The Forty-year History of Revenue Management: Bibliometric Analysis

Yun Prihantina Mulyani[1]
[1] Program Studi Teknik Industri
Departemen Teknik Mesin dan Industri, Fakultas Teknik, Universitas Gadjah Mada
Jl. Grafika No. 2, Yogyakarta, 55281
email: *yun.prihantina@ugm.ac.id*
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ABSTRACT

This paper presents research trends, leading publishers, influential articles, and shifting concerns in the field of Revenue Management for over forty years based on bibliometric analysis. Bibliometric data was retrieved from Web of Science core collection with a well-defined strategy. The data was processed using Network Analysis Interface for Literature Studies Project scripts. Subject-wise and year-wise research trends were presented. The shifting concerns in RM in terms of topic, method, and domain were highlighted using keyword analysis. In general, RM showed an increasing number of published papers with exponential manner every year. The research core in RM covered the three major decisions in RM including pricing, quantity control, and structural decision. It was highlighted that RM's concern has shifted from single-firm decision to be more consumer- and competition-centric. The data showed that the needs of empirical study and more advanced quantitative methods for complex and real-time problems were urged. In addition, the adoption of RM was extended for industries with semi-flexible capacity. The top influential publishers were Decision Sciences, Operations Research, Management Science, and Management Science Manufacturing & Service Operations Management.

Keywords: *revenue management; review; citation network; keyword analysis*

1. INTRODUCTION

Revenue management (RM) was a relatively emerging topic which has been developed since the 1970s. It involves "allocating right type of capacity to the right kind of consumer at the right price in the right time to maximize revenue or yield" (Kimes, 1989) and also "to the right distribution channel" in the case of mix channel (Hayes & Miller, 2011). In short, it covers price decisions, capacity or quantity decisions, and structural decisions which explain other supporting schemes for the two decisions above, for example selling format, segmentation mechanism, and terms of trade to offer. Scientific advances in economics, statistics, and operations research and advances in information technology are entailed to supervise the decision-making process. Those advances provide the capability to automate, capture and store data or transactions, to quantify uncertainties, demand, economic conditions, and market response, and to compute or solve complex decision problems. Therefore, multidisciplinary becomes a necessity in this field. For a thorough introduction to revenue management, its history, theory, and application, can be further seen in Talurri & Ryzin (2004).

The Airline Deregulation Act of 1978 has initiated the development of RM (Talurri & Ryzin, 2004). The act cut the U.S. Civil Aviation Board (CAB)'s control of airline prices and led to quick change and impulsive innovation in the industry. The initial application of dynamic pricing was made in 1978. The success of RM practice in airline industry inspired the adoption of RM practice in other sectors with conditions: inflexible capacity, perishable products, variable and uncertain demand, and heterogeneous consumers. Some RM adopters are hotels, restaurants, sport and entertainment ticketing to name a few (Ivanov & Zhechev, 2012; Kimes, 2003; Qiwen, 2010; Talurri & Ryzin, 2004).

From then, RM continues to grow to accommodate the changes and create improvement for the better decision-making process and get massive attention from both professional and academic sectors.

Revenue management has been made since the 70s, but the real study has started in the early 90s. Littlewood, written in 1972, made the first pioneer work about marginal seat revenue, followed by Rohtstein (1974) about overbooking policy and Belobaba (1987, 1989) about EMSR (Expected Marginal Seat Revenue) rules. In the late 90s, some scholars have reviewed this field to formulate its definition, conceptual framework, objectives, application, and advantages. They also defined the characteristics of industries that can be adopters. Some of the authors are Kimes, (1989), Weatherford and Bodily (1992), Lieberman (1993), Jauncey et al. (1995), to name a few. Those papers proposed to promote revenue management theory and positioned the field.

Works in this field published by various disciplines such as operations research, transportation science, and management (Qiwen, 2010). It was because many famous experts of those disciplines had joined this field, and specific scholarly journal in revenue management were not available at that time. Later, Journal of Revenue and Pricing Management (JRPM) was created in 2003, followed by International Journal of Revenue Management (IJRM) in 2007.

In the early 2000s, many scholars started to do reviews on the progressing works in RM, projected the future research, and identified the future challenges or changes with which RM must cope. Some of them reviewed according to: 1) themes for example service revenue management by Qiwen (2010); 2) type of decisions, methods, and models such as pricing decision by Elmaghraby and Keskinoeak (2002) and quantity decisions by (Klein et al., 2020); 3) industrial types as sample such as airline industry by Pak and Piersma (2002), hotel by Guillet et al. (2015), car rental by Jose et al. (2011), and remanufacturing by Kumar et al. (2016); 4) dimensions for example consumer behavior by Shen and Su (2007), and customer choice model by Strauss et al. (2018). Some of them concerned about the position of revenue management among other management methods such as Boyd and Bilegan (2003). Only a few

papers discussed comprehensive overview in Revenue Management. Besides, the contribution made by other disciplines for the development of RM has not been discussed so far.

