Developments in Management Science in Engineering 2018

Perspectives from Scientific Journals

Jiuping Xu

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Cambridge Scholars Publishing

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Chapter 1
Introduction

Last year, we published the scientific journal report, Developments in Management Science in Engineering 2017, and presented it at the opening ceremony of the 12th International Conference on Management Science and Engineering Management in Melbourne, Australia. Participants gave positive comments on the report saying that it assisted editors in proposing methods for improving journal impact and allowed for an evaluation of journals based on both impact factor and the comprehensive index. They also highlighted the main differences between this journal report and other journal rankings, stating that it: (1) identified the dynamic relationships between the seven management science in engineering (MSE) journal categories and the frontier and emerging journal categories; (2) introduced a five-year journal performance index as a journal evaluation measure; and (3) defined and classified the MSE journal categories for the first time. Encouraged by this strong social response, we continued the work on scientific MSE journal reporting to develop and publish this 2018 edition.

As in the previous version, the aim of this report is to identify the main MSE research categories and identify the most representative journals in each category. In this report, an integrated methodology is proposed consisting of literature mining, cluster analysis and expert systems. The data for the proposed methodology came primarily from the Web of Science and Journal Citation Reports (JCR), the results from which identified the seven categories most related to MSE: civil engineering, engineering management, industrial engineering, energy engineering, environmental engi-

neering, information engineering, and agricultural engineering. The most related journals in each category were identified from literature mining using Note-Express and the CiteSpace software, from which it was found that there were, respectively, 93, 90, 64, 65, 90, 47 and 21 journals in each of the seven categories. All identified journals in each category were then graded into four zones labeled A to D, with A being journals that had the most significant influence on subject development; B journals that had high-quality papers, high submissions, and low acceptance rates; C journals that were well recognized journals but had limited impact; and D journals with good lightly referred papers that were less important. The dynamic impact factor changes in the journals in the different zones were analyzed and the principal components of the journal evaluation indicators discussed. The main advantage of this report is that it adjusts for the journal impact and citation differences across subject areas over a long-term period.

This report was developed through the joint efforts of the scientific board members, many of whom are editors-in-chief of the most related journals, academicians, fellows from different countries, and members of professional societies. We would like to express our sincere appreciation for their contributions during the report writing. Compared with the last version published in 2017, in this version, some category journals have been replaced and others added based on the topic concentrations. However, two types of journals from the 2017 version have been removed from this edition: journals that have changed their research directions so that management science in engineering related topics are not the 2018 focus; and, as the journal scope in this edition is generally in compliance with JCR's SCI journals, the journals that have been excluded from the Web of Science due to paper quality are also not included in this report.

Chapter 2
Support Committee

Support for this proposed MSE journal report was received from both the expert committee and the organizational committee. In the expert support group, the expert-in-chief, professional expert board, and the working group all worked together. The expert-in-chief was Prof. Jiuping Xu, a distinguished MSE researcher, the professional expert board was made up of fellows from different national academies of sciences and editors from international journals, and the main members of the working group were PhD candidates with MSE majors. An introduction to the expert support is given in the following sections.

2.1 Experts Committee

The expert support for this journal report came from the expert-in-chief and the professional expert board.

2.1.1 Expert-in-chief

Jiuping Xu
Assistant Vice-President of Sichuan University and Dean of the Business

School;
Most cited Chinese researcher in the field of Decision Science, Elsevier, 2018;
Honorary Academician, Academy of Sciences of Moldova, 2016; Academician, Mongolian National Academy of Sciences, 2016;
Lifetime Academician, International Academy for Systems and Cybernetic Sciences (IASCYS), 2010;
President, International Society for Management Science and Engineering Management (ISMSEM), 2007-present;

2.1.2 Professional Expert Board

Benjamin Lev
Editor-in-Chief of Omega, the International Journal of Management Science.
Professor, LeBow College of Business, Drexel University, Philadelphia PA, USA.

Syed Ejaz Ahmed
Professor, Faculty of Mathematics and Science, Brock University, Ontario, Canada.
Associate Editor, Journal of Statistical Computation and Simulation.

Asaf Hajiyev
Secretary General of Parliamentary Assembly of the Black Sea Cooperation (PABSEC);
Academician at Azerbaijan National Academy of Sciences.

Gheorghe DUCA
President, academician, the Academy of Sciences of Moldova;
Chemist, founder of the Research School on Ecological Chemistry.
Editor-in-chief, Chemistry Journal of Moldova.

Mitsuo Gen
Tokyo University of Science, Research Institution for Science and Technology Fuzzy Logic Systems Institute, Japan.

Mohamed Abdou
Distinguished Professor and Director of the Center for Energy Science and Technology, UCLA;
Founding President, Council of Energy Research and Education Leaders (CEREL), USA.

Nozer D. Singpurwalla
Chair Professor of Risk Analysis and Management Science at The City University of Hong Kong.

Shibli Rubayat Ul Islam
Professor and Chairman, Department of Banking & Insurance;
Dean, Faculty of Business Studies, Faculty of Business Studies University of Dhaka.

Bernard Han
Professor of Department of Business Information, Systems, Western Michigan University, Kalamazoo, USA.

Voratas Kachitvichyanukul
Professor of Industrial Engineering and Management, Asian Institute of Technology, Krung Thep, Thailand.

2.1.3 Working Group

Ziqiang Zeng
Researcher at Sichuan University, Business School, China.
Member of the American Institute of Electrical and Electronics Engineers (IEEE).

Associate Member of the American Society of Civil Engineers (ASCE).

Zongmin Li
Associate Professor, Sichuan University, China.
Managing editor of International Journal of Management Science and Engineering Management (IJMSEM).

Yi Lu
Associate Professor, Sichuan University, China.
Guest editor of Environmental Hazards.

Liming Yao
Researcher at Sichuan University, Business School, China.
Member of the Institute for Operations Research and Management Sciences (INFORMS).

Zhimiao Tao
Associate Professor, Sichuan University, China.

Zhibin Wu
Researcher, doctoral tutor at Sichuan University, China.
Visiting Scholar at the Department of Industrial and Systems Engineering, University of Washington.

Other members of the working group were: Chengwei Lyu, Fengjuan Wang, Yan Wang, Weiyao Tang, Qian Huang, Rongwei Sun, Wen Zhang, Liying Liu, Yawen Deng and others.

2.2 Organizing Committee

The International Academy for Systems and Cybernetic Sciences (IASCYS);
International Society of Management Science and Engineering Management (ISMSEM);
Sichuan University

Chapter 3
General Methodology

Academic journals are one of the most important vehicles for academic exchange, and studying the co-citation relationships between academic journals can reveal the relationships between disciplinary subject development. Systematic theoretical analyses, that typically encompass concepts such as paradigms, theoretical models, phases, and quantitative or qualitative techniques, are necessary to elucidate the methods and principles associated with a certain branch of knowledge and determine the co-citation relationships. Therefore, to deeply evaluate journals, a systematic but general methodological classification method is needed to identify the journal categories and their rankings. Therefore, in this report, a specific literature analysis approach was taken in which: (a) the Web of Science database was employed for the literature analysis; and (b) CiteSpace was used to visualize the scientific literature patterns and trends. Compared to purely qualitative methods, this classification method was deemed to be fairer and more objective and could more accurately reflect the actual situation.

3.1 Data Acquisition

The data used for the category identification and journal recognition came mainly from the Web of Science (WoS) database, which is an online subscription based scientific citation indexing service that was originally estab-

lished by the Institute for Scientific Information (ISI) and has been maintained by Clarivate Analytics since December, 2017 [1]. This database has access to multiple databases that reference cross-disciplinary research, and therefore allows for an in-depth exploration of the specialized subfields within an academic or scientific discipline [4]. The WoS platform connects the WoS Core Collection to regional citation indexes, patent data, specialized subject indexes, and an index of research data sets, and covers over 5,200 social science publications across 55 disciplines dating back to 1900 [2, 3].

To increase the accuracy of the analyses, the WoS Core Collection Indexes were chosen for the data acquisition. The Web of Science Core Collection-Citation index has six main online databases: the Science Citation Index Expanded (SCI-Expanded); the Social Sciences Citation Index (SSCI); the Arts & Humanities Citation Index (A&HCI)[8]; the Emerging Sources Citation Index (ESCI); Conference Proceedings Citation Index Science (CPCI-S); and Conference Proceedings Citation Index-Social Science & Humanities (CPCI-SSH)[2, 3], as shown in Fig. 3.1.

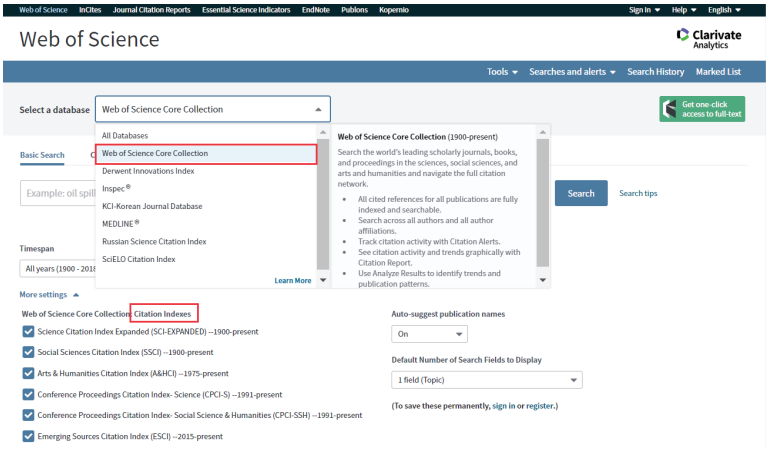

Fig. 3.1: Web of Science Core Collection Database

Advanced search

As it has been found to be a significant improvement on more conventional finite state algorithms, the WoS advanced search was chosen because it involves a finite state pattern-matching algorithm in a library bibliographic search program that can identify all the titles that satisfy the Boolean keywords and phrases in a citation index. An advanced search query consists of one or more field tags and a search string, with both Booleans and wildcards allowed. Records are searched for using field tags, set combinations or a combination of both. Some commonly used file tags are: TS= Topic, TI= Title, AU=Author, AI= Author Identifiers, GP= Group Author, ED= Editor, SO=Publication Name, DO=DOI, PY=Year Published, CF=Conference, AD=Address, OG=Organization-Enhanced, OO= Organization, SG= Suborganization, SA= Street Address, CI= City, PS=Province/State, CU= Country/Region, ZP= Zip/Postal Code, FO= Funding Agency, FG= Grant Number, FT= Funding Text, SU= Research Area, WC= Web of Science Category, IS= ISSN/ISBN, UT= Accession Number, PMID=PubMed ID, ALL= All Fields.

The Boolean Operators in the Web of Science Advanced Search are: **AND**, to find records containing all terms; **OR**, to find records containing any of the terms; **NOT**, exclude records containing certain words in the search; **Near**, to find records containing all terms within a certain number (n) of each other; and **SAME**, to search terms that must occur within the same sentence. Truncation and wildcard characters are used for more control when retrieving plurals and when there are different spellings. Item *****, to retrieve words with a variant zero to many characters, Item **?**, to retrieve words with the replacement of 1 character; Item **$**, to retrieve zero or one character, and Item **“”**, to search for exact phrases.

To obtain the search results, the following steps for the “advanced search” steps were followed: (1) Go to the Web of Science website, select Web of Science Core Collection database and enter the Advanced Search item; (2) Set search command as “TS=(management science)”, restrict results by setting language as “English” and document types as “Article OR Proceeding Paper OR Review”. Other items are set by default, including “Timespan=All years (1900-2018)”, “Web of Science Core Collection: Citation Indexes=SCI-Expanded, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI”; (3)

Click the “Search” item and find the search results at the bottom of the page in “Search History”, shown in Fig. 3.2.

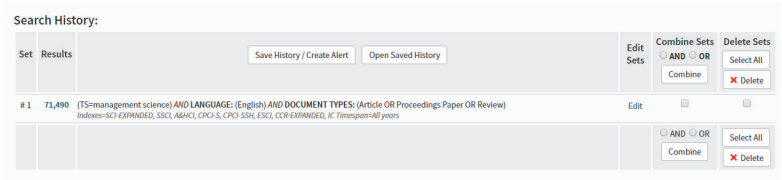

Fig. 3.2: Search history in the Web of Science Core Collection Database

A search history is a search query or multiple search queries saved to a server or hard drive. There is no limit to the number of search histories that can be saved, and combined search sets can be created from the Search and Advanced Search functions and are listed in the Search History table in reverse numerical order, with the most recently created set at the top. The operational steps for this are as follows: (1) Click the AND or the OR option; (2) Select the check box for each set that is to be combined; (3) Click the Combine button; (4) Click the link in the Results column to view the results of your search.

Data Export

In the Web of Science, the search results are displayed with the full title, author names, and source as a list of 10, 25, or 50 items per page. When the full text is available, the option to “view free full text” appears. Related records can be found and sorted by the latest date, times cited, relevance, first author, publication year, and source title. The results can also be analyzed (i.e., by author, country/ territory or document type), and a citation report presented with a labeled bar chart. The results can also be further refined, and the records viewed or excluded.

Output options are available at the bottom of the Results pages (as shown in Fig. 3.4), including Save to Endnote Online, Save to EndNote Desktop, Save to ResearcherID, Save to Incites, and Save to Other File Formats. As CiteSpace software was used for the follow-up analysis, the Save to Other File Formats was chosen.

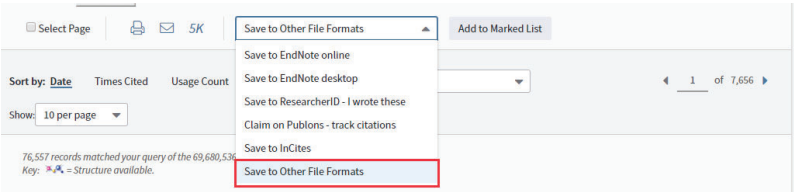

Fig. 3.3: Data Export in the Web of Science Core Collection Database

This option allowed for the output selection of all search results (no more than 500 at a time) or specific record(s) such as: (1) Selected records on a page by checking the box for each desired record; (2) All records on page by selecting a value in the Show 10, 25, or 50 per page list; and (3) Records, to select a range of records. In this case, 500 items at a time were selected until all the records had been exported.

Four Record items are provided: (1) Author, Title, Source; (2) Author, Title, Source, Abstract; (3) Full record; and (4) Full Records and Cited References. The CiteSpace analysis was based on the "Full Records and Cited References", as shown in Fig. 3.4. The following file formats are available for Saving to Other File Formats: Other Reference Software, HTML, Plain Text, Tab-delimited (Win), Tab-delimited (Mac), Tab-delimited (Win, UTF-8), and Tab-delimited (Mac, UTF-8). For this paper, Plain Text was chosen.

Click "send" and the system saves the document as a text file (for example, savedrecs.txt). The selected data include the following information: (1) Bibliographic Fields includes author, title, and source information; (2) Bibliographic plus Abstract includes bibliographic fields and author abstract; (3) Full Record includes all data on the Full Record page; and (4) Full Record plus Cited Reference includes all data on the Full Record page as well as the cited references.

3.2 Category Identification

A systematic literature review allows for current findings to be discussed in relation to a particular research question, as scientific knowledge based on text usually has its own evolving life cycle. Therefore, analyzing the evolu-

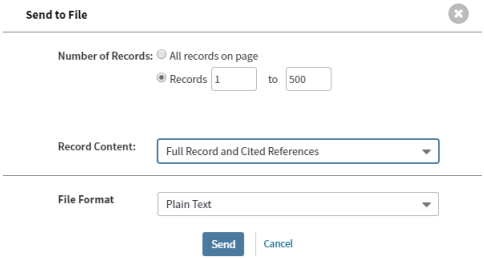

Fig. 3.4: Send to File in the Web of Science Core Collection Database

tionary patterns has become an increasingly important text mining research direction in recent years [9, 10]. As the literature analysis expands the literature mining scope, it can be used to categorize the journals and rank the related journals. In this work, all MSE management related journals were identified, and categorized using CiteSpace software.

CiteSpace is Java language information visualization software based on the citation analysis theory developed by Dr. Chen [15]. The CiteSpace design was inspired by Thomas Kuhn's scientific revolution structure, with the central idea being that research foci change over time, sometimes incrementally and sometimes drastically. Therefore, scientific developments can be traced by studying the footprints revealed in scholarly publications. As contemporary scientific community members make contributions, these form a dynamic, self-organizing knowledge system that embodies consensus, disputes, uncertainties, hypotheses, mysteries, unsolved problems, and unanswered questions, thereby providing a better understanding of the ways that a specific topic is related to other topics.

The CiteSpace foundation is network analysis and visualization. Network modeling and visualization explores the intellectual landscape of a knowledge domain, discerns the questions researchers have been trying to answer, and identifies the methods and tools that have been developed to find solutions. The software integrates an information visualization method, a bibliometric method, a data mining algorithm, and a network algorithm, all of which allows the research data to be transformed into a scientific knowledge map, from which knowledge generation and interpretation, the critical evolutionary research field path, and the knowledge inflection points can be

determined, thereby allowing for a detailed exploration of the citations in the management science journals [5, 6].

Parameter Setting

The user interface is divided into left and right. The left-hand side has the project controls (i.e. input datasets) and the progress report windows, while the right-hand side contains several panels that allow the process to be configured using various parameters. Specifically, the CiteSpace process takes a current project input dataset, constructs network models of the bibliographic entities, and visualizes the trends and patterns extracted from the dataset in networks.

First, a new project is built so that the relevant research is entered into CiteSpace. The establishment of the literature database for entry into CiteSpace is shown in Fig. 3.5.

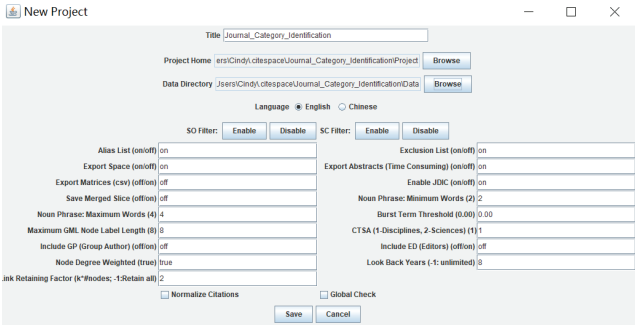

Fig. 3.5: Establishment of the literature database for entry into CiteSpace

Second, the basic parameters are set using the right-hand side panels and based on the research object, the Node Types chosen for the cited journals, as shown in Fig. 3.6.

CiteSpace has a variety of functions: a collaboration atlas (author, institution and country), a co-occurrence atlas (feature word, keyword, subject category), and a co-citation atlas (literature, author and journal). A cited journal refers to the journals cited in the same document and reflects the

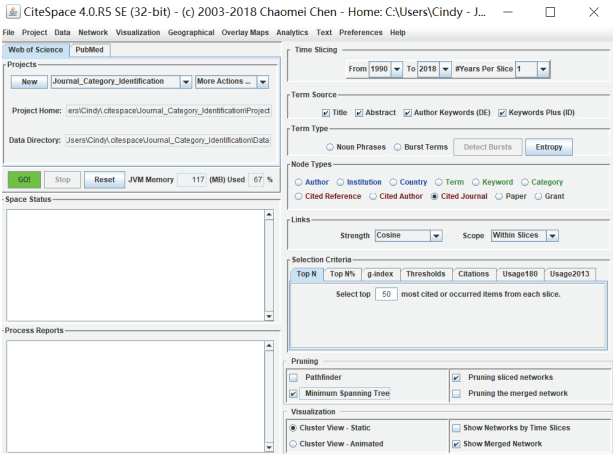

Fig. 3.6: CiteSpace interface for configuring analysis.

relevance of the various journals and disciplines. The knowledge base distribution in a research field can be obtained from a cited journal analysis to further reveal the classifications for the cited periodicals.

Third, pressing the green GO button starts the process. CiteSpace reads the data files in the current project (Demo) and reports the progress in the two windows on the left-hand side of the user interface. When the modeling process is complete, there are three options given: Visualize; Save As GraphML; or Cancel. Visualize is selected, which moves the analysis to the visualization window for further interactive exploration.

Visualization results

After clicking the Visualize button, the Visualization Window appears, which initially has movements on a black background. Once the movements have settled, the background color turns white. Here, the initial visualization is examined and the additional functions explained. First, CiteSpace gives a merged network visualization of the developments in the field based on several networks that correspond to consecutive years from 1990 through 2018 and shows the most important footprints for the related research activities.

Each dot represents a node or the cited journals in the network. CiteSpace can also generate networks for other types of entities. The lines that connect the nodes are the co-citation links; again, CiteSpace can generate networks for other types of links. The line colors indicate when a connection was made for the first time.

Fig. 3.7 is the original graph, in which each node represents a different journal and the lines indicate the connections between the journals. The node size is related to the number of journals, that is, the greater the frequency, the larger the node. A control panel is shown on the right-hand side of the Visualization Window, in which the node labels are displayed and can be changed using the sliders and a combination of threshold values; the node size can also be changed using the node size slider.

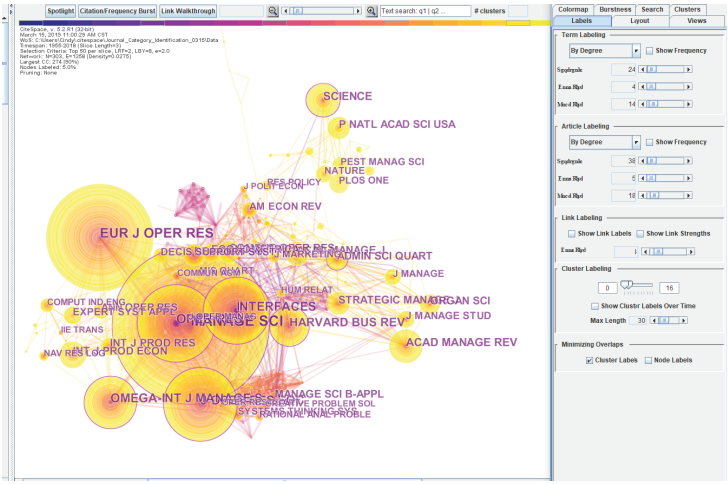

Fig. 3.7: Visualization window: Journal cooperation and affiliations

Clustering

Although it is possible to identify some prominent groupings by studying the visualized network, the clustering function in CiteSpace provides greater precision when seeking to identify the groupings or clusters. To start

the clustering function, the Find cluster icon is simply clicked. To characterize the nature of an identified cluster, CiteSpace extracts noun phrases from the titles (T in the following icon), keyword lists (K) or abstracts (A) of articles that cite a particular cluster; here, T was chosen. Once the process is finished, the chosen labels are displayed. By default, labels based on one of the three selection algorithms are shown; that is, TF*IDF. Cluster labels are displayed once the process is completed, and the "♯ Clusters" are shown on the upper right corner of the canvas. The clusters are numbered in descending order of cluster size, starting from the largest cluster ♯ 0, the second-largest ♯ 1, and so on.

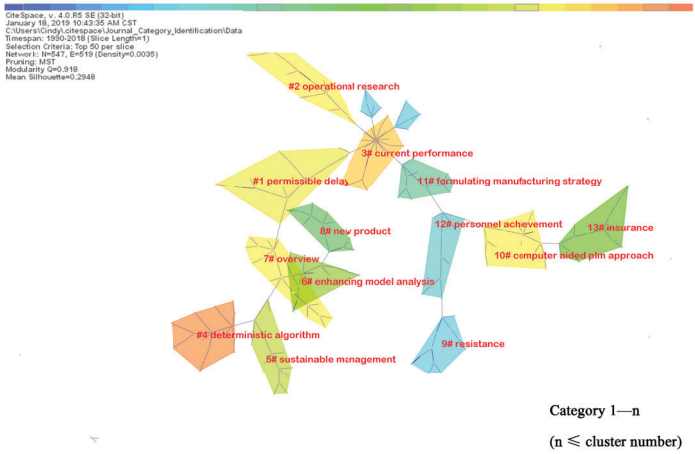

Fig. 3.8: Members of different clusters are shown in different colors.

Fig. 3.8 shows the clustering from an analysis of relevant literature from a cited management science journal, with each cluster corresponding to an underlying theme, a topic, or a line of research. Kuhn's paradigm involves time period clustering, with the cluster colors indicating the average years for that cluster [12]. From this visualization, a deeper understanding of the connections from one cluster to another cluster can be gained.

Two important metrics for describing the overall structural properties of the network and modularity and the mean silhouette scores. As seen in Fig

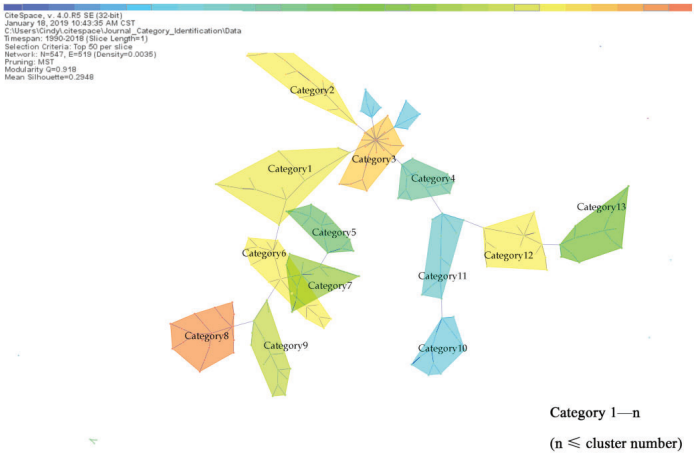

Fig. 3.9: Cluster view for category identification (C-A).

3.8, the modularity values (0.918) were relatively high, indicating that the networks' loosely coupled clusters were reasonably divided. The silhouette measure is used to determine whether the data are appropriately clustered: when the Silhouette measure is close to one, the data are appropriately clustered and when the Silhouette measure is close to minus one, the data are not appropriately clustered; however, when the Silhouette measure is close to zero, the data are on the border of two natural clusters [13]. The mean silhouette scores from the analysis indicated that on average, the management science cluster homogeneity (0.2948) was relatively high.

Auto-labeling was used to identify the clusters; however, to determine which of these were the most appropriate, silhouette and size measures were used. *n* clusters with a high silhouette (ID: ID1, ID2, ..., IDn; silhouette: S1, S2, ..., Sn) and a large size (SZ1, SZ2, ..., SZn) were extracted and the cluster labels (TF*IDF) summarized as "category 1", "category 2", ..., "category n". The category identification cluster view is shown in Fig. 3.9. Once the categories in the above *n* clusters were distinguished, the representative journals for the management science categories were identified. By summarizing the clusters, all *n* clusters and the respective details for each group were identified, as shown in Fig. 3.10.

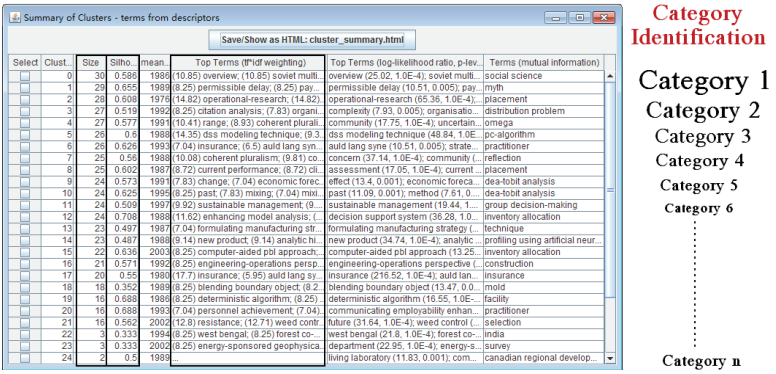

Fig. 3.10: Cluster list for target categories.

3.3 Journal Recognition

To identify the related journals in each of the journal categories identified in the last section, a new data analysis system was designed. To determine the number of citations and the relationships between the cited journals, first the data analysis system was used to identify and review thousands of management science research papers, after which literature mining, the process of extracting unknown, comprehensible and available knowledge, was applied to organize the information [7, 14].

The scientific knowledge map analyses were made up of word frequency analysis, co-word analysis, co-citation analysis, and cluster analysis, which together showed the breadth of information in the scientific knowledge field and the scientific research directions. A knowledge map is based on a knowledge domain and illustrates the development and structure of the scientific knowledge by identifying the complex relationships between the knowledge units or knowledge groups, the network structure, the interactions, the evolution, and the new knowledge. The CiteSpace visualization process has four stages: document retrieval and preservation; data guide and tuning; map customization; and map analysis.

Data recollection and tuning

The analyzed data, which included SCI-EXPANDED, SSCI, A&HCI, and other citation libraries [11] was also extracted from the WoS core collection. An advanced search was then used after which articles, proceedings papers, and reviews were selected. After unnecessary research was filtered out, the related articles were downloaded in Plain Text format, with each data record made up of author, title, abstract, and research citation, and with the retrieval period being from 1990-2018. When searching, the search command was set at X_i AND Y_i, for which "X_i" represented "management" and "Y_i" represented "category n". When the search was complete, all related articles were downloaded and saved in CiteSpace, after which it was necessary to coordinate the data.

(a) Time slicing

The time span specifies the range of citations published over a certain time, the value of which is determined by the citation year distribution and the period the analyst is interested in. The time division length refers to the complete time span, which is divided into equal yearly time intervals.

(b) Term source and term type

The cluster tags are derived from the Title, Abstract, Author Keywords, and the Keywords Plus (ID). The keywords are divided into noun phrases and emergent words; however, CiteSpace automatically extracts specific noun phrases as the cluster labels to reflect the specific research focus.

(c) Node types

Depending on the subject analysis, the cited journal is selected as the node type, which then determines the type of object that is represented in the graph. Cited journals are used as important indexes for the terms extracted from the published articles in the journals or databases.

(d) Set threshold

CiteSpace controls the number of network nodes based on a threshold value in a single time zone. The citation that satisfies the threshold condition is then visualized under four settings: Top N; Top N%; Threshold Interpolation; and Select Citers. Top N selects the highest cited N citations, Top N% selects first by the number of citations and then by the percentage of citations (N%) in the same time threshold, and Threshold Interpolation sets the threshold from the citation counts, co-citation counts, and co-citation coefficients (c, cc, ccv), the formula for which is:

$$CC_{\cos ine}[i,j] = \frac{cc(i,j)}{sqrt(c(i),c(j))}. \tag{3.1}$$

A threshold anchor is set in the time span for the first, middle and last partitioned times, and a linear interpolation algorithm is used on the rest of the time partition threshold to calculate the time needed to achieve a different personalized partition threshold. The citation literature was selected (Select Citers) based on the TC value in the citation records, and then one of the three methods (Top N, Top N%, Threshold Interpolation) was used to screen the references in the citation literature. A reasonable threshold can be calculated and compared depending on the number of selected citations, nodes, and connections in the lower left corner of the CiteSpace interface (Space Status and Process Reports).

(e) Pruning and visualization

The Minimum Spanning Tree is used to control the number of network connections, reduce connection density, and reduce cross connections. Using the Pruning sliced network and the Pruning merged network tools, the earliest connections are found and retained and the entire time span for the merged network structure displayed. After setting the parameters, GO is clicked to start the document screening, from which a statistical analysis and a results graph that shows the nodes and lines are produced.

Atlas interpretation

The main purpose of the analysis is to clarify the graph's meaning and analyze the themes. The node object depends on the type of node set and node ring thickness, with the corresponding time partition being proportional to the number of cited journals for which the ring color represents the cited year; the greater the nodes across the time span, the higher the number of citations. Therefore, the size of the node is proportional to the number of citations, with the number of citations being standardized by publication date. The connections between the nodes indicate common citation relationships, and the connections between the line length and thickness indicate the connection strength between two nodes. The length and width of the edges are proportional to the same coefficient. A visual view of the category identification is shown in Fig. 3.11.

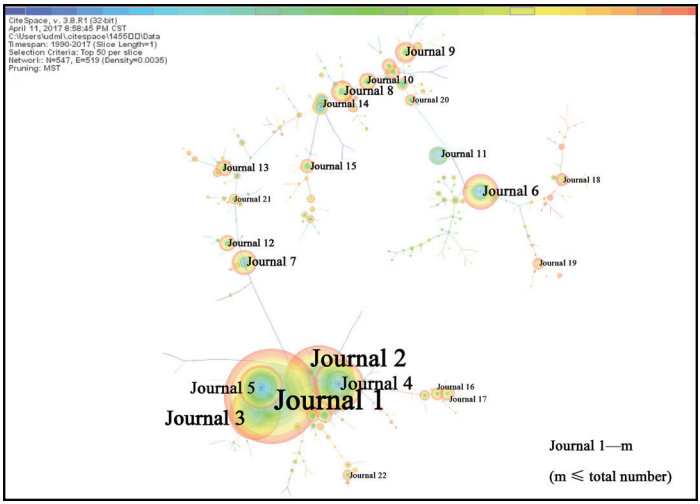

Fig. 3.11: Visual view for category identification (V-B).

As can be seen from Fig. 3.11, Journal 1 had the highest number of nodes, indicating that it was the most cited. Further, the connection degree between Journal 1 and Journals 2, 3 and 4 was also the highest. Fig. 3.11 only shows a selection of the higher frequency journals. It should also be noted that "m" is less than or equal to the total number of retrieved journals..

Frequency selection

CiteSpace visualization is clear and easy to read. The different colors, node sizes, and node positions make it easy to identify the high citation frequency nodes, the distribution of the cited journals, and the citation years; that is, the cited journal analysis identifies the relevance and academic influence of the journals. Based on the cited frequency of the core journals, a list is generated, which can be sorted by citation frequency, centrality or year, that gives the name of the journal, the publication time and other information,. A node in the list can also be shown or hidden. Fig. 3.12 shows the journal frequency list for management science

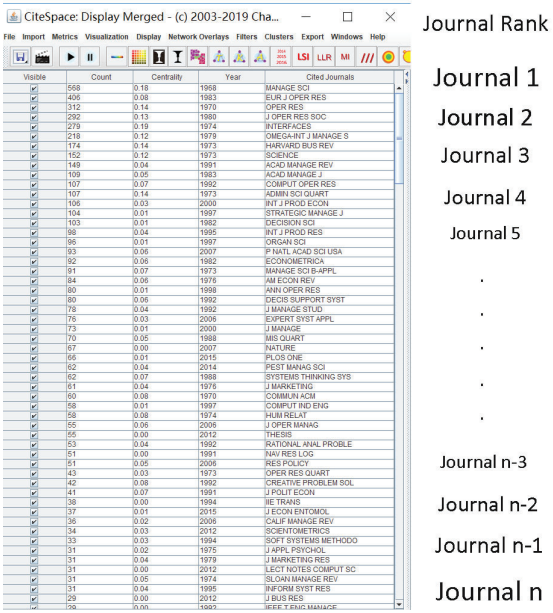

Fig. 3.12: Journal ranking I for category identification.

Frequency refers to how often an event is repeated per unit time and a frequency distribution is a table that displays a sample of the frequencies from various outcomes by summarizing the data groupings and occurrences in a class. Generally, low frequency journals are not selected as sorting objects as journals that publish fewer articles each year are cited less frequently. Therefore, it is necessary to compare the number of selected journals with the total number of articles published each year, as shown in Eq. 3.2. If F is still small, the journal is not selected.

$$\mathrm{F} = \frac{\text{Frenquency}}{\text{Annual Total of Articles}}. \tag{3.2}$$

3.4 Journal Classification

At present, the main evaluation system used for mainstream journals in China is the Chinese Academy of Sciences Journal partition table and Clarivate Analytics JCR Journal Ranking, and while both are based on SCI journal impact factors, there are many differences. Understanding the quality of a journal is important when seeking to study a subject or field from published articles.

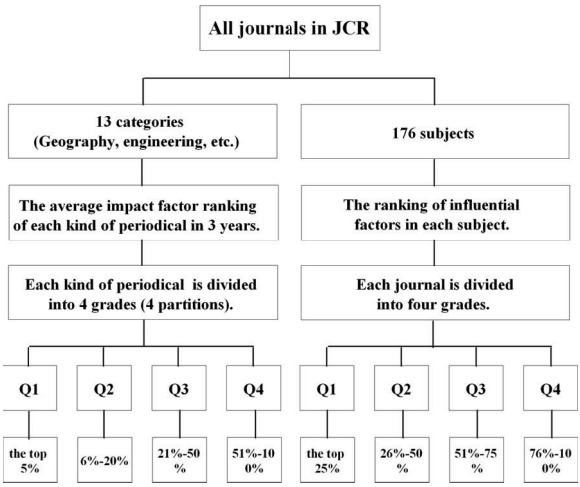

Fig. 3.13: Journal ranking for Clarivate Analytics and the Chinese Academy of Sciences.

(1) Clarivate Analytics Journal Ranking

JCR divides journals into 176 different categories, with the subjects first classified according to the impact factor (IF) in that year and then divided into four quartiles; Q1 for the top 25%; Q2 for those between 50% and 25%; Q3 for those between 75% and 50%; and Q4 for those in the bottom 25% of the IF distribution; therefore, the journals are evenly divided into four. This method has been widely recognized by most universities and research institutions in the world.

(2) Chinese Academy of Sciences Journal Ranking

The Chinese Academy of Sciences first divides all JCR journals into 13 categories: mathematics, physics, chemistry, biology, earth science, astronomy, engineering, medicine, environmental science, agricultural science, social science, management science, and comprehensive journals. These are then divided into four districts based on the average influence factors for each journal in the previous 3 years; the first 5% is District 1; from 6% to 20% is District 2; 21%-50% is District 3; and the remaining area is District 4. The number of journals in these four districts of the Chinese Academy of Sciences is shown in a pyramid structure.

In Districts 1 and 2, there are few journals, indicating that the journal quality is relatively high and that these are the top journals in the relevant field. Therefore, there are significantly more journals in Clarivate Analytics Q1 range than in the Chinese Academy of Sciences District 1. This means that some journals in Clarivate Analytics Q1 may not be in District 1 but in District 2 or 3 under the Chinese Academy of Sciences classification.

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Chapter 4
Civil Engineering

Civil engineering focuses on the design, construction, and maintenance of the natural and built environment, such as roads, bridges, canals, and dams. In this chapter, 93 civil engineering-related journals are comprehensively examined to track the academic discipline development. The results of this comprehensive, systematic analysis provides a useful journal selection channel for researchers.

4.1 Category Description

Civil engineering is the technical work associated with surveying, planning, designing, constructing, installing, and maintaining buildings, structures and related support facilities for construction, reconstruction or expansion [3]. Civil engineering is the second-oldest engineering discipline after military engineering and was originally defined as such to distinguish it from military engineering [10]. Civil engineering is also closely related to both public and private sector projects such as the government oriented municipal projects and individual homeowner oriented construction projects [7].

Civil engineers are involved in infrastructure planning applications, and the design, construction, maintenance, and operation of new and existing infrastructure while protecting public and environmental health. The term "civil engineer" was first established by John Smeaton in 1750 to distinguish

the engineers working on civil projects from military engineers [13] working on armaments and defense. Over time, various civil engineering subdisciplines have become recognized, with most military engineering having now been absorbed into the civil engineering discipline [12].

