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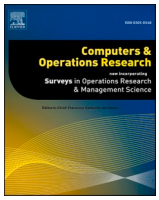

50 years of Computers & Operations Research: A bibliometric analysis

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ABSTRACT

Computers & Operations Research (COR) is a leading international journal in the field of Operations Research, established with a vision to provide a platform for emphasising and promoting the application of computers and operations research techniques to problems of world concern and general interest. The journal published its first issue in 1974 and in 2024 celebrated its 50th anniversary. Motivated by this special event, this paper aims to present a complete bibliometric overview of the most significant development patterns and trends of the journal during its first half-century of publishing history from 1974 to 2023. The study uses the Web of Science Core Collection database to collect bibliographic information and analyse the data, complemented by the Scopus database and the journal's webpage. Based on a wide range of bibliometric indicators, the results of the bibliometric analysis highlight the publication and citation structure of COR, the most cited documents, the leading authors, institutions, countries/territories, and supranational regions, and the most popular keywords and research topics in the journal. Additionally, the work also graphically maps the bibliographic material with techniques of co-citation, bibliographic coupling, and co-occurrence of author keywords by using the Visualization of Similarities (VOS) viewer software. The findings of the study provide strong evidence of the significant growth of COR through its lifetime development and its international diversity having publications from all over the world. The study is also useful for understanding the substantial contributions of the journal it has made to the scientific community.

1. Introduction

Computers & Operations Research (COR) is a leading international journal devoted to the development and application of computers and operations research techniques in a wide range of scientific fields, including transportation, economics, investment strategy, inventory control, logistics, safety, reliability, energy, urban planning, and ecology, among others (https://www.sciencedirect.com/journal/computers-and-operations-research). After several plans that go back to 1963, the journal was founded in 1974 as an international forum on Operations Research applications and applications-related developments, intended for Operations Research practitioners and users in these and related fields (Raff, 1974). The common elements in all the scientific areas that COR addresses are the growing needs for not only the optimisation methodology for determining viable solutions to problems, based on computers and the techniques of Operations Research, but also the applications of the optimisation methods used. The journal is very broad in the scope of subject matter, concerning applied mathematics, modelling and simulation, information systems and management, operations research and management science (OR-MS), and computer science.

Samuel J. Raff (1921–2011), a nuclear physicist and a professor of computer science and electrical engineering at George Washington University, was the Founding Editor of COR and published the first issue in March 1974. The publisher of the journal was Pergamon Press, founded by Robert Maxwell in 1951 and reacquired by him in 1974 (Cox, 2002). Historically, the inception and development of the journal are closely related to Robert Maxwell and Pergamon Press (Raff, 1988). In 1991, Pergamon Press was acquired by Elsevier (Cox, 2002; Miranda,

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2001) and from March 1994 to January 2004, the journal was published with the imprint of Pergamon Press within the Elsevier publishing group. Raff was Editor for 40 years (1963–2003) and made a significant contribution to the journal's development. Gilbert Laporte of HEC Montréal Department of Decision Sciences (affiliated with the Université de Montréal) took over the editorship in 2003 and led the journal for four years. He was succeeded in 2006 as Editor by Stefan Nickel of Saarland University (now with Karlsruhe Institute of Technology since 2009). The current Editor-in-Chief, Francisco Saldanha-da-Gama of University of Lisbon (now with University of Sheffield), took the Editor position in 2016 while Nickel remained in charge as Consulting Editor until April 2019. For more information regarding the editors of COR, see their webpages at:

- Gilbert Laporte: https://www.hec.ca/en/profs/gilbert.laporte.html
- Stefan Nickel: https://dol.ior.kit.edu/english/Team_Nickel.php
- Francisco Saldanha-da-Gama: https://www.sheffield.ac.uk/management/people/academic-staff/francisco-saldanha-da-gama

The system of the journal's editorial team changed several times. To deal with an increasing number of submissions on a variety of topics, several scholars were appointed as Area Editors in 2013. This represented a change in the previous system comprising the Editor-in-Chief and the Editorial Advisory Board for professional guidance. Michael F. Gorman (University of Dayton, OH, USA) joined the team in 2019 as Surveys Editor and served the journal for three years. In March 2020, the journal changed to a new departmental structure defined by an Editor-in-Chief, six Editors, and a Surveys Editor. This system has been used until today. The current Editors are Christian Blum (Artificial Intelligence Research Institute, Spain), Güneş Erdoğan (University of Bath, UK), Mikhail Kovalyov (National Academy of Sciences, Minsk, Belarus), Roger Ríos-Mercado (Autonomous University of Nuevo Leon, San Nicolás de los Garza, NL, Mexico), Alexander Vinel (Auburn University, AL, USA), and Shuming Wang (University of Chinese Academy of Sciences, Beijing, China). Alice E. Smith (Auburn University, AL, USA) is the current Surveys Editor. The Editorial Board has seen a larger number of colleagues collaborating from more than 20 countries/territories around the world, a number that has nearly tripled since its foundation.

In 1974, COR published four issues with 32 research articles, short communications, and conference information. In 1985, the journal started to increase the number of articles publishing 54 documents and becoming a bimonthly journal. In 1991, the journal increased to eight issues, and in 1994, to 10 issues containing 96 articles. In 1996, COR was changed to a monthly journal, and in 1999, it grew again publishing 14 issues. During the period 2005–2013, it returned to be a monthly journal, but the number of articles published per year was far larger than that between 1996 and 1998, reaching a record of 314 articles published in 2012. Due to a significant growth in the number of submissions from all over the world, the journal began to publish multiple volumes in 2014 with 232 articles, and since then, it has been publishing 12 volumes per year on a monthly basis. Note that now COR incorporates two other journals: *Location Science* (1993–1998) and *Surveys in Operations Research and Management Science* (2011–2016) (formerly known as *Handbooks in Operations Research and Management Science* (1989–2007)).

Nowadays, COR is very well recognised for its high-quality publications in the scientific community and has a strong influence on computer science and Operations Research in a variety of scientific fields of application. In the 2023 Journal Citation Reports (JCR) of Clarivate Web of Science (WoS), the journal has an impact factor (IF) of 4.1, being ranked in the 26th position out of 106 journals in the WoS category of OR-MS (Science Citation Index Expanded (SCIE) edition). The journal also appears under the WoS category of Computer Science, Interdisciplinary Applications (SCIE edition) in the 43rd position out of 169 journals, and Engineering, Industrial (SCIE edition) in the 18th position out of 69 journals.

In 2024, COR celebrated its 50th anniversary. Motivated by this event, the paper develops a general bibliometric overview of the most significant trends that have occurred in the journal during this period. The study aims to identify and visualise the main patterns of the journal, particularly with respect to the publication and citation structure, the most influential articles, the leading authors, institutions, and countries/territories, and the most popular keywords and topics. To this end, the work uses the WoS Core Collection database to collect all the documents published in COR between 1974 and 2023 and analyses the bibliographic material based on a wide range of bibliometric indicators (Cancino et al., 2017; Laengle et al., 2017; Merigó et al., 2018). Additionally, the study also maps graphically the bibliographic data by applying the Visualisation of Similarities (VOS) viewer software (Van Eck and Waltman, 2010). For developing the mapping analysis, the work employs different bibliometric techniques including co-citation (Small, 1973), bibliographic coupling (Kessler, 1963), and co-occurrence of author keywords (Merigó et al., 2018; Wang et al., 2020).

Observe that COR published special anniversary issues, e.g., to celebrate 25 years of analytic hierarchy process (AHP)-based decision making (Wasil and Golden, 2003) and 20 years of tabu search (Gendreau and Hertz, 2006), respectively. In addition, several review papers concerning the existing knowledge and practice in the field of OR-MS have also been included in COR (Mustafee and Katsaliaki, 2020; Schryen and Sperling, 2023). However, no paper has been published providing a general overview of the journal.

It is very common to develop some special activities when a journal celebrates its significant anniversaries (Petropoulos et al., 2024). For example, some journals have published special anniversary issues, including *Operations Research* (Wein, 2002), *Journal of the Operational Research Society* (Williams et al., 2010), *Knowledge-Based Systems* (Fujita and Lu, 2015), *Management Science* (Simchi-Levi, 2021), *International Journal of Production Research* (Dolgui, 2022), *Transportation Research Part E-Logistics and Transportation Review* (Chen et al., 2022), and *International Transactions in Operational Research* (Ribeiro and Bell, 2023), while some other journals have celebrated their anniversaries by publishing remarkable editorials (Barley, 2016; Meredith, 2002; Shugan, 2006) or reviews (Kube et al., 2018; Savelsbergh and Van Woensel, 2016; Van Fleet et al., 2006). Moreover, to attract the attention of readers of a journal, it is also very common to celebrate the anniversary of a remarkable topic (Cárdenas-Barrón et al., 2014; Dubois and Prade, 2015; Kolm et al., 2014; Royston, 2009), institution (Dasgupta, 2010; Hausken, 2024; Martí et al., 2024), or scholar (Emrouznejad et al., 2019; Martello, 2010), with a special issue or some papers published in the journal.

For obtaining a quantitative retrospective evaluation of the leading trends of the journal or related topics, many journals have included a bibliometric analysis to prepare special activities for special anniversaries. A number of related bibliometric studies have already been developed a long time ago. For example, Heck et al. (1986) analysed the publications of the first 40 years of the *Journal of Finance* to identify the contributing authors and institutions, and Schwert (1993) provided a retrospective evaluation of the *Journal of Financial Economics* during the period 1974–1991. This approach is becoming very popular and practical, thanks to the strong technological development of computers and the internet during the last decades (Bar-Ilan, 2008; Cancino et al., 2017). In recent years, Biemans et al. (2007) developed a bibliometric analysis of the first 20 years of the *Journal of Product Innovation Management*, Cobo et al. (2015) commemorated the 25th anniversary of *Knowledge-Based Systems* by analysing the journal between 1991 and 2014. Motivated by a journal's 40th anniversary, Laengle et al. (2017) presented a bibliometric overview of *European Journal of Operational Research*, Wang et al. (2020) of *Omega-International Journal of Management Science*, Modak et al. (2020) of *Computers & Chemical Engineering*, Jiang et al. (2020) of *Transportation Research Part B-Methodological*, Dabić et al. (2021) of *Technovation*, Donthu et al. (2021b) of *International Journal of Information Management*, Verma et al. (2021) of *Applied*

Fig. 1. Procedure of the study based on the SPAR-4-SLR protocol.

Mathematical Modelling, and Goerlandt and Li (2022) of *Risk Analysis*.

To celebrate a journal's 50th anniversary, Martínez-López et al. (2018) conducted a bibliometric analysis of the *European Journal of Marketing*, Merigó et al. (2018) studied the first 50 years of *Information Sciences*, and then Merigó et al. (2024) provided a general bibliometric overview of *Resources Policy*. Furthermore, many other authors have also published bibliometric studies of other journals motivated by a journal's specific anniversary, and these journals include the *Journal of Cleaner Production* (Zou et al., 2017), *International Journal of Computer Integrated Manufacturing* (Laengle et al., 2018), *IEEE Transactions on Fuzzy Systems* (Yu et al., 2018), *International Journal of Production Research* (Silva et al., 2019), *Fuzzy Optimization and Decision Making* (Yu et al., 2019), *Operations Research* (Calma et al., 2021), *Operations Management Research* (Dhiaf et al., 2021), *Journal of International Management* (Kumar et al., 2023), and the *Journal of Risk Research* (Guan et al., 2024).

The rest of the paper is organised as follows. Section 2 briefly describes the bibliometric methodology used throughout the paper. Section 3 presents the publication and citation structure of the journal. Section 4 describes the influential papers of COR. Section 5 presents the leading authors, institutions, and countries/territories publishing in the journal. Section 6 develops a graphical analysis of the bibliographic data of COR by using the VOS viewer software. Section 7 develops a keyword and topical analysis. Section 8 concludes the paper by summarising the main findings and limitations of the study.

2. Bibliometric methods

Bibliometrics, originating from the field of library and information sciences, analyses bibliographic material for data classification and develops representative summaries of leading results by using quantitative

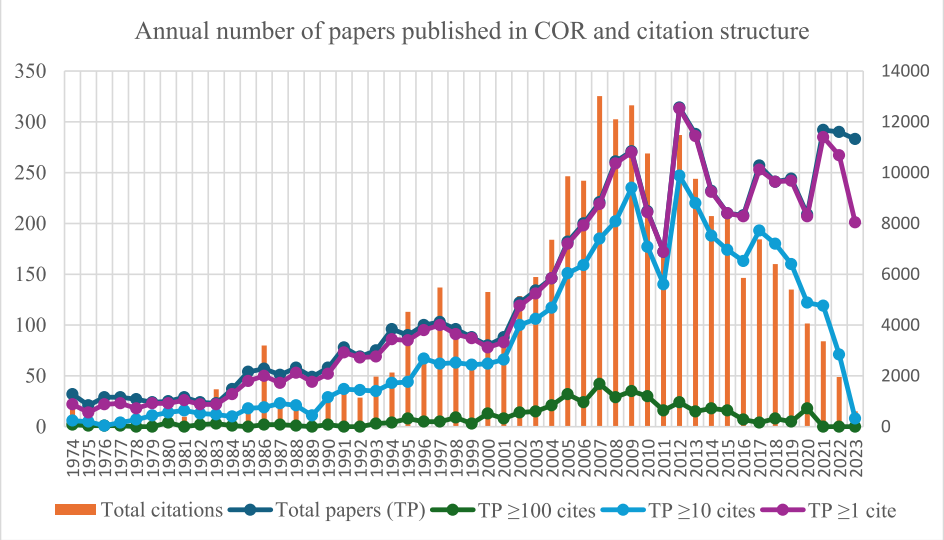

Fig. 2. Annual number of papers published in COR and citation structure.

methods (Broadus, 1987; Pritchard, 1969). One of the key advantages is that it can produce a general overview of a scientific field, journal, institution, or country, based on a wide range of bibliometric indicators, by measuring publication and collaboration patterns, determining the impact of research, comparing the performance, and exploring the intellectual structure (Broadus, 1987; Donthu et al., 2021a). Bibliometric analysis is becoming a fundamental methodology for assessing and analysing academic research output (Cobo et al., 2015), especially motivated by the fast development of computers and the internet that greatly enhance the efficiency of collecting bibliographic information (Bar-Ilan, 2008). In the literature, bibliometric studies are used for many different purposes, including analysing topics (Darko et al., 2020), journals (Cancino et al., 2017), institutions (Kalaitzidakis et al., 2003; Linton, 2004), authors (Coupé, 2003; Podsakoff et al., 2008), or countries/territories (Merigó et al., 2016).

In the fields of OR-MS and Computer Science, a wide range of bibliometric studies have been developed in connection with methods, models, algorithms, techniques, and applications. For example, Shang et al. (2015) and Thomé et al. (2016) developed a bibliometric analysis in the field of operations management, Merigó and Yang (2017), Liao et al. (2019), and Laengle et al. (2020), on the field of OR-MS. In supply chain management (SCM), Mishra et al. (2018) and Ben-Daya et al. (2019) reviewed the Big Data research and the Internet of Things research in SCM, respectively, by using the techniques of bibliometrics and network analysis. Fahimnia et al. (2015a) studied the topic of green SCM, and Garcia-Buendia et al. (2021) of lean SCM. Additionally, Fahimnia et al. (2015b) presented a systematic review of the quantitative and analytical models for managing supply chain risks. Kaffash et al. (2021) studied from a bibliometric perspective the Big Data algorithms and applications in intelligent transportation systems, Kriouich and Sarir (2024), the application of artificial intelligence in production scheduling problems, and Colapinto and Mejri (2024), the goal programming model variants that have been applied to multi-dimensional financial portfolio selection problems. Some other specific topics have also been studied through a bibliometric analysis, including linguistic decision making (Liao et al., 2020), correlation clustering (Wahid and Hassini, 2022), multi-criteria classification, sorting, and clustering (Amor et al., 2023), grey system theory research (Yin, 2013), AHP (Pereira and Bamel, 2023; Yu et al., 2021), data envelopment analysis (Lampe and Hilgers, 2015; Panwar et al., 2022; Zhou et al., 2018), and ant colony optimisation (Deng and Lin, 2012).

COR has also recently published several bibliometric-related studies on different aspects of Operations Research. Júnior et al. (2022) presented a bibliometric overview of the rectangular two-dimensional strip packing problem and provided a useful foundation in real-life practical constraints and opportunities for supporting future research in this field. Based on bibliometric and systematic review methods, Minas et al. (2020) undertook a comprehensive survey of emergency response operations, and Pinto et al. (2024) provided in-depth analyses of nesting and scheduling problems in the context of additive manufacturing. Mara et al. (2022) studied the developments and applications of adaptive large neighbourhood search algorithms with a bibliometric analysis, Camacho-Vallejo et al. (2024), the evolution of metaheuristics that solve bilevel programming problems, and Ying et al. (2024), the development trajectory of parallel machine scheduling problems.

This study focuses on a thorough bibliometric analysis of the research conducted by COR over the past 50 years from 1974 to 2023. The methodology provides an effective way to quantitatively analyse the bibliographic material of the journal from a macro perspective. By using a diverse range of bibliometric indicators (Ding et al., 2014; Donthu et al., 2021a; Garfield, 1955; Merigó et al., 2018), various bibliometric issues of the journal are investigated to identify the key elements and influences most associated with COR, including the publication and citation structure, most cited papers, leading authors, institutions, countries/territories, supranational regions, keywords, topics, and patterns of the temporal evolution. The aim of using bibliometric indicators is to provide a representative and informative view of the available bibliographic data (Cancino et al., 2017). However, today there is no consensus on the optimal indicator to represent the information (Ding et al., 2014). Therefore, the study considers several indicators for evaluating the same variable, intending to have a complete picture when assessing the bibliographic data. It is worth noting that the rankings of the same variable can be different given the specific indicator used. The work provides flexibility to readers for interpreting the data aligning with their own interests and at the same time identifying strengths and opportunities of the journal. Among others, some of the most popular indicators are used in this paper such as the total number of publications, the total number of citations, the citations per paper ratio, the *h*-index (Hirsch, 2005), citation thresholds (Merigó et al., 2018), citing articles, and highly cited papers (Liao et al. 2019).

In general, productivity and influence are two main characteristics to evaluate research (Hirsch, 2005; Podsakoff et al. 2008). Productivity is usually measured by the number of publications, while influence is evaluated by the number of citations (Merigó et al. 2018). The *h*-index (Hirsch, 2005) is an indicator that combines the aspects of productivity

Table 1
Annual citation structure of COR.

Year	TP	TC	≥500	≥200	≥100	≥50	≥20	≥10	≥5	≥1	T50	HCP
1974	32	872	0	2	2	3	4	6	11	22	2	–
1975	21	252	0	0	1	2	2	5	5	14	0	–
1976	29	197	0	0	1	0	1	1	7	22	0	–
1977	29	306	0	0	1	1	3	4	8	23	0	–
1978	27	217	0	0	0	1	2	7	13	18	0	–
1979	24	295	0	0	0	1	5	11	12	23	0	–
1980	25	880	0	0	4	5	9	14	18	23	0	–
1981	29	392	0	0	0	0	5	16	21	26	0	–
1982	24	847	0	2	2	3	6	13	15	22	1	–
1983	23	1,472	1	1	3	4	6	12	16	22	1	–
1984	37	610	0	1	1	2	7	10	15	32	1	–
1985	54	592	0	0	0	3	12	18	30	45	0	–
1986	57	3,195	1	1	2	5	12	19	30	50	1	–
1987	51	875	0	0	2	3	13	23	29	43	0	–
1988	58	896	0	0	1	5	11	21	35	53	0	–
1989	49	449	0	0	0	1	6	11	30	44	0	–
1990	58	1,226	0	1	2	4	19	29	38	52	0	–
1991	78	1,294	0	0	0	8	24	37	43	73	0	–
1992	69	1,147	0	0	0	6	21	36	42	68	0	–
1993	75	1,974	1	1	3	8	19	35	53	69	1	–
1994	96	2,133	0	1	4	9	28	43	57	86	0	–
1995	90	4,519	2	2	8	19	34	44	67	85	2	–
1996	100	2,887	0	1	5	17	42	67	80	95	0	–
1997	103	5,480	1	3	5	18	43	62	79	100	2	–
1998	96	3,479	0	1	9	23	46	63	73	91	1	–
1999	88	2,665	0	0	3	20	42	61	76	87	0	–
2000	80	5,301	3	5	13	21	45	62	71	78	4	–
2001	88	3,477	0	3	8	20	50	66	76	83	0	–
2002	122	5,139	0	3	14	30	77	100	111	119	0	–
2003	134	5,890	0	3	15	15	40	106	116	131	2	–
2004	146	7,357	1	6	21	43	86	117	131	146	3	–
2005	182	9,860	1	5	32	60	123	151	172	180	1	–
2006	200	9,681	0	8	24	63	130	159	181	198	2	–
2007	221	13,015	1	10	42	81	136	185	202	219	4	–
2008	261	12,100	1	6	29	80	157	202	240	259	4	–
2009	271	12,648	0	5	35	82	187	235	260	270	1	–
2010	212	10,757	0	6	30	68	139	177	199	211	4	–
2011	172	6,921	0	0	16	51	106	140	165	172	0	–
2012	314	11,483	0	5	24	67	163	247	286	313	5	–
2013	288	9,756	0	2	15	48	161	220	257	286	2	–
2014	232	8,290	0	0	18	54	139	188	216	231	0	0
2015	210	8,323	0	4	16	53	127	174	193	210	2	4
2016	208	5,857	0	0	7	28	109	163	194	207	0	0
2017	257	7,374	0	0	4	30	133	193	229	253	2	2
2018	241	6,399	0	1	8	23	111	180	218	241	1	1
2019	244	5,400	0	0	5	28	91	160	207	242	0	1
2020	209	4,061	1	3	18	50	57	122	169	207	1	2
2021	292	3,361	0	1	0	4	50	119	195	285	0	1
2022	290	1,955	0	0	0	1	14	71	147	267	0	1
2023	283	604	0	0	0	0	2	8	36	201	0	2
74–83	263	5,730	1	5	14	20	43	89	126	215	4	–
84–93	586	12,258	2	4	11	45	144	239	345	529	3	–
94–03	997	40,970	6	22	84	192	447	674	806	955	11	–
04–13	2,267	103,578	4	53	268	643	1,388	1,833	2,093	2,254	26	–
14–23	2,466	51,624	1	9	76	271	833	1,378	1,804	2,344	6	14
Total	6,579	214,160	14	93	453	1,171	2,855	4,213	5,174	6,297	50	14
%	100 %	–	0.21 %	1.41 %	6.9 %	17.8 %	43.4 %	64.0 %	78.6 %	95.7 %	–	–

Abbreviations: TP and TC = Total papers and citations; ≥500, ≥200, ≥100, ≥50, ≥20, ≥10, ≥5, ≥1 = Number of papers with equal or more than 500, 200, 100, 50, 20, 10, 5 and 1 citations; T50 = Number of papers in Table 4; HCP = Number of papers selected by WoS – ESI as Highly Cited Papers in the research field of Computer Science.

and influence to represent the importance of a set of documents. That is, if a set of documents has an *h*-index of *X*,then the *X* number of documents in this set have received at least *X* number of citations each. Furthermore, this means that there are no $X + 1$ documents that have received $X + 1$ citations or more. Note that the *h*-index has been extended and generalised by many authors since its introduction (Alonso et al., 2009). Several citation thresholds (Cancino et al., 2017) are used in the study to identify the number of documents that have reached a specific number of citations (i.e., a certain level of influence), for example, 10, 50, or 100 citations. The citation threshold indicator helps to prepare a comparative analysis of quality contributions. The citing articles are those that cite the material considered in the analysis, in this case, the COR publications, which can be studied from the aspects of citing authors, institutions, countries/territories, or academic journals to specifically identify the origin of the journal's citations.

Additionally, the work analyses the highly cited papers in a specific group of documents based on either the higher number of citations received (e.g., the top 50 most cited papers) or the modern and dynamic approach followed by WoS. The Essential Science Indicators (ESI) is an analytical sub-database of WoS, containing papers that enter the top 1 % of sum citations of a research field based on a highly cited threshold for the field and publication year. The time period for counts considered by

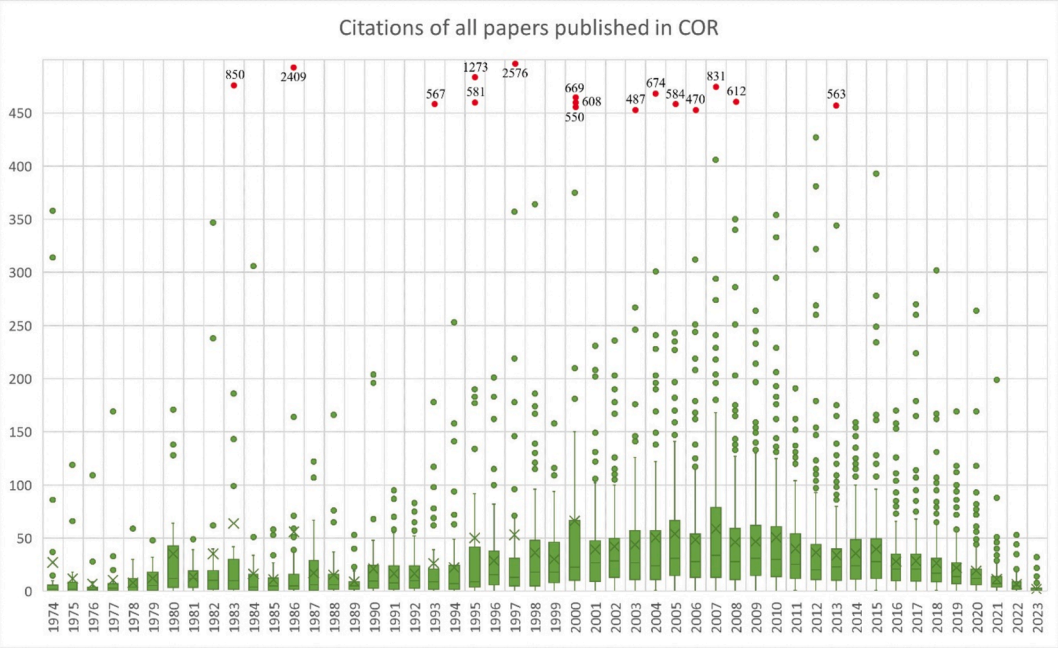

Fig. 3. Annual box-whisker plot structure of the citations of all papers published in COR.

WoS – ESI is 10 years, plus partial year counts for the current year (data is updated every two to four months), and only papers from journals covered by WoS Core Collection are counted (Clarivate, 2024). Currently, only the documents published between 2014 and 2024 are considered by WoS – ESI. Through analysing the highly cited papers that are of high quality in a specific group or a certain field, the development and influence of some noted scholars, institutions, countries/territories, or academic journals can be evaluated (Liao et al., 2019).

