Available online at www.sciencedirect.com
ScienceDirect
Computers & Industrial Engineering 54 (2008) 118–127
computers & industrial engineering
www.elsevier.com/locate/dsw

Developing staff schedules for a bilingual telecommunication call center with flexible workers

Kadir Ertogral [a,*], Bader Bamuqabel [b]

[a] Department of Industrial Engineering, TOBB University of Economics and Technology, Sogutozu cad. No.43, 06560, Sogutozu, Ankara, Turkey
[b] Systems Engineering Department, King Fahd University of Petroleum and Minerals, 31261 Dhahran, Saudi Arabia

Received 13 December 2006; received in revised form 14 May 2007; accepted 23 June 2007
Available online 29 June 2007

Abstract

Call centers constitute growing and significant portions in national economies. This is due to the fact that the customer satisfaction has become the sole performance measure that drives the businesses today, and the call centers are the main means for companies to communicate with their customers. Additionally many public services, such as emergency and security services, cannot operate without their call centers. There is a vast body of literature on different aspects of the call center related problems. In this study, we describe a comprehensive methodology for developing staff schedules in a bilingual (Arabic and English) call center of a local telecommunication company. Our approach involves two main parts. First we obtain agent requirements in each hour across a week. In this part we use data analysis, a queuing approximation, and a simulation model. The second part is about constructing optimization models for scheduling agents. We utilize two models; one for the case with no flexible workers, and another for the case with flexible workers. We include numerical experiments and analysis at the end to show the schedule optimization results under several scenarios.

Keywords: Staff scheduling; Call center

1. Introduction

Customer satisfaction has become the most important concern driving businesses in today's competitive market. Call centers (or contact centers as they are recently being called with additional multimedia support) have become the common vital channel for companies to communicate with their customers. Some call centers handle purely inbound calls, such as customer help lines of a telephone company or reservation services of an airline, while some other call centers are set up to generate only outbound calls, such as telemarketing centers. Call centers constitute a significant and expanding portion of national economies. For example, the number of employees working as call center agents was reported to be 1.55 million in USA in 1999 with an annual growth

* Corresponding author. Fax: +90 312 2924091.
E-mail address: kertogral@etu.edu.tr (K. Ertogral).

0360-8352/$ - see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.cie.2007.06.040

rate of 8%. This figure is equivalent to more than 1.4% of the all private-business employment in USA in 1999 (Gans, Koole, & Mandelbaum, 2003).

In this study, we try to address a staffing and staff scheduling problem in a local call center that belongs to a major telecommunication company. Before describing the problem that we deal with, we would like to give the steps of the overall staffing process in call centers as described by Mason, Ryan, and Panton (1998):

1. Estimate the customer load over the planning horizon. The planning horizon can be typically one or two weeks long and the base period for forecasting is usually between 15 min and 1 h.
2. Given a certain customer service measure, determine the minimum number of agents required during each period. Customer service requirement is typically given in terms of customer waiting times and/or abandonment rates in the queue.
3. Select staff shifts that cover the requirements. This problem is usually solved through a set-covering integer program; see Mason et al. (1998) for more details.
4. Allocate employees to the shifts.

Our study mainly covers the items 2–4 above. We will assume that the recent past data about the call arrival rates represents the future arrivals for some foreseeable future. Therefore, there is no forecasting part in our work. Besides, if needed, forecasting part can easily be integrated into our study as an extension in the form of "what if" analysis about the call arrival rates. In this study, we first estimate the minimum number of agents needed during a day based on analyzing the data, using a simple analytical queuing model, and employing a simulation model. After determining the minimum number of agents needed, we find the allocation of the groups of workers to schedules using optimization models under different scenarios about the agent flexibility and group compositions.

With regard to the estimation of the required staffing levels, queuing models are used Green, Kolesar, and Soares (2001) as approximations in the literature. The main difficulty is the changing arrival rates across the periods and the interaction between the periods. We will use a simple queuing formula given in Gross and Harris (1998) to obtain the approximate requirements, and then adjust the requirements through the use of a simulation model.

In the staff scheduling part of the problem, there is a vast body of literature. The staff scheduling problems is also called tour scheduling since the employees keep repeating the same schedule (tour). The tour scheduling is a practical problem for organizations that operate 7 days a week and more than one shift a day, such as call centers, hotels, police stations, and airlines. Naturally, employees must be given daily and weekly breaks. Therefore, employees must be assigned to specific days-off during each week and specific hours-off during each day. In other words, we need to specify the particular tour (i.e., the hours of the day and days of the week) in which each employee must work. The objective is to determine the number of employees assigned to each work tour, in order to satisfy the labor demands for each work hour of each day with the objective of minimizing the cost or workforce size. A recent survey on staff scheduling problems is given in Alfares (2004).

Tour scheduling models in the literature basically try to minimize the required number of total workforce while ensuring that the demand in each planning period is satisfied. An earlier tour scheduling model in the literature is a set covering formulation suggested by Dantzig (1954). We also use a modified version of this model in our study. An important model suggested later on in the literature is the formulation of Jacobs and Brusco (1996). This model is called "implicit formulation" since it represents shifts implicitly by their "starting-time bands" and days-on patterns. Same authors also analyzed the effect of the starting times on the solution quality in Brusco and Jacobs (2001). One of the important findings of this large computational study was that a small number of starting times usually generates solutions comparable to those obtained when all possible starting times were considered.

An important aspect of our problems is the fact that we can have flexible agents who can serve customers with either language preference. To accommodate this fact we introduce a model for systems with flexible agents in the call center context. This is the first explicit model, to the best of our knowledge, which considers the flexible agents.

Solution procedures for staff scheduling vary significantly. There have been exact procedures seeking optimal solutions (Brusco, 1998), LP based heuristics (Thompson, 1992, Cezik, Gunluk, & Luss, 2001), heuristics