Until 1900, civil engineering projects were generally managed by creative architects, engineers, or master builders [9]. In the 1950s project management tools began to be applied to ensure systematicity in complex engineering projects. The primary challenge associated with project management has been to achieve all project goals within the given constraints of scope, time, quality, and budget. The secondary challenge is to optimize the necessary input allocations to meet the pre-defined objectives. The overarching aim of project management is to complete the project in compliance with the client objectives.

4.2 Ranking Report

There are four indexes that indicate research journal excellence: impact factor, five-year impact factor, the eigenfactor score, and the article influence score. The impact factor is an internationally accepted periodical evaluation index from which it is possible to measure the average article citation frequency in the previous two years to assess the relative importance of different journals in the same field. The five-year impact factor is used to measure the average article citation frequency in the previous five years to assess the relative importance of different journals. The eigenfactor score is related to the quoted quantity excluding self-citations and reflects the overall importance of a journal. The article influence score is equal to the five-year impact factor except for self-citations, and also reflects the overall importance of the journal. The eigenfactor score and the article influence score are considered more scientific measures as they both consider citation quality; however, this does not mean that the impact factor and five-year impact factor have no value. A certain degree of self-citation indicates that journals are focused on their specific scope and have representative contributions. The impact factor and eigenfactor score evaluate journals in the previous two years while the five-year impact factor and article influence score evaluate journals in the previous five years; as the former indicates the more current

developments and the latter indicates the long-term journal contributions, it would be one-sided to evaluate journals using only one index.

Therefore, as shown in Table 4.1, the four indexes were integrated to develop a novel evaluation model, with each index weight determined using expert scoring: impact factor (0.3), five-year impact factor (0.3), eigenfactor score (0.2), and article influence score (0.2). To resolve the problems associated with the different dimensions of the four indexes, the data were standardized to calculate the comprehensive journal scores. Based on the respective comprehensive scores, the 93 civil engineering journals were divided into four zones to directly characterize the journal level. Journals with scores in the top 5% were allocated to Zone A, scores between 6% and 20% were allocated to Zone B, scores between 21% and 50% were allocated to Zone C, and the remaining 50% were allocated to the Zone D.

As shown in Table.4.2, five journals were allocated to Zone A: *Journal of Hydrology*; *Transportation Research Part B-Methodological*; *Computer-Aided Civil and Infrastructure Engineering*; *Transportation Research Part E-Logistics*; and *Transportation Review and Engineering Structures*. The five-year impact factors for these five journals ranged from 3.06 to 5.109 and the Article Influence Scores ranged from 0.802 to 1.358. The Journal of Hydrology publishes original research papers and comprehensive reviews in all the hydrological science subfields including water-based management and policy issues that impact the economy and society. There was a total of 46,099 citations. Transportation research Part B-Methodological had the highest five-year impact factor of 5.109. The general focus of this journal is the development of solutions to problems related to the design and/or analysis of transportation systems.

As shown in Table 4.3, there were f14 journals in Zone B, with the five-year impact factors ranging from 2.42 to 3.72 and the impact factor ranging from 1.903 to 3.622. *Journal Structural Control and Health Monitoring (No.4)* covers the theoretical and technological aspects of structural control, structural health monitoring theory and smart materials and structures, with a specific focus on aerospace and civil infrastructure and mechanical engineering applications. *Materials and Structures (No.12)* provides a unique international and interdisciplinary forum for new research findings on construction material performances, and is specifically dedicated to the publication of high quality papers that examine the fundamental properties of building materials, processing techniques, the standardization of testing

Table 4.1: Comprehensive scores of “civil engineering” journals

Rank	Full Journal Title	ISSN	JCR Data		Eigenfactor Metrics		Standardization				Comprehensive score
			Impact Factor	Five-Year Impact Factor	Eigenfactor Score	Article Influence Score	Z-Impact Factor	Z-five-Year Impact Factor	Z-Eigenfactor Score	Z-Article Influence Score	
1	Journal of Hydrology	0022-1694	3.727	4.314	0.05549	1.097	2.147	2.437	7.262	2.033	3.234
2	Transportation Research Part B-Methodological	0191-2615	4.081	5.109	0.01355	1.358	2.506	3.195	1.346	2.874	2.554
3	Computer-Aided Civil and Infrastructure Engineering	1093-9687	5.475	4.663	0.00418	1.089	3.918	2.770	0.025	2.007	2.413
4	Transportation Research Part E-Logistics and Transportation Review	1366-5545	3.289	4.093	0.00932	1.109	1.703	2.226	0.750	2.071	1.743
5	Engineering Structures	0141-0296	2.755	3.06	0.03144	0.802	1.162	1.240	3.870	1.081	1.711
6	Structural Safety	0167-4730	3.538	3.72	0.00389	1.181	1.955	1.870	-0.016	2.304	1.605
7	Computers & Structures	0045-7949	2.887	3.362	0.01296	1.076	1.296	1.529	1.263	1.965	1.493
8	Transportation	0049-4488	3.151	3.371	0.00472	1.178	1.563	1.537	0.101	2.294	1.409
9	Structural Control & Health Monitoring	1545-2255	3.622	3.269	0.00399	0.742	2.040	1.440	-0.002	0.888	1.221
10	Thin-Walled Structures	0263-8231	2.881	3.037	0.01269	0.716	1.290	1.219	1.225	0.804	1.158
11	Journal of Water Resources Planning and Management	0733-9496	3.197	3.437	0.00489	0.68	1.610	1.600	0.125	0.688	1.126
12	Earthquake Spectra	8755-2930	2.079	2.926	0.00874	1.228	0.477	1.113	0.668	2.455	1.101
13	Coastal Engineering	0378-3839	2.674	3.139	0.00729	0.899	1.080	1.316	0.463	1.394	1.090
14	Journal of Composites For Construction	1090-0268	2.592	3.177	0.00529	0.861	0.997	1.352	0.181	1.272	0.995
15	Water Resources Management	0920-4741	2.644	2.871	0.01297	0.606	1.049	1.060	1.264	0.449	0.976
16	Steel and Composite Structures	1229-9367	3.594	2.922	0.00393	0.467	2.012	1.109	-0.011	0.001	0.934
17	Materials and Structures	1359-5997	2.271	2.528	0.01074	0.719	0.672	0.733	0.950	0.814	0.774
18	Journal of Structural Engineering	0733-9445	1.903	2.42	0.01255	0.814	0.299	0.630	1.205	1.120	0.744
19	Tunnelling and Underground Space Technology	0886-7798	2.418	2.822	0.00523	0.606	0.820	1.013	0.173	0.449	0.675
20	Archives of Civil and Mechanical Engineering	1644-9665	2.763	2.562	0.00272	0.487	1.170	0.765	-0.181	0.066	0.557
21	Journal of Hydraulic Engineering	0733-9429	2.08	2.384	0.00569	0.681	0.478	0.596	0.238	0.691	0.508
22	Journal of Hydraulic Research	0022-1686	2.076	2.317	0.00351	0.799	0.474	0.532	-0.070	1.072	0.502
23	Journal of Management in Engineering	0742-597X	2.282	2.864	0.00216	0.417	0.683	1.053	-0.260	-0.160	0.437
24	Ieee Journal of Oceanic Engineering	0364-9059	2.065	2.435	0.00325	0.658	0.463	0.644	-0.107	0.617	0.434
25	Journal of Materials in Civil Engineering	0899-1561	1.763	2.256	0.00993	0.561	0.157	0.473	0.836	0.304	0.417
26	Journal of Construction Engineering and Management	0733-9364	2.201	2.596	0.00451	0.433	0.601	0.798	0.071	-0.109	0.412
27	Journal of Hydro-Environment Research	1570-6443	2.087	2.305	0.00162	0.622	0.485	0.520	-0.336	0.501	0.334
28	International Journal of Pavement Engineering	1029-8436	2.322	1.988	0.00243	0.509	0.723	0.218	-0.222	0.137	0.265
29	Journal of Computing in Civil Engineering	0887-3801	1.798	2.35	0.00331	0.52	0.192	0.563	-0.098	0.172	0.241
30	Cold Regions Science and Technology	0165-232X	1.925	2.115	0.00434	0.497	0.321	0.339	0.047	0.098	0.227
31	Frontiers of Structural and Civil Engineering	2095-2430	1.58	1.58	0.0011	0.99	-0.029	-0.171	-0.410	1.688	0.196
32	Journal of Hydrologic Engineering	1084-0699	1.576	2.033	0.00631	0.521	-0.033	0.261	0.325	0.175	0.168
33	Structure and Infrastructure Engineering	1573-2479	1.845	1.811	0.00325	0.466	0.240	0.049	-0.107	-0.002	0.165
34	International Journal of Structural Stability and Dynamics	0219-4554	2.082	1.848	0.00235	0.371	0.480	0.084	-0.234	-0.308	0.061
35	Journal of Bridge Engineering	1084-0702	1.454	1.881	0.00485	0.522	-0.156	0.116	0.119	0.179	0.047
36	Journal of Earthquake Engineering	1363-2469	1.763	1.676	0.00222	0.551	0.157	-0.080	-0.252	0.272	0.027
37	Water International	0250-8060	1.956	1.717	0.00168	0.413	0.352	-0.041	-0.328	-0.173	-0.007
38	Natural Hazards Review	1527-6988	1.278	1.943	0.0013	0.595	-0.335	0.175	-0.382	0.414	0.041
39	Journal of Waterway Port Coastal and Ocean Engineering	0733-950X	1.481	1.605	0.00189	0.603	-0.129	-0.148	-0.298	0.440	-0.055
40	Journal of Infrastructure Systems	1076-0342	1.356	1.996	0.00155	0.494	-0.256	0.225	-0.346	0.088	-0.061
41	Journal of Irrigation and Drainage Engineering	0733-9437	1.616	1.714	0.00295	0.391	0.008	-0.044	-0.149	-0.244	-0.089
42	Engineering Construction and Architectural Management	0969-9988	1.613	1.613	0.00057	0.524	0.005	-0.140	-0.485	0.185	-0.100
43	Advances in Civil Engineering	1687-8086	0.827	0.827	0.00086	1.209	-0.792	-0.890	-0.444	2.394	-0.114
44	Journal of Civil Engineering and Management	1392-3730	1.66	1.749	0.00184	0.29	0.052	-0.010	-0.305	-0.570	-0.162
45	Geomechanics and Engineering	2005-307X	1.818	1.686	0.00104	0.238	0.213	-0.070	-0.418	-0.737	-0.188
46	Journal of Analytical Methods in Chemistry	2090-8865	1.262	1.722	0.00201	0.395	-0.351	-0.036	-0.281	-0.231	-0.219
47	Journal of Surveying Engineering	0733-9453	1.709	1.528	0.00049	0.293	0.102	-0.221	-0.496	-0.560	-0.247
48	Journal of Environmental Engineering	0733-9372	1.396	1.536	0.00295	0.308	-0.215	-0.213	-0.149	-0.512	-0.261
49	Transportation Research Record	0361-1981	0.695	0.954	0.01654	0.258	-0.925	-0.769	1.768	-0.673	-0.289
50	Jounal of Energy Engineering	0733-9402	1.346	1.632	0.00115	0.287	-0.266	-0.122	-0.403	-0.579	-0.313
51	Journal of Performance of Constructed Facilities	0887-3828	1.197	1.382	0.00329	0.369	-0.417	-0.360	-0.101	-0.315	-0.316
52	Structural Design of Tall and Special Buildings	1541-7794	1.5	1.361	0.00139	0.301	-0.110	-0.380	-0.369	-0.534	-0.328
53	Journal of Urban Planning and Development	0733-9488	1.252	1.573	0.00105	0.309	-0.361	-0.178	-0.417	-0.508	-0.347
54	International Journal of Architectural Heritage	1558-3058	1.345	1.373	0.00117	0.339	-0.267	-0.369	-0.400	-0.412	-0.353
55	Journal of Ship Research	0022-4502	1.441	1.281	0.00044	0.36	-0.169	-0.457	-0.503	-0.344	-0.357
56	Proceedings of the Institution of Mechanical Engineers Part F-Journal of Rail and Rapid Transit	0954-4097	1.103	1.379	0.00213	0.391	-0.512	-0.363	-0.265	-0.244	-0.364
57	Journal of Transportation Engineering	0733-947X	0.983	1.34	0.00323	0.404	-0.634	-0.400	-0.109	-0.202	-0.372
58	Journal of Advanced Transportation	0197-6729	1.102	1.382	0.00173	0.386	-0.513	-0.360	-0.321	-0.260	-0.378
59	Journal of Advanced Concrete Technology	1346-8014	1.134	1.383	0.00121	0.387	-0.481	-0.359	-0.394	-0.257	-0.382
60	Coastal Engineering Journal	0578-5634	1.246	1.246	0.0007	0.391	-0.367	-0.490	-0.466	-0.244	-0.399
61	Proceedings of the Institution of Civil Engineers-Engineering Sustainability	1478-4629	1.5	1.208	0.00051	0.296	-0.110	-0.526	-0.493	-0.550	-0.399
62	Journal of Aerospace Engineering	0893-1321	1.296	1.264	0.00209	0.291	-0.316	-0.473	-0.270	-0.566	-0.404
63	Earthquakes and Structures	2092-7614	1.309	1.287	0.00179	0.27	-0.303	-0.451	-0.313	-0.634	-0.416
64	European Journal of Environmental and Civil Engineering	1964-8189	1.29	1.22	0.00166	0.306	-0.322	-0.515	-0.331	-0.518	-0.421
65	Journal of Marine Science and Technology	0948-4280	1.119	1.31	0.00114	0.347	-0.496	-0.429	-0.404	-0.386	-0.435
66	Advances in Structural Engineering	1369-4332	0.968	1.103	0.00294	0.302	-0.649	-0.627	-0.150	-0.531	-0.519
67	Ksce Journal of Civil Engineering	1226-7988	0.94	1.073	0.00408	0.254	-0.677	-0.655	0.011	-0.686	-0.535
68	Earthquake Engineering and Engineering Vibration	1671-3664	0.847	1.166	0.00135	0.333	-0.771	-0.566	-0.375	-0.431	-0.562
69	Journal of Pipeline Systems Engineering and Practice	1949-1190	0.971	1.174	0.00052	0.289	-0.646	-0.559	-0.492	-0.573	-0.574
70	Latin American Journal of Solids and Structures	1679-7825	0.905	1.158	0.00175	0.242	-0.713	-0.574	-0.318	-0.724	-0.595
71	Journal of Water Supply Research and Technology-Aqua	0003-7214	1.179	1.033	0.00085	0.202	-0.435	-0.693	-0.445	-0.853	-0.598
72	Canadian Journal of Civil Engineering	0315-1468	0.869	1.026	0.00223	0.286	-0.749	-0.700	-0.250	-0.583	-0.601
73	Journal of Cold Regions Engineering	0887-381X	0.688	1.015	0.00026	0.299	-0.932	-0.710	-0.528	-0.541	-0.707
74	International Journal of Steel Structures	1598-2351	0.734	0.859	0.00117	0.227	-0.886	-0.859	-0.400	-0.773	-0.758
75	Civel Engineering and Environmental Systems	1028-6608	0.977	0.809	0.00024	0.163	-0.640	-0.907	-0.531	-0.979	-0.766
76	Advanced Steel Construction	1816-112X	0.737	0.754	0.00042	0.231	-0.883	-0.959	-0.506	-0.760	-0.806
77	Proceedings of the Institution of Civil Engineers-Water Management	1741-7589	0.431	0.863	0.00064	0.238	-1.193	-0.855	-0.475	-0.737	-0.857
78	Structural Engineering International	1016-8664	0.621	0.661	0.00085	0.207	-1.000	-1.048	-0.445	-0.837	-0.871
79	Proceedings of the Institution of Civil Engineers-Structures and Buildings	0965-0911	0.674	0.596	0.0007	0.181	-0.947	-1.110	-0.466	-0.921	-0.895
80	China Ocean Engineering	0890-5487	0.674	0.634	0.00072	0.157	-0.947	-1.074	-0.463	-0.999	-0.899
81	Ocean Engineering	0890-5487	0.674	0.634	0.00072	0.157	-0.947	-1.074	-0.463	-0.999	-0.899
82	Beton-Und Stahlbetonbau	0005-9900	0.717	0.491	0.00096	0.154	-0.903	-1.210	-0.430	-1.008	-0.922
83	Internation Journal of Offshore and Polar Engineering	1053-5381	0.469	0.653	0.00062	0.2	-1.154	-1.056	-0.478	-0.860	-0.931
84	Iranian Journal of Science and Technology-Transactions of Civil Engineering	2228-6160	0.514	0.771	0.0003	0.14	-1.109	-0.943	-0.523	-1.053	-0.931
85	Periodica Polytechnica-Civil Engineering	0553-6626	0.636	0.64	0.00028	0.096	-0.985	-1.068	-0.525	-1.195	-0.960
86	Baltic Journal of Road and Bridge Engineering	1822-427X	0.622	0.598	0.00025	0.095	-0.999	-1.108	-0.530	-1.198	-0.978
87	Gradevinar	0350-2465	0.515	0.529	0.00041	0.09	-1.108	-1.174	-0.507	-1.215	-1.029
88	Bauingenieur	0005-6650	0.477	0.373	0.00055	0.123	-1.146	-1.323	-0.487	-1.108	-1.060
89	Proceedings of the Institution of Civil Engineers-Civil Engineering	0965-089X	0.409	0.387	0.00023	0.101	-1.215	-1.310	-0.533	-1.179	-1.100
90	Proceedings of the Institution of Civil Engineers-Transport	0965-092X	0.239	0.415	0.00028	0.111	-1.387	-1.283	-0.525	-1.147	-1.136
91	Bautechnik	0932-8351	0.291	0.256	0.00059	0.096	-1.335	-1.435	-0.482	-1.195	-1.166
92	Stahlbau	0038-9145	0.321	0.278	0.00057	0.068	-1.304	-1.414	-0.485	-1.286	-1.169
93	ITE Journal-Institute of Transportation Engineers	0162-8178	0.2	0.255	0.000274	0.078	-1.427	-1.436	-0.526	-1.253	-1.215

Table 4.2: Civil engineering journals in Zone A

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year pact Factor	Im- Immediacy Index	Articles	Citable Half-life	Eigenfactor Score	Article Influence Score
1	Journal of Hydrology	0022-1694	46,099	3.727	4.314	0.731	97.8	8.6	0.05549	1.097
2	Transportation Research Part B-Methodological	0191-2615	10,457	4.081	5.109	1.146	99.51	7.8	0.01355	1.358
3	Computer-Aided Civil and Infrastructure Engineering	1093-9687	2,583	5.475	4.663	1.233	100	5.6	0.00418	1.089
4	Transportation Research Part E-Logistics and Transportation Review	1366-5545	5,359	3.289	4.093	0.577	99.23	6.2	0.00932	1.109
5	Engineering Structures	0141-0296	19,476	2.755	3.06	0.489	99.12	9.6	0.03144	0.802

methods, and the application of research results. *Journal of Structural Engineering (No.13)*, which had an impact factor of 1.903, is one of the oldest and most respected periodicals in the field. It has a history publishing papers focused on fundamental knowledge that advances the structural engineering state-of-the-art and state-of-the-practice.

Table 4.3: Civil engineering journals in Zone B

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year pact Factor	Im- Immediacy Index	Articles	Citable Half-life	Eigenfactor Score	Article Influence Score
1	Structural Safety	0167-4730	3,254	3.538	3.72	0.403	100	9	0.00389	1.181
2	Computers & Structures	0045-7949	13,157	2.887	3.362	0.707	99.45	10	0.01296	1.076
3	Transportation	0049-4488	3,125	3.151	3.371	0.539	98.68	9.3	0.00472	1.178
4	Structural Control & Health Monitoring	1545-2255	2,472	3.622	3.269	0.779	98.26	4.8	0.00399	0.742
5	Thin-Walled Structures	0263-8231	7,491	2.881	3.037	0.652	98.53	5.3	0.01269	0.716
6	Journal of Water Resources Planning and Management	0733-9496	5,145	3.197	3.437	0.576	98.56	9.1	0.00489	0.680
7	Earthquake Spectra	8755-2930	4,632	2.079	2.926	0.644	100	8	0.00874	1.228
8	Coastal Engineering	0378-3839	5,700	2.674	3.139	0.626	99.07	9	0.00729	0.899
9	Journal of Composites For Construction	1090-0268	4,115	2.592	3.177	0.387	100	9	0.00529	0.861
10	Water Resources Management	0920-4741	8,634	2.644	2.871	0.585	99.32	5.6	0.01297	0.606
11	Steel and Composite Structures	1229-9367	2,153	3.594	2.922	0.378	100	2.5	0.00393	0.467
12	Materials and Structures	1359-5997	8,092	2.271	2.528	0.776	98.82	9.0	0.01074	0.719
13	Journal of Structural Engineering	0733-9445	15,09	1.903	2.42	0.416	99.27	10	0.01255	0.814
14	Tunnelling and Underground Space Technology	0886-7798	4,936	2.418	2.822	0.62	99.5	6.3	0.00523	0.606

As shown in Table 4.4, there were 28 journals in Zone C, with five-year impact factors ranging from 0.622 to 2.763. *Journal of Hydraulic Engineering (No.2)* had the highest total cites in Zone C at 9,790. This journal accepts original contributions on the analysis of and solutions to hydraulic engineering problems, including closed conduit to free-surface flows (canals, rivers, lakes, and estuaries), environmental fluid dynamics and transport processes involving fluids. The *Journal of Surveying Engineering (No.28)* covers the broad surveying and mapping spectrum encountered in modern practice, including traditional areas such as construction surveys, control surveys as well as newer developments such as satellite positioning and spatial database design.

As can be seen in Table 4.5, there were 46 journals in Zone D, with five-year impact factors ranging from 0.2 to 1.5. With a five-year impact factor of

Table 4.4: Civil engineering journals in Zone C

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year pact Factor	Im- Immediacy Index	Articles	Citable Half-life	Eigenfactor Score	Article Influence Score
1	Archives of Civil and Mechanical Engineering	1644-9665	1,499	2.763	2.562	0.879	91.21	3.3	0.00272	0.487
2	Journal of Hydraulic Engineering	0733-9429	9,790	2.08	2.384	0.298	97.16	10	0.00569	0.681
3	Journal of Hydraulic Research	0022-1686	3,556	2.076	2.317	0.738	100	10	0.00351	0.799
4	Journal of Management in Engineering	0742-597X	2,235	2.282	2.864	0.43	97.67	9.5	0.00216	0.417
5	Ieee Journal of Oceannic Engineering	0364-9059	3,516	2.065	2.435	0.663	10	10	0.00325	0.658
6	Journal of Materials in Civil Engineering	0899-1561	7,083	1.763	2.256	0.296	99.27	9	0.00993	0.561
7	Journal of Construction Engineering and Management	0733-9364	6,955	2.201	2.596	0.324	95.35	9.4	0.00451	0.433
8	Journal of Hydro-Environment Research	1570-6443	705	2.087	2.305	0.548	100	4.5	0.00162	0.622
9	International Journal of Pavement Engineering	1029-8436	1,396	2.322	1.988	0.776	100	10	0.00243	0.509
10	Journal of Computing in Civil Engineering	0887-3801	2,256	1.798	2.35	0.352	98.15	8.3	0.00331	0.52
11	Cold Regions Science and Technology	0165-232X	3,891	1.925	2.115	0.358	99.19	7.7	0.00434	0.497
12	Frontiers of Structural and Civil Engineering	2095-2430	370	1.58	1.58	0.283	91.3	4	0.0011	0.99
13	Journal of Hydrologic Engineering	1084-0699	4,270	1.576	2.033	0.366	100	7.1	0.00631	0.521
14	Structure and Infrastructure Engineering	1573-2479	1,477	1.845	1.811	0.617	98.33	9.9	0.00325	0.466
15	International Journal of Structural Stability and Dynamics	0219-4554	1,291	2.082	1.848	0.342	100	3.7	0.00235	0.371
16	Journal of Bridge Engineering	1084-0702	2,721	1.454	1.881	0.239	100	6.2	0.00485	0.522
17	Journal of Earthquake Engineering	1363-2469	1,924	1.763	1.676	0.915	98.31	9.3	0.00222	0.551
18	Water International	0250-8060	1,561	1.956	1.717	0.321	96.43	10	0.00168	0.413
19	Natural Hazards Review	1527-6988	1,060	1.278	1.943	0.4	100	10	0.0013	0.595
20	Journal of Waterway Port Coastal and Ocean Engineering	0733-950X	1,846	1.481	1.605	0.194	98.39	10	0.00189	0.603
21	Journal of Infrastructure Systems	1076-0342	1,376	1.356	1.996	0.239	96.59	9.2	0.00155	0.494
22	Journal of Irrigation and Drainage Engineering	0733-9437	3,468	1.616	1.714	0.246	100	10	0.00295	0.391
23	Engineering Construction and Architectural Management	0969-9988	1,172	1.613	1.613	0.194	94.44	9.3	0.00057	0.524
24	Advances in Civil Engineering	1687-8086	345	0.827	0.827	0.091	90.91	4.6	0.00086	1.209
25	Journal of Civil Engineering and Management	1392-3730	1,381	1.66	1.749	0.486	98.13	4.8	0.00184	0.29
26	Geomechanics and Engineering	2005-307X	647	1.818	1.686	0.417	99.17	2.6	0.00104	0.238
27	Journal of Analytical Methods in Chemistry	2090-8865	663	1.262	1.722	0.202	95.51	3.5	0.00201	0.395
28	Journal of Surveying Engineering	0733-9453	552	1.709	1.528	0.429	100	8	0.00049	0.293

0.859, the *International Journal of Steel Structures (No.27)* provides an international forum for a broad range of technical papers focused on structural steel research and associated applications for both researchers and practicing engineers. With the highest total cites in Zone D at 1,790,000, the *Transportation Research Record (No.2)* offers deep coverage of transportation-related topics, and is one of the most cited and prolific transportation journals. The *Journal of Transportation Engineering (No.10)* had the highest article influence score in zone D at 0.404 and covers the management of roads, bridges, and transit systems; traffic management technology and intelligent transportation systems; connected and automated vehicle impacts; highway engineering; railway engineering; and the economics, safety, and environmental aspects of transportation.

4.3 Statistical Analysis

In this section, a statistical analysis of the journal index is conducted using SPSS 21.0, a software package for logical batched and non-batched statistical analyses. The current version (2015) is officially called IBM SPSS

Table 4.5: Civil engineering journals in Zone D

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year Impact Factor	Immediacy Index	Articles in citable item	Cited Half-life	Eigenfactor Score	Article Influence Score
1	Journal of Environmental Engineering	0733-9372	5,360	1.396	1.536	0.25	97.66	10	0.00295	0.308
2	Transportation Research Record	0361-1981	17,900	0.695	0.954	0.068	100	10	0.01654	0.258
3	Jounal of Energy Engineering	0733-9402	752	1.346	1.632	0.212	100	4	0.00115	0.287
4	Journal of Performance of Constructed Facilities	0887-3828	1,737	1.197	1.382	0.341	100	5.2	0.00329	0.369
5	Structural Design of Tall and Special Buildings	1541-7794	1,076	1.5	1.361	0.447	100	6.4	0.00139	0.301
6	Journal of Urban Planning and Development	0733-9488	981	1.252	1.573	0.211	100	7.1	0.00105	0.309
7	International Journal of Architectural Heritage	1558-3058	569	1.345	1.373	0.513	98.72	3.7	0.00117	0.339
8	Journal of Ship Research	0022-4502	813	1.441	1.281	0.25	100	10	0.00044	0.36
9	Proceedings of the Institution of Mechanical Engineers Part F-Journal of Rail and Rapid Transit	0954-4097	1,294	1.103	1.379	0.22	98.9	7.1	0.00213	0.391
10	Journal of Transportation Engineering	0733-947X	3,220	0.983	1.34	not	not	10	0.00323	0.404
11	Journal of Advanced Transportation	0197-6729	898	1.102	1.382	0.386	98.73	4.8	0.00173	0.386
12	Journal of Advanced Concrete Technology	1346-8014	1,072	1.134	1.383	0.188	100	9.9	0.00121	0.387
13	Coastal Engineering Journal	0578-5634	396	1.246	1.246	0.296	100	7.8	0.0007	0.391
14	Proceedings of the Institution of Civil Engineers-Engineering Sustainability	1478-4629	336	1.5	1.208	1.536	100	4.8	0.00051	0.296
15	Journal of Aerospace Engineering	0893-1321	1,327	1.296	1.264	0.274	100	9.8	0.00209	0.291
16	Earthquakes and Structures	2092-7614	705	1.309	1.287	0.15	99.12	2.9	0.00179	0.27
17	European Journal of Environmental and Civil Engineering	1964-8189	651	1.29	1.22	0.358	90.12	4.3	0.00166	0.306
18	Journal of Marine Science and Technology	0948-4280	776	1.119	1.31	0.19	98.28	7	0.00114	0.347
19	Advances in Structural Engineering	1369-4332	1,287	0.968	1.103	0.211	98.5	5.1	0.00294	0.302
20	Ksce Journal of Civil Engineering	1226-7988	1,848	0.94	1.073	0.248	99.35	4.2	0.00408	0.254
21	Earthquake Engineering and Engineering Vibration	1671-3664	955	0.847	1.166	0.228	100	7.9	0.00135	0.333
22	Journal of Pipeline Systems Engineering and Practice	1949-1190	221	0.971	1.174	0.279	100	3.9	0.00052	0.289
23	Latin American Journal of Solids and Structures	1679-7825	796	0.905	1.158	0.161	99.19	3.5	0.00175	0.242
24	Journal of Water Supply Research and Technology-Aqua	0003-7214	1,041	1.179	1.033	0.377	100	9.6	0.00085	0.202
25	Canadian Journal of Civil Engineering	0315-1468	2,833	0.869	1.026	0.083	100	10	0.00223	0.286
26	Journal of Cold Regions Engineering	0887-381X	290	0.688	1.015	0.6	100	10	0.00026	0.299
27	International Journal of Steel Structures	1598-2351	531	0.734	0.859	0.089	100	4.5	0.00117	0.227
28	Civel Engineering and Environmental Systems	1028-6608	363	0.977	0.809	0.111	100	9.8	0.00024	0.163
29	Advanced Steel Construction	1816-112X	218	0.737	0.754	0.136	100	6.3	0.00042	0.231
30	Proceedings of the Institution of Civil Engineers-Water Management	1741-7589	565	0.431	0.863	1.222	100	7.9	0.00064	0.238
31	Structural Engineering International	1016-8664	523	0.621	0.661	0.047	100	9.2	0.00085	0.207
32	Proceedings of the Institution of Civil Engineers-Structures and Buildings	0965-0911	701	0.674	0.596	1.268	98.59	8.9	0.0007	0.181
33	China Ocean Engineering	0890-5487	467	0.674	0.634	0.056	100	6.4	0.00072	0.157
34	Ocean Engineering	0890-5487	467	0.674	0.634	0.056	100	6.4	0.00072	0.157
35	Beton-Und Stahlbetonbau	0005-9900	427	0.717	0.491	0.339	100	5	0.00096	0.154
36	Internation Journal of Offshore and Polar Engineering	1053-5381	547	0.469	0.653	0.231	100	10	0.00062	0.2
37	Iranian Journal of Science and Technology-Transactions of Civil Engineering	2228-6160	143	0.514	0.771	0.119	100	4	0.0003	0.14
38	Periodica Polytechnica-Civil Engineering	0553-6626	193	0.636	0.64	0.216	98.97	2.9	0.00028	0.096
39	Baltic Journal of Road and Bridge Engineering	1822-427X	210	0.622	0.598	0.059	100	5.2	0.00025	0.095
40	Gradevinar	0350-2465	240	0.515	0.529	0.027	90.54	4.2	0.00041	0.09
41	Bauingenieur	0005-6650	259	0.477	0.373	0.29	100	5	0.00055	0.123
42	Proceedings of the Institution of Civil Engineers-Civil Engineering	0965-089X	267	0.409	0.387	1.677	100	6.8	0.00023	0.101
43	Proceedings of the Institution of Civil Engineers-Transport	0965-092X	273	0.239	0.415	1.194	94.44	6.8	0.00028	0.111
44	Bautechnik	0932-8351	278	0.291	0.256	0.031	100	7.2	0.00059	0.096
45	Stahlbau	0038-9145	497	0.321	0.278	0.303	100	8.9	0.00057	0.068
46	ITE Journal-Institute of Transportation Engineers	0162-8178	297	0.200	0.255	0.064	100	10	0.000274	0.078

Statistics. In the following, the analysis of all 93 journals and the analysis by zone are displayed separately.

Total analysis

The total summary included all 93 civil engineering-related journals. The descriptive analyses are shown in Table 4.6, from which it can be seen that: the total citations ranged from 143 to 46099, with a mean of 3053.71 and a standard deviation of 5716.913; the impact factor ranged from 0.20 to 5.475, with a mean of 1.60827 and a standard deviation of 0.98692; the five-year impact factor ranged from 0.255 to 5.109, with a mean of 1.75974and a standard deviation of 1.048221; and the immediacy index ranged from 0.027 to 9.1, with a mean of 0.97 and a standard deviation of 1.861631.

The index of articles in the citable civil engineering item ranged from 10 to 100, with a mean of 97.7363 and a standard deviation of 9.52098. The index of cited half-life ranged from 2.5 to 10, with a mean of 7.237 and a standard deviation of 2.4237. The eigenfactor score ranged from 0.001 to 9.930, with a mean of 3.26548 and a standard deviation of 2.673264. The article influence ranged from 0.068 to 1.358, with a mean of 0.467 and a standard deviation of 0.31011.

Table 4.6: Descriptive analysis of civil engineering journals

	N	Range	Minimum	Maximum	Sum	Mean		Std. Deviation	Skewness	
						Statistic	Std. Error		Statistic	Std. Error
Total_cites	93	45956	143	46099	283995	3053.71	592.816	5716.913	5.291	0.250
Impact_Factor	93	5.275	0.20	5.475	149.569	1.60827	0.1023	0.98692	1.150	0.250
5_Year_Impact_Factor	93	4.854	0.255	5.109	163.656	1.75974	0.1087	1.048221	0.909	0.250
Immediacy_Index	92	9.073	0.027	9.100	89.217	0.970	0.19409	1.861631	3.353	0.251
Articles_in_cited_item	92	90.00	10.00	100.00	8991.74	97.7363	0.9926	9.52098	-8.806	0.251
Cited_Half_life	93	7.5	2.5	10.0	673.0	7.237	0.2513	2.4237	-0.344	0.250
Eigenfactor_Score	93	9.929	0.001	9.930	303.690	3.26548	.277205	2.673264	0.636	0.250
Article_Influence_Score	93	1.290	0.068	1.358	43.398	0.467	.032156	0.31011	1.082	0.250

Table 4.7 shows the five highest and five lowest extreme values for total cites. The *Engineering Structures* at 46,099 citations was ranked first, *Transportation Research Record* at 19,476 citations was ranked second, *Transportation Research Part B-Methodological* at 17,900 citations was ranked third, *Computers & Structures* at 10,457 citations was ranked fifth. The journals with the lowest total cites were the *Iranian Journal of Science and Technology-Transactions of Civil Engineering*, *Periodica Polytechnica-Civil Engineering*, *Baltic Journal of Road and Bridge Engineering*, *Advanced Steel Construction* and *Journal of Pipeline Systems Engineering and Practice*.

Table 4.7: Extreme total cites values

			Case Number	Journal Title	Value
Total cites	Highest	1	2	Journal of Hydrology	46099
		2	6	Engineering Structures	19476
		3	50	Transportation Research Record	17900
		4	8	Computers & Structures	13157
		5	3	Transportation Research Part B-Methodological	10457
	Lowest	1	85	Iranian Journal of Science and Technology-Transactions of Civil Engineering	143
		2	86	Periodica Polytechnica-Civil Engineering	193
		3	87	Baltic Journal of Road and Bridge Engineering	210
		4	77	Advanced Steel Construction	218
		5	70	Journal of Pipeline Systems Engineering and Practice	221

Table 4.8 shows the five journals with the highest and lowest extreme impact factors. *Computer-Aided Civil and Infrastructure Engineering*, with an impact factor of 5.475, ranked first, followed by *Transportation Research Part B-Methodological*, with an impact factor of 4.081, the *Journal of Hydrology*, with an impact factor of 3.727, *Structural Control & Health Monitoring*, with an impact factor of 3.622, and *Steel and Composite Structures*, with an impact factor of 3.594. The lowest impact factors were for the *ITE Journal-Institute of Transportation Engineers*, *Proceedings of the Institution of Civil Engineers-Transport*, *Bautechnik*, *Stahlbau*, and *Proceedings of the Institution of Civil Engineers-Civil Engineering*.

Table 4.8: Extreme impact factor values

			Case Number	Journal Title	Value
Impact Factor	Highest	1	4	Computer-Aided Civil and Infrastructure Engineering	5.475
		2	3	Transportation Research Part B-Methodological	4.081
		3	2	Journal of Hydrology	3.727
		4	10	Structural Control & Health Monitoring	3.622
		5	17	Steel and Composte Structures	3.594
	Lowest	1	94	ITE Journal-Institute of Transportation Engineers	0.200
		2	91	Proceedings of the Institution of Civil Engineers-Transport	0.239
		3	92	Bautechnik	0.291
		4	93	Stahlbau	0.321
		5	90	Proceedings of the Institution of Civil Engineers-Civil Engineering	0.409

Table 4.9 shows the journals with the highest and lowest extreme five-year impact factors. *Transportation Research Part B-Methodological*, with a five-year impact factor of 5.109, ranked first, followed by *Computer-Aided Civil and Infrastructure Engineering,* with a five-year impact factor of 4.663, the *Journal of Hydrology* with a five-year impact factor of 4.314, *Transportation Research Part E-Logistics and Transportation Review* with a five-year impact factor of 4.093, and *Structural Safety* with a five-year impact factor of 3.720. The lowest five-year impact factors were for the *ITE Journal-Institute of Transportation Engineers*, *Bautechnik*, *Stahlbau*, *Bauingenieur*, and *Proceedings of the Institution of Civil Engineers-Civil Engineering*.

