# 9. Optimization of the United States postal retail network by applying GIS and econometric tools*

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## 1 INTRODUCTION

Declining mail volumes worldwide require posts to adapt retail networks to provide postal services more efficiently. This chapter develops an approach to postal retail optimization using both GIS (Geographic Information System) tools and econometric methods.

With over 30,000 retail locations, United States Postal Service (USPS) operates the largest retail network in the United States. However, this retail network is not a direct result of systematic economic decisions by management. Rather, it is a 'legacy' network with most locations established before the 1970 USPS reformation. This legacy retail network may not optimally balance the needs of twenty-first century postal consumers and those of the postal operator for an efficient social result.

Since 2007, consumer transactions at USPS retail outlets have declined 17.9 percent, from 2.5 billion to 2 billion. Similarly, revenue from retail outlets has decreased 21.4 percent over the same period, from $14 billion to $11 billion. As part of its comprehensive five-year business plan, USPS has outlined retail network cost reductions of $2 billion. Optimizing the retail network, maximizing retail revenue[1] while minimizing operating costs, provides USPS the opportunity to achieve the goal outlined in its business plan.

It is a challenge to optimize postal retail networks using rigorous methods that recognize the concerns of all stakeholders and produce useful results. This requires detailed, accurate information as well as thoughtful and tested methodologies. In the US, a practical and methodologically rigorous postal retail optimization process is needed to balance USPS's stated desire to downsize the retail network, reduce costs, and continue to serve the public effectively.

Postal retail network consolidation is also an important international issue, for similar reasons (Berger, 2009). The availability of software and inexpensive computational power facilitates conducting robust optimization analyses. Because optimization of the arrangement and location of postal facilities is a comparatively new task, the principles, methods and tools that can be used are not yet highly developed. Section 2 itemizes major elements

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of postal network optimization strategy. Section 3 identifies factors that complicate postal retail network optimization. Section 4 describes applicable econometric analysis, specifically walk-in revenue versus socioeconomic variables. Section 5 reviews optimization of customer access to post offices with supply and demand constraints. Section 6 discusses application of network optimization tools at a national level, and Section 7 concludes.

## 2 MAJOR ELEMENTS OF POSTAL NETWORK OPTIMIZATION STRATEGY

An essential element of postal retail network optimization strategy is consideration of the interests of both the customer/consumer (mailers and recipients) and the supplier/producer (the postal operator). Classic optimization modeling relies on an optimization function that minimizes or maximizes output, subject to a set of constraints (Intriligator, 1971). Optimization modeling for retail facilities should incorporate the interaction between supply and demand.

It is worthwhile to consider optimization strategy from two sides – the service supplier/producer side and the customer/consumer side (Ruby, 2003). In the postal retail network, USPS supplies services, while mailers (and recipients) represent customers.[2] An appropriate optimization goal of the postal operator as a supplier is the maximization of retail postal revenue and the minimization of related costs.[3] A goal of mailers (in this case – retail customers) is minimization of distances to the nearest post offices where they can satisfy their demand for postal services/products.[4]

Taking into consideration the interests of both suppliers and customers, two main optimization approaches are considered: (i) optimization of postal retail revenue/costs with constraints on the degree of customers' access to postal retail facilities; and (ii) optimization of customers' retail access to postal retail facilities with constraints on postal retail revenue/costs.

To date, studies have adopted either a 'customer-side' approach focusing primarily on optimal access for customers to postal retail facilities (Klingenberg, 2011; Waters, 2011) or else a 'supplier-side' approach focusing primarily on optimization of postal revenue (Yezer, 2010). Applying these methods requires the use of spatial software (that is, GIS tools) and econometric modeling techniques (that is, statistical methods).

Waters (2011) performs his analysis for the state of Kansas. His algorithm allows minimization of total weighted population distance to the post offices in the network (pp. 10–11). However, his analysis lacks supplier-side constraints considering postal revenue/cost levels. His model can propose optimal levels of access to postal facilities, but supply-side limitations may pose practicality concerns.

