Lecture Notes on Data Engineering and Communications Technologies 144

Jiuping Xu · Fulya Altiparmak · Mohamed Hag Ali Hassan · Fausto Pedro García Márquez · Asaf Hajiyev *Editors*

Proceedings of the Sixteenth International Conference on Management Science and Engineering Management – Volume 1

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Lecture Notes on Data Engineering and Communications Technologies

Volume 144

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Preface

ICMSEM is an international academic research cooperation and scientific research achievement exchange conference platform. Over 362 papers from 30 countries were received, and 115 papers from 25 countries, Australia, Belgium, Canada, China, Egypt, France, India, Iran, Italy, Japan, Kuwait, Melbourne, Moldova, Morocco, Multan, Pakistan, Russia, Spain, Thailand, Turkey, the UK, Ukraine, the USA, and Wales, were accepted for presentation or poster display. Many authors have been involved in international academic research collaborations, with 54 of the accepted papers being co-authored by academics from different countries. Each accepted paper was reviewed by three reviewers, who when necessary have provided revision advice to ensure the conference proceedings is of very high quality, as also evidenced by ICMSEM's active promotion of international academic exchanges and disciplinary development. The proceedings papers have been classified into six sections: dynamic analysis; machine learning; supply chain management; operations management; environmental management; and health and hygiene. The key issues at the sixteenth ICMSEM cover many popular topics, on which experts have been invited to give the keynote speeches. Based on the proceedings divisions, the conference has established six parallel sessions, in which experts from the University of Melbourne, Imperial College London, the University of Castilla-La Mancha (UCLM), the University of Southern California, the University of Michigan, Huazhong University of Science and Technology, the Karlsruhe Institute of Technology, and other related institutions have been invited to preside over. The parallel sessions provide a chance for scholars in the same fields to discuss their research, evaluate and promote each other's work, share frontier research developments, and innovate for future scientific research.

ICMSEM is committed to promoting innovative management science (MS) and engineering management (EM) academic research and development. Every year, renowned experts are invited to deliver the "Developments in Management Science and Engineering–Perspectives from Scientific Journal Report" forum, at which the innovations in Management Science in Engineering journals are discussed.

To further encourage Management Science and Engineering Management state-of-the-art research, ISMSEM awards papers that have made outstanding contributions, which are then included in the IJMSEM journal. ICMSEM is constantly innovating to improve its international conference platform. COVID-19 has brought many unknown challenges to the global community, for which researchers have proposed many innovative theories, methods, and policies for epidemic, social, and economic management; therefore, this year, ICMSEM has a special forum on "International frontiers in COVID-19 research and innovation."

We would like to take this opportunity to thank the participants, all of whom have worked hard to ensure this conference was a success. We want to express our sincere gratitude to the following prestigious academies and institutions for their high-quality papers and ongoing support for ICMSEM: the Azerbaijan Academy of Sciences, Azerbaijan; the Academy of Sciences from the Republic of Uzbekistan, Uzbekistan; the Fuzzy Logic Systems Institute, Tokyo University of Science, Japan; Brock University, Canada; the Moldova Academy of Sciences, Moldova; the University of Castilla-La Mancha (UCLM), Spain; the University of Belgrade, Serbia; the Russian Academy of Sciences, Russia; Gazi University, Turkey; and Sichuan University, China. We would also like to acknowledge the assistance received from the International Society of Management Science and Engineering Management (ISMSEM), Gazi University, and Sichuan University in organizing this conference. We also appreciate the "Lecture Notes on Data Engineering and Communications Technologies" from Springer for the publication of the proceedings. We are grateful to Professor Fulya Altiparmak as the general chair, and Prof. Mehmet Kabak, Prof. Selcuk Kursat Isleyen, and Assoc. Prof. Gul Didem Batur Sir as the organizing committee chairs. We appreciate the support received from all members of the organizing committee, the local arrangement committee, and the program committee, as well as all participants. Finally, we would like to thank all authors for their excellent conference papers, which have significant educational and research value. Conference papers and recommendations can also serve as guiding materials for the administration and management of institutes and enterprises to encourage innovative, scientific business projects and draft or amend relevant policies.

