Final Case Studies

Chapter 9 CP 1 and Chapter 14 CP 1

by

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**Abstract**

The first case is about an advertising campaign being planned by the Flamingo Grill in Florida. They want the best mix of television, radio, and online ads that will optimize their exposure rating while abiding by the constraints they provide. Each constraint is discussed and the Solver tool in Excel is used to calculate the results, with the process being thoroughly detailed. The optimal mix is 15 television ads, 33 radio ads, and 30 online ads, which is the primary solution for this case. The second case is about Wagner Fabricating Company, who is in a dilemma on whether to continue to purchase a part from a supplier or to manufacture the part themselves. In order to get to an EOQ from the supplier we used the how-much-to-order decision model. For the potential manufacturing prospect, we used the economic production lot size model. After reviewing the total annual costs each scenario, it is clear that Wagner Fabricating Company should choose to manufacture the product themselves.

**Final Case Studies**

**Case 1: Chapter 9 Case Problem 1**

**Solutions and recommendations.** The Flamingo Grill in Florida is planning an advertising campaign. The company has requested the maximization of exposure ratings from advertisements, along with providing a budget and constraints for this purpose. This case analysis will answer the first three questions presented in the managerial report. The first question asks for the budget allocation and number of ads for each medium, along with total exposure rating and total number of potential new customers. Based on the information provided, the analysis recommends 15 Television ads, 33 Radio ads, and 30 Online ads. The spending recommendations for each type are $150,000, $99,000, and $30,000, for television, radio, and online, respectively. The total exposure effectiveness rating is 2,160. The total number of potential new customers reached is 127,100.

Question two proposes an additional $10,000 for the overall advertising budget. The resulting exposure rating increases to 2,215 due to the purchase of an additional television ad. The third question asks for a discussion about the ranges for the objective function coefficients. The objective function coefficients are the number of each advertisement purchase, with each medium split according to the diminishing return values for exposure rating. The objective function is:

Maximize: 90T1 + 55T2 + 25R1 + 20R2 + 10N1 + 5N2

Where T1 = number of full benefit tv ads, T2 = number of declined benefit tv ads,

R1 = number of full benefit radio ads, R2 = number of declined benefit radio ads,

N1 = number of full benefit online ads, N2 = number of declined benefit online ads,

and each variable is multiplied by the exposure rating it provides per ad.

The solution is moderately sensitive to changes in the objective function coefficients. These are the numbers that are multiplied by each variable and they indicate exposure rating. Since the goal is to maximize the exposure rating, any major changes to these coefficients is likely to change the optimal solution. Changes to the television coefficients will affect the outcome due to the large size of these coefficients. Television ads are the most effective per ad, as long as they abide by their limited constraints. Changes to the T2 coefficient may have less of an affect due to a lower effectiveness rating and number of ads, which is 5 in the original optimal solution. Changes to the radio and online coefficients will also affect the optimal solution. Even though the values are smaller, these ads are purchased in larger quantities and so any changes will still influence the problem. In short, changes to the objective function coefficients will have a significant effect on the recommended solution.

**Completion and explanation.** The Flamingo Grill in Florida is planning an advertising campaign. The campaigns called for a mix of television, radio, and online advertisements with an overall budget of $279,000. The case is a linear programming problem with the goal of maximizing the exposure effectiveness rating of the advertising campaign. The analysis first determined the variables of the problem and then created the objective function to be maximized. Based on the narrative, the six variables are television advertisements, radio advertisements, online advertisements, exposure rating, new customers reached, and cost per ad. Additionally, the exposure rating and new customers reached per ad will decline after the first few ads in each medium. TV ads decline after 10 ads, radio ads decline after 15, and online ads decline after 20. The chart below presents the corresponding exposure ratings and new customers reached, with “full” denoting full benefit ads and “declined” denoting ads with declined benefit.



Therefore, the objective function to maximize exposure rating is:

Maximize: 90T1 + 55T2 + 25R1 + 20R2 + 10N1 + 5N2

Next, the ten constraints for the case study are shown and explained. The first four constraints shown are budget constraints. Constraint (1) is the overall budget which cannot exceed $279,000. Constraint (2) is the radio budget which cannot exceed $99,000. Constraint (3) is the TV budget which has a minimum of $140,000. Constraint (4) is the online budget which has a minimum of $30,000. These constraints are below:

***Constraint (1)***. Budget: $10,000(T1+T2) + $3,000(R1+R2) + $1,000(N1+N2) <= $279,000

***Constraint (2).*** Radio Budget: $3,000(R1 + R2) <= $99,000

***Constraint (3).*** TV Budget Min: $10,000(T1 + T2) >= $140,000

***Constraint (4).*** Online Budget Min: $1,000(N1 + N2) >= $30,000

The next three constraints are the breakpoints for declines in exposure rating and new customers reached. After an ad medium exceeds these numbers, it will decline in exposure rating and new customers reached per ad. Constraint (5) is the decline breakpoint for TV ads which is 10. Constraint (6) is the decline breakpoint for radio ads which is 15. Constraint (7) is the decline breakpoint for online ads which is 20.

