ASCM CASE COMPETITION

In collaboration with Deloitte.

MEDICRYSTALS CO.

Navigating Pandemic Supply Challenges

Team ID: 2230672

Executive Summary

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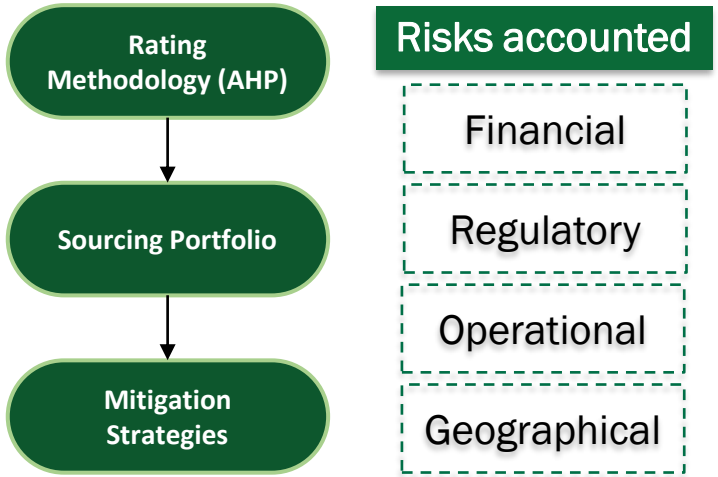
Supplier Risk Management

→ Objectives

- Comprehensive Supplier Risk Rating
- Review Mitigation Strategies

Model: Analytic Hierarchy Process



Assumptions:

1. Given is the exhaustive list of suppliers relevant to MediCrystals Co.
2. External country-specific risk factors and data can be taken into account

Inventory Management

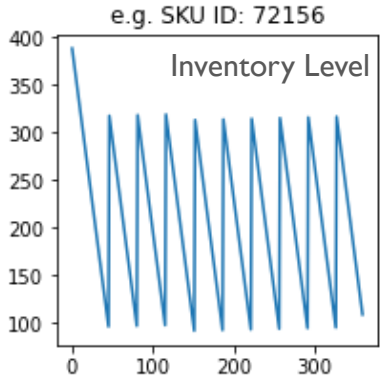
→ Objectives

- Calculate Obsolete Inventory
- Find Change in Inventory Position

Model: Deterministic Demand

Recommended Parameters:

1. Economic Order Quantity
2. Order Aggregation



Constant APU after considering trend$_{APU}$

Reason: Model considered is Deterministic Demand. This is based on the forecasting methods followed in SCMs of fragile goods.

Initial On order Inventory = 0

Reason: No explicit data mentioned in Exhibit 2

Assumptions

Initial and Final Back order Inventories = 0

Reason: No data in Exhibit 2 regarding

1. Initial Back order Inventory
2. Final Lead Time after considering S-OTD thus leading to no specific way to simulate arrival delay in model

Capacity Management

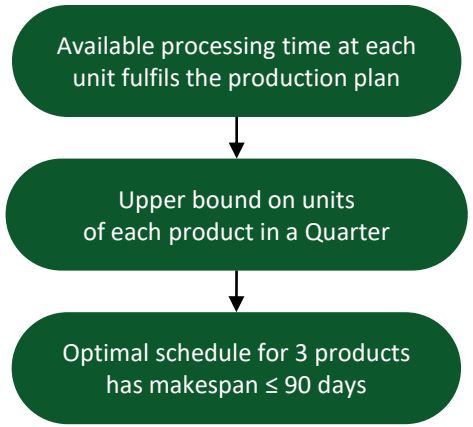
→ Objectives

- Justify Capacity constraint Opinions
- Maximize Capacity Utilization

Model: 3-Step Decision Tree

Production Planning Strategies:

1. Chase Demand Strategy
2. Level Capacity Strategy



Assumptions:

1. Three 8-hour shifts for all working days → 24 hours
2. Uniform distribution of working hours over 4 quarters
3. Zero inter-process transition time
4. One plant → one product → one process at a time
5. Average Processing Time = $24 * \frac{360 - holidays - shutdowns}{4}$

