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Discussion Paper

IT-enabled Excess Capacity Markets for Services: Examining the Economic Potential in Cost-driven Service Supply Chains

by

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Completed Research Paper

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ABSTRACT

Capacity planning is a major challenge for service providers facing volatile demand. Inefficiencies result from idle capacity or lost revenue caused by peak loads. Concerning IT-driven services, recent technological developments offering dynamic integration and information capabilities may help. They enable an on-demand exchange of excess capacity between business partners and create value through efficient capacity allocation within a supply chain. This paper aims at examining this economic potential of IT-enabled excess capacity markets. Therefore, we use the model setting of a three-stage IT-driven service supply chain and discuss different factors influencing the capacity optimization problem. With a discrete-event simulation we then evaluate a representative factor quantitatively. Thus, we provide deeper insights about the usefulness of excess capacity markets for capacity optimization in different settings and scenarios. The results serve as a guide for practitioners, build the basis for further quantitative evaluation and represent a starting point for empirical validation.

Keywords

IT-driven service supply chain, IT-enabled excess capacity markets, inter-organizational systems, capacity planning, volatile demand, design science.

INTRODUCTION

The ex-ante planning of capacity is a widely recognized challenge in different streams of economic literature. Especially in case of volatile demand, non-adjustable capacity in short-term and a time critical execution due to customer needs, this is a crucial task to capture business value (Adenso-Diaz, Gonzalez-Torre and Garcia 2002). Manufacturers cope with this challenge e.g. by building up excess inventories. Service providers cannot rely on this strategy, as one of the main characteristics of services is that they are not storable (Chesbrough and Spohrer 2006). Moreover, especially for IT-driven services, service level agreements (SLA) are quite common, including penalty payments in case of violating the committed quality (Liu, Methapatara and Wynter 2010).

Against this background, seeking to optimize the level of capacity, a service provider is faced with a trade-off (Bassamboo, Ramandeep and van Mieghem 2010): Assigning a high level of capacity allows the buffering of temporary peaks in customer demand but may result in idle costs in time frames of low demand. Assigning less capacity avoids idle costs but may result in waiting costs due to contractual penalties in time frames of high demand. A service provider should aim at minimizing these costs by choosing an appropriate level of capacity (Bassamboo et al. 2010), which is necessary especially in cost-driven service supply chains, where costs are a central competitive factor. As this trade-off is hard to solve, service providers tend to hold significant overcapacity to cover peak demand and to avoid high contractual penalties (Liu et al. 2010) – a strategy often resulting in an inefficient allocation of personnel as well as IT resources.

Recent technological developments offering dynamic integration and information capabilities may help here. With the growing diffusion of service-oriented infrastructures, suitable for the integration of web services, as well as corresponding description languages, service repositories and standards for data exchange, a dynamic integration of business partners has become considerably easier (Grefen, Ludwig, Dan and Angelov 2006; Moitra and Ganesh 2005). These capabilities provide the basis for establishing supply chain relationships on-the-fly and in an adaptive, fine-grained way. Especially for highly standardized and IT-driven services even an on-demand integration of business partners meanwhile is a feasible alternative supporting the establishment of service markets where firms that offer or/and demand services can interact in a highly dynamic manner (Grefen et al. 2006).

With regard to the capacity optimization problem, IT-driven service markets offer an interesting opportunity as underutilized personnel and IT resources can be exchanged within an IT-driven supply chain: Service providers are able to continuously provide relevant information about their available excess capacity. Other service providers evaluate this information and decide for an incoming order, whether to use excess capacity instead of their own in-house resources. This might help to mitigate the described trade-off between idle costs and waiting costs: The in-house capacity of a service provider can be reduced because excessive demand can be routed to the excess capacity market (ECM), consequently leading to a reduction of associated costs. However, the use of excess capacity bears additional risk. As only excess capacity is offered, which otherwise remains idle, the availability of excess capacity is limited. Consequently, a service provider is only getting served as soon as capacity is available on the market what might cause delays and thus waiting costs. Hence, when thinking about the economic benefits of an ECM, this risk has to be considered properly.

