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Creating Competitive Advantage in E-Business Value Chains by Using Excess Capacity via IT-enabled Marketplaces

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Acknowledgments

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Abstract

Innovations through the "business process as a service" (BPaaS) concept have shaped new business opportunities for service providers. Technological progress allows business process service providers (BPSPs) to offer a wide range of digitized and standardized services to business clients. Within this business model, capacity planning is a major challenge for BPSPs, as costs are the decisive factor in the competitive business environment of digital service provision. Accordingly, BPSPs must tackle inefficiencies in capacity planning resulting from both idle capacity and lost revenue caused by volatile demand. However, recent technological developments offering dynamic integration and information capabilities may help, as they enable the exchange of excess capacity between business partners. We examine the corresponding potential of IT-enabled excess capacity markets to create competitive advantage in e-business value chains by analyzing a BPSP's capacity-related optimization problem. We build an analytical model based on queuing theory and evaluate it through a discrete-event simulation applying a possible application scenario. By solving the optimization problem, we identified a remarkable cost advantage in using excess capacity as a first competitive advantage. Building on this cost advantage, we furthermore identified differentiation advantages realizable without raising prices. Both findings highlight the relevance of further research on this topic.

Keywords: Business Process Service Provider; Capacity Management; Excess Capacity; E-Business Value Chain; Optimization; Analytical Model.

Introduction

The increasing digitization of business processes, along with modern information technology (IT), allowing a fast and easy integration of business partners leads to a continuing and radical transformation of e-business value chains as well as new and innovative forms of cooperation (Barua, Konana, Whinston & Yin, 2001; Andal-Ancion, Cartwright & Yip, 2003; Ramirez, Melville & Lawler, 2010). Companies can now source whole business processes from external providers that allocate all technical, personnel, and other resources necessary to ensure an effective and efficient process operation (Sengupta, Heiser & Cook, 2006). Especially for standardized, IT-driven, and digitized business processes, the well-known business process outsourcing (BPO) approach has already evolved, leading to the “business process as a service” (BPaaS) concept. By analogy with concepts such as software or infrastructure as a service, BPaaS describes a dynamic BPO relationship between a business process service provider (BPSP) and its business clients: Both parties technically integrate their processes via Internet-based technologies, allowing the BPSP to deliver its service within a flexible contract period and a consumption-based pricing model. Moreover, the BPSP can share its resources among different business clients flexibly in order to ensure service provision as stipulated in the applicable service level agreement (SLA) (PricewaterhouseCoopers [Pwc], 2010).

As companies usually keep core business processes in-house (e.g., to avoid drain of critical business knowledge), BPSPs mostly offer standardized support for business tasks that do not demand specialized competencies. The range of business processes currently available as services include online payment processing, human resources and procurement services, and other back-office tasks (Pwc, 2010; Kaganer, Carmel, Hirschheim & Olsen, 2013). For instance, in the banking industry, automated bank account relocation services are provided by BPSPs. These services are usually commodities with few distinguishing characteristics and can be offered by a wide range of BPSPs. Especially for such commodity services, business clients aim to minimize the costs of service purchasing; thus, service price is the decisive competition factor among BPSPs (Dorsch, 2013). Further, even highly specialized business processes like automated credit assessment and credit decision-making that require more specialized capabilities and posse a high degree of criticality, e.g. in terms of timing requirements, can also be handled by BPSPs. Accordingly, to succeed in this cost-driven environment, BPSPs must identify and raise potentials for more cost-efficient service provision to realize competitive advantages. To outperform its competitors, a BPSP must either provide the established service level at less than the competitive price or provide improved service at the established price.

An important strategic lever for achieving cost and price leadership is a sophisticated ex-ante planning of the BPSP’s in-house capacities. This is especially important due to the characteristics of service provision: most BPSPs face very volatile demand but are not able to react to demand fluctuations by scaling their IT capacity or their personnel resources on short notice. At the same time, business clients usually specify service quality such as fast response times by contracting SLA with penalty payments in case of insufficient service provision (Chesbrough & Spohrer, 2006; Rai & Sambamurthy, 2006). Consequently, to avoid SLA-related penalties, the BPSP must be able to cover peak demand while also ensuring the efficient use of resources to avoid idle costs in times of average or low demand (Bassamboo, Ramandeep & van Mieghem, 2010a; Bassamboo, Ramandeep & van Mieghem, 2010b). Finding the right balance within this tradeoff is a major key to superior resource usage and a foundation for generating competitive advantage in such cost-driven environments.

In addressing this tradeoff, most methods of handling analogous capacity planning problems in manufacturing (e.g., producing on stock to cover peak demand) cannot be applied to BPSP due to specific service characteristics like non-storable services with uncertain demand. However, when focusing on IT-driven and digitized services, the development of innovative technologies such as service-oriented architectures, cloud-computing, and associated concepts may help mitigate this capacity planning problem. As these technological developments strongly foster firms' integration capabilities of third-party providers, they are also the catalyst for *IT-driven marketplaces*, allowing business partners to interact in a highly dynamic manner (Grefen, Ludwig, Dan & Angelov, 2006; Moitra & Ganesh, 2005). At this, an IT-driven marketplace provides an information platform for a coordinated interplay of its market participants that allows matching available excess capacity with excess demand. Consequently, these new possibilities offer a promising opportunity for exchanging excess capacity to address the tradeoff between idle costs and waiting costs. The in-house capacity of the BPSP can be reduced because excessive demand can be routed to third-party providers with underutilized IT and/or personal capacities forming the *excess capacity market* (ECM).

However, using excess capacity bears additional risk. For instance, excess capacity's availability can be limited. Hence, a BPSP has to consider the risk of waiting times at the ECM when deciding about its in-house capacity and must balance it against the potential economic benefits of an ECM.

This economic potential may be hampered, as not all service requests can or will be routed to the ECM since service requests can differ in terms of specific characteristics such as data quality, legal requirements, or confidentiality (Braunwarth & Ulrich 2010; Braunwarth, Kaiser & Müller, 2010). Thus, when deciding ex-ante about the appropriate level of in-house capacity, the BPSP must consider the inhomogeneity of service requests and, in particular, the expected number of such requests that can or will not be routed externally. Thereby, we define inhomogeneity as the difference of single service request in terms of specific characteristics such as data quality, legal requirements, or confidentiality.

Against the background of a highly competitive market for cost-driven inhomogeneous services, we examine how a BPSP can create competitive advantages through an IT-enabled ECM within its value chain. The central research question of our paper is as follows:

Which competitive advantages can be realized through an IT-enabled ECM within a BPSP's value chain regarding the processing of cost-driven inhomogeneous service requests?

To evaluate the ECM's potential to create competitive advantage, we use a design-science driven research approach and follow its basic paradigm of gaining knowledge by developing and evaluating specific artifacts (Hevner, March, Park & Ram, 2004; Peffers, Tuunanen, Rothenberger & Chatterjee, 2008). With our optimization model we depict the capacity planning problem of a BPSP considering the option of using an ECM and demonstrate the potential of an ECM for creating competitive advantages. We evaluate our model through a discrete event simulation and. Thereby, we identified a remarkable *cost advantage* in using the ECM to process a certain portion of incoming requests in different types of digitized business processes. Building on this *cost advantage*, we examined the possibilities of gaining a *differentiation advantage* and showed that reduced processing times can be guaranteed and executions times (and thus quality) can be increased at equal costs, leading to a competitive advantage. We further discuss the use and strategic advantages of an ECM in different possible digitized business processes by considerably fluctuating model parameters around the values of the initial scenario.

The remainder of this paper is organized as follows: First, we analyze the literature to highlight the research gap this study addresses. Second, we develop the optimization model using queuing theory. We then perform discrete-event simulations in a case study of online identification and authorization services for retailers such as online banking or trading platforms and investigate strategic implications of ECM usage. Finally, we summarize the key findings of the paper and discuss possibilities for future research.

Related Work

Several streams of literature are considered to carve out the research gap and provide the theoretical foundation for our optimization model. First, we briefly overview the literature concerning IT's general role in gaining competitive advantages. Then, we discuss the literature related to the problem of ex-ante capacity planning for services. Finally, we overview the literature on the use of IT-enabled excess capacity markets for services and their potential for ex-ante capacity planning.

IT and Competitive Advantages

The strategic significance of IT and its relevance for creating competitive advantages has been broadly addressed in the literature. According to Porter and Millar (1985), IT is “transforming the nature of products, processes, companies, industries, and even competition itself.” Therefore, IT can affect and reshape business value chains as well as change the structure of whole industries. Furthermore, IT can create competitive advantages by giving companies new ways to outperform their competitors and spawn new businesses from within existing operations (Porter & Millar, 1985). Powell and Dent-Micallef (1997) show that companies have gained competitive advantages by using IT to leverage human and business resources. Various other studies, such as Peteraf (1993), Grant (1991), and Barney (1991), follow this resource-based view and emphasize that a company`s ability to generate competitive advantages is directly determined by its superior usage of resources and capabilities. Furthermore, numerous empirical studies confirm the strong relationship between a company’s IT capabilities and firm performance (e.g., Bharadwaj (2000), Santhanam and Hartono (2003), Aral and Weill (2007), Rai, Patnayakuni and Seth (2006), Stoel and Muhanna (2009), or Ravichandran, Lertwongsatien and Lertwongsatien (2005)).

