Outsourcing and reservation; tools to manage blended sales and services operations in call centers

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1 Introduction

One studied strategy to reduce the flow of inbound calls is to outsource a part of them. As explained in Akşın et al. (2008), two different families of contracts between the call center and the outsourcer can be found in practice. The first type, referred to as Contract 1, is a form of capacity reservation whereby the call center reserves a steady level of calls for the contractor at a given fee. All calls in excess of this level are considered for treatment in-house by the call center. The second type of contract, referred to as Contract 2, stipulates that the call center answers as much call as wanted and outsources the others for a fixed cost per outsourced call. This article considers the two types of contracts which lead to two different problem formulations. The idea is to help the call center manager to better define the contract and to determine for a given contract which calls should be outsourced. This problem is complex when sale activities are blended with service ones. An outsourced customer in need of service does no longer represent a sale opportunity. So, it might not be efficient to outsource too many calls, in particular those who have a high purchase probability. Moreover, the experienced waiting time may influence the purchase probability. Hence, the customer’s waiting time should be taken into account in the outsourcing decision.

The traditional solution used in practice and in the existing models in the literature is to outsource an inbound call upon arrival. The decision to outsource a newly arrived call is based on the system state, i.e., on its expected waiting time. This is referred to as a priori outsourcing. Another possibility, proposed here, is to accept that the new call joins the queue, but allow to outsource it later based on its experienced waiting time. This is referred to as a posteriori outsourcing. Despite of the potential of a posteriori outsourcing policies, they have not been, to the best of our knowledge, addressed in the call center literature.

Outsourcing may allow the call center to better serve and sell to customers. However, due to the nature of Contract 1 which may force to outsource a fixed amount of calls per time unit together with the variability in the arrivals, one may encounter situations where agents are idling. It may then be appropriate to let some of these agents initiate calls to propose selling offers in order to generate extra revenue for the call center. The operational value of outbound calls is that they can be initiated at a chosen time. This allows to prevent idle overcapacity, and to limit the necessity to have extremely accurate forecasts.
Research question. An important question for a call center manager is to determine when should the agent initiate a call, and whether an inbound call should be accepted or outsourced. These decisions often take into account conflicting objectives like the benefit of serving an inbound or an outbound call, and the cost of outsourcing an inbound call. For example, in order to increase the volume of served in-house inbound calls, it would be natural to stop initiating outbound calls or in order to increase the outbound calls throughput, it could be useful to outsource some inbound callers.

2 The Model and the Routing Problem

We consider a call center modeled as a multi-server queueing system with inbound calls (inbounds) and outbound calls (outbounds). The arrival process of inbounds is assumed to be Poisson with rate $\lambda$. If at least one agent is available, an inbound call is directly served. Otherwise, this inbound call has to wait in a first come, first served (FCFS) queue with infinite capacity. There is an infinite supply of stored outbounds. There are $s$ identical, parallel agents. Service times of inbounds and outbounds are assumed to be i.i.d. and exponentially distributed with rate $\mu$.

The objective is to find the optimal reservation and outsourcing policy in order to maximize the call center’s long-run expected revenue per time unit, denoted by $E(G)$. An expected reward $r_{\text{outb}}$ is counted per served outbound. A reward of $r_{\text{inb}}(t)$ is counted per served inbound that has waited exactly $t$ time units, for $t \geq 0$. Under Contract 1, a fixed global cost $C_{\text{outs}}$ per time unit is paid for outsourcing a fixed proportion of inbound calls (i.e., the call center is engaged to send this quantity). Under Contract 2, a cost $c_{\text{outs}}$ is counted per outsourced call.

3 Contributions

By formulating the routing problem as a Markov decision process (MDP) we prove that the optimal policy for agents’ reservation and call outsourcing is of threshold type either based on the number of customer in the queue (a priori) or on the waiting time of the oldest customer (a posteriori). We compute explicitly the performance measures, determine their monotonicity properties and derive a series of insights.

3.1 Analysis with Contract 1

With Contract 1, we get the following results. For low workload situations, a high number of servers and, a low reservation threshold, one extra space in the queue is equivalent to one extra reserved agent in order to answer the constraint of Contract 1. Yet, for higher values of the reservation threshold and higher workload situations, the outsourcing thresholds become almost insensitive to the reservation threshold.

In addition, reservation should be excluded when the call center is engaged by Contract 1 and when
inbound callers purchase ability is insensitive to their waiting times. Otherwise, reservation should increase with $r_{inb}$. As the workload increases, reservation increases. For high workload situations extreme reservation choices are often optimal. The call center size does not impact the optimal decision if the revenue is based on the expected waiting time. Yet, if the revenue is based on a waiting time percentile, as $s$ increases the optimal decision converges to extreme choices (no reservation or full reservation). A priori outsourcing and a posteriori outsourcing have the same reservation threshold except in low workload situations and for small call centers.

3.2 Analysis with Contract 2

With Contract 2, extreme choices for reservation or outsourcing are in general not optimal. Moreover, as the workload increases, reservation increases and outsourcing increases. However, in some cases extreme thresholds are optimal. In particular, as for Contract 1, reservation should be excluded when inbound callers purchase ability is insensitive to their waiting times. Moreover, in this case, inbound calls should either all be served in-house or should all be outsourced. Finally, from an asymptotic analysis, we show that with a high number of agents, it is not optimal to outsource calls and reservation should be limited to at most one agent.

3.3 Comparison of the outsourcing policies

We now compare between the two classes of policies; a priori outsourcing and a posteriori outsourcing under Contract 1 and Contract 2. The main result is proven in Theorem 1 and Corollary 1.

**Theorem 1.** Under Contract 1, for a given reservation threshold $c$,

1. The random variable $W_S$ (waiting time of served in-house calls) is the highest for a priori outsourcing under the usual stochastic ordering.

2. The expected waiting time of all customers (served in-house or outsourced), $E(W)$, is the lowest for a priori outsourcing.

**Corollary 1.** $E(G)$ is maximized for a posteriori outsourcing under Contract 1 and Contract 2.

References