"OPERATION RESEARCH PROJECT"

CASE STUDY 4.1

"FABRICS & FALL FASHION"

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CASE 4.1 Fabrics and Fall Fashions

From the tenth floor of her office building, Katherine Rally watches the swarms of New Yorkers fight their way through the streets infested with yellow cabs and the sidewalks lit- tered with hot dog stands. On this sweltering July day, she pays particular attention to the fashions worn by the various women and wonders what they will choose to wear in the fall. Her thoughts are not simply random musings; they are critical to her work since she owns and manages Trend Lines, an elite women's clothing company. Today is an especially important day because she must meet with Ted Lawson, the production manager, to decide upon next month's production plan for the fall line. Specifically, she must determine the quantity of each clothing item she should produce given the plant's production capacity, limited resources, and demand forecasts. Accurate planning for next month's production is critical to fall sales since the items produced next month will appear in stores during September, and women generally buy the majority of the fall fashions when they first appear in September. She turns back to her sprawling glass desk and looks at the numerous papers covering it. Her eyes roam across the clothing patterns designed almost six months ago, the lists of materials requirements for each pattern, and the lists of demand forecasts for each pattern determined by customer surveys at fashion shows. She remembers the hectic and sometimes nightmarish days of designing the fall line and presenting it at fashion shows in New York, Milan, and Paris. Ultimately, she paid her team of six designers a total of $860,000 for their work on her fall line. With the cost of hir-ing runway models, hair stylists, and makeup artists, sewing and fitting clothes, building the set, choreographing and rehearsing the show, and renting the conference hall, each of the three fashion shows cost her an additional $2,700,000. She studies the clothing patterns and material require-ments. Her fall line consists of both professional and casual fashions. She determined the prices for each clothing item by taking into account the quality and cost of material, the cost of labor and machining, the demand for the item, and the prestige of the TrendLines brand name. The fall professional fashions include:

Clothing Item	Materials Requirements	Price	Labor and Machine Cost
Tailored wool slacks	3 yards of wool 2 yards of acetate for lining	$300	$160
Cashmere sweater	1.5 yards of cashmere	$450	$150
Silk blouse	1.5 yards of silk	$180	$100
Silk camisole	0.5 yard of silk	$120	$ 60
Tailored skirt	2 yards of rayon 1.5 yards of acetate for lining	$270	$120
Wool blazer	2.5 yards of wool 1.5 yards of acetate for lining	$320	$140

The fall casual fashions include:

Clothing Item	Materials Requirements	Price	Labor and Machine Cost
Velvet pants	3 yards of velvet 2 yards of acetate for lining	$350	$175
Cotton sweater	1.5 yards of cotton	$130	$ 60
Cotton miniskirt	0.5 yard of cotton	$ 75	$ 40
Velvet shirt	1.5 yards of velvet	$200	$160
Button-down blouse	1.5 yards of rayon	$120	$ 90

She knows that for the next month, she has ordered 45,000 yards of wool, 28,000 yards of acetate, 9,000 yards of cashmere, 18,000 yards of silk, 30,000 yards of rayon, 20,000 yards of velvet, and 30,000 yards of cotton for production. The prices of the materials are as follows:

Material	Price per yard
Wool	$ 9.00
Acetate	$ 1.50
Cashmere	$60.00
Silk	$13.00
Rayon	$ 2.25
Velvet	$12.00
Cotton	$ 2.50

Any material that is not used in production can be sent back to the textile wholesaler for a full refund, although scrap material cannot be sent back to the wholesaler. She knows that the production of both the silk blouse and cotton sweater leaves leftover scraps of material. Specifically, for the production of one silk blouse or one cotton sweater, 2 yards of silk and cotton, respectively, are needed. From these 2 yards, 1.5 yards are used for the silk blouse or the cotton sweater and 0.5 yard is left as scrap material. She does not want to waste the material, so she plans to use the rectangular scrap of silk or cotton to produce a silk camisole or cotton miniskirt, respectively. Therefore, whenever a silk blouse is produced, a silk camisole is also produced. Likewise, whenever a cotton sweater is produced, a cotton miniskirt is also produced. Note that it is possible to produce a silk camisole without producing a silk blouse and a cotton miniskirt without producing a cotton sweater. The demand forecasts indicate that some items have limited demand. Specifically, because the velvet pants and velvet shirts are fashion fads, Trend Lines has forecasted that it can sell only 5,500 pairs of velvet pants and 6,000 velvet shirts. Trend Lines does not want to produce more than the forecasted demand because once the pants and shirts go out of style, the company cannot sell them. Trend Lines can produce less than the forecasted demand, however, since the company is not required to meet the demand. The cashmere sweater also has limited demand because it is quite expensive, and Trend Lines knows it can sell at most 4,000 cashmere sweaters. The silk blouses and camisoles have limited demand because many women think silk is too hard to care for, and Trend Lines projects that it can sell at most 12,000 silk blouses and 15,000 silk camisoles. The demand forecasts also indicate that the wool slacks, tailored skirts, and wool blazers have a great demand because they are basic items needed in every professional wardrobe. Specifically, the demand for wool slacks is 7,000 pairs of slacks, and the demand for wool blazers is 5,000 blazers. Katherine wants to meet at least 60 percent of the demand for these two items in order to maintain her loyal customer base and not lose business in the future. Although the demand for tailored skirts could not be estimated, Katherine feels she should make at least 2,800 of them.