The study considers some other bibliometric indicators to better develop informative summaries of the leading results. For example, the IF, originally developed by Garfield and Sher (1963), is the most well-known journal metric to evaluate the research quality and impact of a particular journal. Note that this information is covered in the JCR of WoS. The IF of a journal in year n is calculated by dividing the number of citations in year n received by the documents published in years n–1 and n–2 by the number of documents published in years n–1 and n–2. In recent years, there have been many criticisms of the IF, especially because it can be easily manipulated and heavily depends on the research field (Mingers and Yang, 2017; Stonebraker et al., 2012). WoS has also introduced the 5-year IF as an alternative measure of a journal's quality considering the citations received between years n–1 and n–5. Moreover, several other indicators calculated from data indexed in the WoS Core Collection database and published by JCR have also been included in the study for analysing academic journals, including the (average) IF percentile, IF quartile, immediacy index, and article influence score. The immediacy index is simply a 1-year IF, that is, the mean citations in year n to the documents published in year n. The article influence score measures the average influence, per article, of the works published in a particular journal.

In addition, the CiteScore obtained from the Scopus database is used as another supplement to evaluate a journal's quality. The value of CiteScore in year n represents the yearly average citations to the documents of a journal published between years n–3 and n. In particular cases, the study uses other indicators including the ratio of citations per year that measures the average yearly influence of a document, the university rankings for analysing institutions, and the publications/citations per million inhabitants for analysing countries/territories and supranational regions.

This work mainly uses the WoS Core Collection database in the search process of the bibliographic data for the bibliometric analysis of COR's performance over 50 years of publication. The search process was carried out between May and July 2024. The keyword 'Computers Operations Research' is used under the 'Publication Titles' option to retrieve all the documents published in COR, and this initial search obtains 6,830 documents. To consider the documents published in the journal between 1974 and 2023, the search then selects 'show Final Publication Year' and excludes the publications of 2024, resulting in a total of 6,671 documents. Further, we apply an additional filter of 'Document Types' by selecting only 'Article' and 'Review Article', with the aim of focusing only on research contributions. This produces a result of 6,506 documents. However, the journal publications in 1974 and 1975 and some of the publications in 1976 are not directly available in the database. To solve this problem, the cited reference search in the WoS Core Collection database is used to identify all the articles and reviews published between 1974 and 1976 that have received at least one citation. Moreover, for those publications in the period 1974–1976 that have not received any citations, they are tracked by searching the webpage of the journal. Therefore, 73 documents are extracted from the indirect search. As a result, a total of 6,579 documents are obtained for the study. Up to May 2024, the journal has received 214,160 citations from other documents available in WoS, making an average number of citations per paper of 32.55. The h-index is 164, indicating that of the set of 6,579 documents, 164 have received 164 citations or more, but at the same time, there are not 165 documents that have received 165 citations or more.

In the particular cases of obtaining the CiteScore values of the leading journals in OR-MS and other related fields (as shown in Table 3) and analysing the leading topics and topic clusters in COR (as shown in Tables 16 and 17), we collect the data indexed in the Scopus database. Note that the topics and topic clusters that COR has contributed to between 2013 and 2022 are retrieved through the SciVal platform in Scopus (SciVal, 2024).

To more deeply analyse the bibliometric results, the study develops a graphical mapping of the bibliographic material by using the VOS viewer software. Although several other software tools can be alternatively used for mapping bibliographic data (Cobo et al., 2011; Donthu et al., 2021a), the VOS viewer, originally designed by Nees Jan van Eck and Ludo Waltman (Van Eck and Waltman, 2010) from Leiden

Table 2
Analysis of COR in the JCR of the WoS.

Year	TC-CI	IF	5YIF	ImIn	CI	AIS	AJIF	ROR	Q	POR	RCS	Q*	PCS	REI	Q+	PEI
1997	502	0.41	–	0.04	0	–	59.01	17/39	Q2	57.69	29/63	Q2	54.76	9/24	Q2	64.58
1998	506	0.24	–	0.01	96	–	38.31	31/44	Q3	30.68	46/71	Q3	35.92	16/30	Q3	48.33
1999	552	0.31	–	0.00	88	–	48.69	27/50	Q3	47.00	49/76	Q3	36.18	12/31	Q2	62.90
2000	548	0.33	–	0.00	80	–	42.77	34/51	Q3	34.31	57/75	Q4	24.67	10/31	Q2	69.35
2001	634	0.37	–	0.04	88	–	45.40	30/53	Q3	44.34	51/76	Q3	33.55	13/30	Q2	58.33
2002	768	0.44	–	0.02	122	–	44.62	33/54	Q3	39.81	49/80	Q3	39.38	15/32	Q2	54.69
2003	960	0.48	–	0.02	134	–	44.02	31/57	Q3	46.49	59/83	Q3	29.52	15/33	Q2	56.06
2004	1,049	0.56	–	0.07	146	–	50.50	26/56	Q2	54.46	52/83	Q3	37.95	14/33	Q2	59.09
2005	1,366	0.74	–	0.04	199	–	58.51	21/56	Q2	63.39	47/83	Q3	43.98	11/33	Q2	68.18
2006	1,765	0.89	–	0.20	183	–	69.31	17/60	Q2	72.50	39/87	Q2	55.75	7/32	Q1	79.69
2007	2,402	1.14	1.42	0.13	221	0.72	76.92	12/60	Q1	80.83	34/92	Q2	63.59	5/33	Q1	86.36
2008	3,389	1.36	1.78	0.31	261	0.67	71.95	17/64	Q2	74.22	34/94	Q2	64.36	8/33	Q1	77.27
2009	5,033	2.11	2.44	0.35	271	0.84	88.27	9/73	Q1	88.36	19/95	Q1	80.53	2/37	Q1	95.95
2010	4,846	1.76	2.25	0.39	212	0.88	78.19	19/75	Q2	75.33	26/97	Q2	73.71	6/38	Q1	85.53
2011	4,822	1.72	1.98	0.22	172	0.96	79.90	10/77	Q1	87.66	33/99	Q2	67.17	7/43	Q1	84.88
2012	5,810	1.90	2.37	0.35	314	1.02	83.32	10/79	Q1	87.97	26/100	Q2	74.50	6/44	Q1	87.50
2013	6,379	1.71	2.33	0.25	285	0.93	74.20	19/79	Q1	76.58	33/102	Q2	68.14	10/43	Q1	77.91
2014	7,363	1.86	2.45	0.35	232	0.97	76.48	19/81	Q1	77.16	29/102	Q2	72.06	9/43	Q1	80.23
2015	7,545	1.98	2.38	0.44	210	0.90	74.42	19/82	Q1	77.44	32/104	Q2	69.71	11/44	Q1	76.14
2016	9,172	2.60	2.82	0.51	208	0.96	77.53	16/83	Q1	81.33	29/105	Q2	72.86	10/44	Q1	78.41
2017	11,297	2.96	3.17	0.80	257	1.02	79.73	15/84	Q1	82.74	25/105	Q1	76.67	10/47	Q1	79.79
2018	12,444	3.00	3.43	1.01	241	0.90	71.84	20/84	Q1	76.79	32/106	Q2	70.28	15/46	Q2	68.48
2019	13,591	3.42	3.80	0.76	244	1.01	72.14	21/83	Q2	75.30	34/109	Q2	69.27	14/48	Q2	71.88
2020	16,462	4.00	4.45	1.08	209	1.12	67.49	25/84	Q2	70.83	39/111	Q2	65.32	17/49	Q2	66.33
2021	18,486	5.15	5.21	1.00	364	1.10	69.92	20/87	Q1	77.59	35/112	Q2	69.20	19/50	Q2	63.00
2022	18,281	4.6	5.0	0.9	286	1.15	67.8	24/86	Q2	72.7	36/110	Q2	67.7	19/50	Q2	63.0
2023	16,520	4.1	4.5	0.8	289	1.17	75.1	26/106	Q1	75.9	43/169	Q2	74.9	18/69	Q2	74.6

Abbreviations: TC-CI = Total citations received by any citable item indexed in WoS; IF = Impact factor; 5YIF = 5-year impact factor; ImIn = Immediacy index; CI = Citable items; AIS = Article influence score; AJIF = Average journal impact factor percentile; ROR = Ranking by journal impact factor in the WoS category of Operations Research & Management Science (OR-MS); Q = Journal impact factor quartile in OR-MS; POR = Journal impact factor percentile in OR-MS; RCS = Ranking by journal impact factor in the WoS category of Computer Science, Interdisciplinary Applications (CS-IA); Q* = Journal impact factor quartile in CS-IA; PCS = Journal impact factor percentile in CS-IA; REI = Ranking by journal impact factor in the WoS category of Engineering, Industrial (EI); Q+ = Journal impact factor quartile in EI; PEI = Journal impact factor percentile in EI.

University (Netherlands), is widely recognised as a strong analytical package in the field of bibliometrics. It can collect bibliographic information from databases such as WoS or Scopus and construct graphical maps representing bibliometric networks of authors, documents, journals, institutions, countries/territories, keywords, or terms based on co-authorship, citation, co-citation, bibliographic coupling, or co-occurrence relationships. When visualising the bibliometric networks, the size of a node increases with an item's relevance, and the strength of a network link depends on how closely related the linked items are (Laengle et al., 2017; 2018). Moreover, the items can be divided into different groups based on the VOS viewer clustering method, and the clusters are represented by different colours and usually located in different areas within a network.

In this paper, we focus on the graphical visualisation of the bibliometric results of COR using techniques regarding co-citation, bibliographic coupling, and co-occurrence of author keywords. Co-citation (Small, 1973) occurs when two documents receive a citation from the same third document. As the focus of co-citation is on the information provided by the references of the documents, this approach is also applicable to the co-citation analysis of journals and authors. Bibliographic coupling (Kessler, 1963) measures the documents that cite the same references. Two documents are considered to be bibliographically coupled if they cite one or more documents in common. This work implements the bibliographic coupling for analysing documents, authors, institutions, and countries/territories with time information. Co-occurrence of author keywords analyses pairs of keywords that appear more frequently in the same documents (Laengle et al., 2017; Merigó et al., 2018), which is commonly utilised in identifying established and emerging research themes or tracing the patterns of evolution with time (Wang et al., 2020). Note that the current study considers the author keyword list of COR publications, usually available on the title page of most of the articles, for the co-occurrence of author keyword analysis.

To summarise the methodological approach followed in this article, Fig. 1 presents the scientific procedures and rationales for systematic literature reviews (SPAR-4-SLR) approach followed in this bibliometric study (Donthu et al., 2021a; Paul et al., 2021).

3. Publication and citation structure of COR

The first issue of COR was published in March 1974, and the journal grew significantly through time. Fig. 2 displays the temporal evolution of annual number of papers published in COR from 1974 to 2023. Additionally, it also shows the total number of citations that these documents have achieved up to July 2024 and three representative citation thresholds that visualise the number of documents above a citation threshold and compared to the total number of articles published in a specific year.

From a general perspective, the productivity of COR has shown a significant uptrend over its entire lifetime, indicating that the journal has been attracting more and more attention in the scientific community. The specific annual number of COR publications every year between 1974 and 2023 is also presented in Table 1.

During the first decade, the journal was publishing 20–30 papers per year until 1984 when it started to grow very quickly. In the nineties, the number of papers published per year increased to around 100 and in the first decade of the millennium, to around 250. The significant expansion of the journal especially since 2002 can be explained by two main factors. Firstly, the number of researchers worldwide in the OR-related fields has increased exponentially, which contributes to a huge number of submissions to the journal. Secondly, the strong development of computer technologies and the internet facilitates collecting a greater volume of information and tracking the newest trends in the fields more rapidly (Merigó et al., 2018). Observe that the annual number of publications dropped dramatically during the 2009–2011 period (from 271 papers published in 2009 to 172 in 2011), but the journal subsequently reached a peak of 314 publications in 2012. During the last 10 years, the

Table 3
Publication record of leading journals in OR-MS and other related fields.

R	OR-MS	H20	P20	C20	C/P20	H	TP	TC	C/P	HCP	≥500	YW	Y	IF	5YIF	AIS	CS
1	Eur J Oper Res	238	12,686	510,125	40.21	293	19,134	814,689	42.58	114	103	1978	1977	6.0	5.9	1.443	11.9
2	Manag Sci	206	4,281	240,229	56.12	332	8,507	643,688	75.67	60	180	1954	1954	4.6	6.1	3.716	8.8
3	Int J Prod Econ[1]	198	5,696	285,022	50.04	209	8,182	347,403	42.46	120	37	1976	1976	9.8	10.3	1.849	21.4
4	Int J Prod Res	159	7,560	237,080	31.36	177	11,677	341,148	29.22	83	17	1977	1961	7.0	8.3	1.472	19.2
5	Comput Oper Res	148	4,733	158,841	33.56	164	6,506	217,087	33.37	14	14	1976	1963	4.1	4.5	1.174	8.6
6	Omega-Int J Manag Sci	140	1,998	102,043	51.07	161	3,592	146,260	40.72	36	23	1974	1973	6.7	7.0	1.584	13.8
7	Oper Res	126	2,018	82,937	41.10	222	5,870	296,761	50.56	4	58	1956	1952	2.2	3.2	1.875	4.8
8	Math Program	114	2,109	76,796	36.41	173	4,250	197,072	46.37	12	38	1975	1971	2.2	3.3	2.320	5.7
9	SIAM J Optim	113	1,912	71,010	37.14	148	2,621	129,857	49.54	39	33	1991	1991	2.6	3.2	2.356	5.3
10	Annals Oper Res	100	4,764	92,509	19.42	120	6,876	127,096	18.48	27	10	1991	1984	4.4	4.4	0.860	7.9
11	J Oper Res Soc[2]	89	3,099	62,341	20.12	134	6,960	156,403	22.47	6	13	1956	1950	2.7	3.0	0.645	6.8
12	Decision Sci	84	685	31,347	45.76	125	1,553	76,616	49.33	3	17	1984	1970	2.8	4.7	1.301	12.4
13	J Optim Theory Appl	77	3,444	50,863	14.77	120	6,958	128,628	18.49	3	12	1973	1967	1.6	1.8	0.831	3.3
14	J Global Optim	74	2,444	44,472	18.20	99	3,079	90,731	29.47	2	8	1993	1991	1.3	1.8	0.722	3.6
15	Comput Optim Appl	69	1,600	27,427	17.14	82	1,926	37,822	19.64	0	2	1997	1992	1.6	2.0	1.099	3.7
16	INFORMS J Comput[3]	69	1,215	22,638	18.63	80	1,408	30,905	21.95	0	2	1999	1989	2.3	2.6	1.250	4.2
17	OR Spectrum	66	729	19,182	26.31	77	1,269	28,077	22.13	1	2	1983	1979	1.4	2.3	0.646	4.9
18	Math Oper Res	65	1,168	22,907	19.61	115	2,583	79,047	30.60	7	15	1980	1976	1.4	1.8	1.428	3.4
19	Oper Res Letters	62	2,360	27,221	11.53	91	3,671	58,895	16.04	0	5	1983	1981	0.8	1.1	0.502	2.1
20	Eng Optim	61	1,757	30,424	17.32	72	2,340	38,933	16.64	1	1	1977	1974	2.2	2.3	0.481	5.9
21	Naval Res Logist[4]	57	1,057	24,376	23.06	93	3,205	66,637	20.79	1	3	1964	1954	1.9	2.1	0.703	4.2
22	Int Trans Oper Res	54	1,180	18,407	15.60	54	1,272	18,455	14.51	1	1	2009	1994	3.1	3.2	0.611	7.8
23	J Scheduling	53	801	15,599	19.47	58	890	18,730	21.04	0	3	2001	1998	1.4	1.7	0.490	3.8
24	Optim Letters	51	1,909	19,070	9.99	51	1,971	19,091	9.69	12	0	2007	2007	1.3	1.4	0.630	3.4
25	INFORMS J Appl Analyt[5]	45	718	10,124	14.10	82	2,564	41,913	16.35	0	4	1974	1970	1.1	1.3	0.406	3.2
26	J Comb Optim	43	2,155	16,399	7.61	49	2,325	19,979	8.59	4	0	1997	1997	0.9	0.9	0.329	2.0
27	Math Methods Oper Res	41	893	9,793	10.97	51	1,301	16,503	12.68	0	0	1997	1956	0.9	1.0	0.517	1.9
28	4OR-Q J Oper Res	38	378	5,819	15.39	40	412	6,468	15.70	0	0	2003	2003	1.7	2.0	0.634	3.8
29	Central Eur J Oper Res	37	780	8,436	10.82	37	818	8,488	10.38	1	0	2007	2006	1.4	1.8	0.396	4.7
30	RAIRO-Oper Res[6]	32	1,435	7,917	5.52	38	2,046	11,854	5.79	0	0	1977	1968	1.8	1.6	0.295	3.6
31	TOP	32	487	5,354	10.99	32	499	5,355	10.73	0	0	2006	1993	1.5	1.4	0.554	3.7
32	Asia-Pacific J Oper Res	29	1,014	6,846	6.75	34	1,334	8,805	6.60	2	0	1987	1984	1.1	1.1	0.240	2.0
33	SORT-Stat Oper Res Trans	24	215	1,914	8.90	24	215	1,914	8.90	1	0	2007	1977	0.7	1.2	0.497	3.1
34	Military Oper Res	13	312	964	3.09	15	328	1,040	3.17	0	0	2003	1994	0.5	0.5	0.142	0.4
	ComputSci & Eng & Math																
1	J Clean Prod	295	36,410	1,527,711	41.96	297	36,548	1,538,351	42.09	1,230	77	2002	1993	9.7	10.2	1.593	20.4
2	Expert Syst Appl	236	17,894	618,894	34.59	239	18,791	636,990	33.90	228	42	1991	1990	7.5	7.6	1.331	13.8
3	Inform Sci[7]	204	12,578	430,836	34.25	220	14,902	496,883	33.34	178	54	1968	1968	8.1	7.5	1.399	14.0
4	Appl Soft Comput	179	9,405	304,638	32.39	179	9,405	304,638	32.39	115	16	2004	2001	7.2	7.0	1.282	15.8
5	IEEE T Evol Comput	169	1,299	138,940	106.96	192	1,470	212,820	144.78	76	55	1999	1997	11.7	15.5	4.185	21.9
6	Appl Math Comput	158	19,405	377,340	19.45	167	22,567	424,125	18.79	339	16	1980	1975	3.5	3.1	0.813	7.9
7	Int J Adv Manuf Tech	142	22,814	406,645	17.82	146	24,630	435,943	17.70	37	7	1993	1985	2.9	3.2	0.494	5.7
8	Comput Ind Eng	139	7,238	198,444	27.42	146	10,428	237,389	22.76	48	8	1976	1976	6.7	6.7	1.214	12.7
9	Appl Math Model	133	8,626	210,116	24.36	137	10,380	236,215	22.76	27	4	1977	1976	4.4	4.2	0.891	9.8
10	Comput Chem Eng	122	5,165	134,793	26.10	163	8,827	239,955	27.18	6	14	1977	1977	3.9	3.8	0.704	8.7
11	J Intell Manuf	91	2,102	56,874	27.06	97	2,886	67,874	23.52	15	2	1990	1990	5.9	6.4	1.134	19.3
12	IISE Trans[8]	83	1,684	39,783	23.62	113	3,352	86,269	25.74	4	3	1978	1969	2.0	2.8	0.817	5.7
13	J ACM	83	726	34,740	47.85	211	2,984	213,121	71.42	0	73	1954	1954	2.3	3.0	2.128	7.5
14	Discret Appl Math	68	6,364	58,017	9.12	106	9,017	115,472	12.81	0	5	1979	1979	1.0	1.0	0.485	2.3
15	Networks	56	1,072	16,858	15.73	94	2,174	51,403	23.64	2	5	1976	1971	1.6	3.7	1.401	4.4
16	J Heuristics	50	573	12,767	22.28	61	726	19,470	26.82	0	3	1998	1995	1.1	1.9	0.500	5.8

(*continued on next page*)

Table 3 (*continued*)

R	OR-MS	H20	P20	C20	C/P20	H	TP	TC	C/P	HCP	≥500	YW	Y	IF	5YIF	AIS	CS
	Transportation																
1	Transp Res C-Emerg Tech	161	3,575	166,135	46.47	170	3,778	181,966	48.16	82	16	1995	1993	7.6	9.6	2.388	15.8
2	Transp Res B-Meth	149	2,376	122,478	51.55	173	3,249	181,687	55.92	20	24	1979	1979	5.8	7.2	2.281	12.4
3	Transp Res E-Logist	128	2,628	105,676	40.21	136	2,794	115,483	41.33	37	6	1997	1997	8.3	9.2	1.937	16.2
4	Transp Sci	98	1,067	49,579	46.47	140	1,732	90,841	52.45	18	11	1980	1967	4.4	5.5	2.105	8.3

Abbreviations: R = Rank; J = Journal; H20, C20, P20 and C/P20 = H-index, citations, publications, and citations per paper between 2004 and 2023; H, TC, TP and C/P = H-index, citations, publications and citations per paper available in WoS; HCP = Highly Cited Papers; ≥500 = Number of papers with equal or more than 500 citations; YW = The first year directly available in WoS; Y = Year of origin; IF = Impact factor 2023 (WoS); 5YIF = 5-year impact factor 2023 (WoS); AIS = Article influence score 2023 (WoS); CS = CiteScore 2023 (Scopus). The numbers provided in the table only consider the 'Article' and 'Review Article' document types in WoS up to 31 December 2023.

[1] The International Journal of Production Economics was formerly known as Engineering Costs and Production Economics (previously, Engineering and Process Economics).
[2] The Journal of the Operational Research Society was formerly known as Operational Research Quarterly.
[3] The INFORMS Journal on Computing was formerly known as ORSA Journal on Computing.
[4] Naval Research Logistics was formerly known as Naval Research Logistics Quarterly.
[5] The INFORMS Journal on Applied Analytics was formerly known as Interfaces.
[6] RAIRO-Operations Research was formerly known as RAIRO-Recherche Opérationnelle.
[7] The IF and 5YIF of Information Sciences are from the 2022 JCR, because the information is not available in the 2023 JCR.
[8] IISE Transactions was formerly known as IIE Transactions (previously, AIIE Transactions).

number of papers published annually has decreased slightly and currently becomes almost 300 per year. By decade, the number of papers published in COR is 263 (1974–1983), 586 (1984–1993), 997 (1994–2003), 2267 (2004–2013), and 2466 (2014–2023). The annual publications are expected to continue growing with the increasing number of submissions that the journal receives from all over the world.

For a more in-depth analysis of the publication pattern of COR, we further look into the citation structure of the journal. Following the overview of Fig. 2, Table 1 presents the related results in terms of the number of total citations that the COR publications in each specific year have received and the number of publications in each year that have achieved several specific citation thresholds (i.e., equal or more than one citation, five, 10, 20, 50, 100, 200, and 500 citations). The last two columns of Table 1 show the number of papers published in each year that are recognised among the 50 most cited papers of all-time in the journal and of those that are selected as Highly Cited Papers by WoS – ESI, respectively. Note that the Highly Cited Papers that can be considered in the journal are among the top 1 % most cited papers worldwide in the research field of Computer Science and in the 10-year period from 2014 to 2023.

The results in Table 1 show that the journal has been able to maintain good quality and impact throughout its lifetime by consistently publishing many papers that have been highly cited. For the papers published in each specific year during the first two decades of COR, the number of total citations received has seen a relatively stable increase, achieving more than 1,000 citations for the first time in 1983 and a record in this period with 3,195 citations in 1986. Observe that in the first 20 years of the journal, only three papers have obtained 500 or more citations, and seven papers are among the 50 most cited ones in the journal. An interesting question that arises here is how to account for the inflation effect in publications and citations. Currently, there is no consensus on how to correctly assess this (Petersen et al. 2019). But it is obvious that this aspect should be considered when comparing different years with the information provided in Table 1.

Since the nineties, the number of total citations by year has been growing even more significantly, where it reaches a record of 13,015 citations in 2007. In addition, the papers published in each following specific year until 2013 have also received more than 10,000 citations, except for the publications in 2011 with 6,921 citations. It is worth noting that a majority of highly cited papers have been published in the period between 2000 and 2015, indicating that the journal has made a remarkable improvement in its performance over time. However, there has been a downward trend in the total citations during the last 10 years. The cause of this phenomenon is that the recently published papers still need some time to reach their maximum citation level and get wide recognition within the scientific community. Overall, the journal has 93 articles with 200 or more citations, accounting for 1.4 % of all documents, of which 14 have received 500 or more citations. Almost 7 % of the documents have obtained 100 or more citations, 17.8 % 50 or more, and 43.4 % 20 or more. Over half of the documents have received at least 10 citations, and about 80 % have at least five. Only 4.3 % of the publications have not received any citation until now from the documents indexed in WoS. Note that a total of 14 papers have been selected as Highly Cited Papers in the field of Computer Science during the last decade.

To provide a more specific overview of the citation structure of all the papers published in the journal, we further investigate the distribution of the citations that annual publications have received and the citation-related statistical information. Fig. 3 visualises the annual box-and-whisker plot (Tukey, 1977) structure of all COR publications with respect to their citations. Note that the boxplot structure illustrates the 25th percentile (first quartile), 50th percentile (second quartile), and 75th percentile (third quartile) where the most cited papers for a specific year are. The interquartile range (IQR), that is, the range between the 25th percentile and 75th percentile, represents that the middle 50 % of the set of documents in a specific year are within this range. The larger

Table 4
The 50 most cited papers in COR classified by decades.

