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CONCEPTUAL MODEL AND OPERATIONAL PROCESSES OF CUSTOMER VALUE-BASED REVENUE MANAGEMENT IN TRANSPORT AND LOGISTICS

Tobias von Martens, Andreas Hilbert[1]

Abstract
The approach presented in this article addresses the shortcomings of transaction-based revenue management and proposes a conceptual model of customer value-based revenue management to allow for both an efficient utilization of limited capacity resources and the establishment of profitable customer relationships. Furthermore, process models are developed for the operational tasks as well as results of a prototypical implementation are presented. Finally, some concluding remarks and an outlook on remaining research are given.

1. Problem Statement and Research Design

The efficient use of limited capacity resources, e. g. passenger seats or cargo space on transport vehicles, is a prevalent success factor for service providers in transport and logistics [1]. Therefore, revenue management applies methods of operations research to control the acceptance of booking requests in different industries, e. g. airlines, car rental agencies and cruises. Although successful in the short-term, revenue management is transaction based so far by focusing only on short-term willingness-to-pay [13] and neglecting the establishment of relationships with long-term profitable customers that are crucial particularly in B2B markets of transport and logistics.

This article aims to develop a conceptual model of customer value-based revenue management which regards the tasks required on different management levels. Hence, an introduction into transaction-based revenue management and its shortcomings in regard to relationship-focused marketing is given, before the basic idea as well as the strategical and tactical tasks of customer value-based revenue management are described. Afterwards, this article applies modeling methods of information science to specify the operational processes and presents some results of a prototypical implementation as well as a conclusion and an outlook on remaining research.

2. Transaction-Based Revenue Management

This section introduces the basic idea and instruments of transaction-based revenue management as commonly applied so far and identifies its shortcomings regarding the inability to establish relationships with customers whose value derives from indirect or long-term contributions.

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2.1. Basic Idea and Instruments

Service industries are mostly characterized by limited, (at short time) inflexible and perishable capacity resources as well as uncertain and heterogeneous demand. Hence, the acceptance of lower-value booking requests arriving early in the booking period may prevent that sufficient capacity is available for later booking requests of higher value (*revenue displacement*), while declining the acceptance of early booking requests too often may result in idle capacity at the time of service (*revenue loss*). Revenue management aims at utilizing the capacity efficiently by controlling the acceptance of early booking requests accordingly. It comprises a forecast of the relevant variables in the booking period, the allocation of the available capacity on different booking classes with regard to booking class revenues and expected demand as well as a booking control based on the availability of different booking classes (quantity based) or dynamic pricing (price based).

2.2. Shortcomings and State-of-the-Art

Allocation and booking control in revenue management are mostly based on the short-term willingness-to-pay (i. e. booking class prices) and not on the customers' real value for the service provider [13]. Hence, valuable customers like *prospective customers* (i. e. low current but high future contributions) and *reference customers* (i. e. not necessarily high own but high induced contributions) may be declined. The state-of-the-art has recognized the problem but provides only insufficient approaches for a solution so far: Either different revenue management strategies [16] or value classes [7] for various customer segments are suggested. However, without specifying methods for classifying customers in the booking process and calculating the contingents assigned to the value classes. For casino hotels, a decision rule has been developed which compares the customer value in the gambling area with the opportunity costs of occupying a room [10]. Apart from the mentioned articles, there are several other ideas for a modification of transaction-based revenue management [12][25]. However, methods for the identification and integration of customer value into revenue management on operational level as well as strategical tasks of revenue management haven't been regarded sufficiently.

3. Basic Idea and Tasks Customer Value-Based Revenue Management

In this section, a conceptual model of customer value-based revenue management and its tasks on a strategical and tactical level are presented after an introduction into the customer value concept.

3.1. Concept of Customer Value

Customer value represents a key figure of customer relationship management [14]. In the simplest form, it corresponds to the discounted sum of future contribution margins [3] while other approaches conceive it as a manifold construct comprising a market and a resource potential [20]. In general, customer value models may regard direct and indirect as well as past-, present- and future-related contributions of customers [21]. In this article, *customer value* is understood as the whole potential benefit of a customer for a service provider over a defined period of time [9]. The customer value itself is assessed by *determinants*, e. g. expected contribution margins and expected customer referrals. These determinants are projected on the basis of visible *indicators*, e. g. socio-demographic data or past purchase behavior. *Customer value-based revenue management* is conceived as an approach to capacity control that can incorporate customer value into booking control or pricing to make the limited capacity resources available for the most valuable customers.

