BIA-674 SUPPLY CHAIN ANALYTICS

Procurement Analysis

Capacity Analysis

1. Problem Statement

Due to the sudden increase of medical supplies, we need to identify if there is any capacity constraint in Fabricadas new facilities in Chicago. The plant controller senses that the current capacity is not adequate to meet his forecasted demand. In contrast the VP of Operations of Medicrystals believes that they have adequate supply to meet demand. Our team needs to analyze the presence of capacity constraint and recommend how to maximize the utilization to meet demand at current capacity and to meet the increase in demand for these products. And to understand the perspective of plant manager and VP Operations in terms of capacity. Glass vials, one of the products used for vaccines is manufactured in these facilities are time consuming. And Medicrystal wants to meet the demand of other diseases including COVID vaccines.

2. Methodology

We are going to investigate the following areas in this analysis:

- Available Capacity
- Production Plan Forecast
- Production Capacity Results

2.1. Available Capacity

As seen in the Figure 1, demand is increasing in every quarter for all three products including Ampoules, Vials and Syringes. These products are essential for vaccine production.

QUANTITIES FOR RUNNING ANALYSIS (demand projections + Net lot rejected in a quarter)					
	Q3 2020	Q4 2020	Q1 2021	Q2 2021	Total
Ampoules	28	68	73	78	247
Vials	20	35	45	50	150
Syringes	24	49	54	59	186

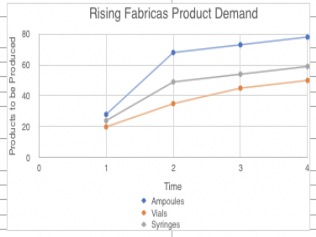


Figure 1

In figure 2, we have units and the products processed in each unit. Total available time for each process namely Tubing, Forming, Washing and Packing. We could observe Ampoules are processed in limited units compared to vials and Syringes.

Process

Product / Unit	Ampoules	Vials	Syringes	Total ShutDown Days	Total Available Hours
Tubing #1	0	0	1	140	5400
Tubing #2	1	1	0	145	5280
Forming #1	1	0	0	140	5400
Forming #2	0	1	1	150	5160
Washing #1	0	0	1	140	5400
Washing #2	1	1	0	145	5280
Washing #3	0	0	1	145	5280
Washing #4	1	1	0	140	5400
Packing #1	0	1	0	145	5280
Packing #2	0	1	1	145	5280
Packing #3	0	0	1	150	5160
Packing #4	0	0	1	140	5400
Packing #5	1	0	0	145	5280
Packing #6	1	1	0	145	5280

Time Calculation

	Total Available Time
Tubing	10680
Forming	10560
Washing	21360
Packing	31680

Figure 2

2.2 Production Plan Forecast

After computing the capacity of each unit for the entire year, we could find feasible solution such that it meets demand, and the utilization hours are within the limit.

	Cycle Time			Process						Assignment Lots			Used Hours		Capacity Hours		
Unit	Ampoules	Vials	Syringes	Ampoules	Vials	Syringes	ampoules	vials	syringes	Ampoules	Vials	Syringes					
Tubing #1	6	9	6	0	0	1	0	0	0	0	0	186	1116	<=	5400	0.206666667	
Tubing #2	6	9	6	1	1	0	0	0	0	384.2857	150	0	3655.714286	<=	5280	0.69237013	
Forming #1	12	9	9	1	0	0	0	0	0	0	0	0	0	<=	5400	0	
Forming #2	12	9	9	0	1	1	0	0	0	0	0	0	0	<=	5160	0	
Washing #1	18	21	18	0	0	1	0	0	0	0	0	186	3348	<=	5400	0.62	
Washing #2	18	21	18	1	1	0	0	0	0	247	39.71429	0	5280	<=	5280	1	
Washing #3	18	21	18	0	0	1	0	0	0	0	0	0	0	<=	5280	0	
Washing #4	18	21	18	1	1	0	0	0	0	137.2857	110.2857	0	4787.142857	<=	5400	0.886507937	
Packing #1	24	24	24	0	1	0				0	39.71429	0	953.1428571	<=	5280	0.180519481	
Packing #2	24	24	24	0	1	1				0	0	0	0	<=	5280	0	
Packing #3	24	24	24	0	0	1				0	0	0	0	<=	5160	0	
Packing #4	24	24	24	0	0	1				0	0	186	4464	<=	5400	0.826666667	
Packing #5	24	24	24	1	0	0				137.2857	0	0	3294.857143	<=	5280	0.624025974	
Packing #6	24	24	24	1	1	0				109.7143	110.2857	0	5280	<=	5280	1	
										247	150	186	32178.85714		74280		
										247	150	186	583			Extra Capacity H	42101.14
										384.2857	150	48					

