



VIRGINIA COMMONWEALTH UNIVERSITY

Prescriptive Analytics (INFO 645)

Office Realignment Project

Phase 2

Submitted to

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Executive Summary

The Ram Wireless home office in Virginia faces inefficiencies in outdated regional service area assignments, increasing travel costs and reducing productivity, particularly in Staunton, Warrenton, Richmond, and Tappahannock offices. COO Melissa Jones and Regional Manager Vance Larson engaged Verve Consulting to optimize assignments while balancing costs, staff satisfaction, and productivity. We are a group of graduate students—Riddhi Rungta, Gauri V Nair, Sarath S, Jesin K Joy, and Adarsh Bharathwaj—pursuing a Master’s in Decision Analytics. This project was assigned as part of our coursework to apply optimization techniques to real-world business problems in two phases: in Phase I, completed in October 2024, we explored optimization methods using spreadsheet models, and in Phase II, we refined our approach, implemented the model in AMPL, and provided detailed recommendations.

The project aimed to reassign 43 stores to four regional offices—Staunton, Warrenton, Richmond, and Tappahannock—while minimizing travel costs and respecting feasibility constraints, ensuring that staff hours available at each office were not exceeded. Initial nearest-office assignments violated these constraints, necessitating an optimization model. Using Mixed Integer Linear Programming (MILP) in Solver, AMPL, and Python, we developed a cost-effective solution that met all constraints. The total optimized cost was \$195,479.31, slightly higher than the nearest-office assignment but feasible. Geographic anomalies were identified in six store assignments, with Stafford County notably assigned to Richmond instead of closer Warrenton, despite shorter distance and time. Reassigning Stafford to Warrenton reduced costs but violated feasibility constraints, exceeding available merchandising hours in Warrenton by 98.38 hours. We recommend optimizing store assignments to minimize costs while addressing capacity constraints, with adjustments for geographically mismatched assignments to improve operational efficiency and alignment.

Essential Components of this optimization problem

Problem Statement

Ram Wireless seeks to realign store assignments for Staunton, Richmond, Warrenton, and Tappahannock regional offices to minimize travel costs, which include both mileage and employee salary expenses. Each store must be assigned to a regional office in a way that reduces unnecessary travel time, allowing employees more time for store-related work. Additionally, each regional office's available hours for each task area must be respected. This phase extends the analysis by explicitly incorporating constraints related to area-specific availability of hours and examining how the assignment aligns geographically to ensure practical implementation.

Data: [Realignment Data](#)

Data Definition

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

$S = \{ Albemarle county, Amherst county, Augusta county, \dots \}$ be the set of stores

$A = \{ Inventory, Payroll, Hiring, Marketing, Merchandising \}$ be the areas for each store.

$mileage_cost$ = state mileage rate, which is \$0.585 per mile

$salary_per_hour$ = the salary being paid to the employees (\$26 per hour)

$mileage_{ji}$ = the distance in miles from store j to regional office $i, i \in R$ and $j \in S$

$travel_time_{ji}$ = time required in hours to travel from a store j to a regional office $i, i \in R$ and $j \in S$

$base_hours_required_{ja}$ = hours required annually by each store j in area $a, j \in S$ and $a \in A$

$hours_available_{ia}$ = employee hours available annually in regional office i in each area $a, i \in R$

R and $a \in A$

$round_trips_{ja}$ = number of annual round trips required by store j in area $a, j \in S$ and $a \in A$

For round trips, we took the annual trips and then in a new sheet, we doubled it to make round trips for our calculation.

Objective in Words

Decide the assignment of stores to regional office (i.e., which regional office each store must be assigned to)

Such that the **total cost** (mileage cost + salary cost) is **minimized**

Subject to the following constraints:

1. Each store must be assigned to only one regional office
2. The hours required by stores assigned to a regional office for each area must not exceed the hours available in that office for that area.

Assumptions:

1. Salary costs for travel are based on annual round trips, doubling the distance to account for return trips.
2. The base hours required for each area (e.g., inventory, payroll) and the number of trips per year are consistent across all stores. This is an estimate given by the employees.
3. External factors such as traffic, weather, or unforeseen delays are not considered in the travel time or cost calculations.