KPIs for Risk Assessment

Supplier Name	Market Share by Revenue	Liquidity (Operating Cash Flow)	Credit Rating	Operating Cash Flow vs Revenue	Labour Unrests	Environment Incidents	Global Political Risk Index (GPRI)	Pharmaceutical Taxes
Plaxian	8.12	$354M	3	5.86	Y	N	82.6	0%
GutesGlas	11.16	$905M	3	10.91	N	N	87.2	7%
Boavidro	12.49	$364M	3	3.92	N	N	68.9	12%
Saanch	4.23	$436M	2	13.85	N	N	67.7	5%
RealGlass	50.74	$3,996M	1	10.59	Y	Y	66.4	13%
Optikiet	0.15	$23M	4	20.63	N	N	66.4	13%
BestOGlass	7.24	$24M	2	0.44	N	N	82.6	0%
MedicMetric	0.01	$10M	4	95.00	N	N	64.2	0%
Shale	3.27	$309M	3	12.72	N	Y	72.9	0%
Opticful	0.13	$6M	3	6.71	N	N	75.3	10%
basicPharm	0.53	$9M	5	2.28	N	N	82.6	0%
PharmyLeaf	1.92	$340M	2	23.79	N	N	67.7	5%

Supplier Name	On Time Delivery (S-OTD)	Single Source	IP Protection	Data security	Exchange Rate Volatility Indicator	Monthly Minimum Wage ($)	Pandemic Reproduction Rate (Rt)	Purchasing Power Index
Plaxian	0.91	Y	N	9	20.91	1257	1.13	108
GutesGlas	0.85	N	N	8	0	1768	1.32	97
Boavidro	0.63	N	N	8	46.74	273	1.04	30
Saanch	0.9	N	N	9	27.78	51	0.86	50
RealGlass	0.82	Y	Y	10	19.05	320	1.16	60
Optikiet	0.88	Y	Y	7	19.05	320	1.16	60
BestOGlass	0.78	Y	N	10	20.91	1257	1.13	108
MedicMetric	0.94	Y	Y	7	30.17	227	0.85	21
Shale	0.86	N	N	8	21.26	800	0.97	93
Opticful	0.92	N	N	5	0	995	1.46	61
basicPharm	0.88	Y	Y	7	20.91	1257	1.13	108
PharmyLeaf	0.79	N	N	8	27.78	51	0.86	50

Key Performance Indicator Data

AHP Matrices

Financial

Financial AHP	Market Share by Revenue	Liquidity (Operating Cash Flow)	Credit Rating	Operating Cash Flow vs Revenue	Geometric Mean	Normalized Weight
Market Share by Revenue	1	2	1	1/2	1.00	**0.23**
Liquidity (Operating Cash Flow)	1/2	1	1/2	1/3	0.54	**0.12**
Credit Rating	1	2	1	1/2	1.00	**0.23**
Operating Cash Flow vs Revenue	2	3	2	1	1.86	**0.42**

Regulatory

Regulatory AHP	Labour Unrests	Environment Incidents	Global Political Risk Index (GPRI)	Pharmaceutical Taxes	Geometric Mean	Normalized Weight
Labour Unrests	1	1	4	3	1.86	**0.39**
Environment Incidents	1	1	4	3	1.86	**0.39**
Global Political Risk Index (GPRI)	1/4	1/4	1	1/2	0.42	**0.09**
Pharmaceutical Taxes	1/3	1/3	2	1	0.69	**0.14**

Operational

Operational AHP	On Time Delivery	Single Source	IP Protection	Data security	Geometric Mean	Normalized Weight
On Time Delivery	1	3	3	2	2.06	**0.46**
Single Source	1/3	1	1	1/2	0.64	**0.14**
IP Protection	1/3	1	1	1/2	0.64	**0.14**
Data security	1/2	2	2	1	1.19	**0.26**

Geographical

Geographical AHP	Exchange Rate Volatility Indicator	Monthly Minimum Wage ($)	Pandemic Reproduction Rate (Rt)	Purchasing Power Index	Geometric Mean	Normalized Weight
Exchange Rate Volatility Indicator	1	2	1/2	2	1.19	**0.26**
Monthly Minimum Wage ($)	1/2	1	1/3	1	0.64	**0.14**
Pandemic Reproduction Rate (Rt)	2	3	1	3	2.06	**0.46**
Purchasing Power Index	1/2	1	1/3	1	0.64	**0.14**

