Chapter 9

Sales and Operations Planning: Planning Supply and Demand in a Supply Chain

Learning Objectives

- Manage supply to improve synchronization in a supply chain in the face of predictable variability.
- Manage demand to improve synchronization in a supply chain in the face of predictable variability.
- Use sales and operations planning to maximize profitability when faced with predictable variability in a supply chain.

Responding to Predictable Variability in a Supply Chain

- Predictable variability is change in demand that can be forecasted
- Can cause increased costs and decreased responsiveness in the supply chain
- Two broad approaches
 - Manage supply using capacity, inventory, subcontracting, and backlogs
 - Manage demand using short-term price discounts and trade promotions

Managing Supply

- Managing capacity
 - Time flexibility from workforce
 - Use of seasonal workforce
 - Use of subcontracting
 - Use of dual facilities specialized and flexible
 - Designing product flexibility into production processes
- Managing inventory
 - Using common components across multiple products
 - Build inventory of high demand or predictable demand products

Inventory/Capacity Trade-off

- Leveling capacity forces inventory to build up in anticipation of seasonal variation in demand
- Carrying low levels of inventory requires capacity to vary with seasonal variation in demand or enough capacity to cover peak demand during season

Managing Demand

Promotion at Red Tomato and Green Thumb

Item	Cost
Material cost	\$10/unit
Inventory holding cost	\$2/unit/month
Marginal cost of stockout/backlog	\$5/unit/month
Hiring and training costs	\$300/worker
Layoff cost	\$500/worker
Labor hours required	4/unit
Regular time cost	\$4/hour
Overtime cost	\$6/hour
Cost of subcontracting	\$30/unit

Table 9-1

Managing Demand

A	Α	В	С	D	E	F	G	Н	1	J	K
1	1 Aggregate Plan Decision Variables										
2		Ht	Lt	Wt	Ot	lt	St	Ct	Pt		
3	Period	# Hired	# Laid off	# Workforce	Overtime	Inventory	Stockout	Subcontract	Production	Demand	Price
4	0	0	0	80	0	1,000	0	0			
5	1	0	15	65	0	1,983	0	0	2,583	1,600	40
6	2	0	0	65	0	1,567	0	0	2,583	3,000	40
7	3	0	0	65	0	950	0	0	2,583	3,200	40
8	4	0	0	65	0	0	267	0	2,583	3,800	40
9	5	0	0	65	0	117	0	0	2,583	2,200	40
10	6	0	0	65	0	500	0	0	2,583	2,200	40
22	2 Total Cost = \$422,275								S		
23				#.12 :-		Base Price)	\$ 40	ľ		
24	4 Total Revenue =		\$640,000	Promote? (0/1	0	Consumpt	ion	0.10			
25	Profit =		\$217,725	Month (1/4)	1	Forward b	uy	0.20			

Figure 9-1

Managing Demand

Total cost over planning horizon = \$422,275

Revenue over planning horizon = \$640,000

Profit over planning horizon = \$217,725

Average seasonal inventory
$$= \frac{(I_0 + I_6)/2 + \left(\mathring{a}_{t=1}^5 I_t \right)}{T} = \frac{5,367}{6} = 895$$

Average flow time =
$$\frac{\text{average inventory}}{\text{average sales}} = \frac{895}{2,667} = 0.34 \text{ months}$$

The Timing of a Promotion

- Impact of the promotion on demand
- Cost of holding inventory
- Cost of changing the level of capacity
- Product margins
- Increase in demand from
 - Market growth
 - Stealing share
 - Forward buying

When to Promote

- Is it more effective to promote during the peak period of offpeak?
- Analyze the impact of a promotion on demand and the resulting optimal aggregate plan

Promotion in January

1	Α	В	С	D	E	F	G	Н	1	J	K
1	Aggregate	Plan De	cision Varia	ables					7.	20	
2		Ht	Lt	Wt	Ot	lt	St	Ct	Pt		
3	Period	# Hired	# Laid off	# Workforce	Overtime	Inventory	Stockout	Subcontract	Production	Demand	Price
4	0	0	0	80	0	1,000	0	0		Į.	
5	1	0	15	65	0	610	0	0	2,610	3,000	39
6	2	0	0	65	0	820	0	0	2,610	2,400	40
7	3	0	0	65	0	870	0	0	2,610	2,560	40
8	4	0	0	65	0	0	320	0	2,610	3,800	40
9	5	0	0	65	0	90	0	0	2,610	2,200	40
10	6	0	0	65	0	500	0	0	2,610	2,200	40
22	2 Total Cost = \$421,915									= 10	
23				4.7		Base Price	•	\$ 40	ľ		
24	The second secon		\$643,400	Promote? (0/1	1	Consumpt	ion	0.10			
25	5 Profit =			Month (1/4)		Forward b		0.20			

Figure 9-2

Promotion in January

Total cost over planning horizon = \$421,915

Revenue over planning horizon = \$643,400

Profit over planning horizon = \$221,485

- Lower seasonal inventory
- A somewhat lower total cost
- A higher total profit

Promotion in April

A	Α	В	С	D	E	F	G	Н	I	J	K
1	Aggregate	Plan De	cision Varia	ables	50		271				
2		Ht	Lt	Wt	Ot	lt	St	Ct	Pt		
3	Period	# Hired	# Laid off	# Workforce	Overtime	Inventory	Stockout	Subcontract	Production	Demand	Price
4	0	0	0	80	0	1,000	0	0			
5	1	0	14	66	0	2,047	0	0	2,647	1,600	40
6	2	0	0	66	0	1,693	0	0	2,647	3,000	40
7	3	0	0	66	0	1,140	0	0	2,647	3,200	40
8	4	0	0	66	0	0	1,273	0	2,647	5,060	39
9	5	0	0	66	0	0	387	0	2,647	1,760	40
10	6	0	0	66	0	500	0	0	2,647	1,760	40
22	2 Total Cost = \$438,857										
23				40 50		Base Price	(a)	\$ 40	ľ		
24			\$650,140	Promote? (0/1	1	Consumpt	ion	0.10			
25	Profit =		[- [- [- [- [- [- [- [- [- [-	Month (1/4)		Forward b		0.20			