Many new MSEM development trends have emerged, and more innovative development activity needs to be encouraged. Next year, we plan to continue ICMSEM and hope to further improve the quality of the proceedings and recommend additional papers for the ISMSEM Advancement Prize. We sincerely hope

you can submit your new MSEM findings and share your great ideas in Ankara, Turkey, in 2022.

August 2022

Jiuping Xu
Fulya Altiparmak
Mohamed Hag Ali Hassan
Fausto Pedro García Márquez
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ICMSEM 2022 was organized by the International Society of Management Science and Engineering Management (ISMSEM), Sichuan University, Gazi University. It was held in cooperation with Lecture Notes on Data Engineering and Communications Technologies (LNDECT) of Springer.

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Contents

Advancement of Dynamic Analysis, Machine Learning, and Supply Chain Management Based on the Sixteenth ICMSEM Proceedings

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Abstract. Management Science (MS) is the broad interdisciplinary study of problem-solving and decision-making in human organizations. Scientific research is conducted to improve an organization's rational management decisions by determining optimal or near-optimal solutions to complex decision problems. With the focus on MS, this paper presents a brief description of the sixteenth ICMSEM proceedings Volume I. First, the key MS research areas are reviewed; dynamic analysis, machine learning, and supply chain management; after which the most prominent concerns in the sixteenth ICMSEM proceedings Volume I are discussed. Finally, CiteSpace is used to analyze the MS developments in the future. Overall, the ICMSEM continues to provide an invaluable platform for academic interaction and communication to ensure future Management Science and Engineering Management (MSEM) innovations.

Keywords: Dynamic analysis · Machine learning · Supply chain management

1 Introduction

The sixteenth International Conference on Management Science and Engineering Management (ICMSEM) in Ankara, Turkey allows management science and engineering management (MSEM) academics to present new innovative research developments in data mining, supply chains, decision making, sustainability, health, and ecology. The papers presented in this volume highlight the significant cross-disciplinary advances in MSEM methodologies and practical applications.

MSEM has experienced extraordinary growth since its origins. In interdisciplinary achievements and using various scientific methods to give solutions to complex decision problems, it is already well versed. Management Science (MS) initially emerged as a branch of operations research (OR), the early challenges in which used linear models to deal with systems optimization problems related to such areas as maximum profit value, assembly line performance,

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crop yields, bandwidth, loss minimization, and risk. Today, MS encompasses any organizational activity for which a problem can be structured in a mathematical form to generate relevant management insights. MS has been focused on a wide range of areas, such as assignment, data mining, financial decision making, forecasting, optimization, project planning and management, simulations, and transportation [1]. Paucar-Caceres [14] classified simulation, optimization, forecasting, mathematical programming, inventory control, Markov analysis, the program evaluation and review technique (PERT), decision trees, transportation and assignment problems, queueing theory, and statistical process control as traditional OR/MS topics. Romero-Silva [15] conducted a bibliometric analysis of MS and found that vehicle routing problems, multicriteria decision making, data envelopment analysis, data mining and analysis, operations management, supply chain management, supply chain networks, and supply chain risk management have been the main MS foci. The sixteenth ICMSEM proceedings Volume I also specifically addressed these popular areas, including dynamic analysis, machine learning, and supply chain management.

As Fig. 1 shows, Sect. 2 reviews previous research related to these three key research fields, Sect. 3 summarizes the central issues in proceedings Volume I, Sect. 4 analyzes MS progress and outlines the future research directions, and conclusions are given in Sect. 5.