With a mathematical optimization model, Dorsch and Häckel (2012) showed that an economic benefit exists in certain circumstances. However, deeper investigations of the economic connections and the factors influencing the amount of benefits have not yet been carried out. Therefore, this paper focuses on the following research questions to further understand the economic potential of IT-enabled ECM for services:

What are the factors influencing the economic benefit of an excess capacity market regarding the capacity optimization problem of a service provider?

How do these factors influence the economic benefit quantitatively?

To answer these questions, 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 and Ram 2004; Peffers, Tuunanen, Rothenberger and Chatterjee 2007). We start with the further development of an existing artifact using the setting of the capacity optimization model introduced by Dorsch and Häckel (2012), which is as a formal representation of the problem context described above. Based on this setting *we first discuss factors influencing the economic benefit of an ECM.* Then we evaluate how these factors influence the economic benefit quantitatively by performing a discrete event simulation which is an accepted experimental design evaluation method (Wacker 1998). Due to the restrictions concerning the length of this paper, *we present the results of evaluating one representative factor* only. Of course, all other influencing factors are evaluable for further insights, too what can be presented in a subsequent full-length paper.

By identifying factors with an influence on the economic benefit of an ECM as well as their quantitative evaluation we make a substantial extension to Dorsch and Häckel (2012) as we provide deeper insights about the applicability and usefulness of ECM in different settings and scenarios. The results can guide practitioners and build the basis for subsequent quantitative research regarding the economic potential of ECM.

In the following, we give a short overview of related work and how this paper differs from the literature. Then we introduce the setting of the three-stage IT-driven service supply chain considered to model the capacity optimization problem of a service provider as well as the ECM along with a short discussion of assumptions as well as some typical real world examples for possible application scenarios. Afterwards, we present and discuss factors influencing the economic benefit of an ECM and evaluate its quantitative effect of one representative factor through a simulation study based on input data from a typical real world application example. Finally, we discuss implications of the key findings and give an outlook on further research.

RELATED WORK

Papers closely related to the idea of an ECM consider so called surplus markets in the areas of production and supply chain management. Among others, Dong and Durbin (2005) study IT-driven markets for surplus components, which allow manufacturers with excess component inventory to sell to firms with a shortage. They derive conditions on demand uncertainty that determine whether a surplus market will increase or decrease supplier profits. Another paper dealing with flexibility of supplier markets is Lee and Whang (2002). The paper investigates the impacts of a secondary market, where resellers can buy and sell excess inventories. For that, Lee et al. (2002) derive optimal decisions for the resellers regarding their ordering policies and analyze the effects of the secondary market both on the sales of the manufacturer and supply chain performance. These and other papers are closely related to the basic idea of the paper at hand. However, as a fundamental difference to our paper, they are focused on physical products and thus concerned with the possible trading of physical excess inventories and its implications on capacity planning.

The problem of capacity planning for services as non-storable goods has been addressed in several papers, especially on the topic of call center outsourcing. Papers from this broad stream of literature usually distinguish between two basic sourcing models a company can us and/or combine to build its capacity planning on: Volume-based contracts, that involve payments only for capacity that is used (corresponding to excess capacity in our approach) and capacity-based contracts, that involve payments for capacity whether it is used or not (corresponding to our in-house capacity). Aksin et al. (2008) e.g. consider a call center outsourcing relationship where a service provider can choose between a volume-based and a capacity-based contract offered by a contractor that aims at determining the optimal capacity levels. The paper determines optimal capacity levels and partially characterizes optimal pricing conditions under each contract. The paper of Gans et al. (2007) also distinguishes between volume or capacity based outsourcing contracts and analyzes the centralized capacity and queuing control problem. Further papers focus on outsourcing decisions in a service setting: 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. One of their core results is that scale economies provide a strong motivation for outsourcing. The work of Allon and Federgruen (2006) analyzes the situation of retailers who are locked in price and waiting-time competition and have the option to outsource their call center service to a vendor. Thereby, especially volume-based contracts and their effects on supply chain coordination are analyzed. Within this stream of literature volume-based contracts are usually backed by a SLA. The paper at hand however explicitly take into account the usage of excess capacity that is usually not SLA backed and thus tends to be cheaper but more risky.

SETTING OF THE THREE-STAGE SUPPLY CHAIN CONSIDERED AND POSSIBLE APPLICATION SCENARIOS

Figure 1 outlines the general setting of a three-stage IT-driven service supply chain which is considered in the model of Dorsch and Häckel (2012) as a formal representation of the problem context described in the introduction.