R	Author	TP	TC	R	Author	TP	TC
	1974–1983				2004–2013		
1	Taylor III, BW	8	48	1	Laporte, G	24	1,557
2	Lee, SM	6	83	2	Cheng, TCE	21	739
3	Intrator, J	6	21	3	Tang, LX	14	512
4	Golden, BL	5	1,081	4	Mosheiov, G	13	251
5	DeWald, CG	5	14	5	Ruiz, R	12	1,156
6	Ignizio, JP	4	159	6	Cordeau, JF	12	1,116
	1984–1993			7	Martí, R	12	470
1	Golden, BL	12	541	8	Prins, C	11	2,035
2	Ghosh, JB	7	112	9	Escudero, LF	11	270
3	Wells, CE	7	112	10	Cui, YD	11	173
4	Schniederjans, MJ	7	71	11	Pardalos, PM	10	938
5	Ignizio, JP	6	65	12	Gendreau, M	10	841
6	Reeves, GR	6	65	13	Haouari, M	10	674
7	Sherali, HD	6	27	14	Fernández, E	10	592
8	Austin, LM	6	24	15	Langevin, A	10	533
9	De, P	5	97	16	Mladenović, N	10	484
10	Wasil, EA	5	56	17	Puerto, J	10	305
11	Karwan, MH	5	39		2014–2023		
	1994–2003			1	Laporte, G	55	2,346
1	Laporte, G	16	1,018	2	Cordeau, JF	18	618
2	Cheng, TCE	13	431	3	Hao, JK	17	173
3	Kim, SH	11	709	4	Coelho, LC	16	676
4	Gupta, JND	7	407	5	Carrizosa, E	16	222
5	Wang, DW	7	388	6	Gendreau, M	15	739
6	Berman, O	7	311	7	Framiñan, JM	15	500
7	Lee, HW	7	129	8	Vanhoucke, M	15	239
8	Batta, R	6	422	9	Archetti, C	14	337
9	Boctor, FF	6	393	10	Puerto, J	14	135
10	Allahverdi, A	6	310	11	Speranza, MG	13	576
11	Drezner, Z	6	155	12	Iori, M	12	454
12	Kim, S	6	84	13	Sörensen, K	12	374
13	Gendreau, M	5	384	14	Van Woensel, T	11	389
14	Renaud, J	5	366	15	Salhi, S	11	367
15	Mosheiov, G	5	343	16	Dauzère-Pérès, S	11	132
16	Liaw, CF	5	265	17	Ghiani, G	10	385
17	Mehrez, A	5	232	18	Fernandez-Viagas, V	10	358
18	Liao, CJ	5	168	19	Guerriero, F	10	313
19	Martí, R	5	166	20	Fagerholt, K	10	262
20	Lee, CY	5	140	21	Morabito, R	10	209
21	Bruneel, H	5	117	22	Mladenović, N	10	203
22	Wesolowsky, GO	5	113	23	Ernst, AT	10	164
23	Pearn, WL	5	94	24	Gendron, B	10	143
				25	Martí, R	10	142
				26	Goerigk, M	10	102

Abbreviations are available in the previous tables except: C/Y = Citations per year.

the IQR, the wider the spread of the middle 50 % of the data. Additionally, the upper and lower whiskers (each limit extends to the furthest data point in each wing that is within 1.5 times the IQR), the minimum (i.e., shown at the end of the lower whisker), the maximum (i.e., shown at the end of the upper whisker), and the average number of citations per paper regarding each specific year are also displayed in the boxplot. Moreover, in Fig. 3, the single dots that are located outside the whiskers of the boxplot are defined as outliers, representing the highly cited papers in their corresponding publication year. Note that the figure is adjusted to 450 citations, and the red dots denote those highly cited papers with more than 450 citations.

As we can see from Fig. 3, most of the highly cited papers (outliers) are distributed in the years between 1993 and 2020. The top three most cited papers of the journal are from 1997, 1986, and 1995, respectively. The papers published in 2000 have obtained the highest average citations (i.e., a ratio of 66.3 citations per paper). It is worth noting that the largest IQR occurs in 2007, indicating that the citation distribution of the publications in 2007 is currently the most dispersed. Furthermore, the papers published in 2007 have also obtained the highest median regarding the citations (i.e., 34 citations), which means half of the publications in 2007 have received 34 or more citations. The size of IQR during the first two decades and the last five years is relatively small because the citation distributions of the papers published in these periods are more concentrated and around a very low number of citations.

Next, according to the available data provided by JCR in the WoS (Clarivate, 2024), we analyse the evolution of the performance of COR from 1997 to 2023. Table 2 presents the results in terms of several bibliometric indicators for measuring the quality of the journal. The journal-level indicators from WoS considered for the analysis include the total citations that COR has received each year from all journals indexed in the WoS Core Collection database, the number of citable items, the impact factor (IF), the 5-year IF, the immediacy index, the article influence score, the average IF percentile, and the journal's rank, quartile, and percentile by the IF in the three WoS categories of OR-MS, Computer Science, Interdisciplinary Applications (CS-IA), and Engineering, Industrial (EI).

From a general perspective, the influence of COR has grown significantly, especially during the last few years. When the IF of the JCR started in 1997, COR had an IF of 0.417. During the first years, the IF of the journal remained stable and started to increase quickly in 2004. The IF obtained a record of 5.159 in 2021, currently being 4.1. Note that the evolution of the number of citable publications and the tendency of total citations during the period 1997–2023 are consistent with the results of Table 1. The 5-year IF of the journal has also been increasing remarkably from 1.429 in 2007 to 4.5 as of today. The journal's immediacy index

Table 5
Citing articles of COR: Institutions, countries/territories, and journals.

R	Institution	TP	Country/Territory	TP	Journal	TP	Percentage
1	Islamic Azad U	1,879	China	24,295	European J Operational Research	4,816	25.17 %
2	U Tehran	1,241	USA	15,294	Computers Operations Research	4,012	61.67 %
3	CNRS	1,238	Iran	7,024	Computers Industrial Engineering	3,001	32.45 %
4	Chinese Academy Sci	1,174	India	5,611	Int J Production Research	2,381	20.39 %
5	Hong Kong Polytechnic U	1,128	Taiwan	5,322	Expert Systems with Applications	2,194	11.68 %
6	Huazhong U Sci Tech	1,025	Canada	4,922	Annals of Operations Research	1,446	20.99 %
7	Tsinghua U	917	UK	4,501	Applied Soft Computing	1,379	14.66 %
8	Beijing Jiaotong U	861	Spain	4,224	Int J Production Economics	1,349	17.99 %
9	Iran U Sci Tech	818	France	4,194	IEEE Access	1,253	1.66 %
10	Amirkabir U Tech	738	Turkey	3,832	J Operational Research Society	1,250	20.08 %
11	Shanghai Jiao Tong U	720	Germany	3,558	Sustainability	1,214	1.60 %
12	Tongji U	704	Italy	3,316	Int J Advanced Manufact Tech	1,081	4.52 %
13	Northeastern U China	673	Australia	2,777	Transportation Research Part E	899	32.18 %
14	Natl U Singapore	665	Brazil	2,701	Mathematical Problems in Eng	892	4.41 %
15	HEC Montréal	627	South Korea	2,448	J Cleaner Production	839	2.30 %
16	City U Hong Kong	592	Netherlands	1,697	Omega-Int J Management Science	820	22.83 %
17	Beihang U	583	Japan	1,510	Soft Computing	735	8.23 %
18	Polytechnique Montréal	550	Portugal	1,417	Applied Mathematical Modelling	694	6.69 %
19	Natl Taiwan U Sci Tech	539	Belgium	1,361	Mathematics	664	3.88 %
20	Dalian U Tech	526	Poland	1,346	Information Sciences	600	4.09 %
21	Central South U	525	Singapore	1,275	Transportation Science	594	18.28 %
22	U Seville	520	Saudi Arabia	1,222	Applied Sciences Basel	568	1.00 %
23	Southeast U China	516	Malaysia	1,172	Int Trans in Operational Research	525	41.18 %
24	U Lisbon	513	Greece	1,134	Transportation Research Part B	514	18.40 %
25	Xi'an Jiaotong U	494	Mexico	1,009	Transportation Research Part C	478	13.31 %
26	Institut Mines-Télécom (IMT)	481	Denmark	831	Applied Mathematics Computation	472	2.16 %
27	U Montréal	479	Chile	752	INFORMS J Computing	428	30.57 %
28	Sichuan U	476	Norway	748	Reliability Eng System Safety	426	5.67 %
29	Shanghai U	474	Austria	740	J Intelligent Fuzzy Systems	418	3.93 %
30	Georgia Inst Tech	466	Israel	713	RAIRO-Operations Research	415	28.12 %

Abbreviations: TP = Total papers (citing articles); Percentage = Percentage of papers of the journal that cites the COR.

has largely improved since 2016, indicating that the papers recently published in COR are attracting citations more rapidly. In the last five years, the article influence score of COR, roughly analogous to the 5-year IF, has always been greater than 1, revealing that each article in the journal has above-average influence. The journal's average IF percentile, and the rank, quartile, and percentile by the IF under the three WoS categories have been very positive and increasing over time, although its influence during the first years was lower than today. One reason is that with the growth of the WoS database, a large number of journals and documents are indexed, generating many more citations to all the journals, especially those with the highest quality. Moreover, COR has significantly improved its quality over the years and developed into a reputable journal in the scientific community. More specifically, according to the 2023 edition of JCR, COR is ranked in the first quartile by journal IF under the WoS category of OR-MS and in the second quartile for both CS-IA and EI categories, with an average journal impact factor percentile of 75.1.

Another interesting issue is to examine the publication and citation performances of COR compared to the leading journals in the field of OR-MS and other related fields connected to the journal. Table 3 presents the results of 34 leading journals (including COR) in the field of OR-MS, 16 leading journals within the fields of Computer Science, Engineering, and Mathematics, and four top journals specifically in the Transportation field. In the journal selection, apart from including the most reputable journals in these fields, the work has also considered the top citing journals and the highly cited journals of COR that appear in Tables 5 and 14 in the following sections. The main aim of the table is to provide a general performance overview of the journals that are strongly connected to COR. A number of bibliometric indicators are considered for comparing the journal performances, including the *h*-index, the number of publications, the number of citations, and the citations per paper both in the past 20 years (i.e., 2004–2023) and in the period since the first year of the journal available in WoS, as well as the number of papers selected by WoS – ESI as Highly Cited Papers, the number of papers achieving the threshold of 500 citations, IF, 5-year IF, article influence score, and CiteScore (obtained from Scopus). Note that Table 3 ranks the journals according to their *h*-index in the past 20 years, and in case of a tie, the number of total citations of the papers published between 2004 and 2023 is also considered.

All the performance measures show that COR has become a well-established journal and is having a significant impact in the scientific community. Note that in Table 3 COR is among the top five journals in the OR-MS research category and also performs very well in other fields, being in the seventh position among the journals connected to Computer Science, Engineering, or Mathematics and in the third place among the journals specialised in the field of Transportation. Although COR has only 14 papers recognised as Highly Cited Papers by ESI, it has surpassed over half of the total leading journals on this indicator. We can see that for most of the top journals, the WoS Core Collection database almost fully covers their publications. Most of the leading journals have greatly increased the number of their publications within the last two decades and accordingly, they are able to receive more citations and a higher *h*-index. Observe that in the table only eight journals have not yet achieved 10,000 citations when focusing on the papers published in the past 20 years.

In the field of OR-MS, the *European Journal of Operational Research* is identified as the top leading journal, followed by *Management Science*, *International Journal of Production Economics*, and *International Journal of Production Research*. EJOR is the most productive and influential journal in the OR-MS field for the period from 2004 to 2023 and of all time. In terms of the citations per paper ratio, *Management Science* performs the best both in the past 20 years and in an overall timeframe, and COR performs very well being ranked in the ninth position, respectively. In addition, among the OR-MS journals, *Management Science* also obtains the first position regarding the *h*-index and article influence score, and it has the highest number of publications (180 papers) achieving 500 citations. The *International Journal of Production Economics* has the highest number of Highly Cited Papers (120 papers) selected by ESI and occupies the first place with respect to the IF, 5-year IF, and CiteScore. It is worth noting that COR is among the top 10 OR-MS leading journals on

the list in terms of all the performance measures except for the 'article influence score' in which COR obtains the 12th position.

In the fields of Computer Science, Engineering, or Mathematics, the *Journal of Cleaner Production*, *Expert Systems with Applications*, and *Information Sciences* are the top three leading journals on the list. Additionally, the *Journal of Cleaner Production* leads the table with the highest number of publications and citations in the 2004–2023 period and of all time, and it outperforms the other journals regarding the *h*-index (in 2004–2023) and the number of Highly Cited Papers (1,230 papers) as well. It is noticeable that although there are not many papers published in *IEEE Transactions on Evolutionary Computation*, the journal has received a large number of citations, contributing to its leading position regarding several performance measures including the citations per paper ratio, IF, 5-year IF, article influence score, and CiteScore. For most of the measures, COR is ranked around the average among the reputable journals in these fields, but it attains fifth place in terms of the citations per paper ratio of all time.

Among the four recognised journals in Transportation, *Transportation Research Part C-Emerging Technologies* is ranked at the top, followed by *Transportation Research Part B-Methodological*, *Transportation Research Part E-Logistics and Transportation Review*, and *Transportation Science*. Compared to these leading journals, COR is closely followed by *Transportation Research Part B-Methodological* in the ranking and performs well for most of the measures.

4. Influential articles in COR

Since the first issue in 1974, COR has published many influential research articles and reviews on the application of computers and Operations Research techniques in a variety of scientific fields. According to the results found in the WoS Core Collection database, Table 4 provides a list with the 50 most cited papers of all time in the journal. Note that in the case of a tie in the number of citations, the youngest paper appears first in the table. The results are classified in five decades: 1974–1983, 1984–1993, 1994–2003, 2004–2013, and 2014–2023.

The most cited paper in COR was authored by Nenad Mladenović and Pierre Hansen (Mladenović and Hansen, 1997) on exploring the variable neighbourhood search approach to a simple and effective metaheuristic for combinatorial optimization. Currently, this paper has already received more than 2,500 citations and also obtained the highest number of citations per year with 95.41 on average. The second most cited paper was from Fred Glover (Glover, 1986) about discussing the promising future directions for integer programming from the perspective of linking artificial intelligence and operations research. This paper has received over 2,000 citations with an average of 63.39 citations per year. Recall that this is the foundational paper on tabu search, a metaheuristic that has become very popular in the last years. It is worth noting that these two papers are also among the 200 most cited papers in OR-MS (Merigó and Yang, 2017). An important proportion of the highly cited papers focuses on the application of genetic algorithms, particle swarm optimization, and heuristics/metaheuristics to vehicle routing or flowshop scheduling problems. Many other topics are also included in the list, such as multicriteria decision-making, mathematical programming, neural networks, machine learning, and multi-objective optimisation.

Most of the highly cited studies are from the first two decades of the millennium, two from the starting year 1974, four from the 1980 s, and six from the 1990s, indicating that the influence of COR's publications has improved along with time. Note that the most recent study among the top 50 most frequently cited papers was published in 2020 by Rohit Sharma and other co-authors (Sharma et al., 2020). It has received an average of 66 citations per year. The year 2012 leads the list with five publications, followed by the years 2007, 2008, and 2010 with four each. 17 papers have obtained more than 30 citations per year; however, only six papers are from the last 10 years. Obviously, the influence of contributions of recent publications still needs some time to catch up. Additionally, among the 50 most influential papers in the journal, eight of them are with one author, while the remaining papers are co-authored work. Note that Bruce L. Golden and Arjang Assad (Bodin et al., 1983; Golden et al., 1984), Christian Prins (Prins, 2004; Vidal et al. 2013), John E. Beasley (Chang et al., 2000; Chu and Beasley, 1997), and Teodor G. Crainic (Hemmelmayr et al., 2012; Vidal et al. 2013), have published two documents each in the list.

Next, we analyse the citing articles of COR in order to identify the origin of the citations received by the journal and to better reflect the influence of COR. Table 5 describes the top 30 institutions, countries/territories, and journals with the highest number of papers citing COR. The data was collected from the citation report generated by WoS when considering all the journal publications. Note that only 'articles' and 'reviews' are considered in the results obtained. Moreover, if one document cites several references from the same journal, only one unit would be counted.

Chinese researchers are, by far, those who cite the journal most frequently. Observe that more than half of the institutions in the top 30 are from China, of which five are ranked in the top 10. China obtains the first position at the country/territory level over the United States of America (USA). This is partly because of the large number of studies in COR that have been done by Chinese researchers and the increasing improvement of the influence of these studies. In addition, Iran, India, and Taiwan occupy the third, fourth, and fifth positions, respectively, from the point of view of countries/territories regarding the citing articles. Turkey is ranked in the 10th position, and some other developing countries/territories appear in the top 30, including Malaysia, Mexico, and Chile. From the institution perspective, Islamic Azad University and the Université de Montréal are the top two leading citing institutions of COR. It is worth noting that none of the institutions in the top 30 are from the United Kingdom (UK) and only one from the USA.

At the journal level, the *European Journal of Operational Research* is the most significant journal that primarily cites COR. Due to the self-citations, COR obtains the second position. Note that the self-citation phenomenon is very common for most of the journals (Merigó et al., 2018), mainly because the studies published previously in the journal tend to have an important influence on the future research of the journal. *Computers & Industrial Engineering*, *International Journal of Production Research*, and *Expert Systems with Applications* are the journals that cite COR publications more frequently each with more than 2,000 articles. Most of the top citing journals are from the fields of OR-MS, Computer Science, and Engineering, and they are among the leading journals shown in Table 3. It is worth noting that large journals that publish a large number of papers are prone to give more citations to COR, although they are not significantly influenced by COR. For example, according to the percentage of all documents of a journal that cites COR, *IEEE Access*, *Sustainability*, the *Journal of Cleaner Production*, *Applied Sciences Basel*, and *Applied Mathematics Computation* are such journals only having less than 3 % related papers. However, although some smaller-sized journals are ranked in lower positions, they are highly influenced by COR and have higher percentage results, such as *International Transactions in Operational Research* with around 41 %, *INFORMS Journal on Computing* with around 30 %, and *RAIRO-Operations Research* with around 28 %.

Another interesting issue is to investigate regards the documents which are most cited by the papers published in COR. Our study uses the VOS viewer software (Van Eck and Waltman, 2010) to identify the most popular and influential documents in the journal through a co-citation analysis of the cited references. Table 6 presents the top 50 most cited documents in COR. Note that in case of a tie for the number of citations, the ranking of the documents cited in the journal is based on the ratio of the citations per year.

The document most cited in COR is the seminal book in computer science and mathematics written by Michael R. Garey and David S. Johnson (Garey and Johnson, 1979) about the theory of NP-completeness and computational intractability. This book has been

Table 6
Top 50 most cited documents in COR publications.

R	Year	First author	Reference	Vol	Page	Type	TC	C/Y
1	1979	Garey, MR	Computers Intractability	–	–	B	306	6.8
2	1979	Graham, RL	Discr Optim	–	p287	BC	202	4.49
3	1997	Mladenović, N	Comput Oper Res	v24	1097	A	200	7.41
4	1983	Kirkpatrick, S	Science	v220	p671	A	176	4.29
5	1987	Solomon, MM	Oper Res	v35	p254	A	147	3.97
6	1990	Glover, F	ORSA J Computing	v2	p4	A	127	3.74
7	1997	Glover, F	Tabu Search	–	–	B	126	4.67
8	1983	Nawaz, M	Omega-Int J Manag Sci	v11	p91	A	126	3.07
9	1993	Ahuja, RK	Network Flows	–	–	B	122	3.94
10	1964	Clarke, G	Oper Res	v12	p568	A	122	2.03
11	2006	Ropke, S	Transport Sci	v40	p455	A	120	6.67
12	1989	Goldberg, DE	Genetic Algorithms	–	–	B	120	3.43
13	2002	Deb, K	IEEE T Evol Comput	v6	p182	A	118	5.36
14	1993	Taillard, E	Eur J Oper Res	v64	p278	A	108	3.48
15	1990	Martello, S	Knapsack Probl: Algor Comp	–	–	B	106	3.12
16	1954	Johnson, S	Naval Res Logist Q	v1	p61	A	101	1.44
17	2007	Pisinger, D	Comput Oper Res	v34	p2403	A	96	5.65
18	2001	Hansen, P	Eur J Oper Res	v130	p449	A	90	3.91
19	1986	Glover, F	Comput Oper Res	v13	p533	A	89	2.34
20	1976	Garey, MR	Math Oper Res	v1	p117	A	87	1.81
21	1998	Shaw, P	Lect Notes Comput Sci	v1520	p417	A	84	3.23
22	1992	Holland, JH	Adaptation Natural Artif Syst	–	–	B	83	2.59
23	1973	Lin, S	Oper Res	v21	p498	A	81	1.59
24	1974	Baker, KR	Intro Sequencing Sch	–	–	B	78	1.56
25	1990	Baker, KR	Oper Res	v38	p22	A	76	2.24
26	1958	Wagner, HM	Manag Sci	v5	p89	A	75	1.14
27	1977	Lenstra, JK	Annals Discret Math	v1	p343	A	74	1.57
28	1995	Feo, TA	J Global Optim	v6	p109	A	72	2.48
29	1998	Barnhart, C	Oper Res	v46	p316	A	71	2.73
30	1978	Charnes, A	Eur J Oper Res	v2	p429	A	71	1.54
31	2007	Wäscher, G	Eur J Oper Res	v183	1109	A	70	4.12
32	1990	Beasley, JE	J Oper Res Soc	v41	p1069	A	68	2
33	1986	Steuer, R	Multiple Crit Optim	–	–	B	66	1.74
34	2005	Benders, JF	Comput Manag Sci	v2	p3	A	65	3.42
35	1988	Nemhauser, G	Integer Combinat	–	–	B	65	1.81
36	1972	Karp, RM	Complexity Computer Computat	–	p85	BC	65	1.25
37	2004	Bertsimas, D	Oper Res	v52	p35	A	63	3.15
38	1991	Reinelt, G	ORSA J Computing	v3	p376	A	63	1.91
39	1965	Lin, S	AT&T Tech J	v44	p2245	A	63	1.07
40	1959	Dijkstra, EW	Numer Math	v1	p269	A	63	0.97
41	1960	Miller, CE	J ACM	v7	p326	A	62	0.97
42	1981	Fisher, ML	Manag Sci	v27	p1	A	60	1.4
43	1974	Held, M	Math Program	v6	p62	A	60	1.2
44	2007	Ruiz, R	Eur J Oper Res	v177	p2033	A	59	3.47
45	1998	Wolsey, L	Integer Programming	–	–	B	57	2.19
46	1960	Dantzig, GB	Oper Res	v8	p101	A	57	0.89
47	2004	Kellerer, H	Multidimensional Knapsack Probl	–	–	B	56	2.8
48	1964	Hakimi, SL	Oper Res	v12	p450	A	56	0.93
49	1959	Dantzig, GB	Manag Sci	v6	p80	A	56	0.86
50	2011	Daskin, MS	Network Discrete Location: Mod	–	–	B	55	4.23

Abbreviations are available in the previous tables except: A = Article; B = Book; BC = Book chapter.
[a]Note that ORSA Journal on Computing became the INFORMS Journal on Computing in 1995 due to the merger of the Operations Research Society of America (ORSA) and The Institute of Management Sciences (TIMS) to form INFORMS (the Institute for Operations Research and the Management Sciences).

cited in 306 publications of COR with an average of 6.8 citations per year. The second position goes to a book chapter of Discrete Optimisation written by Ronald L. Graham in 1979 as the first author (Graham et al., 1979), with 202 citations from COR. Note that the 50 most cited documents contain 36 articles, 12 books, and two book chapters. Three papers from COR appear on the top 50 list, and they are also among the top five most cited papers published in COR (see Table 4). Additionally, eight publications are from *Operations Research*, five from the *European Journal of Operational Research*, and three from *Management Science*. Furthermore, Fred Glover has three documents as the first author among the top 50, and Michael R. Garey, Shen Lin, Kenneth R. Baker, and George B. Dantzig have two for each of them.

5. Leading authors, institutions, and countries/regions of COR

This section analyses the leading authors, institutions, and countries/territories of the journal according to the WoS Core Collection database. The leading position is mainly measured by the total number of publications and total citations. Note that in case of a tie for the number of COR publications, the ranking of authors, institutions, or countries/territories depends on the number of citations those publications have received.

First, let us look into the 50 most productive authors in COR. Table 7 presents the results. The table shows the current affiliation and country/territory corresponding to each author. Apart from the number of publications and citations, several other bibliometric indicators are also considered in the table, including the *h*-index, the citations per paper, the number of papers achieving the citation thresholds of 10 and 50, and the number of papers within the top 50 most cited ones in Table 4. Note that WoS uses full counting, so each co-author of a document receives one unit independently of the number of co-authors. This is a limitation. The problem is that the basic alternative approach, fractional counting (that gives the same fraction to each co-author), also has limitations. For example, the contribution between co-authors usually it is not equal, so

Table 7
Top 50 most productive authors in COR.

R	Author Name	Institution	Country/ Territory	TP	TC	H	C/P	≥50	≥10	T50
1	Laporte, G	HEC Montréal	Canada	99	5,106	44	51.58	41	82	0
2	Cheng, TCE	Hong Kong Polytech U	China	46	1,544	22	33.57	10	40	0
3	Golden, BL	U Maryland-College Park	USA	40	2,756	20	68.90	11	31	2
4	Gendreau, M	Polytechnique Montréal	Canada	30	1,963	24	65.43	12	29	1
5	Cordeau, JF	HEC Montréal	Canada	30	1,732	22	57.73	10	25	1
6	Martí, R	U Valencia	Spain	27	778	17	28.81	3	21	0
7	Hao, JK	U Angers	France	26	562	14	21.62	3	17	0
8	Mosheiov, G	Hebrew U Jerusalem	Israel	25	701	14	28.04	2	17	0
9	Puerto, J	U Seville	Spain	24	440	12	18.33	2	14	0
10	Drezner, Z	California State U-Fullerton	USA	22	687	15	31.23	3	16	0
11	Mladenović, N	Khalifa U	UAE	21	3,326	16	158.38	4	19	1
12	Crainic, TG	U Québec Montréal	Canada	21	1,415	16	67.38	7	18	2
13	Wasil, EA	American U	USA	21	933	15	44.43	5	17	0
14	Speranza, MG	U Brescia	Italy	20	919	15	45.95	6	17	0
15	Batta, R	U Buffalo SUNY	USA	20	805	13	40.25	4	17	0
16	Berman, O	Karlsruhe Inst Tech	Germany	20	698	13	34.90	3	14	0
17	Carrizosa, E	U Seville	Spain	20	362	10	18.10	1	10	0
18	Framiñan, JM	U Seville	Spain	19	971	15	51.11	5	16	1
19	Gupta, JND	U Alabama	USA	19	688	14	36.21	3	14	0
20	Coelho, LC	U Laval	Canada	18	970	13	53.89	6	15	0
21	Van Woensel, T	Eindhoven U Tech	Netherlands	18	717	14	39.83	4	16	0
22	Morabito, R	U Fed Sao Carlos	Brazil	18	681	14	37.83	6	16	0
23	Sörensen, K	U Antwerp	Belgium	18	595	13	33.06	5	14	0
24	Archetti, C	U Brescia	Italy	18	533	12	29.61	2	13	0
25	Salazar-González, JJ	U La Laguna	Spain	18	487	11	27.06	5	12	0
26	Soumis, F	Polytechnique Montréal	Canada	18	449	11	24.94	2	12	0
27	Escudero, LF	U Rey Juan Carlos	Spain	18	386	13	21.44	0	15	0
28	Bruneel, H	Ghent U	Belgium	18	347	10	19.28	2	10	0
29	Guerriero, F	U Calabria	Italy	17	452	10	26.59	3	11	0
30	Vanhoucke, M	Ghent U	Belgium	17	296	11	17.41	0	11	0
31	Ruiz, R	Polytechnic U Valencia	Spain	16	1,389	14	86.81	10	15	1
32	Bard, JF	U Texas Austin	USA	16	875	10	54.69	6	10	1
33	Tang, LX	Northeastern U China	China	16	569	13	35.56	5	14	0
34	Salhi, S	U Kent	UK	16	533	13	33.31	3	15	0
35	Fagerholt, K	Norwegian U Sci Tech	Norway	16	506	11	31.63	4	12	0
36	Smith, JM	U Massachusetts Amherst	USA	16	389	12	24.31	2	12	0
37	Gouveia, L	U Lisbon	Portugal	16	358	10	22.38	2	10	0
38	Dauzère-Pérès, S	U Clermont Auvergne	France	16	308	10	19.25	1	10	0
39	Glover, F	U Colorado Boulder	USA	15	3,040	11	202.67	3	12	1
40	Pardalos, PM	U Florida	USA	15	1,141	11	76.07	7	11	0
41	Liao, CJ	Natl Taiwan U Sci Tech	Taiwan	15	968	10	64.53	5	10	1
42	Fernández, E	U Cadiz	Spain	15	730	13	48.67	6	14	0
43	Langevin, A	Polytechnique Montréal	Canada	15	669	15	44.60	5	15	0
44	Iori, M	U Modena Reggio Emilia	Italy	15	662	12	44.13	3	13	0
45	Desaulniers, G	Polytechnique Montréal	Canada	15	371	12	24.73	2	12	0
46	Della Croce, F	Polytech U Turin	Italy	15	356	8	23.73	2	7	0
47	Potvin, JY	U Montréal	Canada	14	737	11	52.64	5	11	0
48	Ghiani, G	U Salento	Italy	14	522	8	37.29	3	7	0
49	Aktürk, MS	Bilkent U	Turkey	14	278	12	19.86	0	14	0
50	Marín, A	U Murcia	Spain	14	236	7	16.86	2	7	0

Abbreviations are available in the previous tables.

it is difficult to measure what would be the correct fraction to each co-author. Therefore, fractional counting would also not provide correct results when summing all the publications of an author, institution or country. Other related limitations also apply to the case of fractional counting. Due to this, this study follows the approach provided by WoS.