Individual KPI Score

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Supplier Name	Market Share by Revenue	Liquidity (Operating Cash Flow)	Credit Rating	Operating Cash Flow vs Revenue	Financial Score	Labour Unrests	Environment Incidents	Global Political Risk Index (GPRI)	Pharmaceutical Taxes	Regulatory Score
Weights:	***0.23***	***0.12***	***0.23***	***0.42***	***25%***	***0.39***	***0.39***	***0.09***	***0.14***	***25%***
Plaxian	7	6	6	6	6.23	5	10	9	10	7.99
GutesGlas	8	8	6	7	7.12	10	10	10	7	9.57
Boavidro	8	6	6	5	6.03	10	10	7	5	9.03
Saanch	6	7	8	7	7.00	10	10	7	8	9.45
RealGlass	10	10	10	7	8.73	5	5	6	4	4.94
Optikiet	3	4	4	8	5.47	10	10	6	4	8.80
BestOGlass	7	4	8	3	5.17	10	10	9	10	9.91
MedicMetric	1	3	4	10	5.73	10	10	5	10	9.56
Shale	6	5	6	7	6.30	10	5	8	10	7.90
Opticful	3	2	6	6	4.83	10	10	8	6	9.26
basicPharm	4	2	2	5	3.72	10	10	9	10	9.91
PharmyLeaf	5	6	8	8	7.07	10	10	7	8	9.45

Supplier Name	On Time Delivery (S-OTD)	Single Source	IP Protection	Data security	Operational Score	Exchange Rate Volatility Indicator	Monthly Minimum Wage ($)	Pandemic Reproduction Rate (Rt)	Purchasing Power Index	Geographical Score
Weights:	***0.46***	***0.14***	***0.14***	***0.26***	***25%***	***0.26***	***0.14***	***0.46***	***0.14***	***25%***
Plaxian	9	5	10	9	8.58	7	3	6	3	5.42
GutesGlas	7	10	10	8	8.11	10	1	4	5	5.29
Boavidro	2	10	10	8	5.83	2	9	7	9	6.25
Saanch	9	10	10	9	9.28	5	10	9	8	7.95
RealGlass	6	5	5	10	6.77	8	8	5	7	6.49
Optikiet	8	5	5	7	6.89	8	8	5	7	6.49
BestOGlass	5	5	10	10	7.02	7	3	6	3	5.42
MedicMetric	10	5	5	7	7.80	4	9	10	10	8.28
Shale	7	10	10	8	8.11	6	6	8	5	6.77
Opticful	9	10	10	5	8.23	10	5	2	7	5.23
basicPharm	8	5	5	7	6.89	7	3	6	3	5.42
PharmyLeaf	5	10	10	8	7.20	5	10	9	8	7.95

Supplier Scorecard

Individual weights of each KPI has been calculated using the Analytic Hierarchy Process (AHP)

Each supplier has been scored on a scale of 10:
10 – Most Favourable
1 – Least Favourable

Composite Score is calculated using 25% weightage of each of the risk domains shown

An Exclusivity Score of +1 has been granted to every geographically essential supplier