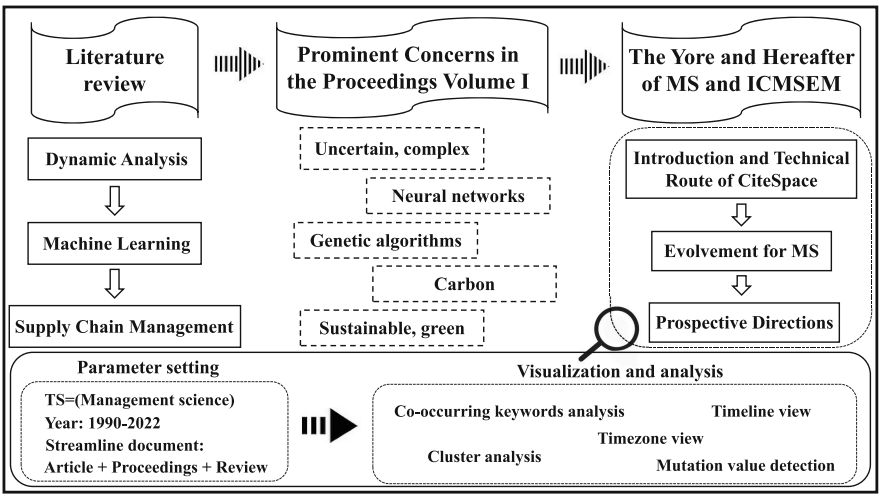

Fig. 1. Framework of the structure of proceeding Volume I

2 Literature Review

Literature reviews elucidate the latest theoretical and methodological contributions to a particular topic. Therefore, this literature review for proceedings Volume I identifies the current research directions, research methods, and research findings that have taken place in dynamic analysis, machine learning, and supply chain management.

2.1 Dynamic Analysis

Management science applies mathematical models and computational tools to study and resolve various management problems, for which models play a crucial role. As an important mathematical modeling method, dynamic programming seeks to resolve optimization problems through bottom-up thinking. Around 2000, researchers began to study invariants based on dynamic techniques. Of course, the milestone research work has been Daikon (a dynamic invariant detection tool to discover possible program invariants through dynamic analysis) [6], which was proposed by Ernst et al. in 1999. Since that time, researchers have been conducting comprehensive research on invariants based on dynamic analysis and have achieved significant results. Over the last few years, there are many mathematical modeling problems that need dynamic programming [4]. Dynamic analysis has evolved considerably in the past few decades to improve modeling and devise new analysis criteria to represent the complexities in current systems [3,5,10]. For example, Bao and Lin introduced the panel vector autoregression (PVAR) model into dynamic analysis [2], and Guo constructed a Bayesian network model that allowed for the gradual input of data into the Bayesian network based on construction progress to provide a dynamic analysis of construction cost [8]. The main differences and specificities in dynamic model structures include transition elements between subsequent activity observations that can establish the interdependence between periods [21]. Dynamic analysis provides a systematic understanding of the complete economic movement process and is, therefore, a useful complement to static analysis and can also be applied to economic systems that have continuous imbalances. Overall, dynamic analysis research has continued to expand and deepen.

2.2 Machine Learning

Machine learning has developed rapidly in recent years due to the developments in computer, storage, and network technologies. Organizational data in governments, hospitals, banks, and other platforms such as e-commerce, retail, and supply chains has been growing exponentially, and machine learning has also been having a major impact in many fields of technology and science. Examples of mature applications include robotics and autonomous vehicle control, speech processing and natural language processing, neuroscience research, and computer vision applications [22]. Machine learning typically provides systems with the ability to learn and automatically improve from experience without the

need for specialized programming, which is why it is generally referred to as the most popular and up-to-date technology of the fourth industrial revolution [17]. Researchers have developed many machine learning algorithms to deal with the wide variety of machine learning data and problem types [9]. One form of computational analysis that has been proven particularly useful in recent years has been optimization theory, in which the upper and lower bounds on the convergence rates in the optimization process have been successfully integrated with machine learning as performance metrics [20]. Hybrid learning models, such as methods integration, the modification or enhancement of existing learning techniques, and the design of new learning methods could be a potential future research avenue [16].

2.3 Supply Chain Management

Supply chain management practices began to develop rapidly in the late 1990s s as information technology capabilities improved. Organizations then began to visualize the entire supply chain and the potential benefits of maximizing customer value through a division of labor based on each other's core competencies. As a result, companies now rely more on their supply chain partners and end customers and have shifted their strategies to coordinate functional activities both within every single company and across the supply chain companies [11,12]. Market and industry structures may encourage companies to adopt disruptive technologies, such as additive technologies and the Internet of Things, which in turn could lead to significant supply chain changes that require new organizational and infrastructure designs and an enhancement of the skills to manage them [7]. With the rapid development in information technology, supply chain management is once again at the crossroads of the fourth industrial revolution [13]. In this context, Zinn and Goldsby suggested that theory building should be fully integrated into the research [23], and Soonhong et al. proposed that in the upcoming Industry 4.0, there are going to be important changes in supply chain management, such as the coexistence of various supply chain configurations and new supply chain cooperation methods [13].