Table 4.10 shows the journals with the highest and lowest immediacy index values. *Advances in Civil Engineering* with an immediacy index of 9.100, ranked first, followed by the *International Journal of Steel Structures* with an immediacy index of 8.9, the *Canadian Journal of Civil Engineering* with an immediacy index of 8.3, the *Transportation Research Record* with

Table 4.9: Extreme five-year impact factor values

			Case Number	Journal Title	Value
Five-Year Impact Factor	Highest	1	3	Transportation Research Part B-Methodological	5.109
		2	4	Computer-Aided Civil and Infrastructure Engineering	4.663
		3	2	Journal of Hydrology	4.314
		4	5	Transportation Research Part E-Logistics and Transportation Review	4.093
		5	7	Structural Safety	3.720
	Lowest	1	94	ITE Journal-Institute of Transportation Engineers	0.255
		2	92	Bautechnik	0.256
		3	93	Stahlbau	0.278
		4	89	Bauingenieur	0.373
		5	90	Proceedings of the Institution of Civil Engineers-Civil Engineering	0.387

an immediacy index of 6.8, and the *Baltic Journal of Road and Bridge Engineering* with an immediacy index of 5.9. The lowest immediacy index values were for *Gradevinar*, *Bautechnik*, *Structural Engineering International*, *ITE Journal-Institute of Transportation Engineers*, and *Civil Engineering and Environmental Systems.*

Table 4.10: Extreme immediacy index values

			Case Number	Journal Title	Value
Immediacy Index	Highest	1	44	Advances in Civil Engineering	9.100
		2	75	International Journal of Steel Structures	8.900
		3	73	Canadian Journal of Civil Engineering	8.300
		4	50	Transportation Research Record	6.800
		5	87	Baltic Journal of Road and Bridge Engineering	5.900
	Lowest	1	88	Gradevinar	0.027
		2	92	Bautechnik	0.031
		3	79	Structural Engineering International	0.047
		4	94	ITE Journal-Institute of Transportation Engineers	0.064
		5	76	Civel Engineering and Environmental Systems	0.111

Table 4.11 shows the journals with five highest and lowest "articles in citable items" value. *Computer-Aided Civil and Infrastructure Engineering*, *Structural Safety*, *Earthquake Spectra*, *Journal of Composites For Construction*, and *Steel and Composite Structures* were the five journals with highest values, and the *IEEE Journal of Oceannic Engineering*, *European Journal of Environmental and Civil Engineering*, *Gradevinar*, *Advances in Civil Engineering*, and *Archives of Civil and Mechanical Engineering* were the five journals with the lowest "articles in citable items" values.

Table 4.12 shows the journals with five highest and lowest "cited half-life" values. *Computers & Structures*, *Journal of Structural Engineering*,

Table 4.11: Extreme articles in citable item values

			Case Number	Journal Title	Value
Articles in citable item	Highest	1	4	Computer-Aided Civil and Infrastructure Engineering	100.00
		2	7	Structural Safety	100.00
		3	13	Earthquake Spectra	100.00
		4	15	Journal of Composites For Construction	100.00
		5	17	Steel and Composite Structures	100.00a
	Lowest	1	25	IEEE Journal of Oceannic Engineering	10.00
		2	65	European Journal of Environmental and Civil Engineering	90.12
		3	88	Gradevinar	90.54
		4	44	Advances in Civil Engineering	90.91
		5	21	Archives of Civil and Mechanical Engineering	91.21

Journal of Hydraulic Engineering, *Journal of Hydraulic Research*, and the *IEEE Journal of Oceannic Engineering* were the five journals with the highest values, and *Steel and Composite Structures*, *Geomechanics and Engineering*, *Periodica Polytechnica-Civil Engineering*, *Earthquakes and Structures*, *Archives of Civil and Mechanical Engineering* were the journals with the lowest values.

Table 4.12: Extreme cited half-life values

			Case Number	Journal Title	Value
Cited Half-life	Highest	1	8	Computers & Structures	10.0
		2	19	Journal of Structural Engineering	10.0
		3	22	Journal of Hydraulic Engineering	10.0
		4	23	Journal of Hydraulic Research	10.0
		5	25	IEEE Journal of Oceannic Engineering	10.0
	Lowest	1	17	Steel and Composite Structures	2.5
		2	46	Geomechanics and Engineering	2.6
		3	86	Periodica Polytechnica-Civil Engineering	2.9
		4	64	Earthquakes and Structures	2.9
		5	21	Archives of Civil and Mechanical Engineering	3.3

Table 4.13 shows the journals with five highest and lowest "eigenfactor scores". The *Journal of Materials in Civil Engineering* with a eigenfactor score of 9.93 ranked first, followed by *Beton-Und Stahlbetonbau* with an eigenfactor score of 9.6, *Transportation Research Part E-Logistics and Transportation Review* with an eigenfactor score of 9.32, *Earthquake Spectra* with an eigenfactor score of 8.74, and *Advances in Civil Engineering* with an eigenfactor score of 8.6. The lowest eigenfactor scores were for the *International Journal of Offshore and Polar Engineering*, *Journal of Marine Science and Technology*, *Journal of Energy Engineering*, *International*

Journal of Steel Structures, and the *International Journal of Architectural Heritage*.

Table 4.13: Extreme eigenfactor scores

			Case Number	Journal Title	Value
Eigenfactor Score	Highest	1	26	Journal of Materials in Civil Engineering	9.930
		2	83	Beton-Und Stahlbetonbau	9.600
		3	5	Transportation Research Part E-Logistics and Transportation Review	9.320
		4	13	Earthquake Spectra	8.740
		5	44	Advances in Civil Engineering	8.600
	Lowest	1	84	Internation Journal of Offshore and Polar Engineering	0.00062
		2	66	Journal of Marine Science and Technology	0.00114
		3	51	Jounal of Energy Engineering	0.00115
		4	75	International Journal of Steel Structures	0.00117
		5	55	International Journal of Architectural Heritage	0.00117

Table 4.14 shows the journals with five highest and lowest "article influence scores". *Transportation Research Part B-Methodological* with an article influence score of 1.358 ranked first, followed by *Earthquake Spectra* with an article influence score of 1.228, *Advances in Civil Engineering* with an article influence score of 1.209, *Structural Safety* with an article influence score of 1.181, and *Transportation* with an article influence score of 1.178. The lowest article influence scores were for *Stahlbau*, *ITE Journal-Institute of Transportation Engineers*, *Gradevinar*, *the Baltic Journal of Road and Bridge Engineering*, and *Bautechnik*.

Table 4.14: Extreme article influence scores

			Case Number	Journal Title	Value
Article Influence Score	Highest	1	3	Transportation Research Part B-Methodological	1.358
		2	13	Earthquake Spectra	1.228
		3	44	Advances in Civil Engineering	1.209
		4	7	Structural Safety	1.181
		5	9	Transportation	1.178
	Lowest	1	93	Stahlbau	0.068
		2	94	ITE Journal-Institute of Transportation Engineers	0.078
		3	88	Gradevinar	0.090
		4	87	Baltic Journal of Road and Bridge Engineering	0.095
		5	92	Bautechnik	0.0960

Zone analysis

SPSS 21.0 software was employed for the statistical descriptive analysis of the civil engineering related journals in the different zones, some of the descriptive results which are shown Tables 4.15-4.22, and the visual box diagrams for which are shown in Figures 4.1-4.8.

Table 4.15 shows the statistical results for the total cites for the journals in each zone. The total cites in the five Zone A journals had a range of 43,516 from a minimum of 2583 to a maximum of 46,099, with mean total citations of 16,794.80 and a standard deviation of 17,598.618. The total cites for the 14 Zone B journals had a range of 11,648 from a minimum of 1509 to a maximum of 13,157, with mean total citations of 5315.36 and a standard deviation of 3147.612. The total cites in the twenty-eight journals in Zone C had a range of 9445 from a minimum of 345 to a maximum of 9790, with mean total citations of 2464.5 and a standard deviation of 2260.935. The total cites for the 46 journals in Zone D had a range of 17,757 from a minimum of 143 to a maximum of 46,099, with mean total citations of 1230.43 and a standard deviation of 2678.491.

Table 4.15: 2017 total cites statistical results for the civil engineering journals

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	5	16794.80	17598.618	10457.00	83974	46099	2583	43516	309711365.200
B	14	5315.36	3147.612	4784.00	74415	13157	1509	11648	9907464.093
C	28	2464.50	2260.935	1530.00	69006	9790	345	9445	5111826.630
D	46	1230.43	2678.491	567.00	56600	17900	143	17757	7174314.385
Total	93	3053.71	5716.913	1291.00	283995	46099	143	45956	32683091.447

Table 4.16 shows the statistical results for the 2017 impact factors for civil engineering journals. The impact factor for the five journals in Zone A had a range of 2.720 from a minimum of 2.755 to a maximum of 5.475 with a mean total impact factor of 3.86540 and a standard error of skewness of 1.027336. The impact factor for the 14 journals in Zone B had a range of 1.719 from a minimum of 0.8270 to a maximum of 2.763, with a mean impact factor of 2.81793 and a standard error of skewness of 0.5529. The impact factor for the 28 journals in Zone C had a range of 1.936 from a minimum of 0.827 to a maximum of 2.763, with a mean impact factor of

1.79421 and a standard error of skewness of 0.36658. The impact factor for the 46 journals in Zone D had a range of 1.3 from a minimum of 0.2 to a maximum of 1.5, with a mean impact factor of 0.88159 and a standard error of skewness of 0.36658.

Table 4.16: 2017 impact factor statistical results for the civil engineering journals

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	5	3.86540	1.027336	3.72700	19.327	5.475	2.755	2.720	1.055
B	14	2.81793	0.5529567	2.77750	39.451	3.622	1.903	1.719	0.3058
C	28	1.79421	0.3918777	1.78050	50.238	2.763	0.8270	1.936	0.1536
D	46	0.88159	0.3665801	0.88700	40.553	1.500	0.2000	1.300	0.1344
Total	93	1.60827	0.9869161	1.39600	149.569	5.475	0.2000	5.275	0.9740

Table 4.17 shows the statistical results for the 2017 impact factors for civil engineering-related journals. For the five journals in Zone A, the five year impact factor had a range of 2.049, from a minimum of 3.060 to a maximum of 5.109, with the mean five-year impact factor being 4.2478 and the standard error of skewness being 0.76702 for the 14 journals in Zone B, the five-year impact factor had a range of 1.3, from a minimum of 2.42 to a maximum of 3.72, with the mean five-year impact factor being 3.0715 and the standard error of skewness being 0.35626. of the 28 journals in Zone C, the impact factor had a range of 2.037, from a minimum of 0.827 to a maximum of 2.864, with the mean five-year impact factor being 1.96789 and the standard error of skewness being 0.42095. For the 46 journals in Zone D, the five-year impact factor had a range of 1.377, from a minimum of 0.255 to a maximum of 1.632, with the mean five-year impact factor being 0.96337 and the standard error of skewness being 0.39074.

Table 4.17: Statistical results of 2017 five year impact factor for civil engineering related journals

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	5	4.24780	0.76702	4.31400	21.239	5.109	3.060	2.049	0.588
B	14	3.07150	0.35626	3.08800	43.001	3.720	2.420	1.300	0.127
C	28	1.96789	0.42095	1.91200	55.101	2.864	0.827	2.037	0.177
D	46	0.96337	0.39074	1.02950	44.315	1.632	0.255	1.377	0.153
Total	93	1.75974	1.04822	1.57300	163.656	5.109	0.255	4.854	1.099

Table 4.18 shows the statistical results of the 2017 immediacy index for civil engineering-related journals. For the five journals in Zone A, the immediacy index had a range of 0.74, from a minimum of 0.49 to a maximum of 1.23, with the mean immediacy index being 0.8352 and the standard error of skewness being 0.33624. of the fourteen journals in Zone B, the immediacy index had a range of 0.4, from a minimum of 0.38 to a maximum of 0.78, with the mean immediacy index being 0.5777 and the standard error of skewness being 0.1373. For the twenty-eight journals in Zone C, the immediacy index had a range of 8.91, from a minimum of 0.19 to a maximum of 9.1, with the mean immediacy index being 0.7376 and the standard error of skewness being 1.65162. For the forty-six journals in Zone D, the immediacy index had a range of 8.87, from a minimum of 0.03 to a maximum of 8.9, with the mean immediacy index being 1.2511 and the standard error of skewness being 1.86163.

Table 4.18: 2017 immediacy index statistical results for the civil engineering journals

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	5	0.8352	0.33624	0.7310	4.18	1.23	0.49	0.74	0.113
B	14	0.5777	0.13730	0.6025	8.09	0.78	0.38	0.40	0.019
C	28	0.7376	1.65162	0.3620	20.65	9.10	0.19	8.91	2.728
D	45	1.2511	2.30470	0.2790	56.30	8.90	0.03	8.87	5.312
Total	92	0.9697	1.86163	0.3820	89.22	9.10	0.03	9.07	3.466

Table 4.19 shows the statistical results for the 2017 “articles in citable item” value for the civil engineering related journals. Of the five journals in Zone A, the articles in citable item had a range of 2.2 from a minimum of 97.8 to a maximum of 100, with the mean articles in citable item being 99.132 and the standard error of skewness being 0.8186. For the 14 journals in Zone B, the articles in citable item had a range of 1.7 from a minimum of 98.3 to a maximum of 100, with the mean articles in citable item being 99.247 and the standard error of skewness being 0.6123. For the 28 journals in Zone C, the articles in citable item had a range of 90.0 from a minimum of 10.0 to a maximum of 100, with the mean articles in citable item being 94.483 and the standard error of skewness being 16.7893. For the 46 journals in Zone D, the articles in citable item had a range of 90 from a minimum of 10 to a maximum of 100, with the mean articles in citable item being 97.736 and the standard error of skewness being 9.521.

Table 4.19: 2017 “articles in citable item” statistical results for the civil engineering related journals

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	5	99.132	0.8186	99.230	495.7	100.0	97.8	2.2	0.670
B	14	99.247	0.6123	99.295	1389.5	100.0	98.3	1.7	0.375
C	28	94.483	16.7893	98.320	2645.5	100.0	10.0	90.0	281.881
D	45	99.136	2.1556	100.000	4461.1	100.0	90.1	9.9	4.647
Total	92	97.736	9.5210	99.505	8991.7	100.0	10.0	90.0	90.649

Table 4.20 shows the statistical results for the 2017 “cited half-life” value for the civil engineering-related journals. Of the five journals in Zone A, the cited half-life had a range of 4 from a minimum of 5.6 to a maximum of 9.6, with the mean cited half-life being 7.56 and the standard error of skewness being 1.6577. Of the 14 journals in Zone B, the cited half-life had a range of 7.5 from a minimum of 2.5 to a maximum of 10, with the mean cited half-life being 7.636 and the standard error of skewness being 2.3117. For the 28 journals in Zone C, the cited half-life had a range of 7.4 from a minimum of 2.6 to a maximum of 10, with the mean cited half-life being 7.639 and the standard error of skewness being 2.6266. For the 46 journals in Zone D, the cited half-life had a range of 75 from a minimum of 2.5 to a maximum of 10, with the mean cited half-life being 7.237 and the standard error of skewness being 2.437.

Table 4.20: 2017 “Cited Half-life” statistical results for the civil engineering related journals

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	5	7.560	1.6577	7.800	37.8	9.6	5.6	4.0	2.748
B	14	7.636	2.3117	9.000	106.9	10.0	2.5	7.5	5.344
C	28	7.639	2.6266	9.100	213.9	10.0	2.6	7.4	6.899
D	46	6.835	2.3990	6.800	314.4	10.0	2.9	7.1	5.755
Total	93	7.237	2.4237	7.800	673.0	10.0	2.5	7.5	5.874

Table 4.21 shows the statistical results for the 2017 “Eigenfactor Score” for the civil engineering related journals. Of the five journals in Zone A, the eigenfactor score had a range of 9.31 from a minimum of 0.01355 to a maximum of 9.32, with the mean eigenfactor score being 4.4413 and the standard error of skewness being 3.40523. For the 14 journals in Zone B, the eigenfactor score had a range of 8.74, from a minimum of 0.00489 to

a maximum of 8.74, with the mean eigenfactor score being 3.2653 and the standard error of skewness being 2.87881. Of the 28 journals in Zone C, the eigenfactor score had a range of 9.93 from a minimum of 0.00189 to a maximum of 9.93, with the mean eigenfactor score being 3.0861 and the standard error of skewness being 2.52308. Of the 46 journals in Zone D, the eigenfactor score had a range of 9.6 from a minimum of 0.00062 to a maximum of 9.93, with the mean eigenfactor score being 3.2469 and the standard error of skewness being 2.68175.

Table 4.21: 2017 "Eigenfactor Score" statistical results for the civil engineering journals

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	5	4.4413	3.40532	4.1800	22.21	9.32	0.01355	9.31	11.596
B	14	3.2653	2.87881	3.9100	45.71	8.74	0.00489	8.74	8.288
C	28	3.0861	2.52308	2.3900	86.41	9.93	0.00189	9.93	6.366
D	46	3.2469	2.68175	2.7700	149.36	9.60	0.00062	9.60	7.192
Total	93	3.2655	2.67326	2.8000	303.69	9.93	0.00062	9.93	7.146

Table 4.22 shows the statistical results for the 2017 "article influence score" for the civil engineering related journals. Of the five journals in Zone A, the article influence score had a range of 0.556 from a minimum of 0.802 to a maximum of 1.358, with the mean article influence score being 1.091 and the standard error of skewness being 0.19696. For the 14 journals in Zone B, the article influence score had a range of 0.761 from a minimum of 0.467 to a maximum of 1.228, with the mean article influence score being 0.84093 and the standard error of skewness being 0.24103. For the 28 journals in Zone C, the article influence score had a range of 0.971, from a minimum of 0.238 to a maximum of 1.209, with the mean article influence score being 0.5375 and the standard error of skewness being 0.20265. Of the 46 journals in Zone D, the article influence score had a range of 0.336 from a minimum of 0.068 to a maximum of 0.404, with the mean article influence score being 0.24174 and the standard error of skewness being 0.10004.

As is shown in Fig. 4.1, Zone A had the largest citation times range, followed by Zone B, Zone C, and Zone D. While the median total cites in each zone varied, the maximum was in Zone A and the minimum was in Zone D; respectively, there were one, one, three, and three extreme values in Zones A-D. As shown in Fig. 4.2, the median impact factors in each zone decreased in turn but the impact factor range in Zone B was larger than in

Table 4.22: 2017 "Article Influence Score" statistical results for the civil engineering journals

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	5	1.09100	0.19696	1.09700	5.455	1.358	0.802	0.556	0.039
B	14	0.84093	0.24103	0.77800	11.773	1.228	0.467	0.761	0.058
C	28	0.53750	0.20265	0.51450	15.050	1.209	0.238	0.971	0.041
D	46	0.24174	0.10004	0.25600	11.120	0.404	0.068	0.336	0.010
Total	93	0.46665	0.31011	0.38700	43.398	1.358	0.068	1.290	0.096

other zones. The median impact factor in each zone varied but the maximum was in Zone A and the minimum was in Zone D. Fig. 4.3 shows that the five-year impact factor in Zone D had the largest range, following by Zone A, Zone C, and Zone B, and the means in each zone decreased in turn. Fig. 4.4 shows the immediacy index for each zone, and that Zone A had the largest range, followed by Zone D. Fig. 4.5 shows that the article indexes in all zones were between 95 and 100 and Zone D journals had the largest range. Fig. 4.6 shows that the largest cited half-life range was in Zone B, Zone A had the smallest cited half-life range, and Zone D had the largest mean. Fig. 4.7 shows that the journal eigenfactor score range varied from zone to zone; Zone D had the largest range followed by Zone C, Zone D had the highest concentration, and Zone A had the lowest. Fig. 4.8 shows that the mean article influence scores in all four zones were less than 2, and there were some extreme values in Zone A and Zone C.

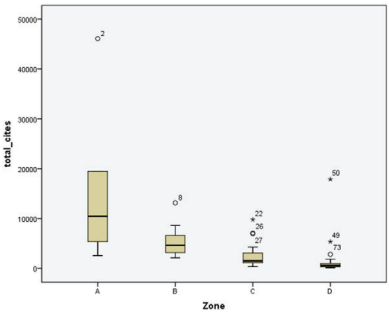

Fig. 4.1: Box diagram for total cites

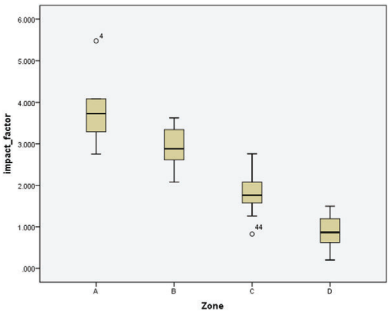

Fig. 4.2: Box diagram for impact factor

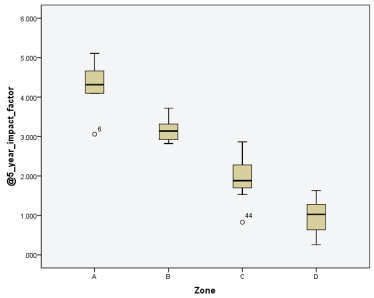

Fig. 4.3: Box diagram for five year impact factor

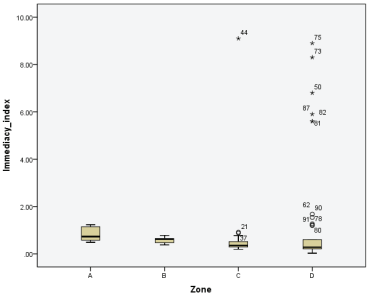

Fig. 4.4: Box diagram for immediacy index

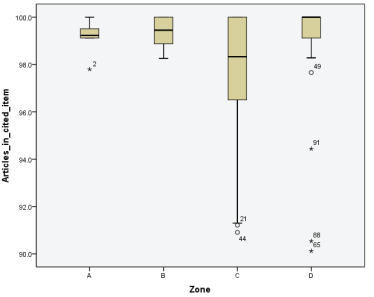

Fig. 4.5: Box diagram for article indexes

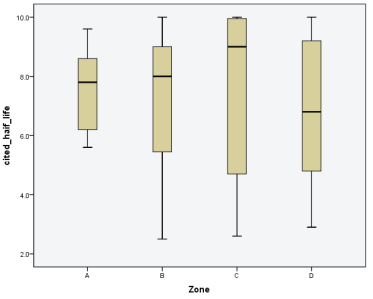

Fig. 4.6: Box diagram for cited half-life

4.4 Comprehensive Discussion

Impact factor changes

Fig. 4.9 shows the impact factor changes for the journals in Zone A from 2013 to 2017. The five journals in this zone had impact factors between

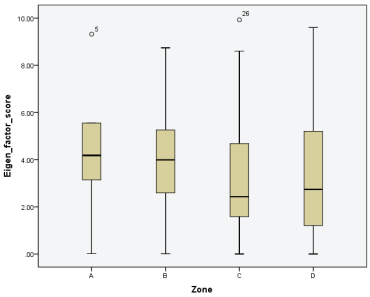

Fig. 4.7: Box diagram for eigenfactor score

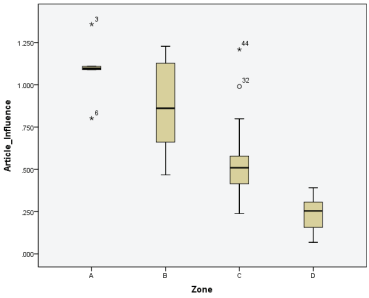

Fig. 4.8: Box diagram for article influence score

1.767 and 5.786, which fluctuated in the previous five years. *Computer-Aided Civil and Infrastructure Engineering* had obvious impact factor fluctuations while the impact factor for *Engineering Structures* showed minor fluctuations. The impact factors for *Transportation Research Part B-Methodological* showed an upward trend.

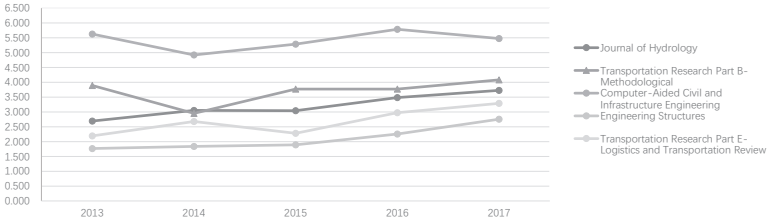

Fig. 4.9: Impact factor in Zone A from 2013-2017

Fig. 4.10 shows the impact factor changes for journals in Zone B from 2013 to 2017. Most of the 14 journals had fluctuating impact factors over the five years. The *Journal of Water Resources Planning and Management, Tunneling, and Underground Space Technology* and *Periodica Polytechnica-*

Civil Engineering had an upward trend. The impact factor for *Structural Safety* moved down in 2014 but then rose gradually. The impact factor for *Thin-Walled Structures* had an obvious fluctuation for most of the five years.

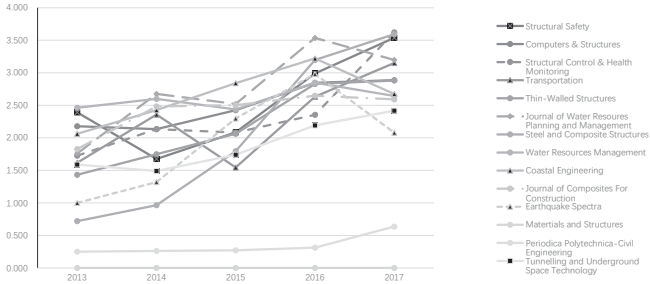

Fig. 4.10: Impact factor in Zone B from 2013 to 2017

Fig. 4.11 shows the impact factor changes for Zone C journals from 2013 to 2017 ranged from 0.519 and 2.763, with most journals having obvious fluctuations over the five-years. *Geomechanics and Engineering*, *the Baltic Journal of Road and Bridge Engineering*, *Structure and Infrastructure Engineering*, and *the International Journal of Pavement Engineering* had higher impact factors, with obvious fluctuations. The *Journal of Computing in Civil Engineering* had the highest 2016 Zone C impact factor at 2.31 and the *Journal of Infrastructure Systems* impact factor grew substantially from 2013 to 2017.

Fig. 4.12 shows that the Zone D journal impact factors changes from 2013 to 2017 spanned a larger range from 0.147 to 2.264, with most journals experiencing fluctuations. The *Journal of Performance of Constructed Facilities, the Journal of Advanced Concrete Technology, and the Journal of Water Supply Research, Technology-Aqua, the Canadian Journal of Civil Engineering and Bauingenieur had rising impact factors*, but the *Proceedings of the Institution of Civil Engineers-Water Management* impact factor had a falling trend. Journals with lower impact factors and no upward trend are no longer included in the Science Citation Index if no actions are taken to improve the publication quality.

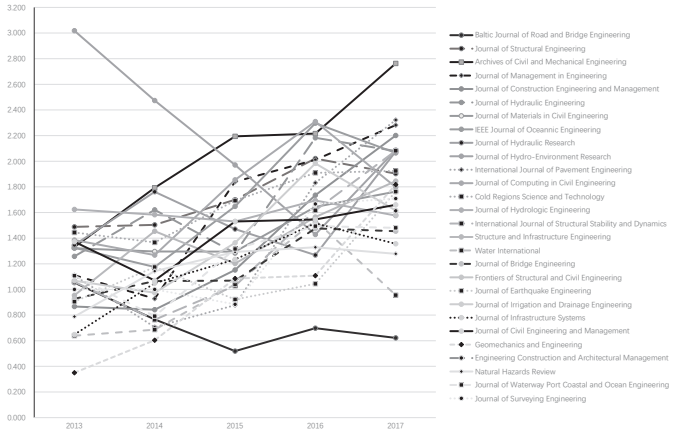

Fig. 4.11: Impact factor in Zone C from 2013 to 2017

Major countries

In this section, the statistical results for the countries that published the most civil engineering-related SCI/SSCI papers are analyzed (Table 4.23 and Fig. 4.13). Civil engineering journals published 4029 papers in 2017, of which 35.49% or 1430 papers were by USA authors, ranking it the first in the world. China contributed 1053 papers (26.14%), Canada 268 (6.65%) Australia 264 (6.55%), Germany 778 (5.49%), Italy 193 papers (4.79%); India 222 (5.51%), the UK 197 (4.89%), Iran 163 (4.05%), and Spain contributed 129 (3.20%).

There were 4029 papers published in civil engineering journals in 2017. Of those, 1430 papers were published by USA authors, accounting for 35.49% and ranking first in the world. Authors from China contributed 1053 papers, which accounted for 26.14%; Canadian authors produced 268 in 2017, which were accounted for 6.65%; Australian authors accounted for 264 (6.55%); German authors accounted for 778 (5.49%); Italian authors published 193 papers (4.79%); Indian authors contributed 222 (5.51%)

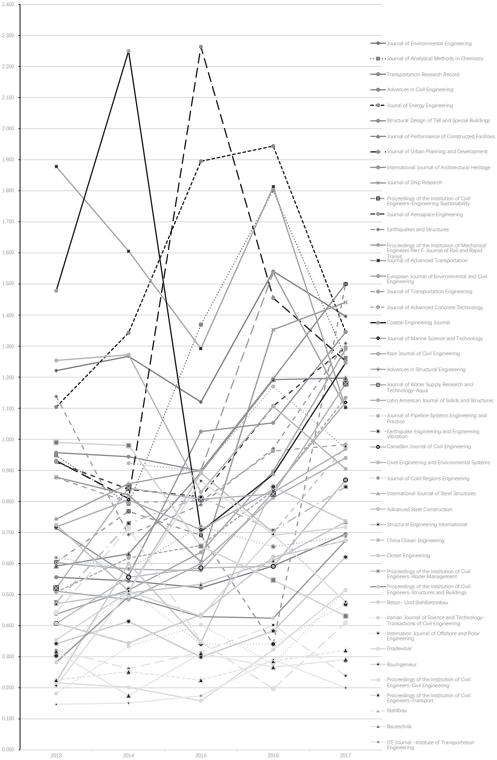

Fig. 4.12: Impact factor in Zone D from 2013 to 2017

papers; British authors published 197 (4.89%); Iran authors produced 163 (4.05%); and Spanish authors published 129 (3.20%).

In 2013, Chinese authors published 2889 (29.40%) civil engineering related papers, US authors published 2113 (29.4%), British authors accounted for 3.34%, and Canadian authors for 4.23% (304) which rose to 4.35% in 2014. The Italian contributions rose from 3.98% in 2013 to 5.43% in 2015, the Australian contributions rose from 4.04% to 6.55% and Indian and Spanish scholars' contribution form 3.14% to 4.04%.

Table 4.23: Major contributing countries for civil engineering related S-CI/SSCI papers in 2013-2017

Country	2013		2014		2015		2016		2017	
	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage
All	7187		6119		6553		6564		4029	
USA	2113	29.40%	1911	31.23%	2099	32.03%	1896	28.88%	1430	35.49%
PEOPLES R CHINA	2889	40.20%	2089	34.14%	1802	27.50%	1906	29.04%	1053	26.14%
CANADA	304	4.23%	266	4.35%	408	6.23%	381	5.80%	268	6.65%
AUSTRALIA	290	4.04%	283	4.62%	368	5.62%	353	5.38%	264	6.55%
ITALY	286	3.98%	295	4.82%	356	5.43%	386	5.88%	193	4.79%
INDIA	336	4.68%	334	5.46%	401	6.12%	485	7.39%	222	5.51%
UK	240	3.34%	275	4.49%	334	5.10%	348	5.30%	197	4.89%
IRAN	218	3.03%	199	3.25%	281	4.29%	316	4.81%	163	4.05%
SPAIN	226	3.14%	206	3.37%	221	3.37%	239	3.64%	129	3.20%
SOUTH KOREA	285	3.97%	261	4.27%	283	4.32%	254	3.87%	110	2.73%

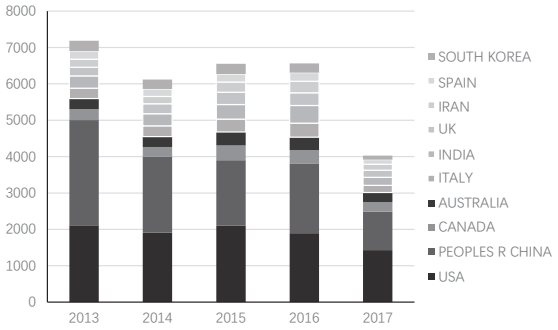

Fig. 4.13: Major SCI civil engineering contributing countries from 2013 to 2017

Correlation analysis

To determine the relationships between the journal influence indicators, Pearson's widely used correlation coefficient was applied using SPSS 21.0. Pearson's correlation coefficient is the covariance of two variables divided by the product of their standard deviations, it is a measure of the linear correlation between two variables X and Y, a has a value between +1 and -1, where 1 means a total positive linear correlation, 0 means no linear correlation, and -1 means a total negative linear correlation.

Fig. 4.14 shows that the total cites was significantly correlated with the impact factor, the five-year impact factor, citable half-life, and article influence score at a level of 0.01. Generally, a correlation coefficient between 0.8 and 1.0 indicates that the two indexes are strongly correlated, 0.6-0.8 indicates a relatively strong correlation, 0.4-0.6 indicates a moderate correlation, and 0.2-0.4 indicates a weak correlation. Therefore, the correlation coefficients of 0.958 and 0.849 clearly indicate that the five-year impact factor was strongly correlated with the impact factor and article influence score. The impact factor and article influence score also had a relatively strong correlation with a coefficient of 0.785; however, the immediacy index, article in citable item, and eigenfactor score did not show any significant correlations with the other indexes.

Correlations

		Total cites	Impact factor	Five year impact factor	Immediacy index	Articles in citable item	Cited half-life	Eigenfactor score	Article influence
Total cites	Pearson Correlation	1	.447**	.520**	.034	−.006	.246*	.053	.447**
	Sig. (2-tailed)		.000	.000	.750	.956	.018	.614	.000
	N	93	93	93	92	92	93	93	93
Impact factor	Pearson Correlation	.447**	1	.958**	−.187	−.049	.058	−.041	.785**
	Sig. (2-tailed)	.000		.000	.074	.646	.578	.695	.000
	N	93	93	93	92	92	93	93	93
Five year impact factor	Pearson Correlation	.520**	.958**	1	−.199	−.063	.139	−.058	.849**
	Sig. (2-tailed)	.000	.000		.057	.548	.184	.581	.000
	N	93	93	93	92	92	93	93	93
Immediacy index	Pearson Correlation	.034	−.187	−.199	1	.007	−.055	.088	−.021
	Sig. (2-tailed)	.750	.074	.057		.946	.601	.405	.840
	N	92	92	92	92	92	92	92	92
Articles in citable item	Pearson Correlation	−.006	−.049	−.063	.007	1	−.068	.139	−.094
	Sig. (2-tailed)	.956	.646	.548	.946		.519	.187	.372
	N	92	92	92	92	92	92	92	92
cited half life	Pearson Correlation	.246*	.058	.139	−.055	−.068	1	.063	.191
	Sig. (2-tailed)	.018	.578	.184	.601	.519		.548	.067
	N	93	93	93	92	92	93	93	93
Eigenfactor score	Pearson Correlation	.053	−.041	−.058	.088	.139	.063	1	.075
	Sig. (2-tailed)	.614	.695	.581	.405	.187	.548		.473
	N	93	93	93	92	92	93	93	93
Article influence	Pearson Correlation	.447**	.785**	.849**	−.021	−.094	.191	.075	1
	Sig. (2-tailed)	.000	.000	.000	.840	.372	.067	.473	
	N	93	93	93	92	92	93	93	93

Fig. 4.14: Pearson's correlation coefficients for the JCR Data and Eigenfactor Metrics

Principal component analysis for the journal evaluation indicators

Correlation studies have shown that there are generally high correlations between the total cites, the impact factor, the five-year impact factor, the citable half-life, and the article influence score. Therefore, based on the exclusiveness principle, it is redundant to use them all. However, which indicators should be adopted for journal evaluation and what attributes do these indicators indicate? To answer these questions, a principal component analysis of the journal evaluation indicators was conducted for the 93 civil engineering journals using IBM SPSS Statistics with the FACTOR command (Analyze>Dimension Reduction>Factor). To track additional information, the latest five-year impact factors, immediacy indexes, articles cited half-lives, eigenfactor scores, and article influence scores were considered concurrently. Fig. 4.15 shows the overall Kaiser-Meyer-Olkin (KMO) and Bartlett's Test output results. Generally, a KMO value from 0.8 to 0.9 indicates that the indicators are suitable for principal component analysis. In this case, with the KMO value was 0.823, indicating that these indicators were very suitable for the principal component analyses.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.823
Bartlett's Test of Sphericity	Approx. Chi-Square	807.414
	df	66
	Sig.	.000

Fig. 4.15: KMO and Bartlett's test

After the principal component extraction procedure, a rotated quartimax transformation was used as this has been shown to have the best performance in making component loadings incline to 1 or 0, and can therefore explain the factors' practical meanings. The quartimax rotation maximizes the variance of the squared factor loadings in each variable; that is, it simplifies the loading matrix rows. In other words, the quartimax minimizes the number of factors needed to explain each variable. The explained eigenvalue and total variances are shown in Fig. 4.16, and the quartimax-rotated loading matrix is shown in Fig. 4.18.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.526	46.048	46.048	5.526	46.048	46.048
2	1.207	10.061	56.109	1.207	10.061	56.109
3	1.154	9.619	65.728	1.154	9.619	65.728
4	1.057	8.804	74.532	1.057	8.804	74.532
5	.946	7.882	82.413			
6	.757	6.310	88.723			
7	.585	4.878	93.601			
8	.406	3.386	96.987			
9	.165	1.372	98.359			
10	.092	.765	99.124			
11	.066	.551	99.675			
12	.039	.325	100.000			

Fig. 4.16: Total variance explained

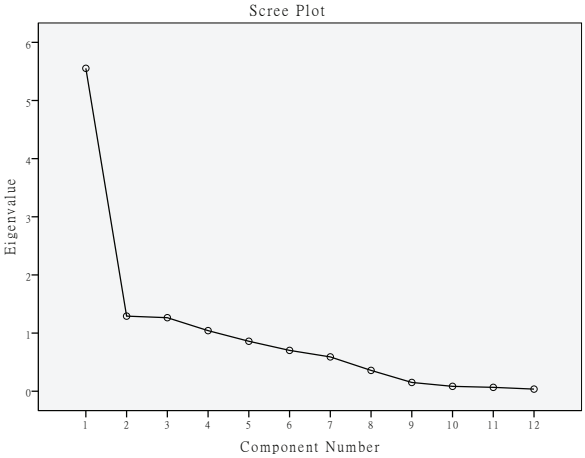

Fig. 4.17: Scree plot

The eigenvalue for component 2 dropped significantly from component 1 (as shown in the scree plot in Fig 4.17); however, the total variance explained was only 46.048%. Therefore, as the best solution, we chose four major components to cover the information from all variables.

As shown in Fig. 4.18, the 2013-2017 impact factors, the five-year impact factor and the article influence score were strongly correlated to the first components, which indicated the integrated journal influence. The eigen-

factor score was closely correlated to the second components, showing the influence of the related journals rather than just the articles. The indicator "cited half-life" was closely related to component three, which indicated whether the journal document structure layout was reasonable. The "immediacy index" indicator was closely related to component four, indicating the influence of the professional journals in newly developing research fields.

Component Matrix[a]

	Component			
	1	2	3	4
Total cites	.597	.162	.076	.271
Five year impact factor	.933	−.108	−.042	.012
Immediacy index	−.139	.472	−.291	.692
Article in citable item	−.011	.524	−.341	−.634
Cited half life	.242	.041	.688	.088
Eigenfactor metrics	−.002	.800	.208	−.028
Article influence score	.841	.058	.019	.189
Impact factor 2013	.916	−.006	−.064	−.114
Impact factor 2014	.928	.012	−.096	−.103
Impact factor 2015	.951	−.010	−.076	−.043
Impact factor 2016	.950	.009	−.066	−.009
Impact factor 2017	.080	.164	.636	−.179

Fig. 4.18: Quartimax rotated loading matrix for the "civil engineering" journal indicators

4.5 Total Summary

There were 93 journals focused on management science in civil engineering, with 5, 14, 28 and 48 respectively distributed in the Zones A, B, C and D. Based on the journal ranking results in section 4.2, the top five most important journals were found to be the *Journal of Hydrology*, *Transportation Research Part B-Methodological*, *Computer-Aided Civil and Infrastructure Engineering*, *Transportation Research Part E-Logistics and Transportation*

Review, and *Engineering Structures*, which had the highest comprehensive scores and were therefore ranked in Zone A. Based on the statistical analysis conducted in section 4.3, *Advances in Civil Engineering* and *Structural Safety* also had very high influence in this category.

