

production planning control

5/2/2019

Forecasting (An actual activity done by organization)

↳ predicting the upcoming demand

↳ Experience.

↳ proper techniques.

Forecasting

What to forecast?

- Level of aggregation.

- units of measurements.

choosing forecasting system.

choosing forecasting technique.

Grouping things

into clusters. (clustering)

(software you need.)

لأذا كانت الشئ
بمنتج كثر
منتجان

بمنتج (software)

لأذا كانت بمنتج منتج واحد

simple excel sheet
(رج منتج)

منتج

91	حليب كامل الدسم القوي	SKU1
	حليب خالي الدسم القوي	SKU2
92	250 ml حليب فواكه	SKU3
	250 ml حليب جوز	
93	1L عسل	
	1L عسل	
94	250 ml عسل	
	250 ml عسل	

- Highest level of aggregation. - All products

المنتجان لأبسط أشكال
ممكنة (بمنتج واحد)

units/year.

units/months

FIVE APPLE

91
92
93
94

SKU = stock keeping unit. sku1 unit/day unit/week.

(الكم والوقت)

ل الكم جزء SKU (جزء من)

ل الوقت جزء SKU (جزء من)

ل الكم كله جزء SKU

* Choosing forecasting technique :-

No historical data about actual demand.

(New product. / مش شرا يكون)

(New market. / ممكن يكون غير مكان)

(New market. / البيع)

Judgemental methods. Essential.

(Experience. / خبرة)

- Sales force estimates. (الباعين)

- Executive opinion (Management. / المديرون)

- Market research. (معرفة الناس عن)

- Delphi method. (طريقة الاستبيانات)

(Experts) (Highest level of aggregation.)

(Anonymous. / مجهول)

(coordinator. / منسق)

(Analyst. / محلل)

(experts. / خبراء)

Historical data about actual demand

quantitative methods

Causal methods

Time series analysis methods

CS57 - No. 8/2/2020

Historical data ab.
actual demand
|
Quantitative methods

Causal methods

- Simple linear regression

Time series analysis

- naive approach

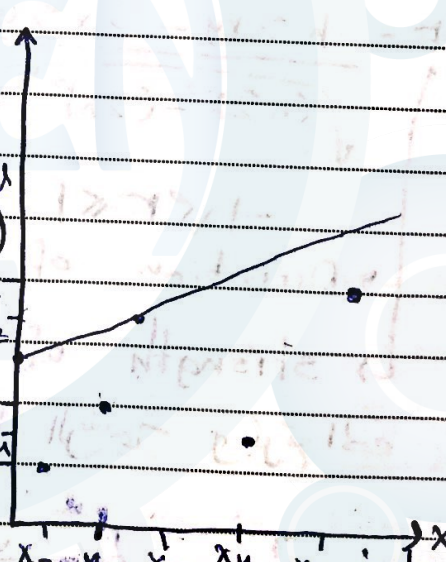
- simple moving average

- weighted moving avg.

- trend analysis

- multiplicative seasonal method.

periods	indp. var. X	dep. var. Y	XY	X^2	Y^2
1	X_1	Y_1	X_1Y_1	X_1^2	Y_1^2
2	X_2	Y_2	X_2Y_2	X_2^2	Y_2^2
3	X_3	Y_3	X_3Y_3	X_3^2	Y_3^2
...	...	...	...	...	...
n	X_n	Y_n	X_nY_n	X_n^2	Y_n^2
	$\sum X$	$\sum Y$	$\sum XY$	$\sum X^2$	$\sum Y^2$



* $n \geq 5$ $\bar{X} = \frac{\sum X}{n}$ $\bar{Y} = \frac{\sum Y}{n}$

We assume that the relationship between them is linear.

$Y = a + bX$

القوانين التي تتبع اليوم مشى موجودة بالكتاب بين رج خطانا يلهم كي
ال e-learning

مجموع التربيعات deviations للنقاط الحداد ال Line
is min.

$$b = \frac{\sum xy - n\bar{x}\bar{y}}{\sum x^2 - n\bar{x}^2}$$

$$a = \bar{y} - b\bar{x}$$

Before we use the model we have to make sure if there's a strong relationship.

By three methods:

1 Correlation coefficient r .

$$r = \frac{n\sum xy - \sum x \sum y}{\sqrt{(n\sum x^2 - (\sum x)^2)(n\sum y^2 - (\sum y)^2)}}$$

$$-1 \leq r \leq 1$$

→ Direction of the relationship.

↳ strength of the relationship.

تربيع الحداد ال a و X في الراسية و تربيع الخطا.

$$-1 \leftarrow 0 \rightarrow 1$$

$r > 0 \Rightarrow$ positive relationship (As x inc. y inc.)

$r < 0 \Rightarrow$ Negative " (" " dec.)

كل ما كانت r اقرب الى 1 او -1
 stronger relationship.

if $r=1$ $\Rightarrow$ كل المتغيرات
 تتكون على الخط

(perfect relationship.)

if $r=0 \Rightarrow$ the relationship isn't
 linear.

There may be a relationship

there may be not.

we have to test
 other models.

$$r = .6$$

$r = .9 \Rightarrow$ Stronger

$$r = .6$$

$$r = -.6$$

$\rightarrow$ The same.

[2] Coeff. of determination.

$$0 \leq r^2 \leq 1$$

Amount of

change in the y caused
 by the indep. var.

$$r = .9$$

$$r^2 = .81 \Rightarrow 81\%$$

demand $\Rightarrow$ المتغير المستقل

المتغير التابع

indep. var.

⇒ It is a strong relationship.

$$r = .6$$

$$36\%$$

$$r^2 = .36$$

⇒ It's not a strong relationship. (Weak, moderately weak)

[3] Standard error of the estimate. (strong, moderately strong)

$$S = \sqrt{\frac{\sum y^2 - a \sum y - b \sum x}{n-2}}$$

بسیاری از مدل‌ها
models
از آنجا که

→ Variability about the line.

(چند کمالات)

We need to make the variability less.

چند کمالات

Example :

And believes that advertising expenditure ---

⇒ Assumption

⇒ Causal method.

period	Sales Y (thousands of units)	Advertising X (thousands of \$)	XY	X ²	Y ²
1	264	2.5			
2	116	1.3			
3	165	1.4			
4	101	1.0			
5	209	2.0			
	$\sum Y$	$\sum X$	$\sum XY$	$\sum X^2$	$\sum Y^2$

$$y = a + bx$$

$$b = \frac{\sum xy - n\bar{x}\bar{y}}{\sum x^2 - n\bar{x}^2}$$

$$b = 109.229$$

$$a = -8.135$$

$$Y = -8.135 + 109.229X$$

$$r = .98$$

↳ positive relationship (As x increases y increases).
 ↳ There's a strong relationship.

$$r^2 = .96$$

$$S = 15.6$$

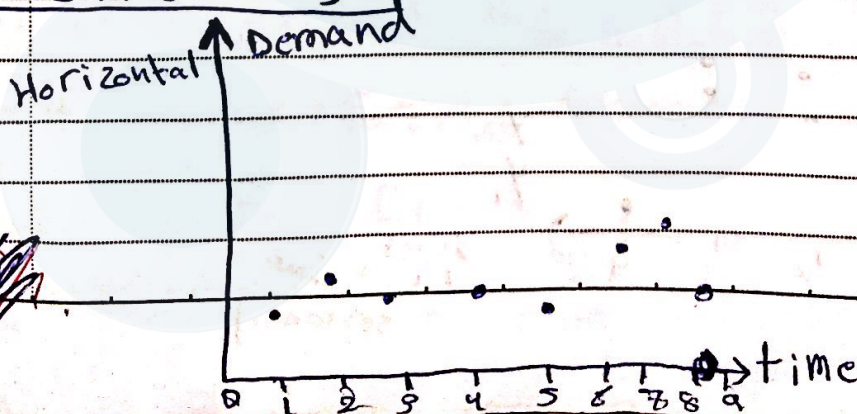
The company will spend \$1750 next month on advert.

$$x = 1.75$$

$$y = -8.135 + 109.229(1.75) \\ = 183.015$$

Forecast _{next month} = 183.015 unit.

Time series analysis:

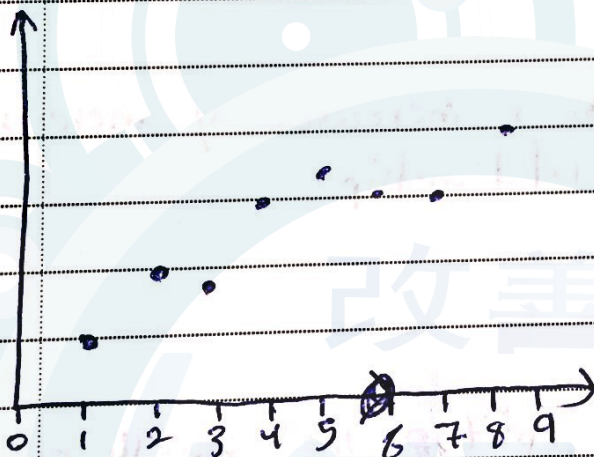


FIVE APPLE

Five basic patterns:

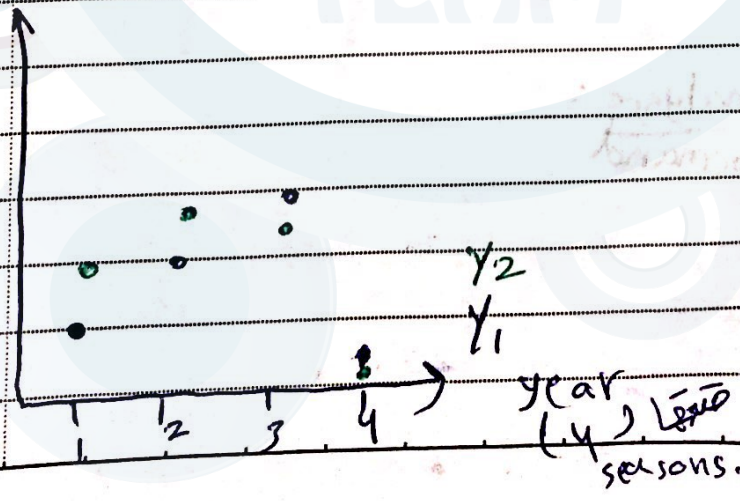
- Horizontal
- trend (consistent increase/decrease in demand over time)
- seasonal (consistent)
- cyclical
- random

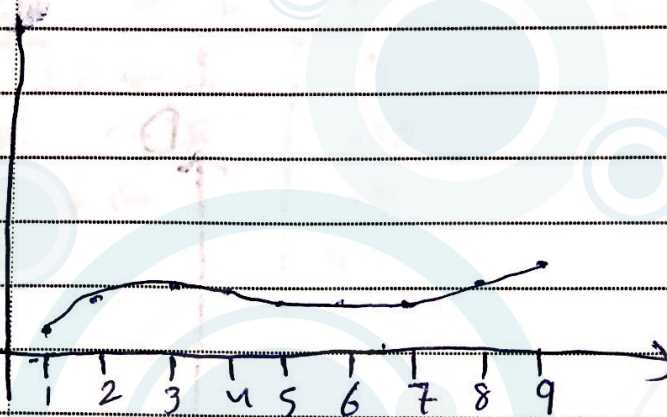
Trend:



To prove that fake the avg for pts. at the end and compare it with the avg for the pts. in the middle & at the beginning.

Seasonal:





Notations:

past Future
 D_{t-3} $\leftarrow E_t \rightarrow$

$t-3$ $t-2$ $t-1$ t $t+1$ $t+2$ $t+3$

$t \Rightarrow$ This $t-2$ $t-1$ t $t+1$ $t+2$ $t+3$
 (the most recent period.)

Actual data (the most recent period.)
 ab. demand.)

$t-1 \Rightarrow$ Last period
 (the second most recent period.)

$t+1 \Rightarrow$ Next period

$D_t \Rightarrow$ Actual demand for period t .

$F_{t+1} \Rightarrow$ Forecast demand for period $t+1$.

$F_t \Rightarrow$ Last period forecast. (Forecast of period t .)

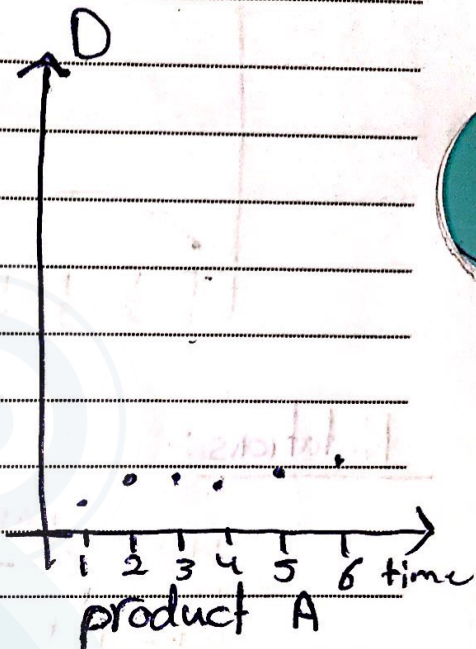
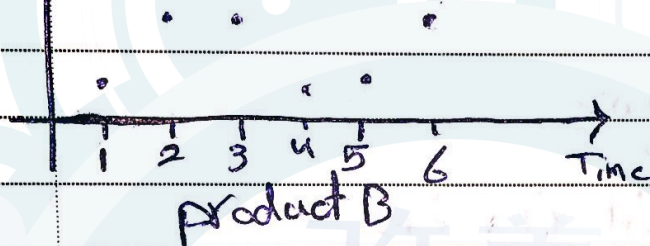
$E_t \Rightarrow$ Error $E_t = D_t - F_t$
 +ve under estimating

-ve over estimating. FIVE APPLE

Naive approach :-

$$F_{t+1} = D_t$$

D ↑



It's more appropriate for the horizontal-pattern.
Here it's more appropriate for product A.

Simple moving average :-

The forecast for the next period equals to the average of the n most recent periods.
demand

$$F_{t+1} = \frac{D_t + D_{t-1} + \dots + D_{t-n+1}}{n}$$

Examples: 3-periods simple moving average

$$F_{t+1} = \frac{D_t + D_{t-1} + D_{t-2}}{3}$$

4-periods

$$F_{t+1} = \frac{D_t + D_{t-1} + D_{t-2} + D_{t-3}}{4}$$

Example: Week patients Arrivals

$t-2 \leftarrow 1$

400

$t-1 \leftarrow 2$

380

$t \leftarrow 3$

411

4

415

- Three week moving average.