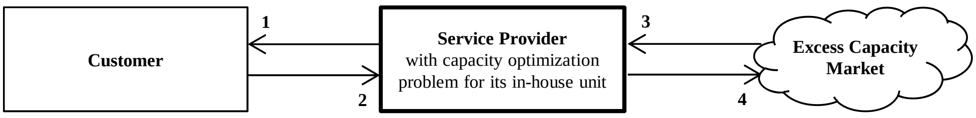

Figure 1. Model Setting of the Three Stage Supply Chain with Excess Capacity Market

(1) A service provider offers an IT-driven service to its customers. The execution of this service is time critical for the customers and the provider commits a SLA including contractual penalties. *(2) The customers use this service from the provider sending orders characterized by volatile demand.* As neither the necessary IT capacity nor the personnel resources of the provider's in-house unit are fully scalable (adjustable in short-term), the service provider faces a capacity optimization problem: For its cost-driven service it wants to minimize the service execution costs and therefore avoid costly violations of the committed SLA caused by capacity shortages in times of peak demand as well as idle costs in times of low demand. In addition to draw on in-house capacity only, the provider can use the ECM. *(3) There, different third-party providers able to execute the specific service, offer their excess capacity.* As excess capacity usually is not SLA backed, this option tends to be more risky (due to possible waiting times when capacity is not yet available at the very moment the order arrives) but cheaper as in-house capacity (as it is excess capacity otherwise remains idle). *(4) Thus, the provider uses excess capacity and sends orders to the market if it caused less service execution costs compared to its in-house unit.*

The basic idea of exchanging capacity using electronic network infrastructure is well-known from grid or cloud computing. Our approach differs from these concepts as we do not only consider the exchange of IT but also personnel resources and thereby the human part of service delivery. Therefore, as a basic assumption to apply our approach, it requires a digitalized service supply chain where orders can be exchanged via electronic networks and at the same time a standardized service which can be offered by different third-party providers forming the ECM. This corresponds with fast-spreading concepts like dynamic business process outsourcing or "Business Process as a Service" (BPaaS), where standardized and IT-driven business processes can be sourced as services from different service providers, albeit the use of excess capacity there has not gained any attention so far. Hence, we address a wide range of possible application scenarios found in nearly all companies and industries. Standardized business processes such as importing high data volumes out of databases as well as services tailored to specific industries as e.g. life insurance origination fulfillment services are already available as corresponding services. Currently, supporting or back-office services like payroll accounting, marketing campaign management or applicant management dominate possible application scenarios. However, it can be expected, that process standardization due to different sourcing decisions leads to wider application possibilities. Especially in industries like financial services with digitalized products, high standardization and a fragmented supply chain with numerous providers for different services, even core processes comply with these requirements and are possible future application scenarios.

NECESSARY INTEGRATION AND INFORMATION CAPABILITIES

Being aware about how the ECM can help to address the capacity optimization problem within an IT-driven service supply chain, it becomes clear that sound integration and information capabilities are a prerequisite. As the relationships between the third-party providers on the ECM change frequently, dynamic *integration capabilities* are necessary. Corresponding concepts and technologies currently spread along with the diffusion of dynamic business process outsourcing and BPaaS, allowing for an on-demand integration of business partners. Products like IBM Business Process Manager, Appian Anywhere or Process Maker Live illustrate the availability of platforms incorporating the concepts and integration capabilities necessary to use the ECM. Once, the dynamic switching between business partners are established, it is a rather straight-forward idea to draw on excess capacity. However, to operationalize this approach especially the supply of information has to be guaranteed: A provider that intends to use excess capacity has to determine whether the market or the in-house unit offers a preferable execution of orders with regard to the service execution costs. Therefore, it has to know which third-party providers holds sufficient excess capacity (or by when excess capacity will be available) and all other relevant parameters, e.g. the costs for a temporary use of excess capacity. Thus, all relevant information has to be provided by third-party providers acting on the ECM, and the provider's IT-platform has to allow a continuous, mostly automated evaluation of this information. To ensure this ongoing information exchange, sophisticated *information capabilities* are necessary. Widely recognized approaches to support information exchange are ebXML and RosettaNet which represent high-level frameworks. Moreover, the web service paradigm coming along with service repositories and well described services based on standardized description languages has evolved as one of the primary standards for a quick and mostly automated evaluation of service providers. In the field of on-demand services so called service marketplaces like e.g. SAP Service Marketplace have developed where firms that offer or/and demand certain services can interact in a highly dynamic manner (Grefen et al. 2006). The basic idea of these service marketplaces is to provide an information platform that enables a coordinated interplay of customers and providers. In this way, such service marketplaces can also be used to foster the realization and utilization of ECM.