Yezer (2010) describes optimization of postal facilities focusing on supply-side and maximization of postal revenue. His analysis established a spatial revenue optimization function within a regression model. Revenue is estimated for each postal facility as a dependent variable, using the socioeconomic and geographical characteristics of the market area of each facility as explanatory variables (ibid., pp. 19–20). The spatial revenue function reflects the role of USPS as a service supplier. Yezer compares optimal revenue with actual revenue for each facility. It would be instructive to conduct similar

analysis for facility costs. However, the spatial revenue function described in the model contains limitations regarding the description and quantification of customer access.

First, the radius of the market area of each facility is included in the model as part of demand data, and constraints on access are not taken into consideration.

Second, the method used to calculate the radius of a facility's market area is geometrically incomplete. Yezer calculates the radius of a market area as half the distance between adjacent postal facilities (p. 6). Consequently, the Yezer model assumes a circular shape for the market area of a postal facility.[5] The method of radius calculation and the assumption about the shape of the market area creates overlaps in coverage (particularly in urban districts) and leaves certain areas uncovered (particularly in rural areas).

Such limitations suggest a second element of optimization strategy for a postal retail network. The postal network is a transportation network and its optimization should comport with principles of transportation planning. Waters (2011) depicts the postal system as a transportation system. USPS moves 'letters and parcels around a transportation network' and its 'customers travel to . . . post offices' (US PRC, 2011, Vol. 3, p. 1324).

The overall service area of the postal operator should be apportioned into transportation/traffic zones with the retail postal facility as a centroid in each zone.[6] The method of defining the applicable market area for each retail postal facility will thus be different from Yezer's model because the market area of each postal facility will be presented as traffic zone generated as polygon or any other shape derived from transportation planning methods (Lane et al., 1974, pp. 29–34).

Depending upon local topography, there may be significant differences between straight-line distances and driving distances between two points – particularly in rural areas with limited road access; steep, hilly terrain; bodies of water; adjacent forests; or frequent weather-related impediments. For simplicity, both Yezer (2010) and Waters (2011) utilize a straight-line approach to measuring the distance to the nearest retail postal facility. Therefore, another element of postal retail network optimization is that driving distance should be used to measure access to postal facilities because it is more relevant than straight-line distance. Also significant are other less easily quantifiable measures such as availability of parking, average wait time in line, and the quality of retail service assistance. Finally, some retail locations are desirable because they are situated where customers are likely to travel ('anyhow' destinations). In general, this analysis relies on driving distance as a good first-order proxy for purposes of retail optimization of post offices.

Waters measures customers' access to post offices based on population density. This approach may not work well in high-density downtown areas, where a large portion of customers are employees of local businesses who work but do not live in the area. Optimization using residency alone is an oversimplification. A comprehensive analysis of optimal access should take into consideration both residents (population or households) and businesses (employees or establishments), as well as local gathering points such as retail centers. Therefore, modeling customer access to post offices should not be limited to population access.

Yezer in his model establishes a strong statistical relationship between socioeconomic variables and postal revenue. Based on his estimated equation, different socioeconomic variables have different impact on the postal demand in the market area of the post office and, as a result, on the revenue of the post office. The number of households and the

number of employees in the market area have the highest positive impact on revenue, while household income has a modest positive impact. Both the size of the market area and the presence of competitive service providers negatively influence postal demand and revenue (ibid., pp. 19–20).

The retail network proposals offered by USPS since 2009 have not included demographic profiles as part of selecting facilities for discontinuance review. USPS has stated that it 'focuses on actual retail transactions of actual customers and local management's knowledge of the retail customer base, based on interactions with those customers' (US PRC, 2011, Vol. 1, p. 63). This approach considers primarily postal revenue and illustrates a supplier-side focus to the analysis. At the same time there is no contradiction between focusing on revenue (actual transactions) and taking into account socioeconomic variables. On the contrary, the Yezer model demonstrates the relationship between revenue and socioeconomic variables. This suggests the following element: economic variables should be considered in the process of optimization of postal retail facilities and their closings. Classical transportation models such as gravity models consider both residents, people who live in the area (households or population), and people who work in the area (employment of the local business) (Travel Demand Forecasting, 2008).