The comprehensive analyses in section 4.4 showed that the journal impact factor changes in Zones A-C between 2013 and 2017 had a straight upward trend, which indicated that there was an obvious increase in average paper quality and journal influence. However, the impact factor changes in the Zone D journals varied significantly. The management science in civil engineering major paper contributing countries over the last five years were USA, China, Canada, Australia and Italy, with increasing contributions also coming from India, Iran and South Korea.

Journal developing trends

To extract the journal development trends in this category, Table 4.23 was developed to shows the differences in the impact factors, five-year impact factors, immediacy indexes, the eigenfactor scores, and the article influence scores. To resolve the problem of different dimensions associated with these indicators, the data were standardized.

Most civil engineering related journals showed a downward trend. The differences between standardized impact factors and standardized five-year impact factors indicated the journal article citation frequency variations. As can be seen in Table 4.23, most Z-IF minus Z-IF5 values were negative, the impact factors for these journals were lower than the five-year impact factors, which indicated that the cited frequency in the two most recent years was somewhat lower than in the first three years. The journals with positive citation developments were found to be *Computer-Aided Civil* and *Infrastructure Engineering*, *Steel and Composite Structure*, and *Structural Control & Health Monitoring*; however, overall, most civil engineering related journals were found to have a downward trend.

It takes time for journals in this category to gain and consolidate a higher influence. The difference between the standardized impact factor and the standardized immediacy index indicated the development distance for the past two years and the current year. In this category, the impact factors for almost all journals were larger than their immediacy indexes, which indicated that it takes time for journals to consolidate their influence. The dif-

ference between the standardized five-year impact factor and standardized eigenfactor score indicated that journal self-citations. When the difference is larger, the journal has a higher self-citation degree. In the *civil engineering category, Computer-Aided Civil and Infrastructure Engineering* had the highest values and the *Journal of Hydrology* had the lowest value; however, most related journals had relatively high self-citation degrees.

Table 4.24: “Civil Engineering” journals

Full Journal Title	ISSN	JCR Data				Standardized JCR data				Z-IF	Z-IF	Z-IF5
		Impact Factor	five-Year Impact Factor	Immediacy Index	Eigenfactor Score	Z-IF	Z-IF5	Z-II	Z-E	minusZ-IF5	minusZ-II	minusZ-E
Journal of Hydrology	0022-1694	3.727	4.314	0.731	0.05549	2.1468	2.4368	-0.1739	7.2618	-0.2899	2.3207	-4.8250
Transportation Research Part B-Methodological	0191-2615	4.081	5.109	1.146	0.01355	2.5055	3.1952	0.0371	1.3462	-0.6897	2.4684	1.8490
Computer-Aided Civil and Infrastructure Engineering	1093-9687	5.475	4.663	1.233	0.00418	3.9180	2.7697	0.0818	0.0246	1.1483	3.8362	2.7451
Transportation Research Part E-Logistics and Transportation Review	1366-5545	3.289	4.093	0.577	0.00932	1.7030	2.2259	-0.2522	0.7496	-0.5229	1.9552	1.4763
Engineering Structures	0141-0296	2.755	3.06	0.489	0.03144	1.1619	1.2404	-0.2969	3.8696	-0.0785	1.4589	-2.6291
Structural Safety	0167-4730	3.538	3.72	0.403	0.00389	1.9553	1.8701	-0.3402	-0.0163	0.0852	2.2955	1.8864
Computers & Structures	70045-7949	2.887	3.362	0.707	0.01296	1.2957	1.5286	-0.1861	1.2630	-0.2329	1.4818	0.2655
Transportation	0049-4488	3.151	3.371	0.539	0.00472	1.5632	1.5371	-0.2710	0.1008	0.0260	1.8342	1.4364
Structural Control & Health Monitoring	1545-2255	3.622	3.269	0.779	0.00399	2.0404	1.4398	-0.1490	-0.0022	0.6006	2.1894	1.4420
Thin-Walled Structures	0263-8231	2.881	3.037	0.652	0.01269	1.2896	1.2185	-0.2136	1.2249	0.0711	1.5032	-0.0064
Journal of Water Resources Planning and Management	0733-9496	3.197	3.437	0.576	0.00489	1.6098	1.6001	-0.2527	0.1248	0.0097	1.8625	1.4754
Earthquake Spectra	8755-2930	2.079	2.926	0.644	0.00874	0.4770	1.1126	-0.2176	0.6678	-0.6356	0.6946	0.4448
Coastal Engineering	0378-3839	2.674	3.139	0.626	0.00729	1.0799	1.3158	-0.2268	0.4633	-0.2360	1.3067	0.8525
Journal of Composites for Construction	1090-0268	2.592	3.177	0.387	0.00529	0.9968	1.3521	-0.3483	0.1812	-0.3553	1.3451	1.1709
Water Resources Management	0920-4741	2.644	2.871	0.585	0.01297	1.0495	1.0601	-0.2481	1.2644	-0.0107	1.2976	-0.2043
Steel and Composite Structures	1229-9367	3.594	2.922	0.378	0.00393	2.0121	1.1088	-0.3529	-0.0107	0.9033	2.3649	1.1194
Materials and Structures	1359-5997	2.271	2.528	0.776	0.01074	0.6715	0.7329	-0.1505	0.9499	-0.0614	0.8221	-0.2170
Journal of Structural Engineering	70733-9445	1.903	2.42	0.416	0.01255	0.2986	0.6299	-0.3341	1.2052	-0.3312	0.6327	-0.5753
Tunneling and Underground Space Technology	0886-7798	2.418	2.822	0.62	0.00523	0.8205	1.0134	-0.2298	0.1727	-0.1929	1.0503	0.8407
Archives of Civil and Mechanical Engineering	1644-9665	2.763	2.562	0.879	0.00272	1.1700	0.7654	-0.0982	-0.1813	0.4047	1.2682	0.9467
Journal of Hydraulic Engineering	0733-9429	2.08	2.384	0.298	0.00569	0.4780	0.5955	-0.3941	0.2376	-0.1176	0.8720	0.3580
Journal of Hydraulic Research	0022-1686	2.076	2.317	0.738	0.00351	0.4739	0.5316	-0.1704	-0.0699	-0.0577	0.6443	0.6015
Journal of Management in Engineering	0742-597X	2.282	2.864	0.43	0.00216	0.6827	1.0535	-0.3264	-0.2603	-0.3708	1.0091	1.3138
Ieee Journal of Oceanic Engineering	0364-9059	2.065	2.435	0.663	0.00325	0.4628	0.6442	-0.2080	-0.1066	-0.1814	0.6708	0.7508
Journal of Materials in Civil Engineering	0899-1561	1.576	1.717	0.296	0.00993	0.1568	0.4734	-0.3951	0.8356	-0.3167	0.5518	-0.2170
Journal of Construction Engineering and Management	0733-9364	2.201	2.596	0.324	0.00451	0.6006	0.7978	-0.3803	0.0712	-0.1972	0.9809	0.7266
Journal of Hydro-Environment Research	1570-6443	2.087	2.305	0.548	0.00162	0.4851	0.5202	-0.2664	-0.3365	-0.0351	0.7515	0.8566
International Journal of Pavement Engineering	1029-8436	2.322	1.988	0.776	0.00243	0.7232	0.2178	-0.1505	-0.2222	0.5054	0.8737	0.4400
Journal of Computing in Civil Engineering	70887-3801	1.798	2.35	0.352	0.00331	0.1923	0.5631	-0.3666	-0.0981	-0.3709	0.5588	0.6612
Cold Regions Science and Technology	70165-232X	1.925	2.115	0.358	0.00434	0.3209	0.3389	-0.3635	0.0472	-0.0180	0.6845	0.2917
Frontiers of Structural and Civil Engineering	2095-2430	1.58	1.58	0.283	0.00110	-0.0286	-0.1715	-0.4017	-0.4098	0.1428	0.3730	0.2384
Journal of Hydrologic Engineering	1084-0699	1.576	2.033	0.366	0.00631	-0.0327	0.2607	-0.3595	0.3250	-0.2934	0.3268	-0.0644
Structure and Infrastructure Engineering	1573-2479	1.861	1.811	0.617	0.00325	0.2399	0.0489	-0.2319	-0.1066	0.1910	0.4717	0.1555
International Journal of Structural Stability and Dynamics	0219-4554	2.082	1.848	0.342	0.00235	0.4800	0.0842	-0.3712	-0.2335	0.3958	0.8512	0.3177
Journal of Bridge Engineering	1084-0702	1.454	1.881	0.239	0.00485	-0.1563	0.1157	-0.4240	0.1191	-0.2720	0.2677	-0.0034
Journal of Earthquake Engineering	1363-2469	1.763	1.676	0.915	0.00222	0.1568	-0.0799	-0.0799	-0.2518	0.2367	0.2366	0.1720
Water International	0250-8060	1.956	1.717	0.321	0.00168	0.3523	0.0408	-0.3819	-0.3280	0.3931	0.7342	0.2872
Natural Hazards Review	1527-6988	1.278	1.943	0.4	0.00130	-0.3347	0.1748	-0.3417	-0.3816	-0.5095	0.0070	0.5564
Journal of Waterway Port Coastal and Ocean Engineering	0733-950X	1.481	1.605	0.194	0.00189	-0.1290	-0.1476	-0.4464	-0.2984	0.0187	0.3175	0.1508
Journal of Infrastructure Systems	1076-0342	1.356	1.996	0.239	0.00155	-0.2556	0.2254	-0.4240	-0.3464	-0.4810	0.1684	0.5717
Journal of Irrigation and Drainage Engineering	0733-9437	1.616	1.714	0.246	0.00295	0.0078	-0.0436	-0.4200	-0.1489	0.0515	0.4278	0.1052
Engineering Construction and Architectural Management	0969-9988	1.613	1.613	0.194	0.00057	0.0048	-0.1400	-0.4464	-0.4846	0.1448	0.4512	0.3446
Advances in Civil Engineering	1687-8086	0.827	0.827	0.091	0.00086	-0.7916	-0.8898	4.0808	-0.4437	0.0982	-4.8724	-0.4462
Journal of Civil Engineering and Management	1392-3730	1.66	1.749	0.486	0.00184	0.0524	-0.0103	-0.2985	-0.3054	0.0627	0.3509	0.2952
Geomechanics and Engineering	2005-307X	1.818	1.686	0.417	0.00104	0.2125	-0.0704	-0.3336	-0.4183	0.2829	0.5461	0.3479
Journal of Analytical Methods in Chemistry	2090-8865	1.262	1.722	0.202	0.00201	-0.3509	-0.0360	-0.4423	-0.2815	-0.3149	0.0915	0.2455
Journal of Surveying Engineering	0733-9453	1.299	1.528	0.429	0.00049	0.1021	-0.2211	-0.3275	-0.4959	0.3232	0.4295	0.2748
Journal of Environmental Engineering	0733-9372	1.396	1.536	0.25	0.00295	-0.2151	-0.2135	-0.4179	-0.1489	-0.0016	0.2029	-0.0646
Transportation Research Record	0361-1981	0.695	0.954	0.068	0.01654	-0.9254	-0.7687	2.9120	1.7680	-0.1567	-3.8374	-2.5366
Jounal of Energy Engineering	70733-9402	1.346	1.632	0.212	0.00115	-0.2658	-0.1219	-0.4378	-0.4028	-0.1439	0.1720	0.2809
Journal of Performance of Constructed Facilities	70887-3828	1.197	1.382	0.341	0.00329	-0.4167	-0.3604	-0.3717	-0.1009	-0.0564	0.0450	-0.2594
Structural Design of Tall and Special Buildings	1541-7794	1.5	1.361	0.447	0.00139	-0.1097	-0.3804	-0.3178	-0.3689	0.2707	0.2081	-0.0115
Journal of Urban Planning and Development	0733-9488	1.252	1.573	0.211	0.00105	-0.3610	-0.1782	-0.4383	-0.4169	-0.1828	0.0773	0.2387
International Journal of Architectural Heritage	1558-3058	1.345	1.373	0.513	0.00117	-0.2668	-0.3690	-0.2842	-0.4000	0.1022	0.0175	0.0310
Journal of Ship Research	0022-4502	1.441	1.381	0.25	0.00044	-0.1695	-0.4567	-0.4179	-0.5029	0.2872	0.2485	0.0462
Proceedings of the Institution of Mechanical Engineers Part F-Journal of Rail and Rapid Transit	0954-4097	1.103	1.379	0.22	0.00213	-0.5120	-0.3632	-0.4332	-0.2645	-0.1487	-0.0788	-0.0987
Journal of Transportation Engineering	0733-947X	0.983	1.34	not	0.00323	-0.6336	-0.4004		-0.1094	-0.2331	-0.6336	-0.2910
Journal of Advanced Transportation	0197-6729	1.102	1.342	0.186	0.00173	-0.5130	-0.3604	-0.3488	-0.3210	-0.1526	-0.1642	-0.0394
Journal of Advanced Concrete Technology	1346-8014	1.134	1.383	0.188	0.00121	-0.4806	-0.3594	-0.4495	-0.3943	-0.1212	-0.0311	0.0349
Coastal Engineering Journal	0578-5634	1.246	1.246	0.296	0.00070	-0.3671	-0.4901	-0.3951	-0.4662	0.1230	0.0280	-0.0239
Proceedings of the Institution of Civil Engineers-Engineering Sustainability	1478-4629	1.5	1.208	1.536	0.00051	-0.1097	-0.5264	0.2359	-0.4930	0.4167	-0.3456	-0.0333
Journal of Aerospace Engineering	0893-1321	1.296	1.264	0.274	0.00209	-0.3164	-0.4729	-0.4057	-0.2702	0.1565	0.0893	-0.2028
Earthquakes and Structures	2092-7614	1.309	1.287	0.15	0.00179	-0.3032	-0.4510	-0.4688	-0.3125	0.1478	0.1655	-0.1385
European Journal of Environmental and Civil Engineering	1964-8189	1.29	1.22	0.358	0.00166	-0.3225	-0.5149	-0.3635	-0.3308	0.1924	0.0411	-0.1841
Journal of Marine Science and Technology	0948-4280	1.119	1.31	0.19	0.00114	-0.4958	-0.4291	-0.4484	-0.4042	-0.0667	-0.0473	-0.0249
Advances in Structural Engineering	71369-4332	0.968	1.103	0.211	0.00294	-0.6488	-0.6265	-0.4383	-0.1503	-0.0222	-0.2105	-0.4762
Ksce Journal of Civil Engineering	1226-7988	0.94	1.073	0.248	0.00408	-0.6771	-0.6552	-0.4190	0.0105	-0.0220	-0.2582	-0.6657
Earthquake Engineering and Engineering Vibration	1671-3664	0.847	1.166	0.228	0.00135	-0.7714	-0.5664	-0.4291	-0.3746	-0.2049	-0.3422	-0.1919
Journal of Pipeline Systems Engineering and Practice	1949-1190	0.971	1.174	0.279	0.00052	-0.6457	-0.5588	-0.4032	-0.4916	-0.0869	-0.2425	-0.4672
Latin American Journal of Solids and Structures	1679-7825	0.905	1.158	0.161	0.00175	-0.7126	-0.5741	-0.4632	-0.3181	-0.1385	-0.2494	-0.2559
Journal of Water Supply Research and Technology-Aqua	0003-7214	1.179	1.033	0.377	0.00085	-0.4350	-0.6933	-0.3534	-0.4451	0.2584	-0.0816	-0.2482
Canadian Journal of Civil Engineering	0315-1468	0.869	1.026	0.083	0.00223	-0.7491	-0.7000	3.6746	-0.2504	-0.0491	-4.4237	-0.4496
Journal of Cold Regions Engineering	0887-381X	0.688	1.015	0.6	0.00026	-0.9325	-0.7105	-0.2400	-0.5283	-0.2220	-0.6925	-0.1822
International Journal of Steel Structures	1598-2351	0.734	0.859	0.089	0.00117	-0.8859	-0.8593	3.9791	-0.4000	-0.0266	-4.8650	-0.4594
Civil Engineering and Environmental Systems	1028-6608	0.977	0.809	0.111	0.00024	-0.6396	-0.9070	-0.4886	-0.5311	0.2674	-0.1510	-0.3759
Advanced Steel Construction	1816-112X	0.737	0.754	0.136	0.00042	-0.8828	-0.9595	-0.4759	-0.5057	0.0767	-0.4069	-0.4537
Proceedings of the Institution of Civil Engineers-Water Management	1741-7589	0.431	0.863	1.222	0.00064	-1.1929	-0.8555	0.0762	-0.4747	-0.3374	-1.2691	-0.3808
Structural Engineering International	1016-8664	0.621	0.661	0.047	0.00085	-1.0004	-1.0482		-0.4451	0.0478	-1.0004	-0.6031
Proceedings of the Institution of Civil Engineers-Structures and Buildings	0965-0911	0.674	0.596	1.268	0.00070	-0.9467	-1.1102	0.0996	-0.4662	0.1636	-1.0463	-0.6440
China Ocean Engineering	0890-5487	0.674	0.634	0.056	0.00072	-0.9467	-1.0740	2.3019	-0.4634	0.1273	-3.2486	-0.6105
Ocean Engineering	0890-5487	0.674	0.634	0.056	0.00072	-0.9467	-1.0740	2.3019	-0.4634	0.1273	-3.2486	-0.6105
Beton-Und Stahlbetonbau	0005-9900	0.717	0.491	0.339	0.00096	-0.9031	-1.2104	-0.3727	-0.4296	0.3073	-0.5304	-0.7808
International Journal of Offshore and Polar Engineering	1053-5381	0.469	0.653	0.231	0.00062	-1.1544	-1.0558	-0.4276	-0.4775	-0.0985	-0.7268	-0.5783
Iranian Journal of Science and Technology-Transactions of Civil Engineering	2228-6160	0.514	0.771	0.119	0.00030	-1.1088	-0.9433	-0.4851	-0.5227	-0.1655	-0.6237	-0.4206
Periodica Polytechnica-Civil Engineering	0553-6626	0.636	0.64	0.216	0.00028	-0.9852	-1.0682	-0.4352	-0.5255	0.0831	-0.5499	-0.5428
Baltic Journal of Road and Bridge Engineering	1822-427X	0.622	0.598	0.059	0.00025	-0.9993	-1.1083	2.4540	-0.5297	0.1090	-3.4533	-0.5786
Gradevinar	0350-2465	0.515	0.529	0.027	0.00041	-1.1078	-1.1741		-0.5071	0.0664	-1.1078	-0.6670
Bauingenieur	0005-6650	0.477	0.373	0.29	0.00055	-1.1463	-1.3230	-0.3981	-0.4874	0.1767	-0.7482	-0.8356
Proceedings of the Institution of Civil Engineers-Civil Engineering	0965-089X	0.409	0.387	1.677	0.00023	-1.2152	-1.3096	0.3075	-0.5325	0.0944	-1.5227	-0.7771
Proceedings of the Institution of Civil Engineers-Transport	0965-092X	0.239	0.415	1.194	0.00028	-1.3874	-1.2829	0.0620	-0.5255	-0.1045	-1.4494	-0.7574
Bautechnik	0932-8351	0.291	0.256	0.031	0.00059	-1.3347	-1.4346		-0.4818	0.0998	-1.3347	-0.9528
Stahlbau	0038-9145	0.321	0.278	0.303	0.00057	-1.3043	-1.4136	-0.3915	-0.4846	0.1093	-0.9128	-0.9290
ITE Journal-Institute of Transportation Engineers	0162-8178	0.2	0.255	0.064	0.00027	-1.4269	-1.4355	2.7087	-0.5263	0.0086	-4.1356	-0.9092

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Chapter 5
Engineering management

In this chapter, engineering management is introduced and the associated journals analyzed. First, based on a literature review and data collection, engineering management, project management, engineers, engineering efficiency, and engineering systems are described. Then, to classify the influence of each journal, statistical software is employed for the journal ranking analysis to describe the relevant indexes. Based on the ranking report, the 90 engineering management related journals are divided into four zones (A, B, C, and D). The changes in journal impact factors from 2013 to 2017 are then analyzed to indirectly assess the journal contributions. Then, using descriptive, correlation, and principal component analyses, the journal characteristics are clarified. This chapter focuses on engineering management related journals to assist readers formulate answers to fundamental engineering management problems.

5.1 Category Description

Engineering management is a comprehensive emerging research area that encompasses a wide range of practical and social science disciplines: mechanical engineering, management science, economics and law, as well as construction technology, project management and construction systems [1, 12]. Management in this context refers to the application of special-

ized project knowledge, skills, tools, and methods to meet or exceed expectations under limited resources [11]. Therefore, engineering management refers to the overall monitoring and control of project planning, scheduling, and progress maintenance [10] to resolve project problems [6] and meet the project requirements for all stakeholders, which involves using relevant skills, methods, and tools [15] for the concurrent planning, organization, leadership and control activities.

There are many engineering management associations and organizations, the largest of which is the IEEE Institute of Engineering Management, which publishes regular trade magazines. Another well-known professional organization is the American Academy of Engineering Management that was founded in 1979 by 20 industrial engineering managers [9]. Engineering management has been a focus for over 50 years [7, 5]. and in the late 1960s and 1970s, project management theories and methods emerged in developed countries to better organize construction engineering projects [9, 3]. By the mid-1970s, universities began to offer project management disciplines and courses to meet these new development needs that involved subjects such as construction organization and technology, project development and management, financial planning, life-cycle planning and management, project management and others [3, 2]. Today engineering management degrees and higher degrees have thus become a popular global study area.

Different from other disciplines, engineering management has a new interdisciplinary focus, engineering technology and management [8] which encompasses both engineering technology and economic management and involves comprehensive management methods such as applied statistics, operations research, accounting, financial management, engineering economics, organizational behavior, and engineering technology for civil engineering, engineering mechanics, and engineering structures, all of which are focused on resolving practical project management problems [11].

Engineering management, therefore, includes the in-depth study of supply chain management, time cost management, model analyses, and other project management aspects. With the deepening of research into engineering management, there has been an increase in related journals.

Therefore, it is important to subdivide these engineering management journals to assist engineering management experts and practitioners in developing solutions and designing novel measurement methods for future research problems.

5.2 Ranking Report

The four important indicators that reflect journal excellence are the impact factor, the five-year impact factor, the eigenfactor score, and the article influence score. The impact factor is an internationally recognized journal evaluation indicator that measures the average citation frequency for articles published in the past two years to assess the relative importance of different journals in the same field. The five-year impact factor is used to measure the average citation frequency of articles published in the last five years to assess the relative importance of different journals. The eigenfactor is a fraction related to all citations except self-citations and reflects the overall importance of the journal. Except for self-citations, the article influence score is equivalent to the five-year impact factor, and reflects the overall importance of the journal. Eigenfactor and article influence scores are considered more scientific measures as they both consider citation quality; however, this does not mean that impact factors and five-year impact factors are of no value. A certain degree of self-citation indicates that a journal pays attention to its own specific scope and has representative contributions; that is, the impact factor reflects the development of the journals, and the five-year impact factor reflects the journal's long-term contribution.

Therefore, in this chapter, the four indexes were integrated to develop a new evaluation model, with the weights for each index determined using expert scoring. The index weights, therefore, were: impact factor (0.3); five-year impact factor (0.35); eigenfactor score (0.2); and article influence score (0.15). To resolve the different dimension problems in the four indexes, the data were standardized, as shown in Table 5.1, to calculate the comprehensive journal scores.

To more directly characterize the journal levels in the engineering management field, the 90 journals were divided into four zones based on their respective comprehensive scores and partitions were created to deepen the understanding of the engineering management journals in Zones A, B, C, and D. Journals with comprehensive impact scores in the top 5% were allocated to Zone A, scores between 6% and 20% were allocated to Zone B, scores between 21% and 50% were allocated to Zone C, and the remaining 50% of journals were allocated to Zone D.

As can be seen in Table 5.2, five journals were allocated to Zone A, all of which had impact factors above 3 and five-year impact factors above

Table 5.1: Comprehensive scores of “engineering management” journals

Rank	Full Journal Title	ISSN	JCR Data		Eigenfactor Metrics		Standardization				Comprehensive score
			Impact Factor	Five-Year Impact Factor	Eigenfactor Score	Article Influence Score	Z-Impact Factor	Z-5-Year Impact Factor	Z-Eigenfactor Score	Z-Article Influence Score	
1	Management Science	0025-1909	3.544	4.927	0.04258	3.691	1.20577	1.42527	3.55686	4.92626	2.3108865
2	Journal of Operations Management	0272-6963	4.899	7.485	0.00624	2.267	2.37805	3.04574	0.07662	2.61278	2.186665
3	Journal of Hydrology	0022-1694	3.727	4.314	0.05549	1.097	1.36409	1.03694	4.79324	0.71197	1.8375995
4	Organization Science	1047-7039	3.027	5.431	0.02004	3.121	0.75848	1.74455	1.39823	4.00022	1.7178155
5	Construction and Building Materials	0950-0618	3.485	4.039	0.05935	0.661	1.15472	0.86273	5.16291	0.00363	1.681498
6	Building and Environment	0360-1323	4.539	5.221	0.02166	0.902	2.0666	1.61151	1.55337	0.39516	1.5539565
7	International Journal of Production Economics	0925-5273	4.407	4.976	0.0226	0.971	1.9524	1.45631	1.6434	0.50726	1.5001975
8	Omega-International Journal of Management Science	0305-0483	4.311	5.525	0.01027	1.494	1.86934	1.8041	0.46256	1.35694	1.48829
9	Supply Chain Management-An International Journal	1359-8546	3.833	7.038	0.0034	1.057	1.4558	2.76257	-0.19537	0.64698	1.4616125
10	Corporate Social Responsibility and Environmental Management	1535-3958	4.918	5.856	0.00106	0.556	2.39449	2.01378	-0.41947	-0.16696	1.3142232
11	Building and Environment	0360-1323	4.053	4.464	0.01942	0.832	1.64613	1.13196	1.33885	0.28144	1.200011
12	Journal of Product Innovation Management	0737-6782	4.305	4.926	0.00562	1.039	1.86415	1.42464	0.01724	0.61774	1.153978
13	International Journal of Project Management	0263-7863	4.328	5.07	0.00506	0.644	1.88405	1.51586	-0.03639	-0.02399	1.0848895
14	Information Systems Research	1047-7047	2.301	5.153	0.00846	2.241	0.13038	1.56844	0.28922	2.57054	1.031493
15	Automation in Construction	0926-5805	4.032	4.437	0.00802	0.676	1.62796	1.11486	0.24708	0.028	0.932205
16	Journal of Service Management	1757-5818	3.414	5.407	0.00203	0.913	1.0933	1.72934	-0.32657	0.41304	0.929901
17	Journal of Purchasing and Supply Management	1478-4092	3.667	5.188	0.00131	0.746	1.31218	1.59061	-0.39553	0.14172	0.8925195
18	Industrial Marketing Management	0019-8501	3.678	4.488	0.00561	0.63	1.3217	1.14717	0.01628	-0.04674	0.7942645
19	Robotics and Computer-Integrated Manufacturing	0736-5845	3.464	4.031	0.0042	0.79	1.13655	0.85766	-0.11875	0.21321	0.6493775
20	California Management Review	0008-1256	3.302	4.162	0.00188	1.005	0.9964	0.94065	-0.34094	0.5625	0.6443345
21	Journal of Management Information Systems	0742-1222	2.744	4.262	0.00366	1.265	0.51364	1.004	-0.17047	0.9849	0.619133
22	Operations Research	0030-364X	2.263	3.047	0.01386	2.062	0.0975	0.23431	0.80638	2.27973	0.614494
23	Journal of Manufacturing Systems	0278-6125	3.699	3.621	0.0037	0.708	1.33987	0.59793	-0.16664	0.07999	0.5899907
24	International Journal of Operations & Production Management	0144-3577	2.955	4.371	0.00292	0.684	0.69619	1.07305	-0.24134	0.04099	0.542305
25	International Journal of Advanced Manufacturing Technology	0268-3768	2.601	2.748	0.02877	0.397	0.38993	0.04489	2.23429	-0.42527	0.515758
26	Journal of Intelligent Manufacturing	0956-5515	3.667	3.383	0.00464	0.576	1.31218	0.44716	-0.07662	-0.13447	0.5146655
27	International Journal of Production Research	0020-7543	2.623	2.78	0.01699	0.544	0.40896	0.06517	1.10613	-0.18645	0.4803756
28	M&SOM-Manufacturing & Service Operations Management	1523-4614	1.795	2.867	0.00561	1.931	-0.30739	0.12028	0.01628	2.06691	0.2631735
29	International Journal of Forecasting	0169-2070	2.186	2.724	0.0064	1.2	0.03089	0.02969	0.09194	0.8793	0.1699415
30	Production and Operations Management	1059-1478	1.772	2.921	0.0095	1.21	-0.32729	0.15449	0.38882	0.89555	0.167981
31	European Management Journal	0263-2373	2.369	3.412	0.00243	0.61	0.18921	0.46553	-0.28826	-0.07923	0.150162
32	Research in Engineering Design-Theory Applications and Concurrent Engineering	0934-9839	2.625	3.275	0.00081	0.578	0.41069	0.37874	-0.44341	-0.13122	0.147401
33	Flexible Services and Manufacturing Journal	1936-6582	2.346	3.129	0.00157	0.923	0.16931	0.28625	-0.37063	0.42928	0.1412465
34	Journal of Engineering and Technology Management	0923-4748	2.686	3.213	0.00098	0.525	0.46346	0.33947	-0.42713	-0.21732	0.1398285
35	Industrial and Corporate Change	0960-6491	2.198	2.763	0.00349	1.002	0.04127	0.0544	-0.18675	0.55763	0.0797155
36	Stochastic Environmental Research and Risk Assessment	1436-3240	2.668	2.645	0.00202	0.429	0.44789	-0.02036	-0.32753	-0.37329	0.0057415
37	Production Planning & Control	0953-7287	2.33	2.933	0.00226	0.409	0.15547	0.16209	-0.30455	-0.40578	-0.0184045
38	Materials and Manufacturing Processes	1042-6914	2.669	2.359	0.00472	0.307	0.44876	-0.20153	-0.06895	-0.57149	-0.035421
39	Journal of Management in Engineering	0742-597X	2.282	2.864	0.00216	0.417	0.11394	0.11838	-0.31412	-0.39278	-0.046126
40	Management International Review	0938-8249	2.279	2.752	0.00127	0.574	0.11135	0.04743	-0.39936	-0.13771	-0.050523
41	Project Management Journal	8756-9728	1.957	2.9	0.00157	0.545	-0.16723	0.14118	-0.37063	-0.18483	-0.1026065
42	International Transactions in Operational Research	0969-6016	2.4	2.178	0.00218	0.642	0.21603	-0.3162	-0.31221	-0.02724	-0.112389
43	Journal of Construction Engineering and Management	0733-9364	1.735	2.35	0.0043	0.421	-0.3593	-0.20724	-0.10918	-0.38628	-0.260102
44	International Journal of Computer Integrated Manufacturing	0951-192X	1.995	2.016	0.00217	0.37	-0.13436	-0.41882	-0.31316	-0.46914	-0.319898
45	International Journal of Logistics Management	0957-4093	1.776	2.437	0.00063	0.326	-0.32383	-0.15212	-0.46065	-0.54062	-0.323614
46	MIS Quarterly Executive	1540-1960	1.862	1.987	0.00055	0.519	-0.24942	-0.43719	-0.46831	-0.22707	-0.355565
47	Electronic Commerce Research	1389-5753	1.489	2.452	0.00067	0.427	-0.57213	-0.14262	-0.45682	-0.37654	-0.369401
48	Management Decision	0025-1747	1.525	2.34	0.00235	0.312	-0.54098	-0.21357	-0.29593	-0.56337	-0.380725
49	IEEE Transactions on Components Packaging and Manufacturing Technology	2156-3950	1.66	1.662	0.00649	0.424	-0.42419	-0.64308	0.10056	-0.38141	-0.3894345
50	Engineering Economist	0013-791X	2	1.705	0.00038	0.358	-0.13003	-0.61584	-0.48459	-0.48863	-0.4247655
51	IEEE Transactions on Engineering Management	0018-9391	1.416	2.087	0.00173	0.474	-0.63528	-0.37384	-0.3553	-0.30018	-0.437515
52	Journal of the Operational Research Society	0160-5682	1.396	1.634	0.00537	0.527	-0.65259	-0.66081	-0.0067	-0.21407	-0.460511
53	Journal of Economics & Management Strategy	1058-6407	1.163	1.436	0.00301	1.123	0.85417	-0.78625	-0.23272	0.75421	-0.464851
54	International Journal of Precision Engineering and Manufacturing	2234-7593	1.661	1.491	0.00597	0.294	-0.42332	-0.7514	0.05076	-0.59261	-0.4687255
55	Journal of Infrastructure Systems	1076-0342	1.356	1.996	0.00155	0.494	-0.68719	-0.43149	-0.37254	-0.26768	-0.4718385
56	International Journal of Logistics-Research and Applications	1367-5567	1.82	1.717	0.00059	0.296	-0.28576	-0.60824	-0.46448	-0.59936	-0.4799912
57	Industry and Innovation	1366-2716	1.338	1.96	0.00124	0.521	-0.70277	-0.4543	-0.40223	-0.22382	-0.483855
58	Scandinavian Journal of Management	0956-5221	1.344	2.026	0.00098	0.473	-0.69757	-0.41249	-0.42713	-0.3018	-0.4843385
59	Journal of Civil Engineering and Management	1392-3730	1.66	1.749	0.00184	0.29	-0.42419	-0.58796	-0.34477	-0.59911	-0.4918635
60	European Management Review	1740-4754	1.25	2.095	0.00048	0.48	-0.7789	-0.36878	-0.47501	-0.29043	-0.5013095
61	Engineering Construction and Architectural Management	0969-9988	1.613	1.613	0.00057	0.524	-0.46485	-0.67412	-0.4664	-0.21895	-0.5015195
62	Cross Cultural Management-an International Journal	1352-7606	1.8	1.583	0.00028	0.203	-0.30306	-0.69312	-0.49417	-0.74045	-0.5434115
63	Advances in Production Engineering & Management	1854-6250	1.596	1.596	0.0003	0.254	-0.47956	-0.68489	-0.49225	-0.6576	-0.5806695
64	Journal of Environmental Engineering	0733-9372	1.396	1.536	0.00295	0.308	-0.65259	-0.7229	-0.23846	-0.56987	-0.5819645
65	International Journal of Design	1991-3761	1.163	1.938	0.00056	0.363	-0.85417	-0.46823	-0.46735	-0.48051	-0.585678
66	Journal of Computing and Information Science in Engineering	1530-9827	1.588	1.49	0.00072	0.257	-0.48648	-0.75204	-0.45203	-0.65272	-0.597472
67	Machining Science and Technology	1091-0344	1.339	1.658	0.00069	0.324	-0.7019	-0.64561	-0.4549	-0.54387	-0.609094
68	Journal of Scheduling	1094-6136	1.153	1.402	0.00214	0.637	-0.86282	-0.80778	-0.31604	-0.03536	-0.6110081
69	Service Industries Journal	0264-2069	1.258	1.686	0.0015	0.271	-0.77198	-0.62787	-0.37733	-0.62998	-0.6211315
70	Journal of Urban Planning and Development	0733-9488	1.252	1.573	0.00105	0.309	-0.77717	-0.69946	-0.42043	-0.56824	-0.647284
71	Operations Management Research	1936-9735	1.524	1.42	0.00013	0.196	-0.54185	-0.79638	-0.50853	-0.75182	-0.655767
72	Decision Analysis	1545-8490	1.063	1.344	0.00087	0.66	-0.94068	-0.84453	-0.43766	0.002	-0.6650215
73	International Journal of Selection and Assessment	0965-075X	1.031	1.394	0.00141	0.546	-0.96837	-0.81285	-0.38595	-0.1832	-0.6796785
74	Journal of Service Theory and Practice	2055-6225	1.395	1.444	0.00014	0.127	-0.65345	-0.78118	-0.50758	-0.86392	-0.700552
75	IEEE Transactions on Semiconductor Manufacturing	0894-6507	1.336	1.199	0.00135	0.301	-0.7045	-0.93638	-0.3917	-0.58124	-0.704609
76	Concurrent Engineering-Research and Applications	1063-293X	1.456	1.252	0.00029	0.161	-0.60068	-0.90281	-0.49321	-0.80869	-0.716133
77	European Journal of Environmental and Civil Engineering	1964-8189	1.29	1.122	0.00016	0.306	-0.74429	-0.98516	-0.36201	-0.57312	-0.726463
78	Australian Journal of Management	0312-8962	1.15	1.417	0.00047	0.25	-0.86541	-0.79828	-0.47597	-0.66409	-0.7338285
79	Journal of Forecasting	0277-6693	0.934	1.21	0.00155	0.493	-1.05229	-0.92941	-0.37254	-0.26931	-0.755885
80	Review of Industrial Organization	0889-938X	0.767	0.821	0.00114	0.425	-1.19677	-1.17584	-0.41181	-0.37978	-0.909904
81	Interfaces	0092-2102	0.579	0.97	0.00123	0.424	-1.35942	-1.08145	-0.40319	-0.38141	-0.924183
82	Civil Engineering and Environmental Systems	1028-6608	0.977	0.809	0.00024	0.163	-1.01509	-1.18344	-0.498	-0.80544	-0.939147
83	Journal for East European Management Studies	0949-6181	0.794	1.012	0.00009	0.081	-1.17341	-1.05485	-0.51236	-0.93866	-0.9644915
84	Chinese Management Studies	1750-614X	0.857	0.936	0.00015	0.067	-1.11891	-1.10299	-0.50662	-0.9614	-0.9672535
85	Systemic Practice and Action Research	1094-429X	0.797	0.88	0.00031	0.145	-1.17081	-1.13847	-0.49129	-0.83468	-0.9731675
86	International Journal of Industrial Engineering-Theory Applications and Practice	1943-670X	0.565	0.705	0.00035	0.121	-1.37153	-1.24933	-0.48746	-0.87367	-1.077267
87	Manufacturing Engineering	0361-0853	0.565	0.705	0.00035	0.121	-1.37153	-1.24933	-0.48746	-0.87367	-1.077267
88	Engineering Management Journal	1042-9247	0.487	0.771	0.00008	0.06	-1.43901	-1.20752	-0.51332	-0.97277	-1.1029145
89	Journal of Advanced Mechanical Design Systems and Manufacturing	1881-3054	0.503	0.54	0.00071	0.118	-1.42517	-1.35385	-0.45299	-0.87855	-1.123779
90	South African Journal of Economic and Management Sciences	2222-3436	0.505	0.491	0.00021	0.074	-1.42344	-1.38489	-0.50087	-0.95003	-1.154422

4. The *Journal of Operations Management* had the highest impact factor score of 4.899 in Zone A, the *Journal of Hydrology* had the highest total cites at 46,099 in 2017, *Construction and Building Materials* had the highest eigenfactor score at 0.05935, *Management Science* had the highest article influence score at 3.691, and the cited half-lives for *Management Science*, *Journal of Operations Management* and *Organization Science* were more than 10, indicating the long-term influence of these journals.

