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Staff rostering in call centers providing employee transportation

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ABSTRACT

We address the staff rostering problem in call centers with the goal of balancing operational cost, agent satisfaction and customer service objectives. In metropolitan cities such as Istanbul and Mumbai, call centers provide the transportation of their staff so that shuttle costs constitute a significant part of the operational costs. We develop a mixed integer programming model that incorporates the shuttle requirements at the beginning and end of the shifts into the agent-shift assignment decisions, while considering the skill sets of the agents, and other constraints due to workforce regulations and agent preferences. We analyze model solutions for a banking call center under various management priorities to understand the interactions among the conflicting objectives. We show that considering transportation costs as well as agent preferences in agent-shift assignments provides significant benefits in terms of both cost savings and employee satisfaction.

1. Introduction

The call center industry has secured a global place in customer relationship management within the last 30 years. Workforce management plays an essential role in the success of call center operations. Call centers face a dynamic demand pattern as call arrival rates vary by months, weeks, days and within different hours throughout a day. The need to balance the variable workload with agents working in shifts, presence of different call types that require various agent skills, constraints arising from agent shift preferences and work place rules, among other operational considerations, all complicate workforce scheduling at call centers. Furthermore, several conflicting objectives with respect to operating costs, customer service and employee satisfaction come into picture. In this study, our aim is to provide a mathematical modeling approach to generate viable and productive workforce schedules that balance the conflicting objectives according to the priorities of call center managers.

This study has been initiated by our collaboration with two call centers operating in Istanbul, which brought up their difficulties with staff rostering. One of them is a banking call center, while the other provides global technical support. Both operate in a multi-skill environment with different skill structures. Operations of these call centers have a common interesting aspect: they provide the transportation of all employees in all shifts, which creates a significant cost component. Like most call centers, they are subject to meeting pre-specified service levels, but have difficulties in achieving these targets at certain time intervals. Furthermore, they acknowledge the effect of work schedules on agent satisfaction, and aim to accommodate staff preferences to increase productivity and commitment.

Agent turnover rates in the call center industry are typically high, with an average of 33% per year and exceeding 50% per year in many call centers (see [1,30,24]). If work schedules are generated to minimize costs only, then the working conditions of the agents may show high variability and the inherent unfairness which leads to higher turnover rates. One way to reduce these rates is to increase agent satisfaction by providing preferred, or at least acceptable, workforce schedules for all agents. This requires identifying the undesired features of an agent's schedule and limiting them as much as possible. Although it is hard to quantify agent preferences, experiences of call center managers allow them to point out major causes of discontent. In light of these causes, it is possible to define appropriate discontent measures. Then, the agents' individual preferences for these measures can be collected through questionnaires, or the call center managers may assess general importance scores for different agent discontent factors. Once the discontent scores are identified, it becomes possible to limit the total discontent of each agent in a schedule, thereby targeting fairness among agent schedules.

The service level in call centers is generally measured by the percentage of calls answered within a specified time limit, e.g. at least 80% of all calls in less than 20 s. Call centers determine the required number of agents for each 15- or 30-min period using this service level criterion. With the existing workforce and budget limitations, these requirements may not be achievable, as frequently observed in one of the call centers we work with. Therefore, considering the requirements as soft constraints may not only

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be necessary in some cases, but also provides flexibility in workforce planning, leading to improvements in other criteria.

As mentioned above, the call centers we worked with have a major cost component due to providing the transportation of their staff by shuttles, a common practice among Turkish companies operating in large cities. Nevertheless, this type of pick-and-drop services is not unique for Turkey. For example, most call centers operating in Mumbai also provide such services in various forms, e.g., pick and drop from/to several central locations within the city, or pick and drop from/to home at night shifts. A typical call center operates for 24 h a day and 7 days a week. These continuous work hours, together with the non-stationary call arrivals, may require a high number of shifts per day, in some extreme cases as high as 50. As the shuttle running costs may become a considerable part of the total operational costs, some call centers even prefer hiring only the agents residing close to the call center, at the expense of losing more skilled labor force. On the other hand, the call centers who provide this type of service need to consider the transportation aspect in scheduling. Typically, they aim to increase the vehicle utilizations by considering the locations of the agents and how they would be grouped into vehicles when assigning them to shifts.

Workforce scheduling is generally carried out using standard industry-specific software packages that do not have the capability to model agent satisfaction, or the transportation aspect of the problem. In current practice, workforce schedules generated by these packages are adjusted by planners to address these issues, which requires a considerable amount of time and effort. To avoid these inefficiencies and to improve the schedules, we develop a mathematical model for call center workforce scheduling that optimizes the three objectives of the problem simultaneously, namely total operating costs, employee satisfaction and understaffing. The specifics of these objectives vary with the call centers. In this study, we model the problem as observed in the call centers we worked with. Although the approach is general, some constraints and performance metrics might be specific to these cases.

