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Seminar Four: Aggregate Planning

Question One

Yog-to-go is a small business that produces high protein yogurts. Their demand fluctuates seasonally due to varying customer preferences. The company needs to create a 6-month aggregate production plan to meet demand while minimising costs. The company currently employs 18 workers, and each worker produces 15 yogurts per day. The hiring cost per worker is £350 and the firing cost is £725 per worker. The inventory holding cost per unit per month is £0.75. The regular production cost is £3.75 per unit. The monthly demand and the number of production days per month are presented in the table below.

Month	Demand	Production Days
January	5,000	21
February	7,500	20
March	6,600	24
April	7,900	23
May	7,750	21
June	8,150	19

Calculate the following for Yog-to-go and show your calculations steps:

a) Convert the forecasted demands to demands in terms of aggregate units and clearly state the aggregate units used

b) Using the minimum constant workforce strategy, calculate the total number of workers to be hired and/or be fired over the 6-month period

c) Calculate the total cost of the plan found in part b).

Question One

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Answer:

In aggregate planning, we usually define an aggregate unit—this could be a product family, labour hours, or another common measure. In this question, the demand is already given in yogurt units, so technically, there's no conversion needed.

In other cases, you might need to convert to something like worker-days or machine hours. Here, it's simple, but the principle is the same: always define your aggregate unit clearly.

Question One

b) Using the minimum constant workforce strategy, calculate the total number of workers to be hired and/or be fired over the 6-month period

Month	Demand	Production Days		
January	5,000	21	5 000	21
February	7,500	20	5000+7500 = 12500	41
March	6,600	24	12500+6600 = 19100	65
April	7,900	23	19100+7900= 27000	88
May	7,750	21	27000+7750=34750	109
June	8,150	19	42900	128

Question One

b) Using the minimum constant workforce strategy, calculate the total number of workers to be hired and/or be fired over the 6-month period

Month	Cumulative demand	Cumulative Production days			
January	5000	21	21 x 15 = 315	5000/315 = 15.873	16
February	12500	41	41 x 15 = 615	12500/615 = 20.325	21
March	19100	65	65 x 15 = 975	19.59	20
April	27000	88	88 x 15 = 1320	20.455	21
May	34750	109	109 x 15 = 1635	21.254	22
June	42900	128	128 x 15 = 1920	22.344	23

Minimum number workers required = 23

number of workers hired = 23 - 18 = 5

Question One

b) Using the minimum constant workforce strategy, calculate the total number of workers to be hired and/or be fired over the 6-month period

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Month	Cumulative demand	Cumulative Production days	Cumulative production per worker	Number of workers required	Number of workers rounded
January	5000	21	315	15.873	16
February	12500	41	615	20.325	21
March	19100	65	975	19.59	20
April	27000	88	1320	20.455	21
May	34750	109	1635	21.254	22
June	42900	128	1920	22.344	23

Minimum number of workers required is 23. Currently Yog-to-go employs 18 workers, so we need to hire 5 workers

Q1b Solution

Question One

c) Calculate the total cost of the plan found in part b).

Month	Demand	Production per worker	No of workers	Production	Inventory
January	5000	315	23	315 x 23 = 7245	7245 - 5000 = 2245
February	7500	300	23	300 x 23 = 6900	6900 + 2245 - 7500 = 1645
March	6600	360	23	360 x 23 = 8280	1645 + 8280 - 6600 = 3325
April	7900	345	23	345 x 23 = 7935	3325 + 7935 - 7900 = 3360
May	7750	315	23	315 x 23 = 7245	2855
June	8150	285	23	285 x 23 = 6555	1260
			Total	44160	14690

Question One

c) Calculate the total cost of the plan found in part b).

Costs

hiring : 350 × 5 = £1,750

production : 3.75 × 44160 = £165,600

holding/inventory : 0.75 × 14690 = £11,017.50

total cost : 1750 + 165600 + 11017.5 = £178,367.50

Question One

c) Calculate the total cost of the plan found in part b).

Month	Demand	Production per worker	No of workers	Production	Inventory
January	5000	315	23	315*23 = 7245	7254-5000 = 2245
February	7500	300	23	300*23 = 6900	2245+6900-7500 = 1645
March	6600	360	23	360*23 = 8280	1645+8280-6600 = 3325
April	7900	345	23	245*23 = 7935	3325+7935-7900 = 3360
May	7750	315	23	315*23 = 7245	3360+7245-7750 = 2855
June	8150	285	23	285*23 = 6555	2855+6555-8150 = 1260
			Total	44160	14690

Q1c Solution

Question One

c) Calculate the total cost of the plan found in part b).