Production

	Lots Produced				Defective lot in quarter				Available Lots				Final Product Lots	Total demand
	Tubing	Hot-forming	Washing	Packing	Bend tubing Rejects	Contamination rejects	Glass breakages	Air bubbles	Tubing	Hot-forming	Washing	Packing		
Ampoules	384.2857	0	384.2857	247	1	5.7	3.5	2.8	383.2857	-5.7	380.7857143	244.2	-5.7	15
Vials	150	0	150	150	2.8	6	3.2	3	147.2	-6	146.8	147	-6	5
Syringes	186	0	186	186	3.4	5.2	2.8	2.6	182.6	-5.2	183.2	183.4	-5.2	10

Objective

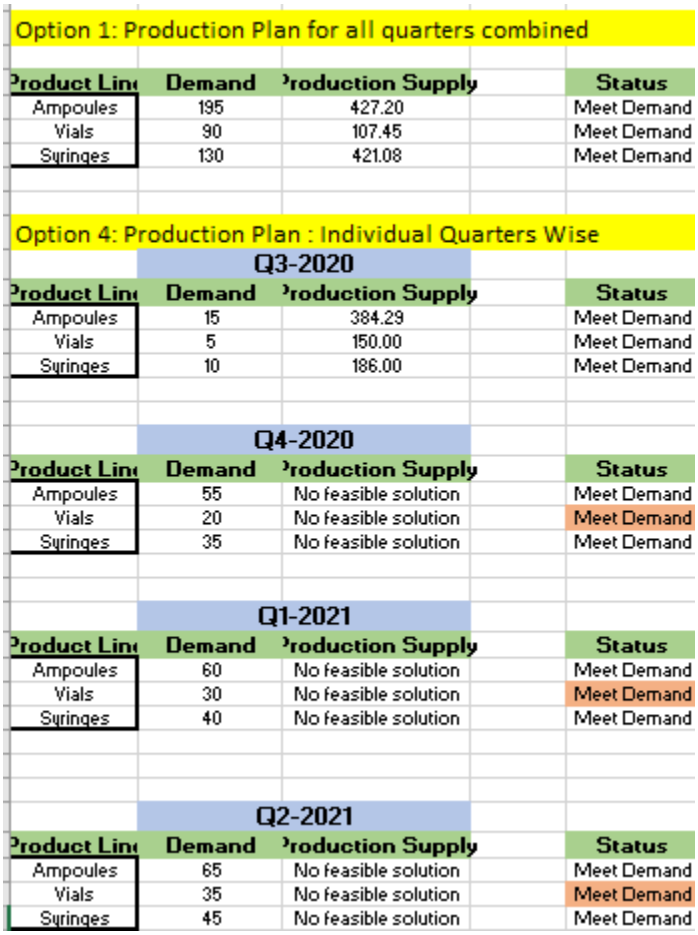
min 583

Figure 3

But what happens when we compute on a quarterly basis? We have tried to compute the capacity of all units for every quarter, and we could not find a feasible solution for the quarters where demand is very high.

2.3. Product Capacity Results

In the earlier section, we noticed that we could not meet demand on a quarterly basis, while we could achieve it for the full year. And the same can be seen in the figure 4. As the demand increases, we fail to get a feasible solution.



Option 1: Production Plan for all quarters combined

Product Line	Demand	Production Supply	Status
Ampoules	195	427.20	Meet Demand
Vials	90	107.45	Meet Demand
Syringes	130	421.08	Meet Demand

Option 4: Production Plan : Individual Quarters Wise

Q3-2020

Product Line	Demand	Production Supply	Status
Ampoules	15	384.29	Meet Demand
Vials	5	150.00	Meet Demand
Syringes	10	186.00	Meet Demand

Q4-2020

Product Line	Demand	Production Supply	Status
Ampoules	55	No feasible solution	Meet Demand
Vials	20	No feasible solution	Meet Demand
Syringes	35	No feasible solution	Meet Demand

Q1-2021

Product Line	Demand	Production Supply	Status
Ampoules	60	No feasible solution	Meet Demand
Vials	30	No feasible solution	Meet Demand
Syringes	40	No feasible solution	Meet Demand

Q2-2021

Product Line	Demand	Production Supply	Status
Ampoules	65	No feasible solution	Meet Demand
Vials	35	No feasible solution	Meet Demand
Syringes	45	No feasible solution	Meet Demand

Figure 4

The only quarter where we get feasible solution is in Quarter 1 where demand is very less.