3.2. Conceptual Model and Tasks on the Strategical and Tactical Level

The tasks of customer value-based revenue management can be systematized along a strategical, tactical and operational management level according to the length of their planning horizon [12]. The strategical level affects the long-term success potential of the service provider and should comprise an environmental analysis as well as the formulation of objectives and strategies. On the tactical level with a medium-term planning horizon, tactical planning, definition of booking classes and pricing are required. The tasks on the operational level are normally associated with a specific booking period and comprise a forecast of the variables required by optimization, an allocation of the capacity on the expected demand (optimization), a control of bookings based on the optimization (transaction control) and an adaptation of forecasting, optimization or transaction control, respectively, based on the current bookings. Furthermore, an analysis of the operational capacity control as well as the development of models used by forecasting, optimization and transaction control are tasks on the operational level (see *Figure 1*).

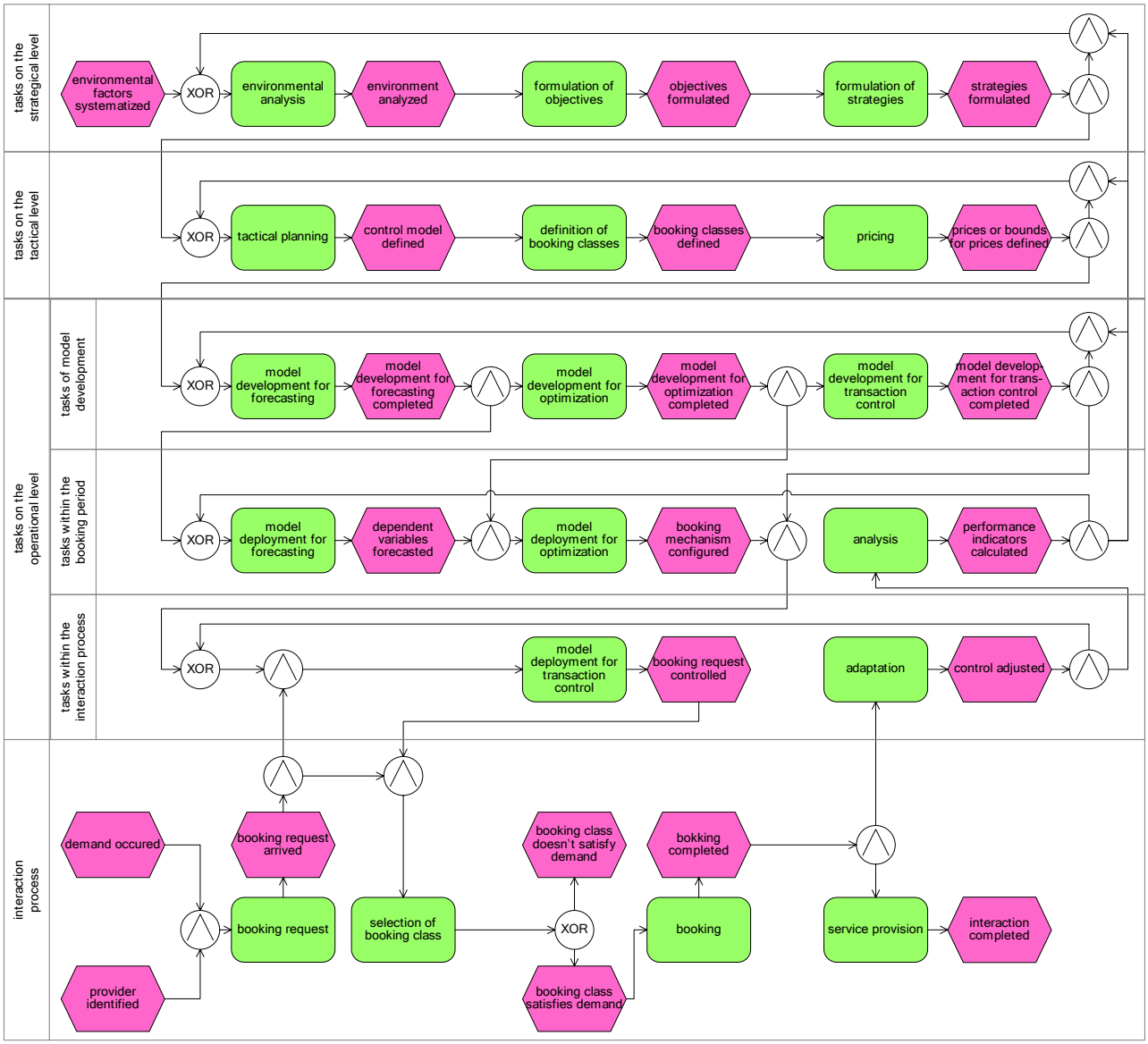

Figure 1: Conceptual Process Model of Customer Value-Based Revenue Management

By means of an *environmental analysis*, the external and internal factors relevant for capacity control are assessed. The process of analysis comprises the identification of relevant factors, their monitoring, a prediction of their changes as well as the evaluation of these changes [2]. The factors important for customer value-based revenue management can be assigned to a micro environment (e. g. service provider-, customer-, competitor- and market-related characteristics) and to a macro environment (e. g. legal, technological and societal conditions).

In customer value-based revenue management, the *formulation of objectives* comprising the selection and weighting of strategical objectives based on the environmental analysis requires an integration of the objectives of transaction-based revenue management that are geared towards the short-term success of a certain service provision, e. g. a flight or an accommodation, and the objectives of customer relationship management that are geared towards the long-term success potential of a relationship. The short-term revenue maximization of revenue management is often operationalized by the maximization of the load factor (or occupancy) and the revenues per sold unit of capacity [12] whereas the value of the customer base (or customer equity) can be affected by the number of (current and potential) customers as well as their individual customer values [9].

Strategy development aims at the definition of an appropriate revenue management strategy to reach the formulated strategical objectives. The systematization of potential strategies can be supported by a strategy framework allowing for a specification of strategies along several dimensions, i. e. degree of relationship focus (transaction- or relationship-focused strategies), degree of customer differentiation (mass or segment-of-one marketing), and source of competitive advantages (advantages in regard to price or quality) [11]. A strategy option is characterized by a combination of parameter values along the strategy dimensions whereupon the selection of a reasonable strategy option is determined by the environmental factors and the set of objectives.