Gilbert Laporte, from HEC Montréal (Canada), is the most productive and influential author in COR, who has published 99 articles with more than 5,000 citations. He also obtains the first position in terms of the *h*-index, and over half of his publications in the journal have received at least 50 citations each. It is worth noting that these results were achieved while he was not the editor-in-chief of the journal. COR always had the policy that current editor-in-chief do not publish in their own journal. The second and third places in the ranking go to T. C. E. Cheng from the Hong Kong Polytechnic University with 46 articles and Bruce L. Golden from the University of Maryland-College Park (USA) with 40 articles, respectively. Fred Glover, from the University of Colorado Boulder (USA), leads the list in the 'citations per paper' category with a ratio of 202.67, followed by Nenad Mladenović from Khalifa University (United Arab Emirates). Note that both of them are among the top three most cited authors with more than 3,000 citations. Bruce L. Golden and Teodor G. Crainic from the Université du Québec à Montréal (Canada), have two documents among the top 50 most cited papers in the journal (see Table 4), and eight authors on the list have one. It is also worth noting that the top 50 leading authors come from 17 countries/territories around the world. The authors from the USA, Canada, and Spain lead the ranking of the top 50, and each of these countries has nine authors, followed by Italy with six authors. Currently, the Polytechnique Montréal is the institution with the largest number of leading authors on the list, with four authors. The University of Seville (Spain) has three authors on the list, and Ghent University (Belgium), HEC Montréal, and the University of Brescia (Italy) have two authors each. Furthermore, it is worth mentioning that 15 authors among the top 50 list are currently members of the Editorial Advisory Board of COR, Gilbert Laporte (the previous Editor from 2003 to 2006), Jean-François Cordeau, Jin-Kao Hao, Gur Mosheiov, Bruce L. Golden, Justo Puerto, Rajan Batta, Juan-José Salazar-González, Mario Vanhoucke, Rubén Ruiz, Luis Gouveia,

Elena Fernández, Frederico Della Croce, Jean-Yves Potvin, and Alfredo Marín.

To deeply examine the productivity and influence of the leading authors over time, a temporal analysis is conducted in five 10-year periods of COR: 1974–1983, 1984–1993, 1994–2003, 2004–2013, and 2014–2023. Table 8 shows the results of the temporal evolution of the most productive authors in COR. Note that the table considers the authors with at least four publications in the journal for the first period of 1974–1983, at least five publications for the periods of 1984–1993 and 1994–2003, at least 10 publications for the last two periods of 2004–2013 and 2014–2023. The reason for this setting is that the number of documents published in COR has grown significantly during each period, especially for the first four decades of the journal.

From the results, we can see that Gilbert Laporte is the most productive author in the last three periods of 1994–2003, 2004–2013, and 2014–2023, having the most representative presence in the journal throughout its entire lifetime together with Michel Gendreau from the Polytechnique Montréal and Rafael Martí from the University of Valencia (Spain). In addition, Gilbert Laporte is also the most influential author in the journal from 1994 to 2003 and from 2014 to 2023, and he is well ahead of other authors in the journal for the last 10 years with 55 publications and 2,346 citations. T. C. E. Cheng, ranked in the second position among the top 50 in Table 7, also obtains remarkable productivity results, being in the second position for both of the 1994–2003 and 2004–2013 periods. During the first 10 years of the journal, Bernard W. Taylor III from the Virginia Polytechnic Institute and State University (USA) was the most productive author with eight publications, and Bruce L. Golden was the most influential author with more than 1,000 citations. For the period between 1984 and 1993, Bruce L. Golden is ranked first as the most productive and influential author. Christian Prins, from the University of Technology of Troyes (France), has been the most cited author in COR during the period of 2004–2013; note that he has published two highly cited papers among the top 50 most cited in the journal (see Table 4). Jean-François Cordeau, from HEC Montréal, has also been very influential during the last two decades, attaining the sixth position during the 2004–2013 period and second position in 2014–2023.

Next, we investigate the most productive and influential institutions in the journal from a historical perspective. To this end, the work analyses the author affiliation at the time of publication of each paper in COR. Note that some of the papers from the same author may be affiliated with different or multiple institutions if authors have changed their

Table 8
Temporal evolution of the most productive authors.

R	Author	TP	TC	R	Author	TP	TC
1974–1983				2004–2013			
1	Taylor III, BW	8	48	1	Laporte, G	24	1,557
2	Lee, SM	6	83	2	Cheng, TCE	21	739
3	Intrator, J	6	21	3	Tang, LX	14	512
4	Golden, BL	5	1,081	4	Mosheiov, G	13	251
5	DeWald, CG	5	14	5	Ruiz, R	12	1,156
6	Ignizio, JP	4	159	6	Cordeau, JF	12	1,116
1984–1993				7	Martí, R	12	470
1	Golden, BL	12	541	8	Prins, C	11	2,035
2	Ghosh, JB	7	112	9	Escudero, LF	11	270
3	Wells, CE	7	112	10	Cui, YD	11	173
4	Schniederjans, MJ	7	71	11	Pardalos, PM	10	938
5	Ignizio, JP	6	65	12	Gendreau, M	10	841
6	Reeves, GR	6	65	13	Haouari, M	10	674
7	Sherali, HD	6	27	14	Fernández, E	10	592
8	Austin, LM	6	24	15	Langevin, A	10	533
9	De, P	5	97	16	Mladenović, N	10	484
10	Wasil, EA	5	56	17	Puerto, J	10	305
11	Karwan, MH	5	39	2014–2023			
1994–2003				1	Laporte, G	55	2,346
1	Laporte, G	16	1,018	2	Cordeau, JF	18	618
2	Cheng, TCE	13	431	3	Hao, JK	17	173
3	Kim, SH	11	709	4	Coelho, LC	16	676
4	Gupta, JND	7	407	5	Carrizosa, E	16	222
5	Wang, DW	7	388	6	Gendreau, M	15	739
6	Berman, O	7	311	7	Framiñan, JM	15	500
7	Lee, HW	7	129	8	Vanhoucke, M	15	239
8	Batta, R	6	422	9	Archetti, C	14	337
9	Boctor, FF	6	393	10	Puerto, J	14	135
10	Allahverdi, A	6	310	11	Speranza, MG	13	576
11	Drezner, Z	6	155	12	Iori, M	12	454
12	Kim, S	6	84	13	Sörensen, K	12	374
13	Gendreau, M	5	384	14	Van Woensel, T	11	389
14	Renaud, J	5	366	15	Salhi, S	11	367
15	Mosheiov, G	5	343	16	Dauzère-Pérès, S	11	132
16	Liaw, CF	5	265	17	Ghiani, G	10	385
17	Mehrez, A	5	232	18	Fernandez-Viagas, V	10	358
18	Liao, CJ	5	168	19	Guerriero, F	10	313
19	Martí, R	5	166	20	Fagerholt, K	10	262
20	Lee, CY	5	140	21	Morabito, R	10	209
21	Bruneel, H	5	117	22	Mladenović, N	10	203
22	Wesolowsky, GO	5	113	23	Ernst, AT	10	164
23	Pearn, WL	5	94	24	Gendron, B	10	143
				25	Martí, R	10	142
				26	Goerigk, M	10	102

Abbreviations are available in the previous tables.

institutions or due to some other reasons. Table 9 shows the 50 most productive institutions in COR. Similarly to the analysis of leading authors, not only does this table consider the bibliometric indicators used in Table 7 to analyse the publications of an institution but also the number of articles with equal or more than 200 citations and the university rankings (i.e., the Academic Ranking of World Universities (ARWU) and the Quacquarelli & Symonds (QS) World University Rankings).

CNRS (the National Centre for Scientific Research of France) is the most productive institution in the journal with 162 publications. The second and third positions go to HEC Montréal and Polytechnique Montréal with 154 and 109 documents respectively. Moreover, HEC Montréal is the most cited and influential institution with 9,653 citations. HEC Montréal and Polytechnique Montréal also perform very well in the rest of the indicators. Note that these two institutions are technically independent from the Université de Montréal although they are affiliated to it. This aspect is important because WoS currently indexes all the documents of these two institutions together with the Université de Montréal. The University of Seville obtains the fourth position with 87 articles, followed by the University of Maryland – College Park with 82 publications, and the Université de Montréal with 79 publications. Note that CNRS is a French network with more than 30,000 researchers located in more than 1,100 laboratories and universities in France and abroad. Therefore, it cannot be really compared with normal universities. For more information regarding the organization of the CNRS, see: https://www.cnrs.fr/en/le-cnrs/organisation.

In terms of the 'citations per paper' category, HEC Montréal performs the best on the list, followed by Tsinghua University (China) and the University of Florida (USA). Observe that the University of Maryland-College Park ranks first regarding the number of articles with equal or more than 200 citations (four papers) and the number of papers in the top 50 list of Table 4 (three papers). The top 50 institutions in the table

Table 9
The most productive and influential institutions in COR.

R	Institution	Country/Territory	TP	TC	H	C/P	≥200	≥50	≥10	T50	QS	ARWU
1	CNRS	France	162	4,264	36	26.32	0	25	107	0	–	–
2	HEC Montréal	Canada	154	9,653	49	62.68	3	48	118	2	–	–
3	Polytechnique Montréal	Canada	109	3,536	33	32.44	1	20	78	1	–	–
4	U Seville	Spain	87	2,412	26	27.72	1	12	49	1	462	401–500
5	U Maryland-College Park	USA	82	4,489	30	54.74	4	22	56	3	218	58
6	U Montréal	Canada	79	2,916	34	36.91	0	20	60	0	159	151–200
7	Korea Adv Inst Sci Tech	South Korea	75	2,437	28	32.49	2	12	42	1	53	201–300
8	Hong Kong Polytechnic U	China	70	2,202	27	31.46	0	12	56	0	57	151–200
9	Huazhong U Sci Tech	China	65	2,732	28	42.03	2	16	45	0	300	79
10	U Lisbon	Portugal	64	1,643	22	25.67	1	9	41	0	260	201–300
11	Bilkent U	Turkey	63	1,882	24	29.87	1	11	45	0	477	–
12	Virginia Polytech Inst State U	USA	62	1,072	16	17.29	0	6	27	0	389	201–300
13	U Buffalo SUNY	USA	58	1,915	23	33.02	0	12	39	0	466	401–500
14	Polytechnic U Catalonia	Spain	56	2,013	27	35.95	1	11	44	1	371	801–900
15	Institut Mines-Télécom (IMT)	France	56	1,854	24	33.11	1	9	41	0	–	–
16	KU Leuven	Belgium	56	1,756	22	31.36	1	12	41	0	63	78
17	U Vienna	Austria	52	2,252	26	43.31	1	18	36	0	137	101–150
18	Ghent U	Belgium	52	1,025	19	19.71	0	4	31	0	169	90
19	Pennsylvania State U	USA	51	1,382	19	27.10	1	8	28	0	89	101–150
20	Tsinghua U	China	50	2,904	28	58.08	3	19	45	0	20	22
21	U Coimbra	Portugal	49	1,165	19	23.78	0	7	36	0	355	501–600
22	U Calabria	Italy	48	1,701	24	35.44	0	11	37	0	901–950	701–800
23	U Valencia	Spain	48	1,602	23	33.38	0	9	39	0	445	201–300
24	Shanghai Jiao Tong U	China	47	1,189	20	25.30	0	9	27	0	45	38
25	City U Hong Kong	China	46	2,206	27	47.96	1	16	36	0	62	101–150
26	Eindhoven U Tech	Netherlands	45	1,579	23	35.09	0	8	32	0	136	401–500
27	Natl U Singapore	Singapore	45	1,425	21	31.67	1	8	30	1	8	68
28	Natl Yang Ming Chiao Tung U	Taiwan	44	1,000	19	22.73	0	4	33	0	219	401–500
29	Northeastern U China	China	43	1,752	24	40.74	0	12	39	0	–	201–300
30	U Toronto	Canada	43	1,408	22	32.74	0	9	27	0	25	26
31	Natl Taiwan U Sci Tech	Taiwan	42	2,164	24	51.52	1	13	31	1	392	701–800
32	U Laval	Canada	42	1,907	25	45.40	1	12	32	0	423	301–400
33	U La Laguna	Spain	42	928	19	22.10	0	5	30	0	–	501–600
34	U Sao Paulo	Brazil	40	1,169	21	29.23	0	5	32	0	92	101–150
35	U Michigan	USA	40	1,022	17	25.55	0	6	23	0	44	30
36	U Bologna	Italy	39	1,431	21	36.69	0	9	30	0	133	201–300
37	Erasmus U Rotterdam	Netherlands	38	1,153	17	30.34	0	6	30	0	158	101–150
38	U Porto	Portugal	38	1,092	19	28.74	0	4	31	0	278	201–300
39	Clemson U	USA	38	746	14	19.63	0	4	19	0	951–1000	701–800
40	State U Campinas	Brazil	38	739	15	19.45	0	3	20	0	232	401–500
41	U Florida	USA	37	2,087	21	56.41	3	11	28	0	215	101–150
42	Norwegian U Sci Tech	Norway	37	1,697	20	45.86	2	11	24	1	264	151–200
43	Federal U Minas Gerais	Brazil	37	1,299	18	35.11	0	9	29	0	671–680	501–600
44	Tongji U	China	37	703	15	19.00	0	4	21	0	192	151–200
45	Rutgers U-New Brunswick	USA	37	374	11	10.11	0	0	16	0	328	101–150
46	Polytechnic U Valencia	Spain	36	1,873	22	52.03	1	11	31	1	436	401–500
47	Natl Tsing Hua U	Taiwan	36	1,374	17	38.17	0	8	23	0	210	401–500
48	U Libre Bruxelles	Belgium	36	1,332	17	37.00	1	8	26	0	230	101–150
49	U Brescia	Italy	36	1,242	20	34.50	1	6	27	0	691–700	601–700
50	Georgia Inst Tech	USA	36	1,107	18	30.75	3	7	23	0	97	151–200

Abbreviations are available in the previous tables except: CNRS = The National Centre for Scientific Research (Centre national de la recherche scientifique) of France; ARWU = Academic Ranking of World Universities 2024; QS = Quacquarelli & Symonds World University Rankings 2025.
*Note that U Montréal includes the publications of HEC Montréal and Polytechnique Montréal. The reason is that although HEC Montréal and Polytechnique Montréal are independent institutions, they are also affiliated with U Montréal.

are from 16 countries/territories, among which nine are from the USA, seven from China, and five from Canada and Spain each. From this perspective, there is a fair mixture of institutions worldwide contributing to COR, which also indicates the international diversity of the journal. It is worth noting that there is no UK institution among the top 50 listed. Most of the leading universities in COR are among the top 500 of the world university rankings. According to the ARWU, nine of the universities are in the top 100 in the world, and 12 are part of the top 100 based on the QS world university rankings, including the National University of Singapore and Tsinghua University which enter the top 20.

To further investigate the most productive institutions in COR over time, we conduct a temporal analysis focusing on the five periods of 1974–1983, 1984–1993, 1994–2003, 2004–2013, and 2014–2023, respectively. Table 10 presents the results. The table considers the institutions with at least five papers published in the journal during the first period 1974–1983, at least 10 papers for the periods of 1984–1993 and 1994–2003, at least 18 papers for 2004–2013, and at least 20 papers for 2014–2023.

The four most productive institutions from 2014 to 2023 are also the top four among the 50 most productive institutions in Table 9, i.e., CNRS, HEC Montréal, Polytechnique Montréal and the University of Seville. The CNRS has been performing remarkably well in the last two decades, consistently occupying the first position in the ranking for the periods of 2004–2013 and 2014–2023. For the first decade of COR

Table 10
Temporal evolution of the most productive institutions.

R	Institution	TP	TC	R	Institution	TP	TC
1974–1983				2004–2013			
1	Virginia Polytech Inst State U	11	50	1	CNRS	62	2,572
2	U Maryland-College Park	9	1,169	2	HEC Montréal	49	3,004
3	Massachusetts Inst Tech (MIT)	7	439	3	Polytechnique Montréal	42	1,893
4	Pennsylvania State U	7	164	4	Polytechnic U Catalonia	34	1,468
5	U Georgia	7	38	5	Bilkent U	31	1,312
6	George Washington U	6	392	6	U Lisbon	31	1,138
7	U Buffalo SUNY	6	49	7	Tsinghua U	29	1,817
8	U Nebraska-Lincoln	5	77	8	Hong Kong Polytechnic U	29	1,001
9	Rutgers U-New Brunswick	5	39	9	U Seville	28	1,241
10	US Environmental Protection Agency	5	39	10	U Coimbra	25	764
1984–1993				11	U Valencia	23	974
1	U Maryland-College Park	25	817	12	Polytechnic U Valencia	22	1,451
2	Virginia Polytech Inst State U	19	121	13	U Sao Paulo	22	837
3	Pennsylvania State U	14	205	14	U Toronto	22	765
4	Rutgers U-New Brunswick	14	130	15	U Montréal	20	1,068
5	U Buffalo SUNY	13	280	16	Institut Mines-Télécom (IMT)	20	927
6	Korea Adva Inst Sci Tech	13	215	17	U Maryland-College Park	19	1,708
7	U Montréal	12	273	18	KU Leuven	19	1,021
8	U Georgia	12	51	19	Federal U Minas Gerais	19	933
9	Ohio State U	11	309	20	Northeastern U China	19	727
10	U Houston	11	275	21	U Calabria	19	649
11	U South Carolina	11	112	22	U Florida	18	1,453
12	Purdue U	11	62	23	Natl U Singapore	18	941
13	U Nebraska-Lincoln	10	81	24	Natl Yang Ming Chiao Tung U	18	559
14	Tel Aviv U	10	75	25	U La Laguna	18	490
1994–2003				26	Korea Adv Inst Sci Tech	18	422
1	Korea Adv Inst Sci Tech	36	1,692	2014–2023			
2	City U Hong Kong	18	807	1	CNRS	99	1,680
3	Natl Taiwan U Sci Tech	17	799	2	HEC Montréal	92	3,282
4	Hong Kong Polytechnic U	17	689	3	Polytechnique Montréal	60	1,455
5	Virginia Polytech Inst State U	17	463	4	U Seville	58	1,116
6	Natl Yang Ming Chiao Tung U	17	250	5	Huazhong U Sci Tech	47	1,450
7	Clemson U	16	246	6	Institut Mines-Télécom (IMT)	36	926
8	U Buffalo SUNY	14	602	7	KU Leuven	36	699
9	Pennsylvania State U	14	365	8	U Montréal	35	901
10	U Florida	12	405	9	Shanghai Jiao Tong U	31	633
11	U Maryland-College Park	12	344	10	U Vienna	30	587
12	Natl Tsing Hua U	12	143	11	Tongji U	30	484
13	U Montréal	11	631	12	Eindhoven U Tech	29	634
14	HEC Montréal	10	3,255	13	Ghent U	29	399
15	Chinese U Hong Kong	10	581	14	U Lisbon	29	359
				15	Bilkent U	27	440
				16	U Calabria	26	1,022
				17	U Brescia	25	791
				18	U Electronic Sci Tech China	25	718
				19	Hong Kong Polytechnic U	24	511
				20	INESC TEC	24	460
				21	U Laval	23	1,028
				22	U Bologna	23	688
				23	Norwegian U Sci Tech	23	444
				24	U La Laguna	22	383
				25	Paris-Saclay U	22	308
				26	Xi'an Jiaotong U	22	299
				27	Polytechnic U Catalonia	20	528
				28	U Quebec	20	361
				29	Middle East Technical U	20	300
				30	U Angers	20	200

Abbreviations are available in the previous tables except: INESC TEC = The Institute for Systems and Computer Engineering, Technology and Science in Portugal.

between 1974 and 1983, the Virginia Polytechnic Institute and State University was the most productive institution with 11 publications, and the University of Maryland-College Park was the most cited institution in the period with 1,169 citations. In addition, all the leading institutions in this period are from the USA. The period between 1984 and 1993 has seen the leading position of the University of Maryland-College Park with the highest number of publications and citations. During the third period of 1994–2003, the Korea Advanced Institute of Science and Technology became the most productive institution in the journal having 36 publications and the second most cited one with 1,692 citations. Observe that seven of the leading institutions between 1994 and 2003 are from Asian countries/territories including China, Taiwan, and Korea. The temporal analysis of the results also show that during the first years of the journal, the institutions of the USA had more influence and led the ranking. However, other institutions have become more relevant over time, especially with the strong emergence of Asian and European institutions publishing in COR during the last two decades. Moreover, it is interesting to observe whether an institution can continue its performance in the future or not. For example, Polytechnic University of Catalonia (Spain) obtained the fourth position in the 2004–2013 period but has decreased to the 27th during the last decade. In contrast, KU Leuven (Belgium) has become more productive in the journal during the last decade, rising from the 18th place in the 2004–2013 period to the 7th today. Note that no UK institution appears among the leading institutions of the journal in all periods.

Another interesting aspect is to examine regards the journal publications in the past 50 years at the country/territory level. Similarly to the institution analysis, the country/territory represents the affiliation of an institution where an author is working at the time of publication. Note that in many cases, some authors have changed the country/territory where they work through time. Table 11 presents the 50 most productive countries/territories in COR. Like Tables 7 and 9, the table considers similar bibliometric indicators to provide a complete picture for the country/territory analysis. In addition, this analysis also considers the total population of a country/territory to obtain the publications and citations per million inhabitants. Note that WoS uses full

Table 11
The most productive and influential countries/territories in COR.

R	Country/Territory	TP	TC	H	C/P	≥100	≥10	T50	Population	P/Pop	C/Pop
1	USA	1,874	56,072	108	29.92	120	1,052	15	336,385,000	5.57	166.69
2	China	757	27,118	82	35.82	50	538	6	1,432,000,000	0.53	18.94
3	Canada	640	25,114	77	39.24	54	429	4	38,949,000	16.43	644.79
4	France	469	14,244	57	30.37	29	304	4	65,310,000	7.18	218.10
5	Spain	449	13,860	59	30.87	23	321	2	47,278,000	9.50	293.16
6	UK	395	15,278	61	38.68	31	276	7	67,000,000	5.90	228.03
7	Italy	371	10,366	52	27.94	19	227	1	59,618,000	6.22	173.87
8	Taiwan	321	14,089	64	43.89	40	241	3	23,923,276	13.42	588.92
9	Brazil	309	8,476	49	27.43	16	212	0	216,284,000	1.43	39.19
10	Germany	299	8,989	50	30.06	20	208	1	83,695,000	3.57	107.40
11	Turkey	287	10,338	56	36.02	27	207	1	85,771,000	3.35	120.53
12	South Korea	207	6,296	42	30.42	13	124	1	51,844,000	3.99	121.44
13	Belgium	195	6,474	44	33.20	9	131	2	11,631,000	16.77	556.62
14	Australia	172	6,072	44	35.30	10	118	2	26,439,111	6.51	229.66
15	Portugal	171	4,251	36	24.86	5	120	0	10,298,000	16.61	412.80
16	Netherlands	170	5,469	39	32.17	15	111	0	17,618,299	9.65	310.42
17	Iran	161	6,691	44	41.56	14	121	5	88,608,000	1.82	75.51
18	India	145	4,835	37	33.34	6	92	3	1,439,323,000	0.10	3.36
19	Israel	117	2,689	28	22.98	6	59	0	9,342,000	12.52	287.84
20	Austria	89	3,627	31	40.75	11	56	2	9,112,000	9.77	398.05
21	Denmark	85	4,291	33	50.48	10	64	2	5,888,000	14.44	728.77
22	Norway	82	3,217	28	39.23	8	58	2	5,515,000	14.87	583.32
23	Singapore	76	2,411	27	31.72	4	48	1	5,952,000	12.77	405.07
24	Japan	67	3,099	26	46.25	5	46	3	125,220,000	0.54	24.75
25	Chile	66	1,601	24	24.26	1	38	0	19,629,590	3.36	81.56
26	Greece	60	4,274	31	71.23	6	57	2	10,364,000	5.79	412.39
27	Poland	45	1,601	21	35.58	4	34	0	38,008,000	1.18	42.12
28	Mexico	44	1,073	21	24.39	0	36	0	131,900,000	0.33	8.13
29	Switzerland	43	1,324	21	30.79	3	31	0	8,864,000	4.85	149.37
30	New Zealand	39	1,747	22	44.79	4	28	0	5,160,000	7.56	338.57
31	Saudi Arabia	39	1,339	20	34.33	3	29	0	36,947,025	1.06	36.24
32	Finland	37	1,794	19	48.49	5	28	1	5,554,000	6.66	323.01
33	Tunisia	29	1,514	18	52.21	4	25	1	12,458,223	2.33	121.53
34	Kuwait	27	990	20	36.67	2	23	0	4,376,000	6.17	226.23
35	Colombia	26	969	17	37.27	2	18	0	52,222,000	0.50	18.56
36	Serbia	26	954	17	36.69	2	23	0	8,655,000	3.00	110.23
37	U Arab Emirates	26	873	15	33.58	1	22	0	10,008,000	2.60	87.23
38	Russia	26	688	13	26.46	1	16	0	145,805,947	0.18	4.72
39	Belarus	23	540	14	23.48	0	18	0	9,476,000	2.43	56.99
40	Sweden	23	534	14	23.22	1	14	0	10,452,000	2.20	51.09
41	South Africa	19	870	11	45.79	2	12	1	60,756,135	0.31	14.32
42	Algeria	17	351	10	20.65	0	11	0	45,433,000	0.37	7.73
43	Ireland	17	348	9	20.47	0	9	0	5,124,000	3.32	67.92
44	Morocco	15	255	7	17.00	1	5	0	37,840,044	0.40	6.74
45	Hungary	14	251	9	17.93	0	9	0	9,705,000	1.44	25.86
46	Thailand	13	589	10	45.31	1	10	1	70,180,000	0.19	8.39
47	Lebanon	13	277	9	21.31	0	9	0	5,479,000	2.37	50.56
48	Malaysia	11	567	11	51.55	1	11	0	34,308,525	0.32	16.53
49	Indonesia	11	412	8	37.45	1	7	0	279,134,505	0.04	1.48
50	Czech Republic	11	160	7	14.55	0	6	0	10,494,000	1.05	15.25

Abbreviations are available in the previous tables except: P/Pop and C/Pop = Publications and citations per million inhabitants.

counting. Therefore, all the co-authoring countries of a paper get one unit independently of the number of co-authors and the number of co-authors from the same country.