For BPSPs operating in a cost-driven market and following the basic principles of Porter and Millar (1985), there are two possible business strategies. It can offer the established service at less than the competitive price or it can offer an improved service (e.g., through an improved SLA) at the established (competitive) price. Differentiation strategies such as offering a significantly improved service for a *higher* price are barely relevant for the provision of very standardized services, as price is the decisive factor. The relevant differentiation strategies for BPSP in such a cost-driven market must therefore build directly on cost advantages. A BPSP will obtain these cost advantages mainly through superior usage of resources (i.e., by providing cost-efficient services). Thus, the usage of an IT-enabled ECM might offer the potential to reduce fixed costs for maintaining internal capacities, generating a competitive cost advantage. According to Mata, Fuerst and Barney (1995), this competitive advantage can be either sustained or temporary depending on the level of challenges competing firms face when trying to imitate and reproduce the strategy. The competitive advantage created through the usage of IT-enabled ECM is therefore not expected to be fully sustainable, since it decreases over time as an increasing number of competitors acquire the competencies and resources (e.g., IT capabilities and skilled personnel) necessary to duplicate the strategy. Nevertheless, companies can create at least a temporary competitive advantage by implementing ECM usage before most of their direct competitors do. As a functioning ECM requires a minimum number of participants, it is important to understand that, due to the high degree of service standardization, both competitors as well as non-competing companies can participate in the ECM. This supports the possibility of using excess capacity to realize at least a temporary competitive advantage, as the participation of direct competitors in the ECM is not a prerequisite for its emergence.

Outsourcing and Capacity Planning for Service Provision

Outsourcing and corresponding effects on capacity planning have been well researched in literature. For instance, Kremic, Tukel and Rom (2006) conclude based on an extensive literature review that strategic motivations for outsourcing can be categorized as follows: cost, strategy, and politics (mostly for public organizations). In literature, mainly transaction-cost-theory is applied to investigate cost saving potentials due to specialization and economies of scale, while resource-based view is applied to explain outsourcing from a strategic perspective (Boulaksil & Fransoo, 2010). Thereby, companies outsource tasks to concentrate on core competencies or to increase flexibility for managing uncertain demand (Lankford & Parsa, 1999). Regarding the outsourced tasks, two types can be differentiated: the outsourcing of storable goods and the outsourcing of non-storable goods and services. Both are well researched in literature. For example, Dong and Durbin (2005) investigate surplus production markets that enable the exchange of excess components between suppliers with excess inventory and manufacturers with shortage. They show that participants can profit from the exchange of excess inventory on surplus markets.

The general problem of ex-ante capacity planning for non-storable goods and services under uncertain demand has also long been examined in scientific literature. In particular, the topic of call center outsourcing, which reflects a common example for capacity planning for services, has been widely discussed. These studies usually distinguish between the two basic sourcing models that companies can use: volume-based contracts and capacity-based contracts (Milner & Kouvelis, 2007; Ghose, Telang & Krishnan, 2005). Volume-based contracts (“pay-for-job”) involve payments only for the used capacity, whereas capacity-based contracts (“pay-for-capacity”) involve payments for all capacity, whether employed or not. Considering these basic sourcing models, Akşin, de Véricourt and Karaesmen (2008) determine the optimal capacity levels and partially characterize the optimal pricing conditions for each type of contract. Gans and Zhou (2007) analyze the centralized capacity and queuing control problem within this context. Studies dealing with outsourcing decisions in a service setting include Ruth, Brush and

Ryu (2015), Cachon and Harker (2002), Allon and Federgruen (2008), and Ren and Zhou (2008). Ruth et al. (2015) investigate by means of transaction-cost and agency-cost the influence of IT on outsourcing decisions and the level of centralization of HR-related services within a firm. Based on a survey among 243 firms, they find that IT facilitates outsourcing. Cachon and Harker (2002) study the competition between two service providers with price- and time-sensitive demand by modeling this setting as a queuing game. Allon and Federgruen (2008) analyze volume-based contracts and their effects on supply chain coordination. Ren and Zhou (2008) study contracting issues between a client and a vendor and analyze contracts the client can use to induce the vendor to choose staffing and effort levels that are optimal for the supply chain. The aforementioned studies analyze various aspects of volume- and capacity-based contracts in the context of capacity planning for services, but they do not consider the option of IT-enabled exchanges of excess capacities. However, an understanding of the influence of IT-enabled exchanges of excess capacities on ex-ante capacity planning decisions is highly important, as IT-enabled ECMs, in contrast to conventional exchange markets, enable the highly dynamic and automated exchange of excess capacities between business partners and influence the operational principals of such excess capacity markets (and thus their advantageousness).

IT-enabled Markets for Excess Capacity

This paper focuses on how IT-enabled ECMs foster the exchange of excess capacities between companies and thus addresses the problem of ex-ante capacity planning for BPSPs. The basic idea of exchanging capacities to facilitate ex-ante planning has been discussed in production and supply chain management studies on the so-called "surplus markets" (Gans & Zhou, 2007; Akşin et al. 2008; Cachon & Harker, 2002; Allon & Federgruen, 2008; Ren & Zhou, 2008). These papers are related to our approach, as firms with a shortage of capacity or inventory can buy available overcapacities or excess inventories from other firms. In a fundamental difference, however, these papers deal with physical products and examine the trading of physical excess inventories.

Insert Figure 1 About Here

By contrast, we seek to facilitate capacity planning for digital, non-storable IT services with uncertain demand by using IT-enabled ECM (cf. Figure 1). The usage of IT-enabled ECM and the potential for the ex-ante capacity planning for digital services has been examined only recently by Dorsch and Häckel (2012a, 2012b, 2014). Dorsch and Häckel examine the cost advantage to service providers of the on-demand integration of business partners (Dorsch & Häckel, 2012a) and analyze the environmental sustainability benefits of excess capacity markets in cloud service environments (Dorsch & Häckel, 2012b). The advantages of combining the usage of on-demand surplus capacity with classical models of capacity supply (dedicated capacity and elastic capacity) are also elaborated (Dorsch & Häckel, 2014). Though this research provides valuable insights into the impact of an IT-enabled ECM on capacity planning for services, it focuses on the realization of cost advantages in processing homogeneous services. Our approach differs in two key ways. First, we explicitly consider the given inhomogeneity of service requests (Braunwarth & Ulrich, 2010; Braunwarth et al., 2010) by acknowledging that not all requests can or will be processed on external markets. Second, we investigate how a BPSP can gain differentiation advantages through an IT-enabled ECM, comparable to the concept of reinsurance in the insurance industry. We therefore extend the existing models significantly and examine how competitive advantages can be generated in this distinctly more complex and realistic scenario.

In the following, we present a modeling approach to help optimizing the ex-ante capacity planning of a BPSP when considering the option of using an IT-enabled ECM. Within this modeling approach, we consider the inhomogeneity of service requests. The results of this optimization model provide valuable findings on the possible competitive advantages enabled by IT-enabled ECM.

Modeling the Business Process Service Provider's Value Chain

To substantiate the idea of IT-enabled ECM and demonstrate our model, we first elaborate on our research methodology, then describe the general setting and discuss the necessary information and integration capabilities. Then, we define the model and its assumptions, starting with the underlying capacity optimization problem, followed by a description of the in-house unit and the ECM and all relevant parameters and (objective) functions. Finally, we introduce a routing algorithm necessary to solve the optimization problem.

Research Methodology

To address the raised research question, we apply a typical design-science driven research (DSR) approach (Hevner et al., 2004, Peffers et al., 2008). DSR in information systems (IS) is important to solve organizational problems and gain knowledge of a problem by the development of artifacts (Hevner et al., 2004, Peffers et al., 2008). The typical DSR methodology (Peffers et al., 2008) suggests six activities: (1) identify problem; (2) define design objectives for solution; (3) design and develop; (4) demonstrate; (5) evaluate; and (6) communicate. The first activity was already addressed by highlighting the relevance of formalized methods for the depiction and simulation of ECM's potential to create competitive advantage in the introduction section. In the following, we start with the development of an artifact, an optimization model depicting the capacity planning problem of a BPSP considering the option of using an ECM, as building a mathematical model is one common way to represent an artifact in a structured and formalized way (Hevner et al., 2004). Next, we describe a detailed real world scenario (descriptive design evaluation method) and evaluate our model through a discrete event simulation, a widely accepted experimental design evaluation method (Wacker, 1998). To ensure utility as a major goal of design-science research (Hevner et al., 2004), we aim to demonstrate how our approach can be applied to a specific scenario and how the advantages of using an IT-enabled ECM can be valuated based on this model. Our approach is also closely related to the research cycle of Meredith, Raturi, Amoako-Gyampah and Kaplan (1989) who emphasize that describing non-examined research areas qualitatively and mathematically and thus predicting first results provides the basis for generating hypothesis that can be tested within future empirical research. To outline directions for further research, we discuss next steps regarding our optimization approach that might be addressed by applying various empirical evaluation methods like e. g. case studies, field studies or field experiments at the end of the paper.

General Setting and Necessary Information and Integration Capabilities

We consider a three-stage e-business value chain, as illustrated in Figure 1. Here, a BPSP offers an IT-driven service to numerous business clients. The activities necessary to provide the service require IT as well as personnel resources because some activities require manual interventions. As the execution of the service is time-critical, the BPSP offers an SLA to its business clients (arrow number 1). The business client's requests are characterized by volatile demand (arrow number 2). As neither the IT capacity nor the personnel resources are fully scalable on short notice, the BPSP faces a capacity optimization problem for its in-house unit: to avoid both costly violations of the committed SLA due to capacity shortages in times of peak demand and idle costs in times of low demand, internal resources must be properly balanced. In addition, the BPSP can use the ECM to route certain service requests to third-party providers, offering their temporarily unused capacity (arrows number 3 and 4).

