Comprehensive Study of the Location of Highway Division Offices

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A study was undertaken for the Alabama Highway Department to determine whether field maintenance operations would be more efficient if one or more of the nine division offices were relocated, or if an additional division office was constructed. Historical changes in division office locations or division boundaries, previous studies performed by the department to find optimum locations of district (county-level maintenance) offices, and results of extensive interviews with department managers were examined. Additionally, the research staff obtained data on field office locations from other southeastern departments of transportation, compared division characteristics to look for more efficient arrangements, conducted two different types of modeling exercises, and performed an economic analysis. The study found that one existing division office could be moved approximately 50 mi to substantially enhance work travel patterns. The payback period for the relocation of this office would be 5 to 7 years. As a result of the study, the Alabama Highway Department has begun the relocation of the division office.

Highway agencies must make subjective decisions while selecting new locations for field maintenance offices. There appear to be few or no firm criteria that may be used to decide when a new office is needed or how to optimize the location of the new office. This study was conducted by the University of Alabama to assist the Alabama Highway Department in making such decisions.

The project work included analysis of historical changes in department field offices, interviews with department managers, examination of previous studies by the department to relocate district offices (county-level maintenance offices), survey of other southeastern state departments of transportation (DOTs), comparison of characteristics of existing department division offices, two modeling efforts, and an economic analysis.

ORGANIZATION OF THE ALABAMA HIGHWAY DEPARTMENT

The central offices of the Alabama Highway Department are located in Montgomery, Alabama. This location provides convenient access to all of the department's field offices. For management of maintenance and construction activities, the department has divided the state into nine large geographical areas called divisions. The divisions are relatively autonomous. They are subject to the policies and funding provided by the central office, yet their managers have great leeway in directing operations. Within each division, there are three to six subdivisions called districts. Each division and each district has its own office complex. This study focused on whether new divisions were justified or whether existing divisions could be reconfigured (by realigning districts) to increase service or efficiency of operation. The division boundaries and district office locations at the time of this study are shown in Figure 1.

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HISTORICAL CHANGES

The department had periodically shifted districts between divisions for the sake of efficiency and has occasionally created a new division to keep pace with growth in the state. These actions are shown by three substantial changes of the last 25 years.

Special division offices had been created in Birmingham and Montogmery to guide the development of the Alabama Interstate system. These offices were abolished in 1965. At the same time, an entirely new division was created for the Montgomery region from parts of the existing Divisions 3, 4, and 7, bringing the total to eight division offices.

Until 1973, Division 1 stretched across the entire top of the state. This width became awkward and too large to manage efficiently, so it was subdivided to create two divisions. When this occurred, all divisions in the state were renumbered from the northeast to the southwest, and at least eight districts were simultaneously shifted to new divisions. In 1980, the third major change occurred when division boundaries were again realigned. At least three districts were transferred at this time into the adjacent division for the sake of efficiency.

PREVIOUS FIELD OFFICE LOCATION STUDIES

The department had conducted two previous studies to determine optimum locations of offices; however, both of these studies were directed toward finding the best locations for district offices within a given division. In both studies, the researchers applied analytical techniques to minimize employee travel time in reaching job sites. The linear programming technique was used to find the number and location of offices that would minimize travel time (i.e., lost work time) while employees traveled to the job site. The studies documented two important issues. First, of all the factors considered during the two analyses, employee travel time was found to be the most important in optimizing total roadway main-

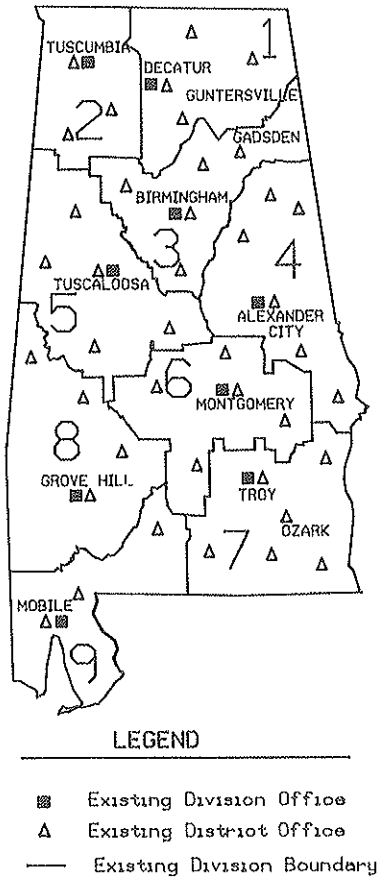

FIGURE 1 Current district and division office locations.

tenance costs. Second, the research found in both instances that the most efficient mode of operation was to close some existing offices. The department's efficiency increased with consolidation of operations through closing of offices. The key in minimizing maintenance expenses was consolidation, not expansion, of field offices.