## 3 FACTORS THAT COMPLICATE POSTAL RETAIL NETWORK OPTIMIZATION

It is important to be aware of the strengths, weaknesses and limitations of the factors and methods used in the optimization process, which can be complicated to varying degrees by a number of factors: (i) geographical/topographical diversity (including water barriers/islands/borders, mountainous terrain or lack or roads); (ii) nonhomogeneous population density or demographic profile; (iii) nonhomogeneous Internet broadband access; (iv) diversity of transportation modes, transit routes or parking regulations; (v) quality of retail counter service/employee helpfulness; (vi) constraints related to the existing retail network since the optimization process does not start from scratch; (vii) change in population and employment over time (demographic trends); (viii) changes in the use of postal services over time (societal trends); (ix) changes in demographic profile over time; (x) changes in transportation networks and transit routes over time; and (xi) accuracy of input data.

Real-world factors can complicate a post office optimization model to varying degrees. In general, geographical features and topographical diversity change the relationship between straight-line distance, driving distance and driving time. Bodies of water, islands or national borders may impose barriers that block passage and require longer or more laborious alternative routes or even alternative forms of transportation. Mountainous terrain is associated with the greatest differential between straight-line distance and driving distance and difficulty, and can cause access issues that may become exacerbated in the wintertime. Some, but not all, of these issues can be addressed by substituting driving routes for straight-line distances.

Population density is non-uniform, varying significantly throughout a service area and even varying throughout a census block or tract. Demographic profiles are similarly

non-uniform. As there is a distinct relationship between age cohort and mail usage, areas with a higher average age may make greater use of the mail.

Availability of affordable Internet broadband service can have an impact upon household mail usage, upon the use of packages, and also upon the rate of electronic substitution for letter mail. The existence, alignment and reliability of bus and other transit routes affect post office optimization, as does the availability of parking and the nearby levels of traffic congestion. Customers can be drawn to a post office with more parking available, even if a geographically closer office exists. Similarly, the perceived quality of retail counter service (including wait times on line) and the level of helpfulness of employees is a factor that can draw postal customers toward some locations and away from others. There are locations to which people ordinarily travel for other purposes (anyhow travel). If those places coincide with post office locations, these centers of activity will likely contribute to the postal customer base. Another factor that strongly affects post office optimization is the existence of the current network. The slate is not blank. Locations are not being selected from scratch. Rather, the existing post offices form a base from which changes are to be made. Finally, there are changes that occur over time: population, demographic profiles, and societal trends including the use of postal services, and to a lesser degree, changes in transportation routes. As a result of these factors an exact solution is not possible.

## 4 ECONOMETRIC ANALYSIS: WALK-IN REVENUE VERSUS SOCIOECONOMIC VARIABLES

Data development, spatial modeling, and further optimization of the mail network are facilitated through the use of software in the areas of GIS, statistical analysis, optimization and database handling. The use of such software makes the application of assessing and including the aforementioned optimization principles practical. This will improve the ability to reconfigure the postal retail network in an optimal and objective manner. This econometric analysis implements some of these principles in optimization of postal retail networks.

First, a relationship is established between walk-in revenue (reflecting transactions between USPS and customers) and socioeconomic variables. The entire US serves as a study area. A transportation zoning system for the US was developed. Each zone is equal to a 5-digit ZIP code area with the post office as a centroid. A base year of 2008 was used.

Original socioeconomic data input into the model included population, number of employees and number of establishments by place of work, adjusted gross income and number of tax returns. The data were collected by 5-digit ZIP code from US Census Bureau and IRS (Internal Revenue Service) online databases. The 2008 data on number of employees and number of establishments was collected from the US Census Bureau (2008). The 2008 data on number of households was estimated based on data on the number of households by 5-digit ZIP code for the years of 2010 and 2000, respectively, from 2010 and 2000 US Census data (2010b). The 2008 data on average adjusted income per tax return was calculated using data on adjusted gross income and number of tax returns from the US Internal Revenue Service (2008). For each 5-digit ZIP code average

adjusted income per tax return was calculated as adjusted gross income/number of tax returns.