Though service requests have standardized purposes, they are inhomogeneous in terms of the requirements of individual requests. Thus, following recent studies on (IT) business process outsourcing (e.g., McIvor (2008) or Atkinson, Bayazit and Karpak (2015)), the BPSP divides incoming requests into two categories: requests that can be routed to the ECM (the regular requests) and those that need to be processed by the in-house unit of the BPSP (the special requests). Special requests may require specific expertise only available at the BPSP's in-house unit, or they must be processed in-house due to legal or confidentiality requirements. Therefore, the BPSP has to consider these two categories when optimizing the BPSP's in-house capacity. As a consequence, the competitive advantages that can be achieved through an ECM as well as the appropriate level of in-house capacity are highly dependent on the inhomogeneity of incoming service requests. Furthermore, as excess capacity can be booked only on short notice, it is usually not SLA-backed, and its use tends to be more risky (due to possible delays) but also cheaper than in-house processing (as there are no idle costs). Thus, to decide whether an external execution of regular requests is preferable, the BPSP has to compare the costs for external execution and the risk of possible delays against the total processing costs of the in-house unit.

To operationalize the use of excess capacity, the BPSP must develop several integration and information capabilities. Building these capabilities is an essential precondition of realizing competitive advantages through excess capacity. In concrete terms, the BPSP must be able to (1) automatically determine which of the third-party providers is offering excess capacity on the market at any point during operation, (2) gather all the information relevant to its decision (e.g., current waiting time until external capacity is available, price for processing the request), and (3) connect its IT system to that of the third-party provider. Thus, its own IT system has to allow for a continuous evaluation of the ECM, and all necessary information must be provided by the ECM. The supply of information is supported by high-level frameworks for information exchange such as BizTalk, ebXML and RosettaNet as well as by various B2B platforms offered by product vendors (e.g., Oracle, Microsoft, IBM). In recent years, the web service paradigm emerging with service repositories and well-described services based on standardized description languages have evolved into one of the primary standards for the dynamic evaluation and integration of service providers (Grefen et al., 2006). Through these technological developments, a decentralized information exchange between various service providers regarding the usage of excess capacity is possible. Furthermore, a more centralized approach has been enabled by the development of (on-demand) service marketplaces such as SAP Service Marketplace, HubSpot, or Zimory, by which firms offering or/and seeking certain services can interact in a highly dynamic manner (Grefen et al., 2006; Weinhardt et al., 2009).

Underlying Capacity Optimization Problem

As mentioned, each incoming request triggers a service execution. The arrival rate λ (i.e., the number of time-critical requests sent from the business clients per time unit) is random. The statistical distribution of λ can be approximated based on historical data. The planning horizon considered is finite and divided into equidistant time units. After the BPSP has finished all activities necessary to complete the request, it is returned to the respective business client. The time frame between the accepting and returning of the request is called the *processing time*. Service level s (e.g., a maximum processing time with penalty payments for each time unit the request exceeds this limit) is guaranteed to the business clients for this processing time. Any request that fails to maintain this service level causes costs subsumed within c_s.

Taking these characteristics into account, the BPSP must decide ex-ante on the capacity (i.e., the number of requests $y \in IN_0$ that can be handled simultaneously) to allocate to its in-house unit, which minimizes its *total processing costs c*. The simplified objective function for this discrete optimization problem is therefore given by

$$\min_{y} c(\lambda, y, s)$$

Concerning these main characteristics (e.g., random demand, limited capacity), it is appropriate to model the capacity optimization problem using *queuing theory*. In the following, we therefore rely on its basic assumptions as described, for example, in Gross, Shortle, Thompson and Harris (2008), while extending them by the necessary parameters and functions.

Service System of In-house Unit and Excess Capacity Market

Unless all capacity units within the in-house unit are busy, the execution of a request starts immediately after its arrival in the BPSP's IT system. If all units of capacity are busy, each incoming request lines up in an infinite waiting queue, to be executed immediately when capacity is available again, i.e. as soon as a request has been processed. Free units of capacity are idle and cannot be used to accelerate the execution of other requests. The timeframe within which the request stays in the queue in front of the in-house unit is called *waiting time*. The timeframe between the beginning of the service's first activity and the end of the last is called *execution time*. Accordingly, waiting and execution time sum up to the *processing time* mentioned above. Hence, long waiting times might lead to processing times that do not maintain the agreed service level and cause corresponding costs.

In addition to the in-house unit, third-party providers offer excess capacity for temporary use, forming an ECM. On this market, capacity cannot be booked in advance, and constant availability is not enforced by SLA. The availability of capacity on the ECM therefore changes constantly, and a non-negligible and risky waiting time must be considered when relying on the ECM. This exogenous waiting time for capacity on the ECM has to be provided constantly by third-party providers. Timeframe *a* denotes the time a request must wait in the ECM queue. With *a* > 0, requests cannot be executed immediately, and the exogenous waiting time might be too long to keep up with the service level agreed with the business clients, causing corresponding costs.

When considering the ECM as a second queuing system, the combination of in-house capacity and ECM forms a *service system* that offers two separate *execution paths* for incoming service requests. Thus, as illustrated in Figure 2, the BPSP can decide whether it routes a (regular) request to the in-house unit or to the ECM. As mentioned, special requests can be executed only in-house due to reasons of competence, confidentiality, or legality.

Total Processing Costs and Detailed Objective Function

To determine the actual total processing costs *c*, additional parameters specifying the two queuing systems are necessary and the *execution time* for regular and special requests must be determined: Considering a special request, the statistical distribution of the execution time t_s within the in-house unit can be derived based on historical data. Likewise, the statistical distribution of the execution time t_r for a regular request can be determined. The *in-house unit* causes *fixed costs* c_f per unit capacity but no additional *variable costs*. The fixed costs considered for one unit of capacity contain recurring capacity costs such as employee wages, running costs for the IT system and other equipment, overhead costs, and all non-recurring initial costs. The total number of regular requests finally processed in-house is denoted by $o_{i,r}$, and the total number of special requests executed in-house is denoted by $o_{i,s}$. The *external execution* involves no fixed costs, but variable costs c_e for each request sent to the ECM. As prices may change during operations, price c_e must be provided along with the information about the waiting time *a*, as described above. The total number of externally routed regular requests is denoted by o_e.

We can now determine the BPSP's total processing costs. The detailed objective function reads

$$\min_{y} c = c_f\, y + c_e\, o_e + c_s\big(\lambda, y, o_{i,r}, o_{i,s}, o_e, s, t_r, t_s, a\big)$$

As mentioned, the total processing costs considered in this model consist of the fixed costs c_f of in-house capacity, the variable costs c_e of using excess capacity, and the costs c_s resulting from requests that violated the SLA (i.e., *compensations* for delayed requests and *penalties* for requests that remain unexecuted). Consequently, the optimization problem is related to the amount of capacity *y* the BPSP allocates to the in-house unit. Integrating the ECM changes the total processing costs *c*, as the processing costs of regular requests differ depending on the execution path and overall waiting times. Solving the objective function for the integer values of *y* results in the optimal amount of capacity the BPSP should allocate in-house to minimize total operating costs. Figure 2 and Table 1 summarizes the model (parameters).

Insert Figure 2 About Here

Insert Table 1 About Here

Routing Algorithm Necessary to Solve the Optimization Problem

To solve this optimization problem, it is not sufficient to evaluate the two queuing systems representing the in-house unit and the ECM separately. Rather, the service system must be evaluated as a whole because the two queuing systems interact during operations and influence waiting times. Although queuing theory provides a strong mathematical foundation, this cannot be done analytically since the two queuing systems have different characteristics, especially concerning their distribution of processing times.

The routing decision must take place during operations for every single request immediately after arrival. In the beginning, the IT system must separate regular requests from special ones. Then, the routing decision requires a routing algorithm that links the two interacting queuing systems and decides about the execution path for a regular request.

The routing algorithm works as follows (cf. Figure 3). First, it determines the processing time for each queuing system. This is easily determined for the in-house unit, as the state of the system depends on its own capacity *y*, the arrival rate of requests *λ*, and the execution time t_r. Besides, the timeframe *a* until free capacity is available on the ECM has to be determined. Second, if these processing times result in a violation of agreed-upon service level *s*, SLA-induced compensations and penalties must be calculated. The tradeoff between additional variable external execution costs c_e and a possible reduction of compensations and penalties c_s builds the basis for this decision. Third, having determined processing times and considered the SLA effects, the processing costs of each execution path for each request, and thus the preferable path for the execution, can be determined.

To demonstrate our model, we present an application scenario based on a real-world example. We perform a discrete-event simulation, an established method for analyzing queuing systems (Gross et al., 2009). Our simulation implements the quantitative optimization model described above with all relevant cost functions and parameters of the described tradeoff. Furthermore, the necessary routing algorithm is implemented to evaluate the interaction of both queuing systems. Through this method, a simulation-based optimum ("optimal capacity" hereafter) can be determined for different scenarios in order to answer our research question.

Insert Figure 3 About Here

Evaluating the Potential of Excess Capacity Markets

To evaluate the potential of integrating excess capacity to create competitive advantages and to demonstrate the feasibility of our model, we conduct simulations for a real-world example in an artificial setting enabling different scenario analysis. The application of simulations is reasonable as different input parameters influence the cost advantageousness of ECMs and, at the same time, make it difficult for human decision-makers to weigh corresponding decisions under consideration of all influencing factors. For this, in our simulation, we present the application scenario of a specific BPSP, a payment service provider (PSP) offering online identification and authorization services and electronic payment processing (e.g., Amazon Payments, PayPal). These services are typical tasks required by online retailers such as stores, trading platforms, and financial institutions. Of course, specific BPSP settings in reality are far more complex including a variety influencing factors. Nevertheless, the simulation of a close-to-real-world scenario within our simulation and its results demonstrate that our model is principally suitable for more complex scenarios and provides a basis for the profound economic evaluation.