Figure 9-3

Promotion in April

Total cost over planning horizon = \$438,857

Revenue over planning horizon = \$650,140

Profit over planning horizon = \$211,283

- Higher seasonal inventory
- A somewhat higher total cost
- A slightly smaller total profit

Promotion in January

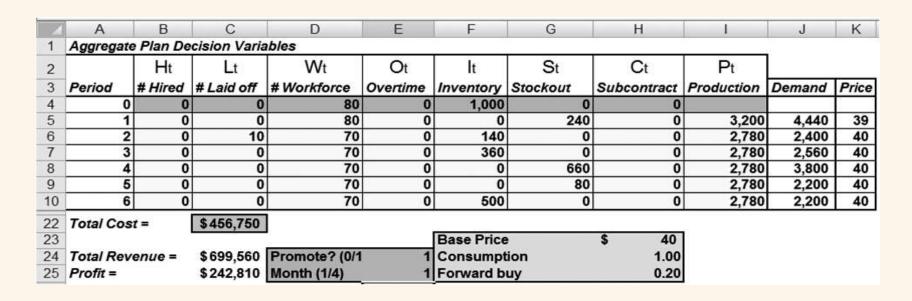


Figure 9-4

Total cost over planning horizon = \$456,750

Revenue over planning horizon = \$699,560

Profit over planning horizon = \$242,810

Higher total profit than base case

Promotion in April

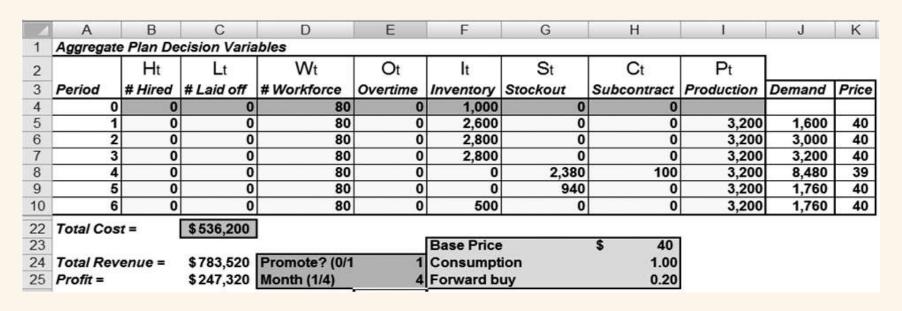


Figure 9-5

Total cost over planning horizon = \$536,200

Revenue over planning horizon = \$783,520

Profit over planning horizon = \$247,320

- Much higher level of seasonal inventory
- Uses more stockouts and subcontracting
- Revenues increase
- Overall profits higher

Supply Chain Performance

Regular Price	Promotion Price	Promotion Period	Percentage of Increase in Demand	Percentage of Forward Buying	Profit	Average Inventory
\$40	\$40	NA	NA	NA	\$217,725	895
\$40	\$39	January	10%	20%	\$221,485	523
\$40	\$39	April	10%	20%	\$211,283	938
\$40	\$39	January	100%	20%	\$242,810	208
\$40	\$39	April	100%	20%	\$247,320	1,492
\$31	\$31	NA	NA	NA	\$ 73,725	895
\$31	\$30	January	100%	20%	\$ 84,410	208
\$31	\$30	April	100%	20%	\$ 69,120	1,492

Table 9-2

Impact on Promotion Timing

Factor	Impact on Timing of Promotion/Forward Buy
High forward buying	Favors promotion during low-demand periods
High ability to steal market share	Favors promotion during peak-demand periods
High ability to increase overall market	Favors promotion during peak-demand periods
High margin	Favors promotion during peak-demand periods
Low margin	Favors promotion during low-demand periods
High manufacturer holding costs	Favors promotion during low-demand periods
High costs of changing capacity	Favors promotion during low-demand periods
High retailer holding costs	Decreases forward buying by retailer
High promotion elasticity of consumer	Decreases forward buying by retailer

Table 9-3

Conclusions on Promotion

- Average inventory increases if a promotion is run during the peak period and decreases if the promotion is run during the off-peak period
- Promoting during a peak-demand month may decrease overall profitability if there is a small increase in consumption and a significant fraction of the demand increase results from a forward buy

Conclusions on Promotion

- As consumption increase from discounting grows and forward buying becomes a smaller fraction of the demand increase from a promotion, it is more profitable to promote during the peak period
- As the product margin declines, promoting during the peakdemand period becomes less profitable

Implementing Sales and Operations Planning in Practice

- Coordinate planning across enterprises in the supply chain
- Take predictable variability into account when making strategic decisions
- Design S&OP to understand and manage the drivers of demand usage
- Ensure that the S&OP process modifies plans as the reality or forecasts change

Summary of Learning Objectives

- Manage supply to improve synchronization in a supply chain in the face of predictable variability
- Manage demand to improve synchronization in a supply chain in the face of predictable variability
- Use sales and operations planning to maximize profitability when faced with predictable variability in a supply chain