FACTORS INFLUENCING THE ECONOMIC BENEFIT OF AN EXCESS CAPACITY MARKET

With regard to the model setting representing the cost-related trade-off of the provider's capacity optimization problem, we identified different factors influencing the economic benefit of an ECM. We clustered these factors using five categories which refer to different parts of the three-stage supply chain. Within these categories we discuss the factors with regard to their influence of the economic benefit of an ECM. Of course, this discussion of how the change of a single factor can have an influence on the economic benefit simplifies the complex connections within the considered service supply chain. It does not replace a proper analytical evaluation of these factors within the model. Nevertheless, this discussion is valuable to introduce and to give a summary of the various factors which have to be examined quantitatively and therefore form the basis for the experimental evaluation.

Customer-Provider-Relationship

Within this relationship two main factors have influence on the economic benefit of an ECM: the *service level guaranteed* and the *volatility of demand*. Both factors affect the fluctuation in the amount of capacity the provider needs during operations. If the SLA defines time frames until the service has to be executed after an order arrives, peak times require a high amount of capacity which would be partially idle in times of low demand. Here, the ECM might unfold a high economic benefit, if excess capacity is provided continuously and on short notice as the amount of in-house capacity then can remain on a limited level. This would be different if the SLA defines a deadline until the service has to be executed on all orders of a certain period (e.g. all orders of a certain day have to be executed before 8 p.m.). Then, during this period peak demand can wait for times of low demand and the capacity of the in-house unit can be utilized evenly. This eases the capacity planning problem and therefore the benefit of the ECM might be rather low. Of course, the distribution of times with peak and low demand has an effect as well. With regard to the case of a defined deadline for a certain time period, the orders only can spaced out evenly, if peak times alternate with times of low demand. Peak times just before the deadline e.g. can counter this strategy and the benefit of an ECM which is able to handle the peak demand ahead of the deadline might be high.

Service Characteristics

Concerning the characteristics of the service offered by the provider, there are also two main factors with an influence on the economic benefit of the ECM: the *time the execution of an order actually utilizes capacity* and *the possibility to allocate idle capacity to one order to accelerate its execution*. The time an order utilizes capacity can be different for the in-house unit and excess capacity. If the in-house unit works faster than the third-party providers (e.g. as the employees of the in-house unit are more familiar with orders sent from well-known customers than the employees of third-party providers working with such orders from time to time only) and therefore excess capacity cannot keep up with the SLA or always cause more service execution costs compared to the in-house unit, the economic benefit of the ECM might be limited. In extreme cases, if the time the excess capacity is utilized by one order is close to the maximum time frame guaranteed in the SLA, no waiting times are acceptable resulting in a limited economic benefit of the ECM, as the risk of waiting times is inherent. Furthermore, it has to be considered whether idle capacity can be allocated to an order to accelerate the execution. Then, longer waiting times in front of the in-house unit are acceptable due to an accelerated execution in times of low demand which helps to keep up with the SLA. This also might limit the ECM's benefit, as it reduces the total amount of capacity necessary for the in-house unit.

Provider Characteristics

As we focus a cost-based trade-off, the decision of the provider whether to rely on excess capacity heavily depends on the *associated costs which arise for the provision of capacity* within the in-house unit. For the in-house unit mainly fixed costs have to be considered while the use of excess capacity would naturally cause variable costs for every order sent to the ECM. As excess capacity can be cheaper than in-house capacity (e.g. when third-party providers sell below cost price), the economic benefit of the ECM might be high, as longer waiting times for excess capacity are acceptable. This might also be given, if the ECM helps to avoid supplementary costs for the in-house unit (e.g. overtime premiums for peak demand which cannot be handled within the regular working time). In contrast, for cases where capacity within the in-house unit can provided cheaply (e.g. because of scale economics), idle costs are low and the economic benefit of the ECM might be limited.