3 Prominent Concerns in Proceedings Volume I

Based on the most popular research topics, papers were called for from around the world, 115 of which were finally accepted, and divided into two proceedings volumes, with volume I comprising 58 of these. The keyword analysis revealed that the first volume reflects the latest theoretical and methodological MS research trends and development frontiers in dynamic analysis, machine learning, and supply chain management.

Given the dynamic factors and uncertainties that exist in management and economic problems, dynamic analysis of economic systems has become increasingly important. The management optimization of unstable resources has been

a key focus of many researchers. Marugan presented a complete dynamic multi-objective environment to simulate the maintenance activities at an offshore wind turbine farm that considered availability, electricity generation, maintenance costs, and wind farm incomes as the objective functions. By analyzing current company plans, Yucel et al. developed a risk management process for strategic plans using an analytic hierarchy process (AHP) approach to create a network of relationships at the micro and macro level to raise the strategic planning situational awareness. Dynamic analysis has also been introduced in other areas such as agriculture. To overcome a lack of information or the mismanagement of database resources for potato crop predictions, Javed et al. developed an innovative AgroInfo Decision support framework (DSF) and dashboard to collect data from different sensors. Studies on this topic in this volume have made leading contributions to dynamic analysis in various ways.

Machine learning involves such areas as probability theory, statistics, approximation theory, convex analysis, and computational complexity theory, and includes supervised learning, unsupervised learning and reinforcement learning. Unsupervised learning can replace supervised learning to identify image anomalies. For example, Nakata et al. built an anomaly detection model with an adaptive weighted loss variational autoencoder (AWL-VAE), which had better accuracy than conventional VAE for industrial product image datasets. To detect anomalies, precise models or complex algorithms are needed to improve accuracy, such as ensemble learning algorithms; bagging, boosted, and rusboost. Peco, et al. implemented ensemble tree algorithms to predict and classify alarms and the detection of false alarms. Based on an assembly line balance problem, Arikan proposed a TS algorithm to increase productivity in a U-shaped assembly line and pioneered forbidden algorithms to deal with assembly-line problems. The optimization of models, the development and innovation of algorithms, and comprehensive applications are all areas of future machine learning research.

Supply chain management has always been customer-centric and benefit-oriented, and with the introduction of the "double carbon" concept, the sustainable development of the supply chain has become a priority. Desticioglu et al. considered three sustainability dimensions; environmental, social, and economic; to study sustainability reports from companies in the Borsa Istanbul Stock Exchange Sustainability Index and examine company supply chain management actions. Yozgat et al. investigated a sustainable closed-loop supply chain model consisting of seven echelons and developed a deterministic mixed-integer linear programming model (MILP) that included an economic sustainability dimension. Many studies have also focused on benefits improvements. Batur Sir and Caliskan examined a process shop scheduling problem and rate modification activities (RMA) and proposed a mixed-integer programming model, with a focus on environmental protection, Jiang and Chen examined waste disposal logistics, and Chen assessed emergency non-infectious medical waste (NMW) disposal for COVID-19. Based on an environmental-economy equilibrium method, Jiang optimized the reverse logistics network of kitchen waste disposal. Other studies on supply chains mostly focus on production and green production are also mentioned.

4 The Yore and Hereafter of MS and ICMSEM

This section used CiteSpace software to transform research data into a scientific knowledge map to analyze MS research. First, CiteSpace is briefly introduced and the technical research route is described, and then the MS research hotspots are analyzed. Finally, the research evolution is described and prospective MS research directions are indicated.

4.1 Introduction and Technical Route of Citespace

Literature mining identifies the most relevant scientific studies in areas of special interest [18], and has proven to be a powerful method for revealing major trends in the published scientific literature over the years to construct thematic maps. Citespace, which was first proposed by Chen, a Chinese scholar at Drexel University, is a Java program for co-citation analysis, especially for visualizing co-citation networks. Citespace is multivariate, time-phased, dynamic visual analysis software for mapping scientific knowledge, visually revealing the developments and structural relationships in a research field, and analyzing research hotspots, flashpoints, frontier directions and research trends. Therefore, it has been widely used for knowledge mapping visualization [19] using a visual graphical analysis called the "scientific knowledge map". Currently, citation data from the ISI (Institute for Scientific Information) is exported, from which node-and-link drawings of co-citation networks are generated. A typical way to use Citespace is to slice a time interval into smaller segments and study how the co-citation networks in the individual time slices are patched together. It essentially belongs to the macro information visualization technology in Metrology Science, and therefore has unique meanings and measurement indicators. For this analysis, data taken from the Web of Science (WOS), the Chinese Social Science Citation Index (CSSCI), the China National Knowledge Infrastructure (CNKI), NSF, Derwent, Scopus, arXive-Print, Pubmed, and the Sloan Digital Sky Survey (SDSS) were imported into the software and the author, institution, country, terms, keywords, category, cited references, cited authors, and cited journals were analyzed.