Table 5.2: Engineering management journals in Zone A

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year Impact Factor	Immediacy Index	Articles	Cited Half-life	Eigenfactor Score	Article Influence Score
1	Management Science	0025-1909	29,449	3.544	4.927	0.762	100	>10.0	0.04258	3.691
2	Journal of Operations Management	0272-6963	8,874	4.899	7.485	1.118	100	>10.0	0.00624	2.267
3	Journal of Hydrology	0022-1694	46099	3.727	4.314	0.731	97.8	8.6	0.05549	1.097
4	Organization Science	1047-7039	17,360	3.027	5.431	0.328	100	>10.0	0.02004	3.121
5	Construction and Building Materials	0950-0618	39,161	3.485	4.039	0.6	96.77	4.3	0.05935	0.661

Table 5.3 shows the 13 journals in Zone B, all of which had five-year impact factor scores between 2.301 and 4.918. These journals are often considered relatively important to engineering management research. *Corporate Social Responsibility and Environmental Management* had the highest 2017 impact factor at 4.918, *Building and Environment* had the highest total cites of 21261, *Supply Chain Management-An International Journal* had the highest five-year impact factor at 7.038, *Information Systems Research* had more than 10 cited half-life scores and had the highest article influence score of 2.241, *Omega-International Journal of Management Science* had the highest immediacy index at 1.274, and the *International Journal of Production Economics* had the highest Eigenfactor Score at 0.0226.

Table 5.3: Engineering management journals in Zone B

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year Impact Factor	Immediacy Index	Articles	Cited Half-life	Eigenfactor Score	Article Influence Score
1	Building and Environment	0360-1323	21,261	4.539	5.221	1	95.63	6.8	0.02166	0.902
2	International Journal of Production Economics	0925-5273	18,583	4.407	4.976	0.865	97.97	6.5	0.0226	0.971
3	Omega-International Journal of Management Science	0305-0483	7,143	4.311	5.525	1.274	97.17	8.3	0.01027	1.494
4	Supply Chain Management-An International Journal	1359-8546	4,307	3.833	7.038	0.353	88.24	8.1	0.0034	1.057
5	Corporate Social Responsibility and Environmental Management	1535-3958	1,985	4.918	5.856	0.708	89.58	6.9	0.00106	0.556
6	Building and Environment	0360-1323	17,359	4.053	4.464	1.049	94.82	6.7	0.01942	0.832
7	Journal of Product Innovation Management	0737-6782	5,988	4.305	4.926	0.571	97.62	8.7	0.00562	1.039
8	International Journal of Project Management	0263-7863	8,339	4.328	5.07	1.017	96.67	8.5	0.00506	0.644
9	Information Systems Research	1047-7047	6,640	2.301	5.153	0.217	97.83	>10.0	0.00846	2.241
10	Automation in Construction	0926-5805	6,520	4.032	4.437	0.741	93.51	4.9	0.00802	0.676
11	Journal of Service Management	1757-5818	1,479	3.414	5.407	0.205	92.31	5.5	0.00203	0.913
12	Journal of Purchasing and Supply Management	1478-4092	1,476	3.667	5.188	0.696	95.65	6.5	0.00131	0.746
13	Industrial Marketing Management	0019-8501	8,498	3.678	4.488	1.015	96.21	7.5	0.00561	0.63

Table5.4shows that the 27 journals in Zone C had impact factor scores between 1.735 and 3.699 and five-year impact factors between 2.016 and 4.371. The highest impact factor of 3.699 was for the *Journal of Manufacturing Systems* five-year impact factor of 4.371 was for the *International Journal of Operations & Production Management*. The *International Journal of Advanced Manufacturing Technology* had the highest total cites at 25357 and the highest eigenfactor score at 0.01386. The *Journal of Intelligent Manufacturing* had the highest immediacy index score of 1.299. Eight journal articles in the citable item were 100, and 8 journals' cited half-lives were more than 10. The highest article influence score was 2.062 for *Operations Research*.

Table 5.4: Engineering management journals in Zone C

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year Impact Factor	Immediacy Index	Articles	Cited Half-life	Eigenfactor Score	Article Influence Score
1	Robotics and Computer-Integrated Manufacturing	0736-5845	3,366	3.464	4.031	1.097	100	6	0.0042	0.79
2	California Management Review	0008-1256	5,087	3.302	4.162	0.357	100	> 10.0	0.00188	1.005
3	Journal of Management Information Systems	0742-1222	4,560	2.744	4.262	0.256	94.87	>10.0	0.00366	1.265
4	Operations Research	0030-364X	12,552	2.263	3.047	0.297	100	>10.0	0.01386	2.062
5	Journal of Manufacturing Systems	0278-6125	2,307	3.699	3.621	0.486	95.5	4.5	0.0037	0.708
6	International Journal of Operations & Production Management	0144-3577	5,910	2.955	4.371	0.671	96.2	> 10.0	0.00292	0.684
7	International Journal of Advanced Manufacturing Technology	0268-3768	25,357	2.601	2.748	0.402	98.64	4.7	0.02877	0.397
8	Journal of Intelligent Manufacturing	0956-5515	3,457	3.667	3.383	1.299	99.27	5.1	0.00464	0.576
9	International Journal of Production Research	0020-7543	14,789	2.623	2.78	0.69	97.02	6.9	0.01699	0.544
10	M&SOM-Manufacturing & Service Operations Management	1523-4614	2,295	1.795	2.867	0.381	100	9.2	0.00561	1.931
11	International Journal of Forecasting	0169-2070	3,796	2.186	2.724	0.419	100	>10.0	0.0064	1.2
12	Production and Operations Management	1059-1478	4,423	1.772	2.921	0.379	97.58	8.1	0.0095	1.21
13	European Management Journal	0263-2373	3,386	2.369	3.412	0.293	97.33	>10.0	0.00243	0.61
14	Research in Engineering Design-Theory Applications and Concurrent Engineering	0934-9839	1,094	2.625	3.275	0.5	100	9.8	8.10E-04	0.578
15	Flexible Services and Manufacturing Journal	1936-6582	468	2.346	3.129	0.333	95.83	3.9	0.00157	0.923
16	Journal of Engineering and Technology Management	0923-4748	1,069	2.686	3.213	0.263	100	8	0.0098	0.525
17	Industrial and Corporate Change	0960-6491	3,708	2.198	2.763	0.308	100	>10.0	0.00349	1.002
18	Stochastic Environmental Research and Risk Assessment	1436-3240	3307	2.668	2.645	0.831	97.67	4.3	0.00202	0.429
19	Production Planning & Control	0953-7287	2,516	2.33	2.933	0.247	87.63	6.3	0.00226	0.409
20	Materials and Manufacturing Processes	1042-6914	4,568	2.669	2.359	0.473	98.23	4.9	0.00472	0.307
21	Journal of Management in Engineering	0742-597X	2,235	2.282	2.864	0.43	97.67	6	0.00216	0.417
22	Management International Review	0938-8249	1,835	2.279	2.752	0.25	93.75	9.9	0.00127	0.574
23	Project Management Journal	8756-9728	1,608	1.957	2.9	0.256	97.67	7.9	0.00157	0.545
24	International Transactions in Operational Research	0969-6016	1,233	2.4	2.178	0.889	97.22	6.4	0.00218	0.642
25	Journal of Construction Engineering and Management	0733-9364	6,109	1.735	2.35	0.2	99.43	9.3	0.0043	0.421
26	International Journal of Computer Integrated Manufacturing	0951-192X	1,749	1.995	2.016	0.778	98.89	5.6	0.00217	0.37
27	International Journal of Logistics Management	0957-4093	1,557	1.776	2.437	0.167	90	>10.0	6.30E-04	0.326

Table 5.5shows the 45 journals allocated to Zone D, all of which had lower impact factors than the other three zones at between 0.487 and 2, with only *Engineering Economist* having an impact factor of 2. The five-year impact factor ranged from 0.491 to 2.452, with five journals having five-year impact factors higher than 2. The *Journal of the Operational Research Society* had the highest total cites at 6607, the *Journal of Economics & Management Strategy* had the highest article influence score at 1.123, and *Industry and Innovation* had the highest immediacy index of 0.943. Twelve journals had impact factors between 0 and 1.

Table 5.5: Engineering management journals in Zone D

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year Impact Factor	Immediacy Index	Articles	Cited Half-life	Eigenfactor Score	Article Influence Score
1	MIS Quarterly Executive	1540-1960	459	1.862	1.987	0.375	100	7.3	5.50E-04	0.519
2	Electronic Commerce Research	1389-5753	519	1.489	2.452	0.069	96.55	5.6	0.0067	0.427
3	Management Decision	0025-1747	4,203	1.525	2.34	0.192	97.5	9.1	0.00235	0.312
4	IEEE Transactions on Components Packaging and Manufacturing Technology	2156-3950	5,236	1.66	1.662	0.304	100	8.2	0.00649	0.424
5	Engineering Economist	0013-791X	445	2	1.705	0.056	100	>10.0	0.0038	0.358
6	IEEE Transactions on Engineering Management	0018-9391	2,484	1.416	2.087	0.196	97.83	>10.0	0.00173	0.474
7	Journal of the Operational Research Society	0160-5682	6,607	1.396	1.634	0.315	98.43	>10.0	0.00537	0.527
8	Journal of Economics & Management Strategy	1058-6407	1,577	1.163	1.436	0.175	100	>10.0	0.00301	1.123
9	International Journal of Precision Engineering and Manufacturing	2234-7593	2,942	1.661	1.491	0.141	99.06	4.2	0.00597	0.294
10	Journal of Infrastructure Systems	1076-0342	1,376	1.356	1.996	0.239	96.59	9.2	0.00155	0.494
11	International Journal of Logistics-Research and Applications	1367-5567	763	1.82	1.717	0.313	90.63	8.9	0.0059	0.296
12	Industry and Innovation	1366-2716	1,159	1.338	1.96	0.943	100	8.3	0.00124	0.521
13	Scandinavian Journal of Management	0956-5221	1,275	1.344	2.026	0.182	100	8.7	0.0094	0.473
14	Journal of Civil Engineering and Management	1392-3730	1,381	1.66	1.749	0.486	98.13	4.8	0.00184	0.29
15	European Management Review	1740-4754	539	1.25	2.095	0.2	96	8.1	0.0048	0.48
16	Engineering Construction and Architectural Management	0969-9988	1,172	1.613	1.613	0.194	94.44	9.1	0.0057	0.524
17	Cross Cultural Management-an International Journal	1352-7606	532	1.8	1.583	Not able	Avail- Not able	Avail- 8.2	0.0028	0.203
18	Advances in Production Engineering & Management	1854-6250	196	1.596	1.596	0.412	100	3.5	0.0003	0.254
19	Journal of Environmental Engineering	0733-9372	5360	1.396	1.536	0.25	97.66	>10.0	0.00295	0.308
20	International Journal of Design	1991-3761	523	1.163	1.938	0.067	100	6.5	0.0056	0.363
21	Journal of Computing and Information Science in Engineering	1530-9827	752	1.588	1.49	0.145	96.36	7.5	0.0072	0.257
22	Machining Science and Technology	1091-0344	842	1.339	1.658	0.061	96.97	9.4	0.0069	0.324
23	Journal of Scheduling	1094-6136	1,123	1.153	1.402	0.209	100	8.4	0.00214	0.637
24	Service Industries Journal	0264-2069	2,266	1.258	1.686	0.088	91.23	8	0.0015	0.271
25	Journal of Urban Planning and Development	0733-9488	981	1.252	1.573	0.211	100	7.1	0.00105	0.309
26	Operations Management Research	1936-9735	212	1.524	1.42	0.182	100	7.2	0.0013	0.196
27	Decision Analysis	1545-8490	352	1.063	1.344	0.375	93.75	7.3	0.0087	0.66
28	International Journal of Selection and Assessment	0965-075X	1,350	1.031	1.394	0.158	94.74	>10.0	0.00141	0.546
29	Journal of Service Theory and Practice	2055-6225	147	1.395	1.444	0.529	98.04	2.1	0.0014	0.127
30	IEEE Transactions on Semiconductor Manufacturing	0894-6507	1,274	1.336	1.199	0.057	100	>10.0	0.00135	0.301
31	Concurrent Engineering-Research and Applications	1063-293X	497	1.456	1.252	0.077	88.46	>10.0	0.0029	0.161
32	European Journal of Environmental and Civil Engineering	1964-8189	651	1.29	1.122	0.358	90.12	4.3	0.00166	0.306
33	Australian Journal of Management	0312-8962	610	1.15	1.417	0.367	96.67	9.5	0.0047	0.25
34	Journal of Forecasting	0277-6693	1,413	0.934	1.21	0.343	100	>10.0	0.00155	0.493
35	Review of Industrial Organization	0889-938X	975	0.767	0.821	0.22	100	>10.0	0.00114	0.425
36	Interfaces	0092-2102	1,541	0.579	0.97	0.152	100	>10.0	0.00123	0.424
37	Civil Engineering and Environmental Systems	1028-6608	363	0.977	0.809	0.111	100	9.8	0.0024	0.163
38	Journal for East European Management Studies	0949-6181	167	0.794	1.012	0.04	100	5.7	0.0009	0.081
39	Chinese Management Studies	1750-614X	290	0.857	0.936	0.4	97.5	4.8	0.0015	0.067
40	Systemic Practice and Action Research	1094-429X	375	0.797	0.88	0.125	96.88	8.2	0.0031	0.145
41	International Journal of Industrial Engineering-Theory Applications and Practice	1943-670X	333	0.565	0.705	0.022	97.78	7.1	0.0035	0.121
42	Manufacturing Engineering	0361-0853	333	0.565	0.705	0.022	97.78	7.1	0.0035	0.121
43	Engineering Management Journal	1042-9247	387	0.487	0.771	0.091	90.91	>10.0	0.00008	0.06
44	Journal of Advanced Mechanical Design Systems and Manufacturing	1881-3054	432	0.503	0.54	0.036	100	5.6	0.00071	0.118
45	South African Journal of Economic and Management Sciences	2222-3436	193	0.505	0.491	0.154	100	5.3	0.00021	0.074

5.3 Statistical Analysis

In this section, a statistical analysis of the journal index is conducted using SPSS 21.0, a software package for logical batched and non-batched statistical analyses. The current version (2015) is officially called IBM SPSS Statistics. In the following, a total analysis and an analysis by zone is given.

Total analysis

The immediacy index range was 1.277 and the maximum and minimum were 0.022 and 1.299, an average of 0.4027 and a standard deviation of 0.314. The articles in citable items range was 12.37, the maximum and minimum were 100 and 87.63, the average was 97.1706, and the standard deviation was 3.178. The index of cited half-life range was 7.9, and the mini-

mum and maximum were 2.1 and 10. The average eigenfactor was 0.05927, the standard deviation was 0.01, the maximum and minimum were 0.00008 and 0.05935, the mean was 0.00544 and the standard deviation was 0.01. The article influence score range was 3.631, the maximum and minimum were 3.691 and 0.06, the average was 0.6587 and the standard deviation was 0.615.

Table 5.6: Descriptive analysis of engineering management journals

	N	Range	Minimum	Maximum	Sum	Mean		Std. Deviation	Skewness	
						Statistic	Std. Error		Statistic	Std. Error
Total Cites	90	156462	94	156556	930152	10335.022	2191.202	20787.565	4.817	0.254
Impact Factor	90	7.369	0.314	7.683	264.922	2.944	0.183	1.738	0.747	0.254
5_Year Impact Factor	89	9.399	0.470	9.869	294.781	3.312	0.216	2.037	0.925	0.255
Immediacy Index	90	3.128	0.000	3.128	62.484	0.694	0.053	0.504	1.451	0.254
Articles in citable item	90	100.00	0.00	100.00	8134.66	90.385	2.421	22.969	-3.545	0.254
Cited Half life	90	10	0	10	565	6.277	0.251	2.385	0.040	0.254
Eigenfactor Score	90	0.18362	0.00011	0.18373	1.21104	0.013	0.003	0.025	4.460	0.254
Article Influence Score	90	3.233	0.033	3.266	69.858	0.776	0.060	0.570	1.736	0.254

Table5.7 shows the extreme values for the highest and lowest total cites; the top five journals were the *Journal of Hydrology*, with 46,099 citations followed by *Construction and Building Materials*, with 39,161 citations, *Management Science*, with 29,449 citations, the *International Journal of Advanced Manufacturing Technology*, with 25,357 citations, and *Building and Environment*, with 21,261 citations. The five lowest total cites were the *Journal of Service Theory and Practice* (147), the *Journal for East European Management Studies* (167), the *South African Journal of Economic and Management Sciences* (193), *Advances in Production Engineering & Management* (196) and *Operations Management Research* (212).

Table 5.7: Highest and lowest total cites

			Case Number	Journal Title	Value
Total Cites	Highest	1	16	Journal of Hydrology	46099
		2	19	Construction and Building Materials	39161
		3	5	Management Science	29449
		4	32	International Journal of Advanced Manufacturing Technology	25357
		5	6	Building and Environment	21261
	Lowest	1	71	Journal of Service Theory and Practice	147
		2	80	Journal for East European Management Studies	167
		3	90	South African Journal of Economic and Management Sciences	193
		4	61	Advances in Production Engineering & Management	196
		5	69	Operations Management Research	212

Table 5.8 shows the highest and lowest impact factors. The top five journals were *Corporate Social Responsibility and Environmental Management*, with an impact factor of 4.918 followed by the *Journal of Operations Management*, with an impact factor of 4.899, *Building and Environment*, with an impact factor of 4.539, the *International Journal of Production Economics*, with an impact factor of 4.407, the *International Journal of Project Management*, with an impact factor of 4.328. The lowest five impact factors were for the *Engineering Management Journal*(0.487), *Journal of Advanced Mechanical Design Systems and Manufacturing* (0.503), *South African Journal of Economic and Management Sciences*(0.505), *Manufacturing Engineering* (0.565), and the *International Journal of Industrial Engineering-Theory Applications and Practice* (0.565).

Table 5.8: Highest and lowest impact factors

			Case Number	Journal Title	Value
Impact Factor	Highest	1	3	Corporate Social Responsibility and Environmental Management	4.918
		2	1	Journal of Operations Management	4.899
		3	6	Building and Environment	4.539
		4	8	International Journal of Production Economics	4.407
		5	10	International Journal of Project Management	4.328
	Lowest	1	88	Engineering Management Journal	0.487
		2	89	Journal of Advanced Mechanical Design Systems and Manufacturing	0.503
		3	90	South African Journal of Economic and Management Sciences	0.505
		4	87	Manufacturing Engineering	0.565

Table 5.9 shows the highest and lowest five-year impact factors. The top five journals were the *Journal of Operations Management*, with a five-year impact factor of 7.485, *Supply Chain Management-An International Journal*, with a five-year impact factor of 7.038, *Corporate Social Responsibility and Environmental Management*, with a factor of 5.856, the *Omega-International Journal of Management Science*, with 5.525, and *Organization Science*, with 5.431. The journals with the lowest five-year impact factors were the *Journal of Economic and Management Sciences* (0.491), the *Journal of Advanced Mechanical Design Systems and Manufacturing* (0.54), the *Manufacturing Engineering* (0.705), the *International Journal of Industrial Engineering-Theory Applications and Practice* (0.705), and *Engineering Management Journal* (0.771).

Table 5.10 shows the highest and lowest immediacy indexes. The top five journals were the *Journal of Intelligent Manufacturing*, with an immediacy

Table 5.9: Highest and lowest five-year impact factors

			Case Number	Journal Title	Value
Five-Year Impact Factor	Highest	1	1	Journal of Operations Management	7.485
		2	2	Supply Chain Management-An International Journal	7.038
		3	3	Corporate Social Responsibility and Environmental Management	5.856
		4	4	Omega-International Journal of Management Science	5.525
		5	7	Organization Science	5.431
	Lowest	1	90	South African Journal of Economic and Management Sciences	0.491
		2	89	Journal of Advanced Mechanical Design Systems and Manufacturing	0.54
		3	87	Manufacturing Engineering	0.705
		4	86	International Journal of Industrial Engineering-Theory Applications and Practice	0.705
		5	88	Engineering Management Journal	0.771

index of 1.299, followed by the *Omega-International Journal of Management Science*, with an immediacy index of 1.274, the *Journal of Operations Management*, with an immediacy index of 1.118, *Robotics and Computer-Integrated Manufacturing*, with an immediacy index of 1.097, and *Building and Environment*, with an immediacy index of 1.049 times. The journals with the lowest five immediacy indexes were *Manufacturing Engineering* (0.022), *International Journal of Industrial Engineering-Theory Applications and Practice* (0.022), *Journal of Advanced Mechanical Design Systems and Manufacturing(0.036)*, *Journal for East European Management Studies(0.04)*, and *Engineering Economist(0.056).*

Table 5.10: Highest and lowest immediacy indexes

			Case Number	Journal Title	Value
Immediacy Index	Highest	1	24	Journal of Intelligent Manufacturing	1.299
		2	4	Omega-International Journal of Management Science	1.274
		3	1	Journal of Operations Management	1.118
		4	20	Robotics and Computer-Integrated Manufacturing	1.097
		5	13	Building and Environment	1.049
	Lowest	1	87	Manufacturing Engineering	0.022
		2	86	International Journal of Industrial Engineering-Theory Applications and Practice	0.022
		3	89	Journal of Advanced Mechanical Design Systems and Manufacturing	0.036
		4	80	Journal for East European Management Studies	0.04
		5	49	Engineering Economist	0.056

Table 5.11 shows highest and lowest articles in citable item. The top five journals were the *Journal of Operations Management*, *Management Sci-*

ence, *Organization Science*, *California Management Review and Robotics*, and *Computer-Integrated Manufacturing*, all of which had an articles in citable item value of 100. The journals with five lowest "articles in citable item" were *Production Planning & Control (87.63), Supply Chain Management-An International Journal (88.24), Concurrent Engineering-Research and Applications (88.46), Corporate Social Responsibility and Environmental Management (89.58)*, and the *International Journal of Logistics Management (90)*.

Table 5.11: Extreme value of articles in citable item

			Case Number	Journal Title	Value
Articles citable item	in Highest	1	1	Journal of Operations Management	100
		2	5	Management Science	100
		3	7	Organization Science	100
		4	18	California Management Review	100
		5	20	Robotics and Computer-Integrated Manufacturing	100
	Lowest	1	35	Production Planning & Control	87.63
		2	2	Supply Chain Management-An International Journal	88.24
		3	73	Concurrent Engineering-Research and Applications	88.46
		4	3	Corporate Social Responsibility and Environmental Management	89.58
		5	43	International Journal of Logistics Management	90

Table 5.12 shows highest and lowest cited half-life values. The top five journals were the *Journal of Operations Management*, *Management Science*, *Organization Science*, *Information Systems Research*, and *California Management Review*, all of which had articles in cited half-lives larger than 10. The journals with the five lowest "cited half-life" were the *Journal of Service Theory and Practice* (2.1), *Advances in Production Engineering & Management* (3.5), *Flexible Services and Manufacturing Journal* (3.9), *International Journal of Precision Engineering and Manufacturing* (4.2), *European Journal of Environmental and Civil Engineering (4.3)*.

Table 5.13 shows the highest and lowest eigenfactor scores. The top five journals were *Construction and Building Materials*, with an eigenfactor score of 0.05935, the *ournal of Hydrology*, with an eigenfactor score of 0.05549, the *Journal of Management Science*, with an eigenfactor score of 0.04258, the *International Journal of Advanced Manufacturing Technology*, with an eigenfactor score of 0.02877, and the *International Journal of Production Economics*, with an eigenfactor score of 0.0226. The journals with the five lowest eigenfactor scores were the *Engineering Management Journal* (0.00008), *Journal for East European Management Studies* (0.00009),

Table 5.12: Highest and lowest citable half-lives

			Case Number	Journal Title	Value
Cited Half-life	Highest	1	1	Journal of Operations Management	10
		2	5	Management Science	10
		3	7	Organization Science	10
		4	15	Information Systems Research	10
		5	18	California Management Review	10.0b
	Lowest	1	71	Journal of Service Theory and Practice	2.1
		2	61	Advances in Production Engineering & Management	3.5
		3	29	Flexible Services and Manufacturing Journal	3.9
		4	63	International Journal of Precision Engineering and Manufacturing	4.2
		5	78	European Journal of Environmental and Civil Engineering	4.3c

Operations Management Research (0.00013), *Journal of Service Theory and Practice* (0.00014), adn *Chinese Management Studies (0.00015).*

Table 5.13: Highest and lowest eigenfactor scores

			Case Number	Journal Title	Value
Eigenfactor Score	Highest	1	19	Construction and Building Materials	0.05935
		2	16	Journal of Hydrology	0.05549
		3	5	Management Science	0.04258
		4	32	International Journal of Advanced Manufacturing Technology	0.02877
		5	8	International Journal of Production Economics	0.0226
	Lowest	1	88	Engineering Management Journal	0.00008
		2	80	Journal for East European Management Studies	0.00009
		3	69	Operations Management Research	0.00013
		4	71	Journal of Service Theory and Practice	0.00014
		5	82	Chinese Management Studies	0.00015

Table 5.14 shows the highest and lowest article influence score. The top five journals were *Management Science*, with an article influence score of 3.691, *Organization Science*, with an article influence score of 3.121, the *Journal of Operations Management*, with a score of 2.267, *Information Systems Research*, with 2.241, and *Operations Research*, with 2.062. The journals with the lowest five article influence scores were the *Engineering Management Journal* (0.06), *Chinese Management Studies* (0.067), *South African Journal of Economic and Management Sciences* (0.074), *Journal for East European Management Studies* (0.081), and *Journal of Advanced Mechanical Design Systems and Manufacturing (0.118).*

Table 5.14: Highest and lowest article influence score

		Case Number	Journal Title	Value
Article Influence Score	Highest 1	5	Management Science	3.691
	2	7	Organization Science	3.121
	3	1	Journal of Operations Management	2.267
	4	15	Information Systems Research	2.241
	5	25	Operations Research	2.062
	Lowest 1	88	Engineering Management Journal	0.06
	2	82	Chinese Management Studies	0.067
	3	90	South African Journal of Economic and Management Sciences	0.074
	4	80	Journal for East European Management Studies	0.081
	5	89	Journal of Advanced Mechanical Design Systems and Manufacturing	0.118

Zone analysis

In this section, a descriptive analysis is given of the index differences between the journals in each zone.

Table 5.15 shows the statistical results for the 2017 total cites for the engineering management related journals in each zone. The mean total cites in Zone A was 10,351.6, with a range of 27,464, a maximum of 29,449 and a minimum of 1985. The mean total cites in Zone B was 12,668.38, a range of 44,642, a maximum of 46,099 and the minimum of 1476. The mean total cites in in Zone C was 5821.667, with a range of 38,692, a maximum of 39,161 and a minimum of 468. The mean total cites in Zone D was 1285.267, a range of 6460, and a maximum of 6607 and a minimum of 147.

Table 5.15: 2017 total cites statistical results for the engineering management journals in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	5	10351.6	10996.88919	7143	51758	29449	1985	27464	120931571.8
B	13	12668.38462	12018.35871	8339	164689	46099	1476	44623	144440946.1
C	27	5821.666667	8502.719357	3366	157185	39161	468	38693	72296236.46
D	45	1285.266667	1454.860684	763	57837	6607	147	6460	2116619.609
Total	90	4794.1	8025.858397	1592.5	431469	46099	147	45952	64414403.01

Table 5.16 shows the statistical results for the 2017 impact factors for engineering management related journals in each zone. The mean impact factor in Zone A was 4.301, with a range of 1.374, a maximum of 4.918 and a minimum of 3.544. The mean impact factor in Zone B was 3.752,

with a range of 2.238, a maximum of 4.539 and a minimum of 2.301. The mean impact factor in Zone C was 2.483, with a range of 2.21, a maximum of 3.699 and a minimum of 1.489. The mean impact factor in Zone D was 1.248, with a range of 1.513, a maximum of 2 and a minimum of 0.487.

Table 5.16: 2017 impact factor statistical results for engineering management journals in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	5	4.301	0.618	4.311	21.505	4.918	3.544	1.374	0.382
B	13	3.752	0.633	3.727	48.78	4.539	2.301	2.238	0.401
C	27	2.483	0.587	2.369	67.063	3.699	1.489	2.21	0.344
D	45	1.248	0.412	1.336	56.179	2	0.487	1.513	0.17
Total	90	2.15	1.1558	1.7975	193.527	4.918	0.487	4.431	1.336

Table 5.17 shows the statistical results for the 2017 five-year impact factor for the engineering management related journals in each zone. The mean five-year impact factor in Zone A was 6.166, with a range of 2.558, a maximum of 7.485 and a minimum of 4.927. In Zone B it was 4.864, with a range of 1.269, a maximum of 5.431 and a minimum of 4.162. In Zone C it was 3.054, with a range of 2.193, a maximum of 4.371 and a minimum of 2.178. In Zone D zone it was 1.431, with a range of 1.849, a maximum of 2.34 and a minimum of 0.491.

Table 5.17: 2017 five-year impact factor statistical results for engineering management journals in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	5	6.166	1.065	5.856	30.831	7.485	4.927	2.558	1.135
B	13	4.864	0.434	4.976	63.237	5.431	4.162	1.269	0.189
C	27	3.054	0.588	2.9	82.456	4.371	2.178	2.193	0.345
D	45	1.431	0.458	1.49	64.418	2.34	0.491	1.849	0.21
Total	90	2.677	1.578	2.259	240.942	7.485	0.491	6.994	2.491

Table 5.18 shows the statistical results for the 2017 immediacy index for engineering management related journals in each zone. The mean immediacy index in Zone A was 0.843, with a range of 0.921, a maximum of 1.274 and a minimum of 0.353; in Zone B, 0.676308, with a range of 0.844, a maximum of 1.049 and a minimum of 0.205; in Zone C, 0.462444, with a range of 1.23, a maximum of 1.299 and the minimum of 0.069; and in Zone

D, 0.23525, with a range of 0.921, a maximum of 0.943 and a minimum of 0.022.

Table 5.18: 2017 immediacy index statistical results for engineering management journals in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	5	0.843	0.362723035	0.762	4.215	1.274	0.353	0.921	0.131568
B	13	0.676307692	0.314256897	0.731	8.792	1.049	0.205	0.844	0.098757397
C	27	0.462444444	0.289625399	0.381	12.486	1.299	0.069	1.23	0.083882872
D	44	0.23525	0.189470759	0.193	10.351	0.943	0.022	0.921	0.035899169
Total	89	0.402741573	0.314581379	0.313	35.844	1.299	0.022	1.277	0.098961444

Table 5.19 shows the statistical results in 2017 for the "articles in citable item" value for the engineering management related journals in each zone. The mean for the articles in citable item in Zone A was 94.998, with a range of 11.76, a maximum of 100 and a minimum of 88.24; in Zone B it was 96.616, with a range of 7.69, a maximum of 100 and a minimum of 92.31; in Zone C it was 97.215, with a range of 12.37, with a maximum of 100 and the minimum of 87.63; and in Zone D it was 97.553, with a range of 11.54, a maximum of 100 and a minimum of 88.46.

Table 5.19: 2017 "articles in citable item" statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	5	94.998	5.696	97.17	474.99	100	88.24	11.76	32.445
B	13	96.616	2.274	96.67	1256.02	100	92.31	7.69	5.175
C	27	97.215	3.008	97.67	2624.83	100	87.63	12.37	9.048
D	44	97.553	3.153	98.28	4292.35	100	88.46	11.54	9.947
Total	89	97.17	3.178	97.78	8648.19	100	87.63	12.37	10.101

Table 5.20 shows the statistical results for the 2017 "cited half-life" for engineering management-related journals in each zone. The mean for the cited half-life in Zone A was 8.66, with a range of 3.1, a maximum of 10 and a minimum of 6.9; in Zone B, 7.707, with a range of 5.1, a maximum of 10 and a minimum of 4.9; in Zone C, 7.448, with a range of 6.1, a maximum of 10 and a minimum of 3.9; and in Zone D, 7.868, with a range of 7.9, a maximum of 10 and a minimum of 7.9.

Table 5.21 shows the statistical results for the 2017 eigenfactor score for engineering related journals in each zone. The mean eigenfactor score

Table 5.20: 2017 cited half-life statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	5	8.66	1.335	8.3	43.3	10	6.9	3.1	1.783
B	13	7.707	1.725	7.5	100.2	10	4.9	5.1	2.977
C	27	7.448	2.283	7.9	201.1	10	3.9	6.1	5.213
D	45	7.868	2.102	8.2	354.1	10	2.1	7.9	4.421
Total	90	7.763	2.066	8.15	698.7	10	2.1	7.9	4.271

in Zone A was 0.012, with a range of 0.041, a maximum of 0.042 and a minimum of 0.001; in Zone B, 0.013, with a range of 0.013, a maximum of 0.055 and a minimum of 0.0013; in Zone C, 0.007, with a range of 0.058, a maximum of 0.059 and a minimum of 0.0006; and in Zone D, 0.001, with a range of 0.006, a maximum of 0.0068 and a minimum of 0.0008.

Table 5.21: 2017 eigenfactor score statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	5	0.012	0.017	0.006	0.063	0.042	0.001	0.041	0.00029
B	13	0.013	0.015	0.008	0.177	0.055	0.0013	0.054	0.00022
C	27	0.007	0.012	0.003	0.19	0.059	0.0006	0.058	0.00014
D	45	0.001	0.001	0.0007	0.058	0.006	0.00008	0.006	0.00002
Total	90	0.005	0.01	0.002	0.489	0.059	0.00008	0.059	0.0001

Table 5.22 shows the statistical results for the 2017 article influence score in each zone. The mean article influence score in Zone A was 1.813, with a range of 3.135, a maximum of 3.691 and a minimum of 0.556; in Zone B, 1.139, with a range of 2.491, a maximum of 3.121 and a minimum of 0.63; in Zone C, 0.746, with a range of 1.755, a maximum of 2.062 and a minimum of 0.307; and in Zone D, 0.338, with a range of 1.063, a maximum of 1.123 and a minimum of 0.06.

Table 5.22: 2017 article influence score statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	5	1.813	1.223	1.494	9.065	3.691	0.556	3.135	1.496
B	13	1.139	0.723	0.913	14.817	3.121	0.63	2.491	0.523
C	27	0.746	0.447	0.578	20.163	2.062	0.307	1.755	0.2
D	45	0.338	0.2	0.308	15.244	1.123	0.06	1.063	0.04
Total	90	0.658	0.615	0.506	59.289	3.691	0.06	3.631	0.378

Fig. 5.1 shows that the range of total cites in Zone B was the highest, followed by Zone A, Zone C and Zone D. The median for citation times was the largest in Zone B followed by Zone A, Zone C and Zone D. All zones had uncommon total cite values, with Zone D having the highest.

Fig. 5.2 shows that the median impact factors in each zone were obviously different, with the median, maximum and minimum impact factors in each of the four zones decreasing. The first and second diagrams in 5.2 show that there were more journals with smaller impact factors, and the third and fourth diagrams show that there were less journals with smaller impact factors than those that were higher than the median. Zone C had two uncommon total cite values.

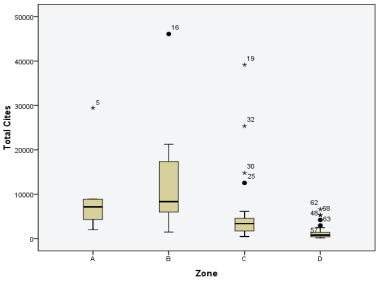

Fig. 5.1: Box diagram for total cites

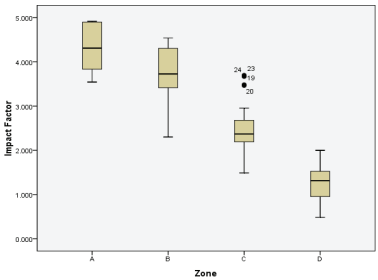

Fig. 5.2: Box diagram for impact factor

Fig. 5.3 shows that the five-year impact factor ranges in Zones A and B were greater than in Zones C and D, and the five-year impact factor median in each zone decreased gradually. In Zone C, there were more journals with larger five-year impact factors than the median and there were two uncommon values.

Fig. 5.4 shows that the immediacy index of the journals in the four zones was less than 2, there were two extreme values in Zones C and D, Zone B had the largest range, and Zone D had the largest concentration degree.

From Fig. 5.5, it can be seen that the index of articles for the journals in all zones was between 88 and 100, and there were extreme values in Zones B, C and D, with the journals in Zone B having the highest concentration

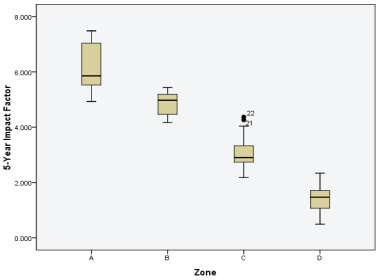

Fig. 5.3: Box diagram for the five-years impact factor

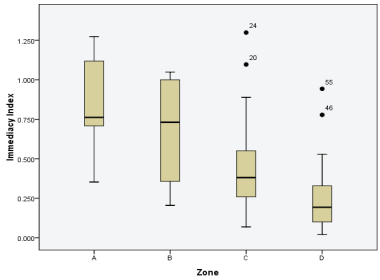

Fig. 5.4: Box diagram for immediacy index

degree in this index, the journals in Zone A having the largest range, and the journals in Zone D having the highest uncommon values.

Fig. 5.6 shows that the for the cited half-life, the journals in Zone C had the largest range, the journals in Zone D had the lowest, and the journals in Zone A had the highest concentration degree. In the second diagram in Fig. 5.6, it can be seen that more journals had a lower cited half-life index value than the median value in Zone A, but that this was the opposite for the other three zones.

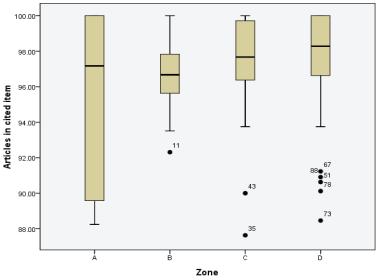

Fig. 5.5: Box diagram of articles in citable item

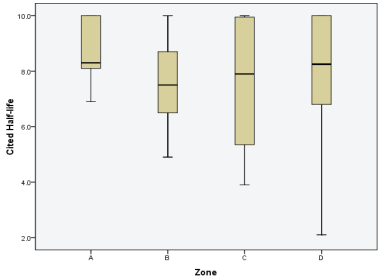

Fig. 5.6: Box diagram of cited half-life

Fig. 5.7 indicates that the eigenfactor score ranges varied from zone to zone; however, the journals in Zone B had the largest range followed by the journals in Zone A. Zone D had the highest concentration degree in this index, however, and the journals in Zone B had the lowest.