Most of the review studies applied systematic review, content analysis, or qualitative approaches to identify the progressing research which was relied on authors' individual view. This kind of review method belongs to traditional review methods and is relatively subjective (Zupic and Cater, 2015). However, some bibliometric analysis with advanced methods such as evaluative techniques or relational techniques has been done in other fields such as tourism and hospitality (Köseoglu et al., 2016) in which revenue management became a part of it.

This paper aims at presenting a general bibliometric analysis in revenue management. It provides the analysis on overview of the research trends, leading publishers, and influential articles in the field. It also captures the dynamic changes in RM to identify the core set problems which remain in RM all the time, and upcoming issues due to the changes in business environment, technology advancement, and so on by mapping the topic, methods, and domain/industries mentioned in the articles based on keywords. In addition to this, the contribution of each discipline/research area/research categories toward RM is analyzed.

Different from the former paper that applied systematic review of some selected highly cited publications, we use all articles in revenue management over the years up to 2017 in Web of Science (WoS) database. WoS is well-known, objective, and the most powerful database in academic research. Many papers collected information through the WoS as it objectively assesses the journals and includes those with the highest standard only. In this paper, we focused on the use of the bibliometric method to evaluate publications in revenue management and did not engage in the criticism of bibliometric methodology. Network Analysis Interface for Literature Studies (NAILS) Project scripts to get the overview of research trends and keyword analysis.

2. METHOD

2.1. Data Collection

In most of the bibliometric studies, the scholars defined the leading journals to be

assessed. However, only two journals in RM are listed by Scopus, which are IJRM and JPRM and only JRPM has been included in Web of Science (WoS) with 83 records during the last two years. Therefore, it does not have many papers at this time. It does not include early and pioneer journals in revenue management before 2016. Besides, multidisciplinary in the field must be highlighted since many studies in RM have been published in management science or operations research, economy, management, decision science, computer science, and so on. The data of research publications on RM from the WoS Core Collection were collected by utilizing

synonymous names to the practice (Talurri and Ryzin, 2004). Further, we restricted the search to English research articles as our focus was to analyze the research trends in RM. Review papers, book chapter, proceedings are excluded.

2.2. Data Analysis

This paper analyses bibliometric data based on a total number of citations and the total number of papers. The most influential articles and authors are identified using three measures, which are in-degree in the citation network, number of citations (only for articles in the dataset), and PageRank score in the citation

Tabel 1. Year-wise overview of articles

SC	TP	TC	NR	PG	TC/TP	NR/TP	PG/TP
1982	1	17	33	14	17.00	33.000	14.00
1992	3	547	54	46	182.33	18.000	15.33
1993	3	111	29	38	37.00	9.667	12.67
1994	3	569	94	41	189.67	31.333	13.67
1995	12	506	238	181	42.17	19.833	15.08
1996	7	152	121	96	21.71	17.286	13.71
1997	10	410	166	120	41.00	16.600	12.00
1998	7	294	259	112	42.00	37.000	16.00
1999	19	927	419	269	48.79	22.053	14.16
2000	19	909	513	315	47.84	27.000	16.58
2001	16	491	395	235	30.69	24.688	14.69
2002	22	535	583	367	24.32	26.500	16.68
2003	29	1106	806	401	38.14	27.793	13.83
2004	22	900	651	367	40.91	29.591	16.68
2005	22	718	616	369	32.64	28.000	16.77
2006	34	766	910	533	22.53	26.765	15.68
2007	68	1411	1971	1062	20.75	28.985	15.62
2008	64	1601	1796	954	25.02	28.063	14.91
2009	89	1643	2774	1407	18.46	31.169	15.81
2010	82	1126	2619	1130	13.73	31.939	13.78
2011	85	860	3000	1279	10.12	35.294	15.05
2012	102	928	3230	1508	9.10	31.667	14.78
2013	91	729	3091	1321	8.01	33.967	14.52
2014	120	663	4657	1887	5.53	38.808	15.73
2015	133	480	5407	2136	3.61	40.654	16.06
2016	184	194	6637	2707	1.05	36.071	14.71