The essential task of *tactical planning* is the definition of a control model which derives specifications from the long-term strategies. The control model, for example, defines whether capacity control is based on quantity or price, which booking mechanism is implemented, which determinants are regarded for customer value and which overbooking policy is applied.

The *definition of booking classes* is required for a customer-oriented utilization of the capacity and for the design of reference figures for forecasting and optimization. The configurations of different product characteristics as expected or accepted by the customers are identified by market research or analyses of past booking periods [22]. A prior segmentation of customers is reasonable if the customer base is heterogeneous to a certain extent in regard to these preferences. Afterwards, different booking classes are defined for a product (e. g. a flight in the economy class) on particular distribution channels according to the preferred and feasible configurations. While products may differ in physical attributes, booking classes are mostly bound to non-physical characteristics, e. g. booking restrictions.

The task of *pricing* is closely connected to the definition of booking classes. In quantity-based revenue management, predefined prices are assigned to particular booking classes. In price-based revenue management, however, upper and lower bounds for booking class prices may be defined while the dynamic price in the booking period is calculated by means of optimization. Pricing can be based on costs, competition or customers [17]. In revenue management, price discrimination, e. g. based on temporal, regional, customer-, quantity- or service-related characteristics [26], is commonly applied for affecting demand [17], skimming consumer surplus [26] and generating additional demand out of customer segments with a lower willingness-to-pay [12].

4. Processes on the Operational Level

The following sections focus on process models representing the necessary steps for the operational tasks of customer value-based revenue management.

4.1. Forecasting

Forecasting provides the information required by optimization and transaction control, e. g. amount of expected demand and its distribution within the booking period as well as segment-specific customer values. Since the quantitative methods applied for forecasting, customer valuation and segmentation are partially based on models [19], model development, e. g. by means of regression and time series analyses [24] as well as decision trees and neural networks [15], is necessary. In order to provide the determinants for value-based customer segmentation, forecasting models for the projection of determinants on the basis of indicators available through past transaction and customer data have to be applied. On the basis of these forecasting models, the variables required for optimization and transaction control can be projected within model deployment (see *Figure 2*).

