Management Report

Executive Summary

The Hawley Lighting Company faces a challenging operational issue in optimizing the production and marketing strategy for their diverse range of lighting products, including table, floor, ceiling, and pendant lamps. With two different manufacturing departments, each with varying material costs and capabilities, the company needs a complete and optimized plan to maximize profitability. This includes distributing their advertising budget among the items, considering the unique effects of each product's marketing on demand. The main objective is to increase competitiveness in the lighting sector by balancing production efficiency, cost-effectiveness, and market response. To optimize production and promotion for their diversified light product range, Hawley Lighting Company conducted a thorough analysis using linear programming and optimization modeling. These techniques were chosen because they work well with the linear relationships present in the production and resource allocation issues faced by the business. Additionally, the analysis investigated the feasibility of outsourcing production and testing of pendant lamps, resulting in a more cost-efficient option. The combination of linear programming and optimization modeling provides Hawley Lighting Company's management with quantitative results to make informed decisions for their complicated scenario in a methodical and efficient manner. In addition to producing the best production schedule, the analysis provided informative insights into future enhancements, resource reallocation, and a strong argument for outsourcing at a reasonable cost. The sensitivity analysis and marginal values allows Hawley's management to better comprehend the ideal solution. By examining the permissible increases and decreases of each variable and constraint, as well as their marginal values, Hawley's management can identify areas for strategic resource allocation optimization. The results concluded that spending more on advertising while staying within allowable limits could increase sales and profits, and that accepting the third-party offer to partially outsource would prove beneficial for the company.

Problem Statement

Optimizing the production and promotion strategy for Hawley Lighting Company's four lighting products, namely table lamps, floor lamps, ceiling lamps, and pendant lamps, is a challenging operational problem. The company has two departments involved in the production process, each with regular and overtime capacity, and varied material costs. Furthermore, by carefully dividing its advertising budget across the products and considering the different ways that each product's promotion influences demand, the corporation strives to optimize sales. The objective is to create an integrated production and advertising plan that maximizes overall profitability within the allocated advertising budget, while also adhering to capacity manufacturing constraints and material prices. In order to improve the company's competitiveness in the lighting business, this problem requires a comprehensive strategy that balances production efficiency, cost-effectiveness, and market response.

Methods

The method of analysis employed for the Hawley Lighting Company case involves the utilization of linear programming (LP) and optimization modeling. The chosen methods for addressing the problem were carefully selected due to their suitability for the specific characteristics of the company's case. Linear programming, with its focus on linear relationships among decision variables and constraints, is designed for situations where the goal is to optimize a linear objective function subject to linear constraints. Hawley deals with decision variables including the number of units to be produced for each product and the allocation of the advertising budget, and constraints such as production capacity, overtime capacity, and advertising limits, and the objective function represents the total profit based on the former. The assumption of linearity in the contribution of decision variables to the objective function, especially in manufacturing scenarios where additional units have a proportional linear impact, further justifies the selection of LP.

Optimization modeling, on the other hand, becomes pivotal in handling the complexities of the decision space in the Hawley Lighting Company case, as it allows for a comprehensive consideration of these factors simultaneously. The quantitative basis provided by optimization models facilitates objective quantification, offering a clear and measurable outcome in terms of profit value and production plans. Furthermore, the inclusion of sensitivity analysis within optimization models proves invaluable for scenario analysis. Decision-makers benefit from understanding how changes in variables and constraints impact the optimal solution, providing essential insights for strategic decision-making and exploration of different scenarios. In essence, the combination of Linear Programming and Optimization Modeling emerges as a robust approach, tailored to the intricacies of the Hawley Lighting Company case, ensuring a comprehensive and effective solution to the identified problem.