Notes: PY = publication year; TP = total papers; TC = total citations; NR = number of references; PG = page counts

search engine in WoS with terms "revenue management", "yield management", "revenue optimi*", "pricing AND revenue optimi*", "revenue AND pricing", and "revenue process optimi*". The system screened title, abstract, author keywords, and keyword plus that contained those terms. Those are other roughly

network. The results are sorted by those measurements accordingly. In addition to this, any highly cited papers outside the WoS database are manually added based on cited references. NAILS was utilized for bibliometric studies. It was based on simple statistic method
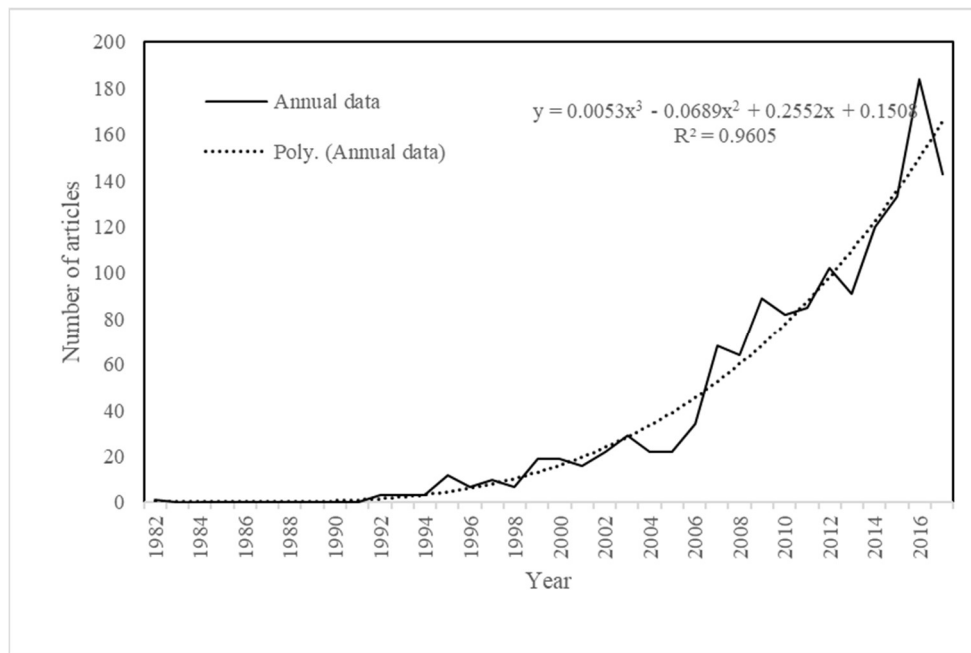
Figure 1. The trend of publications

such as frequency or occurrences for year-wise analysis and subject-wise analysis. It also performed citation network to identify the most influential articles.

This paper also performs the shifting concerns in RM according to the most cited keywords for five-year publications (before 2003, 2003-2007, 2008-2012, and 2013-2017). NAILS resulted in Excel file which contained list of keywords from article's title, author keywords, and keywords Plus. NAILS cannot identify words with similar meaning and group it into one category. Instead, it analyses the exact form of words. For example, "strategic customer" and "strategic consumer" are treated as different keywords. Hence, manual identification of word similarity was done to all possible keywords of 1,390 papers. For example, "inventory allocation", "capacity allocation", "seat allocation", "capacity rationing", "fare class allocation", and "capacity rationing" were grouped into one category, "resource allocation". It intends to get better and more comprehensive results from NAILS project rather than ignoring the possibility of word similarity as resulted from noun derivation, diction, and so on.

3. RESULTS AND DISCUSSION

3.1 Year-wise publication analysis

From the Web of Science Core Collection, 1,390 scientific articles on revenue management were retrieved over forty years until 2017. Table 1 explains the detailed picture of the distribution of articles, total citation counts, number of references, and page counts by year. The first pioneer work in RM was by Littlewood's in 1972 (Littlewood, 2005), two-level seat reservation and Rothstein's (1974) overbooking policy. Those two papers are not found in WoS Core Collection. The missing data from 1983 to 1991 does not mean discontinued publication in RM. This is the limitation mentioned in the method section. Further analysis included cited references that identified the list of all works referred by the papers in the dataset.