Decision Variables

Let x_{ji} be the binary decision variable such that,

$$x_{ji} = \begin{cases} 1, & \text{store } j \text{ is assigned to regional office } i, i \in R; j \in S \\ 0, & \text{otherwise, } i \in R; j \in S \end{cases}$$

Algebraic Formulation

Minimize

$$\sum_{j \in S} \sum_{i \in R} x_{ji} * (\text{mileage_cost} * \text{mileage}_{ji} * \sum_{a \in A} \text{round_trips}_{ja} + \text{salary_per_hour} * \text{travel_time}_{ji} * \sum_{a \in A} \text{round_trips}_{ja}) \quad \text{:Total_Cost}$$

Subject to the constraints:

AssignEachStoreOnce:

$$\sum_{i \in R} x_{ji} = 1, j \in S$$

HoursConstraint:

$$\sum_{j \in S} x_{ij} * (\text{base_hours_required}_{ja} + \text{round_trips}_{ja} * \text{travel_time}_{ji}) \leq \text{hours_available}_{ia}, i \in R, a \in A$$

Modeling Methodology

First, we divided our data in different sheets for the purpose of easy importing. Other than round trips, no other calculation was done in the excel spreadsheet. The optimization problem was approached using **Mixed Integer Linear Programming (MILP)**, which is particularly effective for solving problems with both continuous and discrete decision variables. To ensure robustness and consistency, **Solver, Python, and AMPL** were utilized to model and solve the problem. The results from all three methods aligned, confirming the reliability of the approach.

Implementation

An implementation of the above problem using AMPL and Python can be accessed below:

[AMPL - Office Realignment Project - Phase II](#)

Results

The optimization results indicate that the total cost of \$195,479.31 was achieved under the provided constraints. The optimization successfully achieves the objective of minimizing costs while satisfying the operational and assignment constraints.

Assignment of the stores to the regional offices is detailed below:

Richmond	Staunton	Tappahannock	Warrenton
Charles_City_County	Albemarle_County	Caroline_County	Culpeper_County
Chesterfield_County	Amherst_County	City_of_Fredericksburg	Fauquier_County
City_of_Richmond	Augusta_County	Essex_County	Orange_County
Cumberland_County	Buckingham_County	King_George_County	Page_County
Dinwiddie_County	Greene_County	King_William_County	Prince_William_County
Fluvanna_County	Madison_County	King_and_Queen_Count	Rappahannock_County
Goochland_County	Nelson_County	Mathews_County	Shenandoah_County
Hanover_County	Rockbridge_County	Spotsylvania_County	Warren_County
Henrico_County	Rockingham_County	Westmoreland_County	
Hopewell_County		York_County	
James_City_County			
Louisa_County			
New_Kent_County			
Powhatan_County			
Prince_George_County			
Stafford_County			

Employee hours annually used at each regional office in each department area is given below:

Regional Offices	Inventory	Payroll	Hiring	Marketing	Merchandising
Richmond	2584.8	2730.2	1097.58	1128.62	671.4
Tappahannock	735.24	943.98	1783.04	374.1	708.28
Warrenton	755.96	1418.44	1514.58	624.9	828.78
Staunton	1836.42	3399.58	7594.92	1075.22	457.88

Part C - Unusuality, Mitigation and Ramifications

The solution found in Part B for the assignment of stores to regional offices does not entirely make sense when considering the geographic regions demarcated by the assignments. We referred to the [Virginia Map](#) and found the following unusuality. Six counties are not being assigned to the closest regional office, which increases travel time and subsequently raises costs. The most notable one is Stafford County, while the others include Madison County, City of Fredericksburg, Fluvanna County, Greene County, and Spotsylvania County.

Upon further examinations we noticed that these discrepancies arise due to violations of feasibility constraints despite cost reductions when assigning these counties to their closest regional offices.

The most unusual thing we noticed was Stafford County assignment. It was assigned to Richmond rather than Warrenton which was the closest. The mileage to Warrenton was 42 miles and the time taken was 0.96 hours whereas the mileage to Richmond was 67 miles and the time taken was 1.08 hours.

For fixing this issue, we assigned it to Warrenton instead of Richmond. That reduced the costs; however, this allocation violates the feasibility constraint as the required merchandising hours

exceed the available hours in the merchandising area in Warrenton by 98.38 hours. This implied that the hours available was not enough for that store to be allocated there. This led to feasibility issues.

Similarly, Madison County could have been assigned to Warrenton instead of Staunton for cost efficiency, but this was infeasible as Warrenton lacked the merchandising hours needed.