Walk-in revenue data from individual USPS post offices aggregated by 5-digit ZIP code was set as a dependent variable in a proposed regression model. All socioeconomic and walk-in revenue data were matched together using SQL queries in MS Access. Statistical analysis was performed with SAS Enterprise 4.2 software. After multiple runs, the following three socioeconomic variables were included in a regression model as independent variables: number of employees by place of work, average adjusted income and number of households.[7] The final dataset includes data for 18,629 5-digit ZIP codes in the US. The obtained regression equation exhibits a very strong relationship between walk-in revenue and three socioeconomic variables – households, employment and average adjusted income per tax return. Confidence limits are set at 99 percent and all variables are significant at the 0.01 level. Statistical tests show that all of the coefficients of the independent variables are positive and highly statistically significant and there is no multicollinearity between explanatory variables.[8] The greatest effect on revenue is produced by number of households, followed by the impact from the number of employees. Average income by tax return has a much more moderate positive impact on revenue.

The estimated regression equation is:

$$WIR_{zip5} = -25{,}794 + 73.87HH_{zip5} + 19.48Emp_{zip5} + 2.63AITR_{zip5},$$

where $WIR_{zip5}$ is the walk-in revenue; $HH_{zip5}$ is the number of households in a 5-digit ZIP code area; $Emp_{zip5}$ is the employment by place of work in a 5-digit ZIP code area; and $AITR_{zip5}$ is the average adjusted household income per tax return in a 5-digit ZIP code area.

The estimated regression equation can assist decision making in a number of ways. First, it permits an estimation of optimal revenue as a function of socioeconomic characteristics of the area (on the 5-digit ZIP code level) and making the comparison between the actual and optimal revenues. Second, it provides useful data for making decisions about closing facilities in a particular 5-digit ZIP code area (if the post office is closed, a replacement post office in the same 5-digit ZIP code area is required to assume the functions of the closed one and support customer demand and walk-in revenue). Third, it shows that USPS should take into account socioeconomic characteristics and environment when assessing retail facilities. Fourth, it helps USPS estimate current demand (for example, the negative intercept in the estimated regression equation illustrates that USPS would not achieve positive revenue until households, employment and average income in the area reaches a certain level). Finally, if USPS relies on projected (and not one base year) socioeconomic data, the model can be transformed into a forecasting model and can project walk-in revenue set in a regression equation as a dependent variable from projected explanatory socioeconomic variables.

A similar analysis can be performed for revenue and costs, and net revenue can be estimated. More precise estimates of market area would be useful, using GIS techniques. More precise definition of market areas, especially for urban areas, requires more refined zones based on census tracts, census blocks or traffic analysis zones developed by transportation departments in metropolitan planning organizations (MWCOG, 2010; DRCOG, 2012).

# 5 OPTIMIZATION OF CUSTOMER ACCESS TO POST OFFICES WITH SUPPLY AND DEMAND CONSTRAINTS

To further illustrate the principles of postal retail network optimization, this chapter establishes an optimization model for the state of Alaska using IBM ILOG LogicNet Plus XE 7.2 software. Alaska was selected as the modeling region for three main reasons. It is an isolated state and can be treated as a relatively independent transportation system and postal network. In addition, it is typically excluded from analysis performed for the US (since it is a non-contiguous state within the US). Finally, it consists primarily of rural areas, and that allows the model to undertake analysis unsuited to urban areas.

IBM LogicNet is a highly capable software package that allows spatial optimization of a network based on various optimization criteria and multiple constraints.[9] There were three primary goals in modeling the postal network using LogicNet. First, this method applies most of the optimization principles described in Section 2. Second, the method analyzes the tradeoffs between customer requirements (that is, access, demand) and supplier interests (that is, revenue, number of post offices). Third, the method analyzes procedural challenges encountered during portions of the LogicNet modeling process (database development, set-up assumptions and network assignments, and multi-criteria optimization itself).