Fig. 5.8 shows that the article influence scores for the journals in all four zones were less than 4, with Zone A having the highest range, Zone B having the highest concentration, and Zones B, C, and D having extreme values.

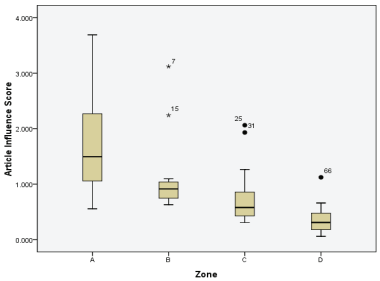

Fig. 5.7: Box diagram for the article influence score

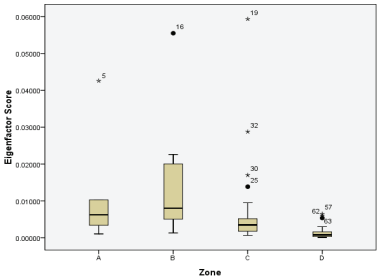

Fig. 5.8: Box diagram for the eigenfactor score

5.4 Comprehensive Discussion

Impact factor changes

Fig. 5.9 shows the impact factor changes for the journals in Zone A from 2013 to 2017. All five journals in this zone had impact factors between 2.265 and 5.207, which fluctuated in the previous five years. The *Journal of Operations Management* and *Organization Science* had obvious impact factor fluctuations between 2013 and 2017. The impact factors for the *Journal of Hydrology, Management Science and Construction* and *Building Materials* had an upward trend over the five years.

Fig. 5.10 shows the impact factors changes for the 13 journals in Zone B from 2013 to 2017, which varied from 1.29 to 4.918, but with most journals showing upward trends. The *Omega-International Journal of Managemen-*

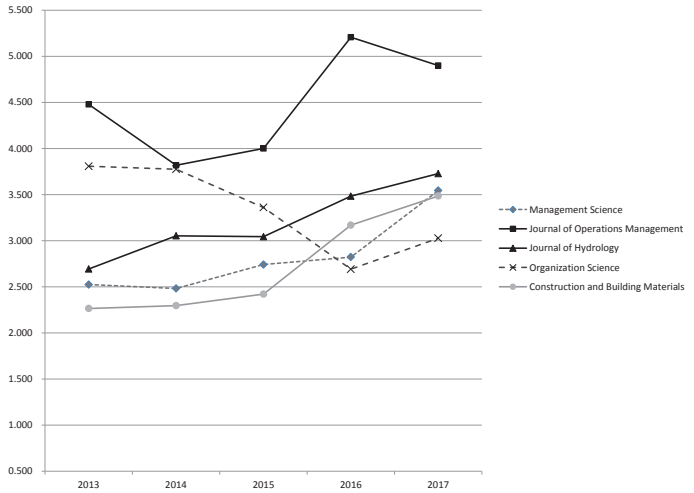

Fig. 5.9: Impact factor changes for the journals in Zone A from 2013 to 2017

t Science, *Supply Chain Management-An International Journal*, *Journal of Purchasing and Supply Management*, and *Information Systems Research* all had obvious fluctuations. The *Omega-International Journal of Management Science* had the highest impact factor of 4.376 in 2014, *Supply Chain Management-An International Journal* had the lowest impact factor at 2.731 in 2015, and *Information Systems Research* had the highest impact factor in 2015. The *Building and Environment*, *International Journal of Production Economics*, *Corporate Social Responsibility and Environmental Management*, *Building and Environment*, *Journal of Product Innovation Management*, *International Journal of Project Management*, *Automation in Construction*, *Journal of Service Management*, and *Industrial Marketing Management* all had upward impact factor trends.

Fig. 5.11 shows the impact factor changes for the 27 journals in Zone C from 2013 to 2017 which ranged from 0.481 and 3.699, and with most journals having obvious fluctuations. From the impact factor trend chart, it can be seen that the *Robotics and Computer-Integrated Manufacturing*, *California Management Review*, *Journal of Management Information Systems*, *Operations Research*, *Journal of Manufacturing Systems*, and *International*

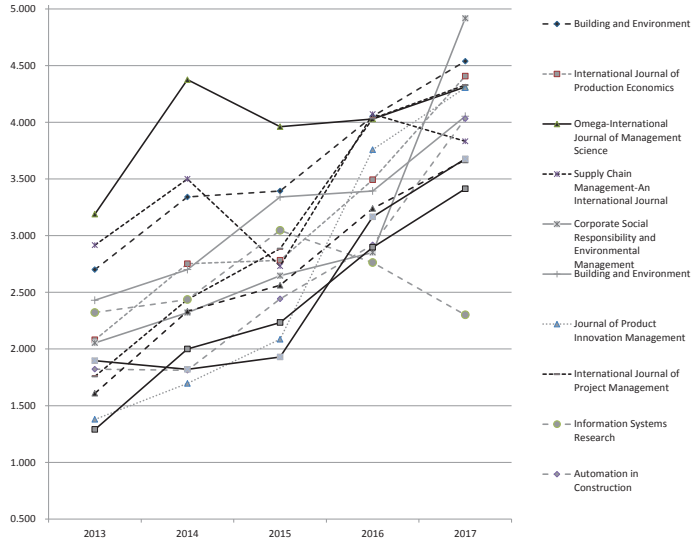

Fig. 5.10: Impact factor changes for the journals in Zone B from 2013 to 2017

Journal of Operations & Production Management had higher impact factors with obvious fluctuations. The *Journal of Manufacturing Systems* had the highest impact factor of 3.699 in 2017, and *Stochastic Environmental Research and Risk Assessment* had the highest impact factor in 2013, which then declined. The impact factor for *International Transactions in Operational Research* grew substantially from 2013 to 2017 from 0.481 to 2.4. The other journals also had obvious upward trends.

Fig. 5.12 shows impact factor changes for the Zone D journals from 2013 to 2017, which ranged from 0.041 to 3.787. The impact factors of most journals fluctuated with some fluctuating more than others. On the whole, *Ecotoxicology and Environmental Safety*, *Environmental and Experimental Botany*, *Agriculture Ecosystems & Environment*, and *Mitigation and Adaptation Strategiesfor Global Change*had recent downward trends. The impact factors for the *International Journal of Logistics-Research and Applications*, *Advances in Production Engineering & Management*, *Journal of Service Theory and Practice*, *Concurrent Engineering-Research and Application-*

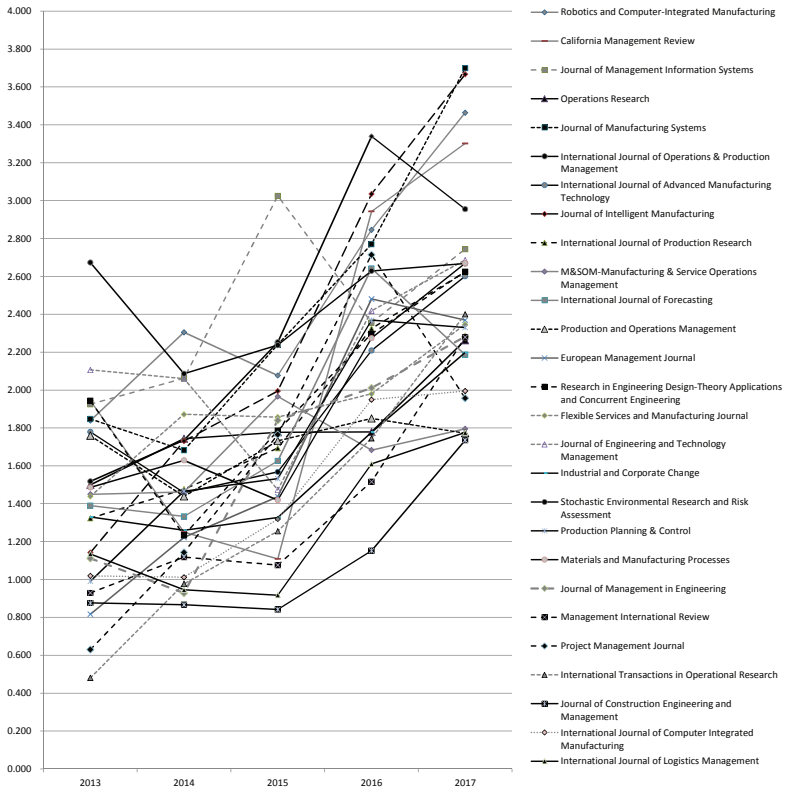

Fig. 5.11: Impact factor changes for the journals in Zone C from 2013 to 2017

s, and *European Journal of Environmental and Civil Engineering* show a recent downward trend. The impact factor of *South African Journal of Economic and Management Sciences*, *Journal of Advanced Mechanical Design Systems*, and *Manufacturing, Engineering Management Journal, Manufacturing Engineering* were less than 1 from 2013 to 2017 and had no upward trend; therefore, the papers published in these journals may no longer be published in the Science Citation Index if there no actions are taken to im-

prove the publication quality The other journals in Zone D had undulating impact factors with no apparent pattern.

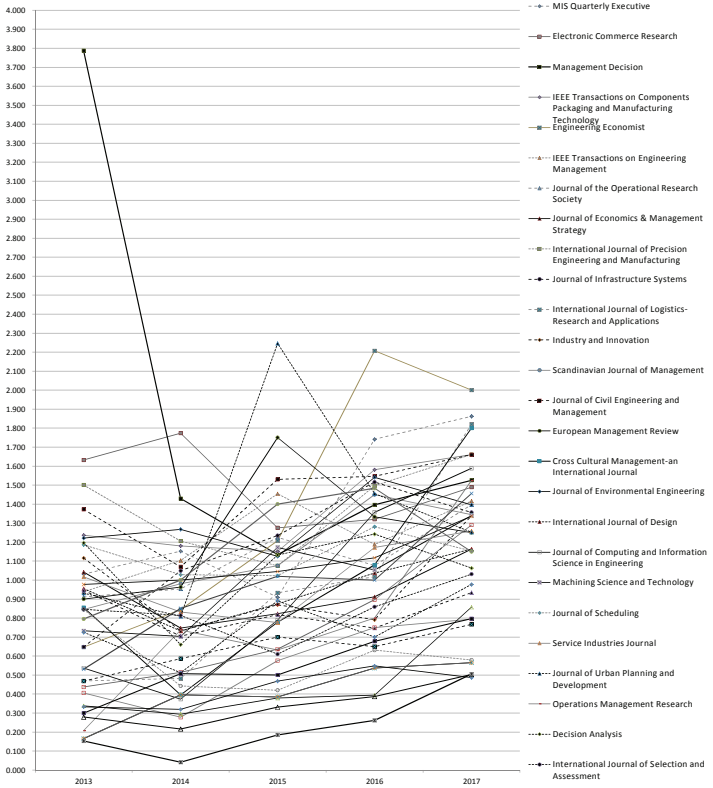

Fig. 5.12: Impact factor changes for Zone D journals from 2013 to 2017

Major countries

In this part, the statistical results for the engineering management S-CI/SSCI papers published in the major countries of the world from 2013 to 2017 are analyzed, as shown in Table 5.23 and Fig. 5.13.

Table 5.23: Engineering Management SCI papers published in major countries from 2013 to 2017

Country	2013		2014		2015		2016		2017	
	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage
ALL	3288		3438		4199		4426		4333	
USA	890	27.06%	893	25.97%	933	22.22%	1026	23.18%	1037	23.93%
CHINA	568	17.27%	546	15.88%	675	16.08%	680	15.36%	719	16.59%
UK	224	6.81%	226	6.57%	271	6.45%	315	7.12%	316	7.29%
GERMANY	196	5.96%	244	7.1%	247	5.88%	253	5.72%	234	5.4%
SPAIN	142	4.32%	194	5.64%	187	4.45%	236	5.33%	178	4.1%
ITALY	107	3.25%	152	4.42%	182	4.33%	244	5.51%	190	4.38%
AUSTRALIA	126	3.83%	137	3.98%	191	4.55%	187	4.23%	222	5.12%
CANADA	165	5.02%	160	4.65%	168	4%	181	4.09%	173	3.99%
FRANCE	145	4.4%	144	4.19%	157	3.74%	177	4%	156	3.6%
INDIA	88	2.68%	98	2.85%	157	3.74%	158	3.57%	170	3.92%

Engineering management journals published 4333 papers in 2017, led by 1,037 papers by American authors (23.93%). Chinese authors contributed 719 papers (16.59%), British authors produced 316 (7.29%) German authors 234 (5.4%), Spanish authors 178 (4.1%), Italian authors 190 (4.38%), Australian authors 222 (5.12%), Canadian authors 173 (3.99%), French authors 156 (3.6%), and Indian authors 170 (3.92%). Overall, from 2013 to 2017, American and Chinese authors published the most papers in journals of this category.

From Fig. 5.13, it can be seen that the number of engineering management papers published changed little over the five years. There was a continual increase in US contributions from 890 articles in 2013 to 893 articles in 2014, 933 articles in 2015, 1026 articles in 2016, and to 1037 articles in 2017. There was also a slight overall increase in the Chinese contributions from 568 articles in 2013, 546 articles in 2014, 675 in 2015, 680 in 2016 and 719 in 2017.

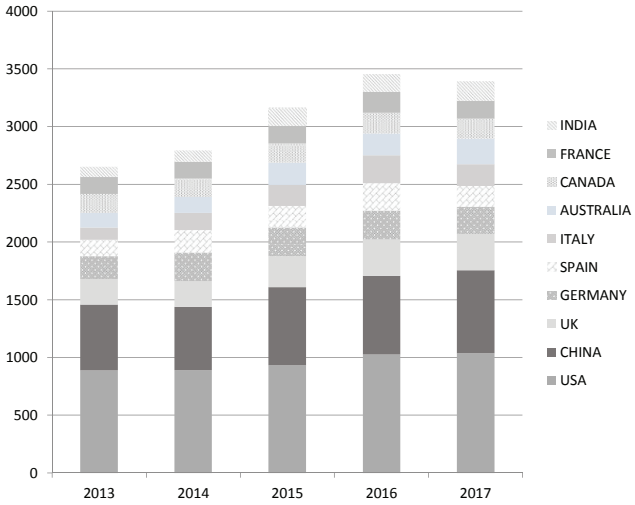

Fig. 5.13: Papers published in engineering management journals from 2013-2017

Correlation analysis

To determine the journal influence relationship between the indicators, Pearson's correlation coefficient, which is widely used in the sciences, was applied, with the bivariate correlation analyses conducted using SPSS 21.0.

From Fig. 5.14, it can be seen that the impact factor variable and the five-year impact factor had a correlation coefficient of 0.924, which meant that the two factors had an extremely strong correlation, with all data points lying on a line and increasing or decreasing together. The total cites and the eigenfactor store variables had a correlation coefficient of 0.979, which meant they also had an extremely strong correlation. The Pearson's correlation coefficient for the impact factor and total cites was 0.513, which meant they had a strong correlation, and the total cites had a correlation coefficient of 0.462 with the article influence score factor. The Pearson's correlation coefficient for the two impact factor and immediacy index variables was 0.755, and for the impact factor and eigenfactor score was 0.452. The impact factor and article influence had a relatively significant correlation with

Correlations

		Total cites	Impact factor	Five-year Impact factor	Immediacy index	Articles in citable item	Cited half-life	Eigenfactor score	Article influence score
Total cites	Pearson Correlation	1	.513**	.467**	.402**	.070	-.059	.979**	.462**
	Sig. (2-tailed)		.000	.000	.000	.515	.638	.000	.000
	N	90	90	90	89	89	66	90	90
Impact factor	Pearson Correlation	.513**	1	.924**	.755**	-.165	-.076	.452**	.488**
	Sig. (2-tailed)	.000		.000	.000	.123	.546	.000	.000
	N	90	90	90	89	89	66	90	90
Five-year impact factor	Pearson Correlation	.467**	.924**	1	.621**	-.179	.029	.406**	.644**
	Sig. (2-tailed)	.000	.000		.000	.093	.816	.000	.000
	N	90	90	90	89	89	66	90	90
Immediacy index	Pearson Correlation	.402**	.755**	.621**	1	.038	-.157	.358**	.322**
	Sig. (2-tailed)	.000	.000	.000		.723	.211	.001	.002
	N	89	89	89	89	89	65	89	89
Articles in citable item	Pearson Correlation	.070	-.165	-.179	.038	1	-.002	.084	.163
	Sig. (2-tailed)	.515	.123	.093	.723		.989	.432	.127
	N	89	89	89	89	89	65	89	89
Cited half-life	Pearson Correlation	-.059	-.076	.029	-.157	-.002	1	-.103	.206
	Sig. (2-tailed)	.638	.546	.816	.211	.989		.409	.097
	N	66	66	66	65	65	66	66	66
Eigenfactor score	Pearson Correlation	.979**	.452**	.406**	.358**	.084	-.103	1	.466**
	Sig. (2-tailed)	.000	.000	.000	.001	.432	.409		.000
	N	90	90	90	89	89	66	90	90
Article influence score	Pearson Correlation	.462**	.488**	.644**	.322**	.163	.206	.466**	1
	Sig. (2-tailed)	.000	.000	.000	.002	.127	.097	.000	
	N	90	90	90	89	89	66	90	90

**. Correlation is significant at the 0.01 level (2-tailed).

Fig. 5.14: Pearson's correlation coefficients for the JCR Data and Eigenfactor Metrics

a Pearson's correlation coefficient of 0.488. The Pearson's correlation coefficient for the five-year impact factor and the eigenfactor score was 0.406, and for the five-year impact and the article influence score was 0.644, indicating an extremely strong correlation. Finally, the eigenfactor score had a correlation coefficient of 0.466 with the article influence score.

Principal component analysis of journal evaluation indicators

Correlation studies have shown that as there are high correlation coefficients between these indicators, it is redundant to use them all because of the exclusiveness principle. However, which indicators should be adopted to evaluate a journal and what attributes do these indicators depict? To answer these questions, after the correlation analyses, a principal component analysis was conducted in IBM SPSS Statistics with the FACTOR command of the journal evaluation indicators for the 90 engineering management journals. To track more information, the impact factors, five-year impact factors,

immediacy indexes, article in citable items, cited half-lives, eigenfactor, and article influence scores were considered concurrently.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.601
Bartlett's Test of Sphericity	Approx. Chi-Square	506.809
	df	28
	Sig.	.000

Fig. 5.15: KMO and Bartlett's test

Fig. 5.15 shows the overall KMO and Bartlett's Test table for the factor output, with the KMO value being 0.601. The significance probability for the Bartlett's Test, which is used to test if samples (90 journals in this case) are from populations with equal variances, was 0.000, indicating that these indicators were suitable for the principal component analyses.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.825	47.807	47.807	3.825	47.807	47.807
2	1.441	18.008	65.815	1.441	18.008	65.815
3	1.104	13.797	79.612	1.104	13.797	79.612
4	.919	11.488	91.100			
5	.411	5.132	96.232			
6	.256	3.201	99.432			
7	.034	.423	99.855			
8	.012	.145	100.000			

Extraction Method: Principal Component Analysis.

Fig. 5.16: Total variance explained

After the principal component extraction procedure, a rotated quartimax transformation was used as this has been shown to have the best performance in making component loadings incline to 1 or 0; therefore, it can explain the factors' practical meanings. Quartimax rotation maximizes the variance of the squared factor loadings in each variable; that is, it simplifies the loading matrix rows. In other words, the quartimax minimizes the number of factors

needed to explain each variable. The explained eigenvalue and total variance are shown in Fig. 5.16.

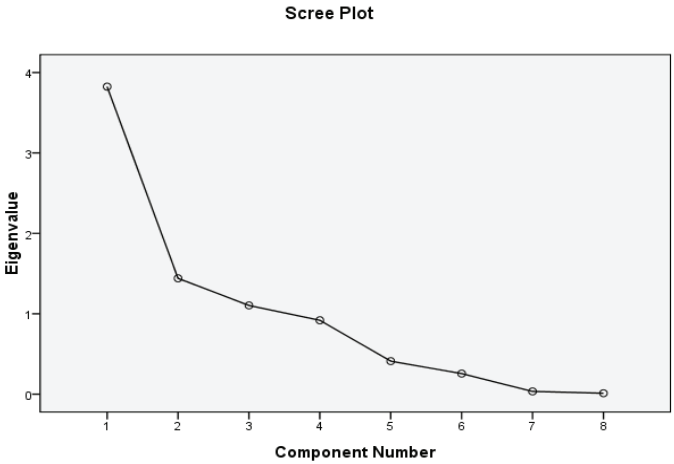

Fig. 5.17: Scree plot

Three components were extracted from all samples for the above variables. As shown in the scree plot in Fig. 5.17, the eigenvalues for all three principal components were above 1. The eigenvalue for component 1 was 3.825, which dropped sharply to 0.012 for component 8. From Fig. 5.17 we see that the three extracted components accounted for more than 79.612% of the total variance in the initial eigenvalues and the extraction sums of squared loadings, which was considered satisfactory. In this paper, three major components were chosen as the best explanations for the variability in the data for the engineering management journals, as they together explained 79.612% of the total variance.

As can be seen in Fig. 5.18, a threshold level of 0.73 led to a clear interpretation. Total cites, impact factors, five-year impact factors, immediacy indexes, and article influence scores were included in the first component; total cites, articles in citable items, and eigenfactor scores were included in the second component; and the indicator “cited half-life” was included in the third component. These are explained in more detail in the following.

Component Matrix[a]

	Component		
	1	2	3
Total cites	.731	.604	.156
Impact factor	.920	-.225	-.155
Five-year impact factor	.888	-.355	-.042
Immediacy index	.749	-.055	-.237
Articles in citable item	-.253	.547	.247
Cited half-life	-.035	-.330	.901
Eigenfactor score	.700	.642	.146
Article influence score	.733	-.275	.320

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

Fig. 5.18: Quartimax rotated loading matrix for the "information engineering" category journal indicators

- The first component was related to a journal's most recent year influence because the impact factor and the five-year impact factor, which are an important part of the first component are highly related to the most recent two or five-year article influence.
- The second component is related to a journal's long-term influence, as total cites are closely related to total paper quality, paper quantity and the year it was published.
- The third component is related to how fast a journal ages. Research journals have a relatively long cited half-life, and time-dependent journals have a relatively short cited half-life.

5.5 Total Summary

There were 90 journals focused on MSE management, with 5, 13, 27, and 45 respectively distributed in Zones A, B, C, and D. Based on the journal ranking results in 5.2, the most important journals in this category were *Management Science*, *Journal of Operations Management*, *Journal of Hydrology*, *Organization Science*, and *Construction and Building Materials*, which had the highest comprehensive scores and were therefore allocated to

Zone A. The statistical analyses in 5.3 found that *Building and Environment*, *Corporate Social Responsibility and Environmental Management*, *Omega-International Journal of Management Science*, and *International Journal of Production Economics* had high eigenfactor scores, immediacy indexes and five-year impact factors, indicating their high influence in this category.

The comprehensive discussion in section 5.4 showed that the impact factors for most journals in this category had an upward trend, indicating that engineering management has been becoming a research hotspot as there are obvious increases in average paper quality and journal influence. The major country analysis found that the USA, China, UK, Germany, and Spain were the most productive countries from 2013 to 2017 and that there were increasing contributions from China, UK, Australia, and India from 2013 to 2017.

Journal developing trends

To extract the development trends for the journals in this category, Table 5.24 shows the differences in the impact factors, five-year impact factors, immediacy indexes, eigenfactor scores, and article influence scores. To resolve the different dimensional problems associated with these indicators, the data was standardized.

Most engineering management related journals showed an upward trend. The differences between the standardized impact factor and the standardized five-year impact factor showed the journal article citation frequency variations. In Table 4.23, most of the Z-IFminusZ-IF5 values were negative for the journals in Zones A-C, indicating that the impact factors for these journals were higher than their five-year impact factors, reflecting the fact that the cited frequency in the most recent two years was higher than that in the first three years. Journals with positive citation development were *Corporate Social Responsibility and Environmental Management*, *Omega-International Journal of Management Science*, and *Building and Environment*. Overall, therefore, most engineering-management related journals had an upward trend.

Most engineering management-related journals had a satisfactory article quality and journal influence. The difference between the standardized impact factor and the standardized immediacy index showed the development distance between the past two years and the current year. In this category, the

impact factors for most of the journals were larger than their immediacy indexes, reflecting the time it takes for journals to consolidate their influence. This feature was particularly prominent in the *Journal of Operations Management*, *Corporate Social Responsibility and Environmental Management* and *International Journal of Production Economics*, as the articles in these journals need a longer time to extend their impact than *Management Science* and *Organization Science*. Generally, journals with higher impact factors and better article quality have relatively higher Z-IFminusZ-II scores. Therefore, most engineering management related journals were found to have a satisfactory article quality and journal influence.

Most related journals in this category had a relatively high self-citation degree. The differences between the standardized five-year impact factors and the standardized eigenfactor scores revealed the self-citation situations; that is, when the difference is larger, the higher the degree of self-citation. In the engineering management category, *Management Science, International Journal of Production Economics* and *Journal of Hydrology* had negative values, indicating that the articles in these journals had extensive references to other journals. However, most related journals in this category had a relatively high self-citation degree.

Table 5.24: Journals in “engineering management” category

Full Journal Title	ISSN	JCR Data				Standardized JCR data				Z-IF	Z-IF	Z-IF5
		Impact Factor	Five-Year Impact Factor	Immediacy Index	Eigenfactor Score	Z-IF	Z-IF5	Z-II	Z-E	minusZ-IF5	minusZ-II	minusZ-E
Journal of Operations Management	0272-6963	4.899	7.485	1.118	0.00624	2.37805	3.04574	-0.00168	0.07662	-0.66769	2.37973	2.96912
Supply Chain Management-An International Journal	1359-8546	3.833	7.038	0.353	0.0034	1.4558	2.76257	-0.38696	-0.19537	-1.30677	1.84276	2.95794
Corporate Social Responsibility and Environmental Management	1535-3958	4.918	5.856	0.708	0.00106	2.39449	2.01378	-0.20817	-0.41947	0.38071	2.60266	2.43325
Omega-International Journal of Management Science	0305-0483	4.311	5.525	1.274	0.01027	1.86934	1.8041	0.07689	0.46256	0.06524	1.79245	1.34154
Management Science	0025-1909	3.544	4.927	0.762	0.04258	1.20577	1.42527	-0.18097	3.55686	-0.2195	1.38674	-2.13159
Building and Environment	0360-1323	4.539	5.221	1	0.02166	2.0666	1.61151	-0.0611	1.55337	0.45509	2.1277	0.05814
Organization Science	1047-7039	3.027	5.431	0.328	0.02004	0.75848	1.74455	-0.39955	1.39823	-0.98607	1.15803	0.34632
International Journal of Production Economics	0925-5273	4.407	4.976	0.865	0.0226	1.9524	1.45631	-0.1291	1.6434	0.49609	2.0815	-0.18709
Journal of Product Innovation Management	0737-6782	4.305	4.926	0.571	0.00562	1.86415	1.42464	-0.27716	0.01724	0.43951	2.14131	1.4074
International Journal of Project Management	0263-7863	4.328	5.07	1.017	0.00506	1.88405	1.51586	-0.05254	-0.03639	0.36819	1.93659	1.55225
Journal of Service Management	1757-5818	3.414	5.407	0.205	0.00203	1.0933	1.72934	-0.4615	-0.32657	-0.63604	1.5548	2.05591
Journal of Purchasing and Supply Management	1478-4092	3.667	5.188	0.696	0.00131	1.31218	1.59061	-0.21421	-0.39553	-0.27843	1.52639	1.98614
Building and Environment	0360-1323	4.053	4.464	1.049	0.01942	1.64613	1.13196	-0.03643	1.33885	0.51417	1.68256	-0.20689
Automation in Construction	0926-5805	4.032	4.437	0.741	0.00802	1.62796	1.11486	-0.19155	0.24708	0.5131	1.81951	0.86778
Information Systems Research	1047-7047	2.301	5.153	0.217	0.00846	0.13038	1.56844	-0.45545	0.28922	-1.43806	0.58583	1.27922
Journal of Hydrology	0022-1694	3.727	4.314	0.731	0.05549	1.36409	1.03694	-0.19658	4.79324	0.32715	1.56067	-3.7563
Industrial Marketing Management	0019-8501	3.678	4.488	1.015	0.00561	1.3217	1.14717	-0.05355	0.01628	0.17453	1.37525	1.13089
California Management Review	0008-1256	3.302	4.162	0.357	0.00188	0.9964	0.94065	-0.38494	-0.34094	0.05575	1.38134	1.28159
Construction and Building Materials	0950-0618	3.485	4.039	0.6	0.05935	1.15472	0.86273	-0.26256	5.16291	0.29199	1.41728	-4.30018
Robotics and Computer-Integrated Manufacturing	0736-5845	3.464	4.031	1.097	0.0042	1.13655	0.85766	-0.01225	-0.11875	0.27889	1.1488	0.97641
International Journal of Operations & Production Management	0144-3577	2.955	4.371	0.671	0.00292	0.69619	1.07305	-0.2268	-0.24134	-0.37686	0.92299	1.31439
Journal of Management Information Systems	0742-1222	2.744	4.262	0.256	0.00366	0.51364	1.004	-0.43581	-0.17047	-0.49036	0.94945	1.17447
Journal of Manufacturing Systems	0278-6125	3.699	3.621	0.486	0.0037	1.33987	0.59793	-0.31997	-0.16664	0.74194	1.65984	0.76457
Journal of Intelligent Manufacturing	0956-5515	3.383	3.983	1.299	0.00464	1.31218	0.44716	0.08948	-0.07662	0.86502	1.2227	0.52378
Operations Research	0030-364X	2.263	3.047	0.297	0.01386	0.0975	0.23431	-0.41516	0.80638	-0.13681	0.51266	-0.57207
Research in Engineering Design-Theory Applications and Concurrent Engineering	0934-9839	2.625	3.275	0.5	0.00081	0.41069	0.37874	-0.31292	-0.44341	0.03195	0.72361	0.82215
Journal of Engineering and Technology Management	0923-4748	2.686	3.213	0.263	0.00098	0.46346	0.33947	-0.43228	-0.42713	0.12399	0.89574	0.7666
European Management Journal	0263-2373	2.369	3.412	0.293	0.00243	0.18921	0.46553	-0.41718	-0.28826	-0.27632	0.60639	0.75379
Flexible Services and Manufacturing Journal	1936-6582	2.346	3.129	0.333	0.00157	0.16931	0.28625	-0.39703	-0.37063	-0.11694	0.56634	0.65688
International Journal of Production Research	0020-7543	2.623	2.78	0.69	0.01699	0.40896	0.06517	-0.21723	1.10613	0.34379	0.62619	-1.04096
M&SOM-Manufacturing & Service Operations Management	1523-4614	1.795	2.867	0.381	0.00561	-0.30739	0.12028	-0.37286	0.01628	-0.42767	0.06547	0.104
International Journal of Advanced Manufacturing Technology	0268-3768	2.601	2.748	0.402	0.02877	0.38993	0.04489	-0.36228	2.23429	0.34504	0.75221	-2.1894
Stochastic Environmental Research and Risk Assessment	1436-3240	2.668	2.645	0.831	0.00202	0.44789	-0.02036	-0.14622	-0.32753	0.46825	0.59411	0.30717
International Journal of Forecasting	0169-2070	2.186	2.724	0.419	0.0064	0.03089	0.02969	-0.35372	0.09194	0.0012	0.38461	-0.06225
Production Planning & Control	0953-7287	2.33	2.933	0.247	0.00226	0.15547	0.16209	-0.44034	-0.30455	-0.00662	0.59581	0.46664
Industrial and Corporate Change	0960-6491	2.198	2.763	0.308	0.00349	0.04127	0.0544	-0.40962	-0.18675	-0.01313	0.45089	0.24115
Journal of Management in Engineering	0742-597X	2.282	2.864	0.43	0.00216	0.11394	0.11838	-0.34818	-0.31412	-0.00444	0.46212	0.4325
Production and Operations Management	1059-1478	1.772	2.921	0.379	0.0095	-0.32729	0.15449	-0.37386	0.38882	-0.48178	0.04657	-0.23433
Management International Review	0938-8249	2.279	2.752	0.25	0.00127	0.11135	0.04743	-0.43883	-0.39936	0.06392	0.55018	0.44679
Project Management Journal	8756-9728	1.957	2.9	0.256	0.00157	-0.16723	0.14118	-0.43581	-0.37063	-0.30841	0.26858	0.51181
Materials and Manufacturing Processes	1042-6914	2.669	2.359	0.473	0.00472	0.44876	-0.20153	-0.32652	-0.06895	0.65029	0.77528	-0.13258
International Transactions in Operational Research	0969-6016	2.4	2.178	0.889	0.00218	0.21603	-0.3162	-0.11701	-0.31221	0.53223	0.33304	-0.00399
International Journal of Logistics Management	0957-4093	1.776	2.437	0.167	0.00063	-0.32383	-0.15212	-0.48063	-0.46065	-0.17171	0.1568	0.30853
Journal of Construction Engineering and Management	0733-9364	1.735	2.35	0.2	0.0043	-0.3593	-0.20724	-0.46401	-0.10918	-0.15206	0.10471	-0.09806
Electronic Commerce Research	1389-5753	1.489	2.452	0.069	0.00067	-0.57213	-0.14262	2.91035	-0.45682	-0.42951	-0.48248	0.3142
International Journal of Computer Integrated Manufacturing	0951-192X	1.995	2.016	0.778	0.00217	-0.13436	-0.41882	-0.17291	-0.31316	0.28446	0.03855	-0.10566
MIS Quarterly Executive	1540-1960	1.862	1.987	0.375	0.00055	-0.24942	-0.43719	-0.37588	-0.46831	0.18777	0.12646	0.03112
Management Decision	0025-1747	1.525	2.34	0.192	0.00235	-0.54098	-0.21357	-0.46804	-0.29593	-0.32741	0.00294	0.08236
Engineering Economist	0013-791X	2	1.705	0.056	0.00038	-0.13003	-0.61584	2.25562	-0.48459	0.48581	-2.38565	-0.13125
IEEE Transactions on Engineering Management	0018-9391	1.416	2.087	0.196	0.00173	-0.63528	-0.37384	-0.46603	-0.3553	-0.26144	-0.16925	-0.01854
International Journal of Logistics-Research and Applications	1367-5567	1.82	1.717	0.313	0.00059	-0.28576	-0.60824	-0.4071	-0.46448	0.32248	0.12134	-0.14376
Scandinavian Journal of Management	0956-5221	1.344	2.026	0.182	0.00098	-0.69757	-0.41249	-0.47308	-0.42713	-0.28508	-0.22449	0.01464
European Management Review	1740-4754	1.25	2.095	0.2	0.00048	-0.7789	-0.36878	-0.46401	-0.47501	-0.41012	-0.31489	0.10623
Journal of Infrastructure Systems	1076-0342	1.356	1.996	0.239	0.00155	-0.68719	-0.43149	-0.44437	-0.37254	-0.2557	-0.24282	-0.05895
Industry and Innovation	1366-2716	1.358	1.95	0.043	0.00124	-0.70277	-0.4543	-0.08981	-0.40223	-0.24847	0.612896	-0.05207
Journal of Civil Engineering and Management	1392-3730	1.66	1.749	0.486	0.00184	-0.42419	-0.58796	-0.31997	-0.34477	0.16377	-0.10422	-0.24319
IEEE Transactions on Components Packaging and Manufacturing Technology	2156-3950	1.66	1.662	0.304	0.00649	-0.42419	-0.64308	-0.41164	0.10056	0.21889	-0.01255	-0.74364
Engineering Construction and Architectural Management	0969-9988	1.613	1.613	0.194	0.00057	-0.46485	-0.67412	-0.46704	-0.4664	0.20927	0.00219	-0.20772
Cross Cultural Management-an International Journal	1352-7606	1.8	1.583	Not Available	0.00028	-0.30306	-0.69312		-0.49417	0.39006	-0.30306	-0.19895
International Journal of Design	1991-3761	1.163	1.938	0.067	0.00056	-0.85417	-0.46823	2.80963	-0.46735	-0.38594	-3.6638	-0.00088
Advances in Production Engineering & Management	1854-6250	1.596	1.596	0.412	0.0003	-0.47956	-0.68489	-0.35724	-0.49225	0.20533	-0.12232	-0.19264
Journal of the Operational Research Society	0160-5682	1.396	1.634	0.315	0.00537	-0.65259	-0.66081	-0.4061	-0.0067	0.00822	-0.24649	-0.65411
International Journal of Precision Engineering and Manufacturing	2234-7593	1.661	1.491	0.141	0.00597	-0.42332	-0.7514	-0.49373	0.05076	0.32808	0.07041	-0.80216
Journal of Computing and Information Science in Engineering	1530-9827	1.588	1.49	0.145	0.00072	-0.48648	-0.75204	-0.49171	-0.45203	0.26556	0.00523	-0.30001
Machining Science and Technology	1091-0344	1.339	1.658	0.061	0.00069	-0.7019	-0.64561	2.50744	-0.4549	-0.05629	-3.20934	-0.19071
Journal of Economics & Management Strategy	1058-6407	1.163	1.436	0.175	0.00301	-0.85417	-0.78625	-0.4766	-0.23272	-0.06792	-0.37757	-0.55353
Service Industries Journal	0264-2069	1.258	1.686	0.088	0.0015	-0.77198	-0.62787	3.86726	-0.37733	-0.14411	-4.63924	-0.25054
Journal of Environmental Engineering	0733-9372	1.396	1.536	0.25	0.00295	-0.65259	-0.7229	-0.43883	-0.23846	0.07031	-0.21376	-0.48444
Operations Management Research	1936-9735	1.524	1.42	0.182	0.00013	-0.54185	-0.79638	-0.47308	-0.50853	0.25453	-0.06877	-0.28785
Journal of Urban Planning and Development	0733-9488	1.252	1.573	0.211	0.00105	-0.77717	-0.69946	-0.45847	-0.42043	-0.07771	-0.3187	-0.27903
Journal of Service Theory and Practice	2055-6225	1.395	1.444	0.529	0.00014	-0.65345	-0.78118	-0.29832	-0.50758	0.12773	-0.35513	-0.2736
Journal of Scheduling	1094-6136	1.153	1.402	0.209	0.00214	-0.86282	-0.80778	-0.45948	-0.31604	-0.05504	-0.40334	-0.49174
Concurrent Engineering-Research and Applications	1063-293X	1.456	1.252	0.077	0.00029	-0.60068	-0.90281	3.31326	-0.49321	0.30213	-3.91394	-0.4096
Decision Analysis	1545-8490	1.063	1.344	0.375	0.00087	-0.94068	-0.84453	-0.37588	-0.43766	-0.09615	-0.5648	-0.40687
International Journal of Selection and Assessment	0965-075X	1.031	1.394	0.158	0.00141	-0.96837	-0.81285	-0.48517	-0.38595	-0.15552	-0.4832	-0.4269
Australian Journal of Management	0312-8962	2.15	1.417	0.367	0.00047	-0.86541	-0.79828	0.37991	-0.47597	-0.06713	-0.4855	-0.32231
IEEE Transactions on Semiconductor Manufacturing	0894-6507	1.336	1.199	0.057	0.00135	-0.7045	-0.93638	2.30599	-0.3917	0.23188	-3.01049	-0.54468
European Journal of Environmental and Civil Engineering	1964-8189	1.29	1.122	0.358	0.00166	-0.74429	-0.98516	-0.38444	-0.36201	0.24087	-0.35985	-0.62315
Journal of Forecasting	0277-6693	0.934	1.21	0.343	0.00155	-1.05229	-0.92941	-0.39199	-0.37254	-0.12288	-0.6603	-0.55687
Journal for East European Management Studies	0949-6181	0.794	1.012	0.04	0.00009	-1.17341	-1.05485	-0.5446	-0.51236	-0.11856	-0.62881	-0.54249
Civil Engineering and Environmental Systems	1028-6608	0.977	0.809	0.111	0.00024	-1.01509	-1.18344	-0.50884	-0.498	0.16835	-0.50625	-0.68544
Chinese Management Studies	1750-614X	0.857	0.936	0.4	0.00015	-1.11891	-1.10299	-0.36329	-0.50662	-0.01592	-0.75562	-0.59637
Review of Industrial Organization	0889-938X	0.767	0.821	0.22	0.00114	-1.19677	-1.17584	-0.45394	-0.41181	-0.02093	-0.74283	-0.76403
Interfaces	0092-2102	0.579	0.97	0.152	0.00123	-1.35942	-1.08145	-0.48819	-0.40319	-0.27797	-0.87123	-0.67826
Systemic Practice and Action Research	1094-429X	0.797	0.88	0.125	0.00031	-1.17081	-1.13847	-0.50179	-0.49129	-0.03234	-0.66902	-0.64718
International Journal of Industrial Engineering-Theory Applications and Practice	1943-670X	0.565	0.705	0.022	0.00035	-1.37153	-1.24933	0.54326	-0.48746	-0.1222	-1.91479	-0.76187
Manufacturing Engineering	0361-0853	0.565	0.705	0.022	0.00035	-1.37153	-1.24933	0.54326	-0.48746	-0.1222	-1.91479	-0.76187
Engineering Management Journal	1042-9247	0.487	0.771	0.091	0.00008	-1.43901	-1.20752	4.01835	-0.51332	-0.23149	-5.45736	-0.6942
Journal of Advanced Mechanical Design Systems and Manufacturing	1881-3054	0.503	0.54	0.036	0.00071	-1.42517	-1.35385	1.24835	-0.45299	-0.07132	-2.67352	-0.90086
South African Journal of Economic and Management Sciences	2222-3436	0.505	0.491	0.154	0.00021	-1.42344	-1.38489	-0.48718	-0.50087	-0.03855	-0.93626	-0.88402

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Chapter 6
Industrial Engineering

Industrial engineering involves an integrated system composed of people, materials, equipment, energy, and information that is improved and implemented through knowledge advancement. The achievements in this system have been confirmed, predicted and evaluated [17, 4, 5]. This chapter examines 64 industrial engineering journals to track the academic development in this discipline; and the industrial engineering discipline under the MSE framework is also introduced.