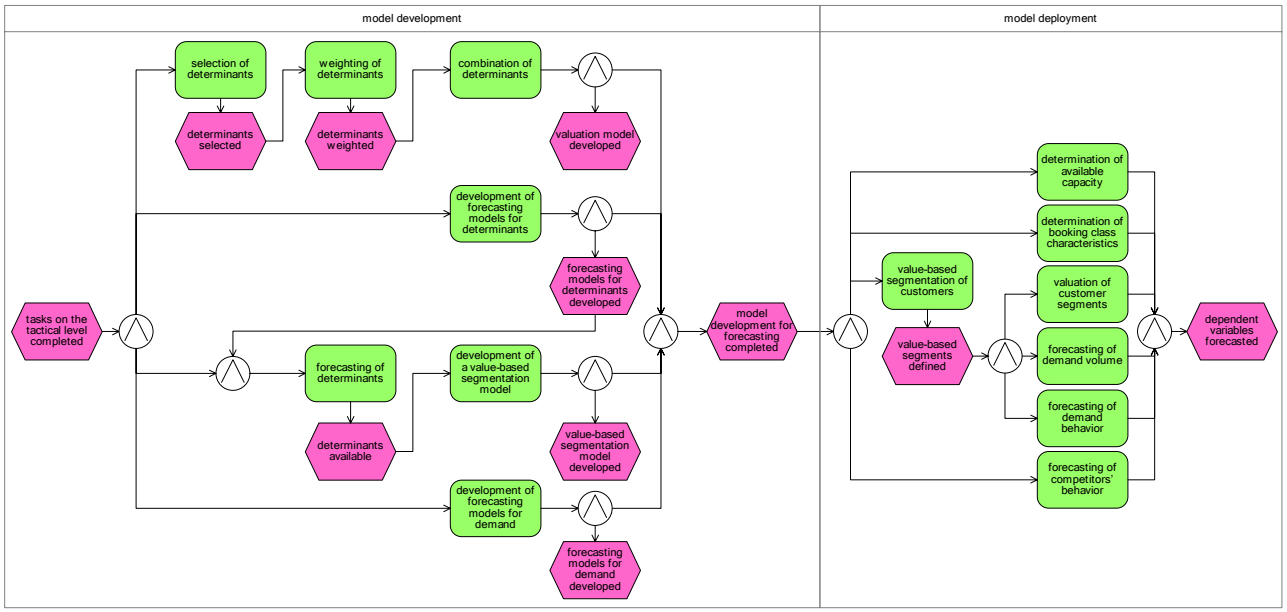

Figure 2: Partial Process Model for Forecasting

4.2. Optimization

Optimization aims at allocating the capacity resources regarding the expected demand to achieve both short-term efficient capacity utilization and long-term profitable customer relationships as specified in the set of objectives. In contrast to transaction-based revenue management, the customer value-based approach assigns the available capacity resources not just to booking classes but also to particular customer segments. Depending on the booking mechanism, contingents, opportunity costs of capacity utilization (bid prices), sets of available booking classes or dynamic booking class prices are calculated by optimization. Contingents, i. e. units of capacity available for a certain customer segment regarding a specific booking class, can be derived directly from the allocation. Opportunity costs representing the decision criterion in case of bid price control can be calculated by comparing the value of the remaining capacity in case of acceptance and decline of a booking request [4]. The calculation of the dynamic booking class prices is mainly based on the

expected demand and price sensitivity [5]. Often, overbooking is applied, i. e. a certain amount of booking requests exceeding the capacity limit is still accepted to efficiently utilize capacity despite cancelations and no shows (customers with reservations don't show up). The definition of an overbooking rate that may depend on time of request, customer segment and booking class is also subject to optimization. Model development for optimization comprises the formulation of optimization models as well as the definition of appropriate solution methods (see *Figure 3*) [8].