بازا لاسا لاسا لاسا

Simple moving

$$F_{w4} = \frac{411 + 380 + 400}{3} = 397 \text{ patients.}$$

if the real demand in week 4 = 415

then $E_{w4} = 415 - 397 = 18 \text{ patients.}$

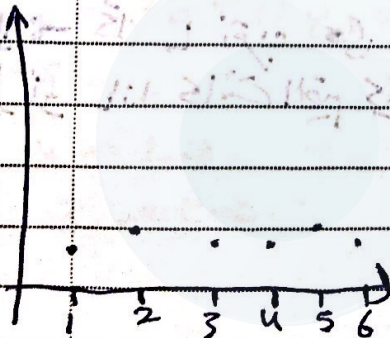
$$F_{w5} = \frac{415 + 411 + 380}{3} = 402 \text{ patients.}$$

$t \rightarrow \text{week 4}$

$t-1 \rightarrow W_3$

$t-2 \rightarrow W_2$

It's appropriate for the horizontal time series.



Forecast

الفترة السابقة = الفترة
التي

إذا كانت أي شيء هو الفترة السابقة
وذلك السابق والآن
يتميز بفترة.

الآن أعرف السابقة ← التالية والتالية وما يليها يتم
(ال Actual)

هناك technique بين تقني التي أعرف ال next
period Forecast.

Weighted moving average:
(More emphasis to the most recent demand.)

$$F_{t+1} = W_1 D_t + W_2 D_{t-1} + \dots + W_n D_{t-n+1}$$

$$W_1 + W_2 + \dots + W_n = 1$$

$$W_1 > W_2 > \dots > W_n$$

not too much periods.

لأن كل ما نريد على الأبعد بتقريبه إلى W على الفترة
(أو إذا كانت القيمة كثير تربية من بعض راجع غير كثيرا simple)

Month	customer Arrivals
t-3 ← 1	800
t-2 ← 2	740
t-1 ← 3	810
t ← 4	790
5	805



3-periods weighted moving average
 $W_1 = .5$ $W_2 = .3$ $W_3 = 0.2$

$$F_{m5} = (0.5)(790) + (0.3)(810) + (0.2)(740)$$

$$= 780 \text{ customer.}$$

After month 5 finished, the Actual demand for it was 805

$$E_{m5} = 805 - 780$$

$$= 19 \text{ customer.}$$

$$F_{m6} = (0.5)(805) + (0.3)(790) + (0.2)(810)$$

$$= 801.5$$

$$\approx 802 \text{ customer.}$$

Round up
or round
down.

Exponential smoothing :-

~~Exponential smoothing~~

We only need to know

↳ D_t

↳ F_t

↳ α (smoothing parameter.)

$$F_{t+1} = \alpha D_t + (1-\alpha)F_t$$

$$= F_t + \alpha(D_t - F_t)$$

$$0 \leq \alpha \leq 1$$

(α is $\uparrow$) more emphasis

$$F_t = \dots$$

more emphasis (α is $\uparrow$)

$$D_t$$

(This period.)

$$\alpha = 0.1$$

$$F_{W4} = (0.1)(411) + (0.9)(390)$$

$$= 392.1 \approx 392$$

(Assume that D_t doesn't exist.)

Week	patient Arrivals
1	400
2	380
3	411
4	415

Because I don't have FWS.

⇒ I can use 2 period simple moving average. (Logic in the first periods.)

$$F_{w_3} = \frac{400 + 380}{2} = 390$$

Software Assumes that $F_{w_i} = D_{w_i} = 400$ (Default.)

F_{w1} bis F_{w3} bis F_{w2} ab

بمسائل الكتاب أنما هي من جنس قية - forecast
بالمتغيرات usually بتغيرها forecast

$$F_{WS} = (0.1)(415) + (0.9)(392.1)$$

$$t \rightarrow 4$$

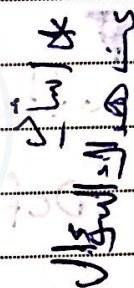
لعل هناك نقلة نوعية الى الغد.

$$= 394.4 \approx 394$$

patients.

الخطوة الى رسائلهم بنطوا لل Horizontal الخطي.

١- ~~تنبؤ~~ forecast
 ٢- ~~نموذج~~ model
 ٣- ~~نموذج~~ model
 ٤- ~~نموذج~~ model
 ٥- ~~نموذج~~ model
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$$n = 4$$

بالموضوع

$$h=4$$

Variation في (الاولا اخرج ما يكون في)

more responsive.

① مثال ال Supplier الي بيبيع كميات ثابتة
(More fixed value.)

Smooth.

② الماكينات الي بيكون لونها في ال Material
(. utilize 100%
(space utilization.)

Factors الي بيؤثر في
النتيجة

(. constraints)

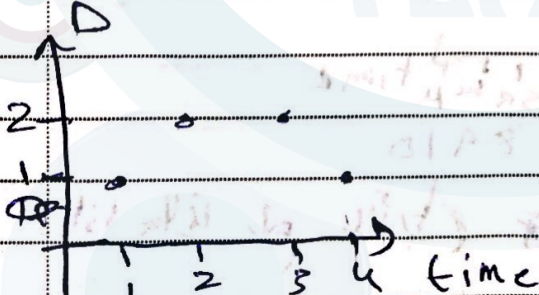
ال α هي عكس ال n

$$F_{t+1} = \alpha D_t + (1-\alpha) F_t$$

More responsive ~~Forecast~~ Forecast.

ال α لا تكون ال α اقل يعني
more emphasize
most
Recent
Demand.)

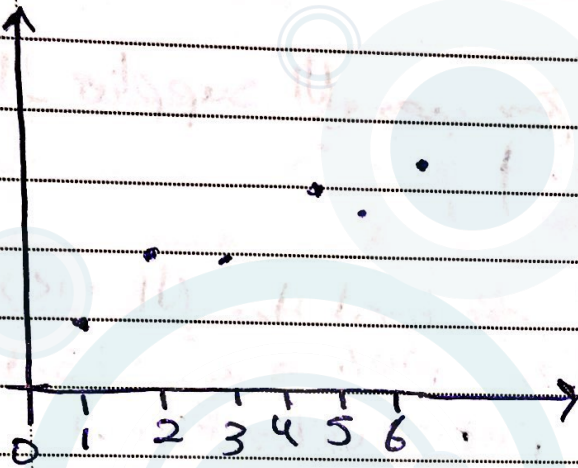
Smaller $\alpha \Rightarrow$ smooth forecast.



ما صغير يكون ال α يعني small

ال α يعني Demand, large

stable



○ Trend (consistent increase.)

Simple

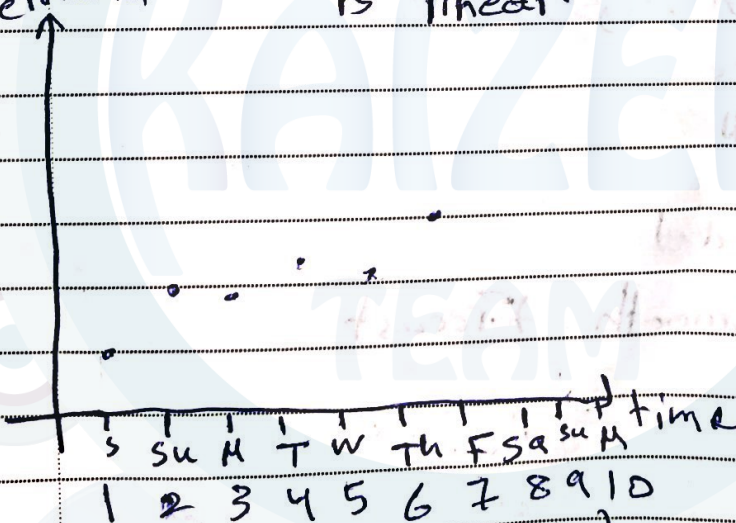
↑ Linear regression is used

BC in We assume that it

the relationship between

the demand & time is linear.

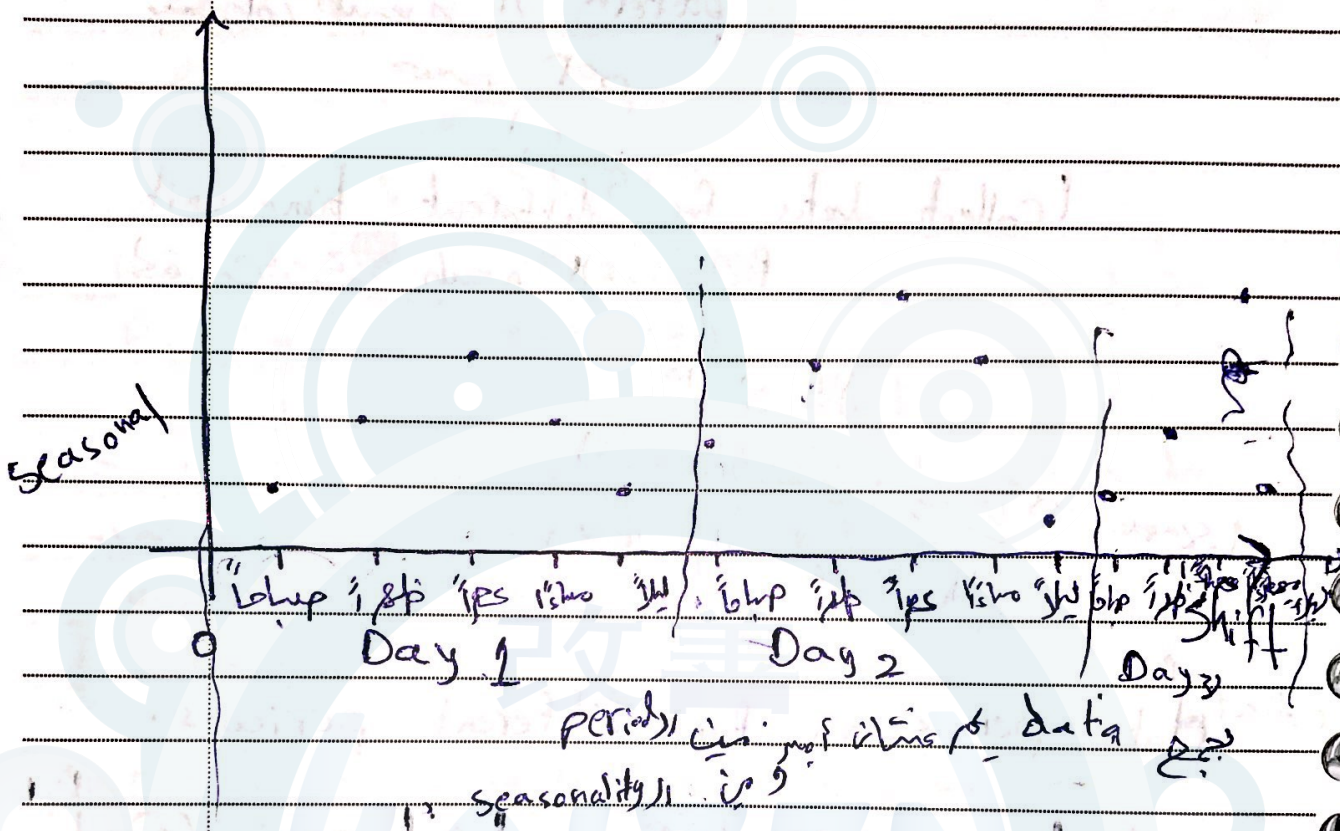
Demand



سوماء 1 2 3 4 5 6 7 8 9 10

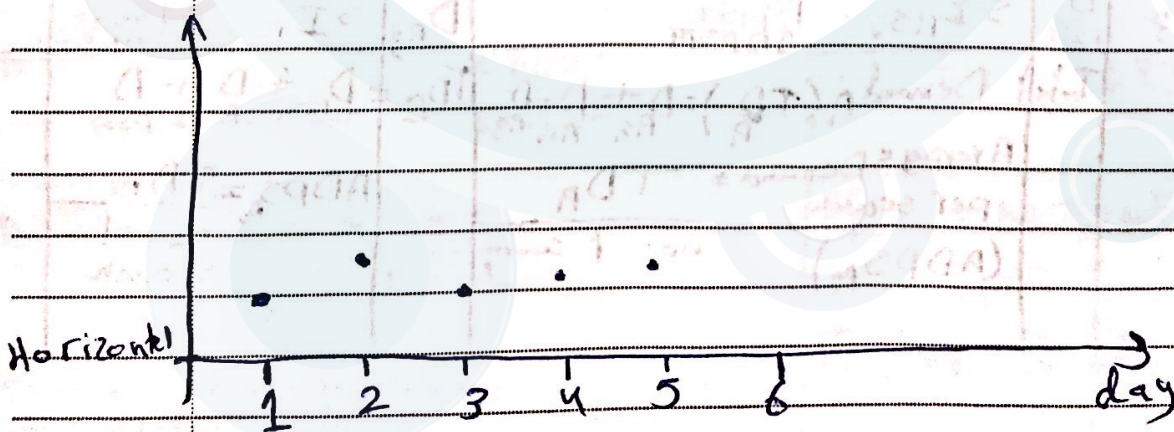
simple linear regression

Seasonality:



Seasonality ← periods of time of data

Better forecast. (better forecast)



product) yield
pattern) $\bar{a}$ $\bar{a}$ $\bar{a}$ $\bar{a}$ $\bar{a}$
per $\bar{a}$

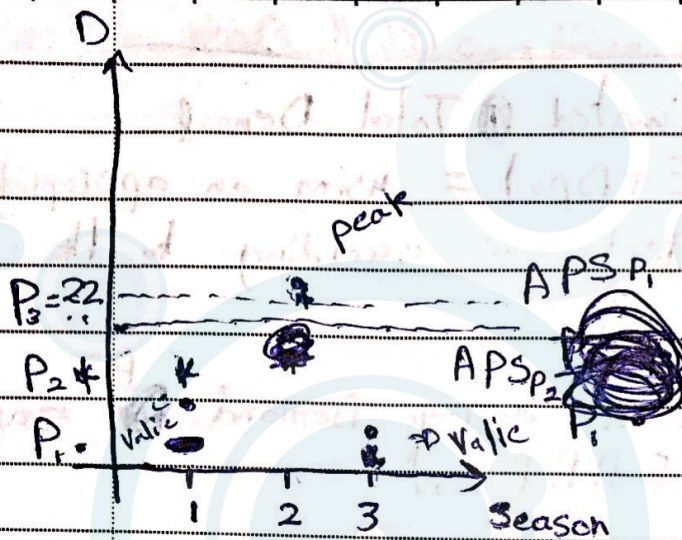
Collect data for different time units
Behavior) $\bar{a}$ $\bar{a}$ $\bar{a}$ $\bar{a}$ $\bar{a}$

($\bar{a}$ $\bar{a}$ $\bar{a}$ $\bar{a}$ $\bar{a}$)

(Seasonality $\bar{a}$ $\bar{a}$ $\bar{a}$ $\bar{a}$ $\bar{a}$)
 $\bar{a}$ $\bar{a}$ $\bar{a}$ $\bar{a}$ $\bar{a}$)

Collect Data per season for different periods.