A rating has been assigned to every supplier using the traditional notation

Ratings and Mitigation Strategies

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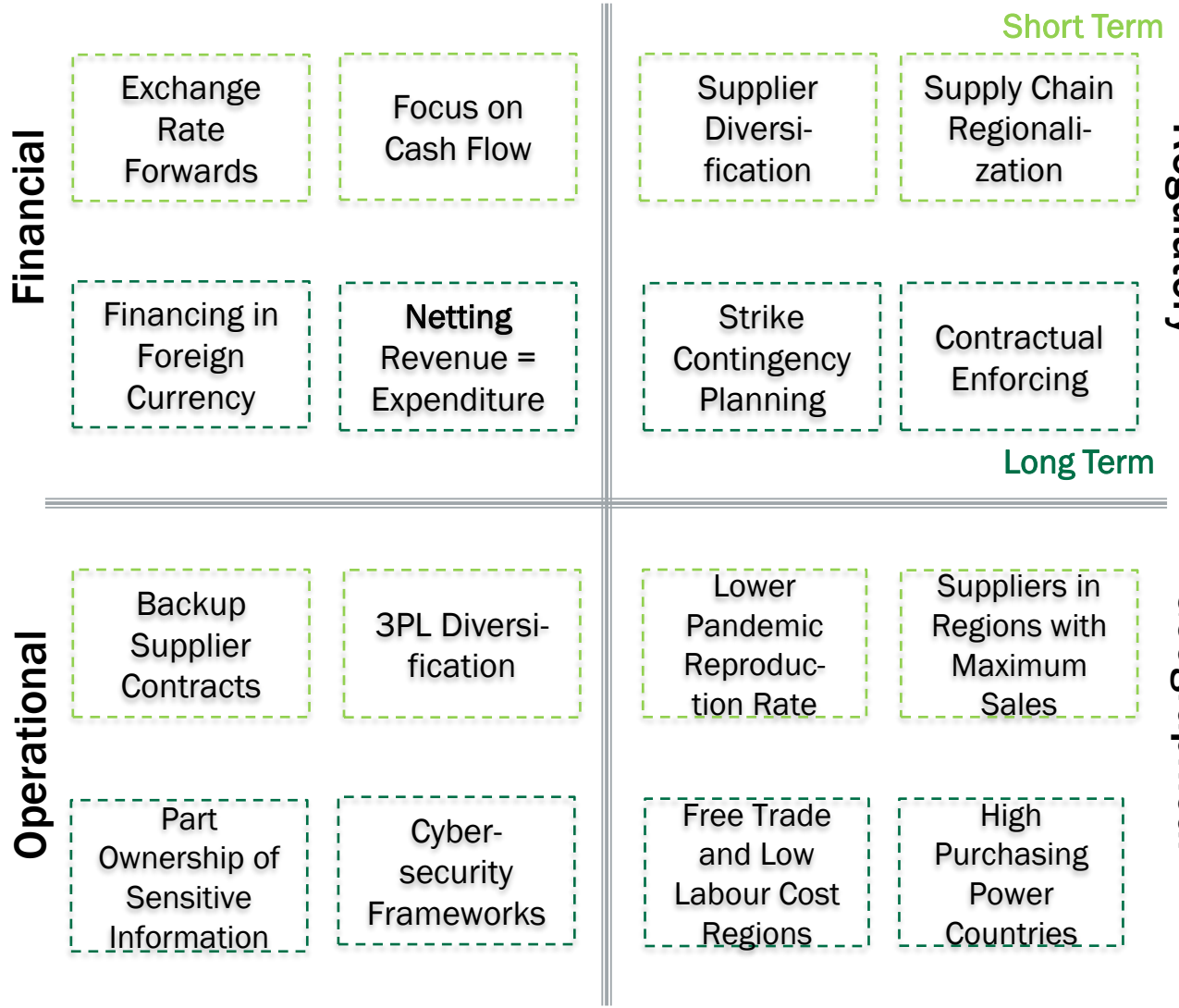
Supplier	Composite Weight	Exclusivity Score	Final Score	Rating
Saanch	8.42	+1	9.42	AAA
MedicMetric	7.85	+1	8.85	AA
GutesGlas	7.52	+1	8.52	AA
Plaxian	7.05	+1	8.05	A
PharmyLeaf	7.92	-	7.92	BBB
Boavidro	6.79	+1	7.79	BBB
RealGlass	6.73	+1	7.73	BBB
Shale	7.27	-	7.27	BB
Optikiet	6.91	-	6.91	CCC
Opticful	6.89	-	6.89	CCC
BestOGlass	6.88	-	6.88	CCC
basicPharm	6.49	-	6.49	CC

Sourcing Portfolio Backup Suppliers Riskiest Supplier



Obsolete Inventory at GlasWork

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Formulae used for derivation :

- Obsolete Inventory of an SKU =
  $$Initial\ Inventory - Standard\ Price * Yearly\ Demand$$
- Yearly Demand = $APU(1 + trend_{APU}) * 12$
- Initial Inventory = $On - hand\ Stock$
- Safety Stock = $Z_\alpha \sqrt{(\mu_L \sigma_D^2 + \mu_D^2\ \sigma_L^2)}$