Provider-Market-Relationship

Within the relationship of the provider and the market, especially the *correlation of peak demand* hitting the provider and all third-party providers who offer excess capacity, influences the economic benefit of the ECM. If these peak times are highly correlated, the need for excess capacity of the provider during times of peak demand meets a lack of excess capacity on the ECM and vice versa, limiting the economic benefit of the ECM. This is the case e.g. if they work within the same industry and in a similar time zone. Or if services are specific and can be executed from third-party providers with similar customers only. Therefore, the correlation of peak demand is one of the most important factors to be considered, as it can lead to a complete uselessness of the ECM when peak times are correlated.

Excess Capacity Market Characteristics

The demand of very specific services leads to another influencing factor, namely the *structure of the excess capacity market* and thereby especially to the *number of third-party providers offering excess capacity*. If the number of third-party providers is limited (e.g. if the service need very specific capabilities or resources), the availability of excess capacity can be very limited, even if there are no correlations regarding the times of peak demand. Then, sending orders to the ECM can have a strong effect on waiting times that might limit the economic benefit of the ECM, whereas the same amount of orders would affect the waiting times of a market with many third-party providers not at all. Furthermore, a limited availability of excess capacity also can raise prices resulting in a limited economic benefit of the ECM.

EXPERIMENTAL EVALUATION OF A REPRESENTATIVE INFLUENCING FACTOR

The discussion of influencing factors demonstrates the dependency of the ECM's economic benefit to the various characteristics and different scenarios the provider's capacity optimization problem can have. It clarifies, that a deeper understanding of the economic connections is necessary to evaluate whether the use of excess capacity is reasonable. This requires quantitative evaluation incorporating the complex interrelationships within the service supply chain. Hence, we implemented the quantitative optimization model of Dorsch and Häckel (2012) within simulation software in order to evaluate the *correlation of peak demand* as one of the most important influencing factors on the ECM's economic benefit.

Summary of Characteristics and Assumptions to Model the Underlying Capacity Optimization Problem

In the model, the setting of the three-stage supply chain introduced above is represented by two different queuing systems as outlined in Figure 2 on the next page. It is assumed, that orders arrive randomly with arrival rate λ and the service provider guarantees a maximum processing time as the SLA s with monetary compensation c_s for each order which does not keep up to this service level. The provider has to decide ex ante about the capacity (i.e. the number of orders $y \in IN_0$ which can be handled simultaneously) it allocates to the in-house unit, which minimizes the total execution costs c for the service. The simplified objective function for this discrete optimization problem without the use of excess capacity therefore reads

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

and the provider faces the trade-off described in the introduction: Orders which cannot be processed immediately due to the restricted amount of capacity wait in a queue and might lead to processing times which do not keep up to the service level.

In addition to the in-house unit, the ECM offer excess capacity for temporary use and therefore offers a second execution path for incoming orders. Excess capacity cannot be booked in advance and no SLA guarantees its constant availability. Rather, the time frame $a > 0$ an order has to wait in the queue in front of the ECM until the next unit of excess capacity will be available is continuously announced. Based on this information the provider decides whether it routes an incoming order to its in-house unit or to the ECM. This decision take place during operations for every single order at the time it arrives and is based on the service execution costs for this order of the respective path.