6.1 Category Description

Industrial engineering is the implementation of integrated systems that involve people, materials and equipment, harness techniques associated with mathematics, the natural and social sciences, and the principles and methods of engineering analysis and design [9, 16]. The aim of traditional industrial engineering is to improve labor productivity through research into time and action, plant layouts, materials handling, and production planning and scheduling, and so forth. Modern industrial engineering has operations research and systems engineering as its theoretical basis, and employs computing for advanced development. Industrial engineering can be combined with operations research, systems engineering, manufacturing engineering, production engineering, management science, management engineering, er-

gonomics, and human factors engineering, safety engineering, and others, depending on the purpose [3, 2, 15].

Industrial engineering developments can be divided into four stages. The first stage was the embryonic and foundational period from the late 19th century to the early 1930s. The first industrial engineering major was opened in 1908 at Pennsylvania State University, and the first industrial engineering organization, the Society of Industrial Engineering, was established in 1917 in the United States. The Principles of Scientific Management, published by F.W. Taylor, an American engineer, was the masterpiece in this era and has become a classic industrial engineering work [14]. The second stage was the growth period in industrial engineering from the early 1930s to the mid-1940s, at which time greater reliance was being placed on mathematical and statistical knowledge and many industrial engineering principles and methods were being developed; for example, Fish pioneered the "engineering economy" to solve economic problems related to equipment [12]. The third stage was the maturing of industrial engineering from the mid-1940s to the late 1970s, at which time operations research became the theoretical basis for industrial engineering, and computers were providing effective technical assistance for industrial engineers. In 1948, the American Institute of Industrial Engineering (AIIE) was established. The fourth stage from the end of the 1970s to the present was the expansion and innovation period. With the development of computer technology and computerized systems, industrial engineering is now applied in a wide variety of disciplines such as systems engineering, safety engineering, science, machine learning, data analysis and data mining, cost engineering, value engineering, quality engineering, project management, management engineering, supply chain management, human engineering, operations management, job design, financial engineering, industrial plant configuration, facilities management, engineering design processes, logistics, accounting, capital projects, and others [8, 7, 10, 1, 13].

The conceptual technology for industrial engineering and operation management is being applied to project activity configuration execution and has become known as project production management [4, 6]. Traditionally, industrial engineering was used for plant layouts, designing assembly lines and other manufacturing paradigms [11]; however, because of the rise of lean manufacturing systems, industrial engineers seek to eliminate waste of time, money, materials, energy and other resources.

6.2 Ranking Report

Based on the characteristics of four indicators: impact factor, five-year impact factor, eigenfactor score, and article influence score; a new evaluation model was constructed, and the weights for each indicator scored by experts. The index weights were: impact factor (0.3); five-year impact factor (0.3); characteristic factor score (0.24); and article impact score (0.16). To resolve the different dimension problems in the four indicators, the data were standardized, as shown in 6.1 to calculate the comprehensive scores for all journals.

In this section, the 64 industrial engineering journals were divided into four zones based on the comprehensive scores. As an important JCR improvement, the index solves the criticisms of short-term citation windows when evaluating the mid-term performances of recent academic and professional journals. The five year impact factor is the average times that journal articles published in the past five-years have been cited in JCR as it measures the impact of journal articles over a long period of time and better reflects the peak citations of most journals. The first 5% of journals were placed in Zone A, the next 6%-20% were allocated to Zone B, 21%-50% to Zone C, and the remaining journals to Zone D.

As shown in Table 6.2, there were three journals with high comprehensive scores allocated to Zone A; *IEEE Industrial Informatics* had the highest comprehensive score (2.7841344) and the *Journal of Supply Chain Management* had the highest impact factor (6.105); however, it scored poorly on the eigenfactor score and article impact score, so was ranked second. IEEE also had a high eigenfactor score of 0.02301 and article influence score of 1.801. An article influence score greater than 1 indicates that *IEEE Transactions on Industrial Informatics* is not only influential in industrial engineering but also influences other highly ranked journals. Compared with *IEEE Transactions and the Journal of Supply Chain Management* the indicators for the *International Journal of Production Economics* were slightly weaker, but had a better impact for technological innovation, social innovation and the conceptualization of new products or processes for commercial use as its quoted half-life (6.5) indicated that its articles had a better long-term influence potential.

Table 6.3 shows the nine industrial engineering journals in Zone B, of which the *International Journal of Machine Tools & Manufacture* had an

Table 6.1: Comprehensive scores of “industrial engineering” journals

Rank	Full Journal Title	ISSN	JCR Data		Eigenfactor Metrics		Standardization				Comprehensive score
			Impact Factor	five-Year Impact Factor	Eige-nfactor Score	Article Influence Score	Z-Impact Factor	Z-five-Year Impact Factor	Z-Eigenf-actor Score	Z-Article Influence Score	
1	IEEE Transactions on Industrial Informatics	1551-3203	5.43	7.227	0.02301	1.801	2.32785	2.89163	2.81491	3.39195	2.78
2	Journal of Supply Chain Management	1523-2409	6.105	8.026	0.00259	1.648	2.82306	3.38632	-0.31057	2.97281	2.26
3	International Journal of Production Economics	0925-5273	4.407	4.976	0.0226	0.971	1.57733	1.49798	2.75216	1.11821	1.76
4	International Journal of Machine Tools & Manufacture	0890-6955	5.106	5.905	0.0081	1.162	2.09015	2.07315	0.53279	1.64144	1.64
5	Composites Part A-Applied Science and Manufacturing	1359-835X	4.514	4.483	0.018	0.895	1.65583	1.19275	2.04808	0.91001	1.49
6	Technovation	0166-4972	4.802	5.407	0.00322	0.942	1.86712	1.76482	-0.21414	1.03876	1.2
7	IEEE-Asme Transactions on Mechatronics	1083-4435	3.936	4.306	0.0111	1.163	1.23179	1.08316	0.99197	1.64418	1.2
8	Journal of Materials Processing Technology	0924-0136	3.647	3.817	0.01891	0.804	1.01976	0.78041	2.18737	0.66072	1.17
9	Journal of Product Innovation Management	0737-6782	4.305	4.926	0.00562	1.039	1.5025	1.46702	0.1532	1.30449	1.14
10	Computers & Operations Research	0305-0548	2.962	3.174	0.01751	1.015	0.51722	0.38231	1.97308	1.23874	0.94
11	International Journal of Advanced Manufacturing Technology	0268-3768	2.601	2.748	0.02877	0.397	0.25237	0.11856	3.69654	-0.45423	0.93
12	Computers & Industrial Engineering	0360-8352	3.195	3.442	0.01514	0.77	0.68816	0.54824	1.61033	0.56758	0.85
13	Cirp Annals-Manufacturing Technology	0007-8506	3.333	4.074	0.00745	0.711	0.7894	0.93953	0.4333	0.40595	0.69
14	International Journal of Physical Distribution & Logistics Management	0960-0035	4.215	4.181	0.00175	0.642	1.43647	1.00577	-0.43914	0.21693	0.66
15	Robotics and Computer-Integrated Manufacturing	0736-5845	3.464	4.031	0.0042	0.79	0.88551	0.9129	-0.06414	0.62237	0.62
16	International Journal of Production Research	0020-7543	2.623	2.78	0.01699	0.544	0.26851	0.13837	1.89349	-0.05154	0.57
17	Journal of Manufacturing Systems	0278-6125	3.699	3.621	0.0037	0.708	1.05791	0.65906	-0.14067	0.39773	0.54
18	International Journal of Precision Engineering and Manufacturing-Green Technology	2288-6206	3.774	3.949	0.00135	0.715	1.11294	0.86213	-0.50036	0.41691	0.54
19	Journal of Business Logistics	0735-3766	2.891	4.19	0.00137	0.827	0.46513	1.01134	-0.4973	0.72373	0.44
20	Production and Operations Management	1059-1478	1.772	2.921	0.0095	1.21	-0.35582	0.22567	0.74708	1.77293	0.42
21	Flexible Services and Manufacturing Journal	1936-6582	2.346	3.129	0.00157	0.923	0.06529	0.35445	-0.46669	0.98671	0.17
22	Journal of Manufacturing Processes	1526-6125	2.809	2.809	0.00339	0.635	0.40497	0.15633	-0.18812	0.19775	0.15
23	Applied Ergonomics	0003-6870	2.435	2.663	0.00666	0.598	0.13059	0.06594	0.31239	0.09639	0.15
24	Precision Engineering-Journal of The International Societies For Precision Engineering and Nanotechnology	0141-6359	2.582	2.684	0.00453	0.574	0.23843	0.07894	-0.01363	0.03065	0.1
25	Journal of Quality Technology	0022-4065	2.306	2.636	0.00157	0.966	0.03595	0.04922	-0.46669	1.10451	0.09
26	Research in Engineering Design	0934-9839	2.625	3.275	0.00081	0.578	0.26998	0.44484	-0.58301	0.04161	0.08
27	Journal of Engineering and Technology Management	0923-4748	2.686	3.213	0.00098	0.525	0.31473	0.40646	-0.55699	-0.10359	0.07
28	Journal of Manufacturing Science and Engineering-Transactions of The Asme	1087-1357	2.578	2.574	0.00418	0.456	0.2355	0.01083	-0.0672	-0.29261	0.01
29	Industrial Management & Data Systems	0263-5577	2.948	2.724	0.00174	0.323	0.50695	0.1037	-0.44067	-0.65695	-0.03
30	IIE Transactions	0740-817X	1.759	2.152	0.00496	0.841	-0.36535	-0.25044	0.05218	0.76208	-0.05
31	Ergonomics	0014-0139	2.019	2.183	0.00596	0.582	-0.17461	-0.23124	0.20524	0.05256	-0.06
32	Production Planning & Control	0953-7287	2.33	2.933	0.00226	0.409	0.05356	0.2331	-0.36108	-0.42136	-0.07
33	Decision Sciences	0011-7315	1.641	2.479	0.00207	0.785	-0.45192	-0.04798	-0.39016	0.60867	-0.15
34	Journal of Manufacturing Technology Management	1741-038X	2.194	2.194	0.00067	0.478	-0.04622	-0.22443	-0.60444	-0.23234	-0.26
35	International Journal of Computer Integrated Manufacturing	0951-192X	1.995	2.016	0.00217	0.37	-0.19221	-0.33464	-0.37485	-0.5282	-0.33
36	Quality and Reliability Engineering International	0748-8017	1.604	1.821	0.00392	0.436	-0.47907	-0.45537	-0.107	-0.3474	-0.36
37	IEEE Transactions on Components Packaging and Manufacturing Technology	2156-3950	1.332	1.662	0.00649	0.424	-0.67862	-0.55381	0.28637	-0.38027	-0.36
38	IEEE Transactions on Engineering Management	0018-9391	1.416	2.087	0.00173	0.474	-0.61699	-0.29068	-0.4422	-0.2433	-0.42
39	Engineering Economist	0013-791X	2	1.705	0.00038	0.358	-0.18855	-0.52719	-0.64883	-0.56107	-0.46
40	International Journal of Simulation Modelling	1726-4529	1.942	1.76	0.0008	0.299	-0.2311	-0.49313	-0.58455	-0.7227	-0.47
41	Journal of Scheduling	1094-6136	1.153	1.402	0.00214	0.637	-0.80994	-0.71478	-0.37944	0.20323	-0.52
42	International Journal of Industrial Ergonomics	0169-8141	1.429	1.607	0.00217	0.356	-0.60746	-0.58786	-0.37485	-0.56655	-0.54
43	International Journal of Design	1991-3761	1.163	1.938	0.00056	0.363	-0.80261	-0.38293	-0.62128	-0.54738	-0.59
44	Advances in Production Engineering & Management	1854-6250	1.596	1.596	0.0003	0.254	-0.48494	-0.59467	-0.66107	-0.84597	-0.62
45	Machining Science and Technology	1091-0344	1.339	1.658	0.00069	0.324	-0.67348	-0.55629	-0.60138	-0.65421	-0.62
46	Journal of Computing and Information Science in Engineering	1530-9827	1.588	1.49	0.00072	0.257	-0.49081	-0.6603	-0.59679	-0.83776	-0.62
47	Advances in Manufacturing	2095-3127	1.706	1.325	0.00047	0.226	-0.40424	-0.76246	-0.63505	-0.92268	-0.65
48	Quality Engineering	0898-2112	1.238	1.351	0.00109	0.393	-0.74758	-0.74636	-0.54016	-0.46519	-0.65
49	IEEE Transactions on Semiconductor Manufacturing	0894-6507	1.336	1.199	0.00135	0.301	-0.67569	-0.84047	-0.50036	-0.71722	-0.69
50	Industrial Robot-The International Journal of Robotics Research and Application	0143-991X	1.205	1.213	0.00097	0.24	-0.77179	-0.8318	-0.55852	-0.88433	-0.76
51	Issues in Science and Technology	0748-5492	1.03	1.013	0.00086	0.398	-0.90018	-0.95562	-0.57536	-0.45149	-0.77
52	Ai Edam-Artificial Intelligence For Engineering Design Analysis and Manufacturing	0890-0604	1.045	1.288	0.00057	0.283	-0.88918	-0.78536	-0.61975	-0.76653	-0.77
53	Probability in The Engineering and Informational Sciences	0269-9648	0.803	0.816	0.00103	0.461	-1.06672	-1.07759	-0.54934	-0.27891	-0.82
54	European Journal of Industrial Engineering	1751-5254	1.085	1.056	0.00056	0.229	-0.85983	-0.929	-0.62128	-0.91446	-0.83
55	IEEE Industry Applications Magazine	1077-2618	0.864	1.004	0.00092	0.302	-1.02197	-0.96119	-0.56618	-0.71448	-0.85
56	Soldering & Surface Mount Technology	0954-0911	1.137	1.057	0.00024	0.148	-0.82168	-0.92838	-0.67026	-1.13636	-0.87
57	Systems Engineering	1098-1241	0.797	1.176	0.00056	0.225	-1.07112	-0.85471	-0.62128	-0.92542	-0.87
58	Human Factors and Ergonomics in Manufacturing & Service Industries	1090-8471	0.917	0.964	0.00063	0.184	-0.98308	-0.98596	-0.61057	-1.03774	-0.9
59	Quality Technology and Quantitative Management	1684-3703	0.662	1.006	0.0006	0.27	-1.17016	-0.95996	-0.61516	-0.80214	-0.92
60	International Journal of Industrial Engineering-Theory Applications and Practice	1943-670X	0.565	0.705	0.00035	0.121	-1.24132	-1.14631	-0.65342	-1.21032	-1.07
61	Journal of Advanced Mechanical Design Systems and Manufacturing	1881-3054	0.503	0.54	0.00071	0.118	-1.28681	-1.24847	-0.59832	-1.21854	-1.1
62	Engineering Management Journal	1042-9247	0.487	0.771	0.00008	0.06	-1.29855	-1.10545	-0.69475	-1.37743	-1.11
63	South African Journal of Industrial Engineering	2224-7890	0.409	0.485	0.00026	0.069	-1.35577	-1.28252	-0.6672	-1.35277	-1.17
64	Manufacturing Engineering	0361-0853	0.063	0.073	0.00007	0.013	-1.60961	-1.5376	-0.69628	-1.50618	-1.35

Table 6.2: Industrial engineering journals in Zone A

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year Impact Factor	Immediacy Index	Articles	Cited Half-life	Eigenfactor Score	Article Influence Score
1	IEEE Transactions on Industrial Informatics	1551-3203	8513	5.43	7.227	1.417	99.69	3.8	0.02301	1.801
2	Journal of Supply Chain Management	1523-2409	2281	6.105	8.026	1.1	95	7.2	0.00259	1.648
3	International Journal of Production Economics	0925-5273	18583	4.407	4.976	0.865	97.97	6.5	0.0226	0.971

impact factor of 5.106 and the highest five-year impact factor of 5.905. The highest overall score also indicated that this journal was the most influential and important journal in Zone B. *Composite Part A-Applied Science and Manufacturing* had the highest total citations (18,038) and a high immediacy index (1.235) but its impact factor was general. *Technovation* had a low citation frequency (5639), and although its five-year impact factor was high (5.407), its ranking declined in recent years. The *Journal of Product Innovation Management* developed rapidly in recent years, with its influencing factors even exceeding the *IEEE-Asme Transactions on Mechatronics* and the *Journal of Materials Processing Technology*. *Computers & Operations Research* (11,297) and *International Journal of Advanced Manufacturing Technology* (25,357), however, have been cited more frequently.

Table 6.3: Industrial engineering journals in Zone B

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year Impact Factor	Immediacy Index	Articles	Cited Half-life	Eigenfactor Score	Article Influence Score
1	International Journal of Machine Tools & Manufacture	0890-6955	13392	5.106	5.905	0.964	96.39	>10	0.0081	1.162
2	Composites Part A-Applied Science and Manufacturing	1359-835X	18038	4.514	4.483	1.235	98.26	7.6	0.018	0.895
3	Technovation	0166-4972	5639	4.802	5.407	0.679	100	9.3	0.00322	0.942
4	IEEE-Asme Transactions on Mechatronics	1083-4435	8132	3.936	4.306	0.833	100	5.2	0.0111	1.163
5	Journal of Materials Processing Technology	0924-0136	29948	3.647	3.817	0.926	99.28	¿10	0.01891	0.804
6	Journal of Product Innovation Management	0737-6782	5988	4.305	4.926	0.571	97.62	8.7	0.00562	1.039
7	Computers & Operations Research	0305-0548	11297	2.962	3.174	0.809	98.83	8.2	0.01751	1.015
8	International Journal of Advanced Manufacturing Technology	0268-3768	25357	2.601	2.748	0.402	98.64	4.7	0.02877	0.397
9	Computers & Industrial Engineering	0360-8352	9868	3.195	3.442	0.463	98.66	5.8	0.01514	0.77
10	Cirp Annals-Manufacturing Technology	0007-8506	11190	3.333	4.074	0.207	100	9.3	0.00745	0.711

There were 19 journals in Zone C, as shown in 6.4, with the five-year impact factor being between 2.933 and 4.19. All journals had stable development trends, of which the *International Journal of Physical Distribution & Logistics Management* had the highest score. However, the *Journal of Business Logistics* had the highest five-year impact factor (4.19) and the highest immediacy index (1.353). The *Journal of Business Logistics* focuses on new information, new theories, new technologies, and new research methods re-

lated to logistics theory and practice, and the integration of logistics theory and current logistics theory and practice that have had a significant impact on the logistics industry *Production and Operation Management* had the highest article influence score (1.21) and has good development potential. The *Flexible Services and Manufacturing Journal* had the lowest citations, but a high five-year impact factor of 3.129, suggesting that the journal has had some high-quality papers; however, the low impact factor indicates that more new high-quality papers are needed to promote its development.

Table 6.4: Industrial engineering journals in Zone C

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year Impact Factor	Immediacy Index	Articles	Cited Half-life	Eigenfactor Score	Article Influence Score
1	International Journal of Physical Distribution & Logistics Management	0960-0035	3485	4.215	4.181	0.467	88.89	9.5	0.00175	0.642
2	Robotics and Computer-Integrated Manufacturing	0736-5845	3366	3.464	4.031	1.097	100	6	0.0042	0.79
3	International Journal of Production Research	0020-7543	14789	2.623	2.78	0.69	97.02	6.9	0.01699	0.544
4	Journal of Manufacturing Systems	0278-6125	2307	3.699	3.621	0.486	95.5	4.5	0.0037	0.708
5	International Journal of Precision Engineering and Manufacturing-Green Technology	2288-6206	561	3.774	3.949	0.4	80	2.5	0.00135	0.715
6	Journal of Business Logistics	0735-3766	2234	2.891	4.19	1.353	100	¿10	0.00137	0.827
7	Production and Operations Management	1059-1478	4423	1.772	2.921	0.379	97.58	8.1	0.0095	1.21
8	Flexible Services and Manufacturing Journal	1936-6582	468	2.346	3.129	0.333	95.83	3.9	0.00157	0.923
9	Journal of Manufacturing Processes	1526-6125	1878	2.809	2.809	0.547	96.74	3.3	0.00339	0.635
10	Applied Ergonomics	0003-6870	5702	2.435	2.663	0.777	94.77	7.7	0.00666	0.598
11	Precision Engineering-Journal of The International Societies For Precision Engineering and Nanotechnology	0141-6359	3798	2.582	2.684	0.544	98.45	7.2	0.00453	0.574
12	Journal of Quality Technology	0022-4065	2758	2.306	2.636	0.316	100	¿10	0.00157	0.966
13	Research in Engineering Design	0934-9839	1094	2.625	3.275	0.5	100	9.8	0.00081	0.578
14	Journal of Engineering and Technology Management	0923-4748	1069	2.686	3.213	0.263	100	8	0.00098	0.525
15	Journal of Manufacturing Science and Engineering-Transactions of The Asme	1087-1357	4648	2.578	2.574	0.446	96.88	8.5	0.00418	0.456
16	Industrial Management & Data Systems	0263-5577	2990	2.948	2.724	0.431	95.12	7.6	0.00174	0.323
17	IIE Transactions	0740-817X	4205	1.759	2.152	0.182	98.96	¿10	0.00496	0.841
18	Ergonomics	0014-0139	7273	2.019	2.183	0.42	95.1	¿10	0.00596	0.582
19	Production Planning & Control	0953-7287	2516	2.33	2.933	0.247	87.63	6.3	0.00226	0.409

Table 6.5 shows the 32 industrial engineering journals in Zone D. These journals had lower five-year impact factors, with only four journals having five-year impact factors greater than 2, seven being less than 1, and most being between 1 and 2. Twenty-four journals had cites less than 1000. As some of these journals have just been included in JCR, there is room for development. *Decision Sciences*, the *Journal of Manufacturing Technology Management*, the *International Journal of Computer Integrated Manufacturing*, and *IEEE Transactions on Engineering Management* have higher five-year impact factors and better potential. The *Engineering Economist* had only 445 total cites, but its five-year impact factor was close to 2, indicating that the journal has significant development potential.

Table 6.5: Industrial engineering journals in Zone D

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year Impact Factor	Immediacy Index	Articles	Cited Half-life	Eigenfactor Score	Article Influence Score
1	Decision Sciences	0011-7315	3547	1.641	2.479	0.243	100	>10	0.00207	0.785
2	Journal of Manufacturing Technology Management	1741-038X	1386	2.194	2.194	0.429	95.92	7.5	0.00067	0.478
3	International Journal of Computer Integrated Manufacturing	0951-192X	1749	1.995	2.016	0.778	98.89	5.6	0.00217	0.37
4	Quality and Reliability Engineering International	0748-8017	2347	1.604	1.821	0.337	98.95	5.5	0.00392	0.436
5	IEEE Transactions on Components Packaging and Manufacturing Technology	2156-3950	5236	1.332	1.662	0.304	100	8.2	0.00649	0.424
6	IEEE Transactions on Engineering Management	0018-9391	2484	1.416	2.087	0.196	97.83	>10	0.00173	0.474
7	Engineering Economist	0013-791X	445	2	1.705	0.056	100	>10	0.00038	0.358
8	International Journal of Simulation Modelling	1726-4529	420	1.942	1.76	0.15	98.33	2.8	0.0008	0.299
9	Journal of Scheduling	1094-6136	1123	1.153	1.402	0.209	100	8.4	0.00214	0.637
10	International Journal of Industrial Ergonomics	0169-8141	3108	1.429	1.607	0.275	100	>10	0.00217	0.356
11	International Journal of Design	1991-3761	523	1.163	1.938	0.067	100	6.5	0.00056	0.363
12	Advances in Production Engineering & Management	1854-6250	196	1.596	1.596	0.412	100	3.5	0.0003	0.254
13	Machining Science and Technology	1091-0344	842	1.339	1.658	0.061	96.97	9.4	0.00069	0.324
14	Journal of Computing and Information Science in Engineering	1530-9827	752	1.588	1.49	0.145	96.36	7.5	0.00072	0.257
15	Advances in Manufacturing	2095-3127	221	1.706	1.325	0.027	94.59	7.6	0.00047	0.226
16	Quality Engineering	0898-2112	862	1.238	1.351	0.288	98.08	9.5	0.00109	0.393
17	IEEE Transactions on Semiconductor Manufacturing	0894-6507	1274	1.336	1.199	0.057	100	>10	0.00135	0.301
18	Industrial Robot-The International Journal of Robotics Research and Application	0143-991X	971	1.205	1.213	0.096	97.26	8.2	0.00097	0.24
19	Issues in Science and Technology	0748-5492	400	1.03	1.013	0.147	100	7.3	0.00086	0.398
20	Ai Edam-Artificial Intelligence For Engineering Design Analysis and Manufacturing	0890-0604	703	1.045	1.288	0.647	100	9	0.00057	0.283
21	Probability in The Engineering and Informational Sciences	0269-9648	585	0.803	0.816	0.2	100	>10	0.00103	0.461
22	European Journal of Industrial Engineering	1751-5254	296	1.085	1.056	0.147	100	4.8	0.00056	0.229
23	IEEE Industry Applications Magazine	1077-2618	811	0.864	1.004	0.575	90	>10	0.00092	0.302
24	Soldering & Surface Mount Technology	0954-0911	287	1.137	1.057	0.148	96.3	6.4	0.00024	0.148
25	Systems Engineering	1098-1241	578	0.797	1.176	0.133	100	8.1	0.00056	0.225
26	Human Factors and Ergonomics in Manufacturing & Service Industries	1090-8471	334	0.917	0.964	0.111	100	4.1	0.00063	0.184
27	Quality Technology and Quantitative Management	1684-3703	266	0.662	1.006	0.111	100	4.8	0.0006	0.27
28	International Journal of Industrial Engineering-Theory Applications and Practice	1943-670X	333	0.565	0.705	0.022	97.78	7.1	0.00035	0.121
29	Journal of Advanced Mechanical Design Systems and Manufacturing	1881-3054	432	0.503	0.54	0.036	100	5.6	0.00071	0.118
30	Engineering Management Journal	1042-9247	387	0.487	0.771	0.091	90.91	>10	0.00008	0.06
31	South African Journal of Industrial Engineering	2224-7890	189	0.409	0.485	0.043	97.83	4.5	0.00026	0.069
32	Manufacturing Engineering	0361-0853	168	0.063	0.073	0.013	100	>10	0.00007	0.013

6.3 Statistical Analysis

In this section, a statistical analysis of the journal indicators of the 65 journals is conducted using SPSS 21.0, a software package for logical batched and non-batched statistical analyses. In the following, a total analysis and an analysis by zone are given.

Total analysis

Table 6.6 presents the descriptive analysis of the journal indexes related to industrial engineering. As can be seen, the total cites range was 29,780, the minimum was 168, the maximum 29,948; the statistical mean for total cites was 4235.078, the standard error was 758.5311, and the standard devi-

ation was 6068.2491. The impact factor range was 6.042, the minimum and maximum were 0.063 and 6.105, and the statistical and standard deviation mean impact factors were 2.257 and 0.1704, with a standard deviation of 1.3631. The range for the five-year impact factor was 7.953, the minimum and maximum were 0.073 and 8.026, the average five-year statistical and standard deviation mean impact factors were 2.57 and 0.2046, with a standard deviation of 1.6241. The range of the immediacy index was 1.404, the minimum and maximum were 0.013 and 1.417, the statistical and standard means were 0.42036 and 0.0435, and the standard deviation was 0.3477. Other index values are shown in Table 6.6.

Table 6.6: Descriptive analysis of industrial engineering journals

	N	Range	Minimum	Maximum	Sum	Mean		Std. Deviation	Skewness	
						Statistic	Std. Error		Statistic	Std. Error
Total Cites	64	29780	168	29948	271045	4235.078	758.5311	6068.2491	2.452	0.299
Impact Factor	64	6.042	0.063	6.105	144.448	2.257	0.1704	1.3631	0.78	0.299
five-Year Impact Factor	63	7.953	0.073	8.026	161.954	2.57	0.2046	1.6241	1.128	0.302
Immediacy Index	64	1.404	0.013	1.417	26.903	0.42036	0.0435	0.3477	1.092	0.299
Articles in citable item	64	20	80	100	6244.81	97.57516	0.4464	3.5709	-2.711	0.299
Cited Half-life	64	7.5	2.5	10	478	7.469	0.2779	2.2235	-0.518	0.299
Eigenfactor Score	64	0.0287	0.00007	0.02877	0.29562	0.0046191	0.0008	0.0065	2.061	0.299
Article Influence Score	64	1.788	0.013	1.801	36.02	0.56281	0.0456	0.365	1.125	0.299

The extreme (highest and lowest) values for total cites, impact factors, five-year impact factor, immediacy index, articles in citable item, cited half-life, eigenfactor score, and article influence scores were then examined.

Table 6.7 shows the extreme values for total cites. The five highest journals for total cites were the *Journal of Materials Processing Technology*, the *International Journal of Advanced Manufacturing Technology*, the *International Journal of Production Economics*, the *Composites Part A-Applied Science*, and the *Manufacturing and International Journal of Production Research*. The lowest journals for total cites were *Manufacturing Engineering*, the *South African Journal of Industrial Engineering*, the *Advances in Production Engineering & Management*, and *Quality Technology and Quantitative Management.*

Table 6.8 shows the extreme values for the impact factor. The top five journal impact factors were for the *Journal of Supply Chain Management*, the *IEEE Transactions on Industrial Informatics*, the *International Journal of Machine Tools & Manufacture*, the *Composites Part A-Applied Science*, and *Manufacturing*. The lowest five impact factors were for *Manufacturing Engineering*, the *South African Journal of Industrial Engineering*, the *Jour-*

Table 6.7: Extreme values for total cites

			Case Number	Journal Title	Value
Total Cites	Highest	1	8	Journal of Materials Processing Technology	29948
		2	11	International Journal of Advanced Manufacturing Technology	25357
		3	3	International Journal of Production Economics	18583
		4	5	Composites Part A-Applied Science and Manufacturing	18038
		5	16	International Journal of Production Research	14789
	Lowest	1	64	Manufacturing Engineering	168
		2	63	South African Journal of Industrial Engineering	189
		3	44	Advances in Production Engineering & Management	196
		4	47	Advances in Manufacturing	221
		5	59	Quality Technology and Quantitative Management	266

nal of Advanced Mechanical Design Systems, *Manufacturing*, and *International Journal of Industrial Engineering-Theory Applications and Practice*.

Table 6.8: Extreme values for the impact factor

			Case Number	Journal Title	Value
Impact Factor	Highest	1	2	Journal of Supply Chain Management	6.105
		2	1	IEEE Transactions on Industrial Informatics	5.43
		3	4	International Journal of Machine Tools & Manufacture	5.106
		4	6	Technovation	4.802
		5	5	Composites Part A-Applied Science and Manufacturing	4.514
	Lowest	1	64	Manufacturing Engineering	0.063
		2	63	South African Journal of Industrial Engineering	0.409
		3	62	Engineering Management Journal	0.487
		4	61	Journal of Advanced Mechanical Design Systems and Manufacturing	0.503
		5	60	International Journal of Industrial Engineering-Theory Applications and Practice	0.565

Table 6.9 shows the extreme values for the five-year impact factor. The highest five journal's five-year impact factors were for the *Journal of Supply Chain Management*, the *IEEE Transactions on Industrial Informatics*, the *International Journal of Machine Tools & Manufacture*, the *Technovation*, and the *International Journal of Production Economics*, while the lowest five journal's five-year impact factors were for *Manufacturing Engineering*, the *South African Journal of Industrial Engineering*, the *Journal of Advanced Mechanical Design Systems and Manufacturing*, the *International Journal of Industrial Engineering-Theory Applications*, and the *Practice and Engineering Management Journal*.

Table 6.10 shows the extreme values for the immediacy index along with the five highest and lowest immediacy indexes. The five highest journals were *IEEE Transactions on Industrial Informatics*, with an immediacy in-

Table 6.9: Extreme values for five-year impact factor

			Case Number	Journal Title	Value
Five-Year Im-pact Factor	Highest	1	2	Journal of Supply Chain Management	8.026
		2	1	IEEE Transactions on Industrial Informatics	7.227
		3	4	International Journal of Machine Tools & Manufacture	5.905
		4	6	Technovation	5.407
		5	3	International Journal of Production Economics	4.976
	Lowest	1	64	Manufacturing Engineering	0.073
		2	63	South African Journal of Industrial Engineering	0.485
		3	61	Journal of Advanced Mechanical Design Systems and Manufactur-ing	0.54
		4	60	International Journal of Industrial Engineering-Theory Applica-tions and Practice	0.705
		5	62	Engineering Management Journal	0.771

dex of 1.417, the *Journal of Business Logistics*, with an immediacy index of 1.353, *Composites Part A-Applied Science and Manufacturing*, with 1.235, the *Journal of Supply Chain Management* with index of 1.1, and *Robotics and Computer-Integrated Manufacturing* with 1.097. The five lowest journals were *Manufacturing Engineering*, the *International Journal of Industrial Engineering-Theory Applications and Practice*, *Advances in Manufacturing*, the *Journal of Advanced Mechanical Design Systems*, and *Manufacturing and South African Journal of Industrial Engineering*.

Table 6.10: Extreme values for the immediacy index

			Case Number	Journal Title	Value
Immediacy Index	Highest	1	1	IEEE Transactions on Industrial Informatics	1.417
		2	19	Journal of Business Logistics	1.353
		3	5	Composites Part A-Applied Science and Manufacturing	1.235
		4	2	Journal of Supply Chain Management	1.1
		5	15	Robotics and Computer-Integrated Manufacturing	1.097
	Lowest	1	64	Manufacturing Engineering	0.013
		2	60	International Journal of Industrial Engineering-Theory Applica-tions and Practice	0.022
		3	47	Advances in Manufacturing	0.027
		4	61	Journal of Advanced Mechanical Design Systems and Manufactur-ing	0.036
		5	63	South African Journal of Industrial Engineering	0.043

Table 6.11 shows the extreme values for the articles in citable item, the top five journals for which were *Technovation*, the *IEEE-Asme Transactions on Mechatronics*, the *Cirp Annals-Manufacturing Technology*, the *Robotics and Computer-Integrated Manufacturing*, and the *Journal of Business Lo-*

gistics. The last five journals were the *International Journal of Precision Engineering and Manufacturing-Green Technology*, the *Production Planning & Control*, the *International Journal of Physical Distribution & Logistics Management*, the *IEEE Industry Applications Magazine*, and the *Engineering Management Journal*.

Table 6.11: Extreme values for the articles in citable item

			Case Number	Journal Title	Value
Articles citable item	in Highest	1	6	Technovation	100
		2	7	IEEE-Asme Transactions on Mechatronics	100
		3	13	Cirp Annals-Manufacturing Technology	100
		4	15	Robotics and Computer-Integrated Manufacturing	100
		5	19	Journal of Business Logistics	100.000[a]
	Lowest	1	18	International Journal of Precision Engineering and Manufacturing-Green Technology	80
		2	32	Production Planning & Control	87.63
		3	14	International Journal of Physical Distribution & Logistics Management	88.89
		4	55	IEEE Industry Applications Magazine	90
		5	62	Engineering Management Journal	90.91

a. Only a partial list of cases with the value 100.000 is shown in the table of upper extremes.

Table 6.12 shows the extreme values for the cited half-life, the top five journals for which were the *International Journal of Machine Tools & Manufacture*, the *Journal of Materials Processing Technology*, the *Journal of Business Logistics*, the *Journal of Quality Technology*, and the *IIE Transactions* and the five lowest of which were the *International Journal of Precision Engineering and Manufacturing-Green Technology*, the *International Journal of Simulation Modelling*, the *Journal of Manufacturing Processes*, *Advances in Production Engineering & Management*, and the *IEEE Transactions on Industrial Informatics.*

Table 6.13 shows the extreme values for the eigenfactor score, the top five journals for which were the *International Journal of Advanced Manufacturing Technology*, with an eigenfactor score of 0.02877, *IEEE Transactions on Industrial Informatics*, with a score of 0.02301, the *International Journal of Production Economics* with 0.0226, the *Journal of Materials Processing Technology*, with 0.01891, and *Composites Part A-Applied Science and Manufacturing* with 0.018. The lowest eigenfactor scores were for the *Manufacturing Engineering*, the *Engineering Management Journal*, the *Soldering & Surface Mount Technology*, the *South African Journal of Industrial Engineering*, and the *Advances in Production Engineering & Management*.

