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Revenue Management in Business Services

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A significant portion of the services industry is focused on providing services (medical, legal, financial, personal, and travel) to individuals. However, studies have shown that a less visible but rapidly growing segment of the service sector comprises firms that provide business functions to other businesses. The sector covers tasks such as payroll processing, procurement, and information systems management, as well as business consulting, technical support, call center operations, and software development. Firms may choose to purchase, rather than perform, these business functions to reduce costs, to mitigate risk, or simply to focus on their processes that provide marketplace differentiation. Transferring a business function from within a firm to an outside supplier is often called "outsourcing"; when the supplier provides the service from a lower-cost country, it is called "offshoring." The risks and benefits of outsourcing to the firm purchasing a business service have been studied in some detail by both academics and consultants. In this paper, we outline revenue management issues faced by business service providers and describe some new opportunities for the use of analytic methods in the service science sector.

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1. Issues Faced by Business Services Providers

A rapidly growing segment of the business services sector comprises firms that provide business functions to other businesses. The sector includes tasks such as payroll processing, procurement, or information systems management (Tanninen-Ahonen 2003, Ravi et al. 2006), as well as business consulting, technical support, call center operations, and software development.

In the market for business services, customers can be partitioned into well-defined tiers based on the volume and range of service purchased. Some service providers serve primarily small enterprises, and others serve primarily large enterprises. The focus of this paper will be revenue management of business services for large enterprises (e.g., Fortune 500 firms and large state and national government agencies). Within this tier, most business services are either performed in-house or outsourced to a single service provider. In early incarnations, such services primarily involved functions connected to automation and information access. Examples included the maintenance and management of the infrastructure of large data centers; the term "outsourcing" is still commonly associated with the delivery of information technology (IT) services. Over the years, the scope and scale of outsourcing have steadily increased. Entire functions of an enterprise have been moved outside of the enterprise. These functions involve IT components, but they also involve a considerable workforce element; an example of such mixture is accounting, which comprises disparate elements such as transactional databases, financial analysts, auditors, and automated reporting systems. In its most recent evolution, providers offer end-to-end business processes to the enterprise. These functions, which are not part of the core business of the enterprise, can be performed more effectively and efficiently by the service provider, who benefits from economies of scope and from reuse (Booz, Allen, Hamilton, Inc. 2005, Clemons and Aron 2004, Dibbern et al. 2004, Kremic et al. 2006). The distinguishing features of business services are as follows:

- **Nonstorability:** Both human labor and information services cannot be accumulated while the resources are idle.
- **Partial or total resource reuse:** Both IT and workforce can be shared across customers or dynamically reallocated during a time interval much shorter than the typical contract duration.
- **Standardization:** To achieve economies of scale, business services need to have standard interfaces with other processes of the customer.
- **Short service life cycle:** In the current business environment, processes are the subject of continuous innovation. The technology enabling such processes is also undergoing relentless transformations, leading to short product life cycles.
- **Heterogeneous customer population:** Customers differ in their planning horizon, capital commitment,

and risk attitude, all features that must be taken into account by the provider to maximize the profitability of its offerings.

- **Monopsony power:** The relatively small number of customers allows these customers to influence the price of the offerings as well as the financial terms and conditions of the offering. Consumer services do not exhibit this characteristic, which accounts in part for the more complex fee structures found in business services.

To focus the discussion of the issues related to revenue management in business services, this paper concentrates on so-called *standardized business services* (SBS). SBS have some traits in common with standardized consumer services (SCS). By SCS, we mean transportation services such as airlines, railways, and rental cars; recreational and hospitality services such as hotel rooms, conference spaces, and cruises; certain health care services such as hospital rooms; and heavy equipment rentals (aircrafts and industrial equipment). All of these services have benefited from the application of revenue management, which we broadly define as a body of dynamic pricing and inventory policies aimed at maximizing revenue. However, there are important differences, and understanding them is necessary to realize the limits of the current revenue management theory and to appreciate the novelty of the problems arising in SBS. In the following, we contrast features of SBS to those of SCS.

Although it is true that SBS rely on *nonstorable* resources as in SCS, the use of human resources in business services is an especially challenging component of the process, which has only begun to be modeled and captured in revenue management models. Contrary to analogous models used for manufacturing, supply chain, etc., *the type and quantity of human resources needed to fulfill business service contracts is rarely specified in a form amenable to optimization and profit management*. In parallel, however, creating and delivering services profitably requires the development of reusable assets, whether they are capital assets such as IT infrastructure, consumable assets such as service parts and materials, specialized labor assets such as skilled employees, and proprietary data or processes. In general, the quantification of such resource requirements and resource characteristics, both for equipment and for personnel, is an important component in a business service profit management framework. In business services, such as professional consulting services, the set of resources associated with an offering (e.g., consulting engagement) may have significant variability depending of the specific features of the transaction. Furthermore, the ability to substitute one resource, whether human or computer, for another, is generally higher in business services than in traditional manufacturing.

