Ten myths of revenue management – A practitioner's view

Received (in revised form): 1st October 2010

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ABSTRACT Ten generally acknowledged facts of revenue management are listed and described. They are considered critically and assessed in the light of literature and practice. The list includes 'myths' such as 'Revenue Management maximizes revenue', 'Revenue Management gives a competitive edge' and 'Revenue Management is improved by network considerations'.

Journal of Revenue and Pricing Management (2011) **10**, 26–31. doi:10.1057/rpm.2010.40

Keywords: revenue management; practice; optimization; network management

INTRODUCTION

As one of the aspects of airline optimization problems, revenue management has been firmly established in research. Now, for the 10th-year anniversary of this magazine, this article collects some assumptions commonly found with regard to this discipline, not unlike the list provided by (Lieberman, 1993). Ten of these 'myths' are considered critically from a practitioner's point of view and assessed for their justification in the light of literature and practice.

REVENUE MANAGEMENT (RM) MAXIMIZES REVENUE

The name 'Revenue Management' combined with the strong association of the concept with

the operations research goal of optimization suggests that the objective of RM is to optimize – maximize – revenue. This objective has been established in one of the perennial classics of RM literature (Littlewood, 1972). Recently published literature supports this impression, devising sophisticated optimization techniques intended to maximize revenue given the challenges of correlated demand (Weatherford and Ratliff, 2010), strategic customers (Jerath *et al*, 2010) and intense competition (Wei and Zhao, 2010).

Yet, regarding the possible key performance indicators considered by a company that may apply RM, revenue does not stand alone. For example, (Liehr *et al*, 2001) suggest that seat load factors are one of the major indicators

informing on the success of an airline, applied even for stock analysis.

The methods of RM can be used well to influence other indicators besides revenue. A success story of optimizing not just revenue but the usage of capacity by applying inventory controls based on a demand forecast is presented by (Harris, 2007). This, still, conforms to the definition of ‘offering the right seat to the right customer at the right price’, as formulated by (American-Airlines, 1987) – what changes is the understanding of the term ‘right’.

RM does, after all, maximize revenue in many cases – but not in all cases, and not regardless of other indicators. It may be more correct to claim: RM can be used to maximize revenue while observing constraints regarding further indicators.

RM IS FOR MATHEMATICIANS

Research articles proposing improved algorithms for RM often require a high degree of mathematical understanding. The required tool set ranges from *linear* and *dynamic programming* to *logit* and *probit* models anticipating *customer choice*. The lay person (for example, the interested airline manager equipped with an MBA) can quickly lose track of the intricacies involved and may find it hard to rate the chances of applying the method described successfully; harder still to quantify the expected earnings from such a move.

Most RM departments do not exclusively hire mathematicians. As an internal survey at Lufthansa German Airlines shows, the specialists that are the designated users of professional RM system are expected to bring ‘an understanding of business indicators’ and ‘analytical thinking’ as well as the equivalent of a bachelor of business. Similar descriptions can be found describing comparable positions with other carriers. Outfitted with a general training (often on the job) as well as specialized software courses, these users set influences to align the forecast and the optimization to a company’s

actual outlook and objectives. Most of them would not aspire to judging the chances of success of an improved optimization algorithm from the description provided in research literature.

At the same time, these specialists determine the outcome of RM: common software packages sold in this area allow for user influences that can significantly alter the forecast or overwrite the results of the optimization (examples of user influences can be found in documentation by providers such as PROS Holdings, Inc. or Lufthansa Systems GmbH). Although the design of new techniques may be a task for mathematicians, the application of RM largely is not. The design of RM systems including state of the art methods would be well advised to take this into account.

RM IS ABOUT OPTIMIZATION

Whether the objective of RM is to maximize revenue or productivity, considering robustness or risk, optimization seems to be at the core of the concept. More than 800 articles dealing with optimization and RM have been published in 2009 alone.