The adoption of LP and optimization modeling stems from their inherent efficiency and rigor in managing linear relationships within decision-making processes. These methods yield quantifiable results, a pivotal factor for managerial decision-making. The strategic decision support provided by the combination of LP and optimization modeling, especially when complemented by sensitivity analysis, empowers decision-makers not only to pinpoint optimal solutions but also to comprehend the

ramifications of changes in various factors on the overall outcome. Thus, the selection of linear programming and optimization modeling for the Hawley Lighting Company is grounded in their compatibility with the linear relationships inherent in production and resource allocation challenges, offering a systematic, quantitative, and strategic approach to decision-making in the intricate scenario faced by the company.

Analysis

The Hawley Lighting Company's manufacturing decisions should be significantly aided by the optimization model conducted through linear programming. Analyzing the tactical and strategic information from the optimal solution as well as the sensitivity report demands an understanding of how the different variables, factors, and results of the performed model and sensitivity analysis have an impact on the resulting objective function.

For that enhanced comprehension, one should analyze not only the optimal output plan for Hawley's Lighting Company, but also the factors that may lead to an even more heightened performance from the firm. Those would include, but not be limited to, the marginal values of possible additional overtime capacity for each of the two departments within the company, the marginal values of possible additional advertising dollars, as well as the marginal values of each product's possible additional sales.

For each of these variables, Hawley's management should inspect the resulting coefficients of each in the objective function, which represent the contribution of each additional unit of said variable to the overall profit objective. Moreover, the marginal values provided by the resulting shadow prices associated with each variable in the sensitivity analysis must also be analyzed, to understand how changes in each constraint would affect the objective function in the model output. It is important to consider that the marginal values for each variable should be scrutinized considering the marginal limits set by the allowable decreases and increases. Remaining within the allowable limits will ensure that the analysis remains true for the output generated in the optimization model. If allowable limits are trespassed, the shadow prices would no longer be valid thus also invalidating the analysis, as the optimization model results would provide a divergent result and consequently a different sensitivity report for each of the constraints.

With Hawley's current variables and constraints, the optimal output plan for the company would yield a profit of $9,677,280. Below is a table displaying the number of units to be produced for each product:

Tr	**62160**	Fr	**20000**	Cr	**55000**	Pr	**35000**
To	**0**	Fo	**0**	Co	**24000**	Po	**0**

Table 1: Units to be produced in optimal output plan

(T = table lamps; F = floor lamps; C = ceiling lamps; P = pendant lamps; r = regular time; o = overtime)

In sequence, the advertising budget allocation for each product under the current optimal output plan:

T	F	C	P
18000	**0**	**0**	**0**

Table 2: Advertising budget allocation in optimal output plan
(T = table lamps; F = floor lamps; C = ceiling lamps; P = pendant lamps)

Analyzing the marginal values of the key variables and constraints of the model would provide Hawley's management with insights on potential improvements in overall performance. For instance, examining the marginal value of the capacity for additional overtime would reveal possible opportunities to enhance production during peak demand periods. On the same line of thought, evaluating the marginal value of additional advertising dollars would highlight the profitability of increased advertising expenditures, guiding decisions on possible reallocation of resources. Essentially, inspecting the marginal values helps decision-makers at the managerial level strategically optimize the allocation of resources and achieve increased performance levels. In the table below the marginal values for the key constraints are displayed, alongside their allowable increases and decreases:

	D1 OT	D2 OT	Additional Ad $	T	F	C	P
Marginal value (shadow price)	**0**	**35**	**5.96**	**58**	**39**	**0**	**30**
Allowable increase	**1.00E+30**	**21000**	**148666.6667**	**17840**	**17840**	**1.00E+30**	**55000**
Allowable decrease	**25000**	**24000**	**18000**	**62160**	**20000**	**21000**	**21000**

Table 3: Marginal values and allowable limits in optimal output plan
(D1 = department 1; D2 = department 2; OT = overtime; Additional Ad $= additional advertising dollars;
T = table lamps; F = floor lamps; C = ceiling lamps; P = pendant lamps)