Using the data of the banking call center, we conduct a case analysis in which we analyze model solutions under varying priorities. The case study serves to: (1) reveal the tradeoffs between cost, customer service and employee satisfaction objectives, (2) quantify the benefits from incorporating the transportation costs into the model, (3) demonstrate how model parameters can be used to reflect management preferences, and hence how the model can support the workforce scheduling process.

We present the literature review in the next section, and describe the problem in Section 3. We give the mixed integer programming model in Section 4. Section 5 describes the input data and analyzes the model solutions under different parameter settings and scenarios. Finally, we summarize our contributions and discuss implementation issues in Section 6.

2. Literature review

Workforce scheduling problems have been studied extensively since Dantzig [19], as they arise in numerous organizations such as call centers, airlines, hospitals, and postal services, to name a few. Ernst et al. [20] present a review of application areas, solution methods and models, whereas Ernst et al. [21] provide an extensive bibliography with a chronicle of over 700 papers. A review of the subject on call centers, on the other hand, can be found in Aksin et al. [1,2].

In the literature, workforce scheduling is commonly conducted in three stages: (1) staffing, (2) shift scheduling and (3) rostering, that are addressed either individually or by combining two of the three. In the former case, the outputs of the previous stages are assumed to be known, whereas the latter studies, usually, iterate between the two stages. We solve a rostering problem taking the staffing requirements and shift descriptions as inputs to our model.

Staffing refers to finding the minimal number of agents that guarantees a service level during each time interval in a planning horizon, which are typically called workforce requirements or staffing requirements. The solution methodologies for staffing problems mainly consist of simulation or queueing theory, or a combination of the two, which may be accompanied by an optimization model in multi-skill settings.

In the context of call centers, the two complicating factors in the staffing problem are the nature of call arrival rates (time-varying and/or random) and the multi-skill environment. Green et al. [25] and Whitt [42] provide examples of papers that study the staffing problem under time-varying and uncertain call arrival rates, respectively. Most call centers are multi-skill environments, where each agent type can handle a different set of call types, i.e. the so-called skills. In such environments, three inter-related problems arise: flexibility design, staffing and call routing.

The flexibility design problem determines the skill sets available for the agents. Generally, the call center management decides on these sets and implements them through appropriate hiring and training policies. Once the flexibility structure is chosen, the staffing problem determines the number of agents needed from each skill set. Note that the staffing problem can change the flexibility structure by assigning a zero level to certain skill sets. Call routing policies, on the other hand, assign calls to agents who can serve them. The staffing levels and the flexibility design affect the routing policies, but also different routing policies will call for different staffing levels and flexibility designs. Gans et al. [24] and Aksin et al. [1,2] review the literature on these topics as well as the interactions between them. Below, we cite the more recent and related ones.

The literature on the staffing problem in multi-skill environments generally take the flexibility structure as well as the routing policy as given and solve for the staffing problem, see e.g., Wallace and Whitt [41], Cezik and L'Ecuyer [17], Pot et al. [36], Avramidis et al. [5], Feldman and Mandelbaum [23]. The literature that characterizes optimal or near-optimal call routing policies, on the other hand, assume that both the flexibility design and the staffing levels are fixed, see e.g., Ormeci [35], Bhulai [10], Bhulai and Roubos [11] and the references therein. Finally, some papers consider both staffing and routing problems. However, they need to simplify the routing policies in order to find explicit solutions. Harrison and Zeevi [26] and Bassamboo et al. [9] formulate the problem hierarchically under a time-varying arrival rate, so that the first stage determines the staffing levels, while the second stage solves for the routing problem through a fluid approximation of the call center. The routing policies found in these papers provide only the number of agents from each skill set who answer a certain type of calls at any time, where these numbers are not necessarily integers. Our approach is similar to these papers, as our model will output the proportion of time that each agent will dedicate to each of his/her skills at each shift.

Shift scheduling identifies which shifts are to be used and finds the number of employees to be assigned to each shift in order to fulfill the workforce requirements. These problems, traditionally, rely on mixed integer programming (MIP) models. Thompson [39], Aykin [6], Bard et al. [8], and Bhulai et al. [12] provide some examples for shift scheduling solved by integer programming, where the staffing levels are taken as input.

Rostering, which is also called *tour scheduling*, generates the complete schedule of all employees over the planning horizon by considering regulations and work place rules, such as the required number of days off, in addition to the workforce requirements. The problem is generally formulated with MIP models. Ertogral and