European Journal of Operational Research 000 (2016) 1–8

Contents lists available at ScienceDirect

European Journal of Operational Research

journal homepage: www.elsevier.com/locate/ejor

Decision Support

Profit management of car rental companies

Igor Lazov

Faculty of Electrical Engineering and Information Technologies, Ss. Cyril and Methodius University, 1000 Skopje, Macedonia

ARTICLE INFO

Article history:
Received 19 August 2015
Accepted 26 August 2016
Available online xxx

Keywords:
Strategic planning
Systems dynamics
Company information, entropy, size and utilization
Company mean profit
Property renting

ABSTRACT

A car rental company consists of a fleet of available rentable vehicles (waiting to be rented and being rented). We model the company as a family of Birth–Death Processes (BDPs) in equilibrium with finite size, indexed by the company utilization parameter. This metric is the ratio of the primary birth and death rates in these BDPs. Relying on the basic concepts of company information and company entropy (i.e., mean information), we promote a procedure for profit management of car rental companies. The company entropy represents the company uncertainty (i.e., risk); moreover, finding optimal values of company utilization and fleet size leads to a unique management of that uncertainty. Introducing the coefficient of proportionality of a company, as ratio of the renting revenue per vehicle per day and costs per vehicle per day, we obtain an expression for the mean profit per day of a company (i.e., profit attained per day from the average number of simultaneously rented vehicles) as a function of company utilization, fleet size and coefficient. Thus, the profit management procedure reduces to finding optimal values of these three metrics, as the key profit drivers of the rental business. Moreover, an expression for the minimal value of the coefficient is introduced (as a function of the other two metrics), determining the zero mean profit per day. Thereby, the efficiency of the company's fleet is determined as a reciprocal of this minimal value. The developed procedure is illustrated on a company which is represented by the Erlang loss system.

1. Introduction

The car rental industry is a worldwide and local business. It is a long-term growing industry, periodic and seasonable. Since it is sensitive to inflation, the players who have a good balance sheet to support the cycle of car procurements have a commanding influence on the car rental industry. There are great challenges (e.g. the prominent issues of cabotage regulations, security, insurance, etc.) and great opportunities (e.g. building a profitable rental operation requires the ability to address the distinct cultural, geographic, economic/fiscal, language and legislative differences) in the car rental industry. Staying on the cutting edge of the car rental business management strategy, gives the managers an advantage over their competitors, allowing them higher profitability and a greater number of satisfied customers. There are many rental operations, such as vehicle maintenance, marketing, franchising, front line performance, operator profiles and car sharing, i.e., factors that go into running a car rental company effectively and efficiently.

E-mail address: igorlazov@gmail.com

http://dx.doi.org/10.1016/j.ejor.2016.08.064
0377-2217/

Car rental companies rent vehicles to corporate and leisure travelers. The majority of revenue is derived from rental payments. The major constituents of costs are depreciation, insurance, maintenance, salaries and interest. The decisive factor to a prosperous car rental company is efficacious asset management (the most of assets are the rentable cars). So, in settling the balance sheet issues, company's fleet size is important. In the car rental industry a few major global players prevail, such as Avis, Hertz, Europcar, Budget, etc. Although there are some regional players, the car rental companies classically trade under the global player brand to seize a commensurate portion of ingoing leisure travel.

As a key ratio to assess a car rental business, the well known financial leverage ratio, i.e., debt-to-equity ratio (directly affecting the company risk) can also be considered (see e.g. Peterson, 1999). If a company's operations can generate a higher rate of return than the interest rate on its loans, then the debt is helping to fuel growth in profits. However, increasing the gearing level too high would cancel any benefits associated with debt-financing, because the increase in the required interest rate (due to the risk of bankruptcy) would outweigh the tax savings as explained in the trade-off theory of capital structure (Welch, 2011).

The factors driving historical industry growth include increases in airline passenger traffic, the trend toward shorter, more frequent vacations resulting from the number of households with two wage earners, the demographic trend toward older, more affluent citizens who travel more frequently and increased business travel. Car rental companies have also been able to increase the revenue they earn on their vehicles through the implementation of *Revenue* (*Yield*) *Management* (*RM*) *systems* similar to those utilized by the major airlines. RM is an essential instrument for matching supply and demand by dividing customers into different segments based on their purchase intentions and allocating capacity to the different segments in a way that maximizes a particular firm's revenues (see Emeksiz, Gursoy, & Icoz, 2006; Guadix, Cortes, Onieva, & Munuzuri, 2010; Lieberman, 2003; Tranter, Stuart-Hill, & Parker, 2008; Vinod, 2004). Also, the basic concepts of a parking reservation system and parking RM system are discussed in Teodorovic and Lucic (2006). In Bifulco (1993) parking pricing is modeled for general transportation networks. A review for efficiency and effectiveness in the urban public transport sector is given in Daraio et al. (2016). Further, a review of the contemporary hotel RM is shown in Ivanov and Zhechev (2012). A broad overview of RM, enabling the reader to be knowledgeable enough to understand the underpinnings of today's RM systems is provided in Kimes and Anderson (2011). Significant theoretical research in RM fundamentals and its application in various industries has also been triggered (Chiang, Chen, & Xu, 2007; Cross, 1997; Ng, 2009). RM theory has also benefited strongly not only from marketing management research, but more profoundly from operations (Talluri & van Ryzin, 2005) and pricing research (Shy, 2008). However, the aspiration of researchers and practitioners to model the hotel operations and market demand as realistically as possible leads to the construction of more multifarious RM problems that require innovative and more sophisticated approaches to solve them. To name a few of the approaches used: Markov model approach (Rothstein, 1974), bid-price and price setting methods (Baker & Collier, 1999, 2003), expected marginal revenue technique (Ivanov, 2006; Netessine & Shumsky, 2002), probabilistic rule-based framework in knowledge discovery technique (Choi & Cho, 2000), robust optimization (Koide & Ishii, 2005; Lai & Ng, 2005), etc. Thus, since the emerging RM issues are encountered by various techniques, there is a need for a *unique* lean financial management (i.e., control) system, also known as profit management, as a result of which, there will be very few "earnings surprises" in company's financial reports. Thus, there should be some universal parameters, applicable for any company (i.e., system), whereby the company can provide the desired profit level dealing only with them (i.e., choosing their suitable values).