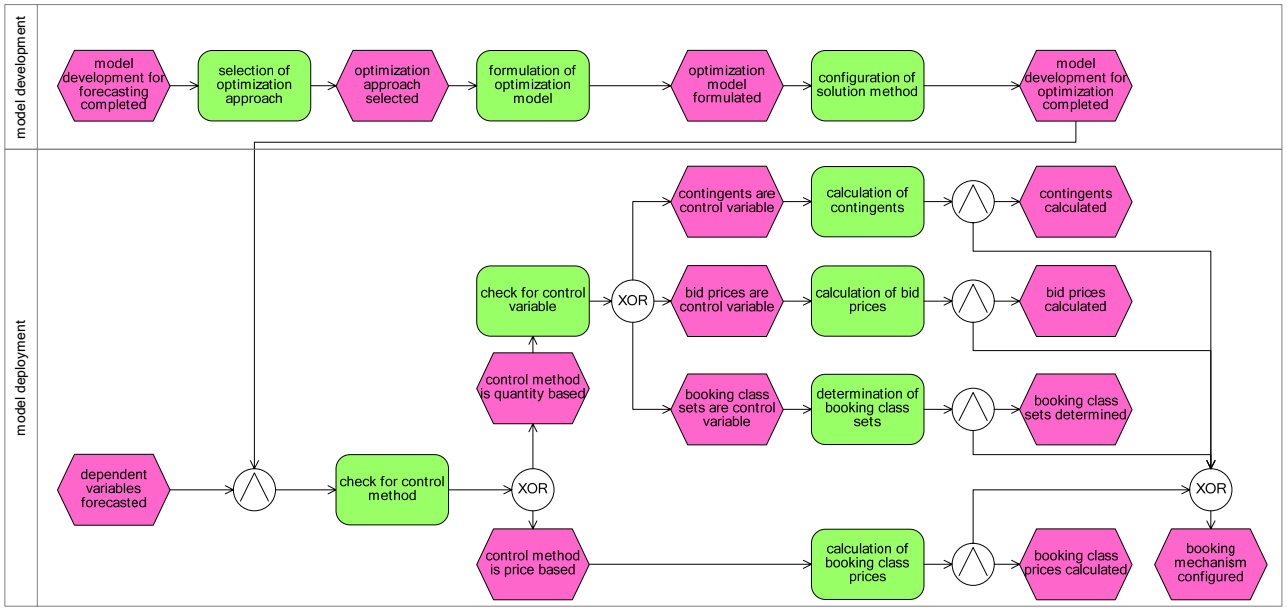

Figure 3: Partial Process Model for Optimization

In order to determine the availability or price of particular booking classes for a specific customer segment, allocation and booking control should be based on value-related revenues, i. e. a weighted combination of booking class price and average customer value within a segment. The weighting factor allows for emphasizing either transaction- or value-based contributions of customers according to the relationship orientation of the strategy. Additionally, value-based overbooking can be applied, i. e. the average customer value within a segment affects overbooking regarding both the definition of overbooking rates and the extent of compensation or the selection of customers, respectively, that are rejected despite reservations in case of overselling (i. e. more customers show up than can be served). Apart from value-related revenues and value-based overbooking, availability guarantees can be applied, i. e. a certain degree of availability of particular booking classes for specific customer segments based, for example, on their customer value. Availability guarantees have to be regarded both when allocating capacity resources on the expected demand and when controlling rejections in case of overselling.

4.3. Transaction Control

In contrast to optimization that can be carried out prior to the booking period, transaction control has to govern the availability (quantity-based approach) or the price of booking classes (price-based approach) when requests arrive. Transaction control aims at reaching the optimal allocation despite an uncertain distribution of booking requests within the booking period. Exemplary booking mechanisms are contingent and bid price control as well as customer choice models [12]. Using contingent control, booking classes are available as long as the contingent that is assigned to a combination of a booking class and a customer segment is positive. Using bid price control, the value-related revenues of the booking request are compared with the opportunity costs emerging

from the utilization of capacity whereat a booking class is available if the value-related revenues outweigh the opportunity costs. Using customer choice models, a set of booking classes that has been determined for the particular time of request is available (see *Figure 4*). The identification of segment-specific contingents, value-related revenues, sets of booking classes or the segment-specific booking class price requires the requesting customer to be assigned to one of the value-based segments that have been defined within forecasting. Hence, model development tasks for the determination of a value-based classification model are reasonable.

