Aycada
Simulation Game for Production and Capacity Management

Examination: Decision Paper of the Product Manager 4

Name: Rogowski

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Group (D1, D2, D3 or BWL/Block): E3

Companies (C1, C2, ... C11): C1

Situation

The Executive Board makes monthly decisions on

- The planned production volumes for the four products offered by the company [PU/month] and
- The planned production capacity for the four production stages [hours/month].

Each month, the Executive Board as a body must therefore make eight individual decisions. The first decision is made for month 36.

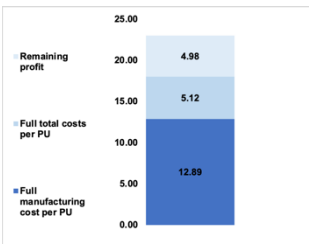
Each board member has the task of creating a decision template, which serves in particular to support the first joint board decision for month 36. This paper answers the following questions:

Questions

Is it economically advantageous to offer the product? (2 points)

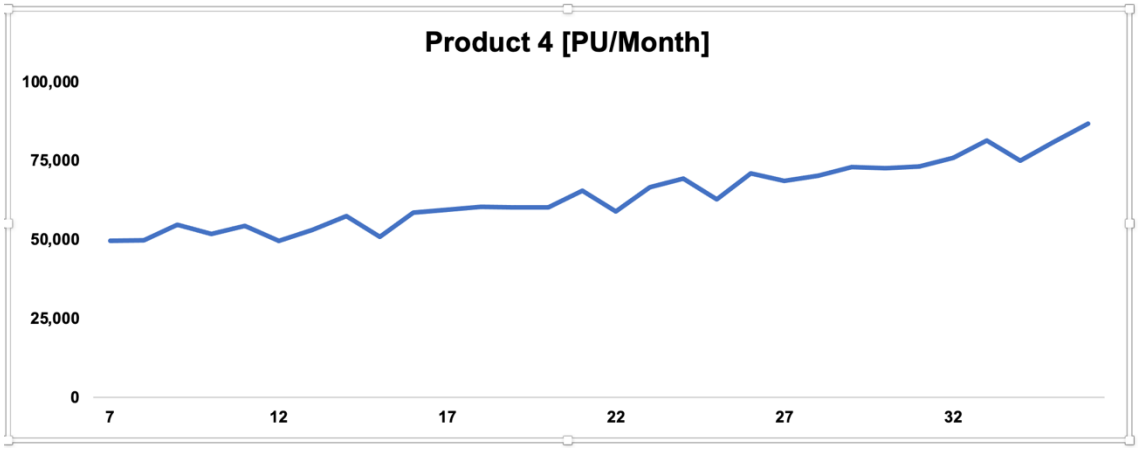
As long as a products' contribution margin is positive, it contributes to covering a company's fixed costs (which is 71.9% of the sales price for product four). However, if the product would yield negative profits and was the only product a company offered it wouldn't be economically advantageous offering it, regardless of its contribution margin, because it only covered the fixed costs partly. But firstly, it is one of four products and secondly, product four yields profits.

It has the second highest profit margin (21.6%) which implies an absolute profit of 4.98€ per sold PU after deducting the total manufacturing costs of 18.01€. This fact makes product four economically advantageous even if it was the only product the company offered. Additionally, the profit per PU is higher than the monthly inventory holding costs of 3.28€ per PU. This shows that you could even hold the product in inventory for one month, sell it the next month and you would still make profits.
Long story short, to offer the product is economically advantageous.



Are there time-dependent patterns in past demand (measured in packaging units of the product)? (2 points)

Time dependent patterns are rather hard to identify for product four as its growth is mostly linear over time with exception for five bigger dips (which didn't show any seasonal trends). However, every time the product demand dipped it rose stronger than it did after the previous dips. Hence, a clear and sustainable demand growth is to be expected with no exposure to seasonality.



Which forecasting technique is best suited to provide the most accurate prediction of demand for the product? (2 points)

I chose to calculate a compound monthly growth rate of incoming orders based on the last 29 months (7-36) because it draws a very concise picture of long-term trends which are essential for the development of long-term tactics.