Costs:

Hiring cost = 5*350 = £1,750

Firing cost = 0

Production cost = 44160*3.75 = £165,600.00

Inventory cost = 14690*0.75 = £11,017.50

Total cost = 1,750 + 165,600.00 + 11,017.50 = **£178,367.50**

Q1c Solution

Question Two

Question Two

A furniture company produces three products: sofa, recliner and footstools. The forecasts over the next 5 months are shown in the table below. Production is as follows: sofas require 5 labour hours, recliners require 4 hours and footstools require 2 hours. There are 20, 18, 23, 15 and 23 working days in the months January through to May respectively.

Month	Sofa	Recliner	Footstools
Jan	10	100	130
Feb	60	90	110
March	75	55	170
April	35	75	135
May	10	50	150

The company currently employs 50 workers that each work 8 hours per day. Workers are paid £1750 per month. Hiring costs are £600 and firing costs are £1750. The inventory holding cost is £2 per aggregate unit of production per month.

a) Convert the product forecasts into an aggregate forecast, clearly explain how you defined an aggregate unit of production.

b) How many workers should be working each month to most closely match the aggregate forecasts from part a)? Compute the total cost of the plan.

c) Assuming that stockouts are not allowed, determine a minimum constant workforce plan using the aggregate forecasts from part (a). Calculate also the cost of the plan and compare with plan (b).

Question Two

a) Convert the product forecasts into an aggregate forecast, clearly explain how you defined an aggregate unit of production.

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	Demand			Net Demand			Aggregate Demand
Month	**Sofa**	**Recliner**	**Footstool**	Sofa	Recliner	footstool	
Jan	10	100	130	10x5 = 50	100 ÷ 4 = 400	260	50 + 400 + 260 = 710
Feb	60	90	110	60x5 = 300	90x4 = 360	220	300 + 360 + 220 = 880
March	75	55	170	75x5 = 375	55x4 = 220	340	955
April	35	75	135	35x5 = 175	75x4 = 300	270	745
May	10	50	150	10x5 = 50	50x4 = 200	300	550

aggregate unit = labour hour

Question Two

a) Convert the product forecasts into an aggregate forecast, clearly explain how you defined an aggregate unit of production.

Since the products (sofa, recliner, footstool) differ in size and labour requirements, the most logical basis is labour hours, because:

- All products require labour to produce.
- Labour hours are additive and reflect resource usage.

Question Two

a) Convert the product forecasts into an aggregate forecast, clearly explain how you defined an aggregate unit of production.

	Demand			Net Demand			
Month	**Sofa**	**Recliner**	**Footstool**	**Sofa**	**Recliner**	**Footstool**	**Aggregate Demand**
Jan	10	100	130	50	400	260	50+400+260 = 710
Feb	60	90	110	300	360	220	300+360+220 = 880
March	75	55	170	375	220	340	375+220+340 = 935
April	35	75	135	175	300	270	175+300+270 = 745
May	10	50	150	50	200	300	50+200+300 = 550

Q2a Solution

Question Two

b) How many workers should be working each month to most closely match the aggregate forecasts from part a)? Compute the total cost of the plan.

Number of workers = 50

Month	Aggregate demand	Working days					
Jan	710	20	20×8 = 160	710/160 = 4.438	5	0	45
Feb	880	18	18×8 = 144	880/144 = 6.111	5? = 7	2	0
March	935	23	23×8 = 184	935/184 = 5.082	6	0	1
April	745	15	15×8 = 120	745/120 = 6.208	7	1	0
May	550	23	23×8 = 184	550/184 = 2.989	3	0	4
					–	3	50

Question Two

b) How many workers should be working each month to most closely match the aggregate forecasts from part a)? Compute the total cost of the plan.

Monthly 1750

Month	Production	Inventory	
Jan	5 x 160 = 800	800 - 710 = 90	5
Feb	7 x 144 = 1008	90 + 1008 - 880 = 218	7
March	6 x 184 = 1104	218 + 1104 - 935 = 387	6
April	7 x 120 = 840	387 + 840 - 745 = 482	7
May	7 x 184 = 552	482 + 552 - 550 = 484	5
	4304	1661	

Costs

Hiring: 3 x 600 = £1800

firing: 30 x 1750 = £87,500

Inventory: 1661 x 2 = 3322

Production: 1750 x 5 = 8750
+ 1750 x 7 = 12250
= 10500
+ 1750 x 6
+ 1750 x 7 = 12250
+ 1750 x 5 = 5250

total cost

Question Two

b) How many workers should be working each month to most closely match the aggregate forecasts from part a)? Compute the total cost of the plan.