For example, in an effort to make the human resource requirements amenable to optimization, Hu et al. (2007) developed mappings of job roles required by different project types to standard employee skill sets, so as to facilitate the optimization of workforce in consulting service engagements. Those matrices were used by Lu et al. (2006) and Wardell et al. (2007) to give a proof of concept for business service profit management. In short, then, the need to quantify the resources required and available to perform business services is a first element that distinguishes revenue management for SBS from that of SCS.

Although services are *standardized* (at least when compared with internal processes), some level of customization is unavoidable. There are several consequences of this. Because of the level of customization required within a large enterprise, service contracts specify not only what process will be provided, but also where and how it will be provided. In fact, when a large enterprise first outsources a process, it is not uncommon for a significant portion of the purchasing enterprises staff and physical resources (e.g., computer hardware) to be transferred to the providing firm. Given the magnitude and complexity of these transactions, it is natural that *the contracted service period for initial outsourcing contracts is quite long*. As enterprises become more experienced in using business services, and as they migrate toward using standardized processes for nondifferentiating functions, the scope and duration of business service contracts decrease (*Economist* 2007).

Hence, the typically long length of contract periods for outsourcing in SBS is a second critical factor to consider when engaging in revenue management for SBS: it implies two or more different time horizons that should be modeled jointly, namely, the prices and terms and conditions to be set during contract negotiation and the usage-dependent prices and resource allocations, which vary during the course of the contract. This multihorizon aspect to revenue management in SBS resembles more closely problems in supply chain modeling than the typical revenue management problems found in SCS.

A third distinguishing aspect of SBS contracts is the presence of complex fee structures. This is due in part to the monopsony power of the clients and therefore the fact that the contracts are negotiated bilaterally. As in traditional applications such as supply chain optimization the delivery costs for business services have both fixed and variable components.

Also analogous is the fact that profit is the difference between realized revenue and realized costs, both of which are in turn dependent on resource allocation decisions. Typical characteristics of the fee structures used in SBS include minimum payments, variable payments based on volume, and penalties

for not meeting specific performance targets. Variable-payment fee structures are seldom straightforward and in many cases involve step functions. Service-level agreements are often complex and may include different structures for penalties and for bonuses. In addition to complex fee structures, business service contracts may include mandatory (time-phased) cost reductions that the service provider must achieve. Typically, service providers seek to achieve cost reduction through the use of lower-cost labor, increased use of automation, and/or decreased technology costs. Often a collection of business processes is outsourced as a bundle, with a single provider acting as a general contractor and subcontracting with other providers for the performance of individual processes. In this case, both pricing structures and terms and conditions of the contracts for the multiple processes must be reconciled across numerous providers. Once again, these features of SBS differ sharply from those found in SCS, in part because of the longer life cycle of the contracts. Some of these characteristics are found in the supply chain context, but, with a greater emphasis in SBS on human resources than on manufacturing and automated processes, there remains work to be done in transferring supply chain models to SBS.

Last, in SBS, the organization contracting for the services (typically procurement) is separate from the business units or end users of the service. Contracts that are designed to optimize enterprise-level measures may have adverse effects on the services consumed by individuals within the firm. This occurs when negotiated prices and terms and conditions for services are made at a corporate level but individual departments are able to obtain those same services punctually from alternate providers at lower cost. Although the department that shops outside the negotiated agreement may save money, the contracting arm of the corporation typically has to pay to pay a penalty for going to alternate suppliers. Hence the multiple objectives of the different organizations involved in the service contract and execution should be considered.

In summary, we have identified four areas in which revenue management for SBS requires research and new models that go beyond those developed for revenue management of consumer services:

(i) the quantification of the resource requirements and the resources available, especially the human resources, in a form amenable to optimization;

(ii) the modeling of long time horizons with at least two distinct decision phases: contract negotiation and project execution;

(iii) the modeling of complex fee structures; and

(iv) the diverse objectives that arise from multiple parts of the organizations involved in contracting the business services.

Together, these four areas cover the particularities of the end-to-end problem of revenue management that should be addressed for SBS.

In some cases, these topics can borrow much from the supply chain literature, which has had a goal of treating the end-to-end supply chain problem. There is considerable overlap between the two, because SBS also calls for an end-to-end solution approach. The next section summarizes some research from the supply chain and related literature that is relevant to revenue management for SBS. However, there are some differences, notably in area (i) mentioned above.