Afterwards, I applied this growth rate monthly to forecasts future incoming orders.

CMGR = 1.9505%

Calculation:

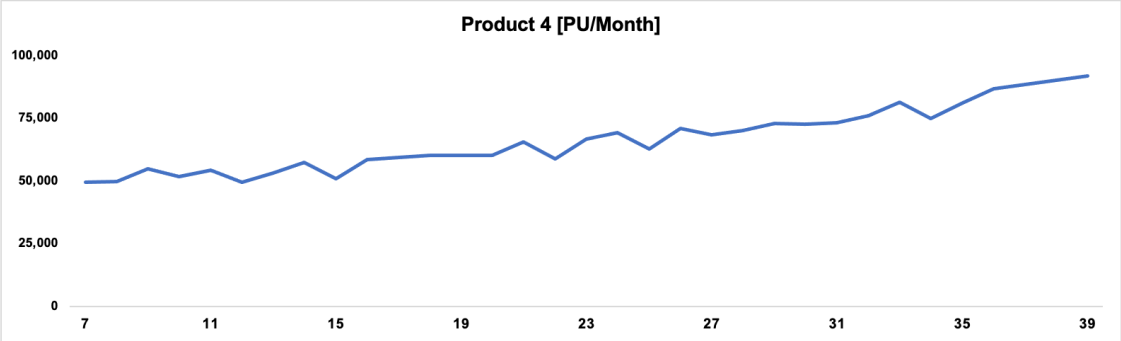
49,617 * (1+x)^29 = 86,880 ➡ (1+x)^29 = 1.751 ➡ 29*ln(1+x) = 0.5602 ➡ ln(1+x) = 0.019317

➡ 1 + x = 1,019505 ➡ x = 0.019505

How high will the demand be in the month (measured in packing units) in which the production quantity to be determined now is available to be delivered? (Note: To answer this question, use the forecast technique recommended above.) (3 points)

Given the aforehand calculated demand growth rate, the demand for the month in which the production quantity to be determined now is available to be delivered would be calculated as follows:

86,880 * 1,019505^3 = 92,064 PU (rounded up)



What is the mean absolute deviation between the actual observed demand for the product and the forecast (both measured in packing units) for months 25 to 36 when the selected forecasting technique is applied? (2 points)

Based on the CMGR calculated aforehand, the forecasted values look like this:

Incoming orders	25	26	27	28	29	30	31	32	33	34	35	36	CMGR
Product 4 [PU/Month]	62,771	71,032	68,634	70,302	73,056	72,665	73,297	75,996	81,416	75,108	81,139	86,880	*1.95%*
change in %	*9.8%*	*13.2%*	*-3.4%*	*2.4%*	*3.9%*	*-0.5%*	*0.9%*	*3.7%*	*7.1%*	*-7.7%*	*8.0%*	*7.1%*	
expected sales	70,764	72,144	73,551	74,986	76,448	77,940	79,460	81,010	82,590	84,201	85,843	87,517	
Δ [sales/expected sales]	-7,993	-1,112	-4,917	-4,684	-3,392	-5,275	-6,163	-5,014	-1,174	-9,093	-4,704	-637	
|deviation from forecast|	7,993	1,112	4,917	4,684	3,392	5,275	6,163	5,014	1,174	9,093	4,704	637	
mean absolute deviation												**4513.04**	

Ultimately, the mean absolute mean deviation of the forecasted values from the actual demand is 4513.04 PU for the last 12 months.

What quantity of the product (measured in packing units) would you keep in inventory? (2 points)

Probably, the best indication is provided by the mean absolute deviation of the actual incoming orders from the forecasted orders.

The question to answer in this matter is whether to rely on the mean absolute deviation of 29 months as the values are based on more data or the mean absolute deviation derived from the values of the last 12 months as they might better represent the current market momentum.