	Demand Projections Plus Net Lot Rejected in a Quarter			Solver Results, Feasible Solution?
	Ampoules	Vials	Syringes	
Q3 2020	28	20	24	Yes, demand can be met
Q4 2020	68	35	49	No, no feasible solution
Q1 2021	73	45	54	No, no feasible solution
Q2 2021	78	50	59	No, no feasible solution
Total	247	150	186	Yes, demand can be met

Figure 5

So, to overcome this problem, we can increase productivity in Q1 such that we can keep up with demand in the following quarters. For the given problem, if we produce the same amount throughout all quarters, we can meet the demands of upcoming quarters. In the below Figure 6, I have increased the lots of Q1, and I could get feasible solution of 146. If I maintain the same for every quarter, it solves the shortage of supply.

	Cycle Time				Process							Assignment Lots			Used Hours		Capacity Hours			
	Ampoules	Vials	Syringes		Ampoules	Vials	Syringes		ampoules	vials	syringes	Ampoules	Vials	Syringes						
Unit																				
Tubing #1	6	9	6		0	0	1		0	0	0	0	0	45	270	<=	1350	0.2		
Tubing #2	6	9	6		1	1	0		0	0	0	96.42857	40	0	938.5714286	<=	1320	0.71038961		
Forming #1	12	9	9		1	0	0		0	0	0	0	0	0	0	<=	1350	0		
Forming #2	12	9	9		0	1	1		0	0	0	0	0	0	0	<=	1290	0		
Washing #1	18	21	18		0	0	1		0	0	0	0	0	45	810	<=	1350	0.6		
Washing #2	18	21	18		1	1	0		0	0	0	61	10.57143	0	1320	<=	1320	1		
Washing #3	18	21	18		0	0	1		0	0	0	0	0	0	0	<=	1320	0		
Washing #4	18	21	18		1	1	0		0	0	0	35.42857	29.42857	0	1255.714286	<=	1350	0.93015873		
Packing #1	24	24	24		0	1	0					0	10.57143	0	253.7142857	<=	1320	0.192207792		
Packing #2	24	24	24		0	1	1					0	0	0	0	<=	1320	0		
Packing #3	24	24	24		0	0	1					0	0	0	0	<=	1290	0		
Packing #4	24	24	24		0	0	1					0	0	45	1080	<=	1350	0.8		
Packing #5	24	24	24		1	0	0					35.42857	0	0	850.2857143	<=	1320	0.644155844		
Packing #6	24	24	24		1	1	0					25.57143	29.42857	0	1320	<=	1320	1		
												61	40	45	8098.285714		18570			
												61	40	45	146			Extra Capacity H	10471.71	
												96.42857	40	48						
Production																				
	Lots Produced				Defective lot in quarter							Available Lots						Final Product Lots		Total demand
	Tubing	Hot-forming	Washing	Packing	Bend tubing Rejects	Contamination rejects	Glass breakages				Air bubbles	Tubing	Hot-forming	Washing	Packing					
Ampoules	96.42857	0	96.42857	61	1	5.7	3.5				2.8	95.42857	-5.7	92.92857143	58.2			-5.7		15
Vials	40	0	40	40	2.8	6	3.2				3	37.2	-6	36.8	37			-6		5
Syringes	45	0	45	45	3.4	5.2	2.8				2.6	41.6	-5.2	42.2	42.4			-5.2		10
Objective																				
min	146																			

Figure 6

The current capacity of the plant is sufficient to satisfy demand. But we can consider other factors to keep the utilization minimum. The capacity of the plant is enough to satisfy demand. We can say there are no capacity constraints necessary. In order to do that utilization should be kept to a minimum,

- Identifying the root cause behind unplanned shutdowns could results in a decrease in the number of unplanned shutdowns.
- Maximum utilization of machinery.

3. Conclusion

MediCrystals needs to maximize its utilization to meet demand by balancing the operation hours, distributing high volume products to least used units such that it reduces operation hours and by reducing the rejection rate of products. And it does not need to increase the current capacity to math demand.