Season	D	period (1) Seasonal Index (SI)	D	period (2) SI
S1	D_{P1S1}	$SI_{P1S1} = \frac{D_{P1S1}}{ADPS_{P1}}$	D_{P2S1}	$SI_{P2S1} = \frac{D_{P2S1}}{ADPS_{P2}}$
S2	D_{P1S2}	$SI_{P1S2} = \frac{D_{P1S2}}{ADPS_{P1}}$	D_{P2S2}	$SI_{P2S2} = \frac{D_{P2S2}}{ADPS_{P2}}$
S3	D_{P1S3}	$SI_{P1S3} = \frac{D_{P1S3}}{ADPS_{P1}}$	D_{P2S3}	$SI_{P2S3} = \frac{D_{P2S3}}{ADPS_{P2}}$
Total	Demand $P_i (TD_{P_i}) = D_{P1S1} + D_{P1S2} + D_{P1S3}$		$TD_{P2} = D_{P2S1} + D_{P2S2} + D_{P2S3}$	
	Average Demand per season (ADPS _{P1}) = $\frac{TD_{P1}}{\text{no. of seasons}}$		ADPS _{P2} = $\frac{TD_{P2}}{\text{no. of seasons}}$	



① calculate Ratio between the demand & the average. ⇒ Indication how much the season is value or peak (how much is far from the average.)

ADPS ⇒ Seasons & Demand & $\frac{D}{A}$

② Average for the seasonal Index for the same season in different periods.

Average Seasonal Index (ASI) period ③

$$ASI_{s1} = \frac{SI_{P1S1} + SI_{P2S1}}{\text{no. of periods}}$$

$$ASI_{s2} = \frac{SI_{P1S2} + SI_{P2S2}}{\text{no. of periods}}$$

$$ASI_{s3} = \frac{SI_{P1S3} + SI_{P2S3}}{\text{no. of periods}}$$

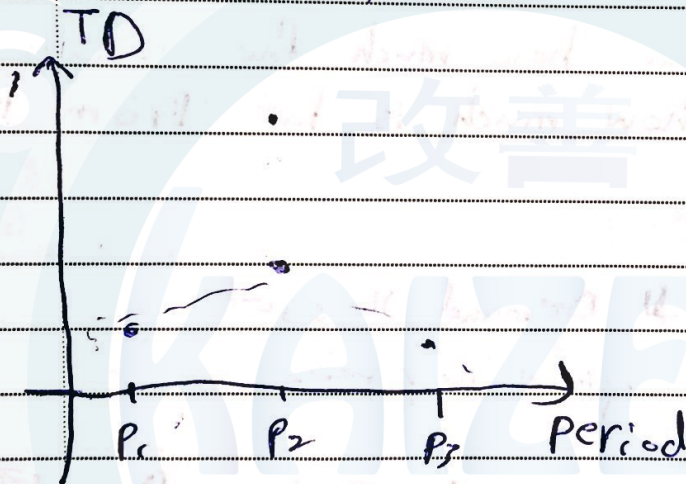
$$F_{P3S1} = ASI_{s1} \times EADPS$$

$$F_{P3S2} = ASI_{s2} \times EADPS$$

$$F_{P3S3} = ASI_{s3} \times EADPS$$

Estimated Total Demand
 $(ETDP_3)$ = using an appropriate
 technique according to the TD
 time series.

Estimated average Demand ^{per}
 $(EADPSp_3)$ ~~Season~~ Season



③ To calculate the estimated total Demand
 we can use any appropriate technique.

(pattern) ~~series~~

Ex.:

تعداد کل (مجموعه)

تعداد کل (مجموعه)

إذا كانت مثلاً $\frac{quarter}{2}$ كل سنة متقاربة بكل ال years مثلا مرة
أو مرتين مثلاً

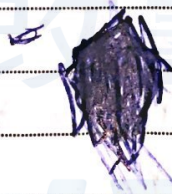
There's a cause
(Look for the reason.) (I have to see what happened.)

مثلاً بعداء الوقت نلجأ إلى التفسير / اختبار / خرب الآلة

How to deal with it?

(مثلاً إذا كانت متقاربة مرة واحدة لخطأ بسيطة)
averaging. (skipping).

للبقية (أو 4 على 4)



نحتاج إلى $ETD =$

أو TD

للتنبؤات المستقبلية، المثال

Increase (Trend.)

Consistent

simple linear regression

$x \Rightarrow$ years

$y \Rightarrow$ TD

$x=5$

الكتاب عمل مقدار الزيادة و Simple moving average

(on avg. تحديث مقدار)

الزيادة

و يجب علينا 400 TD

$(2200 + 400 = 2600)$

period	D	F	E
1	D_1	F_1	Σ_1
2	D_2	F_2	Σ_2
3	D_3	F_3	Σ_3
$\vdots$	$\vdots$	$\vdots$	$\vdots$
n	D_n	F_n	Σ_n

□ Cumulative sum of forecast error (CFE).

$$= \sum_{i=1}^n E_i \rightarrow +ve \text{ underestimating (Bias) to } \downarrow$$

⇒ Indication ab. the bias.

$$E = D - F$$

$= +ve$ underestimating demand

-ve overestimating demand

كل ما كانت أكبر كل ما كان عيب Bias أكثر
(absolute) (أشوأ)

② Mean Bias ($\bar{E}$) = $\frac{\sum_{t=1}^{t=n} E_t}{n}$ — +ve (Bias to under) —
— -ve (Bias to overestimation)

كل ما كانت ألي بيكون أسوأ
6 الله يصبر

3] Mean absolute deviation (HAD) = $\frac{\sum_{i=1}^n |x_i|}{n}$

No.

⇒ Don't average the error

↳ it is not a good idea to average the error

MAD = 10 MAD = 20

on avg. 10

on average 20

10 = average error

20 = average error

EX:

	M1		M2	
	E	Σ^2	E	Σ^2
1	1	1	4	16
2	1	1	0	0
3	1	1	0	0
4	1	1	0	0
MAD	$\frac{4}{4} = 1$		$\frac{4}{4} = 1$	
MSE	$\frac{4}{4} = 1$		$\frac{16}{4} = 4$	

on avg. the error produced is the same.

↳ MAD can't tell us if there are some periods that have very large error.

4) Mean Squared error (MSE) =

$$\frac{\sum_{t=1}^{t=n} E_t^2}{n}$$

بزرگترین خطای مربعی میانگین = $\sqrt{\frac{\sum E_t^2}{n}}$

large error.

Ex: 

D	D	Σ	$\frac{ E }{D}$
product A	1000	1	$\frac{1}{1000}$
Product B	10	1	$\frac{1}{10}$

(same method.)

A $\Rightarrow$ Error produce 1 per 1000
 B $\Rightarrow$ " " " " 1 per 10

Large errors compared as a percent from actual Demand.

5) Mean absolute percent error (MAPE) =
$$\frac{\sum_{t=1}^n \frac{|E_t|}{D_t}}{n} \times 100\%$$
 i.e. Avg error produced as a percent of total.

M1 $MAPE = 20\%$ = D $\rightarrow$ $\frac{1}{10}$

M2 $MAPE = 50\%$

measures up all measures of central tendency

Ex. Standard deviation of error

$$\sigma_e = \sqrt{\frac{\sum_{t=1}^n \sum (K_t - \bar{K})^2}{n-1}}$$

period	D	F	E	E	E^2	$\frac{ E }{D} \times 100$	$(E - \bar{E})^2$
1	200	225	-25	25	625	$\frac{25}{200} \times 100 = 12.5\%$	$(-25 - (-1.87))^2$
2	240	220	20	20	400	$\frac{20}{240} \times 100 = 8.3\%$	
3	300	285	15	15	225	$\frac{15}{300} \times 100 = 5\%$	
4	270	290	-20	20	400	7.4%	
5	230	250	-20	20	400	8.7%	
6	260	240	20	20	400	7.7%	
7	210	250	-40	40	1600	19.0%	
8	275	240	35	35	1225	12.7%	
			-15	15	225	8.1.3%	

$$CFE = \sum_{t=1}^{t=n} E_t = -15$$

$$\bar{E} = \frac{-15}{8} = -1.875$$

$$MAD = \frac{\sum |E_t|}{n} = \frac{195}{8} = 24.4$$

on avg
the dev. from the actual

$$MSE = \frac{\sum E_t^2}{n} = \frac{5275}{8} = 659.375$$

(مربع الخطأ أو التباين)

$$MAPE = \frac{\sum \left[\frac{|E_t|}{D_t} \right] * 100\%}{n} = \frac{8.3}{8}$$

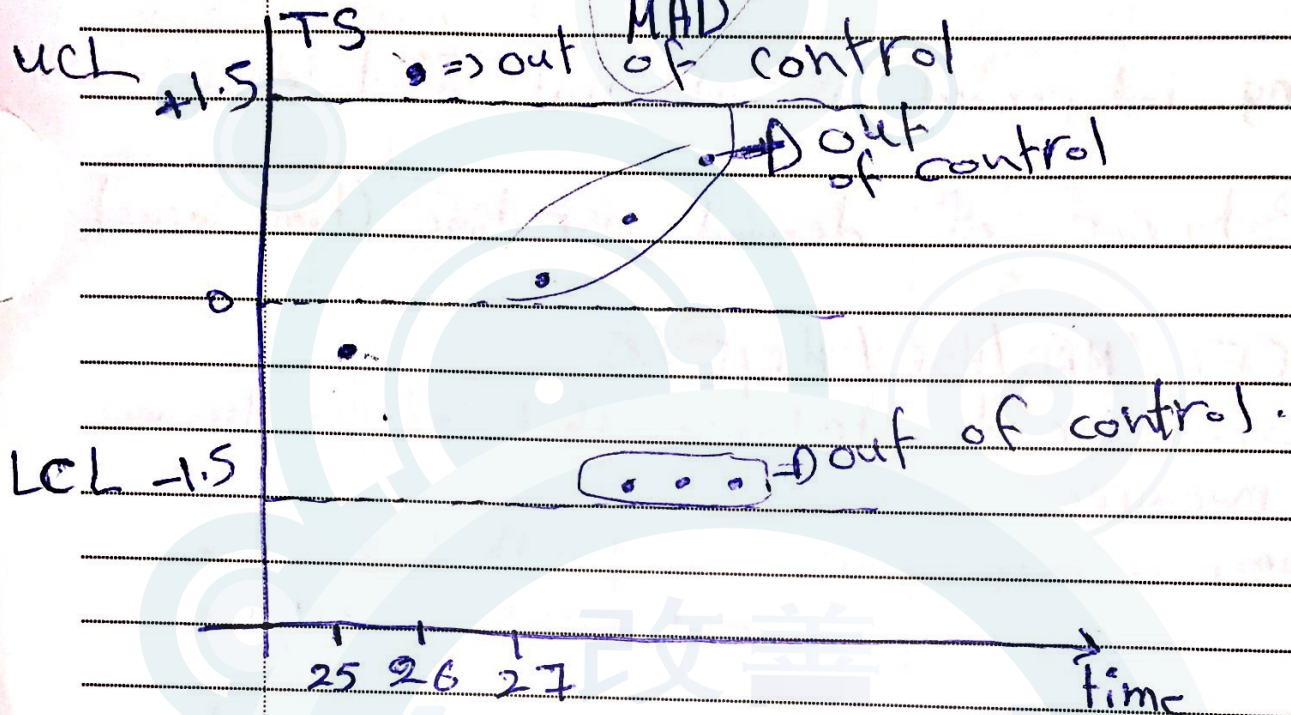
$$= 10.2\%$$

on avg
error is

actual is 10%

$$s_e = \sqrt{\frac{\sum (E_t - \bar{E})^2}{n-1}} = 27.4$$

$$\text{Tracking signal} = \frac{\text{CFE}}{\text{MAD}}$$



• $\Rightarrow$ Limits

$\hookrightarrow$ processes used to forecast are in control.

out of control $\Rightarrow$ our forecasting technique

out of control.

$\Rightarrow$ Alarm $\Rightarrow$ Look for a cause
(Ishikawa's technique) $\Rightarrow$ cause $\Rightarrow$ effect

Tracking signal chart $\Rightarrow$ Indication/ alarm that there's sth. going wrong.

Strategies to choose the appropriate method:

- 1] previous demand data or not.
- 2] Any independent variables that affect demand.
- 3] Behavior of demand over time. (time series).
- 4] CFE / MAD / MSE / MAPE / σ_e .
↳ look for the technique that reduces these measures.

measures $\Rightarrow$ method $\Rightarrow$ measure
أو أقل measure

MAPE $\Leftarrow$ Research paper

5] Tracking signal

6] Combination forecasting. $\Rightarrow$ The forecast that you're going to use in your decision

7] Focus forecasting.

الرقم الذي استعمله
تابع من avg.
forecast for
several techniques
بحسب قيمة Forecast الفترة الجديدة
بشروط بأخر فترة من قبل Method
error $\Rightarrow$ forecasting
الفترة الجديدة

بجدولها / جمع بحسب من أول و جديد
Actual Demand

Combination forecasting:

period	Method 1	Method 2	Method 3	F (decision)
22	$F_{M1(22)}$	$F_{M2(22)}$	$F_{M3(22)}$	$F_{M1(22)} + F_{M2(22)} + F_{M3(22)}$ 3
Focus MAD forecasting				
22	D	F		
23				

↳ This technique is very good.

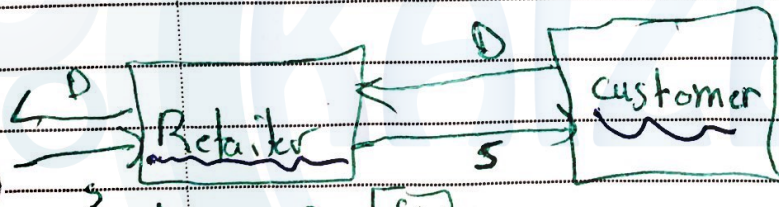
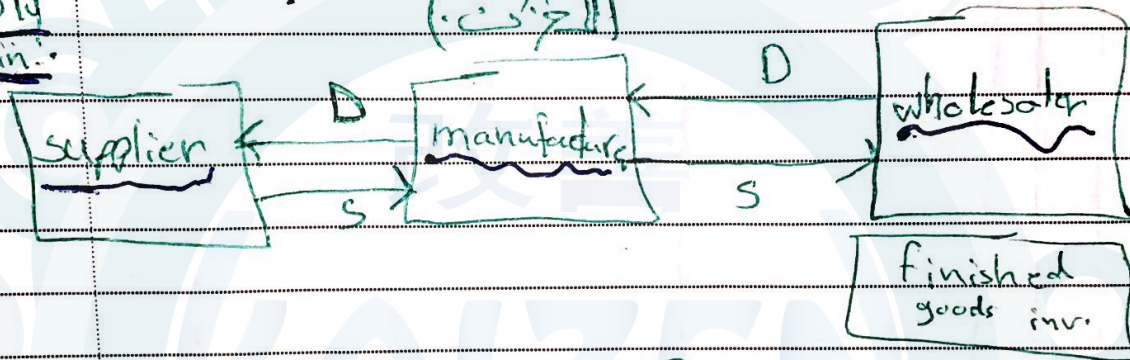
اقتراح احسن من كل tech. لحالها.
(ليس حتى شرط ان يكون لكل الحالات)

التي الجدول تبين
focus forecasting.