Incoming orders	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Product 4 [PU/Month]	49,617	49,795	54,869	51,886	54,377	49,720	53,142	57,619	50,884	58,592	59,582	60,381	60,334	60,254	65,537
change in %	*n/a*	*0.4%*	*10.2%*	*-5.4%*	*4.8%*	*-8.6%*	*6.9%*	*8.4%*	*-11.7%*	*15.1%*	*1.7%*	*1.3%*	*-0.1%*	*-0.1%*	*8.8%*
expected sales development	49,617	50,585	51,571	52,577	53,603	54,648	55,714	56,801	57,909	59,038	60,190	61,364	62,561	63,781	65,025
Δ [sales/expected sales]	*n/a*	*790*	*-3,298*	*691*	*-774*	*-4,928*	*-2,572*	*818*	*-7,025*	*446*	*608*	*983*	*-2,227*	*-3,527*	*512*
|deviation from forecast|	#VALUE!	790	3,298	691	774	4,928	2,572	818	7,025	446	608	983	2,227	3,527	512
mean absolute deviation															

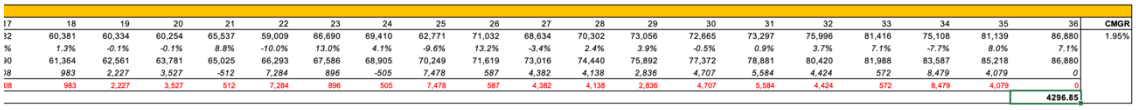
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	CMGR
60,334	60,254	65,537	59,009	66,690	69,410	62,771	71,032	68,634	70,302	73,056	72,665	73,297	75,996	81,416	75,108	81,139	86,880	1.95%
-0.1%	*-0.1%*	*8.8%*	*-10.0%*	*13.0%*	*4.1%*	*-9.6%*	*13.2%*	*-3.4%*	*2.4%*	*3.9%*	*-0.5%*	*0.9%*	*3.7%*	*7.1%*	*-7.7%*	*8.0%*	*7.1%*	
62,561	63,781	65,025	66,293	67,586	68,905	70,249	71,619	73,016	74,440	75,892	77,372	78,881	80,420	81,988	83,587	85,218	86,880	
-2,227	*-3,527*	*-512*	*-7,284*	*-896*	*-505*	*-7,478*	*-587*	*-4,382*	*-4,138*	*-2,836*	*-4,707*	*-5,584*	*-4,424*	*-572*	*-8,479*	*-4,079*	*0*	
2,227	3,527	512	7,284	896	505	7,478	587	4,382	4,138	2,836	4,707	5,584	4,424	572	8,479	4,079	0	
																	3041.09	

Mean absolute deviation = 3041.09 PUs (28 months*) vs. 4513.04 PUs (12 months)

Incoming orders	25	26	27	28	29	30	31	32	33	34	35	36	CMGR
Product 4 [PU/Month]	62,771	71,032	68,634	70,302	73,056	72,665	73,297	75,996	81,416	75,108	81,139	86,880	*1.95%*
change in %	*9.8%*	*13.2%*	*-3.4%*	*2.4%*	*3.9%*	*-0.5%*	*0.9%*	*3.7%*	*7.1%*	*-7.7%*	*8.0%*	*7.1%*	
expected sales	70,764	72,144	73,551	74,986	76,448	77,940	79,460	81,010	82,590	84,201	85,843	87,517	
Δ [sales/expected sales]	-7,993	-1,112	-4,917	-4,684	-3,392	-5,275	-6,163	-5,014	-1,174	-9,093	-4,704	-637	
|deviation from forecast|	7,993	1,112	4,917	4,684	3,392	5,275	6,163	5,014	1,174	9,093	4,704	637	
mean absolute deviation												**4513.04**	

The problem with the second forecast is that the CMGR is applied to the incoming orders from month 24 so the forecasted values are strongly dependent on the number of incoming orders in the respective month.

Therefore, I calculated the mean absolute deviation of the forecasted incoming orders (projected from month 7 to month 36) from the actual incoming orders only focusing on the last 12 months. Furthermore, I left the 36th month out of the calculation as it corresponds exactly to the actual incoming orders anyways due to the very nature of the CMGR forecasting technique.