$\mu_D = Daily\ Demand$
$\mu_L = Lead\ Time * S - OTD$
$\sigma_D = COV_D * \mu_D$
$Z_\alpha = 1.645$

Both Demand and Delivery Lead Time are assumed to be normally distributed

Defined KPI

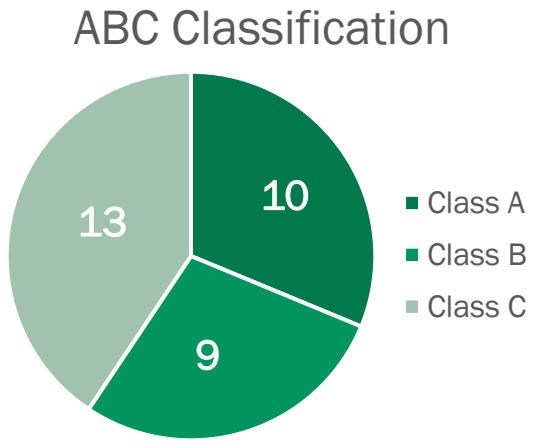
$$\frac{Obsolete\ Inventory}{Safety\ Stock}$$

117.36 %

$$\#obsolete\ SKUs$$

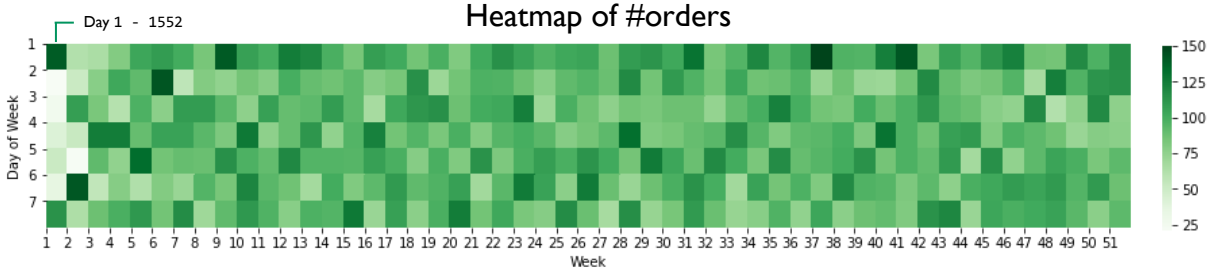
32

Class	Condition
A	10 > KPI
B	100 > KPI ≥ 10
C	KPI ≥ 100



Unaccounted parameters for Cost Reduction

On average 94 SKUs are placed on order for replenishment daily



1. **Order Aggregation** because of lacking data in terms of Coordinated Transportation for delivering multiple SKUs
   - For SKUs sourced from single supplier :
     - Constraint for Lot Sizes to maintain Full Truck Load
     - Managing Joint Economic Lot Sizes for profitability
   - For aggregating order arrivals from multiple suppliers :
     - Information systems to organize dispatches based on lead times

2. **Economic Order Quantity** due to absence of data on
   - Holding Cost
   - Ordering Fixed Cost
   - Supplier Discounting Schedule

Potential **32** obsolete SKUs result to a Total Obsolete Inventory of **$ 50,140.797**

Working Capital Impact at GlasWork

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Observed SCM Metrics

Gross Inventory Ordered	=	$ 921,037,718.242
Total Stockout Loss	=	$ 50,272,666.496
Overall Demand	=	$ 848,623,825.109

97.696%
Average Service Level

Max. acquirable Overall Service Level = $100\left(1 - \frac{Stockout\ Loss}{Demand}\right)$ = 94.076 %

$46,008,199.786	$80,738,869.44	$118,422,092.919
Initial Inventory	**Final Inventory**	**Final On order Inventory**