In the following, we first define the process subject to our exemplary application and describe the related capacity planning problem of the PSP. Next, we determine the input data of our application scenario that are necessary to parameterize our model. The parameterization of the input data is based on various expert interviews as well as many years of experience from prior research in applied research projects with companies in corresponding industries. We then describe the simulation approach to determine the optimal in-house capacity for the process. Finally, we analyze the resulting cost advantage of excess capacity as well as possible differentiation opportunities to investigate strategic implications of excess capacity markets.

Characteristics of the Authorization Process

The digitized business process considered is the identification and authorization process for new customers of online retailers, as illustrated in Figure 4. This task is usually sourced as a service from specialized PSPs linked with the corresponding institutions (e.g., credit card-issuing banks, credit rating agencies, government offices) necessary to identify (e.g., check and verify personal data, address data, and credit card information) and authorize (e.g., after a credit assessment) a customer. The customer data required for the request are forwarded by the retailer to the PSP for processing.

Insert Figure 4 About Here

Though this service is mostly digitized and highly standardized through common interfaces and standard input forms, it requires both intensive IT-supported and manual interventions, such as for reviewing customer inputs (due to reasons of data quality and validity) and identifying erroneous entries. As the correctness of all entered data is essential, the PSP must perform adjustment processes such as (auto)correction, or, if necessary, it must contact the customer for further inquiries. Due to the possibility of customer or third-party interactions, the authorization process must occur during business hours.

The online identification and authorization service is a typical application scenario addressed by our model, as many requests characterized by volatile demand must be processed in time to avoid penalties or loss of customer interest. Therefore, detailed service levels concerning the timeframe for execution are agreed between the retailer and the PSP. Allocating IT capacity and employees to the in-house unit charged with processing the registration procedures is an important optimization problem for the PSP. As the margins are small, the in-house unit’s capacity should be kept as small as possible to keep the corresponding costs to a minimum. Along with the volatile arrival rates of incoming requests, there is a tradeoff between idle times and delayed execution.

An ECM can be used through the technologies and standards described above; requests submitted into the provider’s gateway are not executed by its respective in-house unit but with the ECM capacity. However, only procedures that do not require adjustments of input data or customer callbacks can be routed to the external market due to reasons of expertise and reliability. Accordingly, the PSP has to decide for each incoming request if the external execution path is suitable (i.e., regular requests) and then if routing the request to an external provider would reduce overall processing costs.

Input Data of the Authorization Process

We determine the input data characterizing the authorization process for our simulation. Authorization requests can be processed each day between 8 a.m. and 6 p.m. Requests that arrive outside these hours are still accepted, but authorization will be executed on the following day. Analyzing the historical data reveals different peaks for incoming request arrival depending on exogenous factors such as customer behavior and demand. Dividing the ten hours of processing time in six timeframes, the arrival rate within each timeframe can be approximated by a negative exponential distribution with different means (per minute), as summarized in Table 2.

We assume that 30% of all authorization requests require specialized interventions or callbacks with customers due to incomplete or incorrect application forms. Accordingly, these *special requests* have to be executed in-house, notwithstanding the existence of an ECM. The interventions performed on a regular or special request require one unit of capacity for about 12:00 minutes on average regardless of its execution path. As only one employee can work on one request, idle capacity cannot be used to accelerate the execution of other requests. Cost accounting reveals that one unit of capacity within the in-house unit causes fixed costs of $350 per day.

In e-business, requests must be executed in time to meet external deadlines and avoid loss of customer interest. Furthermore, especially for the sake of reputation, satisfaction, and the retailer's economic interests, no request must be left unexecuted. Therefore, the SLA between the retailer and the PSP consists of two deadlines. First, each request has to be processed within 26:00 minutes after arrival. If a request exceeds this timeframe, a compensation that increases with the duration of the time exceeding this deadline is due. The agreed-upon compensation is determined by $\$0.03 * (minutes\ exceeded)^{1.5}$. Second, there is a final processing deadline for each day: All incoming requests have to be processed until 8:00 p.m. For each request not processed within this deadline, the compensation payment is increased by a penalty of $300. Through this penalty, the retailer offers a strong incentive to execute all incoming requests within a day. Compared with the revenues earned by processing a request, the penalty for the final processing deadline is prohibitive.

For simplicity, the variable costs for one request routed to the ECM are fixed at $8 in the simulation. The waiting time for excess capacity can be approximated based on historical data provided by the external service providers. For one day, three timeframes with different availabilities of the external service provider's capacities are identified. Each timeframe shows different waiting times for free capacity, which can be approximated by a normal distribution, as outlined in Table 3. Requests routed to the ECM have to wait according to the timeframe valid at the time the request is routed to the ECM. With these characteristics, the discrete event simulation now can be established.

Insert Table 2 About Here

Insert Table 3 About Here

Discrete Event Simulation

To determine the optimal capacity allocated to the in-house unit, we apply the following procedure within the simulation software used to implement the model. We perform multiple *simulation experiments* with increasing integer values for the capacity of the in-house unit. Each experiment consists of 800 *simulation runs*. The total processing costs are determined for each run. Starting the experiments with one unit of in-house capacity, we increase the value by one unit before the next experiment begins. This is done until the results of an experiment show that no waiting costs occur in front of the in-house unit for all runs. Consequently, an increase in capacity has no positive effect on the total processing costs. Finally, comparing the average total processing costs for each experiment and choosing the one with the lowest costs produces the optimal in-house capacity.

Regarding the simulation time, it is convenient that all days of our application scenario are independent of each other (e.g., with no unexecuted requests left due to the processing deadline at 8:00 p.m.), and the relevant events determining the optimal in-house capacity are recurrent each day. It is thus sufficient to simulate a single day to determine the optimal capacity.

For each simulation run, incoming requests are generated randomly following their statistical distributions. Whenever a new timeframe is reached, the arrival rate is adapted. Concerning the availability of excess capacity, a random value is generated from the corresponding statistical distribution at the beginning of each timeframe outlined in Table 3. This random value represents the waiting time until the request can be executed externally; this is used by the routing algorithm to determine the processing costs of external execution. Repeating a simulation run 800 times, the risk of waiting times in case of using excess capacity is considered when determining the optimal in-house capacity.

Incoming requests characterized as *special requests* cannot be routed to the ECM; they are routed straight to the in-house unit (specifically, the waiting queue in front of it). For *regular requests*, the routing algorithm determines the current processing costs of both paths and then routes the request to the path with lower costs. The processing costs of the in-house execution thus result only from the SLA with the retailer; there are no variable costs connected with the in-house unit, and all fixed costs are sunk costs, which hence must not be taken into account. Regarding the SLA, costs can occur in two different ways: if a request cannot be processed ahead of the final processing deadline, the penalty has to be considered in the processing costs. Otherwise, if the agreed-upon processing time per request is exceeded, compensation costs per minute are charged. For the external execution, the processing costs consist of the variable cost per request and the costs resulting from the SLA determined analogously.

Determining the Cost Advantages of Excess Capacity

Performing the discrete event simulation *with* and *without* the opportunity to use excess capacity reveals the cost advantages of the ECM (scenario 1). The relation between total costs and assigned in-house capacity is shown in Figure 5.

Insert Figure 5 About Here

The minima of both cost patterns (indicated by the dotted lines) represent the optimal level of capacity within the in-house unit. The optimal level of capacity *without* access to the ECM is reached at 362 units, corresponding to total costs of $144,292 per day, while the optimal level of capacity *with* access to the ECM equals 147 units, corresponding to total costs of $122,982 per day. Thus, total costs can be reduced by $21,310 (14.77%) per day if the ECM was available, although the sourcing of special requests is rejected a priori. In Figure 5, this cost advantage is indicated by the distance between the two dotted lines.

An analysis of the functions that sums up to the total costs (i.e., fixed costs for in-house capacity, variable costs for requests routed to the ECM, compensations and penalties for exceeding the agreed SLA) reveals the following:

For the scenario *without* ECM integration, very small in-house capacity produces long waiting times, and the total costs are high due to the corresponding SLA-induced compensations and penalties. With increased in-house capacity, more requests can be processed ahead of the final processing deadline; thus, total costs decrease drastically due to the fewer violations of the agreed-upon SLA processing time of 26:00 minutes and fewer requests exceeding the final processing deadline. Regarding the optimal level of capacity *without* access to the ECM (362 units), as indicated in Figure 5, no further cost savings are possible beyond this point, as the costs of additional capacity exceed the cost savings from it.

By contrast, in the scenario *with* ECM integration, the possibility of using excess capacities reduces the risk of exceptionally high SLA-induced compensations and penalties because the ECM allows the execution of regular requests that are left unexecuted in the other scenario. The high penalty for unexecuted requests ensures that the routing algorithm chooses the external execution path. Furthermore, as regular requests arriving in peak times (e.g., the early morning or evening) can be routed to the ECM, the waiting times in the queue in front of the in-house unit are reduced. Overall, special requests also benefit from excess capacities, as the waiting time in front of the in-house unit and the corresponding waiting compensations are reduced. Again, with the increased in-house capacity, waiting costs decrease to the point where the costs of additional capacity exceed the waiting-cost savings (147 units).