The USA appears as the most productive and influential country in the journal, well ahead of the second position, China. The USA also leads the table in terms of the *h*-index (i.e., 108), the number of publications with equal or more than 10 and 100 citations (i.e., 1,052 and 120, respectively), the number of articles in the top 50 of Table 4 (i.e., 15), indicating that most of the journal's leading articles have been published by the USA. However, if normalising the results per capita, the USA and China lose their dominance in the ranking, while Canada and Taiwan achieve the best performance among the top 10 leading countries/territories. In terms of the 'publications per million inhabitants' category, Belgium obtains the best result with an average of 16.77 publications per million inhabitants, closely followed by Portugal with 16.61. Under the 'citations per million inhabitants' category, Denmark leads the table with an average of 728.77 citations per million inhabitants. Greece obtains the most remarkable result with respect to the citations per paper ratio (i.e., 71.23), although it is ranked 26th among the 50 most productive countries/territories in the journal. Note that European countries perform very well in COR according to their population size. Moreover, nine European countries appear in the top 20 on the list, and five among them are top 10: France, Spain, the UK, Italy, and Germany. It is worth noting that many developing economies, apart from China, have also contributed to the journal with higher publications and influence, especially Brazil, Turkey, Iran, and India. Some unexpected countries/territories from the Middle East and Africa enter the top 50, such as Tunisia, Kuwait, Algeria, Morocco, and Lebanon. In general, the journal is very diverse with countries/territories and researchers from all over the world publishing in it.

Further, let us analyse the publication evolution of the countries/territories through time. Table 12 shows the temporal evolution results in terms of the top 40 countries/territories. Note that this table specifically focuses on the annual number of publications of each country/territory for the years between 2004 and 2023. Additionally, the total number of publications of each country/territory corresponding to the five 10-year periods (as used in Tables 8 and 10) are respectively analysed: 1974–1983, 1984–1993, 1994–2003, 2004–2013, and 2014–2023.

During the first four decades of the journal, the USA had always been the most productive country with a significant number of articles published. However, since 2019, China has become the most productive country, and during the last decade, it published 68 more articles than the USA. Canada has been performing well since the first years of the journal, being ranked as one of the top three most productive countries/territories of all time except the last decade between 2014 and 2023. Although there is a growing tendency in the number of publications of Canada, its annual productivity has been regularly overtaken by that of China since 2009. Owing to the significant growth of the journal, most of the countries/territories have been increasingly improving their presence over time, especially China, France, the UK, Italy, and Brazil. Observe that in the last few years, France published more articles in comparison to Canada and has become the third most productive country with a total of 274 publications during the last decade. Belgium, Australia and Iran have also increased the number of their publications in the recent decade, with more than 100 articles published from 2014 to 2023. However, an interesting result is that there has been a downward trend in the productivity of some advanced economies over the last decade, including the USA, Taiwan, South Korea, Japan, and Greece. For example, Taiwan is ranked in the second and sixth positions during the periods of 1994–2003 and 2004–2013, respectively, but in recent years, the number of its publications in the journal has reduced a lot with only around four papers each year on average. Note that while Israel is ranked in the third place for both the periods of 1974–1983 and 1984–1993, other more productive countries/territories publishing in the journal have appeared over time.

Finally, we summarise all the publications of COR in the past 50 years on a supranational region basis. The objective is to provide a general picture of the productivity and influence of different regions worldwide. As shown in Table 13, six supranational regions are considered, including Europe, North America, Asia (specifically classified by East Asia, Middle East, and the Rest of Asia), Latin America, Oceania, and Africa. This analysis uses similar bibliometric indicators to those in the country/territory analysis as presented in Table 11.

Europe is by far the most productive and influential region, closely followed by North America and Asia. It also leads the table in terms of the *h*-index, the number of publications with equal or more than 50 and 200 citations, and the number of articles in the top 50 of Table 4. Recall from Table 11 that five out of the top 10 productive countries/territories are from Europe, which can well explain the best results obtained by Europe. Although the productivity of Oceania in the journal is less significant compared to most of the regions, it achieves the best performance under the categories of 'citations per paper', 'publications per million inhabitants', and 'citations per million inhabitants'. Overall, all the regions perform well with many articles published in COR, which also indicates that the journal is having strong impact around the world. Furthermore, with the tremendous growth of scientific activities in developing countries/territories, the number of publications from their associated regions, especially Asia, is expected to increase in COR.

6. Bibliographic connections between leading sources

The previous section provided a general overview of the productivity in COR. To obtain a deeper understanding of the leading trends occurring in the journal, this section develops a graphical analysis of the bibliographic connections between the leading sources. We use the VOS viewer software (Van Eck and Waltman, 2010) to collect the data and generate graphical maps based on several bibliometric techniques including co-citation (Small, 1973), bibliographic coupling (Kessler, 1963), and co-occurrence of author keywords (Merigó et al., 2018; Wang et al., 2020).

The bibliographic data analysed through the VOS viewer software is associated with the 6,506 documents of COR which are directly retrieved from the WoS Core Collection database. That is, the 73 documents of the journal that are not directly available in WoS (published between 1974 and 1976) are not considered in the graphical mapping analysis.

Note that VOS viewer is a computer software that collects the bibliographic data available in different databases like WoS or Scopus and generates graphical maps. The viewer is freely available at: www.vosviewer.com, For more information regarding the use of this software, see Van Eck and Waltman (2010; 2023).

The main advantage of developing graphical maps is that we can see how the most productive actors connect between them in terms of co-citations, bibliographic coupling and co-occurrence of keywords. By doing so, we can identify significant connections that often allows us to describe some characteristics of journals, documents, authors, institutions, countries and keywords. In the case of COR, this is a way to better identify the most frequent trends occurring in the journal and see how the journal is currently positioned in the scientific community in terms of publications and citations.

6.1. Co-citation of journals

First, we look into the co-citation of journals cited in COR. Recall that co-citation of journals occurs when two documents from different journals receive a citation from the same third document of another journal. Fig. 4 illustrates the results between 1976 and 2023 with a minimum threshold of 100 citations and the 100 most representative co-citation connections. The size of a node represents the number of citations received by a journal: the bigger the node, the more citations received; the width of a link denotes the strength of the co-citation

Table 12
Annual number of papers classified by countries/territories.

R	Country/Territory	D1	D2	D3	D4	D5	Total	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	USA	354	477	429	413	201	1,874	38	47	56	59	71	45	37	26	57	41	38	34	35	28	35	32	28	33	45	46
2	China	422	262	65	7	1	757	5	18	14	21	18	35	22	23	52	54	38	27	38	35	33	37	31	60	54	69
3	Canada	263	221	85	57	14	640	23	16	25	24	23	21	17	20	26	26	27	31	19	29	23	25	23	18	38	30
4	France	274	178	15	1	1	469	6	6	18	12	19	21	24	15	33	24	18	12	20	33	21	32	21	32	42	43
5	Spain	218	207	24	0	0	449	10	15	16	14	24	30	25	20	22	31	25	24	16	33	14	23	19	23	20	21
6	UK	201	123	41	23	7	395	6	9	10	6	16	17	13	7	25	14	17	15	15	18	21	14	23	26	24	28
7	Italy	224	120	20	5	2	371	4	7	4	12	15	13	13	18	18	16	17	18	13	26	19	27	18	27	33	26
8	Taiwan	44	144	113	20	0	321	20	25	6	13	14	18	7	9	20	12	7	7	6	4	2	3	4	6	2	3
9	Brazil	186	105	16	2	0	309	3	8	9	9	13	10	13	7	14	19	9	8	17	24	22	21	24	25	19	17
10	Germany	160	102	23	8	6	299	4	3	14	6	9	13	10	6	17	20	11	11	18	13	19	25	13	19	14	17
11	Turkey	161	105	18	2	1	287	3	3	2	19	10	13	9	11	21	14	6	14	14	18	20	20	15	21	24	9
12	South Korea	34	78	73	21	1	207	10	8	8	9	5	7	8	6	10	7	8	4	2	0	5	3	1	3	3	5
13	Belgium	106	65	15	8	1	195	2	5	4	2	5	8	12	8	9	10	9	7	8	8	7	17	10	15	14	11
14	Australia	101	51	15	3	2	172	1	3	6	2	5	7	4	3	11	9	10	13	9	4	13	12	13	12	11	4
15	Portugal	77	81	10	3	0	171	2	6	5	7	16	13	9	6	11	6	6	10	9	5	13	7	3	7	9	8
16	Netherlands	92	53	12	10	3	170	4	0	5	6	7	3	6	7	6	9	7	0	5	12	12	3	15	15	13	10
17	Iran	107	50	3	1	0	161	1	2	0	1	1	10	7	2	13	13	14	10	5	10	13	5	9	10	17	14
18	India	54	32	42	15	2	145	5	5	3	1	0	1	4	3	7	3	5	8	1	7	11	1	3	6	6	6
19	Israel	18	32	28	24	15	117	6	2	1	2	2	5	4	2	6	2	2	2	1	3	2	0	1	2	4	1
20	Austria	51	27	9	2	0	89	1	0	2	3	4	1	4	4	6	2	2	2	5	9	3	9	5	7	4	5
21	Denmark	44	30	7	1	3	85	1	2	4	4	5	2	4	1	3	4	3	5	5	4	8	4	4	3	5	3
22	Norway	49	32	1	0	0	82	1	3	3	1	6	3	4	3	3	5	1	4	3	3	5	6	4	9	6	8
23	Singapore	36	28	7	5	0	76	1	2	4	1	3	5	2	3	5	2	1	1	4	3	1	4	3	6	8	5
24	Japan	13	37	15	1	1	67	3	4	5	3	5	1	5	1	9	1	1	1	1	2	4	1	2	1	0	0
25	Chile	44	15	7	0	0	66	0	0	1	0	6	3	0	1	3	1	3	1	5	7	4	5	5	5	4	5
26	Greece	15	32	12	1	0	60	1	2	2	2	4	5	6	0	4	6	0	3	4	2	0	0	1	3	1	1
27	Poland	18	19	5	3	0	45	2	1	4	1	3	1	1	2	3	1	4	0	1	4	2	2	1	1	3	0
28	Mexico	27	14	2	1	0	44	0	0	1	0	2	6	2	0	1	2	2	7	0	2	2	1	1	5	4	3
29	Switzerland	17	18	6	2	0	43	2	1	2	0	3	0	2	3	2	3	0	0	1	2	0	3	4	2	2	3
30	New Zealand	9	19	8	1	2	39	1	2	4	2	1	2	3	1	1	2	1	3	1	1	1	0	0	0	0	2
31	Saudi Arabia	10	18	8	3	0	39	1	3	2	1	4	0	3	0	2	2	1	0	1	0	1	2	0	0	2	3
32	Finland	11	15	7	3	1	37	1	1	2	3	0	1	3	0	2	2	1	0	0	3	5	2	0	0	0	0
33	Tunisia	10	16	2	1	0	29	1	1	1	3	0	3	2	1	2	2	2	2	1	2	0	0	1	0	1	1
34	Kuwait	6	11	9	1	0	27	1	0	1	1	0	4	2	1	0	1	2	1	1	0	0	0	1	0	0	1
35	Colombia	18	7	1	0	0	26	0	0	0	0	0	0	1	2	1	3	1	1	3	0	1	3	2	2	2	3
36	Serbia	14	12	0	0	0	26	1	2	1	1	0	3	1	1	1	1	6	0	2	2	0	1	0	0	2	1
37	U Arab Emirates	19	5	2	0	0	26	0	0	0	1	2	0	1	0	0	1	0	2	0	2	3	3	4	2	2	1
38	Russia	14	10	1	1	0	26	0	0	1	0	0	2	0	0	4	3	1	1	1	1	3	2	1	3	1	0
39	Belarus	7	10	6	0	0	23	0	0	1	0	0	4	2	0	2	1	2	1	1	0	0	1	0	2	0	0
40	Sweden	11	8	4	0	0	23	0	1	2	0	0	1	2	1	0	1	1	0	2	0	0	1	2	1	3	1

Abbreviations are available in the previous tables except: D1–D5 represent the number of publications in the 10-year periods of 2014–2023, 2004–2013, 1994–2003, 1984–1993, and 1974–1983, respectively. The exact years 04–23 indicate the number of publications in that year.

Table 13
Publication structure classified by supranational regions.

R	Region	TP	TC	H	C/P	≥200	≥50	T50	Population	P/Pop	C/Pop
1	Europe	2,598	88,157	123	33.93	42	467	25	750,000,000	3.46	117.54
2	North America	2,444	79,183	122	32.40	33	428	19	380,000,000	6.43	208.38
3	Asia	2,195	77,463	118	35.29	39	454	19	4,700,000,000	0.47	16.48
	East Asia	1,319	47,932	101	36.34	25	283	9	1,600,000,000	0.82	29.96
	Middle East	405	13,969	61	34.49	8	77	6	350,000,000	1.16	39.91
	Rest of Asia	553	19,092	70	34.52	9	114	6	2,750,000,000	0.20	6.94
4	Latin America	456	12,766	58	28.00	2	71	1	660,000,000	0.69	19.34
5	Oceania	210	7,790	48	37.10	3	47	2	31,000,000	6.77	251.29
6	Africa	100	3,436	29	34.36	4	18	2	1,400,000,000	0.07	2.45

Abbreviations are available in the previous tables.

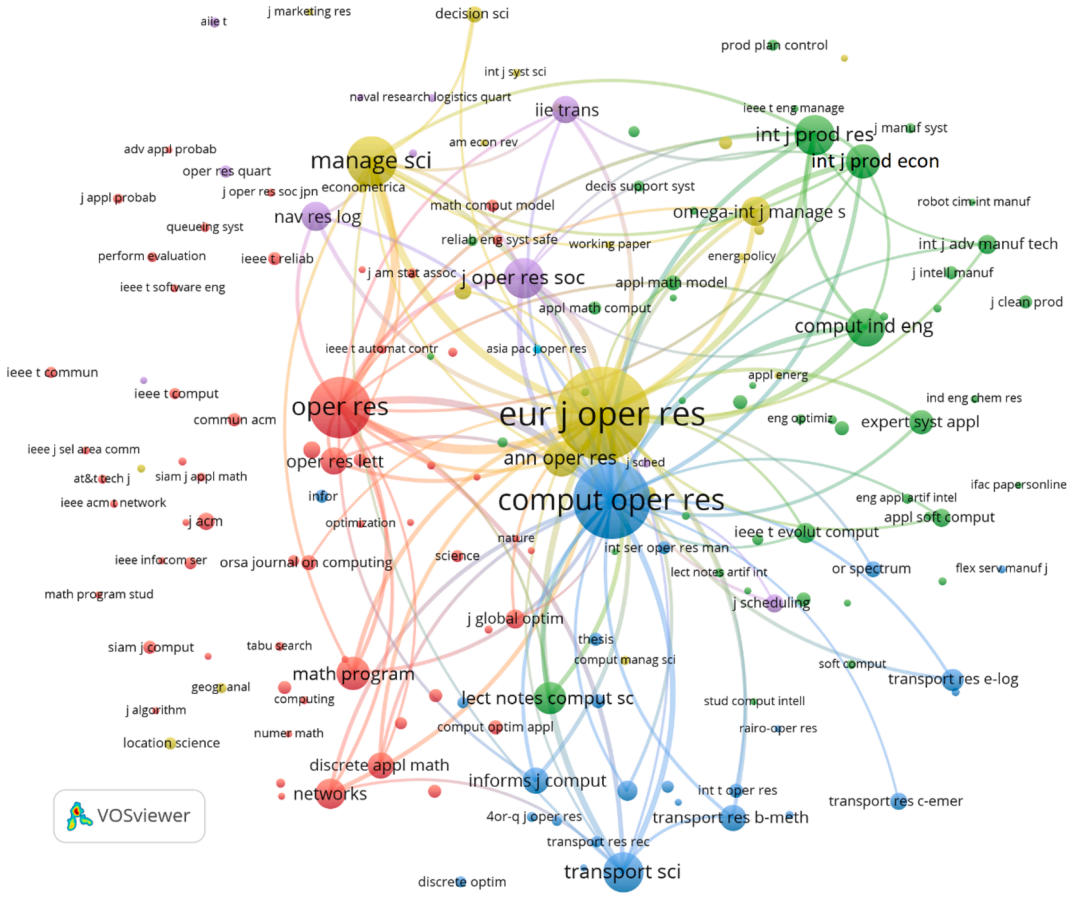

Fig. 4. Co-citation of journals cited in COR: minimum citation threshold of 100 and 100 links.

relationship between a pair of journals. The thicker the link, the more frequently the two journals are co-cited. In addition, the colour of a node in the figure indicates the cluster to which the journal belongs.

The *European Journal of Operational Research* is the most cited journal in COR. Moreover, COR itself, *Operations Research*, *Management Science*, and *International Journal of Production Research* are also highly cited. We recall that self-citations in a journal are common because the research appearing in one journal tends to influence future research in the same outlet. Therefore, it is reasonable that a substantial part of the references of the journal publications are from COR itself. Five main clusters are identified in Fig. 4. The first cluster (yellow) connects several general journals related to OR-MS, Business, and Economics, among which the *European Journal of Operational Research*, *Management Science*, *Annals of Operations Research*, and *Omega-International Journal of Management Science* are the most influential ones. The second cluster (blue) includes COR and groups the journals specialised in Transportation and Operations Research. Most of the journals covered by the third cluster (red) are in the fields of Computer Science and Mathematics, although *Operations Research* appears as the most influential journal within this cluster. Note that *Operations Research* appears in red because COR papers that frequently cite *Operations Research*, tend to be papers that also cite journals in mathematics and computer science. However, the position of *Operations Research* in the figure indicates that although it is clustered with journals in Mathematics and Computer Science, it has close connections to OR-MS journals like *Management Science*, *Journal of the Operational Research Society*, *European Journal of Operational Research* and COR. The fourth cluster (green) mainly represents Industrial and Manufacturing Engineering journals, including the *International Journal of Production Research*, *Computers & Industrial Engineering*, and the *International Journal of Production Economics*. The fifth cluster (purple) includes a few of OR-MS journals that are frequently cited in COR, such as the *Journal of the Operational Research Society*, *Naval Research Logistics*,

and *IIE Transactions*. Observe that Fig. 4 further confirms the broad scope of subject matter and the interdisciplinary profile of COR by citing journals not only from the fields of OR-MS and Computer Science, but also from other fields such as Engineering, Transportation, Mathematics, Business, and Economics.

Next, we analyse the evolution of co-citation of journals cited in COR. Figs. 5–8 present the co-citation of journals corresponding to the four periods of 1976–1993, 1994–2003, 2004–2013, and 2014–2023, respectively. Note that the minimum citation thresholds for these figures are 10, 20, 50, and 50, respectively, and the co-citation networks consider the 100 most representative links for each one. Additionally, note that the figures are not connected between each other. Therefore, the colours that VOS viewer generate for each figure are independent between them with the objective of showing in each figure how the journals cluster between them according to co-citations from COR.

Fig. 5 illustrates the co-citation of journals in COR between 1976 and 1993. As we can see in this period, *Management Science* and *Operations Research* are the most influential journals cited by COR publications. Moreover, COR has the strongest co-citation links with the two most cited journals. The self-citations of COR also play an important role in the references of the journal publications. The clusters in this graphical map are quite dispersed, where many journals in the fields of OR-MS and Mathematics are more connected while there are fewer co-citation links among the journals belonging to Industrial Engineering, Manufacturing Engineering, and Computer Science.

Fig. 6 shows the co-citation of journals in COR between 1994 and 2003. In this figure, the clusters tend to be more evident, and two main groups are formulated around *Operations Research* and *Management Science*, respectively. Compared to the first period, many journals have become more influential in COR, including the *European Journal of Operational Research*, *International Journal of Production Research*, *Computers & Industrial Engineering*, and *IEEE Transactions on Reliability*. Additionally, more representative co-citation links have emerged in this graph connecting to the journals of Industrial Engineering, Manufacturing Engineering, and Computer Science, indicating that high-quality articles in these fields are having an increasing impact on the research in COR.

Fig. 7 presents the co-citation of journals in COR between 2004 and 2013. In this case, the *European Journal of Operational Research* is the most influential journal in COR, followed by COR itself, *Operations Research*, and *Management Science*. A major cluster can be observed connecting mainly journals of OR-MS and Engineering. Note that many other journals have also become more relevant, such as *Transportation Science*, *Lecture Notes in Computer Science*, and *Discrete Applied Mathematics*. However, the citations to Computer Science and Mathematics journals are still relatively low.

Fig. 8 presents the co-citation of journals in COR between 2014 and 2023. In this period, the graphical map is denser than the other ones with more journals being cited by COR. The *European Journal of Operational Research* remains the most influential journal in COR, while the self-citations of COR are becoming more influential over time. In addition, the main structure of the co-citations in the last decade is very similar to the general structure shown in Fig. 4. In recent COR publications, the citations to journals from the fields of Engineering and Computer Science are increasing significantly, especially *Transportation Science*, *Computers & Industrial Engineering*, *International Journal of Production Research*, and *International Journal of Production Economics* that have already been cited more than *Management Science*. It is worth

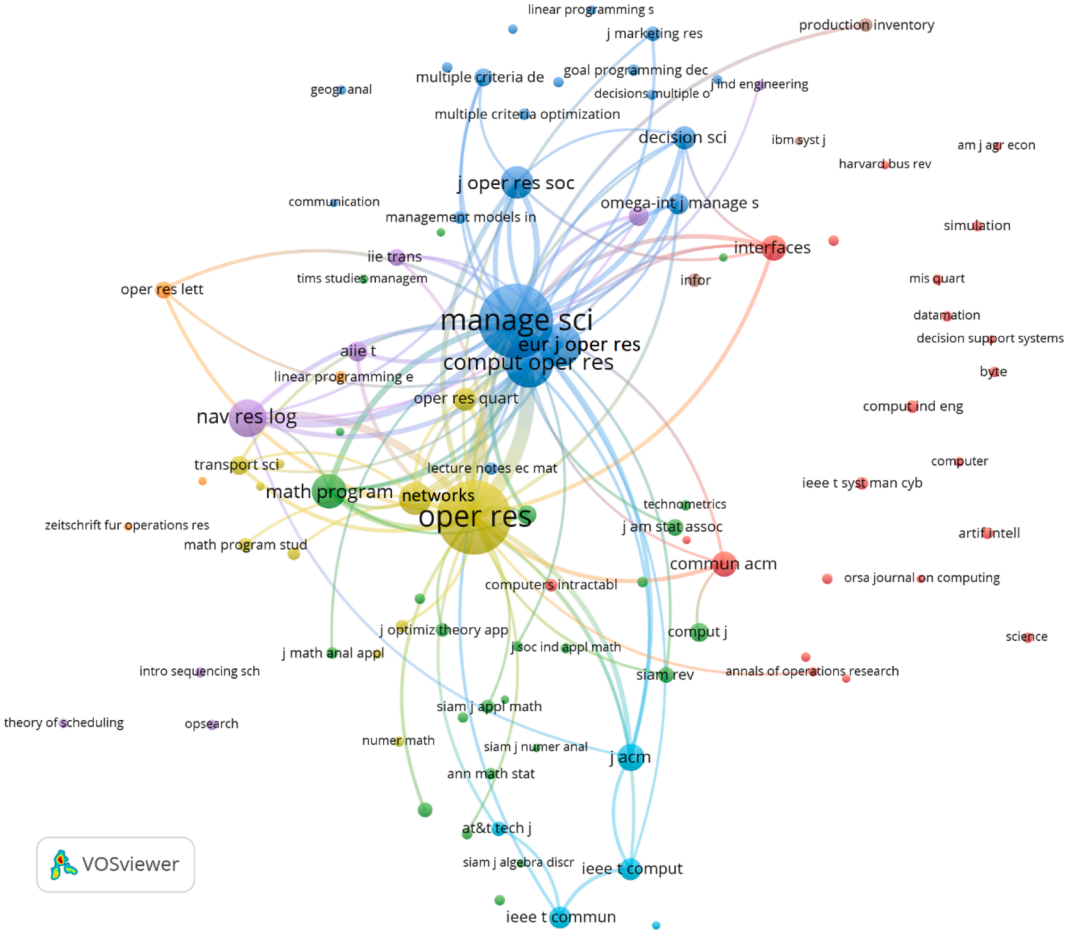

Fig. 5. Co-citation of journals in COR: 1976–1993 (minimum citation threshold of 10 and 100 links).

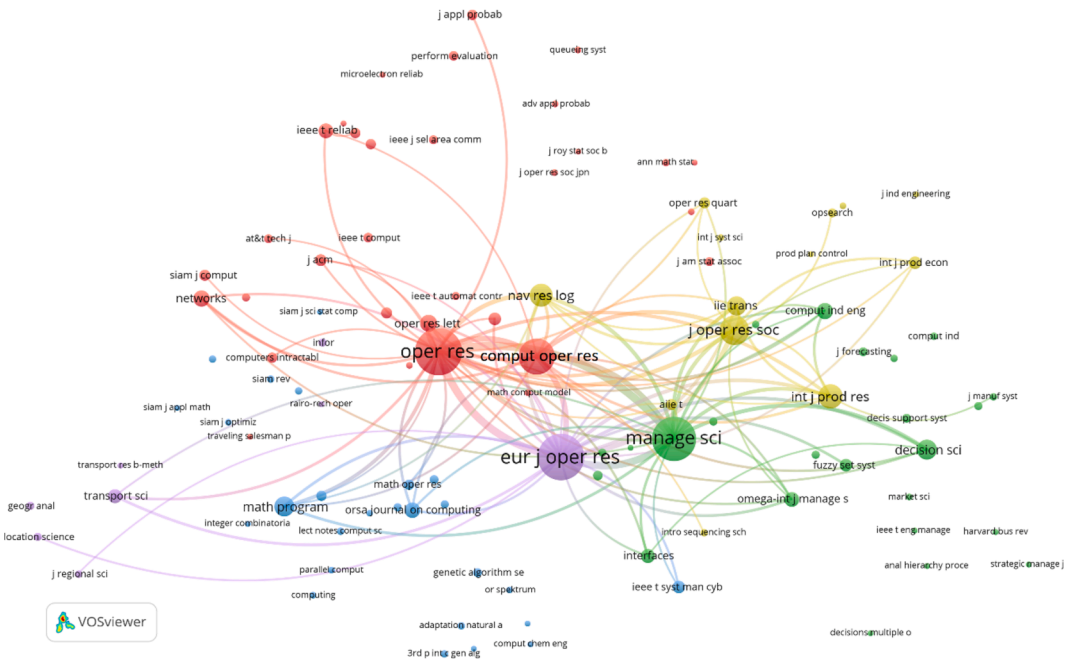

Fig. 6. Co-citation of journals in COR: 1994–2003 (minimum citation threshold of 20 and 100 links).