This paper focuses on the basics of the car rental industry. We look at the economics, risk and possibilities that investors may expect to find in a typical car rental business. Thus, e.g. in Fulga (2016), an integrated methodological approach for selecting portfolios is presented, proposing a risk measure, which captures better the practical behavior of the loss-averse investor; and a dynamic model of the competitive firm under multiple correlated uncertainties is developed in Alghalith (2016). Moreover, we identify the profit drivers behind this industry and critical success factors, including the rental revenue (i.e., pricing of rental transactions), volume (i.e., number of rental transactions), utilization rate of the rental fleet, etc.

While many aspects of the profit management have been evaluated (e.g. Chan, 1998; Eggert, Hogreve, Ulaga, & Muenkoff, 2011, 2014; Kraatz & Zajac, 2001; Miller, 1987; Neely, 2008; Ployhart & Vandenberg, 2010; Reinartz & Ulaga, 2008; Wernerfelt, 1984; Yeoman & McMahon-Beattie, 2011), and of the rental business have been considered (e.g. Savin, Cohen, Gans, & Katalan, 2005), analytical models based on *company information* and *company entropy* analysis are largely absent. In general, there exists only the widely used and exploited *information-theoretic method*, based on maximizing entropy given certain constraints, e.g. Cozzolino and Zahner (1973), Ferdinand (1970), Gell-Mann and Tsallis (2004), Guiasu (1986), Karmeshu (2003), Thomas (1979), Touchette and Lloyd (2004), Wilson (1970).

In this work, relying on the basic concepts of *information* i and *entropy* S of a car rental company (with N – current number of rented vehicles and M – maximum number of available rentable vehicles, i.e., fleet size, $0 \le N \le M$), which is modeled by a Birth–Death Process (BDP) with size $M+1$, we promote a procedure for *profit management of car rental companies*. The BDP, modeling (the behavior of) the car rental company, is in the state n, $n = 0, 1, \ldots, M$, if $N = n$. Thereby, by definition, the company entropy $S = E(i)$ is the *company uncertainty*. Formally, we apply Gibbs' (1878) formula for entropy and its adaptation to random variables (RVs), firstly proposed by Shannon (1948) (but, solely its discrete version). We note that the approach promoted here does not use the well known concept of "mutual information". Although the car rental is the main focus of this paper, the approach introduced here can be used for any *property renting* as well.

An arriving customer is served by the company if at least one vehicle in the company's fleet is available. Thus, each newly arriving customer is given his private vehicle. Arriving customers for which no vehicle is available are lost (they will go to another company). Thus, a car rental company represents a M-server loss system.

Three metrics are essential in the proposed procedure. The first metric is the *utilization parameter* $\boldsymbol{\rho}$ of a company, ratio of the primary birth and death rates in the BDP modeling the company, $\rho = \lambda/\mu$. It physically defines the (*equilibrium*) *macrostates* of the company. The primary renting time per vehicle is $T = 1/\mu$. The second metric is the fleet size M, i.e., the *size* $M+1$ of a company. The third metric is the *coefficient of proportionality* x of a company, ratio of the *renting revenue per vehicle per day* and *costs per vehicle per day*, $x = R/C$. Thus, the profit management procedure reduces to finding optimal values of these three metrics (given desired company uncertainty level), as the key profit drivers of the rental business. While $p_n = Prob\{N = n\}$ *is the weight associated to the state* n *of the company* (i.e., of the BDP), then i_n *is quantity of information the company possesses in the state* n (both being functions of parameters ρ and M). Thus, the company information i has possible values i_n, $i_n = -\ln p_n$, $n = 0, 1, \ldots, M$. In such a way, this procedure introduces a new *paradigm* for describing the behavior of a rental company. Thereby, when the rental companies want to maximize their chances of success, the approach introduced here will help and enable them to achieve their goals, e.g. to improve pricing decisions, enhance the efficiency of trade spending and ensure product availability.

So, concerning car rental companies, the contribution of the approach proposed here is based on the fact that the company information is the first and foremost characteristic of the particular states of the company, which are determined by the current number N of simultaneously rented cars by that company (this fact is initially promoted in Lazov and Lazov (2014) for an arbitrary population of entities). That is also used in Lazov (2015, 2016), regarding broadband wireless access (BWA) systems. In the former, for two BWA systems, both representing a private wireless network with size $M+1$ (i.e., with at most M active users in the vicinity of its base station), it is shown that *smaller* uncertainty (i.e., risk) is associated to the system acting as a M-server loss system, than to the system acting as a single-server delay system, given the average number of active users. In the latter, a capacity analysis of BWA systems is presented, showing that system capacity, as a function of system information, is expressed by the system utilization parameter ρ. Moreover, in general, we can say that, any system with discrete number of states (shortly, discrete system) is a valid candidate for this type of information analysis. But, in this paper, this