The number of articles had increased significantly every year from less than 10 papers to hundreds papers. The year 2006 showed steep increase in number of articles from 22 (2005) to 34 articles (2006) and the growth continued onwards except for the year 2013 and 2017. This growth indicates the significance and the escalating interests in RM globally. The articles published in the early years, 1992 and 1994, had received highest citation counts per article

Tabel 1. Year-wise overview of articles

SC	TP	TC	NR	PG	TC/TP	NR/TP	PG/TP
OR/MS	432	9124	13246	6714	21.12	30.66	15.54
MEF	239	2481	7846	3512	10.38	32.83	14.69
HTT&A	250	2536	9946	3557	10.14	39.78	14.23
CS&A	97	1737	2660	1306	17.91	27.42	13.46
Total	1018						

Notes: SC = subject categories; TP = total papers; TC = total citations; NR = number of references; PG = page counts; OR/MS = Operations Research or Management Science; MEF = Management, Economics, and Finance; HTT&A = Hospitality, Tourism, Transportation Science, and Other Applications, CS&A = Computer Science and Application

(182.33 and 189.67 respectively) compared to later years. The average citation counts per article before 2006 was quite high at 58.5 compared to the average citation during the period which was 36.82 per article. The number of references cited per article ranged from 9.67 to 41.27. The lowest and the highest scores were in 1993 and 2007 respectively. It made sense as only a few RM's articles published before 1993. The increase was parallel with the growing number in publications. However, it is interesting to note that the trend of cited

interest keeps growing in an exponential manner every year.

3.2 Subject-wise analysis

Scientific articles in revenue management has been categorised under four WoS subject categories (Table 2). This is relevant to the statement by Qiwen (2010) that this field is multidiciplinary research especially operations research, transportation science, and management. One more category is computer science and its application along with the
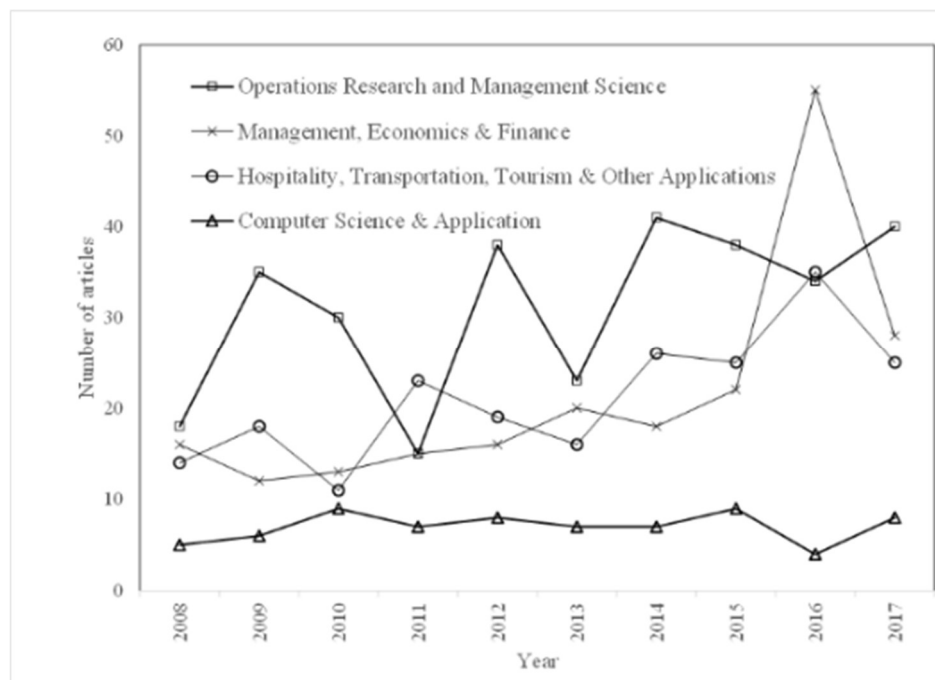

Figure 2. Distribution of articles by WoS categories during 2008-2017

references per article was not commensurate with that of number of articles published. Table 1 and Figure 1 showed that revenue management has become a burning research issue, and the

condition where the practice of RM requires computerisation and automation for data collection, computation, and decision support system.

Operations Research or Management Science was the major category with 432 articles published during 2008-2017 with relatively steady in number of articles published per year. Most of the core articles before 2000s published in OR/MS platforms. The second major subject was Hospitality, Tourism, Transporation Science, and Other Applications (HTT&A) with slightly differences in number of articles to the third subject of Management, Economics and Finance (MEF), 250 and 239 in total respectively. Both showed increasing trend per year as depicted in Figure 2.

Meanwhile, a few papers published in the caregory of computer science and application (CS&A) which remained stable during 2008-2017. The subject category-wise analysis of articles signified that about half of the artiles in revenue management are categorised under the subject of Management Science or Operatons Research. However, the growth in number of articles in the other two subjects, MEF nd HTT&A, might rise in popularity.