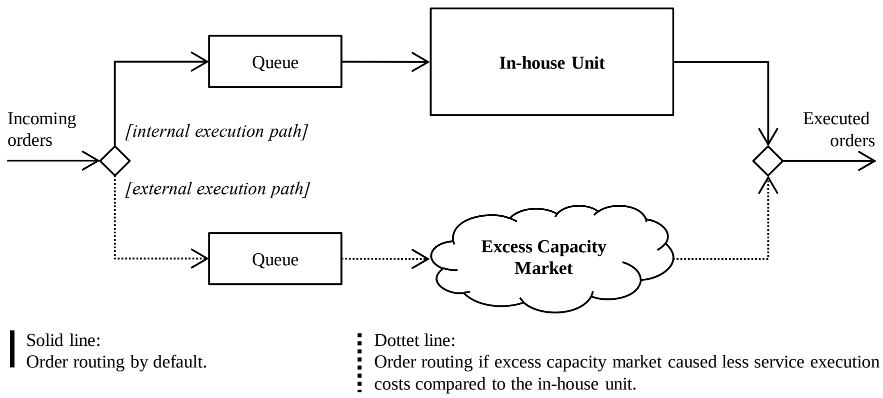

Figure 2. Service System Realized Within the Simulation Software

It is further assumed that there is a homogenous execution time *t* for each order regardless of its execution path. Moreover, there are fixed costs c_f per unit capacity of the in-house unit but no additional variable costs. In contrast, the ECM raises no fixed costs but variable costs c_e for each order executed. Denoting the number of orders executed in-house with o_i and the number of orders executed externally with o_e respectively, the detailed objective function for the optimization problem with use of excess capacity reads

$$\min_{y} c = c_f\, y + c_e\, o_e + c_s(\lambda, y, s, o_i, o_e, t, a)$$

Solving the objective function for integer values of *y* result in the optimal amount of capacity, the provider should allocate in-house to minimize the total execution costs *c*.

Set Up of the Discrete-event Simulation Study

To solve the optimization problem it is not sufficient to evaluate the two queuing systems separately as they interact during operations influencing the respective waiting times. Rather, the service system consistent of both queuing systems has to be evaluated as a whole. This cannot be done analytically and require the model to be implemented with simulation software. Performing the simulation, the software simulates randomly arriving orders and decides whether these orders should be routed to the-in house unit or the ECM. According to the model setting, this decision is made for every single order at the very moment it arrives. A routing algorithm evaluates the current service execution costs for both execution paths and choses the path with lowest costs. Thereby, to simulate the risk of waiting times for excess capacity, this parameter is implemented as a random variable. The result of the simulation run is the sum of execution costs the provider faces once all orders are executed.

The optimal amount of in-house capacity can be found, if multiple simulation runs (simulation experiment) are performed with increasing integer values for the capacity of the in-house unit. The optimal amount then can be identified by the simulation run with lowest total operating costs. The economic benefit of the ECM finally can be determined, if this experiment is carried out twice: The first time using in-house capacity only. And the second time with both execution paths. Identifying the optimal amount of in-house capacity for both experiments and determining the delta in total execution costs then leads to the economic benefit of the ECM.

Evaluation of the Quantitative Effect of Correlated Peak Demand

We consider the securities trading and settlement process with all necessary activities to be executed when securities are sold or bought. This process is a typical application scenario for our model. It is a cost-driven business process mostly sourced from specialized service providers which have to process a large number of randomly arriving orders in time to meet regulatory standards and to avoid penalties or losses of interest when payments are not executed in time. With few exceptions it is fully digitalized and standardized through regulations and cross-company agreements. Nevertheless some manual interventions are necessary, e.g. digitalized documents have to be checked or files and reports have to be completed.

As we want to evaluate the *correlation of peak demand* as one representative influencing factor on the ECM's economic benefit, we designed two sets of input parameters which differ only with regard to this correlation. Within the model, a correlation of peak demand means that a high arrival rates of orders (λ) occur along with high waiting times a for excess capacity as the different third-party providers face high demand for their services, too. Table 1 and 2 summarize the corresponding input data for λ and a for a bank working day between 8 a.m. and 6 p.m. In scenario 1, the third-party providers face peak demand in the morning and in the mid of the day while in scenario 2 demand is nearly balanced throughout the day with a minor peak in the morning. As the service provider faces peak demand in the morning and in the mid of the day *a strong correlation of peak demand* is therefore given within scenario 1.

8:00 a.m. – 9:30 a.m.	9:30 a.m. – 11:30 a.m.	11:30 a.m. – 12:00 noon	12:00 noon – 1:30 p.m.	1:30 p.m. – 4:00 p.m.	4:00 p.m. – 6:00 p.m.
60	3	80	7	15	4

Table 1. λ: mean of an exponential distribution representing the number of orders per minute

Scenario 1	8:00 a.m. – 11:00 a.m.	11:00 a.m. – 3:00 p.m.	after 3:00 p.m.
	μ = 51:00; σ = 3:00	μ = 62:00; σ = 4:15	μ = 7:00; σ = 3:00
Scenario 2	8:00 a.m. – 12:00 noon	12:00 noon – 2:00 p.m.	after 2:00 p.m.
	μ = 25:00; σ = 8:00	μ = 12:00; σ = 2:10	μ = 10:00; σ = 7:00