Any optimization technique calls for the inclusion of an objective function as well as restrictions. In the case of RM, objective function and restriction are defined using parameters such as capacity, fares, booking classes and expected demand. The model underlying the optimization sets the requirements in terms of parameters. Using this input, the algorithm determines optimal settings – provided that the parameters prove to be correct. One of the first methods described for optimizing revenue, (Littlewood, 1972), provides an example for this process.

If, for instance, the expected demand is faulty, the optimization remains mathematically sound. It results in a set of inventory controls intended to channel the expected demand according to the objective function. If the actual demand, however, does not correspond

to the expectation, the results may be anything but optimal. The consequences of such an error are described in (Cooper *et al*, 2006).

Optimization does play a considerable role in the process of RM. But it is one component: other components, such as the forecast, have a significant – and sometimes decisive – influence on the outcome of RM as well.

RM IS ABOUT AVAILABILITIES

Inventory controls tailored to maximize revenue are the desired outcome described frequently in RM literature. Examples of this may be found, for example, in (Littlewood, 1972) and (Simpson, 1989). These inventory controls result in certain fare classes being available (or not) for booking short *availabilities*. As the result of optimization, these availabilities seem intended to determine the outcome of RM.

But is RM all about availabilities? If a customer is willing to pay a price that is not even offered by the airline, no set of availabilities can maximize revenue with regard to this willingness to pay. As a form of inventory control, availabilities can only be set for fixed sets of prices – these may be extended using pricing tariffs and sales options not considered in the RM process.

Approaches to RM considering dynamic prices such as (Gallego and van Ryzin, 1997) implement a model that subsumes availabilities with prices and products. For a limited set of products (described by characteristics such as flexibility, minimum stays and special target groups), an unlimited set of prices is available. The output of the RM process is the price at which a product is available, not the binary availability of a booking class.

In practice, the availability of professional solutions including the forecast and optimization methods necessary for dynamic pricing at the desired level of complexity still halts the spread of this approach. However, as with many concepts, this might be only a question of time. Once the required solutions are in place, the

flexible combination of price and product may replace the traditional concept of availabilities.

RM IS IMPROVED BY NETWORK CONSIDERATIONS

Presented in literature since the 1980s (McGill and Van Ryzin, 1999), network RM has been regarded as a natural contribution to maximize revenue. (Rockmann and Alder, 2009) show that RM considering an origin-destination view of itineraries rather than single flights can provide superior results in practice. With difficulties of performance being solved by both improved algorithms and Moore's Law, it seems there is no reason for a network carrier not to employ a network approach.

The implications of origin-destination RM with regard to the organization, performance benchmarking and human resources, however, are rarely included in the benchmarks. Although the automated system provided correct input results in higher revenue, this cannot be guaranteed for the practical implementation.

Problems connected to the implementation of a network approach to RM have been outlined, for example, in (Talluri and Van Ryzin, 2004, p. 83). One of the most important issues is conflict of interests: Whereas in a flight based approach, it is comparatively simple to assign a fixed set of flights to an analyst, a network-based approach asks for the assignment of markets described by sets of origin and destination. The conflict between local and transfer traffic can be resolved clearly within the automated algorithm, but gains complexity when user influences are considered.

Customers traveling from Hamburg to Seattle via Frankfurt need bookings on the leg Hamburg–Frankfurt and on the leg Frankfurt–Seattle. If the leg Hamburg–Frankfurt is under the control of an analyst in charge of the domestic market, the availabilities on this leg can depend on the current situation in the domestic market. A trade-fair in Frankfurt can,

therefore, cause highly restrictive user influences, making this itinerary comparatively expensive for the customer with the destination Seattle. As a result, instead of transferring in Frankfurt, this customer may prefer the offer of a competing airline and fly via London. The valuable intercontinental customer is lost due to user influences aimed only at domestic customers.