3.3 Analysis of the most influential articles

According to three measurement which are in-degree, times cited, and page rank, Table 3 displayed fifty top influential articles all over years along with source title. The scores of in-degree and page rank ranged from 14 to 236 and from 0.0000501 to 0.0003937, respectively. All the 50 publications had received 5,011 citations based on WoS core collections with missing values excluded or 19,348 citations based on Google Scholars (GS). The range was too wide which was 57 (144) to 568 (1461) according to WoS (Google Scholars). However, 19 articles of the top fifty articles received more than 400 citations. Of the top fifty articles, 28% (14 articles), 18% (9 articles), 18% (9 articles), 8% (4 articles), and 6% (3 articles) published in Management Science, Operations Research, Transportation Science, Management Science Manufacturing & Service Operations Management, and Decision Sciences respectively. The majority of the most influential articles in revenue management had published in the discipline of operations research/management science.

Rank resulted in Table 3 was generally parallel to the number of citations. However, some highly cited articles are not in the top list, for example, Kimes (1989), Bitran &

Mondschein (1997), Su (2007), Aviv & Pazgal (2008), and Gupta & Denton (2008). Those papers had very high citations from 520 to 745 citations. This probably because those citations were coming from the same authors as in-degree calculates distinct citing authors rather than simple citation counts. PageRank in Figure 4 showed linear relationship with final rank. The score decreased as the rank increased meaning that the measurement of PageRank was relatively similar to in-degree.
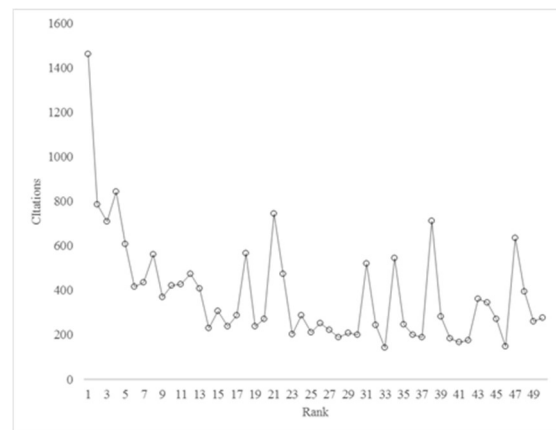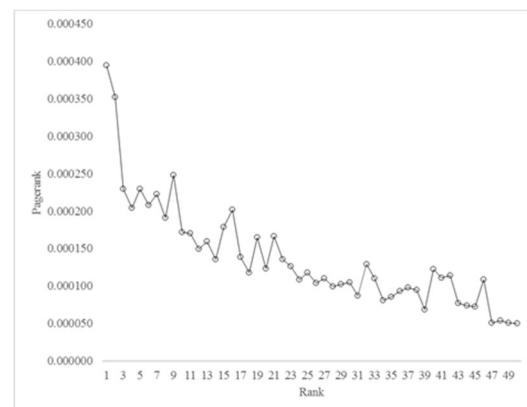

Figure 3. Citation performance

Figure 4. PageRank performance

Figure 5 – Figure 7 showed top salient keywords for terms, methods, and research domains in revenue management. The analysis had been conducted for every five years. The number of citations of earlier publications might be relatively higher than recent publications, for example, times cited for keywords before 2003 ranged from 5 to 2639 and 1 to 869 for 2012-2017. Hence, times cited scores were normalized in the range of 0-1 so that the significance could be comparable between periods.

According to our analysis, the top three foci of research in revenue management over the

years up to 2017 correspond to two main decisions in RM which are pricing-based and quantity-based decisions (Talurri, 2004). However, "resource allocation" showed a downward trend until the last five year while "pricing" continued to rise and dominate until 2017.

The problem of dealing with demand uncertainty and estimation, and optimization were relatively stable. It also happened to any type of structural decision to support the two-main decisions above such as price fencing, booking policy (advance selling, overbooking, no-show, and cancellation), distribution channel, and network RM. Those issues have become foci and long-last topic in revenue management. However, some of favorite keywords before 2003 were no longer discussed or getting very limited attention in later years such as "finite horizon", "revenue losses", "switching time", "welfare maximation", and "coordination". There are some emerging topics in the recent years, which had hardly mentioned before 2003 but getting much attention and showing upward trend until 2017 including consumer behavior, consumer choice, price perception, fairness, and dispersion, competition, and cooperation.