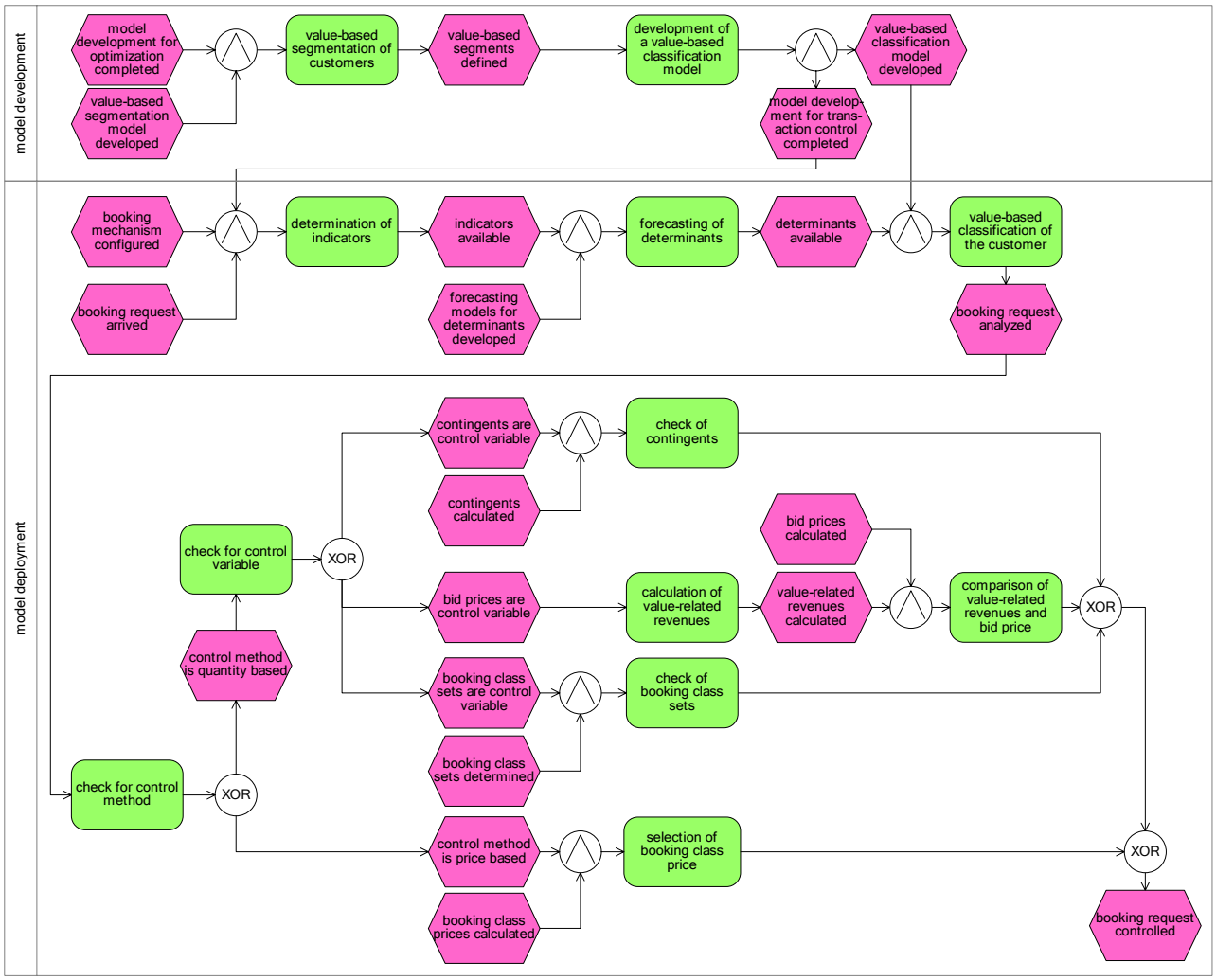

Figure 4: Partial Process Model for Transaction Control

4.4. Adaptation

Adaptation adjusts forecasting, optimization or transaction control, respectively, during the booking period based on the observed booking progress. Using contingent control, for example, the contingent assigned to a customer segment regarding a particular booking class has to be reduced in case of a booking. If the forecasted and current booking profile differ or external factors, e. g. short-term promotional activities or capacity changes, occur, contingents, opportunity costs, sets of booking classes or dynamic prices may have to be re-calculated by means of optimization.