The City of Fredericksburg faces a similar issue. Assigning it to Warrenton instead of Tappahannock would reduce costs but exceeds the available hours in both merchandising and inventory areas in Warrenton.

Fluvanna County, if assigned to Staunton instead of Richmond, would have reduced costs but violated the payroll area feasibility constraint due to insufficient available hours in Staunton.

For Greene County, assigning it to Staunton instead of Warrenton would lower costs but violates payroll area constraints in Staunton.

Finally, Spotsylvania County, which could have been allocated to Warrenton instead of Tappahannock for cost reduction, exceeds the available merchandising hours in Warrenton, rendering this allocation infeasible.

In conclusion, while assigning these counties to their closest regional offices would minimize costs, the feasibility constraints related to the availability of resources in merchandising, payroll, and inventory areas necessitated these allocations. These constraints ensure that operational requirements are met, even if it means higher travel costs and less geographic alignment.

Link to the workings for Part C: [Link to the workings for Part C](#)

Conclusion

The report identifies several key issues, including the assignment of certain counties to distant regional offices due to capacity shortfalls in specific program areas, such as merchandising and payroll. The analysis highlights instances where stores like Stafford, Madison, and Fredericksburg were assigned to far-off offices due to insufficient hours in the nearby regional offices, causing inefficiencies in both costs and operations. These inefficiencies led to increased travel time and costs, negatively impacting employee satisfaction due to longer commutes and less time spent on-site at stores. Furthermore, the capacity constraints in certain regional offices resulted in an inability to meet the operational needs of stores, leading to potential service delays and compromised work quality.

The consequences of these challenges included not only higher operational costs but also reduced productivity and employee morale. By addressing the assignment inefficiencies and capacity shortfalls, the Ram Wireless home office can optimize resource allocation, improve service delivery, and enhance overall operational efficiency.

Recommendations

To address inefficiencies and misalignments in the current regional office assignments, a targeted strategy is recommended to optimize resource utilization and enhance operational alignment. Redistributing staff hours across regional offices is critical to resolving capacity constraints in high-demand areas. Stafford County, currently assigned to Richmond due to a shortfall of 98.38 merchandising hours in Warrenton, can be reassigned to Warrenton by reallocating surplus hours from Richmond. Similarly, Madison County, which faces a shortfall of 26.14 merchandising hours, and Fredericksburg, which has a combined shortfall of 150.74 hours for merchandising and inventory, can also be reassigned through similar transfers. Payroll-related shortfalls in Staunton that impacted Fluvanna and Greene counties can be resolved by shifting hours from Richmond to Staunton, enabling these counties to be serviced by the nearest office without exceeding operational limits.

The optimization model should integrate geographic proximity as a secondary objective alongside cost minimization. This hybrid approach, which assigns weights to both factors, ensures that counties are aligned with their nearest regional offices while respecting capacity constraints. Assignments such as Stafford to Richmond and Fredericksburg to Tappahannock highlight the need for this adjustment. A proximity-weighted optimization model would better balance cost efficiency with geographic practicality, reducing unnecessary travel and improving employee satisfaction.

Introducing flexible staffing models offers a practical solution for addressing temporary capacity shortfalls. A shared support framework, where staff from one office assist another during high-demand periods, would facilitate geographically logical assignments. For instance, merchandising staff from Richmond could temporarily support Warrenton, ensuring assignments like Stafford to Warrenton remain feasible. Similarly, floating staff could address

combined deficiencies in counties like Fredericksburg, enabling closer office alignments without operational compromise.

To ensure sustainability, we recommend implementing incremental adjustments, starting with the most problematic assignments such as Stafford, Madison, and Fredericksburg. Gradual changes will provide immediate benefits while allowing the organization to monitor the broader impact before scaling the strategy. Additionally, adopting advanced scheduling and monitoring tools for real-time tracking of staff hours and capacity will streamline resource allocation and reduce administrative burdens. Regular reassessments of capacity and assignments will be essential to adapting to changing operational needs.

This approach not only addresses current inefficiencies but also establishes a flexible, sustainable framework for future assignments. By prioritizing cost-efficiency, geographic alignment, and operational adaptability, these recommendations provide a balanced solution to enhance productivity and resource utilization.

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Appendix

Interaction with the AI can be found here:

AMPL Code	AI Interaction
Report	AI Interaction 1 AI Interaction 2