Office Realignment Project

1. Problem

Ram Wireless, with stores located across Virginia, relies on regional offices to provide support services in inventory, payroll, hiring, local marketing, and merchandising. Due to geographic expansion and increasing travel demands, inefficiencies have emerged in assigning stores to regional offices. Currently, employees spend excessive time commuting, impacting productivity, cost-efficiency, and employee satisfaction.

Melissa Jones (COO) and Vance Larson (regional manager) aim to realign store assignments to regional offices in Staunton, Richmond, Warrenton, and Tappahannock. The primary objective is to minimize travel costs, balancing travel distance and workload. They have hired Verve Consulting to evaluate and optimize the assignment of stores to these regional offices to reduce travel time and costs while meeting each office’s capacity limitations.

1. Data

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Hours available | Inventory | Payroll | Hiring | Marketing | Merchandising |
| Richmond | 5000 | 3025 | 1225 | 1750 | 3675 |
| Tappahannock | 3400 | 5550 | 3250 | 1200 | 1600 |
| Warrenton | 825 | 2500 | 3375 | 1325 | 850 |
| Staunton | 3550 | 3450 | 9100 | 1700 | 1850 |

|  |  |
| --- | --- |
| Average cost per mileage | 0.585 |
| Average hourly salary for employee | 26 |

Additional data can be found in these document [Data](https://docs.google.com/spreadsheets/d/1c39MMdwWzBSdRqP4HYzl4dft0aoekJfR/edit?usp=sharing&ouid=111363104572172397978&rtpof=true&sd=true) .

Let,

R = {Staunton, Richmond, Warrenton, Tappahannock} be the set of regional offices.

S = {Albemarle County, Amherst County, Augusta County, Buckingham County, Caroline County, Charles City County, Chesterfield County, City of Fredericksburg, City of Richmond, Culpeper County, Cumberland County, Dinwiddie County, Essex County, Fauquier County, Fluvanna County, Goochland County, Greene County, Hanover County, Henrico County, Hopewell County, James City County, King and Queen County, King George County, King William County, Louisa County, Madison County, Mathews County, Nelson County, New Kent County, Orange County, Page County, Powhatan County, Prince George County, Prince William County, Rappahannock County, Rockbridge County, Rockingham County, Shenandoah County, Spotsylvania County, Stafford County, Warren County, Westmoreland County, York County} be the set of the stores.

A = {Inventory, Payroll, Hiring, Marketing, Merchandising} be the set of support areas (activities).

we have converted the “—” to 1000000 to make infusible allocation to maximum penalty.

1. Decision Variables

Let

1. Part A – Problem

Vance and Melissa at Ram Wireless want to assign each store to the nearest regional office based solely on mileage distance. This assignment does not factor in any cost constraints; rather, each store is simply assigned to the closest regional office in terms of mileage. After making this assignment, the objective is to calculate the total travel cost associated with the allocation and evaluate feasibility.

1. Objective in Words

Decide how to assign each store to the closest regional office based on mileage distance so that the total mileage is minimized, subject to the following constraints:

* Each store is assigned to exactly one regional office.
* Nonnegativity constraints.

1. Algebraic Formulation
2. Optimization Model

(total\_mileage)

(assignment\_constraint)

(Nonnegativity and binnary Constraint)

1. Calculation of Total Travel Cost

(total\_travel\_cost)

1. Feasibility Check

(feasibility\_ckeck)

1. Part B – Problem

Following the initial assignment based purely on mileage (Part A), Vance and Melissa now want to find the lowest-cost assignment of all stores to regional offices. This assignment must minimize the total travel cost, factoring in both mileage and salary costs. Specifically, each regional office has a limited number of hours available for each activity area (inventory, payroll, hiring, marketing, merchandising), and the assignment must ensure that the total hours required for each activity at the assigned stores does not exceed the hours available at any regional office.

1. Objective in Words

Decide how to assign each store to a regional office so that the total travel cost is minimized, subject to the following constraints:

* Each store is assigned to exactly one regional office.
* The total required hours for each activity at each regional office do not exceed the hours available for that activity at the office
* Nonnegativity constraint.