INTERVIEWS WITH DEPARTMENT MANAGERS

The research staff conducted a series of interviews with key managers to gain insight into the factors that were felt be be important in locating field offices. Twenty individuals were identified as prospective interviewees. Discussions were conducted with all nine division engineers, five of the department's most-senior district engineers (all from urban locations), and six high-level managers from the central office.

The managers were keenly aware of the need for efficiency in field maintenance operations. The topic mentioned most frequently during the discussions was minimization of travel time for employees, which translated into increased work time at the job site. The second most frequently mentioned was minimizing the creation of new field offices to minimize overhead expenses and conserve maintenance monies. Virtually all managers were aware of previous studies that targeted travel time and closing of offices.

Several managers indicated that division or district boundaries should follow county lines. When a county was divided between two districts or divisions, highway managers experienced difficulties with local politicians. It seemed that the politicians did not always know which highway manager controlled which roads, and they consequently became frustrated.

Division engineers expressed the opinion that several divisions were already too small, and that their managers had difficulty in fully using division-wide crews. They were concerned that adding a new division would further decrease the size of adjacent divisions and seriously diminish efficiency.

There were few clear thoughts among the division engineers about how to correlate growth trends in population, vehicle travel, economic development, and other factors with the need for new division offices. One important consideration was present in almost every interview. This was a strong concern for the human aspects of closing or moving division offices and putting people out of work. The managers expressed support for such actions only if they represented the best long-term interests of the department, and urged that these changes not be taken lightly.

ANALYSIS OF OTHER STATES

A survey was conducted of a dozen southeastern state DOTs. The survey was conducted for two reasons: (a) to review the size and field office configurations of other DOTs for comparative purposes, and (b) to determine if any state had developed a model for selecting locations for division offices. The interviews were conducted by telephone. Discussions were held with the chief engineer, maintenance engineer, and other knowledgeable management officials, and requests were made that the discussion be confirmed with written materials following the telephone conversations. Nine of the states in the survey provided these written materials.

No state had developed a successful, quantifiable methodology for measuring the need for new division offices or for determining the best locations for division offices. Almost without exception, managers contacted during the telephone survey expressed a desire for such a tool.

A comparison of DOT configurations from state to state yielded useful results. Examples are shown in Figures 2 and 3. One useful piece of information shown in Figure 2 is the number of lane-miles of roadway per division. In this factor,

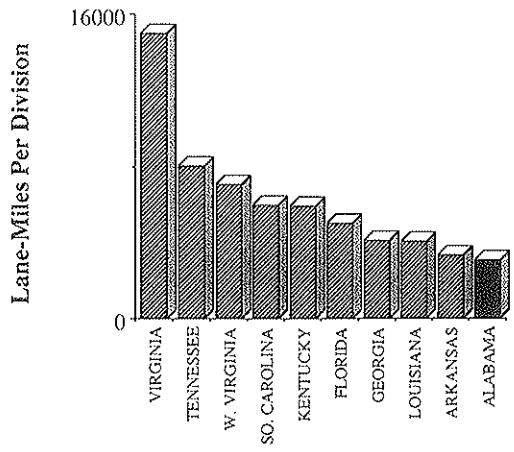

FIGURE 2 Lane-miles per division office.

Alabama was found to rank last. Because the department had fewer miles per division than other southeastern states, its divisions had to be smaller than those of other states. Alabama was already subdivided into smaller units than other state DOTs in the southeast. This suggested that any decision to add additional division offices had to approached carefully. Otherwise, Alabama divisions could become too small for efficient operations. Figure 3 shows similar information regarding maintenance funds. Because Alabama ranked last among the surveyed states, further subdivision would diminish, not increase, maintenance capability.

Figure 4 showed a familiar pattern. The amount of vehicle mileage per division was only relatively low in Alabama, primarily because the department had small divisions with a limited number of miles of state route in each. However, because Alabama was last in miles of road per division but above that level for vehicle miles of travel (VMT), Alabama roads were carrying more traffic per mile than some sister states.