## Development of Input Data

LogicNet optimization software allows modeling the spatial interaction between customers and plants with multiple constraints on supply, demand, access, and so on. Each resident of Alaska was modeled as a customer/mailer.[10] Alaska's post offices were represented as plants that provide/ship services/products to customers. Data on population were drawn from each census block based on 2010 US Census data (US Census Bureau, 2010a). To perform spatial network analysis, geographic coordinates for customer and supplier locations were required for the model. Coordinates for the center of population for each census block were obtained from a US Census database (ibid.); coordinates for postal facilities were obtained from USPS facilities database. This is consistent with general transportation network modeling – each census block serves as a transportation zone, and the center of its population serves as a centroid. The LogicNet model also calculates distances as driving distances, and this provides a significant improvement in modeling the approximation of customer access compared to its approximation as straight-line distances applied by Yezer (2010) and by Waters (2011) in their respective analyses.

## Modeling Process and Initial Results

We first optimized customer access by minimizing the weighted average distance between customers (located in 534 census blocks) and postal suppliers (203 post offices). Three initial constraints were included in this model: (i) maximum acceptable distance from customers to a post office; (ii) percentage of customer demand satisfied; and (iii) maximum number of post offices that could be kept open.[11] For purposes of this model, it was assumed that each mailer produces equal demand for postal services.[12] The population

figure in each census block was adopted by the model as an approximation for customer demand for postal services.

LogicNet permits the user to change optimization criteria or set up additional constraints in an optimization model. For example, the model can calculate optimal results based on optimization criterion and constraints described above with the minimum number of active (open) postal facilities in the network. After several preliminary runs, the maximum distance constraint was set at 50 miles with over 99 percent of customer demand satisfied. The optimal solution obtained in the model showed that in order to serve customers, 126 Alaskan post offices (out of 203 post offices analyzed) could remain open. Weighted average distance between population centers of each census block and the nearest post office is five miles.

One very useful LogicNet modeling feature is an ability to perform so-called multi-objective analysis and generate a graph illustrating the tradeoff between the number of open postal facilities in the network and the weighted average distance from customers to a nearest post office (Figure 9.1).[13]