Thus far, we have used a percentage of 30% of authorization requests that require specialized interventions or customer callbacks due to incomplete or inaccurate registration forms in our simulation. However, this percentage may vary depending on the service considered. For example, the number of data required for the identification and authorization service, its complexity (e.g., dependencies between data packages) as well as the target group of the service (e.g., retailer focuses on customers with little online experience) can strongly influence the error rate induced by the user. To examine the influence of the number of incoming special requests, we vary the percentage of special requests while all other parameters are kept at their initial values.

Figure 6 summarizes the total costs assuming different percentage rates for special requests. The costs when employing the optimal level of in-house capacity combined with the ECM are lower for each setting (e.g., 10%, 30%, 50%) than in the solution without external service providers.

Insert Figure 6 About Here

This *general cost advantage* can be explained the following way. In the scenario without ECM integration, all requests (whether regular or special) must be processed by the in-house unit, which leads to the cost disadvantages mentioned above. Likewise, in the scenario with ECM integration, a PSP would have to process all requests in-house if they were all categorized as special. Thus, the scenario without ECM integration corresponds exactly to a setting of 100% special requests, as, in both scenarios, the PSP has to execute all requests in-house. Accordingly, the optimal setting with ECM integration is preferable for all levels of special requests to the optimal setting without ECM integration. This is caused, inter alia, by the fact that ECM integration involves only the variable costs for each request sent to external providers. Accordingly, integrating excess capacity enables a general cost advantage which, however, decreases by the percentage rate of special requests. Table 4 summarizes this general cost advantage by presenting both optimal in-house capacity and the associated costs for the different percentage rates of special requests as well as the corresponding cost advantages compared to the scenario without ECM utilization.

Insert Table 4 About Here

So far, we have identified a general cost advantage for the PSP as an opportunity to gain a competitive advantage by using ECM. In a cost-driven market environment, this cost advantage can be used for price differentiation on the side of the PSP to establish price leadership. However, based on the innovative opportunities of the on-demand integration of excess capacity, further strategies for gaining competitive advantages become evident. In the following, we therefore analyze how cost leadership can be used to create differentiation advantages besides that of price in competitive cost-driven markets.

Determining the Differentiation Advantage of Excess Capacity

By pursuing a differentiation strategy, the PSP can create a unique selling proposition aside from cost leadership. Due to the cost-effective processing of requests via ECM, the PSP can use its cost advantage to create a variety of differentiation advantages; the PSP can distinguish its services regarding qualitative benefits and offer more cost-intensive services, while the cost advantage of ECM ($21,310 in our simulation) allows equal-cost market competition. In the following, we demonstrate differentiation strategy options and examine their benefits.

The starting point of our consideration is the model parameters set forth above. We employ the basic setting of our simulation (30% special requests). Furthermore, we consider parameters representing qualitative aspects for differentiation opportunities. For example, the PSP can offer an improved service level, meaning that it commits to a shorter processing time for incoming requests (scenario 2). Alternatively, the execution time the in-house unit spends on special requests can be expanded, allowing the in-house unit more time to increase the processing quality for special requests (scenario 3). For both differentiation strategies, we now determine to what extent a PSP *with* access to excess capacity can improve its service quality and thereby develop a substantial differentiation advantage.

In scenario 2, we examine the reduction of the agreed-upon SLA processing time in order to identify a lower limit for it. The benchmark for this optimization is represented by a competitor *without* access to excess capacity. First, we gradually reduce the SLA processing time (starting at 26:00 min) and determine the minimum of the total costs for each level of SLA processing time. Each experiment consists of 800 simulation runs. This is repeated until the minimum of the total costs of the PSP *with* access to the ECM equals the minimum of the total costs of the competitor *without* access to the ECM. Figure 7 shows the cost patterns leading to identical costs. According to this staged optimization approach, the PSP *with* ECM access can offer an SLA processing time of 10:54 minutes (as a lower limit) instead of 26:00 minutes while realizing the same total costs as a competitor *without* ECM access. This means that the PSP can offer an SLA that is 58% stricter at an identical price. Accordingly, any SLA between 26:00 and 10:54 minutes generates both differentiation advantages (a more attractive SLA) and cost advantages (the remaining cost benefit) when utilizing ECM.

In scenario 3, we use the same staged optimization approach to determine the upper limit of the extra time the in-house unit can spend on special requests. Starting with our basic simulation setting, we gradually increase the processing time for special requests (starting at 12:00 minutes) until the minimum of the total costs of the PSP *with* access to the ECM equal the costs of the competitor without it. As shown in Figure 8, the PSP can increase the processing time for requests by 4:13 to 16:13 minutes (upper limit). Consequently, the in-house unit has about 35% more time for correcting and post-processing and for contacting customers to complete identification and authorization procedures.

Insert Figure 7 About Here

Insert Figure 8 About Here

Table 5 provides details on the differentiation advantages illustrated in Figure 7 and 8 by specifying the total costs of scenarios 2 and 3, their cost components, and the shifting of the cost advantage (shown in brackets) compared to the basic setting with ECM access (scenario 1). It considers the costs for the in-house unit, the costs for excess capacity, compensations, and penalties. For the sake of completeness, the setting without ECM access (benchmark) is shown in the far-right.

Insert Table 5 About Here

In scenario 2, the PSP can offer a more attractive SLA and, at the same time, face higher compensation payments due to the reduction in the agreed-upon SLA timeframe. Thus, most of the cost advantage of ECM integration is passed on to the retailer. However, the PSP has to consider possible negative side effects on customer (i.e. retailer) perception caused by increasing SLA-violations, which are not included in our model. Accordingly, the improved SLA of 10:54 minutes represents the absolute minimum of the processing time and does not contain any concrete action recommendation. To emphasize the advantages, we further examined the optimal level of capacity *without* access to the ECM with the corresponding SLA processing time of scenario 2 (10:54 minutes). The optimal level of capacity *without* access to the ECM and a SLA processing time of 10:54 minutes is reached at 399 units, corresponding to total costs of $164,136 per day.

In scenario 3, longer execution times for special requests require more in-house capacity, and compensation payments between the PSP and the retailer increase. However, as the PSP’s in-house unit is given more time to focus on non-standard procedures, processing quality can be increased. Though quality and customer satisfaction are, as indicated, not captured in our model, we assume that increased processing times can be utilized to respond individually to customer needs, thereby strengthening customer relationships. Thus, the differentiation strategy of scenario 3 can constitute a significant competitive advantage for the PSP, as it may increase customer satisfaction as well as the retailer’s prospects for customer retention. Analogous to the underpinning of the advantages of scenario 2 the optimal level of capacity *without* access to the ECM with the corresponding execution time (16:13 minutes) is reached at 464 units, corresponding to total costs of $190,927 per day.

Based on the previous advantage analysis of ECM, we conduct a more detailed analysis of the application of ECMs in different digitized business processes to investigate strategic implications of ECM.

Detailed Cost Analysis for Different Process Types

To further analyze our model and to ensure its applicability to real-world strategic decisions we analyze the use of an ECM in different possible digitized business processes by considerably fluctuating model parameters around the values of the initial scenario. Therefore, we choose parameterizations that differ in terms of their *degree of criticality*, concerning the SLA-induced compensations, as well as in terms of the *degree of specialization*, concerning different percentage rates of special requests. By changing the parameterization of the agreed-upon SLA compensation to either $\$0.02 * (minutes\ exceeded)^{1.25}$ or $\$0.07 * (minutes\ exceeded)^{2.25}$ (low or high degree of criticality) while simultaneously changing the percentage rates of special requests to either 10% or 50% (low or high degree of specialization), we obtain four different digitized business processes (cf. Table 6). Performing the discrete event simulation *with* and *without* the opportunity to use excess capacity reveals the advantages of the ECM and, thus, its strategic implications on business strategy. Depending on their business model and the associated processes, one or more of the analyzed business processes may be relevant for companies. With the help of the insights gained from the simulation, it can be deduced for which of a company's processes - measured in terms of the request's degrees of criticality and specialization - the potential of integrating excess capacity is worthwhile to create competitive strategic advantages. Table 6 summarizes the results for the different processes by presenting the respective parametrization, the optimal in-house capacity, the associated costs for the different percentage rates of special requests as well as the corresponding cost advantages compared to the scenario without ECM utilization. The corresponding relation between total costs and assigned in-house capacity is shown in Figure 9.

Insert Table 6 About Here

Insert Figure 9 About Here

For a process with a *high degree of specialization* and *a low degree of criticality* (Process 1), we consider exemplarily a bank account relocation service which is offered to new customers of a bank to relocate all their existing contracts with other institutions to the new bank. This service is characterized by a high degree of specialization as the correctness of all entered data is essential and the bank products to be relocated have a low degree of standardization, which may lead to frequent inquiries being made to the customer. A low degree of criticality is reasonable since the relocation service is not extremely time-critical and does not lead to critical problems or discomfort for the customer, at least in the short term, if the SLA deadline is exceeded. The optimal level of capacity for this process *without access as well as with access* to the ECM is reached at 247 units, corresponding to total costs of $112,653 per day. Thus, in this process, integrating excess capacity would not result in any cost advantage for the optimal in-house capacity level. However, in terms of total costs, a downside deviation from the optimal in-house capacity, i.e. a very small in-house capacity that produces long waiting times, is more critical in a scenario without ECM integration than in a scenario with ECM integration. As the total costs in the scenario with ECM integration are always equal to or lower than in the scenario without ECM integration, regardless of the capacity selected, an integration of the ECM also offers an advantage here, since the optimal capacity in a real world setting is difficult to determine exactly or can fluctuate slightly on a daily basis.