RM REQUIRES DEDICATED SOFTWARE SYSTEMS

So far in this text, we have taken for granted that RM works by connecting sophisticated demand forecast systems with corresponding optimization systems and automated inventories. Several suppliers of dedicated software systems offer their support for the implementation of just such a system for companies interested in applying RM. Used by specialized analysts, these systems apply state of the art mathematics and data mining to determine revenue optimal inventory controls.

But, is a dedicated software system actually a requirement to apply RM? The research articles on RM have been published as early as 1958 (Beckmann and Bobkowski, 1958). As often cited, the success story of airline RM started with the airline deregulation act in 1978. If software systems were a strict requirement, the performance currently required by state of the art systems in the past decades would argue against the success of RM in the past.

In fact, the flexibility of the concept of RM has been a major argument for its use in a variety of industries long before tailored software systems were developed. Of course, a sophisticated and automated system contributes to the success of RM on the large scale. But it is feasible to implement a RM heuristic using a basic demand forecast in the form of, for instance, a spreadsheet for a small to middle sized company and its product and price range. Using such a simple solution can still improve revenues significantly when

compared to the default ‘first come first serve’ approach. Examples of this are provided in (Cross, 1997).

RM WAS INVENTED BY AIRLINES

As mentioned above, a common tale of RM tells of its invention being caused by the Airline Deregulation Act increasing competitive pressure for airlines in 1978. This is supported by the fact that since then the bulk of academic research on RM has been published (McGill and Van Ryzin, 1999).

But is the concept of RM really that novel? A basic example of RM may be experienced firsthand at the farmers’ market. Fruit, vegetables and bread are priced according to customer segments, characterized by their time of arrival: Early customers pay the full price, but at the end of the day (when the produce is still fresh, but it does not pay for the sellers to keep it another day) prices drop. This type of RM has certainly been practiced successfully for considerably more than 30 years.

RM GIVES A COMPETITIVE EDGE

One of the motivations to implement RM is that it allows for a better use of capacity through tailoring reduced fares for different customer segments. This creates an edge that allows companies to thrive even in competitive environments, as described in (Cross, 1997).

However, during the last decades, as the Internet has rendered many markets quite transparent and some products, such as telecommunication or air travel, are much easier to compare and substitute. Under these circumstances, RM may lead either to a decrease in competitive power or to a ruinous price-combat:

If the demand forecast included in a company’s RM does not consider the fact that competition offers are available at bargain prices, the resulting inventory controls may be

too restrictive. As a result, expected demand does not arrive as planned and the expected revenue cannot be realized. This risk has been described in (Lancaster, 2003).

If RM does consider competition, one strategy can be to ‘underbid’ the competitor. However, if two competing companies use RM systems that try to increase demand by being cheaper than the competition, a spiral down of prices can occur. As a result, RM can increase the negative effects of competition. This risk has been described in (Isler and Imhof, 2008).

RM IS ABOUT MAKING CUSTOMERS PAY AS MUCH AS POSSIBLE

Maximizing revenue by segmenting customers implies the immediate goal of making customers pay as much as possible. Business customers with a high willingness to pay, arriving late in the booking horizon, are offered only the most expensive booking classes. Tourist travelers on a limited budget, planning and booking their itinerary early in advance, are offered reduced fares. This principle is stated throughout standard literature as, for example (Talluri and Van Ryzin, 2004). Each customers’ maximum willingness to pay is utilized as fully as possible (provided the forecast is correct and buy-down is avoided as far as possible).

Yet, state-of-the-art literature has started to consider more than just the price a customer is willing to pay right now. The idea of customer value as described, for example, in (Hendler and Hendler, 2004) takes into account the future business that may be generated if a customer is not forced to pay ‘as much as possible’ but is provided a reasonable offer likely to make him return for more. Strategic behavior as an additional aspect of customer choice implies that customers learn from experience and that it may be advantageous to include the long-term view in RM (Jerath *et al*, 2010).