In summary, two important facts emerged from this portion of the research. First, no other states had developed a way to predict the need for, or the optimum location of, division offices. Second, extreme care had to be used before creating any additional division offices, because Alabama divisions were already smaller than those of all other southeastern states.

COST FOR NEW OFFICES

The creation of new district or division offices would require the one-time expenditure of funds for capital development, plus creation of a continuing annual cost for the salaries of administrative staff to run the new office. Department accounting records were screened to determine the costs associated with new division or new district offices. The values (in 1989 dollars) are summarized as follows:

Item	*Amount (1989$)*
Construction of new division office	3,948,020
Annual personnel expenses for new division	1,750,731
Construction of new district office	1,414,539
Annual personnel expenses for new district	190,000

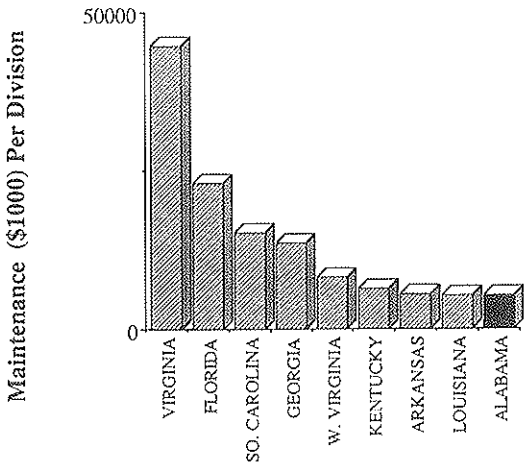

FIGURE 3 Maintenance funds per division office.

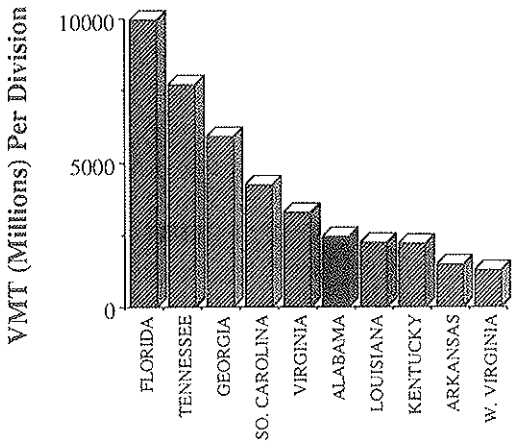

FIGURE 4 Million VMT per division office.

The capital costs included land, design fees, office building, office equipment, rolling stock, warehouse, shop, soil testing lab, gashouse, and assembly area. These cost values represented the department's actual expenses the last time that such facilities were constructed, adjusted for subsequent inflation. The most recent division and district offices were both small, so cost values were thought to be conservative, but appropriate for this study.

New district offices absorb some of the maintenance responsibilities of surrounding districts. Most of the employees of new district offices are thus transferred from these same offices, so the increase in payroll is small. Division employees are primarily administrative in nature and cannot be transferred from other divisions. A new division office requires a new staff of administrators, with a large (new) payroll.

COMPARISON OF DIVISION CHARACTERISTICS

The research staff tabulated and compared several characteristics of division offices to identify parameters that might be used to predict the efficiency of field office operation. The research staff also wished to find the normal range for these parameters. The staff examined lane-miles of highway, centerline miles, vehicle-miles of travel, population, population density, maintenance costs, and economic factors. Ideally, these characteristics would be balanced between divisions; however, real-world constraints often prevent such a balance.

One of the most pertinent findings of the review was that maintenance expenses were closely related to lane mileage. The comparison is shown in Figure 5. The strong relationship between lane mileage and maintenance cost in each division was confirmed through a statistical analysis. A regression model was used to predict maintenance costs based on lane-miles per division, with strong measures of effectiveness. The R^2 value was 0.80 and the standard error of estimate was 231 for the following equation:

$$\text{Maintenance (in \$1,000)} = -205.1 + 1.926\ (\text{number of lane-miles})$$

Further examination of characteristics indicated that population (see Figure 6) and vehicle mileage varied widely from