a) Ted is trying to convince Katherine not to produce any velvet shirts since the demand for this fashion fad is quite low. He argues that this fashion fad alone accounts for $500,000 of the fixed design and other costs. The net contribution (price of clothing item materials cost labor cost) from selling the fashion fad should cover these fixed costs. Each velvet shirt generates a net contribution of $22. He argues that given the net contribution, even satisfying the maximum demand will not yield a profit. What do you think of Ted's argument?

It won't create a benefit to find the most elevated request. Then, at that point, the Ted's contention is fixed plan and design costs are sunk costs and subsequently ought not be considered when beginning assembling in July now. Since the velvet shirts have a helpful commitment to covering the indented costs, as indicated by the predetermined direct programming model they ought to be made or if nothing else respected for the relegated creation. Presently Ted raised these issues before any decent expenses were created, then, at that point, the suggestion against creating and delivering the shirts would have been precise. With a $22 commitment and a 6,000-unit interest, the most elevated expected benefit is just $132,000. This sum won't be adequate to straightforwardly credit the $500,000 in fixed expenses for this item.

b) Formulate and solve a linear programming problem to maximize profit given the production, resource, and demand constraints. Before she makes her final decision, Katherine plans to explore the following questions independently except where otherwise indicated.

		Wool Slacks	Cashmere Sweater	Silk blouse	Silk Camisole	Tailored Skirt	Wool blazer	velvet pants	cotton sweater	cotton miniskirt	velvet shirt	bottom down blowse
Price		300	450	180	120	270	320	350	130	75	200	120
L & M cost		160	150	100	60	120	140	175	60	40	160	90
Material cost		30	90	19.5	6.5	6.75	24.75		3.75	1.25		3.38
Net contribution		110	210	60.5	53.5	143.25	155.25	175	66.25	33.75	40	26.62

	Cost of Material	Material Requirements											Material used		Material available
Wool	9	3					2.5						25,100	<=	45,000
Acetate	1.5	2				1.5	1.5	2					28,000	<=	28,000
Cashmere	60		1.5										6000	<=	9000
Silk	13			1.5	0.5								18,000	<=	18,000
Rayon	2.25					2						1.5	30,000	<=	30,000
Velvet	12							3			1.5		19,998	<=	20,000
Cotton	2.5								1.5	0.5			30,000	<=	30,000

	Wool Slacks	Cashmere Sweater	Silk Blouse	Silk Camisole	Tailored Skirt	Wool blazer	Velvet pants	Cotton sweater	Cotton miniskirt	Velvet shirt	Bottom down blowse		Total Contribution
Item produced	4200	4000	7000	15,000	3178	5000	3666	0	60,000	6000	15,762		7,085,633
	<=	<=	<=	<=		<=	<=			<=		Fixed cost	8,960,000
Maximum production	7000	4000	12,000	15,000		5000	5500			6000		Velvet Sunk cost	240,000
	>=				>=	>=						Total Pofit	-2,114,367
Minimum production	4200				2800	3000		Also:					
	60%					60%	Silk camisole >= Silk blouse						
	of demand					of demand	otton miniskirt >= cotton sweater						

c) **The textile wholesaler informs Katherine that the velvet cannot be sent back because the demand forecasts show that the demand for velvet will decrease in the future. Katherine can therefore get no refund for the velvet. How does this fact change the production plan?**