To determine the MS scientific knowledge map, the MS keyword trends were determined based on qualitative scientometrics. The Web of Science (WoS) core collection database was chosen as the primary database to search for all relevant research as it accesses multiple essential databases and allows for an in-depth exploration of specialized subfields within academic or scientific disciplines. Appropriate search strategies were then specified to ensure adequate correlations for the data cleaning, that is, the search string "management science" was used to search for and retrieve articles from 1990 to 2022, the advanced search from which identified 101,924 articles. "AK = (management science)" was then set to refine the research selection, which reduced the article number to 3,607. After selecting "Article", "Proceedings Paper", and "Review" as the document type, the less formal literature was eliminated. In this way, the literature was scrutinized until only 3,434 MS documents were finally extracted and input to Citespace. Then, each data record; author, title, abstract, and research citation; was downloaded and entered into Citespace for further analysis.

4.2 MS Evolution

The full records and cited references for the 3,434 articles exported from the WOS database were stored as txt files. First, the txt document was imported into Citespace for "Remove Duplicates" and the data were converted into a format that the software could recognize for parameter selection. Then a new "Project" was created and the period set from 1990 to 2022, with the time slice set at one year and the theme selection set based on the titles, abstract subject words, identifiers, and keywords to allow for the node selection, with the networks constructed using the "Pathfinder" pruning algorithm. Then, regions with the 35 highest keyword records were clustered and analyzed, from which a minimum treemap was created.

By setting "Threshold = 35", a total of 914 nodes and 5,156 edges were obtained, with the overall network density being 0.0124, S = 0.783. The keywords co-occurrence are shown in Fig. 2. Using the keywords and the label title clustering, 41 categories were identified. As shown in Fig. 3, the system frequency identified dynamic analysis, machine learning, supply chain management, and science and management as the highest-ranked areas, which indicated that these areas were the most popular current management science research fields and are the possible future MS development trends. Table 1 shows the largest 10 clusters based on the size and silhouette values. The most popular terms were then used as the key research foci in the corresponding clusters, from which it can be seen that "Knowledge Management" was the most researched area in 2008, as it had the largest cluster. Other topics such as "Uncertainty", "Machine Learning", "Supply Chain Management" and "Environmental Science" were also major research areas in different years. It is worth noting that "System Dynamics" and "Fuzzy Control" were hot research topics back in 2001. With the continuous development of information technology, "Dynamic Analysis" has gradually become a key trend.

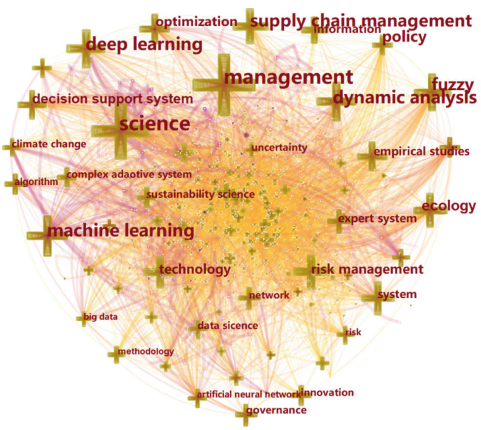

Fig. 2. Keywords co-occurrence network

Table 1. Summarization of top 10 clusters

Cluster ID	Size	Silhouette	Year	Label
0	128	0.672	2008	Knowledge management
1	122	0.754	2008	Machine learning
2	81	0.854	2009	Dynamic analysis
3	80	0.787	2012	Bibliometric analysis
4	76	0.787	2008	Supply chain management
5	64	0.769	2005	Environmental science
6	49	0.838	2013	Complex systems
7	47	0.819	2013	Science
8	35	0.912	2002	Performance
9	34	0.934	2002	Management