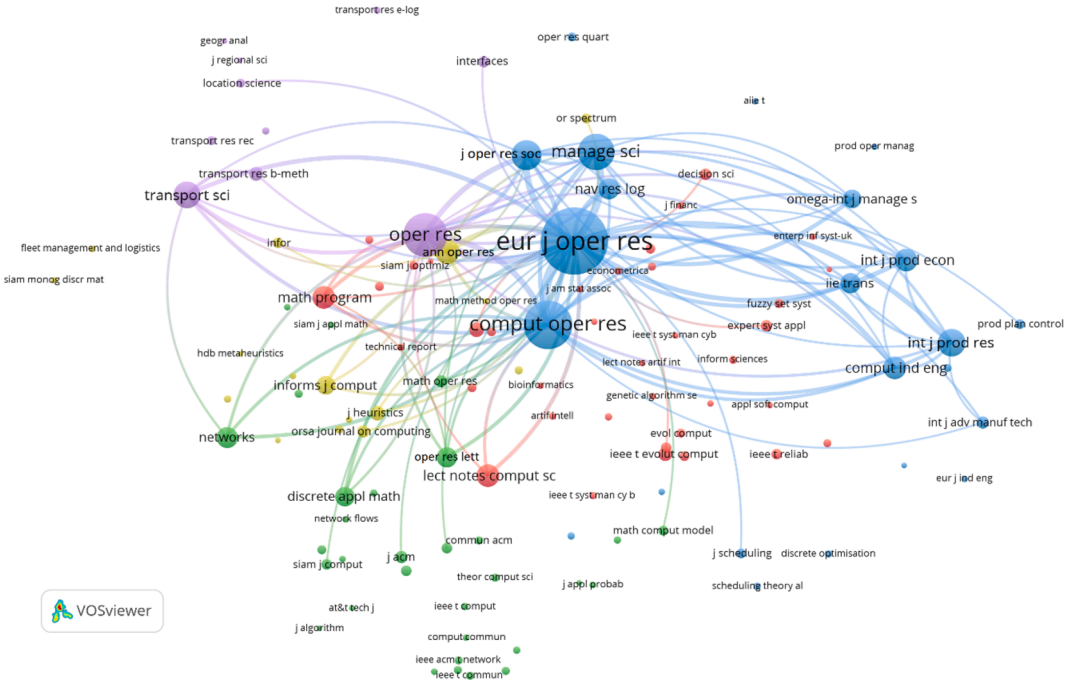

Fig. 7. Co-citation of journals in COR: 2004–2013 (minimum citation threshold of 50 and 100 links).

noting that more Transportation journals appear on the co-citation network for this period and are highly connected with COR, including *Transportation Science*, *Transportation Research Part E-Logistics and Transportation Review*, and *Transportation Research Part C-Emerging Technologies*.

To analyse the results of the co-citation of journals more deeply, Table 14 presents the details of the 40 most cited journals in COR considering the total results and the four periods mentioned above.

The results show that the leading OR-MS journals including the *European Journal of Operational Research*, *Operations Research*, and *Management Science* have been the mostly cited in COR. The self-citations of COR also take up a significant part of the references of the papers published in the journal, being ranked in the second position for the past 20 years. The *Journal of the Operational Research Society* has also shown a remarkable presence on the list since the first years of COR and remains as one of the top ten most cited journals for all the periods. Currently, the *European Journal of Operational Research*, COR itself, and *Operations Research* are the top three most influential journals in COR. Note that *Transportation Science*, *Computers & Industrial Engineering*, and *International Journal of Production Economics* have become more and more influential in COR over time, achieving the fourth, fifth, and seventh positions, respectively, in the last decade. In addition, several other

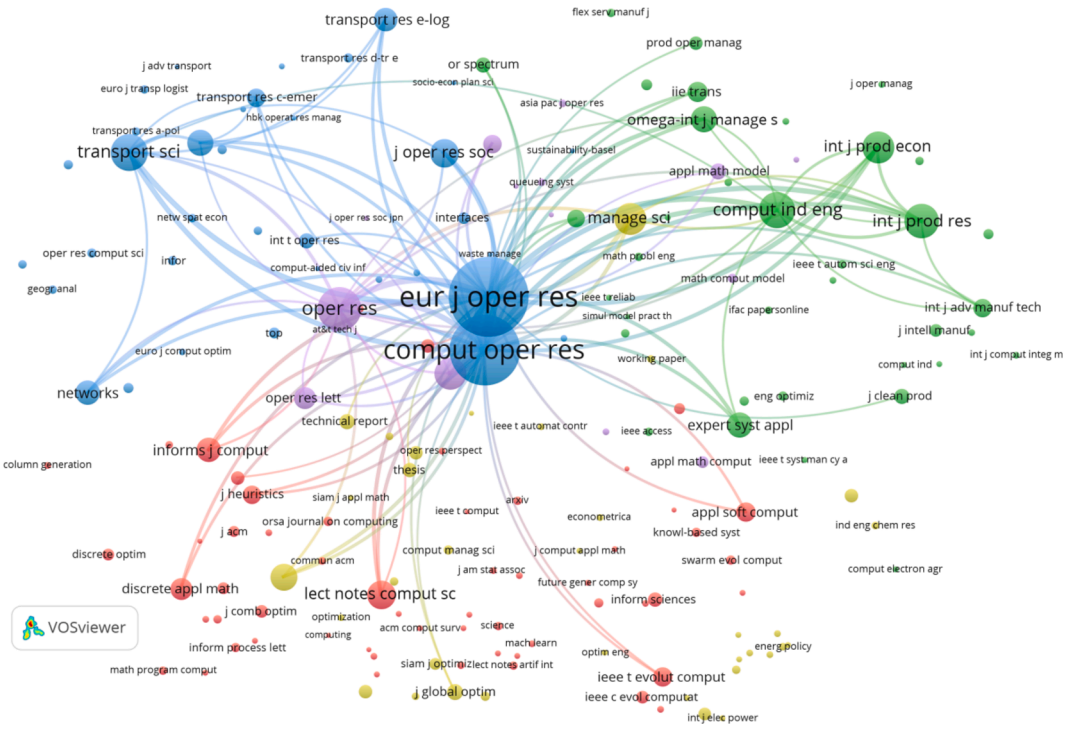

Fig. 8. Co-citation of journals in COR: 2014–2023 (minimum citation threshold of 50 and 100 links).

journals have also received more citations from the COR publications in the last few years, such as *Expert Systems with Applications* rising from 30th place in the 2004–2013 period to the 15th recently. The temporal analysis results further confirm the growing influence of Transportation journals on the papers published in COR. However, some journals have lost their edge in recent years, including *Naval Research Logistics*, *Mathematical Programming*, *Networks*, *Decision Sciences*, and *Journal of the ACM*. Moreover, the citations to *Management Science* in the journal have dropped to ninth place in the last decade. It is also worth noting that although many journals in the fields of Computer Science, Engineering, and Mathematics are not ranked in the leading positions compared to OR-MS journals, their influence on the research of COR has been increasing remarkably through time.

6.2. Co-citation of documents and authors

Next, we analyse the co-citation of documents cited in COR. The co-cited documents here are those that receive citations from the same documents published in COR. Fig. 9 presents the results with a minimum threshold of 40 citations and the 100 most representative co-citation connections among the documents.

As we can see the majority of the highly cited documents appearing in Fig. 9 are visualised in Table 6. In addition, the documents from OR-MS journals take a large proportion in this general co-citation map, among which the classic works by Nenad Mladenović, Marius M. Solomon, and Fred Glover, are the most relevant ones. Note that in this map, the most cited book "Computers and Intractability: A Guide to the Theory of NP-Completeness" by Garey and Johnson (1979) (Table 6) appears as "anonymous". The second most cited document is the book chapter of Discrete Optimisation by Ronald L. Graham.

To examine who have significantly influenced the papers published in COR and how the corresponding profiles are connected, we focus on the co-citation analysis of authors cited in the journal. The co-citation of authors occurs when two documents of different authors receive a citation from the same third document. Fig. 10 visualises the authors who have received at least 100 citations from COR and the 100 most representative co-citation connections among the authors.

The most influential author to COR is Fred Glover, who has three highly cited documents in COR publications among the top 50 in Table 6. Furthermore, he has the largest number of representative co-citation links with other cited authors. Some other most cited authors in the journal are Gilbert Laporte, Michel Gendreau, Pierre Hansen, and Jean-François Cordeau. It is logical that many of the highly cited researchers in Fig. 10 are also authors of documents shown in Table 6 and Fig. 9 because the authors having highly cited documents tend to be more influential to the journal. It is worth noting that the top five leading authors in COR (shown in Table 7), including Gilbert Laporte, T. C. E. Cheng, Bruce L. Golden, Michel Gendreau, and Jean-François Cordeau, all appear on the co-citation map of authors, which indicates their strong effect on the journal's publications.

6.3. Bibliographic coupling

Another interesting aspect to investigate is the bibliographic coupling of documents published in COR. Recall that bibliographic coupling occurs when two documents cite the same third work in their references (Kessler, 1963).

6.3.1. Bibliographic coupling of articles and authors

By incorporating time information, Fig. 11 shows the 200 strongest bibliographic coupling links between the papers published in COR that have obtained a minimum threshold of 150 citations within the WoS. Note that the colour of a paper in the map indicates the paper's publication year.

The results of this figure are consistent with those of Table 4. The main advantage is that in the figure we visualise how each of the influential papers of COR is connected to the other ones. The top five most influential COR publications are mainly from the eighties and nineties. This is partly because the older work is likely to receive more citations than recent one. Observe that the papers published within the same five-year period tend to be connected more frequently — that is, they are more related to each other by citing the same bibliographic material. For example, the strongest bibliographic coupling connection occurs between the works by Aringhieri et al. (2017) and Ahmadi-Javid

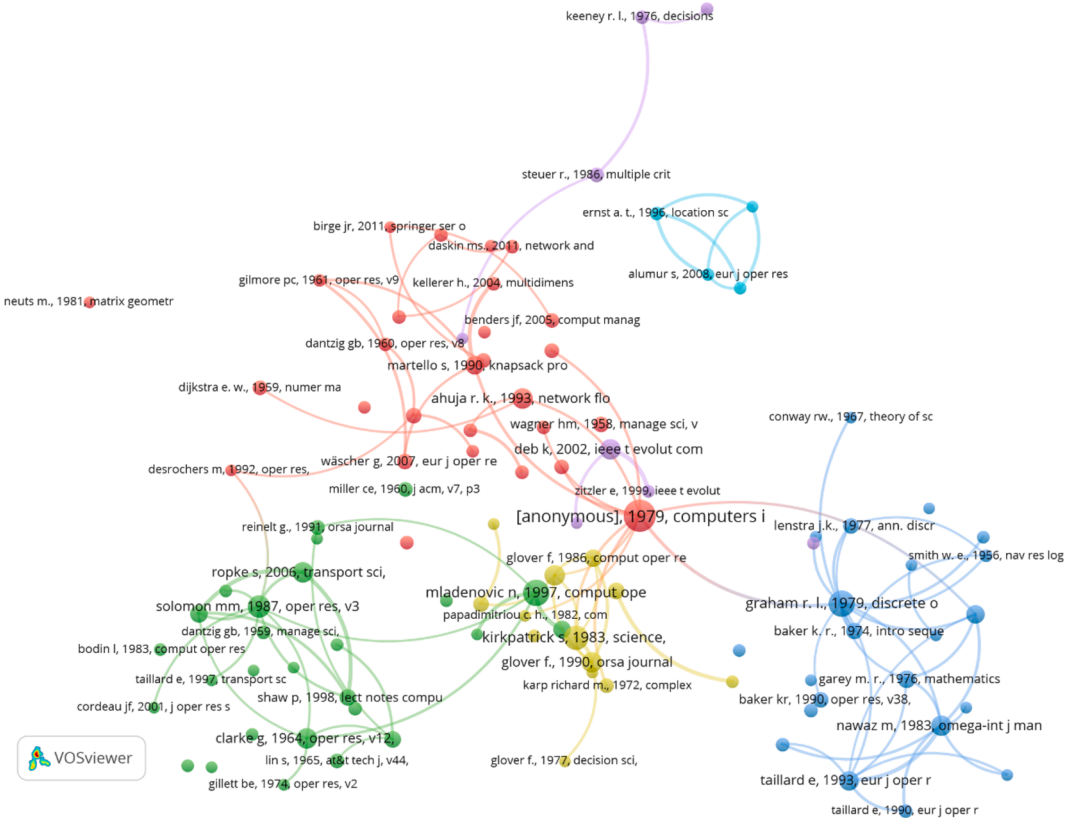

Fig. 9. Co-citation of documents cited in COR: minimum citation threshold of 40 and 100 links.

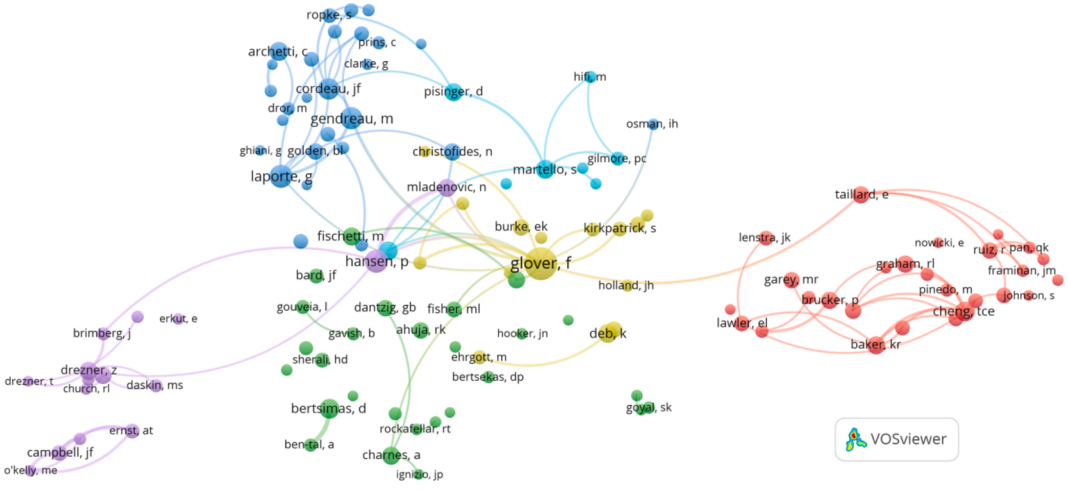

Fig. 10. Co-citation of authors cited in COR: minimum citation threshold of 100 and 100 links.

et al. (2017), both addressing the application of Operations Research in healthcare services. In addition, the papers published in the last 20 years are more connected through representative bibliographic coupling links. However, one special case is that the research on the routing and scheduling of vehicles and crews from Bodin et al. (1983) is strongly connected to many other COR publications in the same domain. Although the papers by Mladenović and Hansen (1997) and Glover (1986) have received the highest number of citations, they have few bibliographic coupling links in the graph.

We focus now on the bibliographic coupling analysis involving authors who have published in COR. This type of coupling occurs when two authors with two different documents cite the same third document. Fig. 12 displays the leading authors with a minimum threshold of 10 documents published in the journal and the 100 most representative bibliographic coupling links between authors. The more of the same documents a pair of COR publications co-cite, the thicker the link connecting the two authors, and the more likely the two authors work in similar areas. Note that the colour of a node in this graph represents the average publication year of all the author's papers published in COR.

As we can observe from Fig. 12, the top 50 leading authors in COR presented in Table 7 appear in this figure as the most productive authors. Additionally, aligning with Table 8, most of the authors have published more papers in the journal during the last decade, and they are also the core authors with many strong bibliographic coupling links. Gilbert

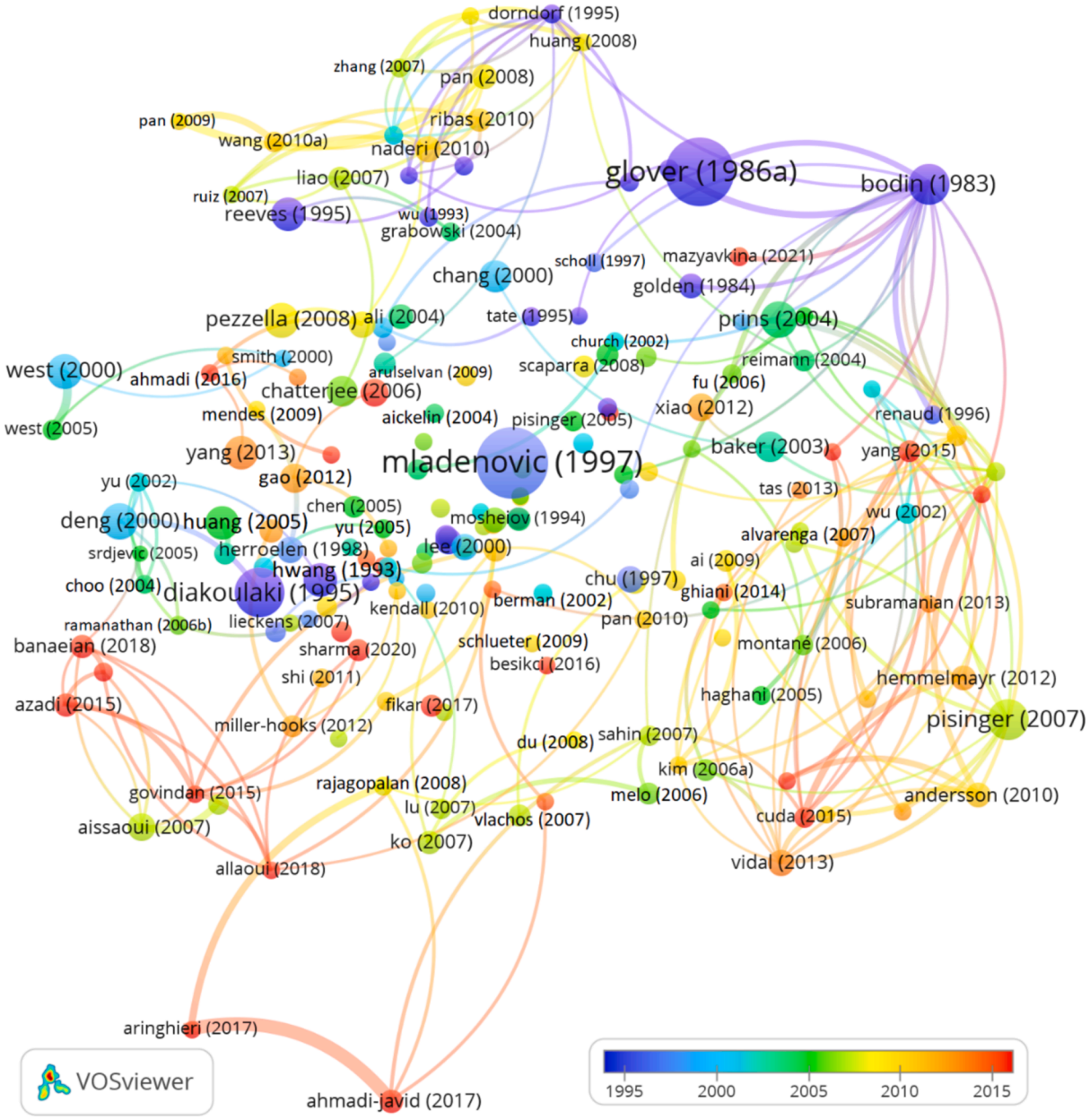

Fig. 11. Bibliographic coupling of articles published in COR: minimum threshold of 150 citations and 200 links.

Laporte is the most productive author in the journal and has the richest coupling connections with other productive authors in the graph. Moreover, there is a significant bibliographic coupling connection between Jose M. Framiñan and Victor Fernandez-Viagas, reflecting that the two authors have similar research profiles, especially for Operations Research in production planning and scheduling. Notably, the most productive authors during the first three decades of the journal's publication are not frequently connected with the other authors via the bibliographic coupling relationship.

6.3.2. *Bibliographic coupling of institutions and regions*

Next, we analyse the bibliographic coupling of institutions the authors publishing in the journal belong to. Note that the bibliographic data of institutions depends on the author affiliations at the time of publication of papers in COR. Similarly to the bibliographic coupling of authors, institution coupling occurs when two documents by authors from two different institutions cite the same third document. Fig. 13 presents the results considering a minimum publication threshold of 10 documents and the 100 strongest bibliographic coupling links between institutions. The more references pairs of COR papers (corresponding to two different institutions) co-cite, the larger the link strength connecting the two institutions, and the higher the probability that the two institutions undertake similar research. In addition, for a specific institution, the average publication year of all its COR publications is denoted by a certain colour in this figure.

The results of this figure are in accordance with those of Tables 9 and 10. HEC Montréal is the most productive institution, followed by the University of Seville and Polytechnique Montréal. Note that in Table 9, CNRS is ranked in the first position among the 50 most productive and influential institutions in the journal, but it is not shown in the map of the bibliographic coupling of institutions. The reason is that although the papers published by some research centres of the universities in France are also associated with CNRS, they are only counted in their affiliated universities in the VOS viewer software. As revealed by Fig. 13, most of the institutions from the USA and Canada show an important presence in the period around 2005–2010. Many European institutions,

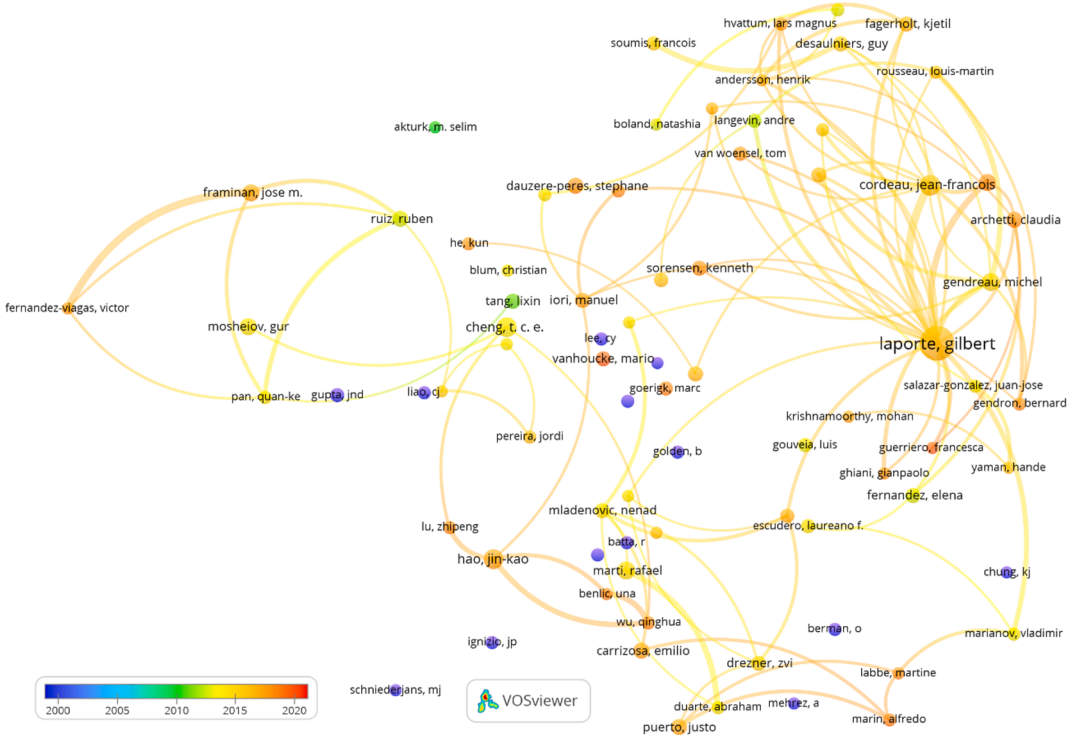

Fig. 12. Bibliographic coupling of authors publishing in COR: minimum publication threshold of 10 documents and 100 links.

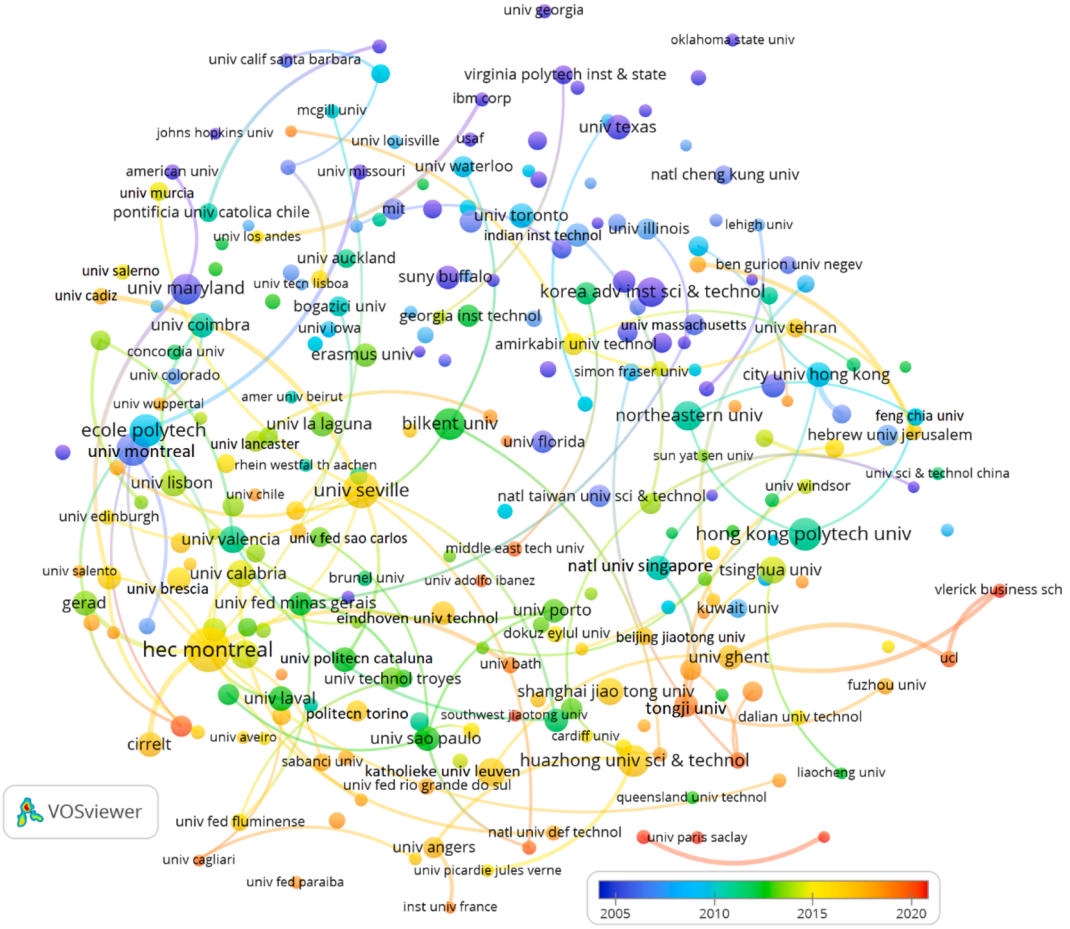

Fig. 13. Bibliographic coupling of institutions publishing in COR: minimum publication threshold of 10 documents and 100 links.

especially from France, Spain, the UK, and Italy, have published most of their papers in COR during the last decade. In the recent few years, more institutions from developing economies, particularly China, have published regularly in the journal. Furthermore, it is worth noting that institutions are most closely coupled with those in the same or nearby countries/territories. This finding indicates that these institutions tend to work on closer topics or research areas. Another interesting fact is that most of the representative coupling links in the graph connect the institutions with similar average publication years.

