**Optimization Analysis and Sensitivity Report**

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**Introduction**

This report presents an optimization analysis aimed at maximizing profitability while considering budgetary and warehouse space constraints. The analysis focuses on determining the optimal allocation of funds across four products: Pressure Washers, Go-Karts, Generators, and Water Pumps. Using R for linear programming, we identify the best allocation strategy, assess sensitivity factors, and provide actionable recommendations for improving profitability.

**Analysis**

Let:

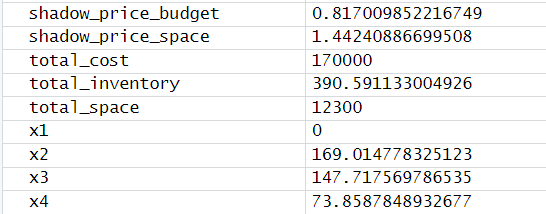
* x1 be the number of Pressure Washers purchased
* x2 be the number of Go-Karts purchased
* x3 be the number of Generators purchased
* x4 be the number of Water Pumps purchased

**Objective Function:** Maximize Profit: Z=169.99\*x1​ + 359.99\*x2 ​+ 290.99\*x3​ + 714.95\*x4​

**Constraints:**

1. **Budget Constraint:** 330\*x1 ​+ 370\*x2 ​+ 410\*x3 ​+ 635\*x4 ​≤ 170000
2. **Warehouse Space Constraint:** 25\*x1 ​ +40\*x2 ​+ 25\*x3 ​+ 25\*x4 ​≤ 12300
3. **Non-Negativity Constraint:** x1​, x2​, x3​, x4 ​≥ 0

**Optimization Results**

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**Optimal Allocation of Inventory**

* **Pressure Washers:** **0** units
* **Go-Karts:** **169.014** units
* **Generators:** **147.717** units
* **Water Pumps:** **73.858** units

**Total Cost and Warehouse Utilization**

* **Total Cost:** **$170,000** (fully utilized budget)
* **Total Warehouse Space Used:** **12,300 square feet** (fully utilized)
* **Optimal Monthly Profit:** **$156,633.30**

**Sensitivity Analysis**

**1. Adjusting the Selling Price of Pressure Washers**

The **reduced cost** for Pressure Washers is **-135.68**, meaning its profitability per unit must increase by at least **$135.68** for it to become a viable product in the optimal solution.

* **New minimum selling price:**

169.99 + 135.68 = 305.67

**2. Budget Expansion and Impact on Profitability**

The **shadow price** for the budget constraint is **0.817**, indicating that increasing the budget by **$1** results in a **$0.817** increase in profit.

* If the company increases its budget by **$10,000**, the estimated additional profit would be:

10000 × 0.817 = 8170

* Thus, increasing the purchasing budget could be a profitable decision.

**3. Warehouse Space Optimization**

* The **shadow price** for warehouse space is **1.442**, meaning every additional **square foot** of storage increases profit by **$1.442**.
* Renting **2,000 additional square feet** would lead to an estimated profit increase of:

2000 × 1.442 = 2884

**Conclusion & Recommendations**

The results from **R-based optimization** indicate that maximizing profitability requires a strategic allocation of resources, prioritizing high-margin products while considering budget and space limitations.

**Key Insights:**

1. **Pricing Strategy Adjustment:** Pressure Washers should be priced at a minimum of **$305.67** per unit for inclusion in the optimal inventory.
2. **Budget Expansion:** Increasing the budget by **$10,000** is projected to yield an additional profit of **$8,170**, making it a worthwhile investment.
3. **Warehouse Space Optimization:** Expanding the warehouse by **2,000 square feet** could generate approximately **$2,884** in additional monthly profit.

**Actionable Recommendations:**

* Reassess the pricing strategy for Pressure Washers to improve their contribution to overall profitability.
* Increase the purchasing budget beyond **$170,000** to capitalize on higher profitability potential.
* Expand warehouse storage by at least **2,000 square feet** to better accommodate inventory and drive additional profit.

By implementing these recommendations, the company can **enhance profitability** while ensuring an **efficient allocation of resources**, supporting long-term business growth.