***Constraint (5).*** TV ad breakpoint: T1 <= 10

***Constraint (6).*** Radio ad breakpoint: R1 <= 15

***Constraint (7).*** Online ad breakpoint: N1 <= 20

The last three constraints are provided by the narrative. Constraint (8) is the limit on TV ads which is 20. Constraint (9) is the required ratio for radio to television ads. The number of radio ads must be equal to or greater than twice the number of television ads. Constraint (10) is the required minimum for new customers reached which is 100,000.

***Constraint (8).*** TV ad limit: T1 + T2 <= 20

***Constraint (9).*** TV/Radio ratio: R1 + R2 >= 2(T1 + T2)

***Constraint (10).*** New customer min:

4,000(T1) + 1,500(T2) + 2,000(R1) + 1,200(R2) + 1,000(N1) + 800(N2) >= 100,000

This case analysis uses the Solver program in Excel to calculate the maximized exposure rating for question one. The SUMPRODUCT() function uses the following outlined areas to calculate the exposure rating:



The SUMPRODUCT() function used is below:



The given limits and minimums from the problem are below:

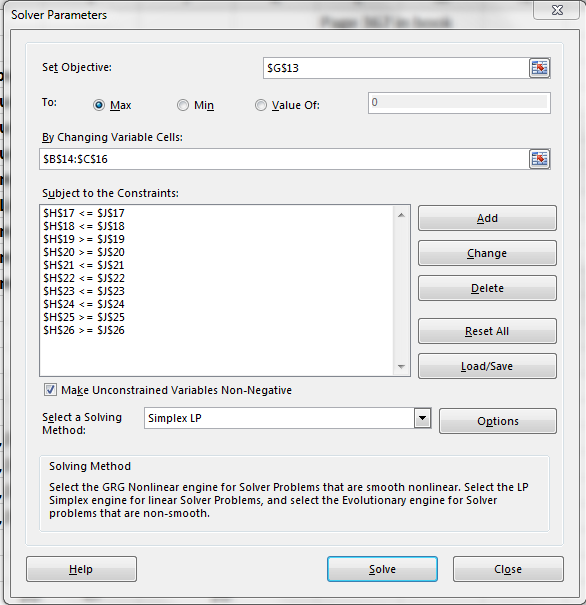


These numbers are referenced to create the constraints used in Solver. When the formulas reference something in the D column, that reference is to a summation of the relevant ad types. For example, D14 is the sum number of television ads from cells B14 and C14. References to column I are referring to the constraint limits and minimum that are above. These formulated constraints are below in both number and formula format:





Once all these are set up, Solver is used to calculate the maximized exposure rating in cell G13. The Solver set up will modify the number of advertisements in each medium, according to the ten constraints, in order to maximum the exposure rating formula. Below is the Solver set up used:



The Solver set up calculates the maximum exposure rating as 2,160 by using 15 television ads, 33 radio ads, and 30 online ads. This solution solves question one in the report. Question two adds $10,000 to the overall budget and requests a discussion of how the total exposure would change. Therefore, $10,000 is added to the “Total Budget Allowed” which brings the total budget to $289,000. The Excel Solver is rerun and results in a new exposure rating of 2,215. One additional television ad was purchased in this scenario, which coincidentally costs $10,000. The third question requests a discussion of the ranges for the objective function coefficients. This question is discussed in detail in the previous section titled “Solutions and recommendations” above.

**Other applications of models.** Linear programming is vastly useful in any business that wants to optimize something based on certain constraints. Since optimization is useful for maximizing production or profit, virtually all businesses can use linear programming to their advantage. One example is a sweets shop that is producing its own ice cream. It can use linear programming to optimize the product mix based on constraints and with the goal of minimizing cost. Another example is minimizing the cost of temporary workers in a manufacturing environment. Linear programming allows a company to take the employment costs along with its hours that need to be filled and find the right mix of hours and workers that minimizes cost. Linear programming is incredibly flexible for all businesses and has a place in practically any business that wants to optimize its quantitative choices.