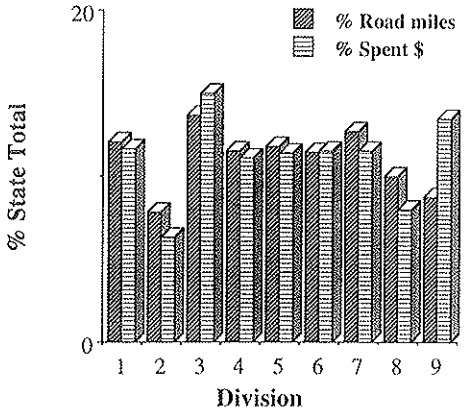

FIGURE 5 Maintenance funds versus centerline miles.

division to division, and that certain divisions seemed out of balance. In particular, Divisions 2 and 8 had much lower population and mileage values, whereas Division 3 had more than its share of the various parameters.

Many characteristics were tabulated, examined in this manner, then tested statistically to identify significant patterns of variations. These variations from division to division provided the initial clues to possible changes that might provide more efficient operations.

p-MEDIAN STUDY

The *p*-median statistical modeling process was used to identify relationships between divisions. A brief description of the *p*-median portion of the research project was published by Turner et al. (*1*). This model determined the optimum number and locations for field offices using surrogate measures, given a fixed number of field offices and the distances between them.

The model worked by assuming trial locations of district offices, and calculating the total travel from each node in the transportation system to the closest district office. Once the amount of travel was calculated, trial locations of division offices were established and the total travel between district and division offices were calculated. The model continued trying different district and division office locations until it found the most efficient sites (for which total travel was minimized).

More than 60 scenarios were modeled using the *p*-median technique. For example, one scenario might have 9 division offices, and the next scenario might have 10 division offices. The model was adjusted between scenarios by using different weighting parameters (miles of pavement, population, economic factors, etc.) to portray the attractiveness between districts and divisions.

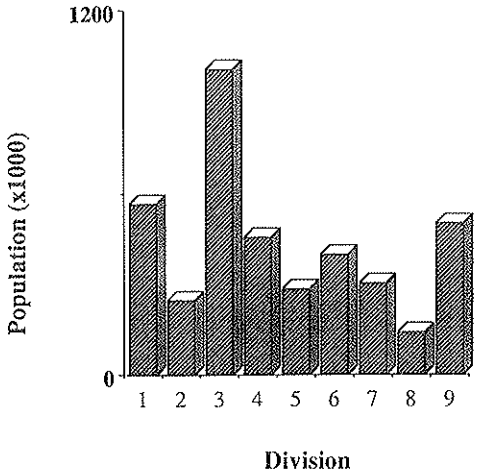

FIGURE 6 Population per division.

Number of Division Offices

The *p*-median model calculated an objective value each time it was run. The objective value was an approximation of total travel time. By examining objective values for different scenarios, the best number of division offices was studied. Figure 7 shows a plot of marginal changes in objective value as the number of division offices increased. The figure indicates that for more than seven division offices there was little increase in efficiency. In other words, when the department increased from seven to nine divisions, there was only a small increase in travel efficiency because of diminishing returns (i.e., the curve on Figure 6 was getting flatter). If the department was to have more than nine offices in the future, there would be little real increase in efficiency of operation. By adding a 10th division office (and increasing overhead costs by 11.1 percent), a gain of only about 2.3 percent would be experienced in travel efficiency. This value suggested that the existing level of nine division offices was a reasonable maximum.

Location of Division Offices

Several scenarios were evaluated to determine the appropriateness of the location of existing offices and the potential for placing new offices at other locations. The model suggested that five existing offices (located in Mobile, Montgomery, Birmingham, Tuscaloosa, and Tuscumbia) were extremely well placed. It suggested that the offices in Division 1 (Decatur), Division 4 (Alexander City), Division 7 (Troy), and Division 8 (Grove Hill) might be more effective if moved to

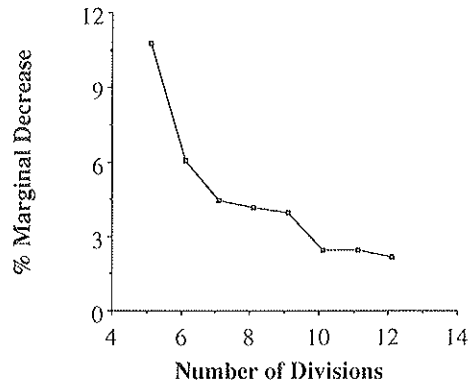

FIGURE 7 Marginal change in objective value.

new locations. Minor improvements could be experienced from relocating Divisions 4 and 8, with more substantial improvements from relocation of Division 1 (from Decatur to Guntersville) and Division 7 (from Troy to Ozark). The model also suggested that an east Alabama city (Gadsden) might be considered for a new office. The locations of these cities are shown on Figure 1.