Inventory: The material itself that was stocked.
(المخزون)

Warehouse: The place where I store inventory.
(المستودع)

Supply chain:



Importance of Inventory

Inventory is To supply the customer with product / service with the shortest delivery time.

(المخزون الهام)

Enablers of Inventory (الممكنات)

Types of inventory:

(Distribution Center.)

Manufacturer

③ criteria

work-in-process inventory

for

SKUs

Stock keeping unit.

① Raw material inventory

② Finished goods inventory

something like

It's final

form that

is ready

to be

delivered,

to the next

stage.

further production.

(not in the

final

form

"

"

"

Finished: Indep. demand

* SKUs. Demand depends on market conditions.

Raw: Dep. demand SKUs.

↳ Demand depends on demand

for another

Lean: To eliminate waste.

(added value)

SKU.

Work-in-process

is waste

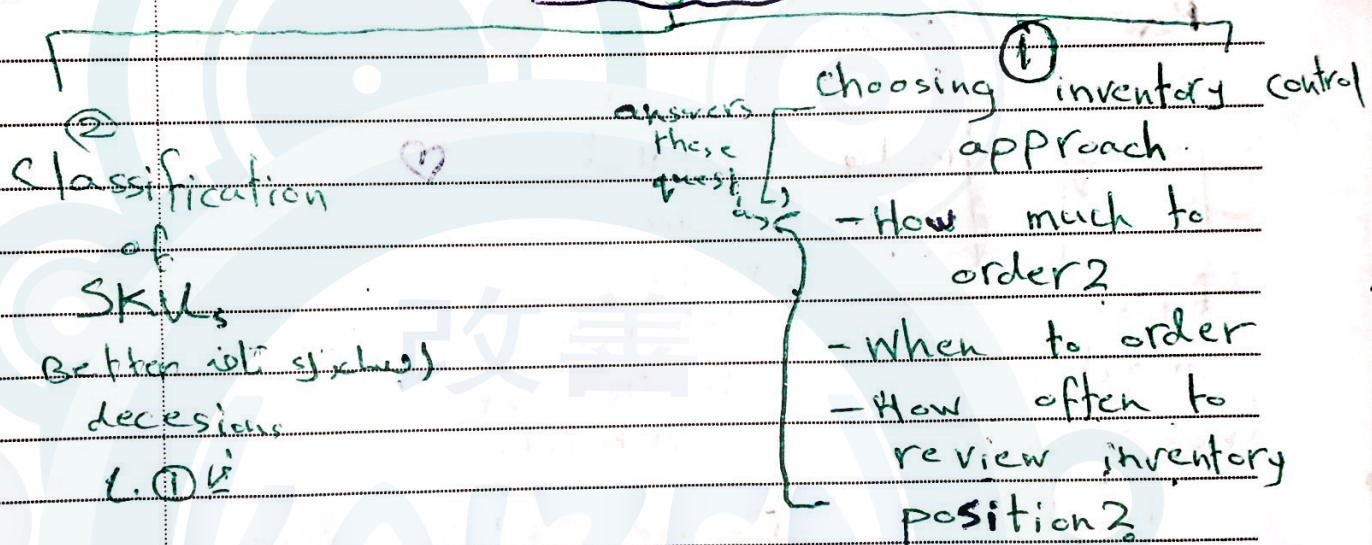
'in Lean.

We need to reduce/eliminate work-in-process.

(Eliminate time)

Inventory Management is an actual activity done by organizations.

Inventory Management



Classification of SKUs - Methods:

- ABC classification → classify into class A, class B, and class C in terms of annual usage value

product	unit cost	Annual Demand	Annual usage value / \$ usage
product A	\$1000	1000000	1000000 \$/year.
product B	\$2000	10	10000 \$/year.

∴ product A is more important.

Size

Pareto principle: (20 80 Rule.)

80%

من الاسباب بسبب

20%

من الاسباب

من الاسباب

20% of causes

بسبب 80% من ال

Defects

(few have the largest effect.)

(More than 50%)

20% of skills have 80% of annual usage value

Annual usage value

القيمة السنوية للاستخدام

Ranking data

بيانات الترتيب

20% of annual usage value

القيمة السنوية للاستخدام

usage value

القيمة السنوية للاستخدام

usage value

القيمة السنوية للاستخدام

usage value

القيمة السنوية للاستخدام

usage value

القيمة السنوية للاستخدام

Multi criteria classification

التصنيف متعدد المعايير

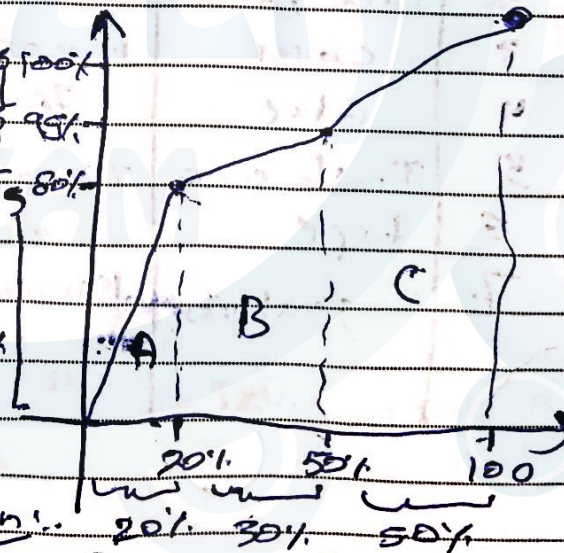
very critical

critical

few critical

Mini useful

class



Spare parts $\Rightarrow$ Not based on ABC classification.
(Slow moving / fast moving.)

H.W:-

Classification of literature using
method

other than ABC

classification

with brief description.

(. 80)

Example: (Solved problems)

SKU no.	Description	quantity used per year	unit value \$	usage value
1	Boxes	500	3	1500
2	Card board	18000	0.02	360
3	cover	10000	0.75	7500
4	Glue	75	40	3000
5	Inside cover	20000	0.05	1000
6	tape	3000	0.15	450
7	signatures	150000	0.45	67500

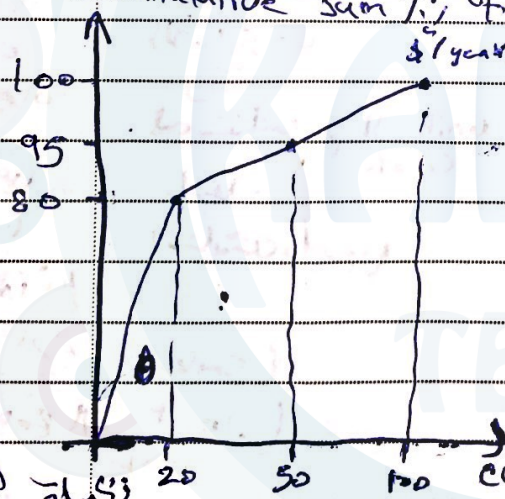
(2/5-1)
Class

No.

Handwritten notes at top right.

Class	SKU No.	Description	Usage value	% SKUs	% usage value	Cumulative % of SKUs	Cumulative % of usage value
A	7	Signatures	67500	$\frac{1}{7} = 14.3$	$\frac{67500}{8136} = 83$	14.3	83
B	3	cover	7500	14.3	9.2	28.6	92.2
B	4	Glue	3000	14.3	3.7	42.9	95.9
C	1	Boxes	1500	14.3	1.8	57.1	97.8
C	5	Inside cover	2000	14.3	1.2	71.4	99
C	6	tape	450	14.3	0.6	85.7	99.6
C	2	Card board	3600	14.3	4	100	100

cummulative sum 8136 of usage values



Identified class

class

A

included in
the purchasing cost.
Transportation Cost.

Inventory Cost

Ordering/setup Cost

Holding Cost (15-35%)

Cost

as a percentage of unit cost.

Cost of Capital

Storage & handling cost

Taxes/insurance/shrinkage

Lossing

the capacity

(مثلاً إذا كان قلم)

على الزيت يكون

خاطئاً (مباريت)

Cost

(القيمة الزائدة)

unit cost

الكل في مكان

cost of capital

(القيمة)

H: \$/unit/year.

(قيمة وحدة في سنة واحدة)

عندما تتكاثف في الزيت

= percent of unit cost.

obsolescence

(out-dated)

detention

(damaged)

(capital)

(value)

original

(القيمة)

(القيمة)

(القيمة)

(القيمة)

(القيمة)

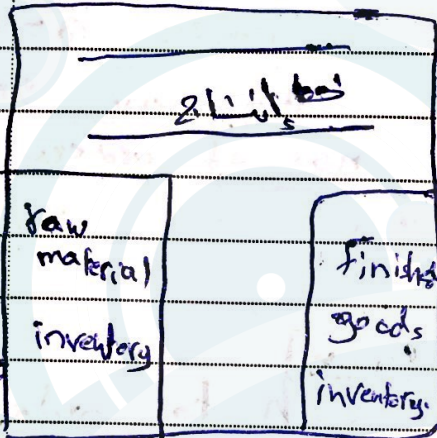
(القيمة)

(القيمة)

(القيمة)

② Ordering / setup cost ⇒ order cost

manufacturer



supplier order

cost of ordering / purchasing

cost of the order / purchase

supplier

supplier

supplier

supplier

supplier

It mo

order internally
product department
setup cost

order internally

product

dep.

setup cost

(cost of setting up production)

(cleaning / roots)

(cleaning / roots)

(cleaning / roots)

Replenishment

(Replenishment) (holding) (purchase)

(order/setup)

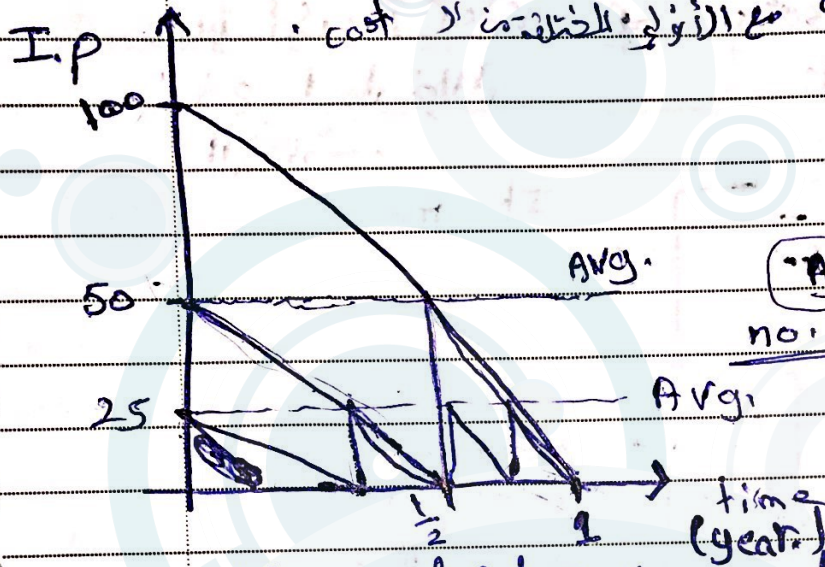
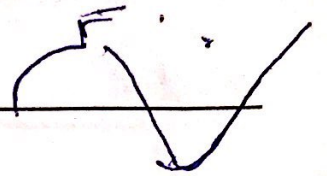
(purchase)

Forecasting

Forecasting



No.



cost of inventory holding & cost of ordering

$D = 100$ unit/year.

Case (1) $Q = 100$

Avg. inv. $= 50 = \frac{Q}{2}$

no. of orders $= \frac{D}{Q} = \frac{100}{100} = 1$

Quantity ordered $\rightarrow$ How much to order.

Inventory position $\rightarrow$ I.P. $\rightarrow$ Inv. $\rightarrow$ C.I.P.

Avg. $\uparrow$ C.I.
no. of orders $\downarrow$

$D \rightarrow$ Annual demand.

Case (2) $Q = 50$

Avg. inv. $= \frac{Q}{2} = \frac{50}{2} = 25$

no. of orders $= \frac{D}{Q} = \frac{100}{50} = 2$

Avg. Inv. $\uparrow$ C.I.
no. of orders $\downarrow$

Case (3) $Q = 25$

Avg. inv. $= \frac{25}{2} = 12.5$

no. of order $= \frac{100}{25} = 4$

FIVE APPLE

Annual cycle inventory cost = Annual holding cost
+ Annual ordering / setup cost.

Cycle inv.

C inv.

تكاليف دورة المخزون
التخزين

saw

tooth

pattern.

logarithmic & linear

1. (تكاليف دورة المخزون)

Total Annual cycle inventory cost

= Annual holding cost + Annual order/setup cost.