Month	Aggregate demand	Working days	Production per worker	Workers required	Workers rounded	Workers hired	Workers fired
Jan	710	20	160	4.4375	5	0	45
Feb	880	18	144	6.111	7	2	0
March	935	23	184	5.082	6	0	1
April	745	15	120	6.208	7	1	0
May	550	23	184	2.989	3	0	4

Q2b Solution

Question Two

b) How many workers should be working each month to most closely match the aggregate forecasts from part a)? Compute the total cost of the plan.

Month	Production	Inventory
Jan	5*160 = 800	90
Feb	7*144 = 1008	218
March	6*184 = 1104	387
April	7*120 = 840	482
May	3*184 = 552	484

Costs:

Hiring: 3*600 = £1800
Firing: 50*1750 = £87,500
Production: (5+7+6+7+3)*1750 = £49,000
Inventory: 1661*2 = £3,322

Total cost: £141,622

Q2b Solution

Question Two

c) Assuming that stockouts are not allowed, determine a minimum constant workforce plan using the aggregate forecasts from part (a). Calculate also the cost of the plan and compare with plan (b).

Month				
Jan				
Feb				
March				
April				
May				

Question Two

- Assuming that stockouts are not allowed, determine a minimum constant workforce plan using the aggregate forecasts from part (a). Calculate also the cost of the plan and compare with plan (b).

Month			
Jan			
Feb			
March			
April			
May			

Question Two

c) Assuming that stockouts are not allowed, determine a minimum constant workforce plan using the aggregate forecasts from part (a). Calculate also the cost of the plan and compare with plan (b).

Month	Cumulative demand	Cumulative production	Workers required	Workers rounded
Jan	710	160	4.4375	5
Feb	1590	304	5.23026316	6
March	2525	488	5.17418033	6
April	3270	608	5.37828947	6
May	3820	792	4.82323232	5

Q2c Solution

Question Two

c) Assuming that stockouts are not allowed, determine a minimum constant workforce plan using the aggregate forecasts from part (a). Calculate also the cost of the plan and compare with plan (b).

Month	Workers	Production per worker	Inventory
Jan	6	960	954
Feb	6	864	1812
March	6	1104	2910
April	6	720	3624
May	6	1104	4722
		4752	14022

Costs:

Hiring: 0
Firing: 44*1750 = £77000
Production: 6*5*1750 = £52,500
Inventory: 2197*2 = £4,395

Total cost: £133,894

Q2c Solution

Question Three

Question Three

ThreadKind produces a clothing line using responsibly sourced wool and cotton. At present, the company produces an Organic Wool Cardigan and a Cotton Everyday Tee from responsibly sourced fibres. The predicted demand for these two items over a six-month planning horizon is as follows:

Month	Number of Working Days	Organic Wool Cardigan	Cotton Everyday Tshirt
1	25	1400	700
2	20	1200	600
3	21	400	200
4	24	500	250
5	18	600	300
6	20	800	400

On average, cardigans require one hour to produce, and tshirts require three hours to produce. All workers are skilled in production of both garments. ThreadKind currently have 20 full-time permanent employees. Permanent employees earn £19 per hour and work 8 hours per day (regular time). They can also do overtime, up to 3 hours per day and during this overtime earn £25 per hour. Recruiting extra full-time permanent workers costs £4250 per worker.

It costs ThreadKind £1.50 to hold one aggregate unit of production in inventory for one month. At the start of month one, ThreadKind holds 300 Cardigans and 150 Tshirts in inventory. There are no ending inventory requirements.

a) Using the individual product forecasts, calculate the corresponding forecasts for aggregate units of production and clearly explain how you defined the aggregation scheme.

b) Ignoring the overtime option for the permanent staff, what would be the size of the permanent workforce required (i.e., the minimum constant workforce plan) to satisfy the demand for the coming six months using regular time only? Calculate the monthly production and inventory levels and all the relevant costs for this plan. Visualise your plan in an appropriate diagram.

Question Three

a) Using the individual product forecasts, calculate the corresponding forecasts for aggregate units of production and clearly explain how you defined the aggregation scheme.