Since customer choice behavior may have been observed or a customer may have been identified as a regular customer during the booking process, additional information may be available after a

booking is completed. This information should be used to classify the customer again. Although the customer's booking remains unaffected, the acceptance of future booking requests may change based on a different valuation of current bookings.

4.5. Analysis

The analysis provides the basis for a monitoring of the capacity control regarding the achievement of the formulated objectives. Additionally, the feasibility of the models applied for forecasting, optimization and transaction control as well as the employed information systems and procedures can be assessed [6]. A system of performance indicators that is based on value-related revenues allows for measuring both short-term success (transaction revenues of accepted booking requests) and long-term success potential (customer values of accepted customers) by using appropriate weighting factors. In order to estimate the effect of the applied capacity control method in isolation, gained value-related revenues should be measured in relation to the ex-post optimal revenues or to the revenues in case of a trivial first-come-first-serve control (fcfs) that accepts all booking requests as long as there is available capacity. The so-called revenue opportunity metric combines these two ratio figures and represents the exploitation of the potential revenue gain owing to the deployment of capacity control compared to the trivial booking control [17].

5. Results of a Prototypical Implementation and Evaluation

Simulation studies have been conducted for an analysis of the performance of value-based revenue management in different application scenarios. In order to assess the effect that a variation of particular environmental factors has on the performance indicators, a simple network structure with two legs, a high- and a low-value booking class on each possible connection as well as a high- and a low-value customer segment has been implemented. Bid price control based on a mathematical programming approach [4] has been applied to control the booking requests. Three parameter values for the weighting factor within value-related revenues have been used for both control and analysis that allow for comparing different booking control methods (i. e. transaction based, customer value based, and hybrid) and measuring the results according to different temporal scales.

The analysis of transaction- and customer value-based revenues in several scenarios distinguished by the *correlation of willingness-to-pay and customer value* shows that customer value-based and transaction-based capacity control lead to comparable results at a positive relationship between customer value and willingness-to-pay. However, if the relationship is non-positive, customer value-based and hybrid capacity control lead to a lower direct, short-term success but a higher indirect or long-term success potential. This justifies, for example, the availability of discounted booking classes for prospective customers, e. g. students, with a low short-term willingness-to-pay but a potentially high long-term customer value [20]. The variation of the *amount of demand* (demand factor) confirms that the additional benefit of all three control methods compared to the fcfs control correlates positively with the demand factor. Therefore, the deployment of capacity control is most reasonable when demand is high in relation to the available capacity, especially in case of a customer value-based or hybrid control. A sensitivity analysis regarding the *arrival of booking requests* shows that the additional benefit of both customer value-based and hybrid capacity control compared to the fcfs control is higher when high-value booking requests (e. g. requests of high-value customer segments) arrive late in the booking period.

6. Conclusion and Outlook on Remaining Research

The transaction-based revenue management commonly applied so far doesn't allow for both efficient capacity utilization and the establishment of profitable customer relationships. Customer value-based revenue management, in contrast, represents an integrated approach being able to overcome these shortcomings. Valuable customers, e. g. prospective or reference customers to whom the service provider should establish long-term profitable relationships, can be favored despite having a low willingness-to-pay. The results of prototypical simulation studies indicate that the traditional, transaction-based approach is outperformed regarding the establishment of long-term or indirect success potential, especially when willingness-to-pay and customer value don't correlate positively. However, in other demand scenarios, customer value-based capacity control doesn't perform worse than transaction-based capacity control.

Research remains, amongst others, in the identification of appropriate indicators and models for customer valuation within capacity control [23]. For the complex customer value-based optimization models, efficient solution techniques, e. g. on the basis of evolutionary algorithms [18], are necessary. The simulation should be supplemented by longitudinal studies in order to assess the development of the customer base over time. Moreover, the applicability of the model with regard to the customers' perception of fairness should be evaluated empirically.

Given the prevalent importance of capacity control and customer relationship management, customer value-based revenue management can provide meaningful findings for the sustained competitive capability of service providers.

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