تكاليف دورة المخزون
 $\frac{Q}{2} H$

تكاليف
 $\frac{D}{Q} S$

Annual holding cost = Average cycle inventory unit holding cost.
 $H: \$/\text{unit}/\text{year}.$

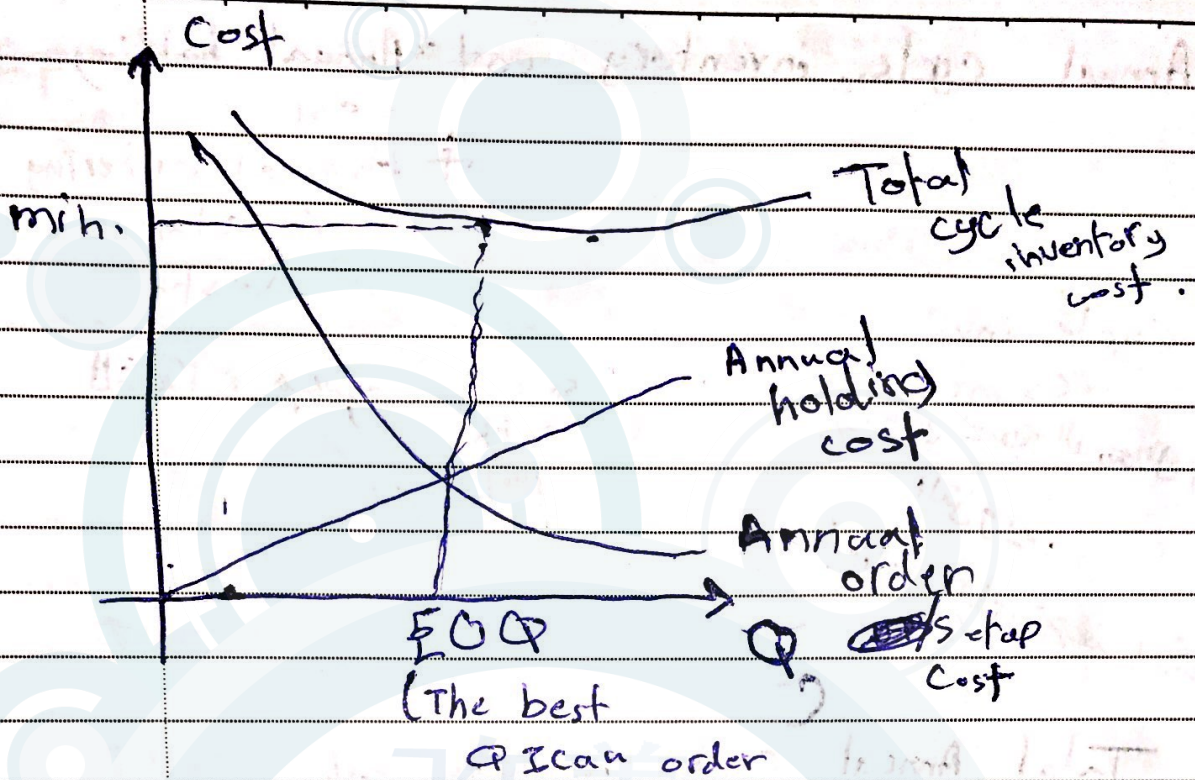
$\frac{Q}{2} (H)$

Annual order / setup cost = no. of orders / year * order / setup cost.

$S: \text{order / setup cost}$

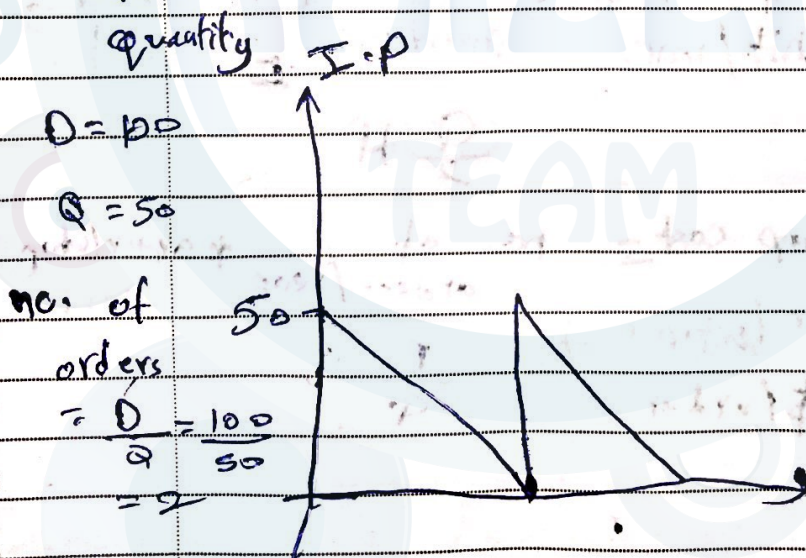
$\$/\text{order}$

$\frac{D}{Q} S$



$$EOQ = \sqrt{\frac{2DS}{H}}$$

economic order quantity



$$TBO = \frac{Q}{D} \text{ year.}$$

(Time between orders)

$L \rightarrow 12$ -- month

$L \rightarrow 52$ -- weeks

$L \rightarrow 365$ days

FIVE APPLE

EX: 22

Sales (Demand)

$d = 18 \text{ units/week.}$

$S = 45 \$$

unit cost = \$60/unit.
(سعر الشراء)

$H = 25\% \text{ of unit cost.}$

$= (0.25)(60) = \$15/\text{unit/year.}$

$Q = 390 \text{ unit.}$
(lot size)

$C = ??$

Q

$EOQ = ??$

$C_{EOQ} = ??$

$$C = \frac{Q}{2} H + \frac{D}{Q} S$$

$Q = 390$

$$= \frac{390}{2} (15) + \frac{(18)(52)(45)}{390} = \$3033$$

$$EOQ = \sqrt{\frac{2DS}{H}} = \sqrt{\frac{(2)(18)(52)(45)}{15}}$$

$$= 74.94 \approx 75 \text{ unit}$$

الطلب
السنوي

عدد الطلبات
السنوية

$$C_{209} = \frac{75(15) + (18)(52)(45)}{75} = \$1124.10$$

$$TBO = \frac{Q}{O} = \frac{75}{(18)(52)} = \dots \text{or year}$$

$$\approx 96 \text{ month} \approx 1 \text{ month.}$$

$$\approx 4.17 \text{ weeks.}$$

$$\approx 4 \text{ weeks}$$

Inventory position = On-hand + Scheduled - Back orders.

I.P =

Inv.

Receipts.

(المخزون الجاهز + الطلبات المخطط لها - الطلبات المتأخرة)

already received orders



Lead time

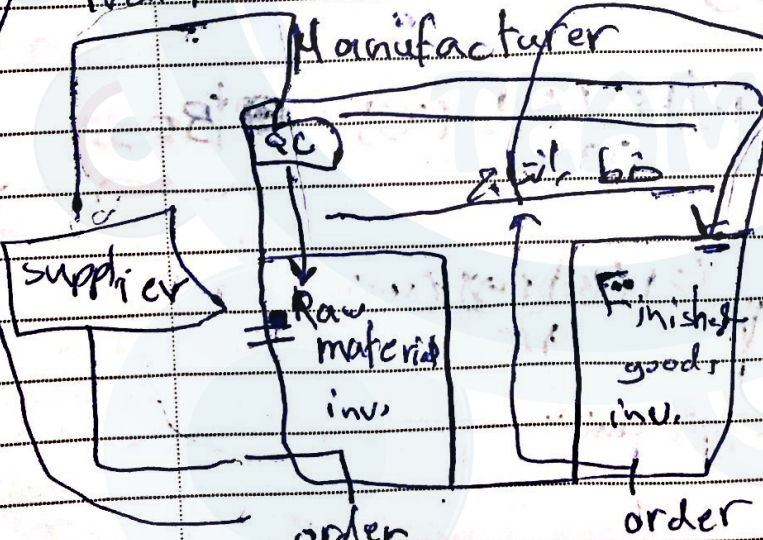
المدة الزمنية بين الطلب والاستلام

$$IP = OH + SR - BO$$

Transport

Manufacturer

Lead time (Const./var.)



Time from the moment you put the order until the order is received & put on shelf.

$$TBO = \frac{Q}{D}$$

Inventory management

Classification of SKUs.

Choosing inventory control system

- When to order?

- How much to order?

- How often to review IP?

Indep. demand SKU

Traditional

inv. control syst.

Hybrid

syst. (both)

Cont. review system.

periodic review syst.

optional Replenishment

Base Stock syst.

Dep. Demand SKU

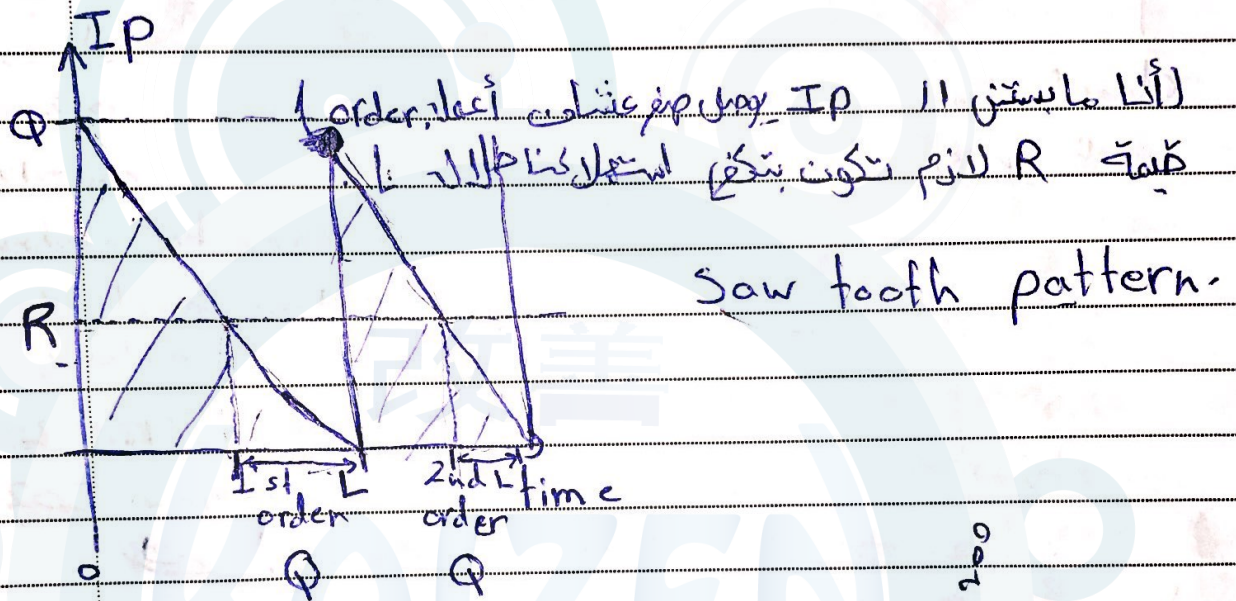
Material Requirement planning (MRP)

Continuous Review system

each time we make withdrawal we are going to check the value of IP.

then compare it to a predetermined level R .
 if $IP = R \Rightarrow$ It's time to make an order.
 $\Rightarrow$ It's a fixed quantity called Q .

Dynamic Behavior of IP while using cont.



At time zero

$$IP = OH + SR - BQ$$

Zero Zero

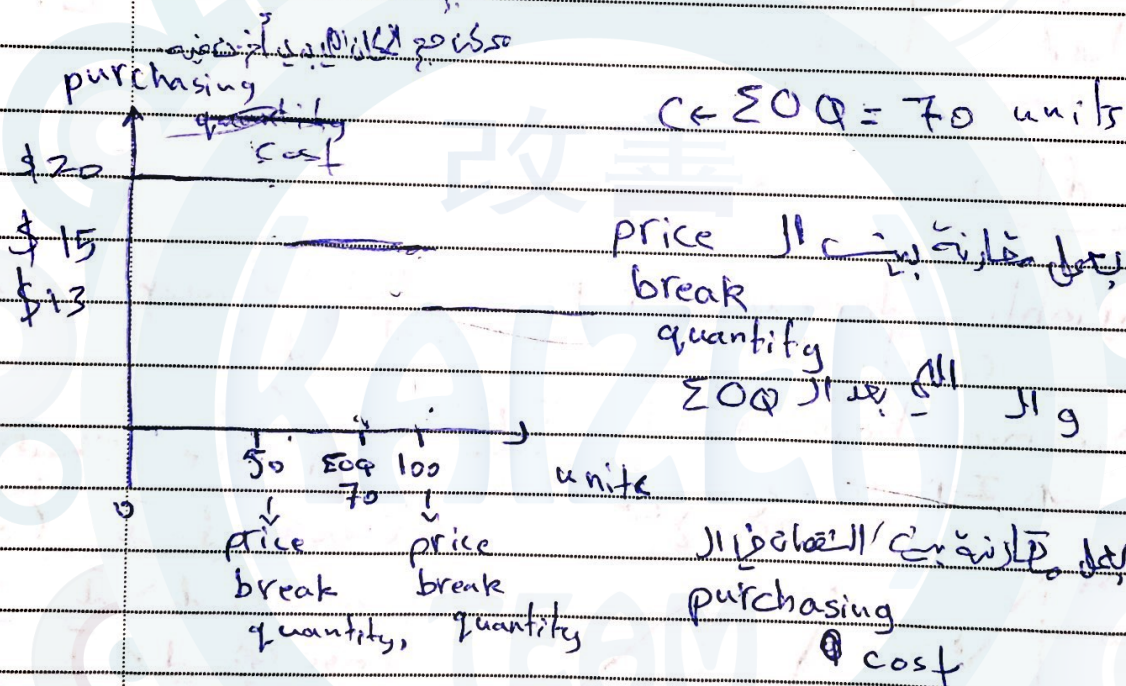
$IP = 200$

- 1 How often to review IP?
Each time we make a ~~order~~ withdrawal.
- 2 When to order?
When IP reaches R .
- 3 How much to order?
fixed quantity Q .

How much to order?

Fixed quantity Q .

EQ	Container size	Any quantity decided by management.	price break quantity.
Constraints	80	(const. from supplier.)	
100 units	شخص بـ 80 وحدة		supplier $\leq$ 70 units.



الزيادة في C
 قد افتر $\uparrow$ price الى ∞ C
 break
 q

كل القعان في purchasing cost
التي لا تكون في cost

price break
g.

life of product. $\Rightarrow$ is const. $\Rightarrow$ is const.

When to order?
when IP reaches R .

Constant demand
Constant lead time

(d)

(L)

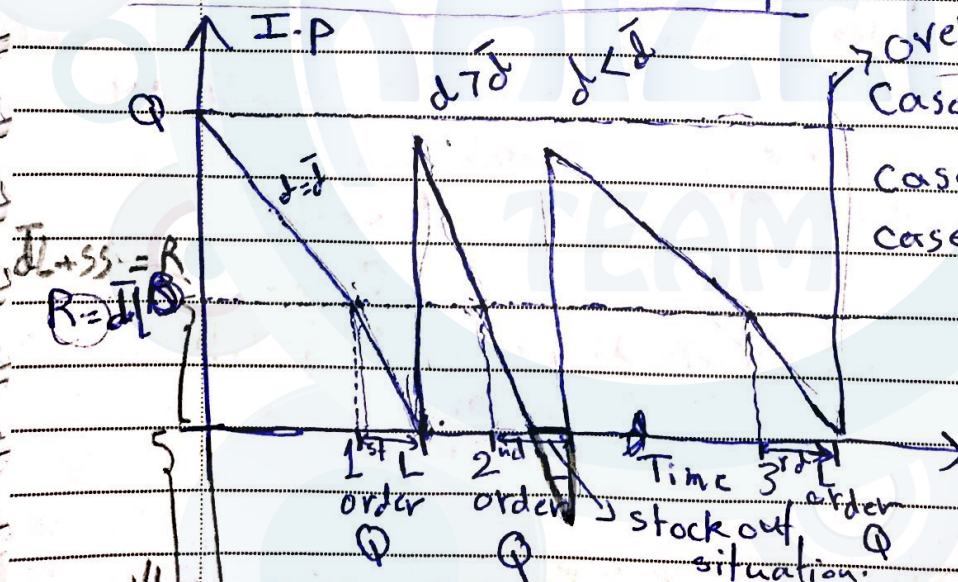
Variable Demand
const. L.