17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	CMGR
32	60,381	60,334	60,254	65,537	59,009	66,690	69,410	62,771	71,032	68,634	70,302	73,056	72,665	73,297	75,996	81,416	75,108	81,139	86,880	1.95%
%	*1.3%*	*-0.1%*	*-0.1%*	*8.8%*	*-10.0%*	*13.0%*	*4.1%*	*-9.6%*	*13.2%*	*-3.4%*	*2.4%*	*3.9%*	*-0.5%*	*0.9%*	*3.7%*	*7.1%*	*-7.7%*	*8.0%*	*7.1%*	
00	61,364	62,561	63,781	65,025	66,293	67,586	68,905	70,249	71,619	73,016	74,440	75,892	77,372	78,881	80,420	81,988	83,587	85,218	86,880	
08	*983*	*2,227*	*3,527*	*-512*	*7,284*	*896*	*-505*	*7,478*	*587*	*4,382*	*4,138*	*2,836*	*4,707*	*5,584*	*4,424*	*572*	*8,479*	*4,079*	*0*	
08	983	2,227	3,527	512	7,284	896	505	7,478	587	4,382	4,138	2,836	4,707	5,584	4,424	572	8,479	4,079	0	
																			4296.85	

With the received result of 4296.85 PUs, one has arguably good reasons to be confident not having significantly too little or too many PUs in inventory in case of different demand than projected. Furthermore, I would build up some inventory which enables me to serve demand which competitors were unable to meet. Integrating another mean absolute deviation in my inventory stock should be sufficient to do that for the moment. Overall, the inventory holding costs would total 28.187,34€ (3.28€ * 4,296.85 * 2 = 28.187,34€) and account for only 1.41% of the revenue earned assuming one met the demand of 86,880 PUs, which certainly is our intention. However, as demand is expected to rise as well, the relative inventory holding costs should also decrease along the way.

**only 28 months yielded insightful data as the last month's forecasted incoming orders are exactly equal to the actual incoming orders in the last month*

What planned production quantity of the product you are responsible for do you propose for month 36? (1 point)

Planned production quantity is released into work in progress inventory the next month and available for sale in the 39th month. Since the company struggled to cover customers demand for the last three months already, it is facing backlog orders either way. This is a trend which is expected to continue as the work in progress inventory is not sufficient to satisfy projected demand.

Hence, the production quantity needs to be increased drastically. The question arising now is by how much we should increase our production. Also, it also remains unclear whether it will be possible to build up the desired inventory stock specified in the task before.

Order backlog					
month	32	33	34	35	36
Product 1 PU	0	0	0	0	0
Product 2 PU	0	0	0	0	0
Product 3 PU	0	8,739	14,844	33,279	52,545
Product 4 PU	0	0	5,367	12,499	23,973

Order cancellation						
month	32	33	34	35	36	**CMGR**
Product 1 PU	0	0	0	0	0	/
Product 2 PU	0	0	0	0	0	/
Product 3 PU	0	873	1,484	3,486	5,814	
cancellations in %	*#DIV/0!*	*9.99%*	*10.00%*	*10.48%*	*11.06%*	**5.20%**

As product three experienced the most backlog orders, it also provides the most historical data of customer behavior and cancellations. Here from, I derived a compound monthly growth rate in order cancellations which is 5.2% starting from the 34th month as customers behavior is expected to not vary greatly. Additionally, a very similar growth in order cancellations was recognizable for product four itself – just less data. This might not be 100% accurate but at least provides a number to calculate with because cancellations increase with increasing unserved orders.

Assuming that the planned production for month 36 wasn't increased and remained at 78,766 the company would face losses by the end of month 39 totaling 513,669€ in revenues and 265,515€ in operating profits. These figures were derived taking accumulated backlog order costs of 2.09€ per PU and missing revenue because of cancelled orders into account. Opportunity costs due to unsatisfied customers who stop ordering from our company and switch their supplier are not considered as historical data for such a calculation misses. Nonetheless, these losses certainly weigh heavily too.