9 Algebraic Formulation

(total\_cost)

(assignment\_constraint)

(feasibility\_constraint)

(Nonnegativity and binary Constraint)

1. Implementation

An implementation and solution of the model using Excel Solverx LP is available here:

<https://docs.google.com/spreadsheets/d/1NWoUL4vkN7BB3eNWR-nR3LpDi3YoIayj/edit?usp=sharing&ouid=111363104572172397978&rtpof=true&sd=true>

1. Results
2. Part A

The optimal solution based on the minimum distance allocation; each store is assigned to the nearest regional office as follows:

|  |  |  |  |
| --- | --- | --- | --- |
| Staunton | Warrenton | Richmond | Tappahannock |
| Albemarle County  Amherst County  Augusta County  Buckingham County  Fluvanna County  Nelson County  Rockbridge County  Rockingham County | City of Fredericksburg  Culpeper County  Fauquier County  Greene County  Madison County  Orange County  Page County  Prince William County  Rappahannock County  Shenandoah County  Spotsylvania County  Stafford County  Warren County | Charle City County  Chesterfield County  City of Richmond  Cumberland County  Dinwiddie County  Goochland County  Hanover County  Henrico County  Hopewell County  James City County  Louisa County  New Kent County  Powhatan County  Prince George County | Caroline County  Essex County  King and Queen County  King George County  King William County  Mathews County  Westmoreland County  York County |

resulting in an optimal total cost of **$96,020.08**.

1. Part B

The optimal solution for Office Realignment Project is to assign:

|  |  |  |  |
| --- | --- | --- | --- |
| Staunton | Warrenton | Richmond | Tappahannock |
| Albemarle County  Amherst County  Augusta County  Buckingham County  Fluvanna County  Greene County  Nelson County  Rockbridge County  Rockingham County | Culpeper County  Fauquier County  Madison County  Orange County  Page County  Prince William County  Rappahannock County  Shenandoah County  Stafford County  Warren County | Charles City County  Chesterfield County  City of Richmond  Cumberland County  Dinwiddie County  Goochland County  Hanover County  Henrico County  Hopewell County  James City County  Louisa County  New Kent County  Powhatan County  Prince George County  Spotsylvania County | Caroline County  City of Fredericksburg  Essex County  King and Queen County  King George County  King William County  Mathews County  Westmoreland County  York County. |

resulting in an optimal total cost of **$ 96,498.675**.

1. Summary

In **Part A**, the optimal solution assigns each store to its nearest regional office based on the minimum travel distance alone. This allocation results in a total cost of **$96,020.08**. However, this assignment is **infeasible** as it does not consider capacity constraints at each regional office. Specifically, the **Warrenton office** is over-allocated, with more hours required than available for Inventory and Merchandising, making it unable to support all assigned stores.

In **Part B**, the solution takes into account both **minimum travel cost and area** **feasibility constraints**. Each store is assigned to a regional office based on minimizing the total travel cost while ensuring each office has the required employee hours to support all assigned activities. This allocation yields a slightly higher total cost of **$96,498.675**, but it is **feasible**, as all regional offices have adequate hours for their assignments.

**Key Differences**

* Part B’s solution respects the feasibility constraints at each office, while Part A's solution does not.
* Part A achieves a lower cost ($96,020.08) but is infeasible, whereas Part B’s cost is slightly higher ($96,498.675) but feasible.
* A few stores were reassigned to different regional offices in Model 2 compared to Model 1, reflecting an adjustment in the allocation strategy. Notably:
  + **City of Fredericksburg** was moved from **Warrenton** to **Tappahannock**.
  + **Greene County** was reassigned from **Warrenton** to **Staunton**.
  + **Spotsylvania County** was moved from **Warrenton** to **Richmond**.

These changes suggest that Model 2 introduced some adjustments potentially to address constraints or reduce overall travel costs.

**Similarities**

* Both parts aim to minimize travel costs for store-to-office assignments.
* Staunton, Richmond, and Tappahannock allocations are mostly consistent between Part A and Part B, as these offices have sufficient capacity under both scenarios.
* Both models-maintained coverage of all stores by the four regional offices, ensuring each store was assigned a specific regional office.
* Both models successfully assigned each store to a single regional office, aligning with the core requirement of having one office per store.

1. Reference

For a detailed explanation of how the document was generated through AI coaching, refer to the transcript at the following link:

<https://chatgpt.com/share/671e6117-af54-8006-9841-d70976075480>