		Wool Slacks	Cashmere Sweater	Silk blouse	Silk Camisole	Tailored Skirt	Wool blazer	velvet pants	cotton sweater	cotton miniskirt	velvet shirt	bottom down blowse
Price		300	450	180	120	270	320	350	130	75	200	120
L & M cost		160	150	100	60	120	140	175	60	40	160	90
Material cost		30	90	19.5	6.5	6.75	24.75		3.75	1.25		3.38
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	Cost of Material	Material Requirements											Material used		Material available
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Acetate	1.5	2				1.5	1.5	2					28,000	<=	28,000
Cashmere	60		1.5										6000	<=	9000
Silk	13			1.5	0.5								18,000	<=	18,000
Rayon	2.25					2						1.5	30,000	<=	30,000
Velvet	12							3			1.5		19,998	<=	20,000
Cotton	2.5								1.5	0.5			30,000	<=	30,000

	Wool Slacks	Cashmere Sweater	Silk Blouse	Silk Camisole	Tailored Skirt	Wool blazer	Velvet pants	Cotton sweater	Cotton miniskirt	Velvet shirt	Bottom down blowse			Total Contribution
Item produced	4200	4000	7000	15,000	3178	5000	3666	0	60,000	6000	15,762			7,085,633
	<=	<=	<=	<=		<=	<=			<=			Fixed cost	8,960,000
Maximum production	7000	4000	12,000	15,000		5000	5500			6000			Velvet Sunk cost	240,000
	>=				>=	>=							Total Pofit	-2,114,367
Minimum production	4200				2800	3000		Also:						
	60%					60%	Silk camisole >= Silk blouse							
	of demand					of demand	Cotton miniskirt >= cotton sweater							

d) **What is an intuitive economic explanation for the difference between the solutions found in parts (b) and (c)?**

When trendlines can't restore the velvet to the distributer the velvet's expense can't be recuperated as the worth measuring to the expense is as the upside (velvet) itself. This is presently no longer thought to be a variable expense yet sunk expense. This thusly builds the net commitment of velvet products making them more alluring for makers which could create income when being sold and contribute towards recuperating the decent expense. This permits the trendlines to now deliver 3666.67 velvet pants rather than none. In any case, these velvet jeans additionally call for acetic acid derivation in their creation. This influences the creation plan of different items/things consequently influencing the actual product. It is not efficient to utilize all the arranged velvet in the past part. Thus, there is no question that misfortune to some degree c is more prominent when contrasted with the misfortune to some degree b.

(E) The sewing staff encounters difficulties sewing the arms and the lining into the wool blazers since the blazer pattern has an awkward shape and the heavy wool material is

difficult to cut and sew. The increased labor time to sew a wool blazer increases the labor and machine cost for each blazer by $80. Given this new cost, how much of each clothing item should Trendlines produce to maximize profit?

	Wool Slacks	Cashmere Sweater	Silk blouse	Silk Camisole	Tailored Skirt	Wool blazer	velvet pants	cotton sweater	cotton miniskirt	velvet shirt	bottom down blowse
Price	300	450	180	120	320	320	350	130	75	200	120
L & M cost	160	150	100	60	220	140	175	60	40	160	90
Material cost	30	90	19.5	6.5	6.75	24.75	39	3.75	1.25	18	3.38
Net contribution	110	210	60.5	53.5	143.25	75.25	136	66.25	33.75	22	26.63

	Cost of Materail	Material Requirements										Material used		Material available
Wool	9	3					2.5					25100	<=	45000
Acetate	1.5	2				15	1.5	2				28000	<=	28000
Cashmere	60		1.5									6000	<=	9000
Silk	13			1.5	0.5							18000	<=	18000
Rayon	2.25					2					1.5	30000	<=	30000
Velvet	12							3			1.5	9000	<=	20000
Cotton	2.5								1.5	0.5		30000	<=	30000

	Wool Slacks	Cashmere Sweater	Silk Blouse	Silk Camisole	Tailored Skirt	Wool blazer	Velvet pants	Cotton sweater	Cotton miniskirt	Velvet shirt	Bottom down blowse		Total Contribution
Item produced	4200	4000	7000	15000	8066.67	3000	0	0	60000	6000	6577.78		6527933
	<=	<=	<=	<=		<=	<=			<=		Fixed cost	8960000
Maximum production	7000	4000	12000	15000		5000	5500			6000		Total profit	-2,432,067
	>=				>=	>=							
Minimum production	4200				2800	3000		Also:					
	60%					60%		Silk camisole >= Silk blouse					
	of demand					of demand		Cotton miniskirt >= cotton sweater					

(F) The textile wholesaler informs Katherine that since another textile customer cancelled his order, she can obtain an extra 10,000 yards of acetate. How much of each clothing item should Trendlines now produce to maximize profit?