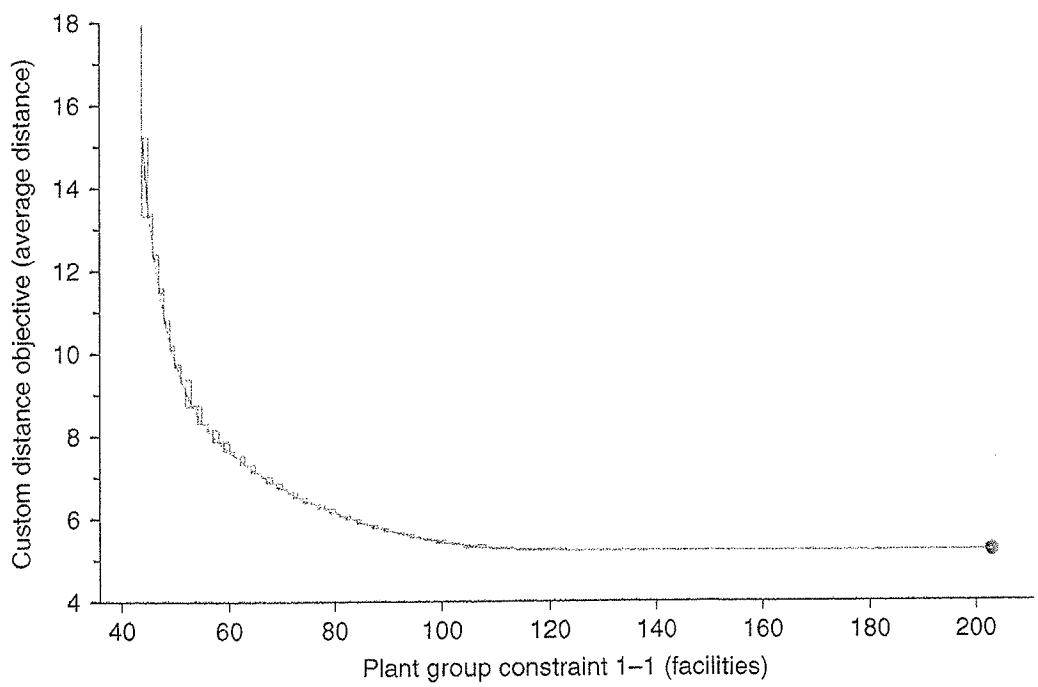


*Figure 9.1 Proximity to customers and number of facilities*

A review of the plant-to-customer report generated by the LogicNet model (representing the assignment of census block population to post offices) highlighted the need for one additional constraint. In analyzing the LogicNet plant-to-customer report, without a constraint on post office capacity (that is, assuming the unlimited capacity for each post office), the model tends to monopolize (localize) the supply of services in an urban area within one or two post offices. To estimate an upper bound for post office retail capacity, this method analyzed data on the number of retail windows in a post office[14] as well as data that match walk-in revenue and population served by these facilities.[15] Based on these two types of analysis, it was possible to develop a rough

estimate for the upper limits of population that can be served by each of five types of postal facilities (related to the number of retail windows in the facility). Upper limits on the maximum number of people that could be served were introduced into the model as a maximum capacity constraint for each post office. Adding capacity constraints into the model while keeping all other parameters unchanged resulted in an increase in the number of post offices that remain open (from 126 to 134). Weighted average distance between population centers of each census block and post offices increased as well – from five to six miles.

A primary modeling goal was to incorporate the interests of both the service supplier and the customers. As it is customer access being optimized, the model incorporated a revenue constraint. Revenue of $10,000 was considered as a minimum floor for each facility.[16] Given the relationship between walk-in revenue of facilities and population served by these facilities, a minimum boundary for post office capacity was assumed in terms of the minimum population that it should serve to generate annual revenue higher than $10,000.[17] However, adding this constraint did not have any notable effect on the results. Therefore, the optimal scenario selected in the previous stage of the modeling process included post offices that would be able to generate walk-in revenue of at least $10,000.

The modeling forms a base for further, more detailed analysis. There are also lessons learned from the modeling. First, it illustrates the broad opportunities for application of modern optimization software to postal needs. Second, similar analysis performed for the State of Alaska could be performed for the US as a whole, or any other country. Third, the main challenge is not the optimization itself, but the development of applicable input data (that is, socioeconomic data by customer and cost-revenue data by post office). Fourth, proper treatment of cost data is required to appropriately consider the postal operator's interests. Fifth, the model can be set up using minimum revenue (net revenue or costs) as optimization criteria with multiple demand and supply constraints. Sixth, additional data on post offices, customers, mail products or transportation can be included in the model to better define a network and/or specify an additional constraint. Accounting for these factors will increase the quality of the retail network optimization model and the value of its potential applications.

## 6 APPLICATION OF NETWORK OPTIMIZATION TOOLS ON A NATIONAL SCALE

In order to change a retail network, it is important to understand the existing retail network. In the US, this starting point poses significant difficulties. USPS has made important strides in maintaining information on the location and cost of its retail outlets, but this information continues to be fragmented and incomplete for a variety of reasons. At this juncture, a comprehensive optimization analysis using all of these methods is infeasible. That does not mean that informative analysis cannot be developed at this time; analysis using the data currently available highlights where baseline data needs to be improved and where savings opportunities can be realized. The following subsections outline the decisions regarding national-level data which must be made before an optimization solution is developed.

## Current Postal Retail Network: Optimization Baseline

USPS has reported operating cost and revenue data for 30,466 post offices in FY 2010 (USPS, 2011). It is important to differentiate between operating revenue and walk-in revenue, which isolates revenue generated by the retail network. USPS has measured the total operating costs for its 30,466 post offices as more than $34 billion in FY 2010, or roughly 50 percent of its total operating costs.[18] The retail network is composed of the post offices, the post office boxes located in post offices, and USPS employees who provide retail counter service at those post offices. However, retail network activities are only a portion of the total activities that occur at post offices. In order to balance the cost of providing retail services at a given location with the demand for that market area, it may be vital to isolate the costs directly attributable to retail activities as input data for an optimization model. For the US, this information is not currently available.