The data displayed in Table 3 details the marginal value for each key variable and constraint and their allowable increases and decreases. Those variables and constraints that provide a positive marginal value would provide enhanced performance for Hawley's manufacturing plan if increased within the allowable increases under the optimal plan. For example, if the company was able to allocate resources to produce extra table lamps (up to 17,840 units more), management would be able to increase profits by $58 per extra unit produced. That same logic applies to all variables with a positive marginal value. When focusing on Hawley's advertising expenditure, the company might want to explore a higher budget with its marketing department. That is because, for every dollar increase in the advertising expenditure, sales would increase by $5.96 within the allowable increase range. Thus, if we increased the advertising budget by the full amount of its allowable increase, profit would increase by $886,053.33 while the solution remains optimal for this production plan.

Furthermore, in light of a third-party company proposing an offer to assemble and test pendant lights for Hawley Lighting Company for $27 per unit, management should also analyze the possibility of partially outsourcing its production. The linear programming model, incorporating the outsourcing offer while maintaining the advertising budget constraint at $18,000, yields a compelling outcome. The analysis reveals that accepting the third-party offer is advantageous for Hawley, as the optimal solution results in an overall profit of $13,026,100 through outsourcing the manufacturing of 37,700 units of pendant lights. This decision is driven by the resulting cost-efficiency of externally assembling the product and the consequent maximization of how resources are utilized in Hawley's production plants.

Through this analysis, the company should accept the third-party's offer, which in turn would result in an optimal production plan consisting of the following manufacturing proposal:

Tr	**60000**	Fr	**20000**	Cr	**90000**	Pr	**0**	POut	**37700**
To	**0**	Fo	**0**	Co	**10000**	Po	**0**		

Table 4: Units to be produced in optimal output plan
(T = table lamps; F = floor lamps; C = ceiling lamps; P = pendant lamps; r = regular time; o = overtime; Out = outsourced)

In sequence, the advertising budget allocation for each product under the new partially outsourced optimal output plan:

T	F	C	P
0	**0**	**0**	**18000**

Table 5: Advertising budget allocation in optimal output plan
(T = table lamps; F = floor lamps; C = ceiling lamps; P = pendant lamps)

The analysis of the linear programming models discussed shed light on the optimal production plan for Hawley's but also on the encouraging opportunity for partial outsource. Investigating the marginal values has highlighted areas for potential improvement and resource reallocation, while exploring outsourcing has presented a compelling case for cost-effective external assembly and testing of pendant lamps.

Conclusions and Recommendations

During this analysis, the application of linear programming was employed. According to the analysis, it has proven to be a powerful tool for optimizing the production and promotion strategy of Hawley Lighting Company. The optimal production plan derived from the analysis maximizes the company's profits at $9,677,280. Moreover, it not only accomplishes that but also identifies key opportunities for additional improvements to enhance performance.

The analysis of marginal values for each product as well as for the overtime capacity of each department reveals the potential to increase production and profitability during high demand periods. Additionally, allocating additional financial resources to the advertising budget could result in a substantial increase in profits, highlighting the lucrativeness of strategic investments in marketing. Furthermore, exploring the outsourcing offer put forward by a third-party, specifically outsourcing the production and testing of pendant lamps, presents a lucrative opportunity, improving Hawley's total profit to a total of $13,026,100.

It is recommended that Hawley Co. accepts the third-party offer to outsource pendant lamps and adopts a dynamic and flexible approach to its in-house production strategy. This may involve optimizing additional production and overtime capacity during high demand periods and strategically increasing advertising expenses to achieve a positive impact on sales and profit. The coordination of advertising and sales strategies should adapt to the unique characteristics of each lighting product,

leveraging market insights and consumer trends. By embracing these recommendations, Hawley Co. can maximize profitability and strengthen its competitiveness in the dynamic lighting industry, staying alert to market trends for successful and sustained outcomes.