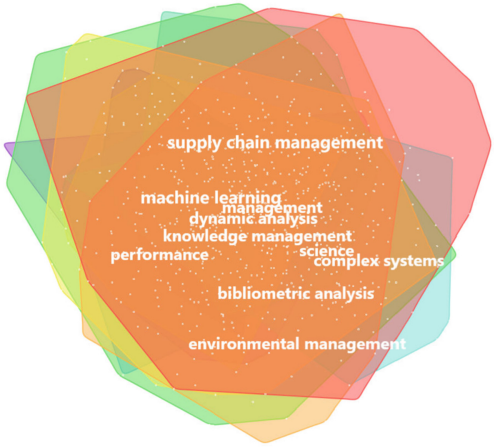

Fig. 3. The results of research fields clustering of MS

4.3 Prospective Directions

To increase the ICMSEM objective of becoming a broader international research forum, this paper further analyzed the popular MS research areas and assessed the future ICMSEM directions. Therefore, the layout was changed to the "Timeline View" to reveal the MS evolvement locus, with time as the horizontal axis, as shown in Fig. 4. Most high-frequency terms appeared in the early years, which indicated that MS has had a long history, an expanding range of applications, and an increasing research differentiation. In the data-led era, dynamic analysis

has increasingly emphasized the full integration of various data and uncertainties. Machine learning is an effective, feasible, efficient tool for complex systems research, and is a future research trend because of the significant cross-discipline development possibilities.

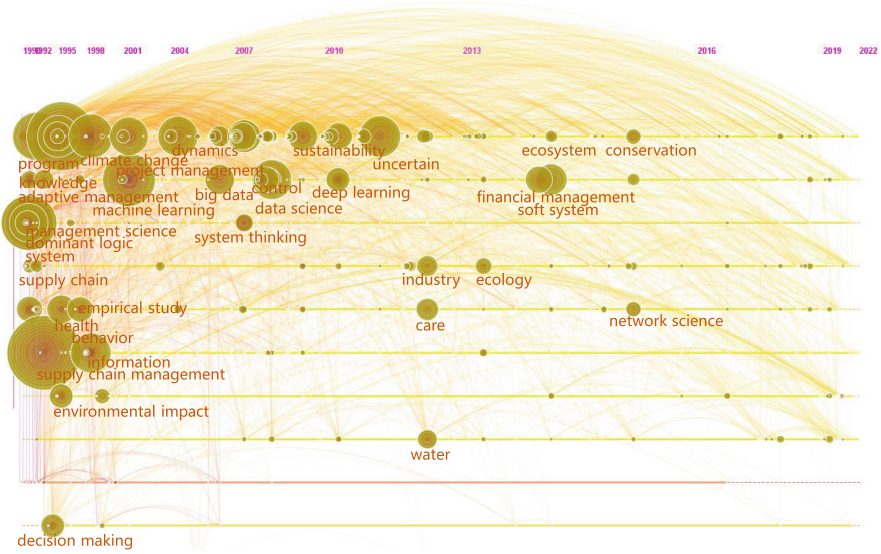

Fig. 4. The timeline view of related keywords

The 914 keywords were sorted from high to low based on citation counts, with the top 30 shown in Table 2. The top-ranked item by citation count was management with 301 citation counts. The data revealed that keywords such as management, science, fuzzy, dynamic, machine learning, and supply chain management had relatively high concentrations. The research areas in this volume include those related to management, economics, engineering, and data and information, all of which are inextricably linked to MSEM and a range of scientific methods and models. The latest research areas and research directions are also included, such as decision support systems, big data, modeling, and risk management, which were the hot research topics at last year's conference.