Where data accuracy is an issue, it may be beneficial, from a cost perspective or a time perspective, to model the cost of retail activities as a starting point for a national optimization. If a post chooses to model retail costs at a national level, analyzing the available data at individual locations for deviation from the modeled cost becomes an important task. In order to further a high-level understanding of the cost structure of the US postal retail network, retail costs were modeled. In this model, each retail window costs $80,000 to open (employee wage costs), and the rent and other miscellaneous costs are $45,750 per facility. This leads to a modeled total retail cost of $6.4 billion. Modeling retail costs in this fashion as a starting point for analysis is useful for several reasons. In the US, over 20,000 offices generate retail revenue of less than $150,000 per year, meaning that these offices have a modeled cost greater than actual revenues. Such cost modeling can provide immediate insight into market areas where retail access efficiency can be improved.

## Market Areas: Census Data

As discussed in Section 4, both residents and businesses generate retail revenues for USPS. A variety of regional information is available about market areas, including the 5-digit ZIP code employment statistics discussed in Section 4. However, the available geographical information about where people work is currently not as detailed as the census data. For the US, the data provided by the US Census is an accurate informational database that provides the residential location of over 311 million people. Using census block data as a starting point for a national optimization exercise is prudent, although it can be improved upon. The geographical distribution can be used to group residents into market areas, and a distance can be calculated to their nearest postal location.

Each census block is drawn and the centroid is mapped. The distance from the center of each census block (centroid) to the retail facility is measured. This method has limitations, as residents are not captive to the closest post office. This method also assumes that each person is located in the population center of the census block, which is a rough estimate, at best. Since the census block is the smallest unit provided by the Census, this is the most granular data regarding geographic location currently available. Table 9.1 contains the current distance to a postal retail location for the US population using this method.

Much like determining the current cost of operating retail facilities is a key data input for a retail optimization exercise, determining the market area responsibility of each

*Table 9.1 Distance between census blocks and post offices*

| Distance (miles) | Population | Percent of population |
|---|---|---|
| More than 20 | 252,088 | 0.08 |
| Between 15 and 20 | 415,466 | 0.13 |
| Between 10 and 15 | 1,536,653 | 0.49 |
| Between 5 and 10 | 17,098,606 | 5.49 |
| Between 4 and 5 | 13,817,934 | 4.44 |
| Between 3 and 4 | 26,002,103 | 8.36 |
| Between 2 and 3 | 51,288,326 | 16.48 |
| Between 1 and 2 | 99,242,719 | 31.89 |
| Less than 1 | 101,558,963 | 32.63 |
| Total population | 311,212,858 | |
| Average distance (miles): | | 2 |

facility is a key starting point. Perfect market area information is not currently available, but the thorough Census Block data allows for very detailed geographical analysis. If census data of this type are not available to a given post, alternative data can be used to define the problem at that national level, provided that there will be additional detailed analysis to check the accuracy of the broad national assumptions in areas where changes are going to be implemented. One potential starting point for geographical coverage is the distance between current postal locations. This information could be coupled with the number of persons who use each postal facility to develop a market size and area for each facility. If this information is also not available, a postal operator could use the number of retail transactions at each facility to estimate the number of customers served.

By linking each retail facility to a market area, the USPS can determine how each facility fits into the complex geographical coverage web. Understanding this web of coverage will allow posts to determine where retail access can be improved.

## 7 CONCLUSION

This chapter has outlined potential methods, ideas, and scenarios that can be used for postal retail network optimization. In the current postal market environment, operators are faced with a universal challenge: maximize revenue and minimize costs. Retail access plays a major role in the financial stability of operators. In the US, over 20 percent of revenue is generated through retail channels. In order to ensure that retail revenue is maximized, operators require a clear understanding of their customers and the corresponding market areas. A well-defined market area leads to efficient distribution of postal access. Such a distribution would balance the needs of the customers and the needs of postal operators.