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Month	Organic Wool Cardigan	Cotton Everyday Tshirt			
January	1400	700			
February	1200	600			
March	400	200			
April	500	250			
May	600	300			
June	800	400			

Question Three

a) Using the individual product forecasts, calculate the corresponding forecasts for aggregate units of production and clearly explain how you defined the aggregation scheme.

Month	Organic Wool Cardigan	Cotton Everyday Tshirt	Net demand - Cardigan	Net demand - Tshirt	Aggregate Demand
January	1400	700	1400-300 = 1100	700 – 150 = 550	3*550+1100 = 2750
February	1200	600	1200	600	3*600+1200 = 3000
March	400	200	400	200	3*200+400 = 1,000
April	500	250	500	250	3*250+500 = 1,250
May	600	300	600	300	3*300+600 = 1,500
June	800	400	800	400	3*400+800 = 2,000

Q3a Solution

Question Three

b) Ignoring the overtime option for the permanent staff, what would be the size of the permanent workforce required (i.e., the minimum constant workforce plan) to satisfy the demand for the coming six months using regular time only? Calculate the monthly production and inventory levels and all the relevant costs for this plan. Visualise your plan in an appropriate diagram.

Question Three

b) Ignoring the overtime option for the permanent staff, what would be the size of the permanent workforce required (i.e., the minimum constant workforce plan) to satisfy the demand for the coming six months using regular time only?

Month							
January							
February							
March							
April							
May							
June							

Question Three

b) Calculate the monthly production and inventory levels and all the relevant costs for this plan. Visualise your plan in an appropriate diagram.

Month			
January			
February			
March			
April			
May			
June			

Question Three

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Month			
January			
February			
March			
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June			

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Question Three

b) Ignoring the overtime option for the permanent staff, what would be the size of the permanent workforce required (i.e., the minimum constant workforce plan) to satisfy the demand for the coming six months using regular time only?

Month	Aggregate Demand	Cumulative demand	Working days per month	cumulative working days	cumulative working hrs	Workers required	Workers rounded
January	2750	2750	25	25	200	13.75	14
February	3000	5750	20	45	360	15.972	16
March	1000	6750	21	66	528	12.784	13
April	1250	8000	24	90	720	11.111	12
May	1500	9500	18	108	864	10.995	11
June	2000	11500	20	128	1024	11.230	12

Q3b Solution

Question Three

b) Calculate the monthly production and inventory levels and all the relevant costs for this plan. Visualise your plan in an appropriate diagram.

Month	Workers rounded	Production	Inventory
January	16	3200	450
February	16	2560	10
March	16	2688	1698
April	16	3072	3520
May	16	2304	4324
June	16	2560	4884
		16384	10002

Q3b Solution

Question Three

b) Calculate the monthly production and inventory levels and all the relevant costs for this plan. Visualise your plan in an appropriate diagram.

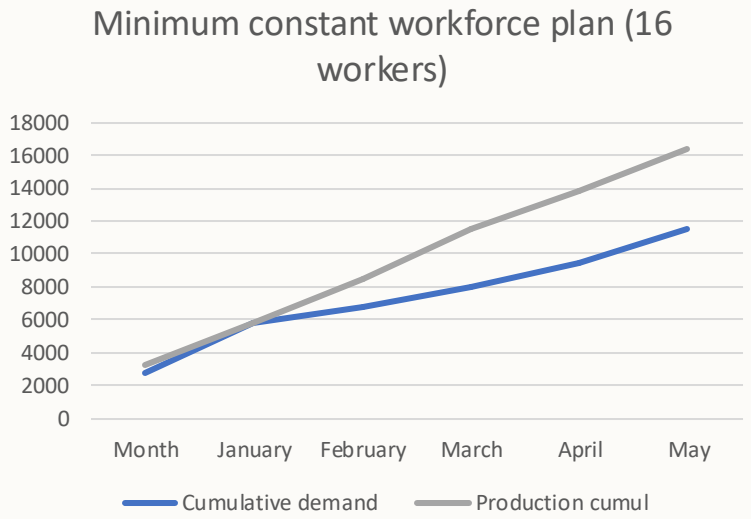
Costs:

Hiring: 0

Firing: **We aren't told firing cost!**

Labour: 19* 16384 = £204,800

Inventory: 1.5 * 10002 = £22,329



Total cost: 204,800 + 22,329 = £227,129 plus firing cost!

Q3b Solution

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Thank you