2. Analytical Methods

Numerous quantitative methods have been used to address some of the four areas of the revenue management problem for SBS. In this section, we discuss the most widely used of these methods and present examples and references to some of the relevant literature. Then we propose a few approaches that may lend themselves to moving in the direction of solving the end-to-end problem of revenue management for SBS.

As discussed previously, the end-to-end problem of revenue management for SBS is composed of four main areas, some of which have been extensively studied in the academic literature and some of which have been successfully implemented in commercial tools. However, several important pieces of the end-to-end chain for SBS have been historically neglected by the analytical community, and one of the goals of this paper is thus to stimulate research in those areas. In addition, and perhaps most importantly, this paper seeks to entice readers to address the end-to-end problem itself, rather than one or two parts in isolation.

Elements of the SBS revenue management problem that have been extensively studied already include contract design, risk assessment, workforce planning or staffing, and resource provisioning. Decisions such as how to price a service, what types of terms and conditions to include in their contracts (what metrics to include, what levels to set, penalties and bonuses, break-out clauses, etc.), how to staff, and how to set up contracts with their suppliers have also been examined in detail.

For instance, a vast body of literature exists on contract design. Game-theoretic and related utility maximization approaches are abundant in the literature. Many of the quantitative papers focus on the nature of the information between the two parties. McAfee and McMillan (1995) proposed describing contracts involving a hierarchy of firms with asymmetric information through a single-time period, game-theoretic framework, where the "type" of each firm is a random

variable and the firm who sets the contract parameters maximizes expected net profit. In DellaVigna and Malmendier (2004) a utility maximization approach was taken to model a profit-maximizing firm and a consumer; the model considers both long-term contracts, with many decision points, and contracts with automatic renewals; consumers choose at each time step between accepting the contract or not, the firm must choose the sign-up or renewal fees along with the usage prices at each decision point in the contract, and consumer renewal behavior is expressed by a probability distribution. The resulting problem is expressed as a nonlinear mathematical program, with as many variables as explicit decision points in the contract. Bolton (1990) summarizes the field of long-term contract design with renegotiation and is concerned with whether information shared by the firm and client is symmetric or observable. Lim (2001) proposes using game theory to study this topic and, in particular, how a firm should design contracts with its suppliers when there is information asymmetry on the quality of the good or service supplied. Her model includes explicit quality control in the form of optimal price rebates paid by the supplier for defective supply and a cost-shared warranty scheme for the final consumer of the good/service. The payoff functions for the supplier and the firm are linear with discrete random terms; the game, while having three steps—contract design, supplier accept/reject, and (if the supplier accepts) play according to contract—was simplified to a "direct mechanism" using Fudenberg and Tirole's (1991) "revelation principle." A comparison of pricing structures for IT-based outsourcing contracts in the presence of competition was presented by Liu et al. (2003).

With respect to the four areas of by revenue management for SBS, some of the above-mentioned references have included relatively complex fee structures, from topic (iii), for instance by including both fixed and variable costs, step functions, etc. However, many have not, and, indeed, for use in SBS, the complexity of the fee structures is an important component. In the above references, resource requirements and availability are assumed to be already quantified: indeed, they were not developed with SBS in mind. Hence, with respect to topic (i), the incorporation of human resources and the resulting quantification problems that it poses would be an important addition to that body of literature. Because the scope of the contracting and contract pricing literature is the medium-to-long term, the topic (ii) is not treated, in general. Topic (iv), the discrepancy between the goals of the procurement organization and the users of the business service, has not been addressed by the literature cited above.

Supply chain-related contract design is of particular relevance to revenue management problems in SBS and hence deserves mention. Tsay and Lovejoy (1999), for example, consider a multiperiod setting in which market demand is stochastic and contracts must be established between each pair of firms: retailer and manufacturer and manufacturer and parts supplier. They formulate a stochastic, dynamic program with a hierarchical flow of information that leads to intractability: notably, the random end-user demands are affected by inventory policies at the manufacturing firm, and hence the random distributions in the manufacturer–supplier problems are very complex. The authors suggest solving a sequence of deterministic problems in an open-loop control fashion, i.e., suppressing future updates to previous time steps' parameters. Cachon (2003), in a lengthy survey of supply chain contract modeling, describes a method for identifying "coordinating contracts" and setting their parameters optimally, i.e., so as to achieve coordination among parties of the supply chain. Cachon begins with the newsvendor problem as a basis and defines contracts using progressively more complex versions of the model, incorporating such features as multiple replenishment times, demand conditioning, multiple customers for a single supplier, inventory, and private information. In the simplest version of the model, he shows that several contract types "coordinate" effectively the supplier's and the retailer's choices: buyback contracts, revenue-sharing contracts, quantity-flexibility contracts, sales-rebate contracts, and quantity-discount contracts. However, in the case of demand conditioning, for example, in which the retailer takes some costly action to increase demand, thereby benefiting both the retailer itself and the supplier, Cachon shows that only quantity-discount contracts can effectively provide incentives to both parties. The analysis takes the form of analyzing the profit functions of the retailer, of the supplier, and of the overall supply chain as a function of the contract parameters.

