number of inhabitants, considering the population's data from the following table? (3 points)

Town:	1	2	3	4	5	6	7	8	9
Inhabitants:	125	100	150	200	110	50	75	300	125

28) What percentage of inhabitants would you suceed in protecting with this last assumption? (2points)

ANSWER:

- First let's find out from where each town can receive protection:

Town	Can receive protection from:			
1	1	2		
2	1	2	4	5
3	1	2	4	5
4		2	4	
5	2	5	6	9
6		5	6	9
7			6	9
8	8			
9		5	6	9

Note that none of the town can receive protection from towns 3 and 7, not because it takes too much time but because there are no infrastructures to lodge the detachments (condition c).

The subgroups of these 9 groups are:

Town	Can receive protection from:			
1	1	2		
4		2	4	
7			6	9
8	8			

Two right solutions exist: place detachments in towns 2,6 and 8 or in 2,9 and 8.

- It is now needed to verify from which towns the better cover is reached:

Town	Towns' cover					Total population	
1	1	2	3		5	375	(125+100+150)
2	1	2	3	4		685	
3	a detachment cannot be placed here						
4		2	3	4	9	450	
5	2	3	5	6		535	
6	5	6	7	9		360	
7	a detachment cannot be placed here						
8			8			**300**	
9	5	6	7	9		360	

The first detachment must be placed in the town 2, because it's the town that has the best population's cover. Now let's calculate where to locate the second detachment:

Town	Towns' cover					Total population	
1	All towns are covered						
2	Anothe detachment cannot be put, already one here						
3	a detachment cannot be placed here						
4	All towns are covered						
5				6	9	175	(125+25)
6		6	7	9		250	
7	a detachment cannot be placed here						
8			8			**300**	
9		6	7	9		250	

(Be careful, there are towns which are already covered by 2 but from which covers other towns that are not even covered)

The second and last detachment will be placed in town 8, because it's the one which has the major population cover (300 inhabitants).

ard and de luxe

One textile company launch its main product in two different forms, standard and deluxe, whose weekly demands are:

	average	standard deviation
standard	3500 un.	400 un.
Deluxe	1800 un.	300 un.

Both forms have been produced from the same material with a making term (setup time) of 24 hours. Nevertheless the fabric manufacture requires 3 weeks with a preparation costs about 85000 pts by making order and average prize of 600 pts/m of fabric.
Realizing that each unit of finished product requires 2,4 meters of fabric and the last demand is constant, the service deadline of 48 hours for a service level of 95% and stock management by reorder point. Calculate the size of making orders, the frequency of which are launched, the safety stock and the reorder point. The annual holding cost by monetary unit is 0,2 (about 20%). The company is interested on fabric purchase.

Solution

Analyzing the information of the problem, we can conclude that the important management stock is about raw material.

Considering that each unit of finished product requires 2,4 meters of fabric, average demand of fabric is 12720 meters

Launch cost is s = 85000 pts
Unit product cost = 600 pts/m
Holding cost by euro storaged and year k = 0,2

a) size of making orders of fabric:

$$EOQ = \sqrt{\frac{2 * S * (52 * d)}{k * Cu}} = \sqrt{\frac{2 * 85000 * 52 * 12720}{0{,}2 * 600}} = 30611 \text{ meters}$$

b) launching frequency:

if weekly demand is 12720 meters ,frequency which making orders will be launched will be one order each $\frac{30611}{12720} = 2{,}4 weeks$

c) safety stock which we must working:

standard deviation of demand is

$$\sigma = 2{,}4 * \sqrt{\sigma s^2 + \sigma d^2} = 2{,}4 * \sqrt{400^2 + 300^2} = 1200 m$$

(note: 2,4 of this section isn´t related with 2,4 weeks calculated on section b)
Procurement term (lead time) is L = 3weeks

$Ss = z_{95} * \sigma * \sqrt{L} = 1{,}65 * 1200 * \sqrt{3} = 3429{,}46 = 3430 meters$

d) reorder point

reorder point is the demand during lead time(procurement period) and the safety stock

PP=d*L+ ss = 12720*3+3430 = 41590

2.19 fortnightly demand

One company has registered it sell information in a fortnightly way. One of its products has a demand that it distributes according to a normal of 500 units each 15 days, with a standard deviation of 150 units.

Each unit has a purchase cost of 100 euros. The cost of each purchase order is 2000 euros. The storage cost of each unit is 20 euros per year. The supply term is 5 weeks. The service level to the customer is 95%.

For a reorder point model , calculate :

a) the economic lot

b) the safety stock

c) which is the reorder point d

d) the cost of associated inventory management ,including the safety stock, the maximum level of storage in 95% of situations.