The *p*-median study was not an absolute predictor of the efficiency of various office configurations because it only examined travel distance, and it used surrogate measures of effectiveness. The model was used because it gave good indications of potential efficiencies, which could be confirmed through other models.

GEOGRAPHICAL INFORMATION SYSTEM LABORATORY MODEL

The researchers used the unique features of the University of Alabama Geography Department's geographical information system (GIS) laboratory to prepare an additional, more-specific model. This computing system was used because it was identical to the computer-aided design and drafting system operated by the Alabama Highway Department.

The GIS system allowed the construction of a model based on a graphic component (map) and an associated data base (characteristics associated with the map). In this case, the map consisted of the state roadway system, and the data base consisted of characteristics associated with it. The characteristics were type of roadway, lane-miles, traffic volumes, maintenance costs, and similar parameters.

A unique feature of the specific model allowed a fence to be drawn around any area on the digitized map. The computer would then calculate the total travel to reach a central office from each roadway segment within that fenced area. When divisions were fenced, an accessibility factor could be calculated by the computer. By moving the fences or by selecting different theoretical locations for division offices, multiple accessibility factors could be calculated and compared. The majority of the research project was used in formulating scenarios and calculating accessibility factors using the travel-specific model.

The model was used for extended investigation of about 20 different scenarios. Four of these were of primary interest to the study. They included

1. Relocate the Division 1 office from Decatur 50 mi southeastward to Guntersville (Scenario D in Figure 8)
2. Relocate the Division 1 office to Guntersville, and realign districts within Divisions 1, 2, and 3 to achieve a better balance (Scenarior G in Figure 8)
3. Relocate the Division 7 office from Troy 30 mi southeastward to Ozark (part of Scenario H in Figure 8)
4. Create a Division 10 in Gadsden, an eastern Alabama city (Scenario I in Figure 8)

The changes in accessibility factors for each of these scenarios were calculated and examined, and are presented in Table 1.

In addition to the four primary scenarios, Scenario L has been listed to illustrate the maximum savings in travel if all offices were moved to optimum locations. This last option was obviously cost-prohibitive because it would require the relocation of many offices and the construction of many new offices.

ECONOMIC ANALYSIS

The research staff identified several factors that might affect the cost-effectiveness of new or relocated division offices. These included the following types of items:

- Expenses

1. One-time cost of new grounds, facilities, and equipment;
2. Continuing cost of new employee salaries;
3. Diminished local economy caused by lost salaries resulting from the closing or relocation of a division office;

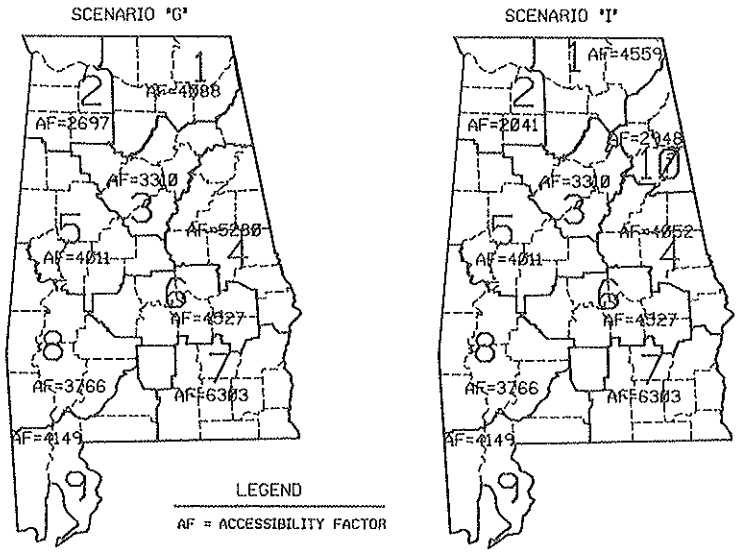

FIGURE 8 Sample scenarios.