In these references, specific contract types found in supply chains are analyzed in great detail, and the resulting insights are very useful for developing better policies. The particularities of contracts in SBS, however, are different, and an analogous stream of papers dedicated to analyzing SBS contract policies would be of great benefit in practice. For example, buyback and sales rebates are not particularly relevant to SBS, in terms of quantities of goods remaining; however, it is not uncommon for clients to cancel long-term SBS contracts before the expiration of the term, so that an analog to buyback or sales rebate would be early termination. The multiperiod and stochastic nature of the contracts modeled in the above-mentioned supply chain literature is

quite relevant to SBS revenue management and different from the existing literature on SCS revenue management; it is clearly an important direction to take in future research for SBS. Again, based on the four problem areas cited in §1 of this paper, areas for further enhancement include (i), (iii), and (iv), the incorporation and quantification of human labor as a critical resource, more complex fee structures, such as step functions, and the multiple objectives that arise from different parties involved in the contracting.

Although operations research-based methods and tools are the focus of this paper, it is worthwhile to note that systems management tools for business-to-business (B2B) and e-commerce interactions are increasingly available; these emerging platforms and tools permit analytical models and algorithms access to data on the B2B interactions, both at the contract level and at the operational level. One example is the framework described by Herring and Milosevic (2001), which provides contract negotiation tools for B2B using Microsoft's BizNet platform. Using this type of infrastructure, it is a small leap to envisage the incorporation of analytical tools as part of the contract terms and condition (T&C)-setting exercise. Indeed, it would be of tremendous benefit to permit B2B firms to analyze the likely impact of the contract T&C parameters and optimize during the negotiation process the response of each firm to the other party's proposal. Kelkar et al. (2002) describe a platform for B2B interactions that links contract T&C, information about the products offered, and prices, whose information is transmitted through electronic catalogs of the products; the authors discuss the XML data structures needed to represent the different forms of pricing useful for B2B e-commerce transactions.

The procurement problem, perhaps more than the contract design problem, has been extensively studied in the supply chain literature, in particular. In view of the work done in providing models and methods for use in B2B contract negotiation, it is natural to ask whether the medium-term planning problem can be taken into account jointly with determination of optimal contract T&C. Analogously, it is natural to ask whether the contract T&C can be effectively integrated into the tactical planning of the B2B operations. This problem, viewed in isolation, is referred to as the optimal procurement problem in the supply chain literature, or the capacity planning problem in networking and other domains. Ample literature exists on models and methods for optimal procurement and capacity planning (see, as an example, Simchi-Levi et al. 2004, Hsu et al. 2006, Lee and Kim 2002, Tempelmeier 2001).

In the above literature, some of the four areas described in §1 have been addressed, whereas others have not. Namely, topic (i), the quantification of human resources, has not been a focus area for work in procurement and capacity planning. Some exceptions exist, and clearly more such work is needed for widespread use of such models in SBS. The long-term nature of the SBS contracts, topic (ii), has in some cases been integrated with the operational problems, especially as it pertains to models such as two-stage stochastic programming, which explicitly considers a first stage for setting terms and conditions and a second stage of decision making in which operational parameters can be set. However, regarding topic (iii), it is not common for those references that treat the long-term and the operational decisions to model complex fee structures as well. However, it is a feature of SBS contracts that cannot be ignored. Finally, topic (iv), the presence of multiple actors in the decision process, has not been treated widely in the procurement and capacity planning literature.

In summary, there is a rich toolkit available to the researcher to address and solve the problem of revenue management for SBS. Models and methods can be borrowed from the supply chain literature, the contract negotiation literature, B2B services in IT, and more. The key to making these models useful for SBS lies in the four areas described in §1, the human resource as a critical component, the long-term contract horizon, the complex fee structures, and the multiple actors and decision makers. More and more there is a need for analytic models to help companies plan and execute SBS profitably. It is the hope of this paper and this special issue of *Production and Operations Management* to stimulate more research and advances in the area of revenue management for business services.

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