The Forty-year History of Revenue Management: Bibliometric Analysis

by Editor Opsi

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ABSTRACT

Bibliometric analysis as quantitative study of publications is very useful to capture a clear understanding of conceptual structure and research progress of a specific discipline. This paper aims at presenting a general bibliometric analysis such as overview of research trends, leading publishers, influential articles, and identifying shifting concerns in revenue management (RM) over the years until 2017. Bibliometric data was collected from Web of Science core collection with a well-defined search strategy. Network Analysis Interface for Literature Studies (NAILS) Project scripts to delineate the year-wise and subject-wise research trends. Then, keyword analysis was utilized to get the detailed picture on how research topic, method, and domain shifted during the period. RM has experienced an increasing trend with exponential manner every year. The top influential journals are Management Science, Operations Research, Management Science Manufacturing & Service Operations Management, and Decision Sciences. Keyword analysis showed that the research foci of RM is related to three main decisions including price, quantity, and structural decision. Consumer and competition recently become emerging topics. Future research demands empirical study and more advanced quantitative methods to deal with complexity and real-time problems. For research domain, RM is now progressing on industries with semi-flexible capacity.

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 (RPM) 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 Belobaba (1989); 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 in RM by Shen and Su (2007). 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 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 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.

2.1. 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 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 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 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.

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

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 (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 references per article was not commensurate with that of number of articles published. Table 1 and Figure 4 showed that revenue management has become a burning research issue, and the interest keeps growing in an exponential manner every year.
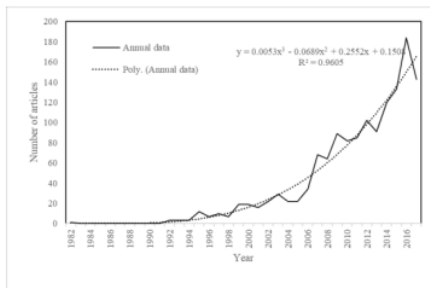

Figure 1. The trend of publications

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 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.

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 citation; 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
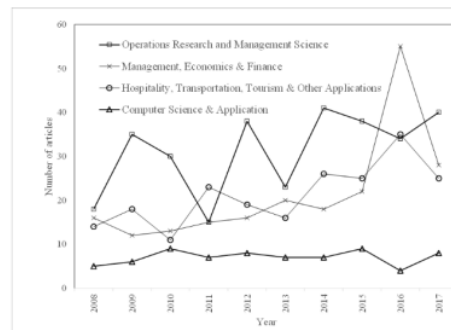

Figure 2. Distribution of articles by WoS categories during 2008-2017

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% [1] 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.
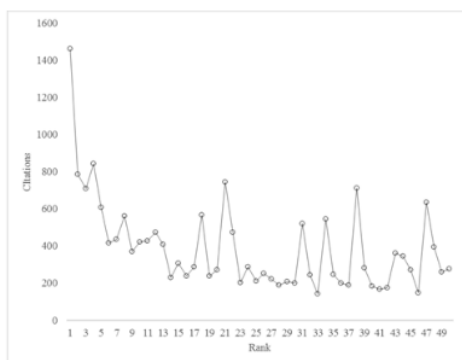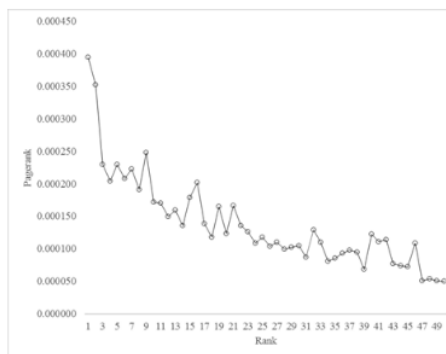

Figure 3. Citation performance

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.

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	[3] Optimal dynamic pricing of inventories with stochastic demand over finite horizons
2	Belobaba, P	1989	Operations Research	159	275 (A)	786	0.000352	[14] Practice—Application of a Probabilistic Decision Model to Airline Seat Inventory Control
3	Talluri and Ryzin	2004	Management Science	153	232	708	0.000229	[19] 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	[3] Overview of Pricing Models for Revenue Management
5	Gallego and Ryzin	1997	Operations Research	140	207	607	0.000229	[15] Multiproduct Dynamic Pricing Problem and Its Applications to Network Yield Management
6	Lee and Hersh	1993	Transportation Science	101	167 (A)	416	0.000208	[27] A Model for Dynamic Airline Seat Inventory Control with Multiple Seat Bookings
7	Brunelle 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	[18] Survey Paper—Airline Yield Management An Overview of Seat Inventory Control
9	Curry, RE	1990	Transportation Science	95	136 (A)	369	0.000248	[5] Optimal Airline Seat Allocation with Fare Classes Nested by Origins and Destinations
10	Subramanian et al.	1999	Transportation Science	92	130	421	0.000171	[8] Airline Yield Management with Overbooking, Cancellations, and No-Shows
11	Talluri and Ryzin	1998	Management Science	91	127	428	0.000170	[2] Analysis of Bid-Price Controls for Network Revenue Management
12	Zhao and Zheng	2000	Management Science	87	183	473	0.000149	[3] Optimal Dynamic Pricing for Perishable Assets with Nonhomogeneous Demand
13	Feng and Gallego	1995	Management Science	80	147	409	0.000159	[2] 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	[2] the Choice-Based Linear Programming Model for Network Revenue Management
15	Wollmer, RD	1992	Operations Research	73	111 (A)	306	0.000178	[3] An Airline Seat Management Model for a Single Leg Route When Lower Fare Classes Book first
16	Brunelle 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	[8] 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	[21] eld management: A tool for capacity-considered service firms
19	Robinson, L.W.	1995	Operations Research	67	98	239	0.000165	[3] 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	[29] Revenue Management in a Dynamic Network Environment
21	Littlewood, K	1972	12th AGIFORS Symposium Proceedings	65	N/A	745	0.000166	[28] Forecasting and control of passenger bookings
22	Bitran and Mondschein	1997	Management Science	65	154 (A)	474	0.000136	[5] 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	[2] Dynamic Pricing Strategies for Multiproduct Revenue Management Problems