Inventory Management Schema for SKUs

$Inventory_t = Inventory_{t-1} - Demand + Arrival$

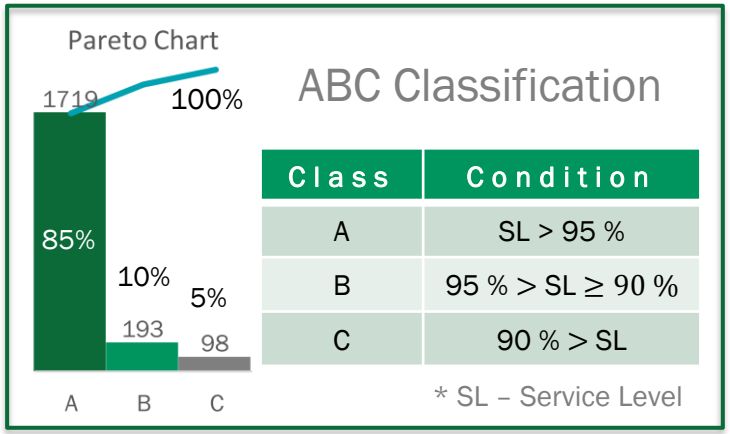
Make 0 | If negative → *Add to Stockout Loss*

IF $Inventory_t \leq Reorder\ Quantity$

$Arrival\ after\ Lead\ Time = Order\ Quantity$

Do not further order *till Lead Time*

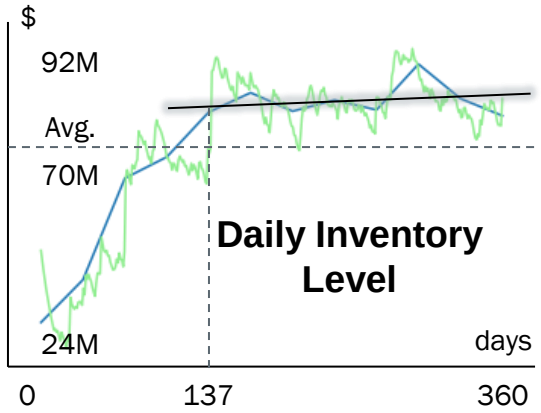
For all 360 days



ABC Classification

Class	Condition
A	SL > 95 %
B	95 % > SL ≥ 90 %
C	90 % > SL

* SL – Service Level



Formulae used for calculation :

- Change in Inventory Position = $Final\ Inventory - Initial\ Inventory + Final\ On\ order\ Inventory$
- Final On order Inventory = $Gross\ Inventory\ Ordered - (Overall\ Demand - Initial\ Inventory)$
- Reorder Quantity = $Expected\ Lead\ Time\ Demand + Safety\ Stock$
- Order Quantity = $Lead\ Time\ Demand + Safety\ Stock$
- Daily Demand = $\frac{APU}{30}(1 + trend_{APU})$

Value of **Assets** under **Inventory** shall increase by **$ 153,152,762.573**

Capacity Management at Fabricadas, Chicago

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$$Corrected\ Demand\ Forecast = Demand\ Forecast + Average\ \#Rejected\ Lots$$

Table 1

Demand Projections	Q3 2020 (actual)	Q4 2020	Q1 2021	Q2 2021
Ampoules	28	68	73	78
Vials	20	35	45	50
Syringes	24	49	54	59

Approximating Capacity Requirement

Table 2

Product	Tubing	Forming	Washing	Packing
Ampoules	T2	F1	[W2] [W4]	[P5,P6] [P5]
Q3 2020	168	336	504	672
Q4 2020	408	816	1224	1632
Q1 2021	438	876	1314	1752
Q2 2021	468	936	1404	1872
Vials	T2	F2	[W2] [W4]	[P1,P2] [P6]
Q3 2020	180	180	420	480
Q4 2020	315	315	735	840
Q1 2021	405	405	945	1080
Q2 2021	450	450	1050	1200
Syringe	T1	F2	[W1] [W3]	[P2,P4] [P3]
Q3 2020	144	216	432	576
Q4 2020	294	441	882	1176
Q1 2021	324	486	972	1296
Q2 2021	354	531	1062	1416

Estimating maximum lots of each product in a quarter

The most lenient upper bound on the number of units of each product that can be produced in a Quarter (2160 hours) can be obtained by assuming the following :