An example for our second process with a *high degree of specialization* and a *high degree of criticality* is the automated credit assessment and credit decision-making. Since the correctness of the data is essential, but at the same time divergent non-standardized input is collected from the customer in the application process, this leads to a high number of special requests and a high degree of specialization. On the other side, it is essential to process the requests in time to avoid the loss of customer interest. The optimal level of capacity *without* access to the ECM is reached at 467 units, corresponding to total costs of $168,030 per day, while the optimal level of capacity *with* access to the ECM equals 430 units, corresponding to total costs of $166,186 per day. In contrast to process 1, the total costs can at least be reduced minimally by $1,844 (1.09%) per day if the ECM was available. Even an ECM integration doesn't offer a high cost advantage, analogous to process 1, the ECM integration nevertheless offers a strategic planning advantage since total costs in the scenario with ECM integration are always equal to or lower than in the scenario without ECM integration and, therefore, it is less critical to determine exactly optimal in-hose capacity.

An example process for our third case example with a *low degree of specialization* and a *low degree of criticality* is a change request to the stored customer master data, such as a change of address. This process is characterized by a low degree of specialization as most of the conceivable requests are standardized, which may lead to rare inquiries being made to the customer. Furthermore, as these requests are usually not time-critical and have no direct influence on customer satisfaction, a low degree of criticality is reasonable. Analogous to our first process, optimal level of capacity for this process *without access* to the ECM is reached at 247 units, corresponding to total costs of $112,653 per day. The optimal level of capacity *with* access to the ECM equals 153 units, corresponding to total costs of $110,230 per day which would lead to cost reduction of $2,423 (2.15%) per day if the ECM was available. Similarly, as with the two previous processes, an integration of the ECM offers at first sight no significant cost advantage. However, as we can observe in the corresponding figure, the ECM integration offers an extremely high strategic planning advantage since total costs in the scenario with ECM integration are always lower than in the scenario without ECM integration. Particularly in the range between 0 and 247 units, the total costs *with access* to the ECM are significantly lower and range between $110,230 (247 units) and $135,510 (0 units). Thus, a selected in-house capacity aside from the optimum would always show a cost advantage with an integration of the ECM. For example, the costs for a capacity of 50 units corresponding sum up to total costs of $364,117 for a scenario *without access* to the ECM and $114,457 for a scenario *with access* to the ECM.

Similar to our initial authorization process case, we assume in our last analyzed case a payment transaction processing process with a *low degree of specialization* and a *high degree of criticality*. However, in contrast to our initial authorization case, we assume an even more critical process, which is related to the higher agreed-upon SLA compensation. The optimal level of capacity *without* access to the ECM is reached at 467 units, corresponding to total costs of $168,030 per day, while the optimal level of capacity *with* access to the ECM equals 107 units, corresponding to total costs of $131,170 per day. In contrast to the previous three processes the total costs can be significantly reduced by $36,860 (21.94%) per day if the ECM was available. For this process, an integration of the ECM delivers not only a strategic planning advantage but also a significant cost advantage. As illustrated in the corresponding figure, the total costs *with access* to the ECM are lower for all selected in-house capacities aside from the optimum significantly, especially in the range between 50 and 467 units. In conclusion, we can state from our cost analysis for different process types that an integration of ECM offers advantages for different types of digitized processes in terms of their *degree of criticality and specialization*. A strategic planning advantage is evident for all examined types of processes but especially for processes with a low degree of specialization. This indicates that the total costs of an ECM integration are always lower or at the most equal to the total cost of an ECM integration – even if the exact optimal in-house capacity has not been determined. Since the parameterizations of individual components of our model are not precisely determinable and / or are volatile in a real-world scenario, the exact determination of the optimal in-house capacity is not feasible. In addition, we further observe a significant cost advantage for processes with a *low degree of specialization* and a *high degree of criticality.* Measured in terms of cost advantage and strategic planning advantage, the ECM integration should be implemented in a company in the following prioritization: Processes with a (1) low degree of specialization and high degree of criticality (2) low degree of specialization and low degree of criticality (3) high degree of specialization and high degree of criticality (4) high degree of specialization and low degree of criticality.

Conclusion, Managerial Implications, and Further Research

Amid the challenges for service providers in cost-driven value chains and the research gap described above, this paper examines the potential of IT-enabled ECM to create *competitive advantages* in e-business value chains for *inhomogeneous* services. Having discussed the information and integration capabilities necessary to utilize excess capacity, we considerably extended the model of Dorsch and Häckel (2012a) and focus on the capacity optimization problem of a BPSP within a three-stage supply chain. We ran a discrete-event simulation with input data from a possible application scenario to analyze the model and derive interpretable results relevant to our research question.

We answered our research question by analyzing the competitive advantages that can be realized through an IT-enabled ECM for the processing of cost-driven inhomogeneous service requests. First, we identified a remarkable *cost advantage* in using the ECM to process a certain portion of incoming requests in different types of digitized business processes, as the capacity of the in-house unit can be reduced without negative effects on service levels, reducing overall operating costs. Our analysis reveals a cost advantage even if the portion of special requests is rather high (i.e., if the portion of incoming requests suitable for handling by third-party providers is low). Nevertheless, the extent of this competitive advantage is rising significantly with the increasing service homogeneity. Building on this *cost advantage*, we examined the possibilities of gaining a *differentiation advantage* (i.e., improvements in service levels and service quality without raising prices). We showed that reduced processing times can be guaranteed and executions times (and thus quality) increased at equal costs, leading to a competitive advantage.

Based on these results, we can derive the following *managerial implications*:

- First, our results suggest that high upfront investments in information and integration capabilities might pay off in the mid to long run due to the economic potential of using excess capacity. The quantitative results of our model show the potential value of such investments and therefore determine an upper bound for investment spending.
- Furthermore, our model provides a sound basis for analyzing the economic advantages of various differentiation strategies. As discussed, the BPSP can, for instance, offer improved service levels and/or higher service quality without raising prices. Our model allows a thorough evaluation of these different business strategies, which might strengthen a BPSP's competitive position.
- As discussed in the introduction, an IT-enabled ECM is most suitable for standardized services rather than complex or non-standardized services. Regarding the processing of these, we propose that a BPSP should carefully evaluate whether investments in the further standardization of services may enable the usage of external service providers such as IT-enabled ECM and whether the resulting economic potential would justify such investments.
- Furthermore, as discussed, the extent of the competitive advantages of an IT-enabled ECM is highly dependent on the inhomogeneity of the service. As a consequence, a BPSP may also consider investments into a further homogenization of the service (e.g., by improving the usability of input forms, thus enhancing the data quality of the incoming service requests) to strengthen the potential competitive advantages.
- To look ahead, a BPSP might also consider establishing new business models connected to excess capacity that consider offering non-SLA backed capacity only or operating as excess capacity brokers or market makers. Highly standardized services, especially those spanning multiple business sectors, may offer strong potential for such business models.

Although our model implies several managerial implications, it also has limitations based on its assumptions, which offer opportunities for future research. We relied on the simplifying assumption of an *exogenous market*, in which the amount of the available excess capacity is not affected by the actual demand of the BPSP or any other market user. Moreover, the interdependencies between peak times both for the BPSP and the market players were not considered. Consequently, modeling an endogenous market may be a promising subsequent step from an *analytical point of view*. Additionally, from an *empirical point of view,* the lack of knowledge concerning the interdependencies between the strategy of a single player and an endogenous ECM should be addressed by appropriate field studies. Moreover, our model focuses on cost minimization, which seems a reasonable first step, as our study is concerned with the analyses of cost-driven services. Nevertheless, our analyses of possible differentiation advantages are limited to a discussion of the differentiation strategies that build on cost advantages and that can be realized without raising prices. Extending the model by incorporating price-demand functions (and thus considering revenue aspects) would facilitate a further analysis of various competitive differentiation strategies and their economic potential.

Aside from these potential starting points for further research, our paper contributes to the knowledge on the competitive advantages that can be realized through IT-enabled ECM within a BPSP`s value chain for the processing of cost-driven inhomogeneous service requests. Our research provides valuable insights for both researchers and managers engaged in business processes and service management.