**Biblical integration.** The Bible has a lot to say about proper decision making, which is also the end goal of linear programming. Proverbs 15:22 says “Without counsel plans fail, but with many advisers they succeed” (ESV). This advice applies to linear programming because we are wise to consult programming methods along with other people in order to make good decisions. If we go on our gut feeling, we will often make poor decisions and lose out in the end. This patience is shown in Romans 8:25, which says “But if we hope for what we do not see, we wait for it with patience” (ESV). As a method, linear programming can be time-consuming. Especially compared to a snap decision, these models and formulas take time to set up, verify, validate, and use. Having patience to wait for a solution we must work towards is a good reminder to not be rash. The last concept to remember is in Proverbs 22:4, which states “The reward for humility and fear of the LORD is riches and honor and life” (ESV). Humility is important in decision making because we must be humble when our initial hypothesis is proven wrong by the analysis. If we pridefully insist on our initial way, we are on the path to ruin in business and life. These biblical concepts are fantastic reminders for whenever we make decisions, whether in linear programming or life.

**Case 2: Chapter 14 Case Problem 1**

**Solutions and recommendations.** Since the total annual cost from buying the part from a supplier is $59,027.80 and the total annual cost to manufacture the part is $57,089, it is obvious that the company would want to manufacture the part themselves. This is because the total cost from manufacturing the part yields a smaller annual cost for the company. By choosing this option Wagner Fabricating Company saves $1,939.13 per year.

**Completion and explanation.** The managers at Wagner Fabricating Company are considering manufacturing a part that they currently buy from a supplier. By reviewing the economic feasibility of manufacturing this part they will have a better understanding of cost benefits to either continue buying a part from a supplier or manufacturing the part themselves.

***Annual holding cost***. In order to determine the annual holding cost we must look at every cost associated with maintaining inventory. Therefore, the cost of capital, insurance, taxes, inventory shrinkage, and warehouse overhead will be examined. In order to determine the annual holding cost rate, every cost will be turned into a percentage. The cost of capital was given, 14%. The insurance and taxes accounted for $24,000. Since $600,000 was the average investment in the company’s inventory, we will take the $24,000 and divide that by $600,000 in order to get a percentage. Insurance and taxes accounted for 4% of the holding cost. We will use this same technique for inventory shrinkage and warehouse overhead. Inventory shrinkage accounted for 1.5% while warehouse overhead accounted for 2.5%. Finally, we will add up all the percentages in order to get the annual holding cost rate of 22%.

***Ordering cost.*** The ordering cost of an item involves any fixed costs associated with placing an order. In this case, it takes approximately two hours in order to process and coordinate an order for a part. Purchasing salaries average about $28 per hour. Therefore, it takes $56 (2 X $28) to place an order. We are also told that telephone, paper, and postage cost $2375 for 125 orders. Therefore, it takes $19 ($2375/125) per order. We then add both costs ($56 + $19) to receive a $75 cost per order.

***Setup cost.*** The setup cost involves any fixed cost associated with preparing a new product. In this case we are told that it takes 8 hours to set up the equipment for producing the part. Labor and lost production time is estimated to be $50 per hour. Therefore, the setup cost (8 X $50) is $400.

***Supplier.*** In order to determine ordering a fixed quantity from a supplier we must examine the annual holding rate cost per unit. We are told it costs $18 to order a part from a supplier. Therefore, we take the annual holding rate cost of 22% and multiply it to $18 and in turn receive an annual holding rate cost of $3.96 per unit. We then use the how-much-to-order decision model in order to find the optimal quantity. In Excel it looks like this: =SQRT(2\*(B5)\*B4/J5). We take the annual demand, multiplied by 2, and ordering cost and divide that by the annual holding rate cost per unit. This will give us the portion that is to be square rooted. This then gives us an optimal fixed quantity of 348.16.

The number of orders per year is simply found by taking the annual demand of 3200 parts and dividing that by the optimal fixed quantity of 348.16 resulting in 9.19 orders per year. The cycle time takes the working days per year, 250, multiplied by the optimal fixed quantity, 348.16, divided by annual demand of 3200. This will give us the appropriate time associated with the time placed between 2 consecutive orders, 27.2 days.

The re-order point is crucial in making sure that stock outs happen rarely and to minimize a high inventory that can result in high holding costs. We are told that a one week lead time is required, it is approximately normally distributed with a mean of 64 units and a standard deviation of 10 units, one stock out per year is acceptable. We take 1 divided by the number of orders per year to receive .1088. This number is then used to locate Z in the areas for the standard normal distribution located in Appendix D. The number associated with this is 1.24. We now use the when-to-order decision model, R=u+z(o). The formula looks like this: R= 64 + 1.24\*10. Notice that the mean standard deviation and Z is used in order to give us a re-order point of 76.4.

The safety stock is inventory maintained in order to reduce costs by reducing the number of stock-outs per year. We simply take the reorder point and subtract it from the units(mean). This results in a 12.4 safety stock. The expected max inventory is self-explanatory. We want to take the optimal quantity along with the safety stock in order to reduce stock-outs and un-necessary holding costs. This gives us a max inventory of 360.56. The average inventory is similar, although we divide the optimal quantity by 2 in order to receive and average, this results in an average inventory of 186.48. The annual holding cost is the average inventory multiplied by the annual holding rate of $3.96 which gives us an annual holding cost of $738.45. The annual ordering cost takes the number of orders per year times the ordering cost, $75. This gives us an annual ordering cost of $689.35. The annual production cost takes the cost per unit, $18, multiplied by the annual demand, 3200, to receive an annual production cost of $57,600. The total annual cost from buying from a supplier is $59,027.80.

