Locating Specialty Crews

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INTRODUCTION

TransAlta Utilities (TAU) is an energy company serving approximately 350,000 customers in an area of 212,000 square kilometers. TAU is Canada's largest investor-owned electric utility. TAU's competitive environment is changing due to the deregulation of Alberta's electric utility market, creating a need for greater operational efficiency. TAU operates seven highly-trained 4-man crews called "specialty crews" located throughout the province. TAU asked us to answer questions about their specialty crews – specifically, the number of specialty crews that they should be operating, the location of the specialty crews, and the opportunity for cost savings.

PROBLEM

TAU needs to know how many specialty crews it should be operating, where each crew should be located, their appropriate service regions, and the instances when it would be beneficial to outsource work. They were also interested in determining the cost of equitable workload distribution between crews. As an alternative, TAU could vary crew sizes or even set up temporary seasonal crews to handle fluctuations in the workload.

TAU's decision-making process is challenging due to specific operational constraints. There are high costs associated with changes in the crew configuration. The crew bases are not completely mobile since they are a permanent location for vehicle and equipment storage. Keeping crews constantly on the road at work will also result in low employee morale. The minimum crew sizes are also fixed for practical operational purposes and in order to adhere to internal labor policies and safety regulations enforced by the Electrical and Communication Utility Systems Regulation.

As previously mentioned, TAU management would like to focus on hotline work, however, seasonal variations in demand dictate that the crews must often pick up other operations type work as filler to maximize their value to TAU. Hotline work, which is the primary focus of these crews, is highly dependent on several economic factors such as the activity in the oil patch. Therefore, analysis of a variety of scenarios is necessary to make decisions that will take into account variations in external market factors.

PROJECT OBJECTIVES AND SCOPE

TAU's primary objective for this project was to obtain a decision methodology that would enable its managers to evaluate the specialty crews' service network configuration and performance several times annually. Furthermore, depending on what the crews' operational priorities are, the methodology would be used with different proxies of demand – for example, hotline work versus non-hotline work in order to test the robustness of the current network configuration. The tool would also enable TAU to decide whether crews are overworked and when additional human resources are needed to support the workload.

APPROACH

The "*p*-median" model is useful in strategically locating facilities, or in our case, locating crews. Our model selects a subset of *p* crew locations from a set of *n* potential locations and assigns work to the selected locations by shortest distance (which represent the service regions for each crew). All models of this type require a set of fixed demand points (with known demands), and distances between demand points and crew locations. The objective of the model is to minimize the sum of the weighted distances (cost) between crew locations and demand centers assigned to them.

TAU provided us with 17 candidate crew locations and asked that we explore the tradeoffs in locating different numbers of crews (4 to 10). To analyze all possible combinations of these locations, it would take more than 30 hours to complete the calculations. TAU wanted to perform "what-if" analysis on a regular basis and needed results quickly. Consequently, we chose a heuristic approach to select *p* crews from the 17 candidate locations.

Data

To place the problem into perspective, it was necessary to obtain spatial data, a demand profile of the province, and estimates of relevant costs. The spatial data, in the form of *X & Y* coordinates of TAU's various service points (157) as well as candidate locations for the crews (17 in total) enabled us to plot a service region. A customer demand profile for the entire province was compiled using information from TAU's crew time sheets. The time sheets also indicated which specific work orders were linked which to specific work locations. This represented the weights used in our model. Finally, relevant costs such as set-up costs (new acquisitions of crew locations and associated equipment, relocation of crewmembers) and operating costs (labor, equipment charge-out rates, depreciation, overnight stay expenses) were also obtained. The cost of using contractors was also relevant to the analysis and will be used as a decision factor when considering the option of outsourcing work.

RESULTS

Given the limited data set, we were still able to confirm many of management's hunches and provide relative trade-offs under several scenarios. Preliminary workload analysis indicated that on average, 25-35% of labor cost was being incurred due to travel. This provided considerable justification for reassessing the current crew configuration. Obviously, if crews were located closer to work, travel costs would be reduced.

TAU managers wished to know what sort of additional travel costs or savings could result among the specialty crews if TAU were to add or subtract from the existing number of crews. We used our model to help provide relative distance savings to TAU under these scenarios. As expected, travel costs were significantly reduced with the addition of extra crews. The model did confirm, however, that the law of diminishing returns applied to the addition of extra crews. Using our travel costs and the locations of the crews, TAU managers were able to compare the costs of operating additional crews versus the savings in travel.

TAU wished to determine some benchmark for the additional travel costs of operating current fixed crew sizes (4 men) and distributing workloads evenly among them. After application of Lagrangian relaxation to the problem, proxies for travel costs under the evenly distributed workload scenarios were generated. As expected, there were significant additional costs to allocating work equitably among crews.

Two separate proxies for demand were used to drive the analytical process. The total number of hours the crews worked in each demand center throughout the province and then the hours spent working on hotline only were used. We found that the model made the same decisions irrespective of the type of work.

IMPLEMENTATION

TAU realized that operational decisions needed to be made on a regular basis and wanted options to be backed up with costs. Our team determined that TAU would be best served by a decision support tool that used our model as its foundation. In addition to determining optimal locations and service areas, this tool offered the ability to test and conduct sensitivity analysis for various levels of demand and crew configurations. Our model helps to make decisions by producing workload and travel estimates for any given scenario.

The decision support tool was implemented on a spreadsheet with the location/assignment algorithms coded as macros. Depending on the user's objectives and time constraints, one has the option of choosing locations without regard for equitable workload. The manager can use different types of work to represent demand, such as construction, maintenance, or hotline work. The manager simply enters a proxy for demand (based either on past data or best future estimates) to appropriately "weight" the relevant areas of TAU's service region. The program can then be run to produce crew locations, service areas, estimated crew workloads, and travel costs for any number of specialty crews.

CONCLUSION

Our partnership with TAU gave the company a refreshing perspective to its business. The project was able to provide immediate feedback to TAU managers on the performance of the specialty crews' current service network. In most cases, the existing network configuration made sense and when it did not, sensible alternatives were provided. TAU now has a quantitative model which, combined with managerial intuition and experience, will make decision making easier and more effective. TAU is now better equipped to respond to changes in the demand environment.

It is important to note that the analysis conducted in this project is on a macro level. In order to obtain more realistic estimates of cost, it would be necessary to actually simulate operations on a day-to-day basis. However, our analysis is sufficient for decision making at the strategic level. In addition, TAU would benefit from more accurate forecasts of demand. A forecasting tool would help the company pinpoint changes in the demand profile throughout the province, reducing future uncertainty.