RM IS HARD TO APPLY

With the consideration of nine myths so far, it seems that RM requires a multitude of considerations and very few simple answers. For instance, it is not strictly about any one indicator or objective, it cannot be simply solved by implementing mathematically sophisticated software systems, and it only provides a competitive edge under certain circumstances. This does not seem to make the concept easy to apply – and yet, it may well be.

Some extent of RM – managing revenue, influencing and improving the availability of certain products and prices in order to maximize the process of sales – is quite simply implemented. Examples of RM having been implemented with great success in a pragmatic context have been provided by (Cross, 1997). Perfectionism and the quest for the highest possible degree of automation, however, lead to questions that keep research in RM... interesting.

REFERENCES

- American-Airlines. (1987) The Art of Managing Yield. American Airlines Annual Report.
- Beckmann, M.J. and Bobkowski, F. (1958) Airline demand: An analysis of some frequency distributions. *Naval Research Logistics Quarterly* 5(1): 43–51.
- Cooper, W.L., Homem-de-Mello, T. and Kleywegt, A.J. (2006) Models of the spiral-down effect in revenue management. *Operations Research* 54(5): 968–987.
- Cross, R.G. (1997) *Revenue Management: Hard-core Tactics for Market Domination*. New York, USA: Broadway Books.
- Gallego, G. and van Ryzin, G. (1997) A multiproduct dynamic Pricing problem and its applications to network yield management. *Operations Research* 45(1): 24–41.
- Harris, F.H.B. (2007) Keynote paper: Large-scale entry deterrence of a low-cost competitor: An early success of airline revenue management. *International Journal of Revenue Management* 1(1): 5–27.
- Hendler, R. and Hendler, F. (2004) Revenue management in fabulous Las Vegas: Combining customer relationship management and revenue management to maximise profitability. *Journal of Revenue and Pricing Management* 3(1): 73–79.
- Isler, K. and Imhof, H. (2008) A game theoretic model for airline revenue management and competitive pricing. *Journal of Revenue and Pricing Management* 7(4): 384–396.
- Jerath, K., Netessine, S. and Veeraraghavan, S.K. (2010) Revenue management with strategic customers: Last-minute selling and opaque selling. *Management Sciences* 56(3): 430–448.
- Lancaster, J. (2003) The financial risk of airline revenue management. *Journal of Revenue and Pricing Management* 2(2): 158–165.

- Lieberman, W.H. (1993) Debunking the myths of yield management. *The Cornell Hotel and Restaurant Administration Quarterly* 34(1): 34–41.
- Liehr, M., Größler, A., Klein, M. and Milling, P.M. (2001) Cycles in the sky: Understanding and managing business cycles in the airline market. *System Dynamics Review* 17(4): 331–332.
- Littlewood, K. (1972) *Forecasting and control of passenger bookings*, AGIFORS Symposium Proceedings. Nathanya, Israel: AGIFORS
- McGill, J.I. and Van Ryzin, G.J. (1999) Revenue management: Research overview and prospects. *Transportation Science* 33(2): 233.
- Rockmann, J. and Alder, C. (2009) *Revenue increase by O&D optimization at Lufthansa*, AGIFORS Reservations and Yield Management Study Group Annual Meeting Proceedings. Amsterdam, the Netherlands.
- Simpson, R.W. (1989) Using network flow techniques to find shadow prices for market and seat inventory control. Memorandum M89-1, MIT Flight Transportation Laboratory.
- Talluri, K.T. and Van Ryzin, G.J. (2004) *Theory and Practice of Revenue Management*. Boston, MA: Kluwer Academic Publishers.
- Weatherford, L.R. and Ratliff, R.M. (2010) Review of revenue management methods with dependent demands. *Journal of Revenue & Pricing Management* 9: 326–340.
- Wei, Y. and Zhao, X. (2010) Revenue management with incomplete information dynamic competition. *2010 International Conference on Logistics Systems and Intelligent Management*. New York: IEEE.