Top salient research method related keywords in Figure 6 were dominated by quantitative methods to support decision-making. Heuristic, dynamic/stochastic programming, mathematical programming, and optimization consistently became top three salient methods in revenue management. Specifically, optimization method was increasingly utilized with positive trend until period 2012-2017. The use of utility theory, forecasting methods, markov decision process, and simulation were stable all the time. Game theory, choice model, logit model, conjoint analysis, structural and estimation showed rapid increase from period 2003-2007 until recent years along with the positive trend to consider consumer and competitor's responses in revenue management. Besides, big data analytics, machine learning, and hybrid model. Those were barely discussed in the period before 2003 but reasonably high usage in the last period (2012-2017).
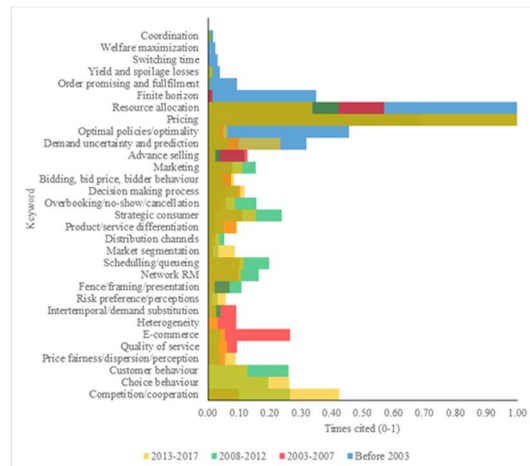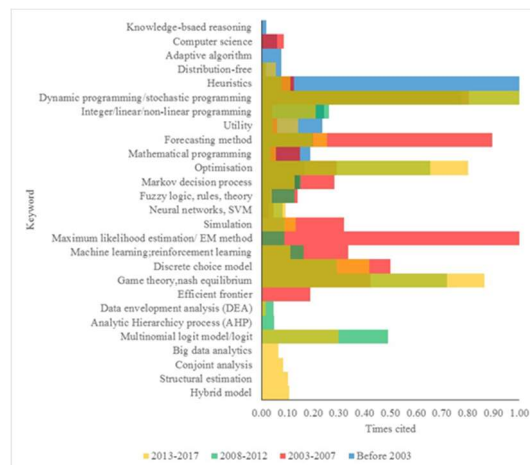

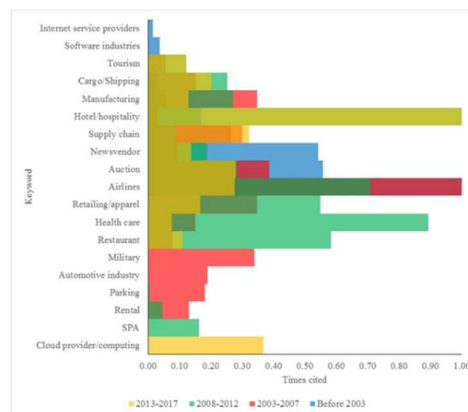**Figure 5.** Top salient terms

Figure 6. Top salient methods

Figure 7. Top salient research domains in revenue management

Table 3. Top 50 most-influential articles

No.	Authors	Year	Source title	In-Degree	Times Cited (WOS)	Times Cited (GS)	PageRank	Title
1	Gallego and Ryzin	1994	*Management Science*	236	537	1461	0.000394	Optimal dynamic pricing of inventories with stochastic demand over finite horizons
2	Belobaba, P	1989	*Operations Research*	159	275 (A)	786	0.000352	OR Practice—Application of a Probabilistic Decision Model to Airline Seat Inventory Control
3	Talurri and Ryzin	2004	*Management Science*	153	232	708	0.000229	Revenue management under a general discrete choice model of consumer behaviour
4	Bitran and Caldentey	2003	*Manufacturing & Service Operations Management*	143	N/A	842	0.000204	An Overview of Pricing Models for Revenue Management
5	Gallego and Ryzin	1997	*Operations Research*	140	207	607	0.000229	A Multiproduct Dynamic Pricing Problem and Its Applications to Network Yield Management
6	Lee and Hersh	1993	*Transportation Science*	101	167 (A)	416	0.000208	A Model for Dynamic Airline Seat Inventory Control with Multiple Seat Bookings
7	Brumelle and McGill	1993	*Operations Research*	98	152 (A)	436	0.000222	Airline Seat Allocation with Multiple Nested Fare Classes
8	Belobaba, PP	1987	*Transportation Science*	96	178 (A)	562	0.000191	Survey Paper—Airline Yield Management An Overview of Seat Inventory Control
9	Curry, RE	1990	*Transportation Science*	95	136 (A)	369	0.000248	Optimal Airline Seat Allocation with Fare Classes Nested by Origins and Destinations
10	Subramanian et al.	1999	*Transportation Science*	92	130	421	0.000171	Airline Yield Management with Overbooking, Cancellations, and No-Shows
11	Talurri and Ryzin	1998	*Management Science*	91	127	428	0.000170	An Analysis of Bid-Price Controls for Network Revenue Management
12	Zhao and Zheng	2000	*Management Science*	87	183	473	0.000149	Optimal Dynamic Pricing for Perishable Assets with Nonhomogeneous Demand
13	Feng and Gallego	1995	*Management Science*	80	147	409	0.000159	Optimal Starting Times for End-of-Season Sales and Optimal Stopping Times for Promotional Fares
14	Liu and Ryzin	2008	*Manufacturing & Service Operations Management*	75	90	229	0.000135	On the Choice-Based Linear Programming Model for Network Revenue Management
15	Wollmer, RD	1992	*Operations Research*	73	111 (A)	306	0.000178	An Airline Seat Management Model for a Single Leg Route When Lower Fare Classes Book First
16	Brumelle et al.	1990	*Transportation Science*	72	97 (A)	238	0.000202	Allocation of Airline Seats between Stochastically Dependent Demands
17	Bitran and Mondschein	1995	*Operations Research*	68	104	288	0.000139	An Application of Yield Management to the Hotel Industry Considering Multiple Day Stays
18	Kimes, SE	1989	*Journal of Operations Management*	67	568	568	0.000118	Yield management: A tool for capacity-considered service firms
19	Robinson, L.W.	1995	*Operations Research*	67	98	239	0.000165	Optimal and Approximate Control Policies for Airline Booking with Sequential Nonmonotonic Fare Classes
20	Bertsimas and Popescu	2003	*Transportation Science*	66	86	271	0.000123	Revenue Management in a Dynamic Network Environment
21	Littlewood, K	1972	*12th AGIFORS Symposium Proceedings*	65	N/A	745	0.000166	Forecasting and control of passenger bookings
22	Bitran and Mondschein	1997	*Management Science*	65	154 (A)	474	0.000136	Periodic pricing of seasonal products in retailing
23	LautenBacher and Stidham	1999	*Transportation Science*	61	76	202	0.000126	The Underlying Markov Decision Process in the Single-Leg Airline Yield-Management Problem
24	Maglaras and Meissner	2006	*Manufacturing & Service Operations Management*	60	88	288	0.000109	Dynamic Pricing Strategies for Multiproduct Revenue Management Problems