Next, we scale up the bibliographic coupling analysis to the country/territory level, that is, the country/territory of the institution in which an author is working at the time of getting the paper published in COR. This type of coupling occurs when two documents from two different countries/territories cite the same third document. Fig. 14 visualises the data by using Scopus database with a minimum publication threshold of five documents and the 50 most significant bibliographic coupling links between countries/territories. Like the institution-level coupling analysis, the more identical documents that are cited by a pair of COR publications, the thicker the link connecting the two countries/territories, and the more likely the two countries/territories working in similar research areas. Note that the colour of a country/territory represents the average publication year of all the COR publications affiliated with the country/territory.

The USA is the most productive country/territory in the journal and holds a central position being strongly connected with many other countries/territories, especially China and Canada. However, the average publication year corresponding to the USA is around 2006, which is the same case for Taiwan, South Korea, and Israel. Canada shows its remarkable presence mainly between 2008 and 2010, and the UK around the year 2012. In the last decade, there have been a growing number of COR publications from China, France, Spain, Italy, Brazil, and Turkey. Moreover, Iran has also seen a recent increase in the papers published in the journal. The results in the figure are consistent with those of Tables 11 and 12. Observe that apart from the USA, the major hubs with a number of strong coupling links include China, France, the UK, Canada, Turkey, Italy, Spain, and Germany.

7. Keyword and topical analysis

In this section, we analyse the most popular keywords and topics of COR to identify the thematic trends in the journal. Firstly, a graphical visualisation of the co-occurrence of author keywords is developed by using the VOS viewer software. The publications in COR have author keywords starting in 1998. Therefore, the 5,297 publications with records of keywords from 1998 to 2023 are considered for the co-occurrence analysis of author keywords. Recall that the co-occurrence occurs when two keywords appear in the same document (Merigó et al., 2018). Fig. 15 illustrates the general map of the most frequently used keywords and their co-occurrence relations in the journal between 1998 and 2023 with at least 10 occurrences and the 100 most significant co-occurrence links.

Scheduling is by far the most popular keyword in the journal, followed by heuristics, combinatorial optimisation, integer programming, and tabu search. Although the clusters are dispersed in the figure, there is a large group (red) centred around scheduling and another major group (dark blue) mainly connected to combinatorial optimisation, metaheuristics, and genetic algorithm. In addition, the less dispersed yellow cluster is built around column generation and vehicle routing although several other keywords in terms of optimisation algorithms are also included. It is clear that scheduling and heuristics are two major hubs with many strong co-occurrence links connected to a number of keywords. The most representative co-occurrence links appearing in Fig. 15 are the ones connecting scheduling with flowshop, heuristics, and makespan, as well as the link between heuristics and tabu search. From a general perspective, the journal shows an obvious orientation to Operations Research, Engineering, Computer Science, and Applied Mathematics.

To investigate the temporal evolution of author keywords in COR and reveal the emergent trends in recent years, Figs. 16–18 present the results, focusing on the three periods: 1998–2003, 2004–2013, and 2014–2023. Specifically, Fig. 16 shows the co-occurrence of author keywords for the documents published in COR between 1998 and 2003 considering a minimum occurrence threshold of three times and the 100

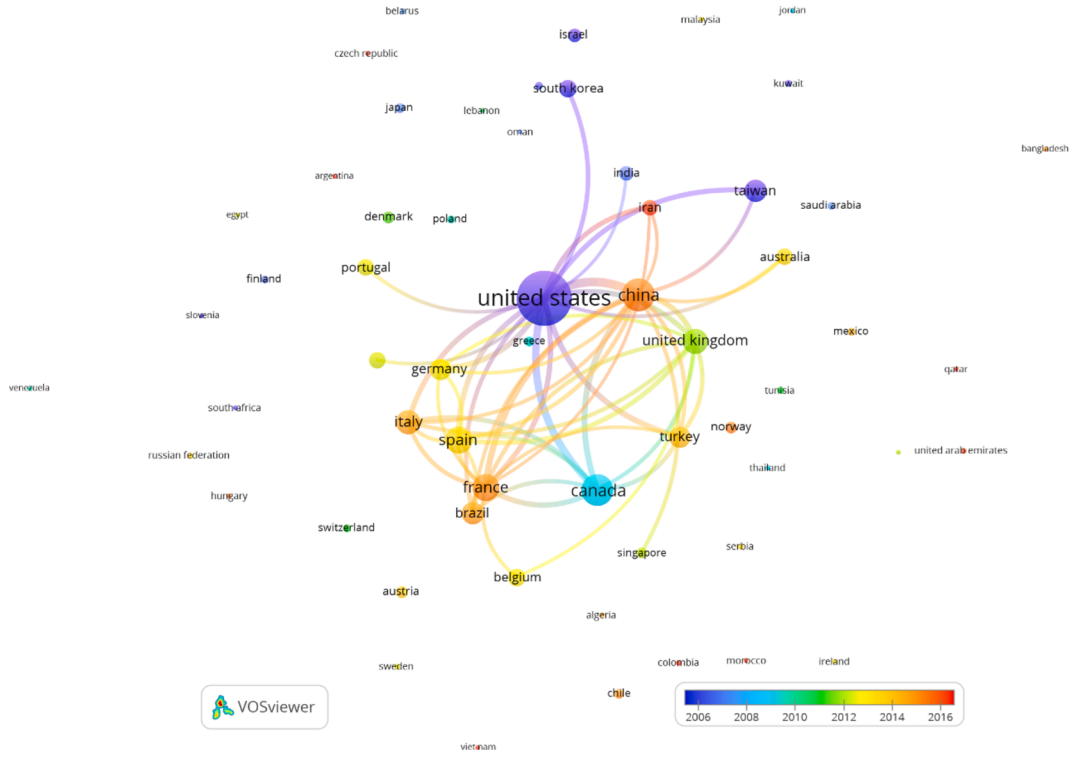

Fig. 14. Bibliographic coupling of countries/territories publishing in COR: minimum publication threshold of 5 documents and 50 links.

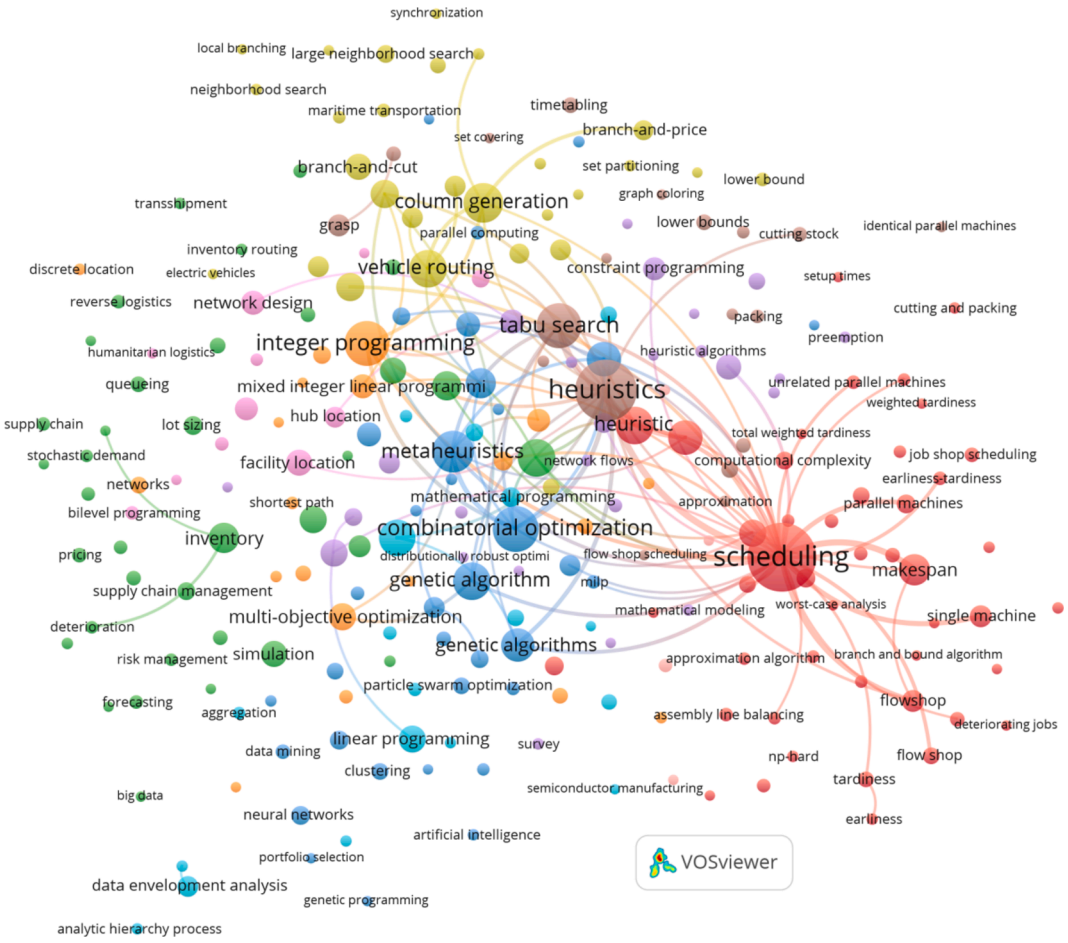

Fig. 15. Co-occurrence of author keywords in COR: minimum occurrence threshold of 10 and 100 links.

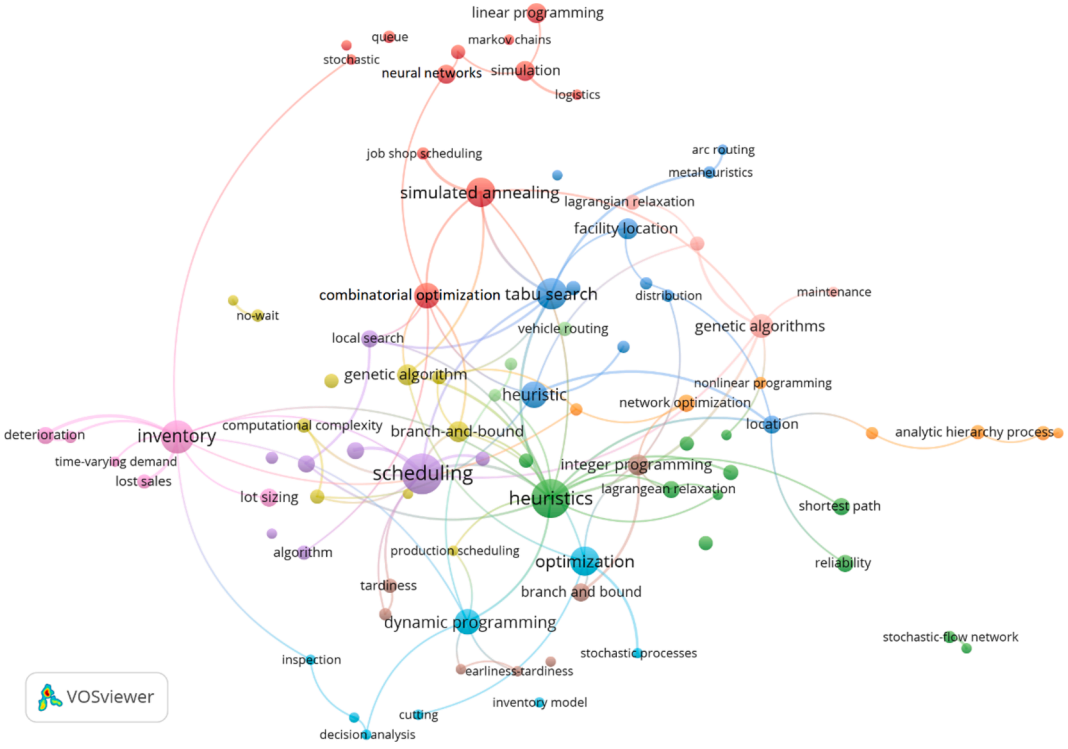

Fig. 16. Co-occurrence of author keywords in COR: 1998–2003 (minimum occurrence threshold of three and 100 links).

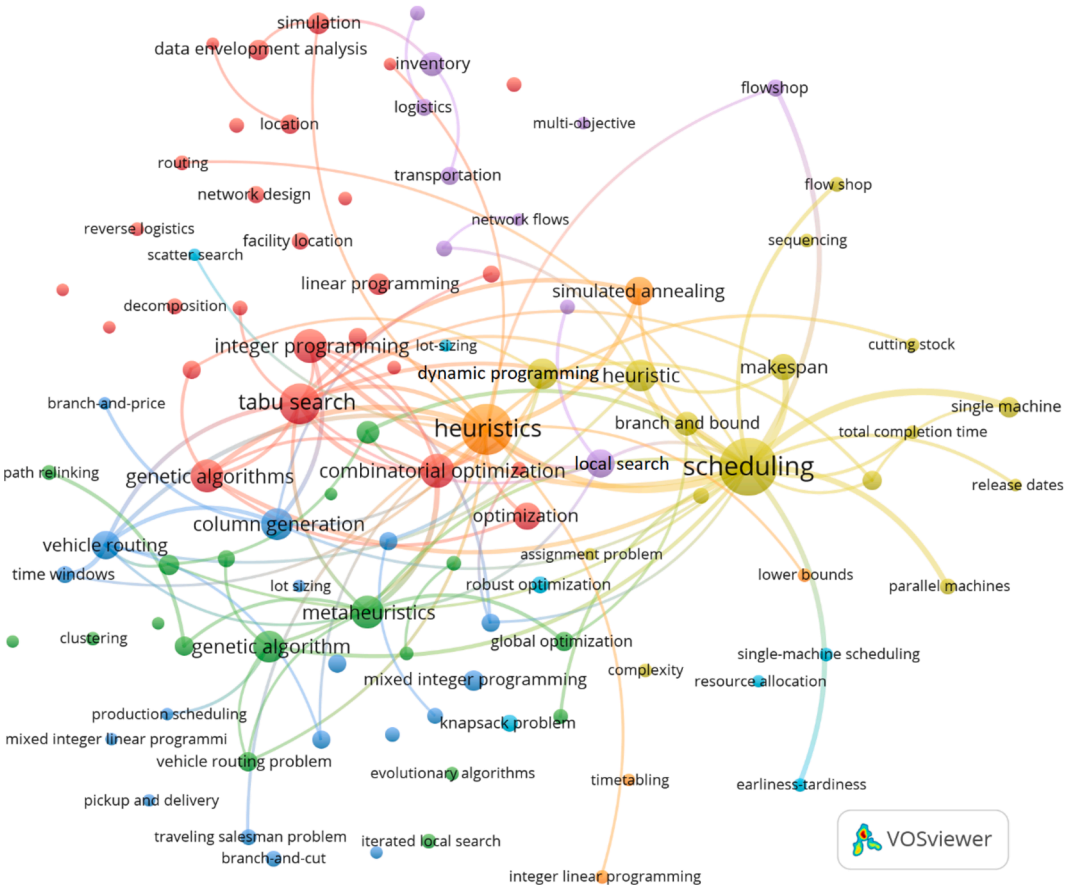

Fig. 17. Co-occurrence of author keywords in COR: 2004–2013 (minimum occurrence threshold of 10 and 100 links).

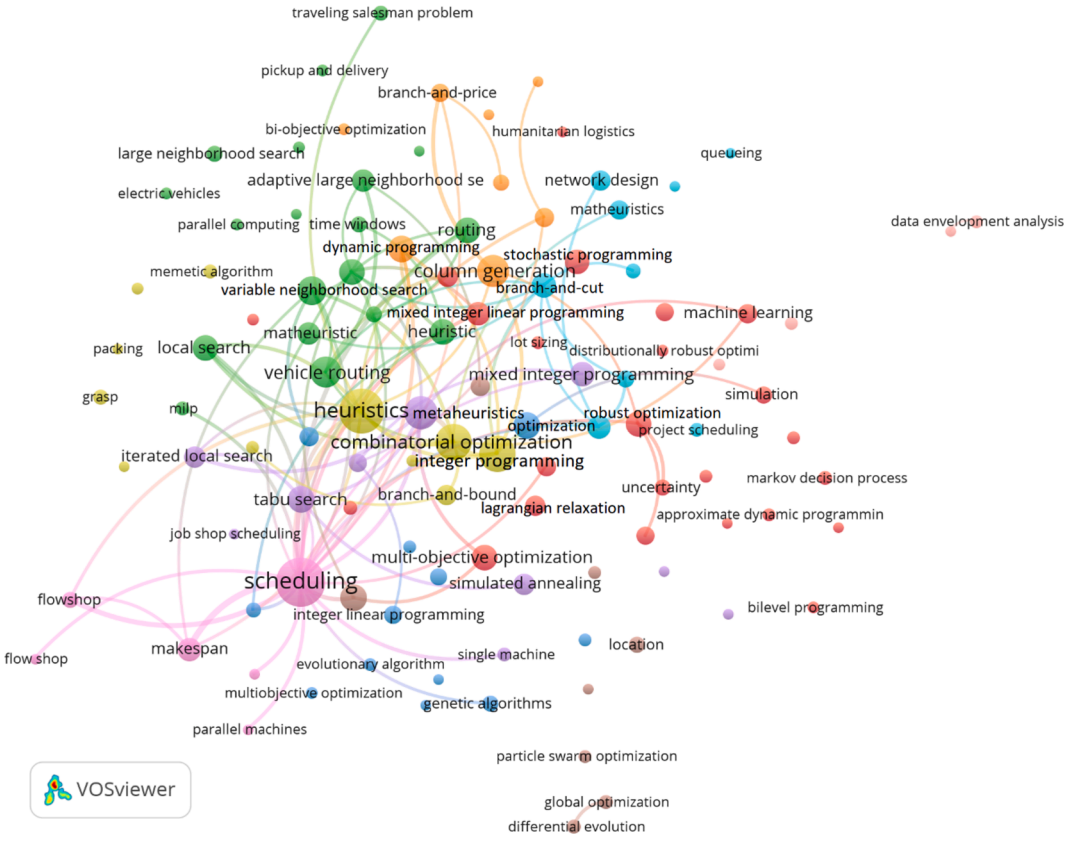

Fig. 18. Co-occurrence of author keywords in COR: 2014–2023 (minimum occurrence threshold of 10 and 100 links).

strongest co-occurrence links.

The most commonly used author keywords in this period are scheduling, heuristics, inventory, and tabu search, which are also strongly connected to a number of other keywords. Three consolidated clusters are located in the central positions of Fig. 16, where the purple cluster is built based on scheduling, the green cluster around heuristics, and the pink cluster mainly on inventory. It is worth noting that apart from heuristics and tabu search, other keywords about the optimisation methods have also obtained significant presences during this period, such as simulated annealing, dynamic programming, genetic algorithms, branch-and-bound, integer programming, and linear programming. However, vehicle routing as a keyword was not used frequently between 1998 and 2003, indicating that the studies related to the topic had just begun.

Fig. 17 presents the co-occurrence of author keywords for the documents published in COR from 2004 to 2013. In this case, the figure uses a minimum occurrence threshold of 10 and the 100 most representative co-occurrence links between the author keywords.

For the period between 2004 and 2013, the graph of the co-occurrence of author keywords has become denser than Fig. 16 with many emergent keywords included, such as column generation, data envelopment analysis, global optimisation, and robust optimisation. Scheduling keeps its leading position in the journal, followed by heuristics, tabu search, combinatorial optimization, and integer programming. These most popular keywords also act as the main hubs strongly connecting with many others. For example, scheduling occurs more frequently together with heuristics, single machine, and parallel machines. Moreover, many keywords appearing in Fig. 16 have received more attention during this period, including scheduling, heuristics, tabu search, integer programming, genetic algorithms, vehicle routing, among others. In this case, the main clusters are formulated towards the general structure of the co-occurrence of author keywords presented in Fig. 15.

Fig. 18 visualises the co-occurrence of author keywords for the documents published in COR during the last decade (i.e., 2014–2023). The figure presents the author keywords with a minimum occurrence threshold of 10 times and the 100 most significant co-occurrence links.

For the last decade, scheduling has been the most popular keyword, followed by heuristics and combinatorial optimisation. Additionally, scheduling and heuristics have the largest network strongly connected to a number of keywords. However, it is noticeable that compared with Fig. 17, the importance of scheduling, heuristics, tabu search, genetic algorithms, and simulated annealing has reduced, especially for tabu search. In contrast, some keywords have highly increased their frequency and relevance between 2014 and 2023, including vehicle routing, mixed integer programming, and network design. It is worth noting that the green and red clusters involve a few new keywords although not many strong co-occurrence links are connected to them, such as adaptive large neighbourhood search, matheuristic, memetic algorithm, and electric vehicles in the green cluster, and multi-objective optimisation, machine learning, uncertainty, and approximate dynamic programming in the red cluster. Two of the most representative co-occurrence links in this graph are those between scheduling and makespan as well as between scheduling and heuristics.

To more specifically observe how the leading author keywords in COR are evolving over time, Table 15 presents the top 40 keywords of all time (from 1998 to 2023) and of the three periods: 1998–2003, 2004–2013, and 2014–2023.

The results of Table 15 are in accordance with those provided by Figs. 15–18. The figures may omit the names of some keywords, but the data shown in Table 15 are more specific with occurrences and co-occurrence link strength corresponding to each keyword among the top 40. As observed in this table, scheduling and heuristics are not only ranked as the top two keywords in the journal of all time but also for all the three periods. In addition, many other keywords, such as tabu search, optimisation, combinatorial optimization, simulated annealing, genetic algorithm, integer programming, and local search, have also persisted for over two decades, which indicates that these themes are long-lasting hotspots in COR. Note that in the last decade, tabu search has been overtaken by combinatorial optimization, integer programming, metaheuristics, column generation, variable neighbourhood search, dynamic programming, and genetic algorithm, although it remains highly relevant in the 11th position. Vehicle routing, routing, and vehicle routing problem have attracted significant attention in recent years. Moreover, there are noteworthy developments of several themes especially related to robust optimisation, multi-objective optimisation, mixed integer programming, branch-and-cut, stochastic programming, Benders decomposition, iterated local search, and network design. Emergent keywords have occurred during each period and currently, matheuristic, adaptive large neighbourhood search, and machine learning are the active ones in the journal. However, inventory and simulated annealing have been seen a significant decrease in their dominance since 2004, which is the same situation for some other keywords including facility location, linear programming, simulation, and neural networks. Observe that the frequency of scheduling, heuristics, and genetic algorithm has also decreased during the last decade, although these keywords still occupy the leading positions. It is worth noting that if we unify singular and plural terms or ignore hyphens, the ranking of heuristic (heuristics), metaheuristic (metaheuristics), genetic algorithm (genetic algorithms), matheuristic (matheuristics), branch and bound (branch-and-bound), mixed integer programming (mixed-integer programming), and mixed integer linear programming (mixed-integer linear programming) would be much higher in the list. For example, heuristic (heuristics) would outrank scheduling and take the first place in the ranking.

To obtain a general picture of the leading topics and topic clusters in COR, we further analyse the bibliographic data provided by Scopus through the SciVal platform. SciVal (SciVal, 2024) is a sub-database of Scopus that can collect and analyse the bibliographic material related to publications listed in Scopus from the last 10 years, 2013–2022. Several shorter periods can also be considered in SciVal for data analysis up to 2024. This platform provides statistical data and high-level overviews of research performance of authors, institutions, countries/territories, and journals in specific research areas or topics. In this study, we focus on investigating the topics and topic clusters that COR has contributed to between 2013 and 2022. Note that every publication can only belong to one topic and one topic cluster.

Table 16 summarises the 50 most frequent topics in COR. In this table, three bibliometric indicators, i.e., the total number of publications, field-weighted citation impact (FWCI), and worldwide prominence percentile are used for measuring the topics. The prominence percentile of a topic represents the worldwide impact of the topic compared to similar topics in all the journals indexed in the Scopus database (Klavans and Boyack, 2017). A topic's FWCI of COR measures how the number of citations received by corresponding COR publications compares with the average number of citations received by related publications on this topic in all the journals indexed in Scopus (Purkayastha et al., 2019). The value of a topic's FWCI equal to 1.00 indicates that the publications of COR on this topic have been cited at world average for similar publications during the period of 2013–2022; the value greater than 1.00 indicates that the publications of COR on this topic have been cited more than expected based on the world average for similar publications; and the value less than 1.00 denotes that the publications of COR on this topic have been cited less than expected based on the world average for similar publications. Note that the ranking of topics is according to the total number of publications, and in case of a tie, the worldwide prominence percentile is considered.

The most popular topic in COR is 'Time windows; Pickup and delivery; Dynamic routing' with 153 publications, followed by 'Flow shop scheduling; Permutation flowshop; Scheduling problem' and 'Hub location; Hub and spoke network; Hub' with 79 and 46 publications, respectively. Observe that many of the leading topics on the list involve

Table 14
Co-citation of journals cited in COR: Global and temporal analysis.

