Module 5 Assignment | Project: Using Linear Programming Models to maximize profits

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Introduction

This analysis report examines the optimal solutions for a northern hardware company to establish

a new distribution center in the southeast region. The company aims to expand its operations by

opening a warehouse and adjacent office space in the area. The problem objective is to maximize

profits by distributing the company's core products to local dealers efficiently. The provided

information will be on four key products: Pressure washers, Go-karts, Generators, and Water

pumps with their costs, selling prices, and storage area. Besides, there are constraints to consider

such as purchasing monthly budget, available warehouse space, product inventory, and selling

allocation. This monthly analysis using a linear programming model aims to maximize the

company's net profit and assist the company in making informed decisions regarding its

inventory strategy.

Analysis and Interpretation: Linear Programming Solution

1. The optimal inventory solutions using the linear programming model:

    - Decision variables: inventory number of four items.

    - Objective parameters: profit per each unit of four items.

Items	Cost per unit	Selling price per unit	Objective parameters
			Profit per unit
Pressure washer	$ 330.00	$ 499.99	$ 169.99
Go-kart	$ 370.00	$ 729.99	$ 359.99
Generator	$ 410.00	$ 700.99	$ 290.99
Water Pump	$ 127.00	$ 269.99	$ 142.99

*Note: The purchase cost of one water pump is calculated by dividing the cost of the

case of 5 water pumps by five ($635/5 = $127).

    - Constraints:

        o Purchasing Monthly Budget: $170,000 in total. It means the product of Cost

        per unit and the number of units cannot exceed the $170,000 budget.

o Warehouse Space: we would calculate the total available space of the

warehouse based on its 82 shelves, with each shelf 30 ft long and 5 ft wide.

Besides, calculating the storage area of each unit is required. From there, we

must ensure that all units' total storage area does not surpass the available

warehouse space.

Storage area per unit (Sq. Ft)	Pallet size	
	length (ft)	width (ft)
25	5	5
40	8	5
25	5	5
1.25	5	5
Warehouse Space Calculation		
Shelf length (ft)	30	
Shelf width (ft)	5	
Area per shelf b(sq. ft)	150	
Number of shelves	82	
Total area of Shelves	12300	

*Note: A 5 ft by 5 ft pallet is used to store four cases of water pumps,

equivalent to $4*5 = 20$ water pumps because one case consists of 5 units of

water pumps.

o Inventory Allocation: at least 30% of its inventory is to pressure washers and

Go Karts. Therefore, the sum of units of pressure washers and Go Karts

should be greater than or equal to 30% of the total inventory.

o Selling Allocation: sell at least twice as many generators as water pumps.

o Non-negative and integer values constraint for decision variables.

- Model objective: maximize net profit.

- Linear objective function:

Maximum profit = 169.99*X1 + 359.99*X2 + 290.99*X3 + 142.99*X4

Whereas, the purchasing number of Pressure washers, Go-karts, Generators, and Water Pumps are denoted as X1, X2, X3, and X4 respectively.

- The optimal inventory solution and the maximum profit:

Max Profit	$	142,050.70

Items	Decision variables Number of units
Pressure washer	0
Go-kart	155
Generator	238
Water Pump	119

2. Solver sensitivity report:

- The optimal value for the Pressure washer is zero, indicating that the current profit margin does not justify its purchase. However, by examining the reduced cost, which is -110.07, we find that if the unit profit of the Pressure washer increases by $110.07, it would become profitable to acquire this product. To achieve this increased profit margin, the selling price should be raised accordingly. Thus, the minimum selling price required to optimize profit through unit sales is calculated as $110.07 + $499.99 = $610.06. Consequently, the initial zero solution transforms into a non-zero solution.

- The shadow price associated with the purchasing monthly budget is $0.5576, representing the marginal contribution of each dollar increase in the budget constraint towards maximizing profit. This means that a one-dollar increment in the purchasing monthly budget, within the allowable limit, results in an increase of $0.5576 in maximum profit. The sensitivity report indicates an allowable increase of $428.8 for

the purchasing budget. Therefore, if the company allocates an additional $428.8 to the existing budget of $170,000, the monthly profit will increase by $428.8 * 0.5576 = $239.1. It is not advisable for the company to allocate more funds to the purchasing budget, as the amount invested ($428.8) exceeds the profit gained ($239.1). Additionally, I recommend reducing the budget by $56,225.

- The shadow price for the total area of the warehouse is $3.84, signifying that each unit increase in square footage leads to a maximum profit increase of $3.84. According to the sensitivity report, the allowable increase in warehouse size is 6078.38 sq. ft. Consequently, the optimal warehouse size would be 12,300 + 6078.38 = 18,378.38 sq. ft. This expansion in warehouse area would result in a monthly profit increase of $23,350. However, it is important to consider the additional costs associated with expanding the warehouse size.

Conclusion

By utilizing a linear programming model, the report focuses on maximizing net profit through efficient distribution of the company's core products: Pressure washers, Go-karts, Generators, and Water pumps. The report considers various constraints, such as the purchasing monthly budget, available warehouse space, product inventory, and selling allocation.

The analysis reveals that the optimal inventory solution involves no purchase of Pressure washers, 155 units of Go-karts, 238 units of Generators, and 119 units of Water pumps, resulting in a maximum net profit of $142,050.70 (or a little adjustment according to the changes in the integer values). The sensitivity report highlights some important findings, including the possibility of making Pressure washers profitable by increasing their unit profit and the potential benefits of adjusting the purchasing budget and warehouse size.

Considering the provided information and the outcomes of the analysis, the report aims to assist the company in making informed decisions regarding inventory strategy and maximizing profitability. However, it is essential to carefully evaluate the associated costs and potential trade-offs before implementing any recommended changes.

References

1. Evans, J. R. (2013). Statistics, data analysis, and decision modeling. Pearson Education.