4. Diminished local economy caused by lost materials and services purchases resulting from the closing or relocation of a division office;
5. Lost jobs for employees whose jobs end, and who do not transfer to a new or revised division;
6. Increased commuting costs for employees who transfer; and
7. Highway maintenance costs that often increased faster than the general rate of inflation.

- Benefits

1. Decreased travel costs,
2. Increased work efficiency for existing employees,
3. Salvage value of closed or relocated facilities,
4. Increased local economy caused by new salaries resulting from the opening or relocation of a division office,
5. Increased local economy caused by materials and services purchases resulting from the opening or relocation of a division office, and
6. Elimination of planned maintenance costs for existing buildings.

Data Sources

The research staff used modeling studies to assess the changes in travel efficiencies. Data regarding the costs of new facilities were gathered from the fiscal files of the department (as reviewed previously). The Maintenance Bureau and Accounting Bureau supplied breakdowns of typical materials, travel, and salary expenses. Division engineers and central office managers supplied salvage values for facilities that might be sold or relocated. Division engineers supplied demographic information regarding their employees. This helped in the estimation of the number of employees that might relocate to a new office versus those that would give up their jobs rather than relocate. The division engineers also provided trip log summaries for vehicle and equipment use. Finally, the University's Center for Business and Economic Research provided background information regarding interest rates, analysis techniques, and subjective criteria relating to economic impacts of openings and closings of major facilities.

All of these economic data were applied to the scenarios that had the most promise. The results are discussed in the following paragraphs.

Scenario D Economic Analysis

Scenario D had high relative savings in travel and relatively low costs. New facilities would be required, but salvage of existing facilities would diminish this cost. The losses to the local economy in Decatur would be offset by the gains in the local economy in Guntersville. Major portions of the existing work force could be expected to relocate to the new site.

TABLE 1 ACCESSIBILITY FACTORS FOR SELECTED SCENARIOS

SCENARIO	DESCRIPTION	ACCESSIBILITY FACTORS FOR AFFECTED AREAS BEFORE	AFTER	CHANGE
"D"	Move Division 1 to Guntersville	6,668	4,655	-30.2%
"G"	Move Division 1 to Guntersville, Realign Divisions:			
	Division 1	6,668	4,088	
	Division 2	2,041	2,697	
	Division 3	5,245	3,310	
		13,954	10,095	-27.7%
"H"	Move Division 7 to Ozark	6,303	5,389	-14.5%
"I"	Best Scenario for a New Division at Gadsden			
	Division 10	0	2,948	
	Division 1	6,668	4,559	
	Division 3	5,245	3,310	
	Division 4	5,280	4,052	
		17,193	14,869	-13.5%
"L"	Maximum Efficiency, Many Changes in Current Division and District Office Locations	41,190	37,217	-11.4%

These factors were more favorable than in other scenarios. The research staff determined that moving the Division 1 office to Guntersville would have about a 10- to 12-year payback period.

There were 102 employee positions assigned to Division 1. Approximately 37 of these positions could be reassigned to other department offices in the Decatur vicinity, and about 65 positions could be transferred to the relocated office. On the basis of the geographic distribution of homes of existing employees, about one-third to one-half of the employees in the 65 positions were predicted to relocate to Guntersville (a loss of approximately 30 to 45 jobs).

Scenario G Analysis

This scenario involved moving the Division 1 office to Guntersville, then realigning divisions. It improved the travel efficiency in two divisions, but decreased it in a third division. The net change was a better accessibility balance and a substantial travel savings. The costs and assumptions for this analysis were identical to those of Scenario D. The payback period for this scenario was 5 to 7 years. Division office personnel would experience the same loss of jobs as in Scenario D.

Scenario H Analysis

The shift of the Division 7 office (Scenario H) from Troy to Ozark shared many of the favorable characteristics of Scenario D; however, the much smaller savings in travel efficiency made it economically unattractive.

Scenario I Analysis

The higher one-time and continuing costs and the smaller total savings in travel caused the creation of a new Division 10 office at Gadsden to be economically nonfeasible.