R	Global			2014–2023			2004–2013			1994–2003			1976–1993		
	Journal	Cit	CLS	Journal	Cit	CLS	Journal	Cit	CLS	Journal	Cit	CLS	Journal	Cit	CLS
1	Eur J Oper Res	17,595	14,211.72	Eur J Oper Res	10,084	8283.09	Eur J Oper Res	6,085	4742.57	Oper Res	1,188	974.07	Manag Sci	769	597.06
2	Comput Oper Res	12,154	10,480.61	Comput Oper Res	7,881	6783.77	Comput Oper Res	3,250	2825.09	Eur J Oper Res	1,175	955.47	Oper Res	753	604.89
3	Oper Res	7,647	6685.41	Oper Res	3,075	2816.84	Oper Res	2,631	2305.08	Manag Sci	1,048	853.88	Comput Oper Res	315	274.29
4	Manag Sci	5,227	4464.04	Transport Sci	2,183	1936.47	Manag Sci	1,797	1558.74	Comput Oper Res	708	620.56	Eur J Oper Res	251	230.41
5	Int J Prod Res	3,342	2856.81	Comput Ind Eng	2,072	1936.73	J Oper Res Soc	1,259	1166.84	J Oper Res Soc	479	381.34	Naval Res Logist	193	170.95
6	Transport Sci	3,309	2889.16	Int J Prod Res	1,926	1707.53	Int J Prod Res	1,038	838.87	Int J Prod Res	324	256.31	Math Program	164	146.07
7	J Oper Res Soc	3,243	2978.78	Int J Prod Econ	1,625	1495.70	Transport Sci	965	809.76	Naval Res Logist	291	266.88	Networks	152	132.31
8	Comput Ind Eng	2,927	2730.53	Annals Oper Res	1,623	1550.68	Annals Oper Res	817	779.63	Math Program	220	186.99	J Oper Res Soc	148	132.06
9	Annals Oper Res	2,538	2424.11	Manag Sci	1,613	1482.93	Lect Notes Comp Sc	737	657.15	Decision Sci	217	183.42	J ACM	102	91.11
10	Int J Prod Econ	2,431	2236.63	J Oper Res Soc	1,357	1303.60	Int J Prod Econ	716	654.78	IIE Trans	202	189.16	Commun ACM	88	78.28
11	Math Program	2,270	2065.43	Lect Notes Comp Sc	1,354	1236.78	Math Program	708	636.85	Oper Res Lett	158	150.38	Interfaces	88	77.47
12	Lect Notes Comput Sc	2,120	1920.80	Math Program	1,178	1094.61	Comput Ind Eng	689	646.12	Networks	150	130.16	Decision Sci	78	69.37
13	Networks	1,909	1755.17	Omega	1,112	1065.82	Naval Res Logist	640	593.21	Comput Ind Eng	144	131.41	Oper Res Quart	76	71.67
14	Omega	1,767	1688.34	Transport Res	1,081	955.98	Networks	621	568.96	Annals Oper Res	139	130.59	IEEE T Commun	68	40.01
15	Naval Res Logist	1,705	1592.86	Expert Syst Appl	1,050	984.48	IIE Trans	586	550.03	ORSA J Comput	131	122.53	IEEE T Comput	67	52.08
16	Oper Res Lett	1,551	1496.98	INFORMS J Comput	986	946.19	Oper Res Lett	582	557.87	Omega	119	113.14	Omega	62	59.74
17	IIE Trans	1,476	1400.96	Networks	986	923.86	Discrete Appl Math	547	516.44	IEEE T Reliab	118	76.66	AIIE Trans	58	49.88
18	INFORMS J Comput	1,468	1413.09	Transport Res E-Log	938	873.04	INFORMS J Comput	477	462.16	Transport Sci	112	99.07	Int J Prod Res	54	49.76
19	Discrete Appl Math	1,376	1311.68	Oper Res Lett	769	747.18	Omega	474	449.27	Interfaces	107	99.35	Comput J	52	41.67
20	Transport Res B-Meth	1,366	1203.39	Discrete Appl Math	763	729.82	J Heuristics	305	296.33	Fuzzy Set Syst	92	52.59	Econometrica	52	47.18
21	Expert Syst Appl	1,249	1156.47	IIE Trans	646	620.38	J Global Optim	290	265.09	IEEE T Syst Man Cy	90	82.10	Transport Sci	49	45.37
22	Transport Res E-Logist	1,016	942.27	Appl Soft Comput	626	603.19	IEEE T Evol Comp	269	239.47	Int J Prod Econ	90	84.93	IIE Trans	42	39.77
23	IEEE T Evolut Comp	865	761.19	IEEE T Evol Comp	596	522.44	Transport Res	255	219.22	J ACM	78	75.84	Oper Res Lett	42	40.19
24	J Heuristics	864	842.82	Naval Res Logist	581	564.27	J ACM	220	211.35	Oper Res Quart	72	67.97	J Am Stat Assoc	40	32.10
25	Int J Adv Manuf Tech	787	747.20	Transport Res C-Emer	574	533.79	Math Oper Res	217	210.82	SIAM J Comput	71	66.15	SIAM Rev	34	33.69
26	J Global Optim	766	719.45	Int J Adv Man Tech	571	544.15	ORSA J Comput	216	211.50	AIIE Trans	69	65.52	AT&T Tech J	33	30.07
27	Appl Soft Comput	690	664.31	J Heuristics	549	536.83	Int J Adv Man Tech	213	200.12	Commun ACM	68	55.93	J Appl Probab	32	26.18
28	J Scheduling	675	649.11	J Scheduling	528	505.82	Interfaces	197	185.36	IEEE T Software Eng	65	46.94	J Marketing Res	31	24.08
29	Interfaces	636	591.48	J Global Optim	440	417.56	Decision Sci	185	171.06	J Appl Probab	64	53.25	Infor	28	27.50
30	Transport Res C-Emer	609	566.52	Appl Math Model	407	393.66	Expert Syst Appl	185	161.36	Math Oper Res	64	62.20	J Optim Theory App	28	27.09
31	Math Oper Res	593	573.93	OR Spectrum	398	389.37	IEEE T Reliab	168	114.62	IEEE T Commun	62	52.87	Production Inventory	28	22.14
32	J ACM	592	568.23	J Clean Prod	374	338.97	SIAM J Comput	158	148.99	Discrete Appl Math	60	58.16	SIAM J Appl Math	28	26.08
33	Decision Sci	573	513.17	Int T Oper Res	371	362.61	Infor	157	154.38	Computers Intractabl	57	57.00	Biol Cybern	27	23.15
34	OR Spectrum	544	525.61	Inform Sci	332	319.20	Inform Process Lett	150	143.00	IEEE T Comput	52	42.88	Math Oper Res	27	26.40
35	ORSA J Comput	515	498.65	Optim Lett	314	310.89	J Scheduling	147	142.97	Perform Evaluation	52	43.06	IEEE T Syst Man Cy	24	22.64
36	Appl Math Model	493	477.66	Comput Chem Eng	298	266.72	OR Spectrum	145	135.79	Econometrica	49	43.89	Ann Discrete Math	23	22.18
37	Comput Chem Eng	449	385.22	Comput Optim Appl	296	287.60	Math Comput Model	137	134.63	Manag Sci B-Appl	49	47.60	Comput Ind Eng	22	17.70
38	Inform Sci	439	419.02	Math Oper Res	289	280.85	Comput Chem Eng	129	96.50	J Forecasting	48	39.63	Fuzzy Set Syst	21	12.79
39	Int T Oper Res	433	423.33	Prod Oper Manag	287	272.20	Prod Plan Control	128	124.09	AT&T Tech J	47	45.76	J Math Anal Appl	21	20.94
40	Comput Optim Appl	422	411.24	J Intell Manuf	275	268.44	Appl Math Comput	127	124.01	J Optim Theory App	47	43.11	Ann Math Stat	20	18.40

Abbreviations: Cit = Citations; CLS = Citation link strength.

Table 15
Co-occurrence of author keywords in COR: Global and temporal analysis.

R	Global			2014–2023			2004–2013			1998–2003		
	Keyword	Occ	Co-oc	Keyword	Occ	Co-oc	Keyword	Occ	Co-oc	Keyword	Occ	Co-oc
1	Scheduling	434	385	Scheduling	184	163	Scheduling	211	163	Scheduling	39	25
2	Heuristics	351	296	Heuristics	151	111	Heuristics	163	129	Heuristics	37	26
3	Combinatorial optimization	190	152	Combinatorial optimization	102	71	Tabu search	105	79	Inventory	27	17
4	Integer programming	185	146	Integer programming	102	71	Combinatorial optimization	72	57	Tabu search	23	18
5	Tabu search	184	150	Metaheuristics	86	66	Integer programming	72	50	Optimization	21	16
6	Metaheuristics	159	137	Column generation	77	51	Genetic algorithms	70	42	Simulated annealing	21	17
7	Column generation	144	108	Vehicle routing	72	53	Metaheuristics	69	54	Heuristic	17	12
8	Genetic algorithm	133	98	Variable neighborhood search	64	44	Genetic algorithm	65	38	Combinatorial optimization	16	12
9	Dynamic programming	131	102	Dynamic programming	57	37	Heuristic	64	42	Dynamic programming	16	12
10	Heuristic	131	102	Genetic algorithm	57	40	Column generation	63	43	Genetic algorithms	14	12
11	Vehicle routing	130	114	Tabu search	56	38	Dynamic programming	58	42	Branch-and-bound	11	9
12	Optimization	123	79	Optimization	54	32	Vehicle routing	53	45	Facility location	11	4
13	Local search	109	96	Robust optimization	52	37	Simulated annealing	52	39	Genetic algorithm	11	7
14	Simulated annealing	108	86	Routing	52	43	Local search	51	39	Integer programming	11	7
15	Genetic algorithms	104	81	Local search	51	40	Optimization	48	26	Linear programming	10	1
16	Makespan	90	85	Vehicle routing problem	51	37	Makespan	42	34	Simulation	10	8
17	Inventory	87	53	Heuristic	50	34	Branch and bound	35	27	Neural networks	9	2
18	Variable neighborhood search	86	67	Multi-objective optimization	50	29	Inventory	35	16	Branch and bound	8	5
19	Mixed integer programming	79	59	Branch-and-cut	46	33	Ant colony optimization	32	24	Location	8	7
20	Vehicle routing problem	76	62	Mixed integer programming	46	28	Simulation	31	15	Lot sizing	8	4
21	Routing	73	63	Stochastic programming	45	23	Linear programming	29	12	Deterioration	7	5
22	Multi-objective optimization	70	51	Mixed integer linear programming	44	28	Data envelopment analysis	28	6	Lagrangean relaxation	7	5
23	Robust optimization	70	52	Benders decomposition	43	32	Mixed integer programming	28	14	Local search	7	7
24	Branch-and-bound	68	54	Makespan	43	37	Single machine	27	27	Network optimization	7	3
25	Linear programming	66	37	Matheuristic	39	26	Metaheuristic	26	23	Parallel machines	7	7
26	Stochastic programming	66	37	Adapt large neighborhood search	38	29	Global optimization	25	16	Reliability	7	4
27	Simulation	64	42	Iterated local search	37	28	Grasp	25	22	Shortest path	7	4
28	Branch-and-cut	62	49	Simulated annealing	35	27	Branch-and-bound	24	20	Traveling salesman problem	7	7
29	Facility location	62	45	Branch-and-bound	33	23	Vehicle routing problem	24	23	Lagrangian relaxation	6	4
30	Lagrangian relaxation	61	53	Lagrangian relaxation	33	27	Location	23	14	Routing	6	5
31	Branch and bound	60	49	Network design	33	24	Constraint programming	22	16	Algorithm	5	3
32	Metaheuristic	55	52	Facility location	31	22	Lagrangian relaxation	22	18	Analytic hierarchy process	5	3
33	Mixed integer linear programming	55	38	Machine learning	30	19	Variable neighborhood search	22	19	Computational complexity	5	4
34	Benders decomposition	54	42	Mixed-integer linear programming	30	21	Arc routing	21	13	Flowshop	5	5
35	Network design	54	42	Transportation	30	22	Neural networks	21	11	Flowshop scheduling	5	4
36	Transportation	53	42	Matheuristics	29	22	Stochastic programming	21	10	Forecasting	5	2
37	Iterated local search	51	45	Metaheuristic	29	23	Transportation	21	17	Goal programming	5	2
38	Location	51	35	Mixed-integer programming	28	20	Facility location	20	15	Lost sales	5	5
39	Constraint programming	50	46	Constraint programming	27	25	Lagrangean relaxation	20	16	Makespan	5	4
40	Flowshop	45	44	Linear programming	27	17	Flowshop	19	17	Mathematical programming	5	2

Abbreviations: Occ = Occurrences; Co-oc = Co-occurrence link strength.

Table 16
Leading topics in COR between 2013 and 2022 (from Scopus).

R	Topic	TP	FWCI	PP
1	Time windows; Pickup and delivery; Dynamic routing	153	2.78	99.699
2	Flow shop scheduling; Permutation flowshop; Scheduling problem	79	2.17	98.928
3	Hub location; Hub and spoke network; Hub	46	1.38	96.804
4	Ambulances; Location-allocation; Emergency vehicles	40	1.39	97.179
5	Cutting stock problem; Strip packing; Cutting process	40	1.54	95.425
6	Production control; Capacitated lot-sizing; Production planning	39	1.29	90.293
7	Deteriorating jobs; Scheduling problem; Due window	38	1.66	93.340
8	Container terminal; Quay; Container	34	1.68	98.132
9	Pickup and delivery; Dials; Allobarbital	34	1.97	96.623
10	Assembly line balancing; Robotic assembly; Assembly machines	33	2.56	96.612
11	Inventory routing; Supply chain; Vendor managed inventory	32	2.96	94.808
12	Crew scheduling; Column generation; Personnel	32	1.26	94.179
13	Job shop scheduling problem; Makespan; Genetic algorithm	31	3.74	98.200
14	Decomposition; Evolutionary multiobjective optimization; Pareto front	30	2.25	99.582
15	Liner shipping; Ship; Fleet	30	2.07	97.966
16	Time windows; Travelling salesman problems; Genetic algorithm	30	1.86	91.147
17	Parallel machine scheduling; Genetic algorithm; Scheduling problem	29	1.93	93.247
18	Resource-constrained project scheduling; Scheduling problem; Resources	28	1.35	96.815
19	Humanitarian logistics; Disaster relief; Disaster	27	3.85	99.328
20	Arc routing; Chinese postman problem; Genetic algorithm	27	1.12	86.322
21	Single machine scheduling; Tardiness; Scheduling problem	27	0.84	79.241
22	Batch processing machine; Batch; Batch scheduling	26	1.44	91.360
23	Multiple objective linear programming; Efficient set; Integer programming	26	0.80	84.514
24	Supply chain design; Costs and cost analysis; Multi-echelon	25	2.76	97.384
25	Heuristics; Pickup and delivery; Inventory routing	24	3.43	92.973
26	Airlines; Helicopter; Fleet	24	1.40	92.023
27	Timetabling; Rescheduling; Line	23	2.56	97.790
28	Timetabling problem; Hyper-heuristics; Genetic algorithm	23	1.69	92.997
29	Robust optimization; Weakly efficient solution; Set	21	1.22	96.747
30	Electric vehicles; Charging; Station	20	3.90	98.987
31	Attack; Sequential game; Contest success function	16	1.61	92.698
32	Lateral transshipment; Supply chain; Inventory systems	16	0.92	91.702
33	Maximal clique; Combinatorial optimisation; Maximum independent set	16	2.15	87.795
34	Competitive location; Facility location problem; Sales	16	1.34	83.410
35	Multidimensional knapsack problem; Knapsack problem; Min-Max problem	15	1.30	87.497
36	Cutting process; Routing problem; Cutting machine	15	1.85	84.710
37	Weber problem; Location problem; Facility location	15	0.85	74.970
38	Information retrieval; AS/RS; Warehouses	14	2.05	98.995
39	Operating rooms; Operation duration; Planning and scheduling	14	3.89	95.181
40	Wafer; Cyclic scheduling; Wafer fabrication	14	1.59	80.527
41	Heuristics; Variable neighborhood search; Greedy randomised adaptive search procedure	14	1.05	78.309
42	Revenue management; Dynamic pricing; Costs and cost analysis	13	0.93	96.909
43	Open pit mine; Planning; Surface mining	13	1.21	93.814
44	Workforce scheduling; Home health care; Delivery of health care	13	1.97	92.999
45	Multistage; Stochastic programming; Complementarity problem	13	1.08	91.128
46	Closed-loop supply chain; Remanufacturing; Reverse logistics	12	4.86	99.813
47	Observation satellite; Mission planning; Spacecraft	12	3.28	90.067
48	Retrial queue; Working vacation; Queueing system	12	1.21	89.462
49	Bilevel programming; Decision making; Stackelberg	12	1.96	87.164
50	Knapsack problem; Quadratic programming; Combinatorial optimisation	12	1.29	78.628

Abbreviations: R = Rank; TP = Total papers; FWCI = Field-weighted citation impact (data from Scopus); PP = Worldwide prominence percentile (according to Scopus and FWCI).

routing, scheduling, location, genetic algorithm, and programming. According to the FWCI, most of the topics in the journal have been cited above the world average for similar publications. Among the top 50 leading topics, around 75 % of the topics are the top 10 % of worldwide topics by prominence.

Then, we analyse the classified topic clusters that group several topics. Table 17 presents the 30 most frequent topic clusters in COR. The results consider the same bibliometric indicators and ranking rule as Table 16.

The most popular topic cluster in the journal is ‘scheduling; Algorithms; Optimization’ with 570 documents published between 2013 and 2022. ‘Vehicle routing; Algorithms; Vehicles’ and ‘supply chains; Supply chain management; Industry’ are also very popular topic clusters with 377 and 257 articles, respectively. Most of the topic clusters have a FWCI above 1.00, and eight among the top 30 above 2.00, meaning that the publications of the journal have been cited well over the world average level. In addition, looking at the worldwide prominence percentile, 13 among the top 30 topic clusters in the journal have a prominence percentile of more than 90, indicating that these topic clusters are currently very popular and in the top 10 % of worldwide topic clusters by prominence.

8. Conclusions

In 2024, COR celebrates the 50th anniversary since its first printed volume. Motivated by this special event, this paper presented a bibliometric overview of COR between 1974 and 2023 to identify the journal’s leading trends that have occurred during this long journey. The study focused on a wide range of issues, by using diverse bibliometric indicators, including the publication and citation structure, the most cited documents, the most productive and influential authors, institutions, countries/territories, and supranational regions, and the most popular keywords, topics, and topic clusters in the journal. The WoS Core Collection database was mainly used to collect bibliographic information for the analysis. The Scopus database and the journal’s webpage were also used in several cases to provide more detailed analysis or

Table 17
Leading topic clusters in COR between 2013 and 2022 (from Scopus).

R	Topic Cluster	TP	FWCI	PP
1	Scheduling; Algorithms; Optimization	570	1.72	91.237
2	Vehicle routing; Algorithms; Vehicles	377	2.20	75.652
3	Supply chains; Supply chain management; Industry	257	2.67	98.462
4	Location; Algorithms; Optimization	133	1.21	37.525
5	Containers; Freight transportation; Ships	113	1.66	69.231
6	Optimization; Algorithms; Evolutionary algorithms	108	2.48	92.040
7	Traffic control; Transportation; Models	61	1.96	97.258
8	Electric power transmission networks; Wind power; Electric power distribution	59	2.54	99.465
9	Models; Risks; Finance	55	1.11	95.987
10	Fixed point; Fixed point theorem; Metric space	55	0.98	63.612
11	Graph in graph theory; Coloring; Graphic methods	55	1.03	58.930
12	Airports; Air transportation; Aircraft	37	1.44	58.528
13	Servers; Queueing theory; Markov processes	37	0.81	32.107
14	Global optimization; Combinatorial optimization; Integer programming	35	0.79	10.234
15	Agents; Game theory; Models	30	0.74	79.398
16	Decision making; Fuzzy sets; Models	29	1.73	92.709
17	Railroads; Railroad transportation; Rails	27	2.50	42.876
18	Emergencies; Patients; Hospitals	25	2.65	58.662
19	Fiber optic networks; Quality of service; Network architecture	21	0.59	85.552
20	Classification (of information); Learning systems; Algorithms	20	1.83	94.783
21	Wireless sensor networks; Sensor nodes; Routing protocols	19	1.49	97.124
22	Cloud computing; Clouds; Distributed computer systems	15	1.93	95.184
23	Models; Social networking (online); Algorithms	15	1.57	92.575
24	Artificial intelligence; Algorithms; Semantics	15	2.74	48.027
25	Data envelopment analysis; Banks; Efficiency	14	2.67	91.104
26	Mines; Mining; Models	13	1.21	29.967
27	Multi agent systems; Motion planning; Robots	11	1.57	91.304
28	Design; Product design; Product development	11	1.74	72.776
29	Accident prevention; Hazards; Accidents	11	1.98	54.783
30	Judgment; Decision making; Probability	11	0.67	53.110

Abbreviations are available in Table 16.

retrieve more practical bibliographic data. We also developed a graphical mapping analysis of the bibliographic material by using the VOS viewer software to visualise the bibliometric networks in terms of journals, documents, authors, institutions, countries/territories, and author keywords from different perspectives.

The results show that COR has significantly improved the number of publications and the impact in the scientific community through its lifetime development, establishing its leading position, particularly in the field of OR-MS. Given that the journal has been devoted to the application of computers and Operations Research techniques, it is also strongly connected to the fields of Computer Science, Engineering, Mathematics, and Transportation. Therefore, COR has strong connections to leading journals in these fields through citing influential work in the journals or being cited by them, such as the *European Journal of Operational Research*, *Operations Research*, *Management Science*, *International Journal of Production Research*, *Computers & Industrial Engineering*, and *Transportation Science*. These results confirm the broad scope and the interdisciplinary profile of the journal.

A huge proportion of the highly cited papers of the journal focus on topics related to metaheuristics including the two most cited articles that introduced the variable neighbourhood search (Mladenović and Hansen, 1997) and tabu search (Glover, 1986). Another interesting issue is that 52 % of the 50 most cited articles were published between 2004 and 2013. We clearly see that this decade is the one that currently has received more citations according to the information available in WoS Core Collection. Additionally, note that almost 7 % of the articles published in COR have currently obtained more than 100 citations according to WoS, 64 % more than 10 citations, and 95 % of the papers at least have been cited once.

Gilbert Laporte is the most productive and influential author in COR, followed by T. C. E. Cheng and Bruce L. Golden. It is worth noting that the authors from the USA, Canada, and Spain, lead the ranking of the 50 most productive authors in the journal, with nine authors each. Many Editorial Advisory Board members of COR are currently among the most productive authors, having made remarkable contributions to the research published in the journal. CNRS (France) and HEC Montréal are the most productive and influential institutions in the journal. Polytechnique Montréal, the University of Seville, the University of Maryland-College Park, the Université de Montréal, and the Korea Advanced Institute of Science and Technology, are also highly productive institutions. There is a fair mixture of institutions worldwide contributing to COR, indicating the international diversity of the journal. However, note that there is no UK institution among the top 50 leading institutions. It is worth noting that during the first years of COR, institutions from the USA had more influence and led the ranking. Over time, other institutions are becoming more relevant in the journal, especially, Asian and European institutions.

Focusing on the journal publication structure at the country/territory level, the USA is by far the most productive and influential country in COR, well ahead of China, Canada, France, Spain, and the UK. In addition, most of the leading articles in the journal are published by the USA. If looking at the results per capita, European countries perform very well in the journal, among which Belgium performs the best in the 'publications per million inhabitants' category, and Denmark leads the ranking regarding the 'citations per million inhabitants' category. Observe that many developing economies have contributed to the journal very significantly, including China, Brazil, Turkey, Iran, and India. Particularly, since 2019, China has become the most productive country in COR, which is expected to play a more important role in leading the journal in the future. However, over the last decade, there has been a downward trend in the productivity of several advanced economies, including the USA, Taiwan, South Korea, Japan, and Greece. But most of the developing economies are still far away from the leading positions in the journal. From the perspective of supranational regions, Europe is by far the most productive and influential region, followed by North America and Asia. Oceania achieves the best performance when normalising the results per capita. These results further demonstrate the journal's strong impact and diversity with publications from all over the world.

To provide a deeper understanding of the bibliometric results, this

study applied the VOS viewer software to generate graphical maps of the data by using co-citation, bibliographic coupling, and co-occurrence of author keywords. The key advantage of the graphical analysis is that we can identify the most productive and popular variables in COR and see how they connect with each other. The graphical maps are consistent with the results provided in the previous sections regarding journals, documents, authors, institutions, and countries/territories. It is also worth noting that the self-citations of COR have a strong relevance, which is very common for most of the journals. Moreover, institutions tend to be strongly coupled with those in the same or nearby countries/territories, and they are more likely to work on closer topics or research areas.

As revealed by the keyword and topical analysis, COR has primarily focused on topics connected to scheduling and vehicle routing problems as well as optimisation methods and techniques including heuristics, metaheuristics, combinatorial optimisation, integer programming, tabu search, column generation, and genetic algorithms. Based on temporal evolution results, vehicle routing problems have attracted significant attention in the recent few years, while the attention on scheduling has slightly decreased. Noteworthy developments have also been seen by other themes such as robust optimisation, multi-objective optimisation, and mixed integer programming. Currently, several emerging keywords are becoming more active in the journal. This includes matheuristic, adaptive large neighbourhood search, and machine learning.

This paper presented a general and informative overview of COR with the aim of identifying leading trends and main patterns during the past half-century. However, there are several limitations when developing a bibliometric analysis. Given that the results are mainly based on data provided by the WoS Core Collection database, some of the limitations stem from the database. Firstly, the COR publications between 1974 and 1976 are not completely available in the WoS Core Collection database. To overcome this issue, we further used the cited reference search in WoS and the journal's webpage to collect the missing papers. However, the graphical analysis in this work did not consider these missing papers, which may lead to small alterations to the current results obtained. Secondly, there is a degree of asymmetry in the publication and citation counting that benefits co-authorship (Podsakoff et al., 2008). The reason is that WoS uses full counting which gives one unit for each participating author of a paper, without distinguishing whether it is one or more authors in the paper, the same operation for each different institution or country/territory of a paper. This may cause some bias in the analysis. To mitigate that, in Section 4, we considered the fractional counting for graphical mapping. Thirdly, it is not easy to compare different research topics because each subfield may have different publication and citation characteristics (Andersen, 2023). Additionally, note that many researchers may change institutions or countries/territories over time. Nevertheless, the aim of the results presented in this paper is to provide a general overview of the bibliometric data of the journal. Finally, this study provides the current picture of the journal considering the bibliographic data between 1974 and 2023. The results can change in the future, especially with the appearance of newer publications that become very popular in the academic community.

CRediT authorship contribution statement

Li Guan: Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation. **Gilbert Laporte:** Writing – review & editing, Visualization, Validation, Formal analysis, Conceptualization. **José M. Merigó:** Writing – review & editing, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Stefan Nickel:** Writing – review & editing, Visualization, Validation, Formal analysis, Conceptualization. **Iman Rahimi:** Visualization, Investigation, Data curation. **Francisco Saldanha-da-Gama:** Writing – review & editing, Visualization, Validation, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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