No.	Authors	Year	Source title	In-Degree	Times Cited (WOS)	Times Cited (GS)	PageRank	Title
25	Talurri and Ryzin	1999	*Transportation Science*	57	95 (A)	211	0.000118	A randomized linear programming method for computing network bid prices
26	Feng and Xiao	2000	*Management Science*	54	86	253	0.000104	A Continuous-Time Yield Management Model with Multiple Prices and Reversible Price Changes
27	Zhang and Cooper	2005	*Operations Research*	54	77	222	0.000110	Revenue Management for Parallel Flights with Customer-Choice Behavior
28	Zhang and Adelman	2009	*Transportation Science*	54	64	189	0.000099	An Approximate Dynamic Programming Approach to Network Revenue Management with Customer Choice
29	Feng and Xiao	2000	*Operations Research*	51	76	209	0.000102	Optimal Policies of Yield Management with Multiple Predetermined Prices
30	Adelman, D	2007	*Operations Research*	51	65	200	0.000105	Dynamic Bid Prices in Revenue Management
31	Su, X	2007	*Management Science*	50	172	520	0.000087	Intertemporal Pricing with Strategic Customer Behavior
32	Glover et al.	1982	*Interfaces*	50	85 (A)	243	0.000130	The passenger-mix problem in the scheduled airlines
33	Cooper, W	2002	*Operations Research*	49	58	144	0.000110	Asymptotic Behavior of an Allocation Policy for Revenue Management
34	Aviv and Pazgal	2008	*Manufacturing & Service Operations Management*	47	158	544	0.000081	Optimal Pricing of Seasonal Products in the Presence of Forward-Looking Consumers
35	Geraghty and Johnson	1997	*Interfaces*	47	84	247	0.000085	Revenue Management Saves National Car Rental
36	Karaesmen and Ryzin	2004	*Operations Research*	47	81	201	0.000093	Overbooking with Substitutable Inventory Classes
37	Miranda, BJ	2009	*Operations Research*	47	60	188	0.000098	A Column Generation Algorithm for Choice-Based Network Revenue Management
38	Federgruen and Heching	1999	*Operations Research*	47	341	711	0.000094	Combined pricing and inventory control under uncertainty
39	Kimes and Wirtz	2003	*Journal of Service Research*	46	N/A	283	0.000069	Has revenue management become acceptable? Findings from an international study on the perceived fairness of rate fences
40	Pfeifer, PE	1989	*Decision Sciences*	46	68 (A)	184	0.000123	The airline discount fare allocation problem
41	Alstrup et al.	1986	*European Journal of Operations Research*	44	75 (A)	166	0.000111	Booking policy for flights with two types of passengers
42	Belobaba and Weatherford	1995	*Decision Sciences*	42	57	175	0.000114	Comparing Decision Rules that Incorporate Customer Diversion in Perishable Asset Revenue Management Situations
43	Liu et al.	2008	*Management Science*	39	123	362	0.000077	Strategic Capacity Rationing to Induce Early Purchases
44	Xie and Shugan	2001	*Marketing Science*	34	157	344	0.000074	Electronic Tickets, Smart Cards, and Online Prepayments: When and How to Advance Sell
45	Desiraju and Shugan	1999	*Journal of Marketing*	31	90	271	0.000072	Strategic Service Pricing and Yield Management
46	Rothstein, M	1974	*Decision Sciences*	31	N/A	149	0.000109	Hotel overbookings as a markovian sequential decision process
47	Gupta and Denton	2008	*IIE Transactions*	16	234	636	0.000051	Appointment scheduling in health care: Challenges and opportunities
48	Paschalidis and Tsitsiklis	2000	*IEEE/ACM Transactions on Networking*	14	159	395	0.000054	Congestion-dependent pricing of network services
49	Patrick et al.	2008	*Operations Research*	14	102	259	0.000051	Dynamic Multipriority Patient Scheduling for a Diagnostic Resource
50	Dana, J	1999	*Rand Journal of Economics*	14	94	276	0.000050	Equilibrium Price Dispersion under Demand Uncertainty: The Roles of Costly Capacity and Market Structure