Table 2. *a*: mean and standard deviation of a normal distribution representing the waiting time for excess capacity in minutes

Further input data reads as follows: The execution time t take 16 minutes. Idle capacity cannot be used to accelerate the execution of orders as only one employee can work on one order. One unit of capacity y causes fixed costs c_f amounting to EUR 330 a working day. The variable costs c_e for each order executed on the ECM are fixed to EUR 8.90. The SLA consists of two deadlines: Each order has to be processed within 30 minutes. For each minute an order exceeds this time frame, a compensation following EUR $0.02 * (minutes\ exceeded)^3$ is due. Additionally, there is a final processing deadline at 8:00 p.m. for each working day. For each order which is not processed within this deadline the compensation rises to a penalty of EUR 100.

With this input data, the simulation was executed to determine the economic benefit of the ECM as described in the previous subsection. Table 3 on the next page summarizes the numerical results of the simulation study which were determined as outlined above.

Key Findings and Limitations of the Simulation Study

The numerical results of the simulation study indicate remarkable cost reductions for the financial service provider. Using the ECM, the total execution costs could be reduced by 12.4% compared to the optimum achievable without using excess capacity. This is a significant competitive advantage within a cost-driven supply chain, where costs are the central competitive factor and cost structures of competitors have to be considered as nearly identical due to highly standardized services. Moreover, the results confirm the findings from the qualitative discussion of the correlation of peak demand as an influencing factor on the economic benefit of the ECM: With strong correlation of peak demand, it loses its economic benefit.

Scenario 1 **with strong correlation of peak demand**	in-house unit only	in-house unit and ECM	delta (economic benefit)
optimal amount of in-house capacity	261	261	0
total execution costs	118,600.85	118,600.85	0.00
Scenario 2 **without strong correlation of peak demand**	in-house unit only	in-house unit and ECM	delta (economic benefit)
optimal amount of in-house capacity	261	61	200
total execution costs	118,600.85	103,870.46	14,730.39 (12.4%)

Table 3. Numerical Results of the Simulation Study

However, one major limitation regarding the model setting has to be mentioned. Currently, the supply of excess capacity on the market is assumed to be exogenous. The opportunity of the service provider to sell excess capacity on its own as well as the possibility of all third-party providers offering excess capacity to use the ECM is not yet considered. Both would have effects on the availability of excess capacity influencing the optimization result for the provider. In particular, this is the case if all providers would apply the same unbalanced strategy (keeping very little/much in-house capacity relying mainly on excess capacity supply/demand) without carefully observing the availability of excess capacity on the whole market. As the positive economic benefit then could be undermined, this limitation should be removed by extending the model at hand in the future.

CONCLUSION AND DIRECTIONS FOR SUBSEQUENT RESEARCH AND VALIDATION

Considering the model setting of a three-stage IT-driven service supply chain, we identified and evaluated factors with an influence on the economic benefit, an ECM can offer to the capacity optimization problem of a service provider facing volatile demand. Based on the first results from Dorsch and Häckel (2012) we gained further insights about how the economic benefit of the service provider depends on its surrounding conditions. Although, the presented results are a first attempt to a deeper understanding, the results can already be a guide for practitioners as they demonstrate the applicability and usefulness of ECM for capacity optimization in different settings and scenarios. Hence, they are e.g. useful in supporting the evaluation whether an IT-investment for the necessary integration and information capabilities enabling access to an ECM is indicated for a certain service supply chain setting or not. The quantitative results thereby provide evidence about the realizable value of the investment and therefore determine acceptable costs. The qualitative discussion of the influencing factors furthermore demonstrates the various characteristics which have to be considered carefully, as they may affect and limit the economic potential.

An obvious next step for a subsequent full-length paper would be the broader presentation (more influencing factors with proper sensitivity analyses etc.) of results from the quantitative evaluation of influencing factors. Based on these results, research regarding an empirical evaluation in a given organizational context might be insightful, especially to contribute to the complementary research cycle between design-science and behavioral-science (Hevner et al. 2004, McKay, Marshall, and Hirschheim, 2012): With e.g. detailed field experiments, influencing factors not discovered so far could be identified, the analytical results could be substantiated with empirical data and the model robustness could be validated.

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