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Figures

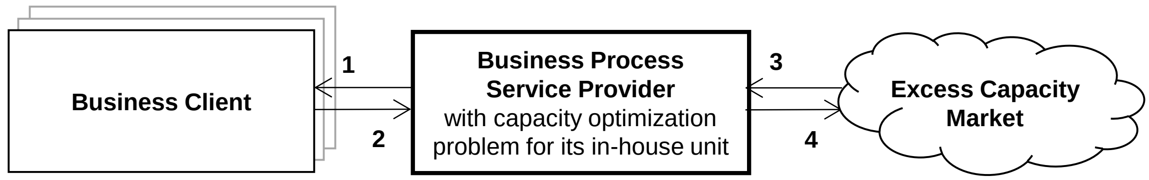

Figure 1. The Business Process Service Provider's Value Chain

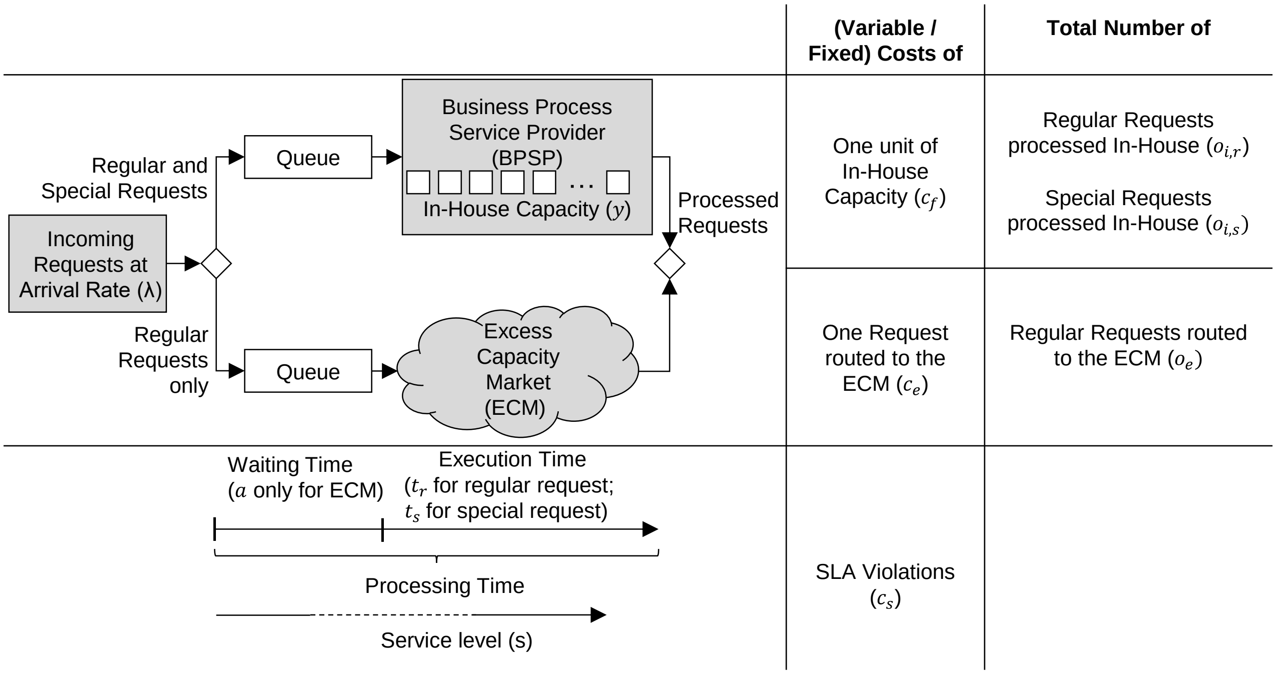

Figure 2. Service System With Two Queuing Systems

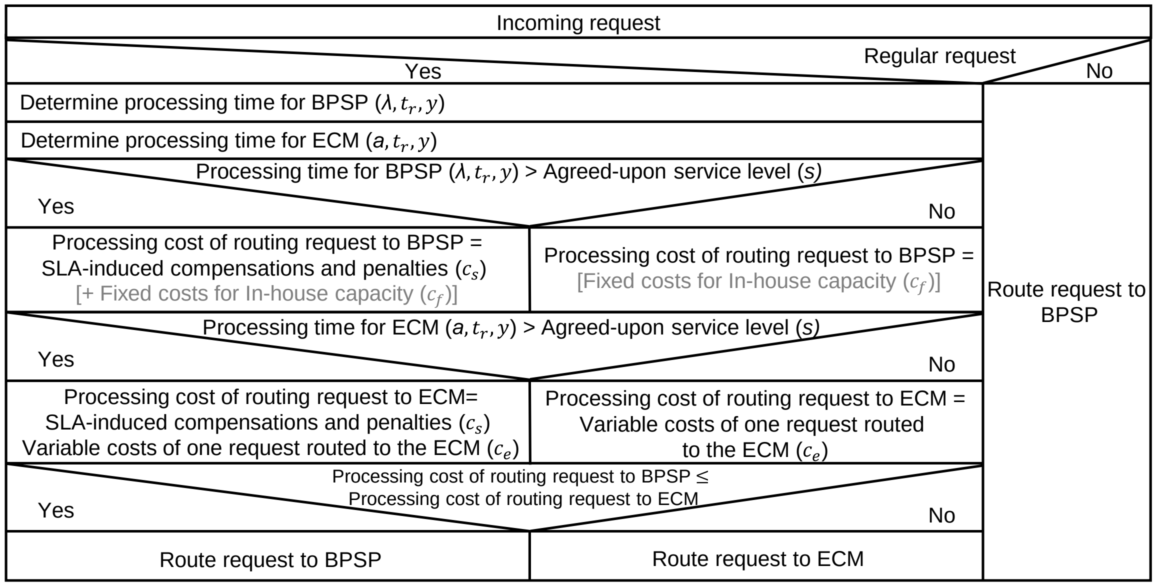

Figure 3. Routing Algorithm

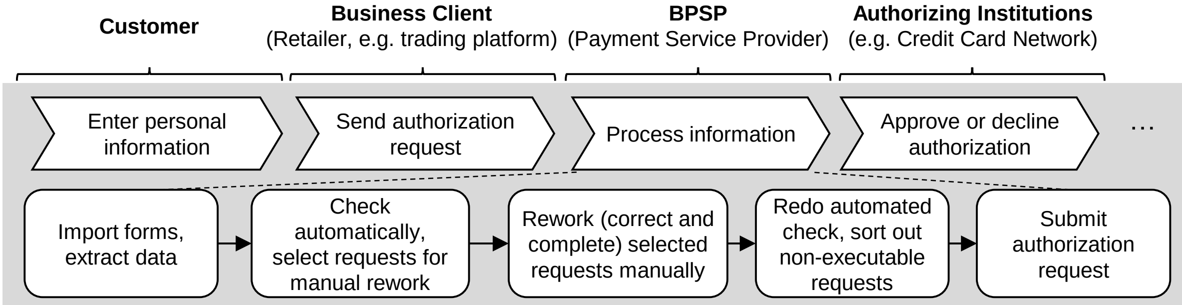

Figure 4. Simplified Identification And Authorization Process

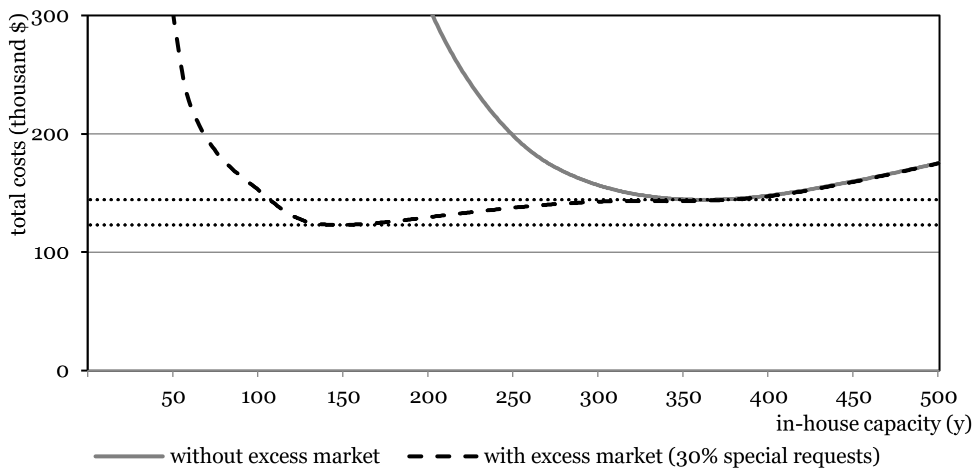

Figure 5. Total Costs With And Without Excess Capacity

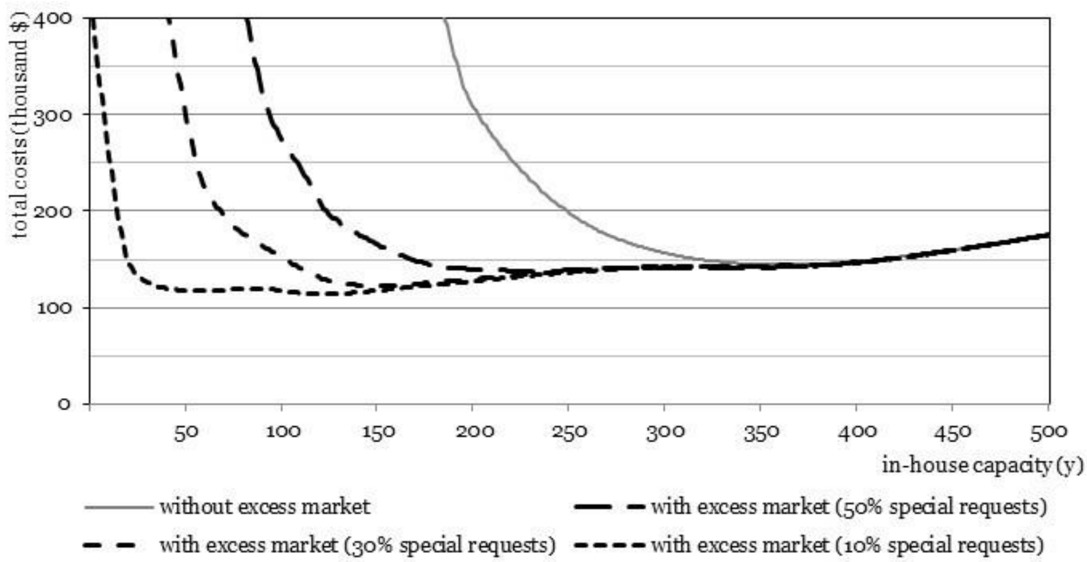

Figure 6. Cost Patterns For Different Percentage Rates For Special Requests

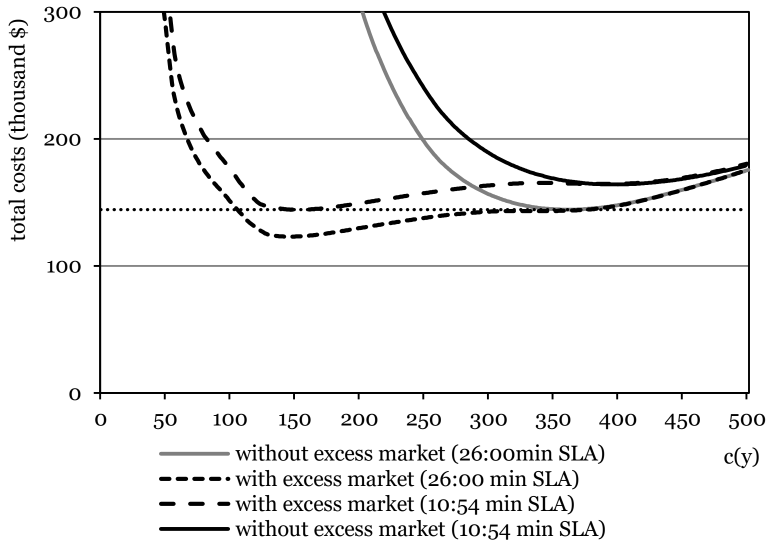

Figure 7. Improved SLA

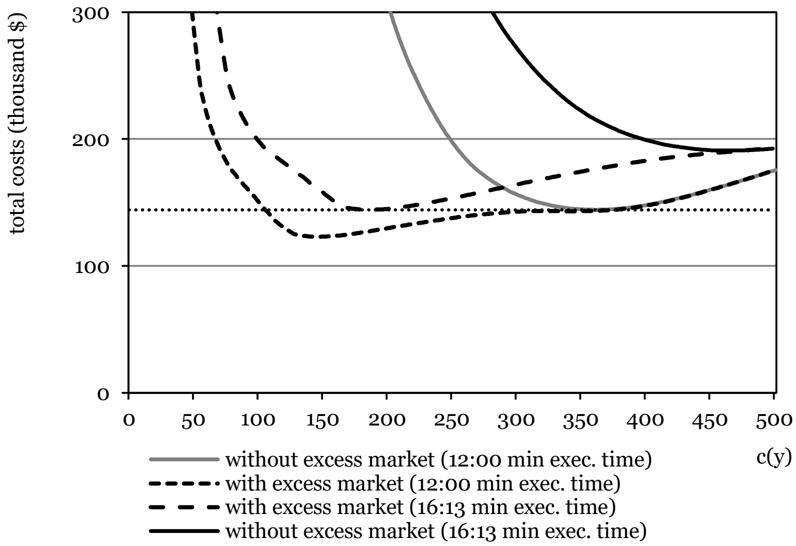

Figure 8. Increased Execution Time

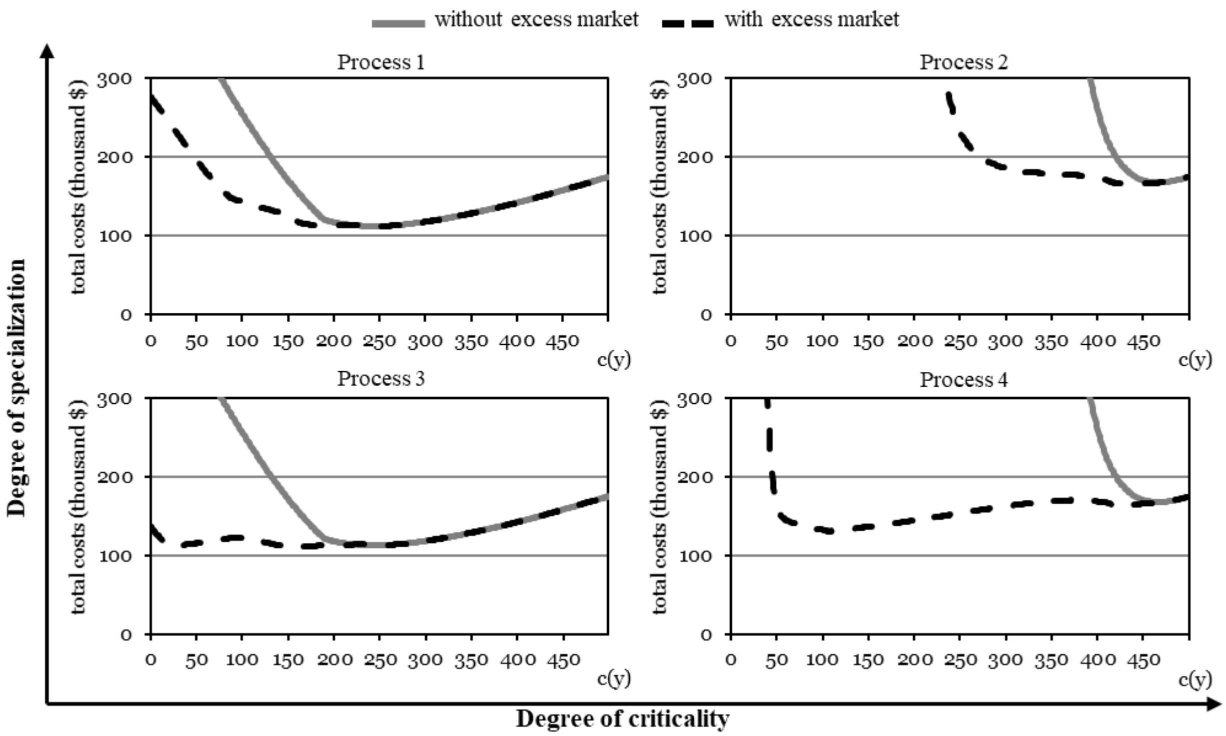

Figure 9. Overview Of Results For Different Digitized Business Processes

Tables

Table 1. Notation Overview

Category	**Notation**	**Description**
Costs	c	Total processing costs
	c_f	Fixed costs of one unit of in-house capacity
	c_e	Variable costs of one request routed to the ECM
	c_s	Costs resulting from requests that violated the SLA (i.e., *compensations* for delayed requests and *penalties* for requests that remain unexecuted).
Requests	$o_{i,r}$	Total number of regular requests processed in-house
	$o_{i,s}$	Total number of special requests processed in-house
	o_e	Total number of regular requests routed to the ECM
Execution Time	t_s	Execution time for a special request.
	t_r	Execution time for a regular request
Other	y	Units of in-house capacity (optimization variable)
	λ	Arrival rate, i.e. the number of time-critical requests sent from the business clients per time unit
	a	Waiting time in queue for a request routed to the ECM
	s	Service level, i.e. a maximum processing time with penalty payments for each time unit the request exceeds this limit

Table 2. Incoming Requests

Timeframe	Mean [min]
08:00 a.m.–09:30 a.m.	50
09:30 a.m.–11:30 a.m.	3