No.	Authors	Year	Source title	In-Degree	Times Cited (WOS)	Times Cited (GS)	PageRank	Title
25	Talluri and Ryzin	1999	Transportation Science	57	95 (A)	211	0.000118	[3] A randomized linear programming method for computing network bid prices
26	Feng and Xiao	2000	Management Science	54	86	253	0.000104	[6] A Continuous-Time Yield Management Model with Multiple Prices and Reversible Price Changes [30]
27	Zhang and Cooper	2005	Operations Research	54	77	222	0.000110	[16] 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	[33] Dynamic Bid Prices in Revenue Management
31	Su, X	2007	Management Science	50	172	520	0.000087	[36] Intertemporal Pricing with Strategic Customer Behavior
32	Glover et al.	1982	Interfaces	50	85 (A)	243	0.000130	[26] The passenger-mix problem in the scheduled airlines
33	Cooper, W	2002	Operations Research	49	58	144	0.000110	[2] Asymptotic Behavior of an Allocation Policy for Revenue Management
34	Aviv and Pazgal	2008	Operations Research Manufacturing & Service Management	47	158	544	0.000081	[5] 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	[2] Overbooking with Substitutable Inventory Classes
37	Miranda, BJ	2009	Operations Research	47	60	188	0.000098	[2] Column Generation Algorithm for Choice-Based Network Revenue Management
38	Federgruen and Heching	1999	Operations Research	47	341	711	0.000094	[3] [9] Combined pricing and inventory control under uncertainty
39	Kimes and Wirtz	2003	Journal of Service Research	46	N/A	283	0.000069	[35] 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 Operational Research	44	75 (A)	166	0.000111	[3] [2] Booking policy for flights with two types of passengers
42	Belobaba and Weatherford	1995	Decision Sciences	42	57	175	0.000114	[3] 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	[2] Strategic Capacity Rationing to Induce Early Purchases
44	Xie and Shugan	2001	Marketing Science	34	157	344	0.000074	[34] 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 [32]
46	Rothstein, M	1974	Decision Sciences	31	N/A	149	0.000109	[5] 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	[11] [5] 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

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. The hot topics relate to consumer behavior, consumer choice, price perception, fairness, and dispersion, competition, and cooperation.
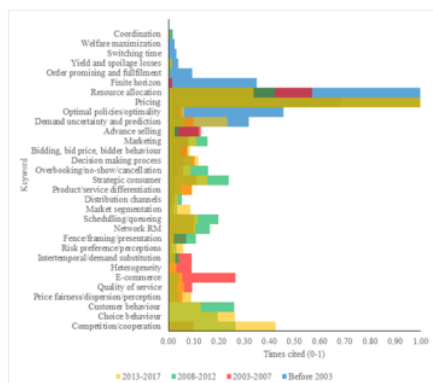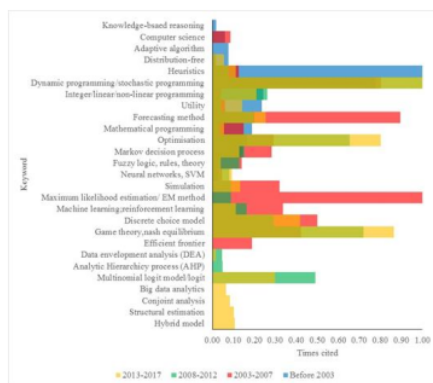

Figure 5. Top salient terms
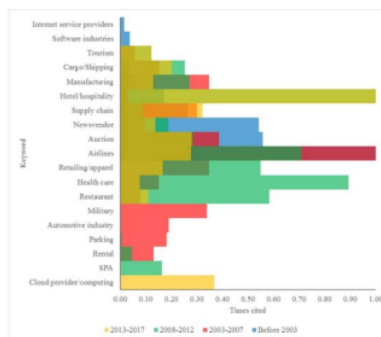

Figure 6. Top salient methods

Figure 7. Top salient research domains in revenue management

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).

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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