compound monthly growth rate of order cancellations:	5.20%

Month	37	38	39	40	41
Demand forecast	88,575	90,302	92,064	93,859	95,690
Product 4 quantity available for sale	71,636	72,214	78,766		0
Production costs					
Product demand not served	16,939	18,088	13,298		
Accumulated backlog	38,392	52,234	59,455	73,319	
Cancellation rate	11.06%	11.63%	12.24%	13.55%	14.26%
Expected cancellations	4,246	6,077	7,277	10,104	
Corrected number of PUs required to eliminate backlogs and serve current demand in month 39:					**52,178**

Accumulated loss in sales due to backlog orders by month 39:	109,051
Accumulated loss in sales due to order cancellations by month 39:	404,618
Overall revenue loss due to unsufficient deliveries by moth 39:	**513,669**
Overall loss in net operating profit by month 39:	**265,515**

In the calculation below, the planned production quantity for month 36 was set equal to 0 because that provides an estimate of how many PUs would be required to satisfy demand in form of accumulated backlog as well as expected incoming orders for month 39.

compound monthly growth rate of order cancellations:	5.20%

Month	37	38	39	40	41
Demand forecast	88,575	90,302	92,064	93,859	95,690
Product 4 quantity available for sale	71,636	72,214	78,766		0
Production costs					
Product demand not served	16,939	18,088	13,298		
Accumulated backlog	38,392	52,234	59,455	73,319	
Cancellation rate	11.06%	11.63%	12.24%	13.55%	14.26%
Expected cancellations	4,246	6,077	7,277	10,104	
Corrected number of PUs required to eliminate backlogs and serve current demand in month 39:					**138,221**

The received result shows, that it would require 138,221 PUs for the company to satisfy the demand ((52,234 – 6,077 cancellations in month 38) PUs accumulated backlog orders + 92,064 PUs expected demand in month 39). Building up the aforehand defined desired inventory stock in addition is optional for the moment. Whether enough capacity can be allocated to product four to produce the 138,221 PUs or 146,815 PUs (with inventory stock) is a question to discuss with the company's capacity manager. Either way, 138,221 PUs is the planned production quantity I emphatically propose for month 36 to keep as many customers and market shares as possible.

What quantity of the product (measured in packing units) will be in the production and quality control process (WIP – work in process) in month 37? (1 point)

Work in Progress inventory consists of units in the production process (granulation, blending, tableting and packaging) and units in the quality control after production. Released production quantity is started to be produced the next month, hence it then moves into the production process for one month. After this month, its quality is checked for another month.

Since quality control is the second step, starting in the month after production, which again starts one month after being specified in released production quantity, the number of units in quality

control for month 37 can be derived from the number of units in released production quantity in month 35 which is 71,636 PUs

Released Production quantity						
	31	32	33	34	35	36
Product 1 [PU/Month]	183,840	181,798	181,697	179,387	180,671	178,288
Product 2 [PU/Month]	147,002	147,174	146,795	145,118	143,815	143,440
Product 3 [PU/Month]	95,330	97,070	98,359	99,799	100,217	103,012
Product 4 [PU/Month]	66,396	67,440	68,416	69,680	71,636	72,214

The number of units in the actual production process are implied by the number of units in released production quantity from month 36. This totals to 72,214 PU which shows that these units will be in the production process in month 37.

Released Production quantity						
	31	32	33	34	35	36
Product 1 [PU/Month]	183,840	181,798	181,697	179,387	180,671	178,288
Product 2 [PU/Month]	147,002	147,174	146,795	145,118	143,815	143,440
Product 3 [PU/Month]	95,330	97,070	98,359	99,799	100,217	103,012
Product 4 [PU/Month]	66,396	67,440	68,416	69,680	71,636	72,214

Altogether, there would be:

72,214 PUs (in production process) + 71,636 PUs (in quality control) = 143,850 PUs in WIP in month 37.

Evaluation criteria

	Insufficient	Satisfactory	Very good
Correctness of the answer	Answer is grossly incorrect	Answer is partially incorrect	Answer is correct
Justification of the answer	No justification available, neither in text form nor as a calculation	Satisfactory justification	Clear and convincing justification of the answer, with calculation (if applicable)
Correctness of the data/information used	Incorrect data/information used	Partly correct, partly incorrect data/information used	Correct and appropriate data/information used