The analytical tools described in this chapter have not yet been applied to the problem of post office optimization. Such optimization should take into account not only supplier and customer perspectives, but also factors such as population density, demographic diversity, local topography and transportation routes. Attempts at optimization without

considering interests of both the postal operator/supplier and the postal customers are likely to produce distorted and misleading results.

Moreover, geography, population density and socioeconomic profiles differ among the various nations. Those national differences suggest the value of a flexible analytical approach to optimizing a retail postal network, an approach that can work with a variety of diverse geographies and population profiles. An approach which uses either only GIS tools or only econometric tools lacks the flexibility afforded by utilizing a combination of these methods.

## NOTES

* The views represented are solely those of the authors and not necessarily those of the Postal Regulatory Commission.

1. Maximizing retail revenue relates to connecting potential customers with sales locations and reducing geographical and other obstacles to access. It is qualitatively different from profit maximization of the enterprise.
2. Mailers not only receive mail products, but also send them.
3. The supplier (postal operator) must also maintain a service quality level acceptable to customers.
4. These may include the purchase of stamps or money orders, sending of parcels, renting post office boxes, or other services.
5. Professor Yezer recognizes the limitation of such assumption and suggests that it would be useful to consider the precise shape of the market area (Yezer, 2010, p. 20).
6. In transportation and regional models a centroid is a point used to represent the characteristic activity of a zone (University of New Brunswick, Transportation Group, 2008). The centroid may focus on the highest population density and/or transit activity in the zone. In other words, and in accordance with the principles of transportation planning, a zone centroid should be located 'at the centre of gravity of all trips from the zone' (Lane et al., 1974, p. 53). That is why the centroid location in the zone might be very different from the geographical center of the zone.
7. Due to multicollinearity observed between the number of employees and the number of establishments, only one variable remained in a regression model. The choice of the variable left in the model was confirmed by statistical testing.
8. The absolute $t$-values of estimated regression coefficients are larger than 7, $F$-value is 11,160 and $R$-square is 0.64. A variance inflation factor test ensures that there is no multicollinearity between the explanatory/dependent variables.
9. LogicNet Plus XE software could be used for 'supply chain network optimization and . . . decision support solution for ongoing strategic planning' (IBM, 2012).
10. Such simplification would allow modeling the network and performing the desired analysis. However, in the future in modeling the customers, local businesses or their employees should also be represented.
11. Since all post offices included in the model (totaling 203) are pre-existing post offices, it was assumed that they might all be kept open. So, the number of post offices was set to between 1 and 203 in the model.
12. Services provided by postal facilities were considered as one aggregated product. It will be useful in the future to model demand for the most frequently used mail products and services.
13. The distance from the center of population block to a post office is an approximation for customers' access adopted in the model. The more refined the zones (population areas) used in the model, the more precise the results.
14. A nonlinear power regression was established between walk-in revenue and number of retail windows. The analysis was performed for the State of Alaska, which is characterized by substantial isolation from other parts of the country, as well as comparatively low population density. It is possible that similar analysis performed for other states, or at a national level, might produce very different results.
15. Population data were collected by 5-digit ZIP code. All walk-in revenue data by post office were aggregated by 5-digit ZIP code. The population of those 5-digit ZIP codes with no post offices was redistributed by other 5-digit ZIP codes with a post office based on a minimum driving distance criterion. Microsoft MapPoint software was used in this analysis. The relationship between walk-in revenue and population was estimated in a form of a polynomial function.
16. This complies with the recent estimates made by USPS for facilities in the State of Alaska (Boldt, 2011, p. 15).

17. According to the estimates relied upon in this chapter, a post office should serve at least 75 households to be able to generate annual revenue of at least $10,000. It is important to note that the postal revenue will be generated not only by these households, but also by local businesses and their employees. Since the overall analysis was performed for the State of Alaska, these estimates are applicable mostly to low-density areas.
18. The Postal Service total operating cost was $75.6 billion in FY 2010.

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