Variable Demand
Variable L.

$$R = dL$$

Variable demand $\Rightarrow$ Assume that behavior of demand
const. L. $\Rightarrow$ Normal. ($\bar{d}$)

Dynamic behavior of I.P.:



over stock situation. (undesirable.)
Case ①: $d = \bar{d}$ (case algo)
Case ②: $d > \bar{d}$ (undesirable)
Case ③: $d < \bar{d}$ (undesirable)
Damage =
outdated material
holding cost

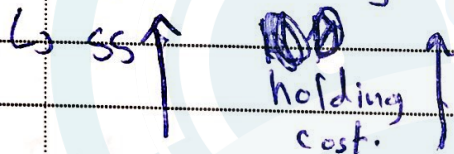
safety stock inv. $\Rightarrow$ To protect IP from off cost of losing profit.
ss. having a stock out sit. during L.

protection interval: Interval that has possibility of having stock out situation.

(Lead time.)

↳ in cost.

Safety stock only costs ~~holding cost~~ holding cost.



Service level:

Supermarket

↳ 100% service level to the customers.

(If I have 100 customers all of them must find products. ($p(\text{stock out}) = \text{zero}$))

Service level

↳ 80%.

↳ (customer will have prob. 80% to find the product he wants.)
(20% that he will not.)

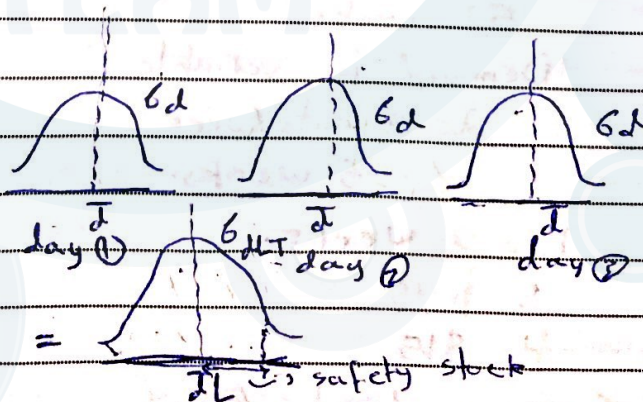
Ex:

$L = 3 \text{ days}$

d (demand per day.)

$$\sigma_{dLT} = \sigma_d \sqrt{L}$$

$$SS = Z \sigma_{dLT}$$



zL is safety stock
dist. of demand
during protection
interval. (L).

FIVE APPLE

If $R = \bar{d}L$

- $\hookrightarrow 50\%$ chance $\bar{d} = \bar{d}$
- $\hookrightarrow 50\%$ " $\bar{d} = \bar{d}$
- $\hookrightarrow$ service level = 50%

R
 Variable Demand ($\bar{d}$)
 $\bar{d}$

Const. L

$$R = \bar{d}L + SS$$

$$SS = Z \sigma_{dLT}$$

Z = no. of standard deviations needed to achieve the cycle service level.

$$\sigma_{dLT} = \sigma_d \sqrt{L}$$

Ex: EOQ = 75 units

52 weeks.

Demand is variable

$\bar{d} = 18$ units/week

$\sigma_d = 5$ weeks.

L = 2 weeks.

S = \$45

H = \$15

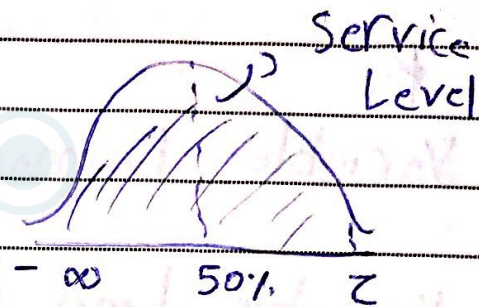
Service level = 90%

$$S.S = 22$$

$$R = 22$$

$$C = 22$$

$$\text{area} = \underline{0.9}$$



$$.8997 \quad .9015$$

(بقيت من المساحة الكلية)

$$z = 1.28$$

$$SS = Z_{\alpha/2} = z \sigma \sqrt{L}$$

$$= (1.28)(5) \sqrt{2} = 9.05 \approx 9 \text{ units}$$

$$R = \bar{x}L + SS$$

$$= (18)(2) + 9 = 45 \text{ units.}$$

$$C = \frac{Q}{2} H + \frac{D}{Q} S + SS H$$

$$= \frac{(75)(15)}{2} + \frac{(18)(52)}{75} (45) + (9)(15)$$

$$= \$1259.1$$

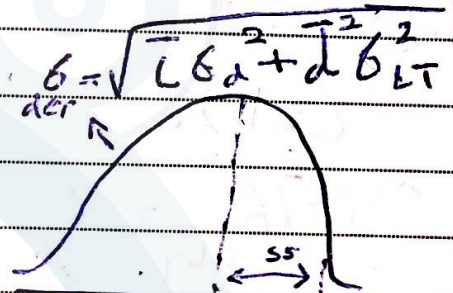
R

Variable Demand ($\bar{d}$
 σ_d)Variable Lead time ($\bar{L}$
 σ_{LT}) σ_{LT} std. dev. of L.

$$R = \bar{d}\bar{L}$$

 $d < \bar{d}$ → over stock

 $d > \bar{d}$ → stock out

 $d = \bar{d}$ ✓


Demand dist.
during protection
Interval (L)

$$\text{Safety Stock} = Z \sigma_{dLT}$$

$$\sigma_{dLT} = \sqrt{\bar{L}\sigma_d^2 + \bar{d}\sigma_{LT}^2}$$

Z: no. of std. dev.
needed to achieve required
service level.

$$R = \bar{d}\bar{L} + SS$$

$$SS = Z \sigma_{dLT}$$

$$\sigma_{dLT} = \sqrt{\bar{L}\sigma_d^2 + \bar{d}\sigma_{LT}^2}$$

Z: no. of std. dev.
needed to achieve req.
service level.

Ex: Pen

$$d = 12000 \text{ pens/week.}$$

$$b_d = 3000 \text{ pens}$$

$$Q = 156000 \text{ pens.}$$

$$L = 5 \text{ weeks.}$$

$$b_{LT} = 2 \text{ Weeks.}$$

95% service level.

$$R = 22$$

95% service level $\Rightarrow Z = 1.65$

$$\text{Safety stock} = Z b_{dLT}$$

$$= Z \sqrt{L b_d^2 + d^2 b_{LT}^2}$$

$$= (1.65) \sqrt{(5)(3000)^2 + (12000)^2 (2)^2}$$

$$= 4117.79 \text{ pens.} \approx 4118 \text{ pens}$$

$$R = dL + SS$$

$$= (12000)(5) + 4118 = 101118 \text{ pens.}$$

b) ~~the~~ Now, $IP = 101200$ pens, we made a withdrawal of 100 pens. There's no scheduled Receipt & no back order. Do we need to make an order? If yes, what is the am. of order?

$$\begin{aligned}\text{New IP} &= \text{OH} + \text{SR} - \text{BO} \\ &= (101200 - 100) + 0 - 0 \\ &= 101100 \text{ pens.}\end{aligned}$$

New $\text{IP} < R$

↳ yes we put order / $Q = 156000$ pens.

To know real values of $\bar{d}$, G_d , $\bar{L}$ n G_{LT}

↳ We have to collect data about demand n Lead time n calculate $\bar{d}$, G_d , $\bar{L}$, n G_{LT} .

(In reality.)

How to choose service level. $\Rightarrow$ (strategy of the company.)

How to decide $\text{IP} = ??$

$$\text{IP} = \text{OH} + \text{SR} - \text{BO}$$

↳

OH : $\rightarrow$ manually count what is on shelf. (Traditional method.)

$\rightarrow$ Scanners, barcode systems.

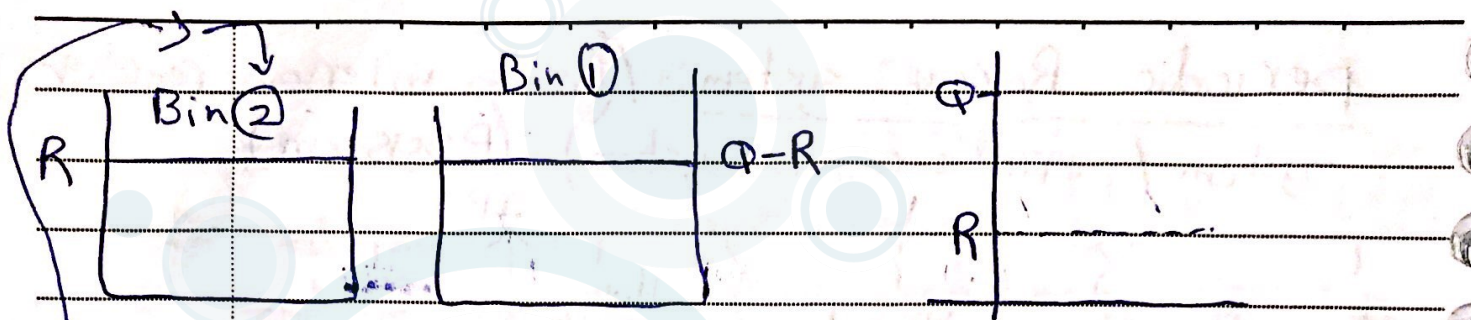
$\rightarrow$ manually (paper.)

SR $\rightarrow$ Integrated information system.

BO $\rightarrow$ (نقص) (SR)

Visual Q system $\rightarrow$ 2 Bin system.

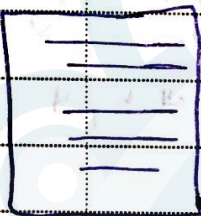
(Another way to know OH quantity.)



withdrawal from Bin 1 $\Rightarrow$ $Q - R$

(I'll notice visually)

R $\leftarrow$



$\Rightarrow$ Immediately write an order.

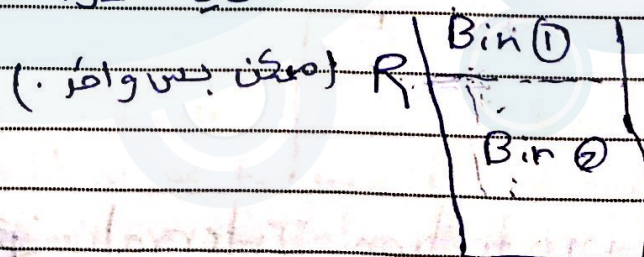
Supplier

(During this time we will make a withdrawal from Bin 2.)

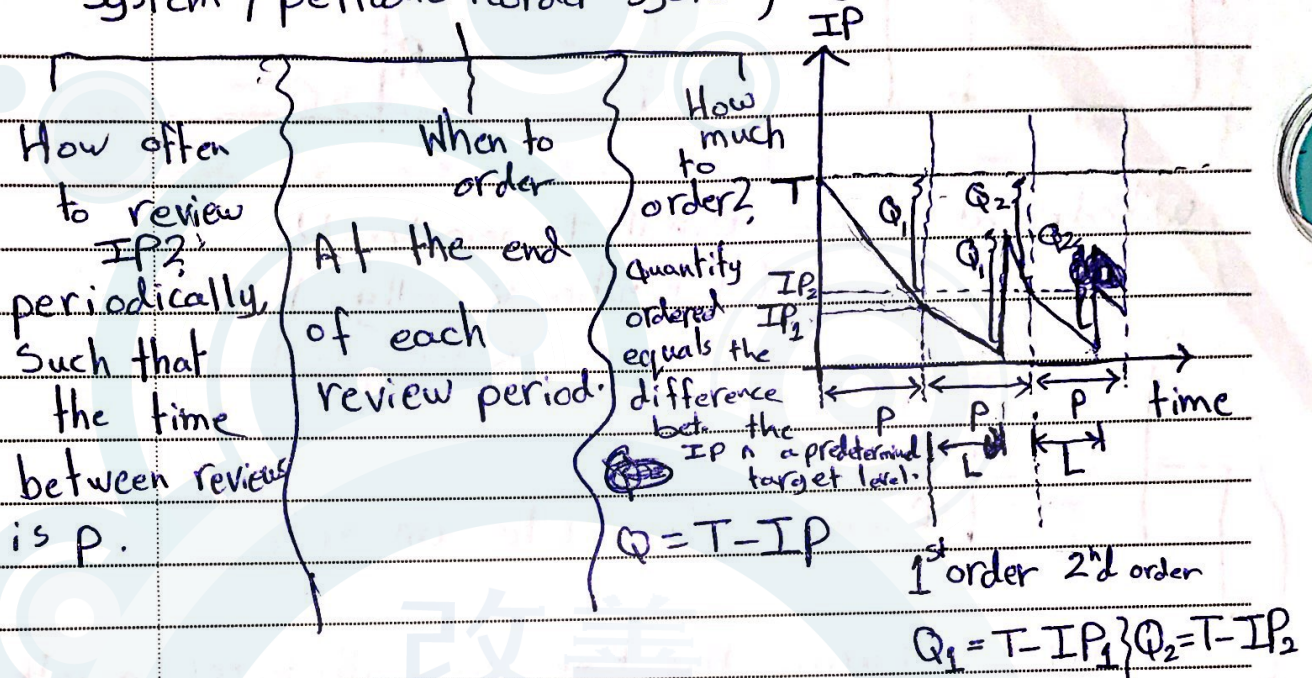
(when the order comes we put it in Bin 2 and the extra we'll put it in Bin 1.)

We usually use this system for cheap items.

(unit cost is low)
② small items we can't count manually & can't put barcode on it.) (بزرگ، گران، ...)



periodic Review system: (fixed interval reorder system / periodic reorder system) (P system.)