***In-plant production.*** In order to find the optimal quantity for in-plant production we must use the economic production lot size model. We must use the SQRT function and plug in the appropriate variables. These are the holding cost (Ch), $3.74, setup cost (Co), $400, annual demand rate (D), 3200, and annual production rate (P), $12000. When plugged into the economic production lot size model we receive an optimal quantity of 966.13.

The number of production runs per year is determined by taking the annual demand and dividing it by the optimal quantity of in-plant production. 3200/966.13= 3.31 production runs per year. The cycle time takes the annual demand and optimal quantity and divides it by the working days per year in order to get an accurate measure of how long to wait when placing two consecutive orders.

The re-order point is similar to that of buying from a supplier. We are told that a two-week lead time is required, it is approximately normally distributed with a mean of 128 units and a standard deviation of 20 units. We take 1 divided by the number of orders per year to receive .3019. This number is then used to locate Z in the areas for the standard normal distribution located in Appendix D. The number associated with this is .52. We now use the re-order model, R=u+z(o). The formula looks like this: R= 128 + .52\*20= 138.4.

The safety stock simply takes the re-order point and subtracts it from the mean units. This gives us a safety stock of 10.4. A safety stock is useful for minimizing the number of stock-outs. The expected max inventory for in-plant production is 718.89. We subtract one from the annual demand and annual production rate and multiply it by the optimal quantity. We then add that to the safety stock in order to maximize the inventory levels. Each part is essential when calculating how much to hold for maximizing inventory levels. The average inventory is unnecessary because we are producing the product. The annual holding cost uses the annual holding rate as means of telling how much of the inventory and safety stock will cost per year. This resulted in an annual holding cost of $1,363.79. The annual set-up cost simply takes the number of productions per year multiplied by the cost per unit resulting in $1,324.88. The annual manufacturing cost takes the annual demand of 3200 multiplied by the $17 cost per unit resulting in $54,400. The total annual cost to use in-plant production to manufacture this part is the sum of the annual holding cost, annual set-up cost, and the annual manufacturing cost. This totals out to be $57,089.

**Other applications of models.** Inventory models are a strategic tool for managers. An inventory model can be used to help a small business owner maintain suitable levels of supplies and equipment. For instance, a pool service business must have enough chlorine, algaecide, acid, and PH testing kits in order to maintain and service pools. An inventory model will be able to tell the business owner when to re-order supplies, and suggest a certain amount of safety stock.

A second application can be used for the United States Army M.W.R. The M.W.R. locations are spread throughout the United States and offer an array of equipment to rent for camping, kayaking, snowboarding, etc. Inventory levels must be maintained effectively in order to prevent a stock-out of equipment. Therefore, The M.W.R. can use an inventory model based on seasonality trends. In the summer, they are going to rarely rent out snowboards. So, it would not make sense to have an excess amount of snowboards in inventory when that space can be used for surfboards, kayaks, and E-Z ups. I suggest flexing seasonal equipment to appropriate locations based on weather and typical recreational activities provided in that state.

**Biblical integration.** The inventory models main purpose is to maintain an optimal level of inventory. The purpose of this is to be a good steward of money and minimize unnecessary expenses for the company, for example holding costs or stock-outs. Proverbs 21:5 states, “The plans of the diligent lead to profit as surely as haste leads to poverty” (NIV). Inventory models are a useful tool in aiding a manager in decision making, primarily how much inventory to hold. These plans will lead to potential profit, although those who make hasty decisions will be lead to poverty. The book of Proverbs provides us with wisdom. Planning ahead will lead to profit because they are aware of quantity of goods to order based on mathematical models. Proverbs 27:12 states, “The prudent see danger and take refuge, but the simple keep going and pay the penalty” (NLT). Inventory models are able to help calculate optimal inventory levels since those who see danger in low purchasing power will stock their inventory levels accordingly, and those who do not heed to the warnings will be foolish and stock in-accurate inventory levels. Proverbs 27:23 states, “Be sure to know the condition of your flocks, give careful attention to your herds” (NIV). This is a wise piece of advice because this relates to the duties of a manager. Managers are meant to take care of their goods and services, they must not neglect them. To know the condition of inventory levels is to properly care for the business.

Reference

Anderson, D. R., Sweeney, D., Williams, T. A., Camm, J. D., Cochran, J. J., & J., F. M. (2016). Quantitative methods for business. Australia: Cengage Learning.