11:30 a.m.–12:00 noon	30
12:00 noon–01:30 p.m.	5
01:30 p.m.– 04:00 p.m.	10
04:00 p.m.– 06:00 p.m.	40

Table 3. External Waiting Times

Timeframe	Distribution [min]
08:00 a.m.–12:00 noon	μ = 16:40; σ = 4:00
12:00 noon–02:00 p.m.	μ = 12:00; σ = 2:10
02:00 p.m.–06:00 p.m.	μ = 10:00; σ = 4:00

Table 4. Cost Advantages For Different Percentage Rates Of Special Requests (SR) With ECM Access Compared To The Scenario Without ECM Access

	w/o ECM	w/ ECM (10% SR)	w/ ECM (30% SR)	w/ ECM (50% SR)
Optimal In-house Capacity [units]	362	125	147	233
Total Costs [USD]	144,292	113,665	122,982	137,808
Cost Advantage [%]	-	21.23	14.77	4.49

Table 5. Summary Of Costs And Cost Components For Different Scenarios

Cost Component	Improved SLA of 10:54 min (scenario 2)	Increased exec. time of 16:13 min (scenario 3)	Basic setting w/ ECM (scenario 1)	Basic setting w/o ECM (benchmark)
Optimal In-house Capacity [units]	154	189	147	362
In-house Capacity Costs [USD]	53,900 (+2,450)	66,150 (+14,700)	51,450	126,700
Excess Capacity Costs [USD]	41,410 (+442)	42,195 (+1,227)	40,968	0
Compensations and Penalties [USD]	48,982 (+18,418)	35,947 (+5,383)	30,564	17,592
Total Costs [USD]	144,292 (+21,310)	144,292 (+21,310)	122,982	144,292

Table 6. Cost Advantages For Different Processes

Exemplary process	Process 1 Bank Account Relocation Service		Process 2 Autom. Credit Assessment & Credit Decision-Making		Process 3 Master Data And Address Data Change		Process 4 Payment Transaction Processing	
	w/o ECM	w/ECM	w/o ECM	w/ECM	w/o ECM	w/ECM	w/o ECM	w/ECM
Degree of Specialization	High		High		Low		Low	
Special requests	50%		50%		10%		10%	
Degree of Criticality	Low		High		Low		High	
SLA compensation	$0.02 * (minutes exceeded)		$0.07 * (minutes exceeded)		$0.02 * (minutes exceeded)		$0.07 * (minutes exceeded)	
Optimal In-house Capacity [units]	247	247	467	430	247	153	467	107
Total Costs [USD]	112,653	112,653	168,030	166,186	112,653	110,230	168,030	131,170
Cost Advantage [%]	-	0.00	-	1.09	-	2.15	-	21.94