How often to review IP? periodically at the end of p

When to order? At the end of review period p .

$$P \rightarrow TBO = \frac{Q}{D}$$

$$TBO = \frac{EOQ}{D}$$

$$TBO = \frac{\text{Container size}}{\text{Container size quantity}} = \frac{Q}{D}$$

$$TBO = \frac{Q_{\text{convenient}}}{D}$$

$$TBO = \frac{\text{price break quantity}}{D}$$

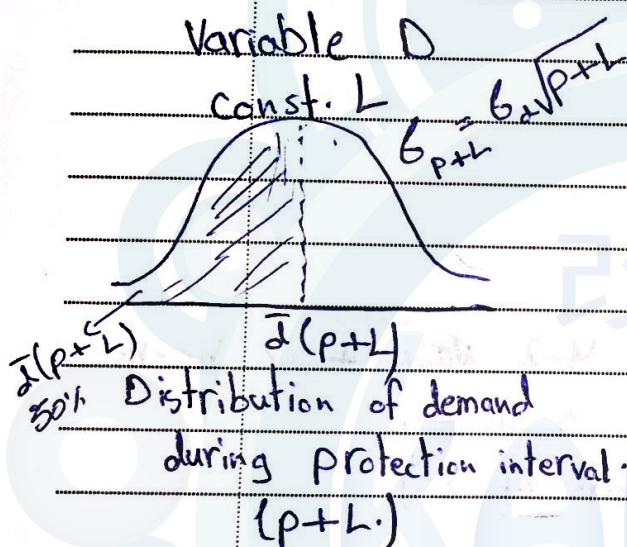
protection Interval: ~~IP~~

$p + L$

How much to order? $Q = T - IP$

$\left. \begin{array}{l} \text{Demand const. (d)} \\ \text{Lead time const. (L)} \end{array} \right\} \begin{array}{l} \text{Variable Demand } (\bar{d}) \\ \text{Constant Lead time (L)} \end{array} \left. \begin{array}{l} \text{Variable Demand } (\bar{d}) \\ \text{Variable L} \end{array} \right\}$

$$T = d(p+L)$$



$$T = \bar{d}(p+L) + SS$$

$$SS = Z \sigma_{p+L}$$

$$\sigma_{p+L} = \sigma_d \sqrt{p+L}$$

Z: no. of std. deviations needed to achieve the required service level.

Variable D

Variable L

We can't assume that distribution during $(p+L)$ is normal, bc this interval is very long.

↳ Use simulation to estimate the demand during protection interval $(p+L)$ so as to use it to determine the value of safety stock & the value of T (under the desired service level.)

EX.: 52 Weeks

$$\bar{d} = 18 \text{ units/week.}$$

$$\sigma_d = 5 \text{ units.}$$

$$L = 2 \text{ weeks.}$$

$$EOQ = 75 \text{ units.}$$

$$S = \$45 / \text{order.}$$

$$H = \$15 / \text{unit / year.}$$

$$\text{Service level} = 90\%$$

p system

$$T = ??$$

$$P = ??$$

$$C = ??$$

$$P = TBO = \frac{EOQ}{\bar{d}} = \frac{75 \times 52}{(18)(52)} = 4.2 \text{ ~~Weeks~~ } \approx 4 \text{ weeks.}$$

(p always in the same units of L.)

$$\begin{aligned} \text{Safety stock} &= Z_{\frac{\alpha}{2}} \sqrt{P+L} \\ &= (1.28)(5)\sqrt{4+2} \\ &= 15.68 \approx 16 \text{ units} \end{aligned}$$

$$T = \bar{d}(p+L) + SS = 18(4+2) + 16 = 124 \text{ units.}$$

$$C = \underbrace{\frac{\bar{d}P}{2} H}_{\text{Holding cost for cycle inventory}} + \underbrace{\frac{D}{\bar{d}P} S}_{\text{ordering cost}} + \underbrace{SS \cdot H}_{\text{for safety stock inv.}}$$

$$= \frac{(18)(4)}{2} (15) + \frac{(18)(52)}{(18)(4)} (45) + (16)(15)$$

$$= \$1365$$

$$C_p = \$1259$$

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why $C_p > C_o$??

$$SS_o = 6\sigma\sqrt{L} \quad \left\{ \quad SS_p = 6\sigma\sqrt{p+L} \right.$$

$SS_p > SS_o$ BC protection interval in p system

" " " Q system

Holding cost for SS

in p > " "

Syst. " "

Total cost P Syst. > " "

The $I_p = 80$ units. / No SR. / $BO = 0$.
(SR = 0)

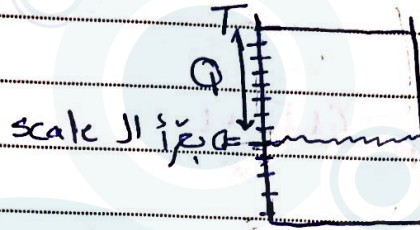
We made a withdrawal of 20 units & now it is the end of review period p. Do we need to make an order? And if yes, what is the quantity of the order?

$$\text{New } IP = (80 - 20) + 0 - 0 = 60$$

Yes we have to make an order.

$$Q = T - IP = 124 - 60 = 64 \text{ units.}$$

Visual p system $\rightarrow$ One-bin system.



We use it for liquids/gases.
(.scanners, barcode و manually لا يقرأ)

Comparison between Q n p systems.
مقارنة

MR I	مادة
$R \leftarrow IP \leftarrow X_1$	X_1
$R \leftarrow IP \leftarrow X_2$	X_2
$R \leftarrow IP \leftarrow X_3$	X_3
عينون	الولادة
X_7	
X_8	
X_4	

$R \leftarrow IP \leftarrow X_1$	X_1
$R \leftarrow IP \leftarrow X_2$	X_2
$R \leftarrow IP \leftarrow X_3$	X_3
$R \leftarrow IP \leftarrow X_4$	X_4
$R \leftarrow IP \leftarrow X_5$	X_5
$R \leftarrow IP \leftarrow X_6$	X_6

Q system. (Lower)
(Main job to notice holding ss.)
IP for every sku.)

Q system $\Rightarrow$ Not appropriate / convenient.
(شأنه لا يقرأ)

(بأوقات مختلفة لا يقرأ في وقت واحد)
(لا يقرأ في وقت واحد لا يقرأ)

(If X_1 n X_4 from the same supplier.)

$\rightarrow$ for X_1 n X_4
I should use p system.

p system $\Rightarrow$ More appropriate / convenient.
(sunday $\Rightarrow$ one order.)

If $X_3 \Rightarrow$ supplier said if we make a specific quantity you can take discount.

$\rightarrow$ in p system Q varies

(لا يمكن التحقق من القيمة للبيانات)

(.Discount)

We use Q system.

$X_1 - IP$
 $X_4 - IP$
(combine orders in one order.)

Cost, Combining orders, discounts, convenient.

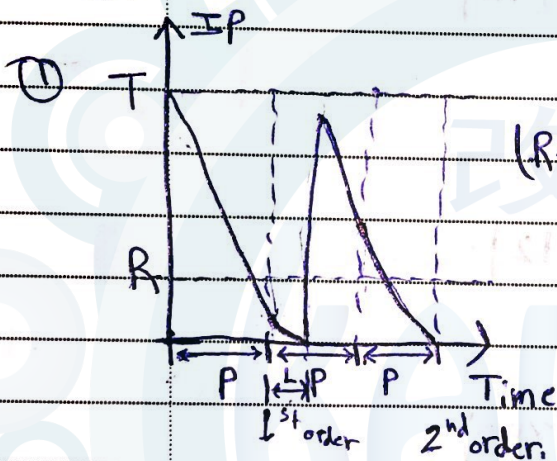
Hybrid systems (combination of Q and P)

Optional Replenishment

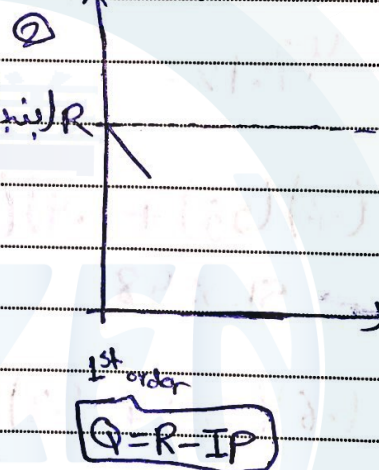
(periodic)
في فترة محددة (P)

Base stock (cont.) system: (P, r, IP)

(Each time we make a withdrawal we check IP.) (order Q reaches to $T_m = R_i$)



① Reaches us to T.



$$Q = R - IP$$

↳ Appropriate for very expensive SKU.

Why do we use them?

① Less no. of orders.

T is very large
(الوقت بين الطلبات كبير)

SS is very large.

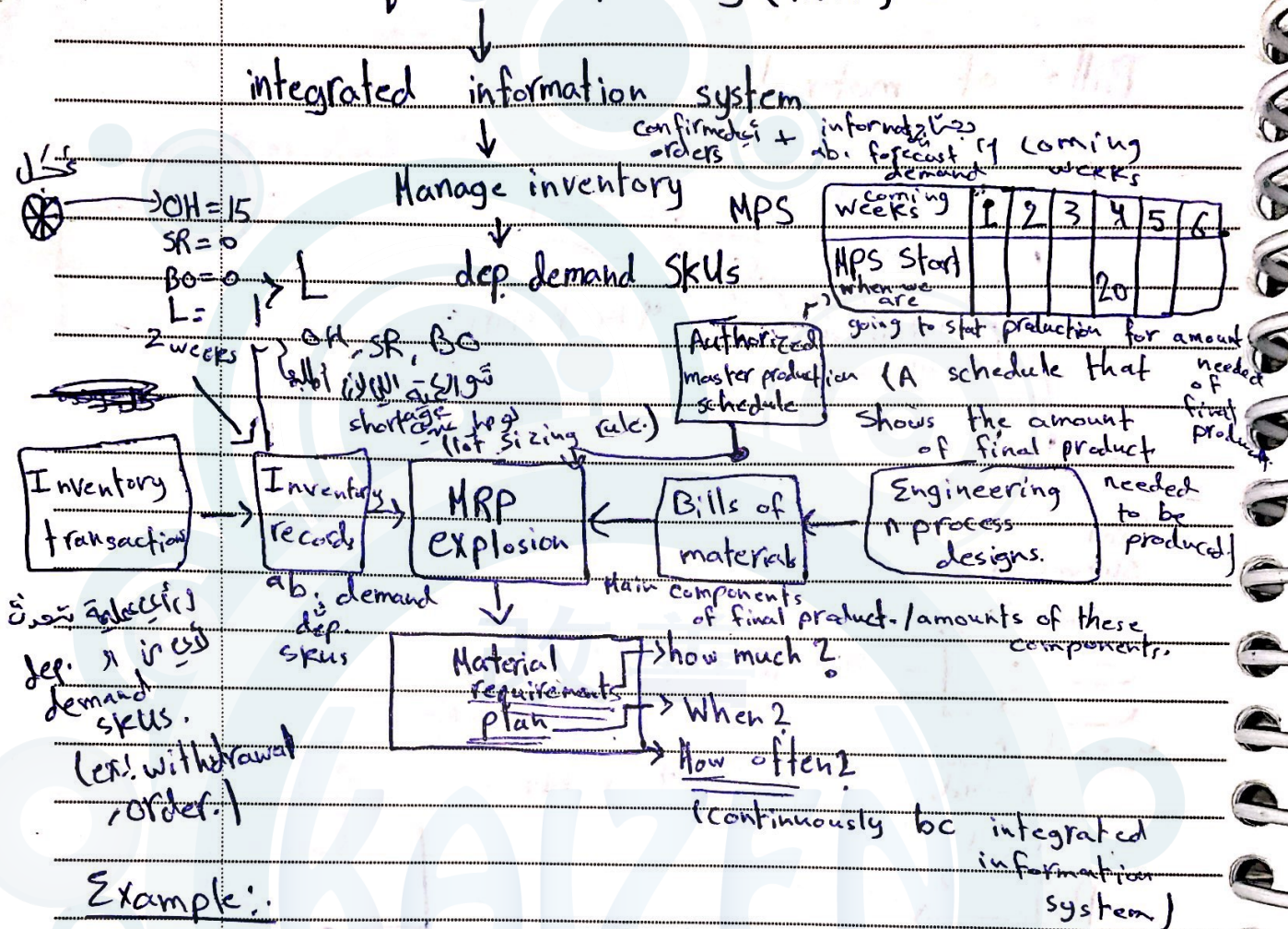
↳ Appropriate for cheap SKU. (Low cost.)

لأنه الـ T كبير و الـ SS كبيرة.

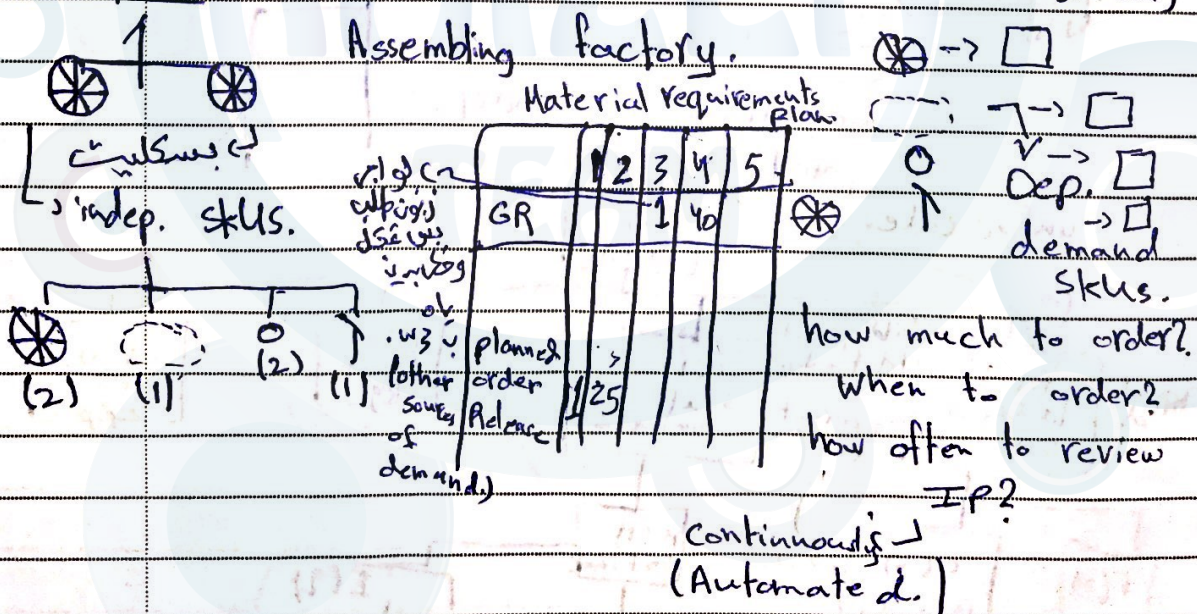
(بشكل الـ R, T) غشيان أقل
الوقت بين الطلبات الـ SS
(بشكل الـ R, T) غشيان أقل
الوقت بين الطلبات الـ SS

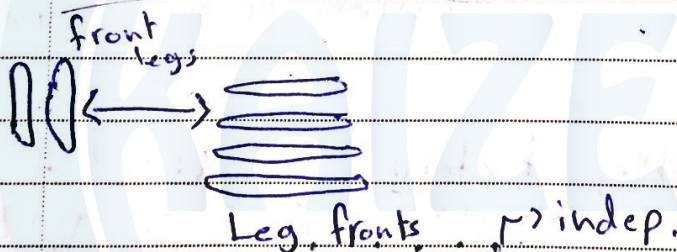
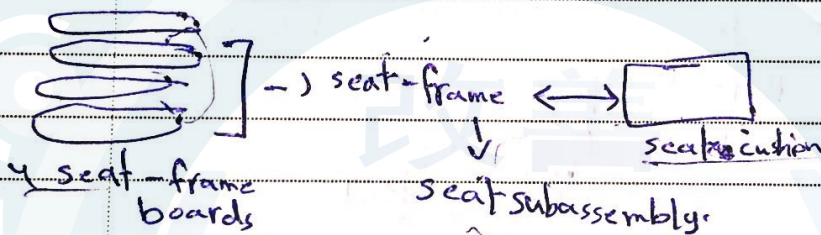
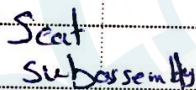
والله مالكم يكون كبير
cost.