FINDINGS

While conducting the multiple studies associated with this research project, the University developed the following findings:

1. The researchers could find no existing methodology that clearly identified the need for a new division office or the optimum location for such an office.
2. Historical data showed that the department periodically adjusted the number of division offices or the location of division boundaries. Three such moves were made in the last 25 years.
3. The department had previously conducted two statistical studies to determine the optimum locations of district offices within given divisions. These district office studies found that the key variable to optimize was employee travel time to reach the job site. The cost of adding or deleting district offices was balanced against decreased or increased travel time in optimizing total expenses.
4. In both previous district office studies, optimum results were found by decreasing the number of field offices. Closing offices and consolidating existing operations minimized maintenance expenses without jeopardizing level of service.
5. Interviews with department managers indicated that they felt employee travel time would be the overwhelming consideration in establishing new division offices, or in relocating existing division offices.
6. Field office managers discouraged the opening of new field offices because they would consume overhead funding and reduce available maintenance monies.
7. Department field managers discouraged division or district boundaries that did not follow county lines.
8. Department managers could not identify any other single factor that they felt might influence the future division office location problem.
9. In comparison to other southeastern states, Alabama had the lowest number of lane-miles per division, the lowest amount of maintenance funding per division, and almost the lowest VMT per division. These factors all indicated that the Alabama Highway Department was already highly subdivided. Further subdivision would create a larger overhead expense per mile of road than other southeastern states. This suggested that divisions should not be added.
10. Transportation agency managers in other states were not aware of any deterministic method to justify a new division office.
11. A review of department records indicated the following minimum costs for adding new offices.

Item	*Minimum Cost ($million)*
Construction of new division office	3.95
Division annual personnel cost	1.75
Construction of new district office	1.41
District annual personnel cost	0.19

The costs were used in the economic analysis of potential new offices.

12. In comparing characteristics of the existing divisions, maintenance expenses were noted to be closely related to lane mileage within a division. This relationship was found to be strong, as confirmed by statistical testing.
13. The study of division office characteristics showed that population and lane mileage varied widely from division to division.
14. When characteristics of divisions were compared, Divisions 2 and 8 had less population and less lane mileage than other divisions, whereas Division 3 had excess population and lane mileage.
15. A *p*-median study was used to estimate the best locations for division offices using travel distances and surrogate measures of attractiveness between the offices.
16. The *p*-median technique indicated that travel efficiency increases from adding new division offices dropped sharply as the department went from seven to nine offices.
17. Any division offices added to the existing configuration would produce an extremely small improvement in efficiency of department travel. The marginal change would be a 2.3 percent increase in travel efficiencies for an 11.1 percent increase in overhead.
18. The *p*-median model showed that the department's current division offices in Birmingham, Tuscumbia, Tuscaloosa,

Montgomery, and Mobile were well placed. The offices in Decatur, Alexander City, Grove Hill, and Troy might be candidates for relocation, especially the Decature and Troy sites. In addition, the model indicated that a new division office might be considered for Gadsden.

19. A travel-specific computer model was prepared to provide a more direct measurement of the efficiency of travel between office locations.

20. More than 20 scenarios were analyzed on the travel-specific model.

21. The model indicated the following general changes in accessibility for changes to the current division office configuration:

Scenario	*Accessibility Change in Affected Division* (%)
Move Division 1 to Guntersville	−30.2
Move Division 1 to Guntersville, realign divisions	−27.7
Move Division 7 to Ozark	−14.5
Create new Division 10	−13.5
Optimum location of all offices	−11.4

22. Economic analysis suggested that moving the Division 1 office to Guntersville was economically feasible, with about a 10- to 12-year payback period. About 37 current employees could be reassigned to other department positions in the Decatur vicinity, and approximately 65 positions could be transferred to Guntersville. One-third to one-half of the existing employees in these 65 positions could be expected to transfer to the new location, resulting in a loss of approximately 30 to 45 jobs for current employees.

23. The most economically feasible scenarios involved moving the Division 1 office to Guntersville, moving three counties from Division 1 to Division 2, and moving two counties from Division 3 to Division 1 (Scenario G). There would be about a 5- to 7-year payback for these changes. Job losses would be the same as expected for Scenario D.

24. Neither moving the Division 7 office to Ozark nor creating a new Division 10 in Gadsden was found to be economically feasible.

25. No other changes in division office locations were found to be economically feasible.

RESULTS OF THE STUDY

After receiving the report associated with this study, the Alabama Highway Department initiated plans to relocate its existing Division 1 office from Decatur, Alabama, approximately 50 miles southeastward to the vicinity of Guntersville, Alabama. The relocation process will take place slowly enough to give the department time to properly plan the move, and to give the affected employees the opportunity to soften the impact of the abrupt change in the location of the division office.

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