	Wool Slacks	Cashmere Sweater	Silk blouse	Silk Camisole	Tailored Skirt	Wool blazer	velvet pants	cotton sweater	cotton miniskirt	velvet shirt	bottom down blowse
Price	300	450	180	120	320	320	350	130	75	200	120
L & M cost	160	150	100	60	220	140	175	60	40	160	90
Material cost	30	90	19.5	6.5	6.75	24.75	39	3.75	1.25	18	3.38
Net contribution	110	210	60.5	53.5	143.25	75.25	136	66.25	33.75	22	26.63

	Cost of Materail	Material Requirements										Material used		Material available
Wool	9	3					2.5					25100	<=	45000
Acetate	1.5	2				15	1.5	2				28000	<=	28000
Cashmere	60		1.5									6000	<=	9000
Silk	13			1.5	0.5							18000	<=	18000
Rayon	2.25					2					1.5	30000	<=	30000
Velvet	12							3			1.5	9000	<=	20000
Cotton	2.5								1.5	0.5		30000	<=	30000

	Wool Slacks	Cashmere Sweater	Silk Blouse	Silk Camisole	Tailored Skirt	Wool blazer	Velvet pants	Cotton sweater	Cotton miniskirt	Velvet shirt	Bottom down blowse		Total Contribution
Item produced	4200	4000	7000	15000	14733.3	5000	0	0	60000	6000	355.556		7,581,267
	<=	<=	<=	<=		<=	<=			<=		Fixed cost	8960000
Maximum production	7000	4000	12000	15000		5000	5500			6000		Total prof	-1378,7332
	>=				>=	>=							
Minimum production	4200				2800	3000		Also:					
	60%					60%		Silk camisole >= Silk blouse					
	of demand					of demand		Cotton miniskirt >= cotton sweater					

(G) Trendlines assumes that it can sell every item that was not sold during September and October in a big sale in November at 60 percent of the original price. Therefore, it can sell all items in unlimited quantity during the November sale. (The previously mentioned upper limits on demand concern only the sales during September and October) what should the new production plan be to maximize profit?

	Wool Slacks	Cashmere Sweater	Silk blouse	Silk Camisole	Tailored Skirt	Wool blazer	velvet pants	cotton sweater	cotton miniskirt	velvet shirt	bottom down blowse
Price	300	450	180	120	270	320	350	130	75	200	120
L & M cost	160	150	100	60	120	140	175	60	40	160	90
Material cost	30	90	19.5	6.5	6.75	24.75	39	3.75	1.25	18	3.38
Net contribution	110	210	60.5	53.5	143.25	155.25	136	66.25	33.75	22	26.63
Nov discount	40%										
Price(Nov)	180	270	108	72	162	192	210	78	45	120	72
Net contribution	-10	30	-11.5	5.5	35.25	27.25	-4	14.25	3..75	-58	-21.375

	Cost of Materail	Material Requirements										Material used		Material available
Wool	9	3				2.5						25100	<=	45000
Acetate	1.5	2			15	1.5	2					28000	<=	28000
Cashmere	60		1.5									6000	<=	9000
Silk	13			1.5	0.5							18000	<=	18000
Rayon	2.25				2						1.5	30000	<=	30000
Velvet	12						3			1.5		9000	<=	20000
Cotton	2.5							1.5	0.5			30000	<=	30000

	Wool Slacks	Cashmere Sweater	Silk Blouse	Silk Camisole	Tailored Skirt	Wool blazer	Velvet pants	Cotton sweater	Cotton miniskirt	Velvet shirt	Bottom down blowse		Total Contribution
Set Oct sales	4200	4000	7000	15000	8066.67	5000	0	0	60000	6000	9244.44		6,922,933
	<=	<=	<=	<=		<=	<=			<=		Fixed cost	8,960,000
Demand forcast	7000	4000	12000	15000		5000	5500			6000		Total profit	-2,037,067
Nov sales	0	2000	0	0	0	0	0	0		0	0		
Total sales	4200	60000	7000	15000	8066.67	5000	0	0	60000	6000	9244.44		
Minimum production	4200				2800	3000		Also:					
	60%					60%		Silk camisole >= Silk blouse					
	of demand					of demand		Cotton miniskirt >= cotton sweater					