Materials Requirement planning (MRP) :-



Example:-



[illegible]

child-parent relationship

end-item: final product.

intermediate component: A component that has a parent

has a child.

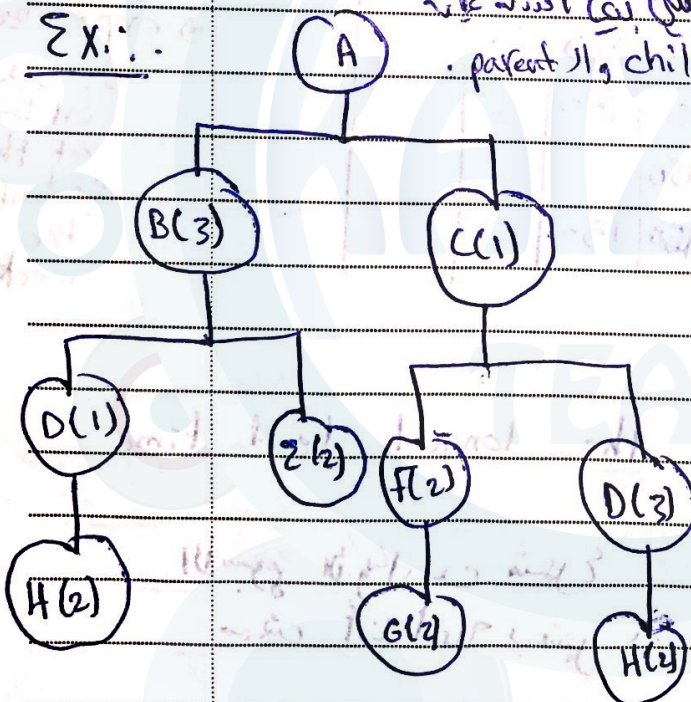
discontinuation

discontinuation

Any component that doesn't have a child.

L₃ purchased item/component.

ΣX_i



A: 5

B = $(5 * 3) = 15$

C = $(15 * 1) = 15$

D = $(15 * 1) + (5 * 3) = 30$

E = $(15 * 2) = 30$

F = $(5 * 2) = 10$

G = $(10 * 2) = 20$

H = $(30 * 2) = 60$

Example: Ladder-back chair

Master production schedule (MPS):

A schedule shows the amount needed to be produced of the final product.

Item: ladder back chair
Lot size: 150 units
L: 1 week

Week

Quantity on hand

Forecast

customer orders (backlog)

projected hand on

MPS quantity

MPS start

Available to promise (ATP)

Customer Q/W

1 13 2

1 2 3 4 5 6 7 8 9 10

30 30 30 30 35 35 35 35

38 27 24 8 0 0 0 0

17 137 107 77 42 7 125 87

0 150 0 0 0 0 150 0

150 150

17 9 7 78 0

108 0

ATP

At least before the longest lead time of the components.

الأسبوع الذي قبله من قبل
ممن أنت لا تبيعهم. عشان أنت عايز
تبيعهم

MPS quantity: Quantity were going to plan

to receive at the beginning of the week

لأن كذا متوقع في البداية
لأن كذا متوقع في البداية
to cover shortage expected on

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MPS start: When we're going to start the order of the planned quantity.

تحتوي على components
الكميات التي نخطط تصنيع 150
تحتوي بالأسبوع الأول و 150
بالتسليم.

Freezing

MRP explosion time

Already components

MPS

MRP explosion

longest

Component

عنصر يكون على شكل component

New customer

Available to promise: OH

confirmed orders

Confirmed orders planned quantity

Example: Item: product A. order policy: 50 units.

L = 1 week.

OH [5]	1	2	3	4	5	6	7	8	9	10
Forecast										
Forecast	20	10	40	10	0	0	30	20	40	20
Booked	30	20	5	8	0	2	0	0	0	0
projected OH	25	5	15	5	5	3	23	3	13	43
Mps q	50	0	50	0	0	0	50	0	50	50
Mps start ⁵⁰		50				50		50	50	
ATP	5		35			0	50		50	50

EX.: Ladder-back chair.

Seat sub assembly. Ladder back chair.

		April				May			
Mps start		1	2	3	4	5	6	7	8
Ladder-back chair	150						150		
Mps kitchen chair					120			120	
Desk chair			200	200		200			200
Aggregate production plans									
			670			670			

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Inventory transactions:

- Releasing new orders.
- receiving scheduled receipts.
- Adjusting due dates for scheduled receipts.
- Withdrawing inventory.
- Canceling orders.
- correcting inventory errors.
- Rejecting shipments.
- Verifying losses and stock returns.
- checking $\frac{\text{مخزون}}{\text{مخزون}} / \frac{\text{مخزون}}{\text{مخزون}} / \frac{\text{مخزون}}{\text{مخزون}}$ MRR:

Item: C		Lot size:				FOQ = 230 units		
Description: ^{sent} _{sub}		Lead Time:				2 weeks		
		Safety stock:				Zero		
Week	1	2	3	4	5	6	7	8
Gross required	150			120		150	120	
scheduled receipts	230							
Projected on hand ³⁰	117	117	117	227	227	77	187	187
planned receipts	0	0	0	230	0	0	230	0
planned order release		230			230			

When to order, how much to order?

SR: $\frac{\text{مخزون}}{\text{مخزون}} \frac{\text{مخزون}}{\text{مخزون}} \frac{\text{مخزون}}{\text{مخزون}}$
 component $\frac{\text{مخزون}}{\text{مخزون}}$ $\frac{\text{مخزون}}{\text{مخزون}}$

Gross requirement: $\frac{\text{مخزون}}{\text{مخزون}} \frac{\text{مخزون}}{\text{مخزون}}$ $\frac{\text{مخزون}}{\text{مخزون}}$ $\frac{\text{مخزون}}{\text{مخزون}}$
 parent $\frac{\text{مخزون}}{\text{مخزون}}$ $\frac{\text{مخزون}}{\text{مخزون}}$ $\frac{\text{مخزون}}{\text{مخزون}}$

planned receipts: We plan to receive at OH the beginning of the week to cover the shortage that we expect in the on hand.

planned order release: when do we need to release the order of the planned quantity.
 • Lead time

shortage $\Rightarrow SS > OH$ if
 • Shortage

		Lot size					FOQ = 100		
Item: A		L					1 week		
Description:		SS					zero		
Week		1	2	3	4	5	6	7	8
Gross requirement			60		25		35		45
SR									
Projected OH		0	40	40	15	15	80	80	35
planned receipts		0	100	0	0	0	100	0	0
planned order releases		100				200			

How to choose FOQ??

FOQ discount quantity container size

Item: A	Lot Size:				POQ (p=4)			
	L:				1 Week			
Description:	SS:				zero			
Week	1	2 ✓	3 ✓	4 ✓	5 ✓	6 ✓	7 ✓	8 ✓
Gross Requirements		60		25		35		45
SR								
Projected OH	0	25	25	0	0	45	45	0
Planned Receipts	0	85	0	0	0	80	0	0
Planned order releases	85				80			

periodic order quantity:

بما أننا ننتظر $p = 4$ $\Rightarrow$ Whenever we expect shortage in OH
 inventory, we plan to receive a quantity
 = Gross Requirement for the
 h periods

شورتاج في كل فترة p ، نخطط لتلقي

كمية الطلب الكلي لـ p فترات.

How to choose p ?

$\hookrightarrow$ TBO أو كمية الطلب

$$p = TBO = \frac{Q}{D} \Rightarrow \text{fixed order quantity / EOQ / container size / any convenient } Q$$

Item: A	Lot size					L4L		
	L					1 week		
Description:	SS					Zero		
Week	1	2	3	4	5	6	7	8
Gross requirement		60		25		35		45
SR								
projected OH	0	0	0	0	0	0	0	0
planned receipts	0	60	0	25	0	35	0	45
planned order release	60		25		35		45	

Lot for lot rule: special case of POQ rule but $p=1$.

↳ Whenever we expect shortage in OH inv.

We plan to receive quantity
= gross requirement

• shortage up (الكمية المطلوبة)

$$OH = SS \rightarrow \text{gross requirement}$$

We are matching requirement with demand of that week.)

At the end of schedule OH = 35 projected

↑ No. OH for next schedule.

FOQ → gross matching requirement.

(قيمة زائدة ما بالبالغة ب.أ.)

Shortage (نقص) و Holding Cost (تلفع على الطلبات)

Requirement (الطلب) Remenant quantity (كمية متبقية من أسبوع)

disadvantage (المتفكة) Holding Cost (تلفع على الطلبات)

Advantage → unpredictable (غير متنبأ)

$$\text{Holding cost} = \frac{0 + 40 + 40 + 15 + 15 + 80 + 35}{8} = 38.1 \text{ H}$$

$$\text{ordering cost} = (2)(5) = 25$$

When to use?

Very cheap items.

~~FOQ~~

(H & S)

no. of orders

FOQ (الطلب)

Holding Cost ↑

no. of orders ↓

ordering cost

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No.

current OH for next schedule.

POQ → Requirement matches demand but for a number of weeks

AVG inv.

المتوسط في المخزون
المتوسط في المخزون
المتوسط في المخزون
المتوسط في المخزون

Remnant (مخزون)

SS (مخزون)

Holding cost + no. of orders

$$\text{Holding cost} = \frac{0 + 25 + 25 + 0 + 0 + 45 + 45 + 0}{8} \times \text{no. of orders} \downarrow$$

$$= 17.5H. < 38.1H$$

$$\text{ordering cost} = (2)(\$) = 2\$$$

Disadvantage → unreliable suppliers / scrap rate

unreliability

فقنی ۱۱

No.

↑
L4

دایره "Lier" ۵
۵

Holding cost = Zero

$$\text{order cost} = (4)(5) = 45. > 25.$$

↳ Largest no. of orders.

Disadvantage

When to use?

↳ Very expensive items $\Rightarrow$ H. ۵

↳ S acceptable compared to H.

Safety stock: unreliability.

Item: A Description:	Lot size:					POQ (p=4)		
	L:					1 Week		
Week	1	2	3	4	5	6	7	8
Gross Required		60		25		35		45
SR								
projected OH	20	45	45	20	20	65	65	20
planned receipts	0	85	0	0	0	80	0	0
planned order releases	85				80			

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EX:

Item: C	Lot size:					FOQ = 230 units		
	L:					2 Weeks		
Description: seat subassembly	SS					Zero		
Week	1	2	3	4	5	6	7	8
Gross requirement	150			120		150	120	
SR	230							
projected OH	117	117	117	227	227	77	187	187
planned receipts	0	0	0	230	0	0	230	0
planned order releases		230			230			

Item: C	Lot size:					POQ (P=3)		
	L:					2 Weeks		
Description: seat subassembly	SS:					Zero		
Week	1	2	3	4	5	6	7	8
Gross req.	150			120		150	120	
SR	230							
projected OH	117	117	117	117	150	0	0	0
planned receipts	0	0	0	230	0	0	120	0
planned order releases		230			120			

$$120 + 0 + 150 - 117 = 153$$

153 is the projected OH at the end of week 5

No.

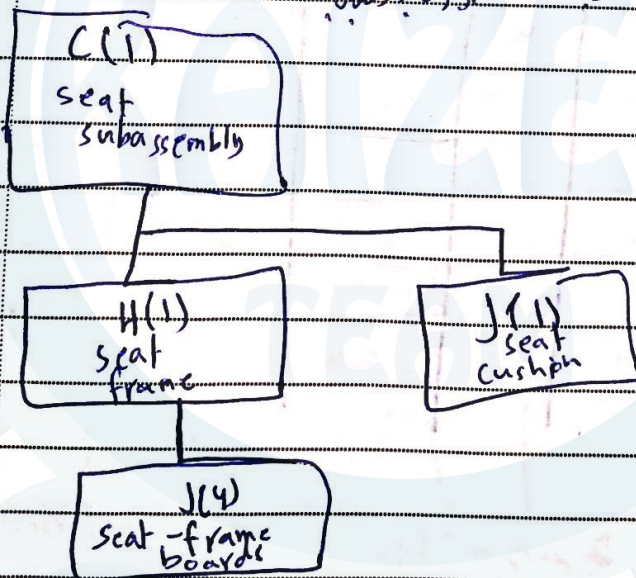
Item: C	Lot size:					L4L		
Description: ^{seat subassembly}	L:					2 Weeks		
Week	1	2	3	4	5	6	7	8
Gross req.	150			120		150	120	
SR	230							
projected OH ³⁷	117	117	117	0	0	0	0	0
planned receipts	0	0	0	3	0	150	120	0
planned order release		3		150	120			

$$120 - 117 = 3$$

MRP explosion

مخطط التفصيل للمواد

EX: 1



No.

Item: D

Description:

Week

Lot size:

L:

SS:

FOQ = 150 units

3 Weeks

Zero

Gross requirement

SR

projected OH 150

Planned receipts

Planned order releases.

1

2

3

4

5

6

100

110

280

150

150

150

200

200

90

110

0

0

0

0

0

300

1

300

Lot size:

L:

SS:

L4L

1 Week

Zero

Item: E

Description:

Week

1

2

3

4

5

6

Gross req.

50

220

220

SR

120

projected OH

0

120

70

70

0

0

Planned receipts

0

0

0

0

150

220

Planned order releases.

1

150

220

220 - 70

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Item: f	Lot size:					POQ (p=2)
Description	L:					2 weeks
Week	SS:					30
	1	2	3	4	5	6
Gross requirement				300	440	
SR						
Projected on 130	130	130	130	470	30	30
Planned receipts	0	0	0	640	0	0
Planned order releases		640				

Item:	Lot size:					FOQ = 150		
Des - -	L:					3 weeks		
	SS:					Zero		
Week	1	2	3	4	5	6	7	8
Gross req.			160	120	125	110		
SR			150					
OH 150	150	150	140	20	45	85		
planned receipts	0	0	0	0	150	150		
planned order releases		150	150					