Individual Assignment #1 – Linear Programming Fundamentals

**Summer Sports Camp at State University**

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**Decision Variables**

The variables to for the case study are:

= number of **new sheets** to buy in week

= number of **sheets cleaned** using the **laundromat** in week

= number of **sheets cleaned** using the **friend’s service** in week

**The Objective Function**

Mary’s objective is to develop a plan for purchasing and cleaning sheets such that the cost will be minimized.

Minimize Z =

Here, 10 = Cost of new sheets

4 = Cost of Sheets cleaned using a laundromat

2 = Cost of Sheets cleaned using a friend’s service

**Model Constraints**

The model contains a constraint which is every week she must replace 20% of the sheets every week

**Week 1:**

**Week 2:**

…

**Week 8:**

**Sensitivity Analysis**

The **constraint impacts** in this scenario are driven by the availability of Mary’s friend's service, which operates with a two-week turnaround. This means that sheets given to Mary’s friend in Week 1 will only be available for use in Week 3. This constraint limits the immediate liquidity of cleaned sheets in the short term, forcing reliance on more expensive resources like new sheets ($10 each) and laundromat services ($4 per sheet) in weeks where the friend's service is not yet returned.

**Marginal values** show that purchasing new sheets increases the total cost significantly at $10 per sheet, while laundromat services increase costs by $4 per sheet. However, when Mary’s friend’s service is available (with a cost of $2 per sheet), it reduces overall expenses, making it the most cost-effective option despite the delay. The need to strategically allocate the friend’s service based on this delay becomes crucial for minimizing costs. In your results, this strategy is reflected by leveraging the friend's service during high-demand weeks like Weeks 5, 6, and 7, once the sheets have been returned.

The **sensitivity ranges** show that the cost implications of small demand changes are minimal. However, significant increases in demand would require more new sheets, driving costs up rapidly due to their high price. **Shadow prices** indicate that extending the availability of Mary’s friend’s service to more weeks, or reducing the two-week delay, would save $2 per sheet cleaned, providing more flexibility in meeting demand with lower costs.

The **effect of added/removed constraints** can be observed in the two-week delay of Mary’s friend’s service. If the service were available with a shorter turnaround (e.g., one week), it would reduce costs even further by providing cleaned sheets more quickly, avoiding reliance on the more expensive laundromat and new sheets. Conversely, if the friend's service were delayed longer or further constrained, the total costs would increase as more laundromat and new sheets would be needed to meet demand.

**Solution Implementation Summary**

The Summer Sports Camp at State University needs to meet weekly bed sheet demand at the lowest possible cost, using new sheets, laundromat services, and Mary’s friend’s cleaning service, which has a two-week delay.

To minimize costs, the solution prioritizes using Mary’s friend’s service, which is the cheapest at $2 per sheet, followed by the laundromat at $4 per sheet, and limits purchasing new sheets, which cost $10 each. Sheets sent to Mary’s friend are cleaned and returned two weeks later, so this service is strategically used during high-demand weeks.

**Recommendations**

* Maximize the use of Mary’s friend’s service for the two highest-demand weeks to minimize costs.
* Use the laundromat service when the friend's service is unavailable to avoid costly new sheet purchases.
* Minimize new sheet purchases as much as possible since they are the most expensive option.
* Invest in the new sheets int the starting weeks as the demand is lower at that time, as the demand increase, we are getting more washed sheets which protects us to from buying more sheets.