- **Whole facility is utilized for only 1 product**; no waiting time

This can be formulated as –

$$Maximize\ \boldsymbol{n}$$

$$Subject\ to:$$

$$\boldsymbol{n}T + \boldsymbol{n}F + \max\left(xW + \max\left(yP, (x - yP)\right), (\boldsymbol{n} - x)(W + P)\right) \leq 2160$$

$$x \leq n$$

$$y \leq x$$

$$x, y, n \rightarrow Positive\ Integers$$

$$Where:$$

$n \rightarrow$ total number of lots produced in a quarter

$x, y \rightarrow$ partition of total lots between parallel units of Washing and Packing

$T, F, W, P \rightarrow$ processing times of a unit at Turning, Forming, Washing and Packing stations respectively

Read Table 2 as :
Number of hours of Turning that Vials have to undergo in Q3 2020 :

= Corrected Demand for vials in Q3_2020 x turning time per unit of vial
= 20 x 9 → 180 hours

Possible Reasons for Capacity Constraint

1. Insufficient Resource/ Processing time at each unit
2. Finite Scheduling Constraint

Maximum Production Units — Table 3

Product	Maximum in any Quarter
Ampoules	60
Vials	57
Syringe	65

Capacity Constraints : Decision Tree Approach

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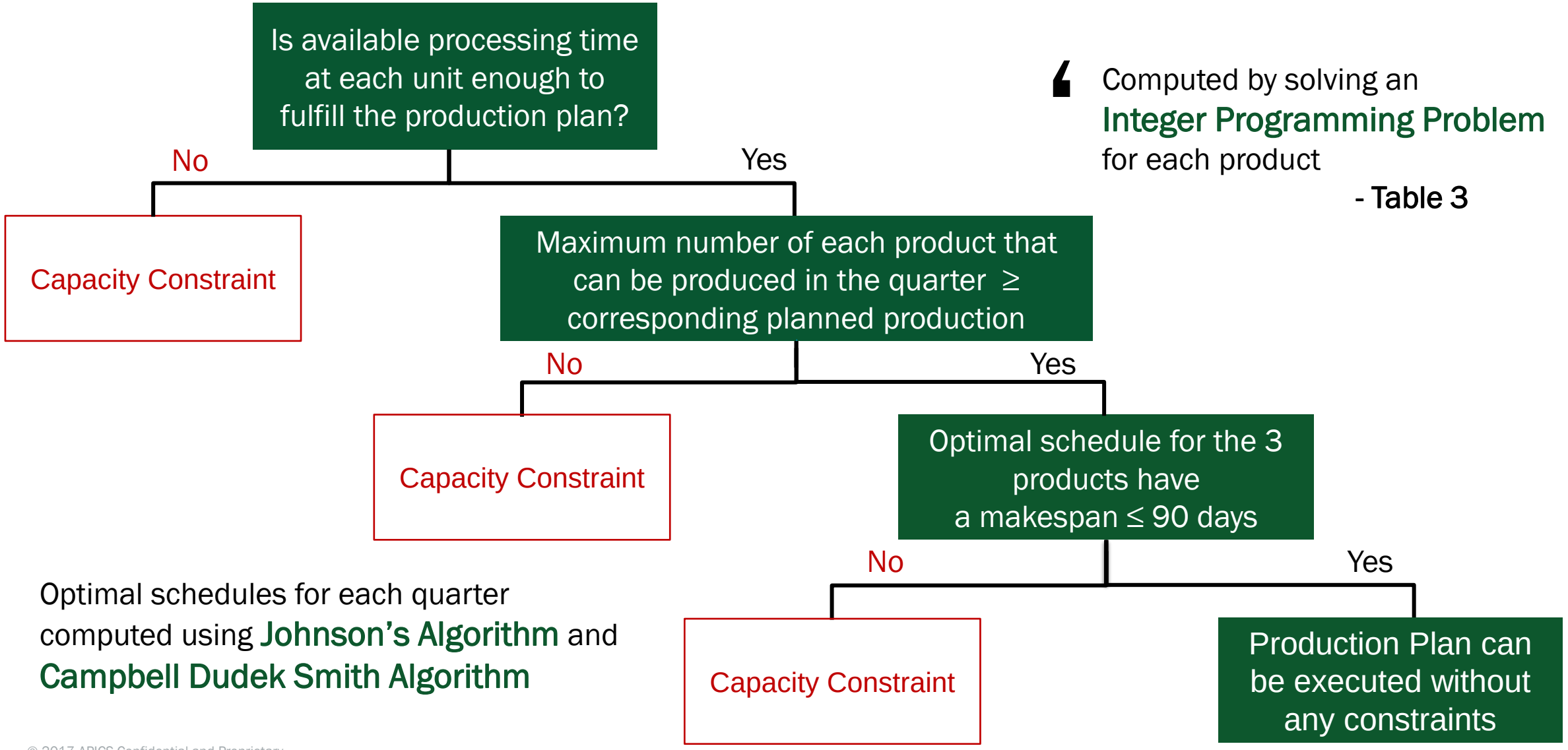