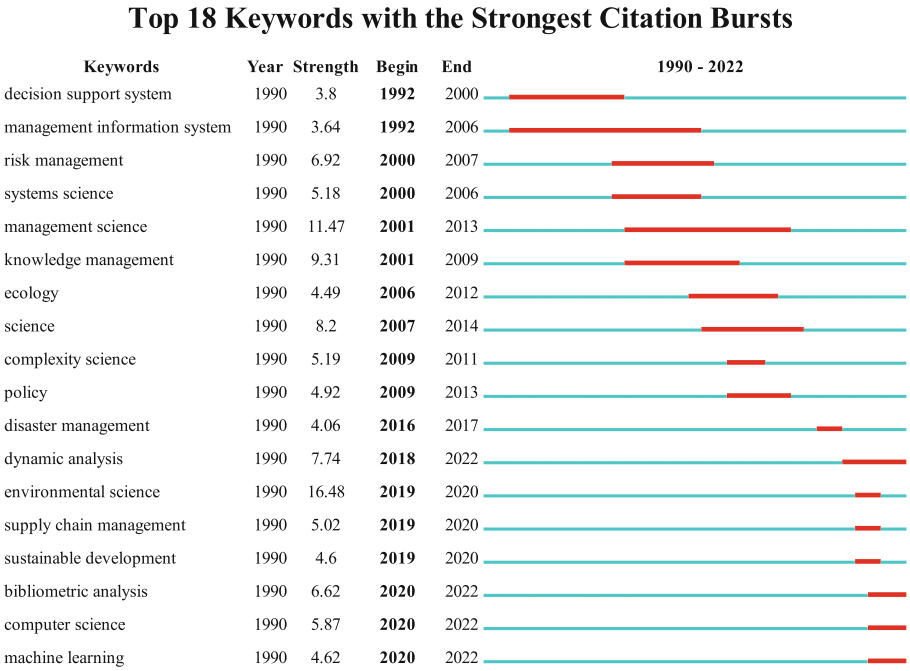

Fig. 5. Top 18 keywords with the strongest citation bursts for MS

To better analyze the MS frontiers and development trends, the keywords mutations were quantified and counted using the "mutation value detection" in the CiteSpace software, the results for which are shown in Fig. 5.

Figure 5 shows that "environmental science" had the highest mutation frequency at 16.48, which started in 2019 and went to the end of 2020, which indicated that "environmental science" received a great deal of attention from 2019 to 2020. The "Management information system" mutation had the longest duration at 14 years, indicating that this is an important research area in the field of management science. The subject areas covered in this volume; "machine learning", "supply chain management", and "dynamic analysis" were burst terms in recent years and have had a continuous development trend. Computer science, bibliometric analysis, sustainable development, and environmental science have also all changed in recent years, which reveals the MS frontiers and development trends.

Table 2. The top thirty central keywords of MS

Frequency	Centrality	Year	Keywords
301	0.27	1991	Management
259	0.12	2004	Science
172	0.08	2003	Machine learning
167	0.11	2001	Deep learning
157	0.08	1993	Fuzzy
151	0.09	2003	Supply chain management
150	0.04	1999	Dynamic analysis
145	0.13	1997	Policy
134	0.06	2000	Decision support system
130	0.22	1999	Optimization
127	0.09	2000	Empirical studies
126	0.15	2010	Information
117	0.06	2002	Risk management
105	0.14	1999	Technology
99	0.09	2008	Uncertainty
98	0.14	1996	Expert system
96	0.20	2002	Ecology
90	0.03	1991	System
87	0.06	2010	Governance
85	0.07	2010	Innovation
84	0.10	2006	Network
84	0.02	2012	Sustainability science
81	0.09	2007	Complex adaotive system
78	0.02	2010	Algorithm
77	0.04	2017	Climate change
75	0.01	2015	Data science
75	0.03	2000	Methodology
72	0.06	2018	Big data
71	0.04	2012	Artificial neural network
70	0.01	2013	Risk

5 Conclusion

Because of its application of scientific methods, MS is the general term for various management decision-making theories and methods. The review of Volume I of the Proceedings revealed that MS blends scientific exploration in dynamic analysis, machine learning and supply chain management. The development sta-

tuses of these three MS sub-disciplines were briefly analyzed to identify the main research foci in the first volume of the ICMSEM Proceedings, and then sub-iterated through Citespace from which the prominent themes in these three areas were identified to assist the reader in better understanding the content of this year's papers. Then we analyzed the MS and ICMSEM development trends based on the scientific knowledge map and found that the focus of the first volume of the ICMSEM Proceedings was consistent with but slightly different from, mainstream MS research. The promotion and development of MS require the participation of researchers in various fields as interdisciplinary research can provide more innovations. The MSEM journals trends need to be led by dedicated researchers.

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