Revenue management had been applied in many domains or industrial types (Figure 6). Period before 2003, airline, retailing, and auction were considered as top three case studies in the field. However, the last ten years, publications put much attention to the application of RM in hotel/hospitality. In addition to this, during 2007-2012, RM for restaurant and health care system were notable and reached the peak. It is interesting to note that RM has been widely used in service industries. In addition to this, the adoption of RM began to be applied to industries with semi-flexible capacity such as parking, car rental, and restaurant where capacity is highly correlated or depending on the time of use. This requires adjustment to take the advantage of RM application.

According to our analysis above, revenue management are now more consumer-centric and put more attention to external responses such as competition or alliances with other players. This is accordance with Noone et al. (2011) who notified that the topics in RM has shifted from single firm problems to more understandings on consumer and competition. Consumer-centric addresses buying behavior, preferences, expectation, and responses while business relation include competition, alliance, cooperation, and any form of business relationship. How to understand competition and consumer and then to utilize such information to develop better revenue management system are still questioned and under discussion. This brought the emergence research methods such as game theory, choice model, and logit and conjoint analysis in the past decade. The trend also naturally expects more empirical evidence rather than conceptual framework or numerical experiment (Gonsch et al., 2013). It associates with the advanced technology applied in RM system that allows real-time data collection. It is not surprising that the use of big data analysis or machine learning were increasing recently. It demands the researchers in this field to provide more sophisticated methods to deal with complexity and real-time problems.

4. CONCLUSION

This paper presented a general bibliometric analysis in revenue management and provided an overview of the research trends, leading publishers, and influential articles in the field by utilizing NAILS project scripts with citation network analysis and three indicators for ranking. It also highlighted the shifting concerns in topics, methods, and research domains based on keywords analysis. The results were generated from WoS Core Collection database. The main contribution of this paper is the formulation of search strategy for paper collection in WoS, the use of relation techniques (citation network through NAILS), and the use of keyword analysis.

The increasing attention on this field was remarkable in exponential manner every year. Most articles in revenue management were published in operations research/management science platforms and even 60% of the most influential articles were published in Management Science, Operations Research, Management Science Manufacturing & Service Operations Management, and Decision Sciences. The results of keyword analysis supported other review papers in RM with systematic review. Revenue management are now more consumer and competition-centric rather than focusing on single-firm problems. Along with sophisticated technology applied in RM system, research in this field demands empirical study and more advanced quantitative methods to deal with complexity and real-time problems. Besides, it is interesting to note that the adoption of RM for semi-flexible capacity requires rigorous reconsideration and adjustment.

However, it is worth noting that there are several limitations of this paper. First, this study is based on WoS Core Collection database in which only one specific journal in the field is recognized, JRPM since 2016 with 83 records. Thus, only a few papers are included in the analysis and the number of citations is also affected. In fact, JRPM and IJRM have published 452 articles since 2009 and 173 articles since 2007, respectively. Second, papers in RM have spread in many platforms. Hence, it is quite difficult to identify the most popular journals to be assessed. This is the reason why this paper used search strategy for data collection, and it could not be proven that the datasets are considerably representative. However, this issue is tackled by the use of cited references to detect other works outside WoS database. For future research, expert judgement

for classifying the top journals in RM is suggested.

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