Solution

a) the economic lot

one year has 26 fortnights

$$EOQ = \sqrt{\frac{2*s*(26*d)}{h}} = \sqrt{\frac{2*2000*26*500}{20}} = 1612{,}4 = 1612 units$$

b) the safety stock

Supply term is 5 weeks and the lead time is 2 weeks (the information related to the demand is in fortnightly way)

$$Ss = z_{95} * \sigma * \sqrt{L} + ss = 1{,}65 * 150 * \sqrt{\frac{5}{2}} = 391{,}3 = 392 units$$

c) the reorder point

considering that the demand is fortnightly and LT in weeks

PP=d*L+ ss = (500/(2*5)) + 392 =1642 units

d) the cost of associated inventory management, including the safety stock

$$TC = \frac{26*d}{Q} * L + H * (\frac{Q}{2} + ss) = \frac{26*500}{1612} * 2000 + 20 * (\frac{1612}{2} + 392) = 16129 + 23960 = 40089 euros$$

g) maximum level of storage in 95% of situation

the maximum level of storage will take place when the demand along the supply term will be lower than the prediction and the order will be received.

similarly to the safety stock that the maximum demand is calculated in the 95%, the minimum demand in 95% of the cases will be superior to (d*L)-ss

then the stock in the storage will always be lower, in the 95% of the cases to

Q+2*ss=1612+2*392=2396 units

2.20 fortnightly demand (2)

Is suggested that in the last company and for the same product we choose a supply periodic system with a weekly, fortnightly or monthly periodical . According to the last information, which is the best option? .Calculate for the best option the maximum level to ask for in each time. Note: each month has 4,3 weeks

Solution

To answer the last question it will be necessary to calculate for each situation (weekly, fortnightly, average level stock in the warehouse) moreover considering that the time units are fortnights.

The average level in the warehouse will be the result of dividing among 2, the safety stock plus maximum warehousing (average purchase set plus safety stock).

$$\text{Ss (1week)} = z_{95} * \sigma * \sqrt{L + PR} = 1{,}65 * 150 * \sqrt{\frac{5+1}{2}} = 429 units$$

$$\text{Ss (2weeks)} = z_{95} * \sigma * \sqrt{L + PR} = 1{,}65 * 150 * \sqrt{\frac{5+2}{2}} = 463 units$$

$$\text{Ss (3weeks)} = z_{95} * \sigma * \sqrt{L + PR} = 1{,}65 * 150 * \sqrt{\frac{5+3}{2}} = 534 units$$

Average level of storage for each situation is:

$$\text{Nmed (1week)} = \frac{Ss(1week) + (dem(1week) + Ss(1week))}{2} = \frac{429 + \frac{500}{2} + 429}{2} = 554 units$$

$$\text{Nmed (2weeks)} = \frac{Ss(2week) + (dem(2week) + Ss(2week))}{2} = \frac{463 + \frac{500}{2} + 463}{2} = 713 units$$

$$\text{Nmed (1month)} = \frac{Ss(1month) + (dem(1month) + Ss(1month))}{2} = \frac{534 + \frac{500}{2} + 534}{2} = 1071{,}5 units$$

Total cost of management annual inventory will be :

TC (1week) =52*S+H*Nmed=52*2000+20*554=104000+11080=115080 euros
TC (2weeks)=26*S+H*Nmed=26*2000+20*713=52000+14260=66260 euros
TC (1month) =12*S+H*Nmed=12*2000+20*1071,5=24000+21430=45430 euros

Monthly periodical is the cheapest
Maximum level to order is

$$\text{Nmax} = d(L + PR) + z_{95} * \sigma * \sqrt{L + PR} = 500\left(\frac{5 + 4{,}3}{2}\right) + 1{,}65 * 150 * \sqrt{\frac{5 + 4{,}3}{2}} = 2859 units$$

2.21 Cubanitos

Cubanitos ,a distribution company of Cuban cigars to the tobacconist´s of Valencia city has to choose a stock management system for its best –selling product.logistic director has this information:

Cigar cost :1euro/unit
Holding cost : 25% of cigar cost (k=0,25)
Purchase cost (launch):500 euros/purchase
Service level to the client :99,99% (z=4)
Lead time :3days
Supplying time :2 weeks
Weekly demand :500 units with standard deviation of 50 units
One year has 52 weeks

You have to evaluate two classic system of inventory control (reorder point and supplying periodical).specify the parameters that identify each management system,using check time of 6 weeks for supplying periodical. Which metod would you advice ? why?

Solution

a) reorder point management (significant parameters)
optimum quantity

$$EOQ = \sqrt{\frac{2*S*(52*D)}{k*Cu}} = \sqrt{\frac{2*500*500*52}{0{,}25*1}} = 10198 units/purchase$$

Safety stock

$$Ss = z_{95} * \sigma * \sqrt{L} = 4*50*\sqrt{2} = 283 units$$

Frequency purchase

$$n^{o} \text{ of purchases} = \frac{500*52}{10198} = 2{,}5 \rightarrow 3 \text{ annual requests}$$

reorder point

PP =D*L+Ss = 500 *2 +283 =1283 units

Total cost

$$Tc = \frac{D*L}{Q^{*}} + h(\frac{Q}{2} + Ss) = \frac{500*500*52}{10198} + 0{,}25(\frac{10198}{2} + 283) = 2610 \text{ €/year}$$

b) Supplying periodical management (significant parameters)

Safety stock

$$Ss = z*\sigma * \sqrt{\frac{L+PR}{PP}} = 4*50*\sqrt{\frac{2+6}{1}} = 566 \text{ units}$$

(note : PR=6 is a problem data)

maximum level in the warehouse

N max =D (L+PR)+Ss =500 (2+6)+566=4566 units

Average level in the warehouse

$$Nmed = \frac{Ss*(Ss*d*PR)}{2} = \frac{566+(566+500*6)}{2} = 2066 \text{ units}$$

Total cost

$$TC = \frac{52}{PR} * L + h * Nmed = \frac{52}{6} * 500 + 0{,}25 * 2056 = 4849{,}8 \text{ euros/year}$$

Analyzing total cost I will recommend first management system.

1975