- Computed by solving an **Integer Programming Problem** for each product
  - **Table 3**

- Optimal schedules for each quarter computed using **Johnson's Algorithm** and **Campbell Dudek Smith Algorithm**

Justification for Differing Viewpoints

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Plant Controller, Fabricadas

- Plans a **CHASE DEMAND STRATEGY** for production in the upcoming quarters which attempts to **match output with fluctuating demand**
- Constraints observed:
  - Demand for ampoules exceeds maximum production limit in Q4 2020, Q1 2021 & Q2 2021
  - No optimal schedule fulfils demands of vials & syringes together in Q2 2021

Products	Q3 2020	Q4 2020	Q1 2021	Q2 2021
Ampoules	Yes	No	No	No
Vials	Yes	Yes	Yes	Yes (No)
Syringes	Yes	Yes	Yes	No (Yes)

VP Operations, MediCrystals Co.

- Plans a **LEVEL CAPACITY STRATEGY** for production where maximum possible units of each product is produced in a quarter and this **output stays constant irrespective of the demand**
- May increase inventory ⟶ justified as probability of overstocking is very low given almost guaranteed surge in demand for the glass products when COVID-19 vaccine is out in the market
- Can overcome the constraints that the Plant Controller is seeing
- Avoids costs incurred by the ineffective use of capacity at periods of low demand, by the need to recruit or lay off staff, by learning-curve effects, and by a possible loss of quality.

Recommendations

Short term ⟵ ⟶ Long term

Short term			Long term		
Avoid excessive stress on the production capacity during demand peaks	Expand Overall Worktime	Ampoules and Vials share common Washer Stations; Former has higher demand	Reduce the time duration of maintenance shutdowns	Relax capacity pressure on Washer units	Reduce the 35% observed rejection
Level capacity strategy is the best strategy in this problem	Operate weekend shifts to increase the capacity	Shut down the vial line when its demand is fulfilled to expand ampoules output	Integrate a robust ERP system to increase responsiveness & reduce maintenance time	Recruit more labor force to enable parallel functioning of units of the same process	Improve quality control strategies to reduce net rejected lots of each product

Conclusion

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Supplier Risk Management

Seven essential suppliers have been recommended based on AHP Risk Assessment

basicPharm is the riskiest supplier owing to inefficiency in **financial, operational and geographical** risk domains

→ Recommendations

- Devise a forward contracts portfolio to ensure zero downside due to foreign currency risk exposure
- Supplier diversification & regionalization
- 3PL diversification between air, ocean and ground is essential for mobility

Inventory Management

$ 50,140.797

Total Obsolete Inventory

From 32 obsolete SKUs

$ 153,152,762.573

Working Capital Impact

Increase of Assets under Inventory

→ Recommendations

- For SL Class C (service level < 90%), $average\ Lead\ Time = 78\ days$
  - To increase overall SL, source these 98 SKUs from local suppliers
- To create positive Working Capital Impact, increase Inventory Turnover Ratio

Capacity Management

There exists a capacity constraint when Chase Demand Strategy is adopted

Level Capacity Production Plan **maximizes the capacity** utilization

→ Recommendations

- Expand available processing time
  - Weekend shifts
  - Methods to reduce maintenance time
  - Identify reasons for unplanned shutdown
- Enable parallel functioning of process units
- Better quality control measures