Table 6.12: Extreme values for cited half-life

			Case Number	Journal Title	Value
Cited Half-life	Highest	1	4	International Journal of Machine Tools & Manufacture	10
		2	8	Journal of Materials Processing Technology	10
		3	19	Journal of Business Logistics	10
		4	25	Journal of Quality Technology	10
		5	30	IIE Transactions	10.0[a]
	Lowest	1	18	International Journal of Precision Engineering and Manufacturing-Green Technology	2.5
		2	40	International Journal of Simulation Modelling	2.8
		3	22	Journal of Manufacturing Processes	3.3
		4	44	Advances in Production Engineering & Management	3.5
		5	1	IEEE Transactions on Industrial Informatics	3.8

a. Only a partial list of cases with the value 10.0 are shown in the table of upper extremes.

Table 6.13: Extreme values for the eigenfactor score

			Case Number	Journal Title	Value
Eigenfactor Score	Highest	1	11	International Journal of Advanced Manufacturing Technology	0.02877
		2	1	IEEE Transactions on Industrial Informatics	0.02301
		3	3	International Journal of Production Economics	0.0226
		4	8	Journal of Materials Processing Technology	0.01891
		5	5	Composites Part A-Applied Science and Manufacturing	0.018
	Lowest	1	64	Manufacturing Engineering	0.00007
		2	62	Engineering Management Journal	0.00008
		3	56	Soldering & Surface Mount Technology	0.00024
		4	63	South African Journal of Industrial Engineering	0.00026
		5	44	Advances in Production Engineering & Management	0.0003

Table 6.14 shows the extreme values for the article influence score, for which the top five journals were *IEEE Transactions on Industrial Informatics* with an article influence score of 1.801, the *Journal of Supply Chain Management* with an article influence score of 1.648, *Production and Operations Management* with a score of 1.21, *IEEE-Asme Transactions on Mechatronics* with 1.163 and the *International Journal of Machine Tools & Manufacture* with 1.162. The lowest article influence scores were for *Manufacturing Engineering*, *Engineering Management Journal*, the *South African Journal of Industrial Engineering*, the *Journal of Advanced Mechanical Design Systems and Manufacturing*, and the *International Journal of Industrial Engineering-Theory Applications and Practice*.

Zone analysis

In Table 6.15, the statistical results for the 2017 total cites in each zone are examined. As can be seen, the largest mean (13884.9), medi-

Table 6.14: Extreme values for the article influence score

			Case Number	Journal Title	Value
Article Influence Score	Highest	1	1	IEEE Transactions on Industrial Informatics	1.801
		2	2	Journal of Supply Chain Management	1.648
		3	20	Production and Operations Management	1.21
		4	7	IEEE-Asme Transactions on Mechatronics	1.163
		5	4	International Journal of Machine Tools & Manufacture	1.162
	Lowest	1	64	Manufacturing Engineering	0.013
		2	62	Engineering Management Journal	0.06
		3	63	South African Journal of Industrial Engineering	0.069
		4	61	Journal of Advanced Mechanical Design Systems and Manufacturing	0.118
		5	60	International Journal of Industrial Engineering-Theory Applications and Practice	0.121

an (13884.9), maximum (29948), and minimum (5639) and range (16302) were in Zone B, while Zone A had the largest standard error of skewness (8225.954) and variance (67666321.333).

Table 6.15: Statistical results for the 2017 total cites in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	3	9792.33	8225.954	8513	29377	18583	2281	16302	67666321.333
B	10	13884.9	8169.526	11243.5	138849	29948	5639	24309	66741155.878
C	19	3661.26	3212.569	2990	69564	14789	468	14321	10320596.538
D	32	1039.22	1152.662	581.5	33255	5236	168	5068	1328630.434
Total	64	4235.08	6068.249	2056	271045	29948	168	29780	36823647.026

Table 6.16 shows the statistical results factors in each zone. As can be seen, the largest mean (5.314), standard error of skewness (0.854923), median (5.43), maximum (6.105), and minimum (4.407), and variance (0.731) were in Zone A; Zone C had the largest sum (51.861), and Zone B the largest range (2.505).

Table 6.16: Statistical results for the 2017 impact factor in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	3	5.314	0.854923	5.43	15.942	6.105	4.407	1.698	0.731
B	10	3.8401	0.831615	3.7915	38.401	5.106	2.601	2.505	0.692
C	19	2.72953	0.660907	2.623	51.861	4.215	1.759	2.456	0.437
D	32	1.19513	0.510495	1.184	38.244	2.194	0.063	2.131	0.261
Total	64	2.257	1.36306	1.9975	144.448	6.105	0.063	6.042	1.858

Table 6.17 shows the statistical results for the 2017 five-year impact factor in each zone. The largest mean (6.74), standard error of skewness (1.582), median (7.23), maximum (8.026), minimum (4.976), and variance (2.638) were in Zone A. Zone C had the largest sum (58.648), and Zone B had the largest range (3.157).

Table 6.17: 2017 five-year impact factor statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	3	6.74	1.582	7.23	20.229	8.026	4.976	3.05	2.501
B	10	4.23	0.993	4.19	42.282	5.905	2.748	3.157	0.986
C	19	3.09	0.634	2.92	58.648	4.19	2.152	2.038	0.402
D	31	1.32	0.544	1.29	40.795	2.479	0.073	2.406	0.295
Total	63	2.57	1.624	2.19	161.954	8.026	0.073	7.953	2.638

Table 6.18 shows the statistical results for the 2017 immediacy index in each zone. The largest mean (1.12733), median (1.1), maximum (1.417) and minimum (0.865) were in Zone A. Zone B had largest standard error of skewness (0.305665) and variance (2.638), and Zone C had the largest sum (9.878) and range (1.171).

Table 6.18: 2017 immediacy index statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	3	1.12733	0.277013	1.1	3.382	1.417	0.865	0.552	0.077
B	10	0.7089	0.305665	0.744	7.089	1.235	0.207	1.028	0.093
C	19	0.51989	0.290261	0.446	9.878	1.353	0.182	1.171	0.084
D	32	0.20481	0.188308	0.147	6.554	0.778	0.013	0.765	0.035
Total	64	0.42036	0.347716	0.335	26.903	1.417	0.013	1.404	0.121

Table 6.19 shows the 2017 articles in citable item statistical results in each zone. The largest values, however, were not in Zone A, indicating that the articles in the Zone A journals were not cited too often; however, Zone B had the largest mean (98.768) and minimum (96.39), Zone C had the largest standard error of skewness (5.153201) and variance (26.555), and Zone D had the largest sum (3146).

Table 6.20 gives the statistical results for the 2017 “cited half-life” in each zone. The largest values were not in Zone A, again indicating that the articles in the Zone A journals were not cited often; however, Zone B had the largest mean (7.88), median (8.45), and minimum (4.7); Zone C had

Table 6.19: 2017 articles in citable item statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	3	97.55333	2.372601	97.97	292.66	99.69	95	4.69	5.629
B	10	98.768	1.158465	98.745	987.68	100	96.39	3.61	1.342
C	19	95.70895	5.153201	96.88	1818.47	100	80	20	26.555
D	32	98.3125	2.566545	100	3146	100	90	10	6.587
Total	64	97.57516	3.570908	98.65	6244.81	100	80	20	12.751

the largest standard error of skewness (2.4072), range (7.5), and variance (5.795); and Zone D had the largest sum value (241.9).

Table 6.20: 2017 cited half-life statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	3	5.833	1.7954	6.5	17.5	7.2	3.8	3.4	3.223
B	10	7.88	1.986	8.45	78.8	10	4.7	5.3	3.944
C	19	7.358	2.4072	7.7	139.8	10	2.5	7.5	5.795
D	32	7.559	2.2362	7.85	241.9	10	2.8	7.2	5.001
Total	64	7.469	2.2235	7.65	478	10	2.5	7.5	4.944

Table 6.21 gives the statistical results for the 2017 eigenfactor scores in each zone. The largest mean (0.01607), standard error of skewness (0.011673), median (0.0226), and variance (0.000136) were in Zone A; and Zone B had the largest sum (0.13382), maximum (0.02877), minimum (0.00322), and range (0.02555).

Table 6.21: 2017 eigenfactor score statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	3	0.01607	0.011673	0.0226	0.0482	0.02301	0.00259	0.02042	0.000136
B	10	0.01338	0.00775	0.01312	0.13382	0.02877	0.00322	0.02555	0.00006
C	19	0.00408	0.003871	0.00339	0.07747	0.01699	0.00081	0.01618	0.000015
D	32	0.00113	0.001269	0.0007	0.03613	0.00649	0.00007	0.00642	0.000002
Total	64	0.00462	0.006533	0.001735	0.29562	0.02877	0.00007	0.0287	0.000043

Table 6.22 gives the statistical results for the 2017 article influence score in each zone. The largest mean (1.47333), standard error of skewness (0.441708), median (1.648), maximum (1.801), minimum(0.971), and variance (0.195) were for Zone A, while Zone C had the largest sum (12.846) and range (0.887).

Table 6.22: 2017 article influence score statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	3	1.47333	0.441708	1.648	4.42	1.801	0.971	0.83	0.195
B	10	0.8898	0.232368	0.9185	8.898	1.163	0.397	0.766	0.054
C	19	0.67611	0.213193	0.635	12.846	1.21	0.323	0.887	0.045
D	32	0.308	0.162903	0.3	9.856	0.785	0.013	0.772	0.027
Total	64	0.56281	0.365038	0.4675	36.02	1.801	0.013	1.788	0.133

As shown in Fig. 6.1, Zone B had the largest citation times range followed by Zone A, Zone C, and Zone D. The median for total cites in each zone varied but the maximum was in Zone B and the minimum was in Zone D, and there are one and four extreme values in Zones C and D. As shown in Fig. 6.2, the median impact factor in each zone decreased in turn but the impact factor range in Zone B was much larger than in other zones. The median impact factor in each zone varied but the maximum was in Zone A and the minimum was in Zone D.

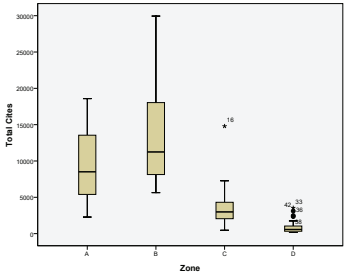

Fig. 6.1: Box diagram of total cites

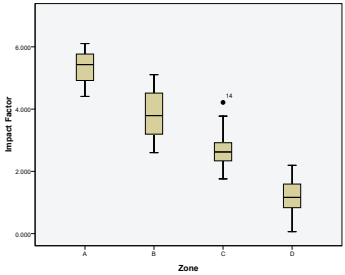

Fig. 6.2: Box diagram of impact factor

Fig. 6.3 shows that the five-year impact factor range in Zone A had the largest range, followed by Zone B, Zone C, and Zone D. The mean in each zone also decreased in turn. Fig. 6.4 shows that Zone B had the largest immediacy index range, followed by Zone A, and the mean in each zone also decreased in turn.

Fig. 6.5 shows that the "article in citable item" in all zones was between 95 and 100, with extreme values in Zone C and D, and with Zone C journals

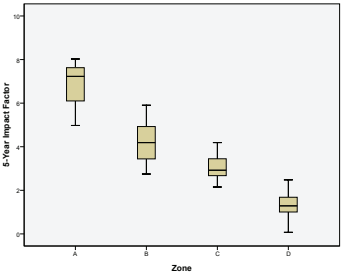

Fig. 6.3: Box diagram of five-year impact factor

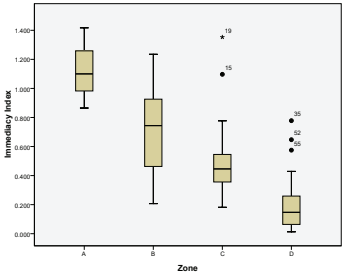

Fig. 6.4: Box diagram of immediacy index

having the largest range. Fig. 6.6 indicates that the largest cited half-life range was in Zone D, the journals in Zone A had the smallest cited half-life range, and Zone B had the largest mean.

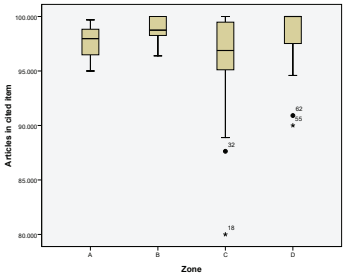

Fig. 6.5: Box diagram for the articles

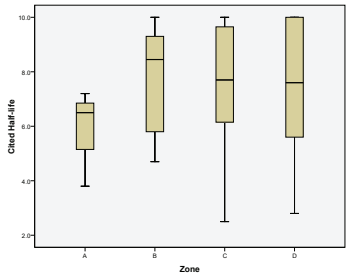

Fig. 6.6: Box diagram for the cited halflife

Fig. 6.7 shows that the journal eigenfactor score range varied from zone to zone, with the journals in Zone B having the largest range followed by Zone A. Zone D journals had the highest concentration and those in Zone B had the lowest. Fig. 6.8 shows that the mean article influence score in all four zones was less than 2, with some extreme values in Zone C and Zone D.

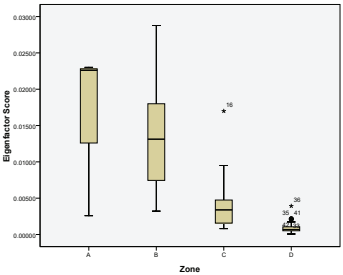

Fig. 6.7: Box diagram for the eigenfactor score

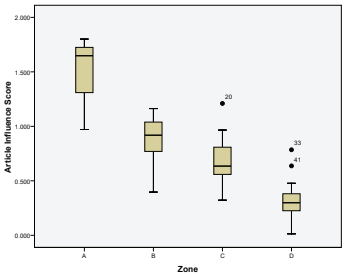

Fig. 6.8: Box diagram for the article influence score

6.4 Comprehensive Discussion

Impact factor changes

Fig. 6.9 shows the impact factor changes for the journals in Zone A. There were three journals in this zone, all of which had high impact factors from 2.752 to 8.785, a large range that fluctuated over the five years. *IEEE Transactions on Industrial Informatics* had an obvious impact factor fluctuation, with a very high 2013 impact factor. This journal plays a very important role in the promotion of industrial engineering research. The impact factor for the *Journal of Supply Chain Management* and the *International Journal of Production Economics* all had upward trends. However, the impact factors for the *International Journal of Production Economics* in 2013 and the impact factor for *IEEE Transactions on Industrial Informatics* in 2014 were missing due to anomalous citation patterns found in the 2014 citation data.

There were 10 industrial engineering journals in Zone B, the impact changes for which varied between 1.379 and 5.106 from 2013 to 2017 , shown in Fig. 6.10; therefore, most journals in this zone had fluctuating impact factors. Except for *IEEE-Asme Transactions on Mechatronics*, the influence of other Zone B journals gradually increased. The *International Journal of Machine Tools & Manufacture* and the *Journal of Product Innovation Management* had obviously increasing impact factors, with relatively significant impact factor rises from 2013 to 2017. Overall, the impact factors for the *International Journal of Industrial Engineering-Theory Application-*

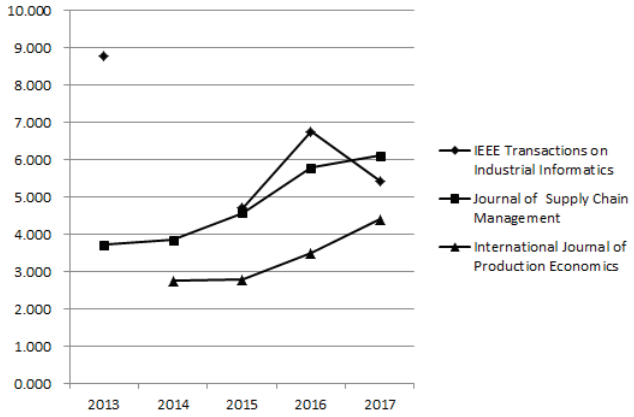

Fig. 6.9: Impact factor changes for Zone A journals from 2013 to 2017

s and Practice had no obvious change as the minimum impact factor was 0.165 and the maximum impact factor was 0.565. The impact factor curve for *Technovation* was an almost a "V" shape, indicating that there were obvious fluctuations down before 2015 and up after 2015.

The impact factors for the 19 journals in Zone C from 2013 to 2017 are shown in Fig. 6.11; these changed between 0.783 and 4.648, indicating that most journals in this zone had fluctuating impact factors. The *Journal of Manufacturing Science* and *Engineering-Transactions of The ASME* had an obvious impact factor fluctuation, rising from 0.783 to 4.648. In general, the *International Journal of Production Research* is deemed to be more important than the other journals in this zone with higher impact factors. The impact factors from 2013 to 2017 show that the *International Journal of Physical Distribution & Logistics Management*, the *International Journal of Production Research*, the *International Journal of Precision Engineering and Manufacturing-Green Technology*, the *International Journal of Precision Engineering and Manufacturing-Green Technology*, the *Journal of Manufacturing Processes*, the *Precision Engineering-Journal of The International Societies For Precision Engineering and Nanotechnology*, and the *Journal of Manufacturing Science and Engineering-Transactions of the ASME* had an almost continuously increasing influence. The impact factors

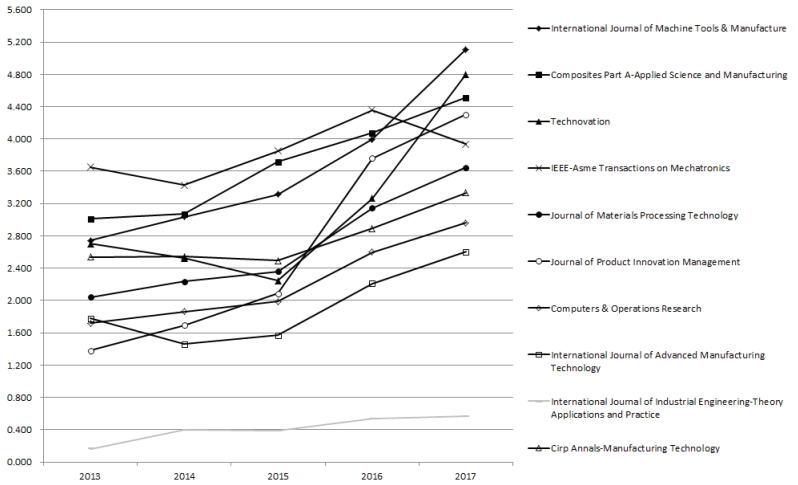

Fig. 6.10: Impact factor changes for Zone B journals from 2013 to 2017

for the *Journal of Business Logistics* fluctuated more noticeably and had a downward trend in 2014.

Half the industrial engineering journals were in Zone D, as shown in Fig. 6.12. The Zone D journal impact factor scores covered a large range from 0.023 to 2.207, which indicated that most of the journals in this zone had fluctuating impact factors. From the impact factor trend chart in Fig. 6.12, the *Engineering Economist* had the highest impact factor, with both up and down fluctuations. The *Journal of Manufacturing Technology Management* had the second-highest impact factor but only had an impact factor for 2017 as this journal had a late entry date. Most journals in this zone had impact factors below 2.5 before 2015; however, the impact factor for the *Engineering Economist* increased from 0.647 in 2013 to 2 in 2017 and fluctuated more noticeably. In general, the *International Journal of Computer Integrated Manufacturing* is deemed to be more important than the journals in this zone that have higher impact factors overall, *Advances in Production Engineering & Management, IEEE Transactions on Semiconductor Manufacturing* and *Ai Edam-Artificial Intelligence for Engineering Design Analysis and Manufacturing* had increasing impact factors.

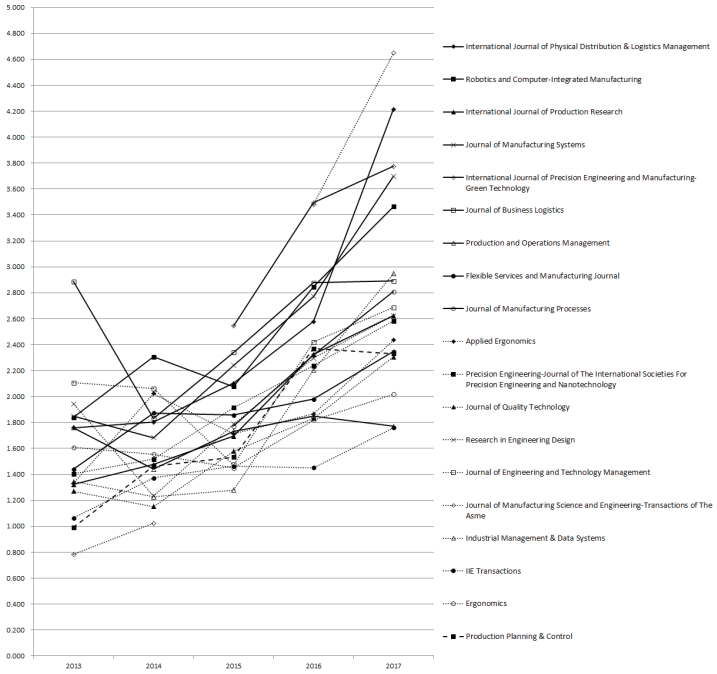

Fig. 6.11: Impact factor changes for Zone C journals from 2013 to 2017

Major countries

In this part, the statistical results for industrial engineering SCI/SSCI papers published by the major countries of the world from 2013 to 2017 are analyzed, as shown in Table 6.23.

Industrial engineering journals published 2853 papers in 2017, of which 655 (22.96%) were by Chinese authors, ranking first in the world. U.S. authors contributed 503 (17.63%), South Korean authors 338 (11.85%), German authors 273 (9.57%), Indian authors 220 (7.71%), Spanish authors 187 papers (6.55%), British authors 200 (7.01%), Italian authors 196 (6.87%), Iranian authors 117 (4.10%), and French authors 164 (5.75%).

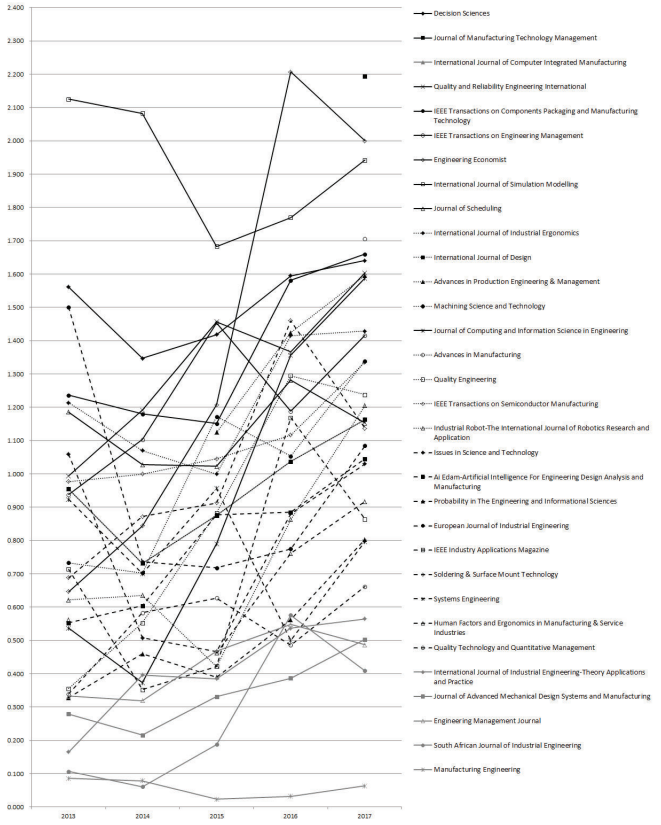

Fig. 6.12: Impact factor changes for Zone D journals from 2013 to 2017

From Fig. 6.13, it can be seen that the numbers of papers published in industrial engineering journals grew from 2013 to 2017. Therefore, China and the USA published the most papers in this category. The contribution by the Chinese authors grew significantly from 327 articles in 2013 to 655 in 2017. The number of papers published in industrial engineering journals by American scholars was 505 or 19.19% in 2016. Other countries had relatively fewer articles published in this category.

Table 6.23: Industrial engineering SCI/SSCI papers published in major countries between 2013 and 2017

Country	2013		2014		2015		2016		2017	
	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage
ALL	1731		2062		2484		2632		2853	
CHINA	327	18.89%	394	19.11%	484	19.48%	582	22.11%	655	22.96%
USA	417	24.09%	437	21.19%	432	17.39%	505	19.19%	503	17.63%
SOUTH KOREA	160	9.24%	188	9.12%	316	12.72%	254	9.65%	338	11.85%
GERMANY	164	9.47%	212	10.28%	255	10.27%	279	10.60%	273	9.57%
INDIA	112	6.47%	149	7.23%	205	8.25%	230	8.74%	220	7.71%
SPAIN	144	8.32%	144	6.98%	169	6.80%	210	7.98%	187	6.55%
UK	112	6.47%	104	5.04%	173	6.96%	187	7.10%	200	7.01%
ITALY	105	6.07%	108	5.24%	151	6.08%	154	5.85%	196	6.87%
IRAN	72	4.16%	208	10.09%	183	7.37%	101	3.84%	117	4.10%
FRANCE	118	6.82%	118	5.72%	116	4.67%	130	4.94%	164	5.75%

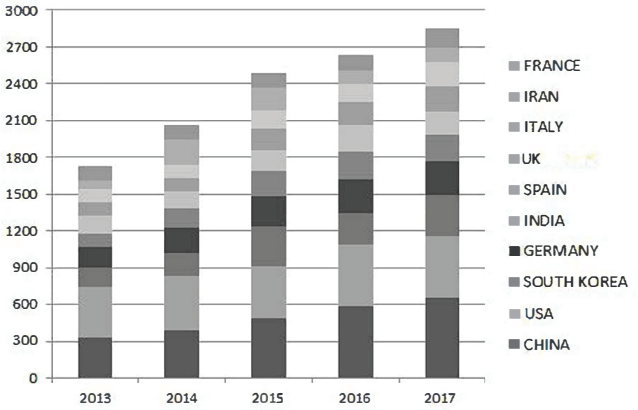

Fig. 6.13: Papers published in the industrial engineering journals from 2013 to 2017

Correlation analysis

The Pearson's correlation coefficient was applied to find the relationships between the indicators that reflected journal influence. The bivariate correlate analysis was conducted using SPSS 21.0. In statistics, Pearson's correlation coefficient is the covariance of the two variables divided by the product of their standard deviations. The definition involves covariance which is the

Correlations

		Total cites	Impact factor	Five-year impact factor	Immediacy index	Articles in citable item	Cited half-life	Eigenfactor score	Article influence score
Total cites	Pearson Correlation	1	.517**	.403**	.508**	.095	.065	.896**	.411**
	Sig. (2-tailed)		.000	.001	.000	.457	.608	.000	.001
	N	64	64	64	64	64	64	64	64
Impact factor	Pearson Correlation	.517**	1	.819**	.769**	-.177	-.092	.525**	.827**
	Sig. (2-tailed)	.000		.000	.000	.161	.472	.000	.000
	N	64	64	64	64	64	64	64	64
Five-year impact factor	Pearson Correlation	.403**	.819**	1	.669**	-.077	.020	.434**	.751**
	Sig. (2-tailed)	.001	.000		.000	.543	.873	.000	.000
	N	64	64	64	64	64	64	64	64
Immediacy index	Pearson Correlation	.508**	.769**	.669**	1	.000	-.041	.556**	.729**
	Sig. (2-tailed)	.000	.000	.000		.997	.747	.000	.000
	N	64	64	64	64	64	64	64	64
Articles in citable item	Pearson Correlation	.095	-.177	-.077	.000	1	.131	.112	.008
	Sig. (2-tailed)	.457	.161	.543	.997		.301	.377	.947
	N	64	64	64	64	64	64	64	64
Cited half-life	Pearson Correlation	.065	-.092	.020	-.041	.131	1	-.130	-.001
	Sig. (2-tailed)	.608	.472	.873	.747	.301		.306	.996
	N	64	64	64	64	64	64	64	64
Eigenfactor score	Pearson Correlation	.896**	.525**	.434**	.556**	.112	-.130	1	.519**
	Sig. (2-tailed)	.000	.000	.000	.000	.377	.306		.000
	N	64	64	64	64	64	64	64	64
Article influence score	Pearson Correlation	.411**	.827**	.751**	.729**	.008	-.001	.519**	1
	Sig. (2-tailed)	.001	.000	.000	.000	.947	.996	.000	
	N	64	64	64	64	64	64	64	64

**. Correlation is significant at the 0.01 level (2-tailed).

Fig. 6.14: Pearson correlation coefficients of the JCR Data and Eigenfactor Metrics

overall error of the two variables and the standard deviation and which is equal to the square root of the arithmetic mean of the mean squared.

From Fig. 6.14 it can be seen that the correlation coefficient between total cites and the eigenfactor was 0.896, which is the maximal value between these factors, indicating that there was a strong correlation between these two factors. The second largest correlation coefficient was 0.827 between the article influence score and the impact factor. The Pearson's correlation coefficient for impact factor and five-year impact factor was 0.819, indicating a strong correlation; the immediacy index had a correlation coefficient of 0.769 with the impact factor. The Pearson's correlation coefficient of the five-year impact factor and the article influence score was 0.751, and 0.729 for the immediacy index and the article influence score.

The coefficient between five-year impact factor and immediacy index was 0.669. The coefficient of total cites and impact factor, five-year impact factor, immediacy index and article influence score are in between (0.4-0.6), which indicated that the corresponding indicator was moderately related. However, the articles in citable item and the cited half-life were found to have very weak relationships with the other six indexes. The index for the articles in citable item and the cited half-life have very low correlation coefficients, below 0.2, with the other indexes.

Principal Component Analysis of the Journal Evaluation Indicators

Correlation studies have shown that as there are high correlation coefficients between these indicators, it is redundant to use them all because of the exclusiveness principle. However, which indicators should be adopted to evaluate a journal and what attributes do these indicators depict? To answer these questions, after the correlation analyses, a principal component analysis was conducted in IBM SPSS software. The related command was: Analyze → Dimension Reduction → Factor. The objective of factor analysis is to identify the independent latent variables. Adherents of these methods believe that the information gained about these interdependencies between the observed variables can be used to reduce the set of variables in a dataset. To track more information, all five years of the impact factors (2013-2017), the five-year impact factors, the immediacy indexes, and the article in citable item, cited half-life, eigenfactor, and article influence scores were considered concurrently.

KMO and Bartlett's Test

	Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.751
Bartlett's Test of Sphericity	Approx. Chi-Square	728.350
	df	66
	Sig.	.000

Fig. 6.15: Pearson correlation coefficients for the JCR Data and Eigenfactor Metrics

Fig. 6.15 shows the overall KMO and Bartlett's Test table for the factor output, with KMO value being 0.751. The significance probability for the Bartlett's Test, which is used to test if the samples are from populations with equal variances, was 0.000 which showed that these indicators were suitable for the principal component analysis; KMO values greater than 0.6 can be considered adequate for variables to have component or factor analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.880	40.669	40.669	4.880	40.669	40.669
2	3.320	27.667	68.336	3.320	27.667	68.336
3	1.153	9.609	77.944	1.153	9.609	77.944
4	.999	8.326	86.271			
5	.628	5.231	91.501			
6	.422	3.513	95.015			
7	.284	2.364	97.379			
8	.162	1.353	98.732			
9	.060	.498	99.230			
10	.039	.321	99.551			
11	.032	.264	99.815			
12	.022	.185	100.000			

Extraction Method: Principal Component Analysis.

Fig. 6.16: Pearson correlation coefficients of the JCR Data and Eigenfactor Metrics

After the principal component extraction procedure, a rotated quartimax transformation was used as this has been shown to perform best in making component loadings incline to ± 1 or 0; therefore, it can explain the factors' practical meanings. Quartimax rotation maximizes the variance of the squared factor loadings in each variable which means it simplifies the loading matrix rows. In other words, the quartimax minimizes the number of factors needed to explain each variable. In the quartimax rotation, there are often many variables in the first rotated factor; therefore, this method is not always helpful. The explained eigenvalue and total variance are shown in Fig. 6.16.

In this work, these three major components were chosen as the best solution to explain the data variability. As shown in Fig. 6.17, the total initial eigenvalues for the top three components were higher than any of the other components. The cumulative extraction sums of squared loadings for components 1 to 3 attained 77.944% of the total variance of the initial eigenvalues and the extraction sums of squared loadings, which was considered satisfactory, as shown in Fig. 6.16.

As can be seen in Fig. 6.18, the impact factors from 2013 to 2017 fell into the first component; total cites, five-year impact factor, the immediacy index, the eigenfactor score, and the article influence score fell into the second component; and the articles in citable item and the cited half-life fell into the

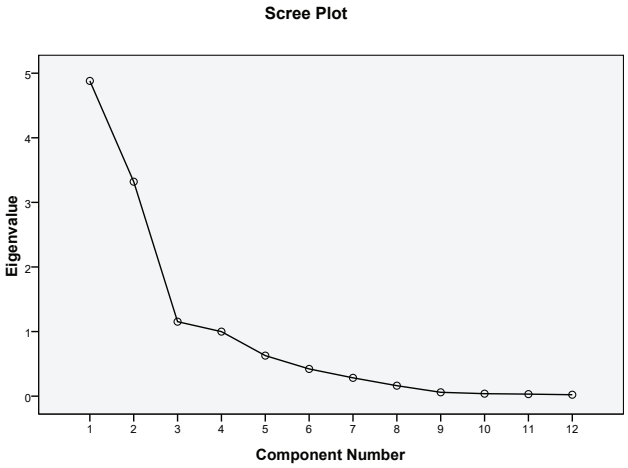

Fig. 6.17: Pearson correlation coefficients for the JCR Data and Eigenfactor Metrics

Component Matrix[a]

	Component		
	1	2	3
Total cites	.201	.852	.215
Five-year impact factor	.398	.651	-.236
Immediacy index	.266	.786	-.159
Articles in citable item	.143	-.042	.859
Cited half-life	.165	.004	.498
Eigenfactor score	.165	.853	.169
Article influence score	.299	.768	-.060
2013 impact factor	.924	-.206	.012
2014 impact factor	.957	-.193	-.005
2015 impact factor	.966	-.174	-.019
2016 impact factor	.944	-.238	-.036
2017 impact factor	.923	-.255	-.082

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

Fig. 6.18: Pearson's correlation coefficients for the JCR Data and Eigenfactor Metrics

third component. This result was similar to the results from the correlation analysis. The interpretation of the components is as follows.

- The first component related to the journal integrated influence because the indicators that made up the first component all measured the influence of the impact every year and the articles published.
- The second component related to the total influence since the eigenfactor score, total cites, five-year impact factor and immediacy index provide measures of a journal's total influence and were related to the quantity of articles a journal published rather than measures of influence per article. The indicators in the first component, by contrast, measured the per-article influence of a given journal.
- The third component related to timeliness; that is, how topical and urgent the work was that was published in the scientific journal.

The correlation analysis showed the correlation coefficients between the indicators in each component (as shown in Table 6.14). Therefore, important indicators were chosen that reflected different characteristics in each component to describe the journals' general performance. In this paper, the impact factor in 2015 was chosen for the integrated impact component as it had more than a 96.6% loading. The eigenfactor score in the second component was also chosen as it had the highest loading in this component. Therefore, to understand the general performance of industrial engineering journals, their records can be examined based on the impact factor in 2015 and the eigenfactor score.

6.5 Total Summary

There were 64 journals focused on management science in industrial engineering, with 3, 10, 19, and 31 distributed in Zones A, B, C and D. Based on the journal ranking results in section 6.2, the top three most important journals were *IEEE Transactions on Industrial Informatics*, and the *Journal of Supply Chain Management*, and the *International Journal of Production Economics*, which had the highest comprehensive score and was ranked in Zone A. The statistical analysis conducted in 6.3 found that that *Technovation, Composites Part A-Applied Science and Manufacturing*, the *Journal*

of Business Logistics, the *International Journal of Advanced Manufacturing Technology* had outstanding performances for the eigenfactor score, the immediacy index and the five-year impact factor, indicating their substantial influence in this category.

The comprehensive discussion in section 6.4 found that the impact factor changes for the journals in Zones A-C from 2013 to 2017 had a straight upward trend, indicating that there had been an obvious increase in average paper quality and journal influence. However, the impact factor changes for the journals in zone D varied significantly, demonstrating the instability in the quality and quantity of the journals' published articles. The major industrial engineering contributing countries were China, the USA, South Korea, Germany and India, and the total papers published in this area increased almost linearly from 2012 to 2018.

Journal development trends

Table 6.24 shows the differences for the impact factor, five-year impact factor, immediacy index, eigenfactor score and article influence score. To resolve the problem of the different indicator dimensions, the data was standardized.

Most industrial engineering-related journals showed an upward trend. The difference between the standardized impact factor and the standardized five-year impact factor indicates the journal article citation frequency variations. In Table 6.24, as most of the Z-IFminusZ-IF5 values were positive, the impact factors for these journals were higher than the five-year impact factors, indicating that the cited frequency in the most recent two years was higher than in the first three years. The journals with negative citation development were *IEEE Transactions on Industrial Informatics, Journal of Supply Chain Management*, and *Cirp Annals-Manufacturing Technology*. Overall, therefore, most industrial engineering related journals had an upward trend.

The global influence of journals in this category is expected to continue to rise in the future. The difference between the standardized impact factor and the standardized immediacy index reveals the development distance in that journal's impact factors were larger than their immediacy indexes; for example, the *Journal of Supply Chain Management*, the *International Journal of Machine Tools & Manufacture, Technovation*, and the *Journal*

of Product Innovation Management, which indicates that it takes time for journals to consolidate their influence. However, many journals had higher immediacy indexes than impact factors such as the *International Journal of Production Economics*, and the *Composites Part A-Applied Science and Manufacturing*, and the *Journal of Product Innovation Management*, which indicates that these journals were focused on popular research areas and had very high quality in 2017.

The developing trend of journals in this field is promising. The difference between the standardized five-year impact factor and the standardized eigenfactor score reveals the journals' self-cited situations. When the difference is larger, this indicates that the journal has a higher self citation degree. However, in the industrial engineering category, many journals had a positive Z-IF5minusZ-E value, meaning that most related journals had a relatively low self-citation degree but that the papers published in these journals had been cited in other high-quality journals. Generally, this shows that the development trend for journals in this field is promising.

Table 6.24: Journals in “industrial engineering” category

Full Journal Title	ISSN	JCR Data				Standardized JCR data				Z-IF minusZ-IF5	Z-IF minusZ-II	Z-IF5 minusZ-E
		Impact Factor	Five-year Impact Factor	Immediacy Index	Eigenfactor Score	Z-IF	Z-IF5	Z-II	Z-E			
IEEE Transactions on Industrial Informatics	1551-3203	5.43	7.227	0.02301	1.417	2.32785	2.67408	2.81491	2.86625	-0.34623	-0.48706	-0.19217
Journal of Supply Chain Management	1523-2409	6.105	8.026	0.00259	1.1	2.82306	3.14447	-0.31057	1.95459	-0.32141	3.13363	1.18988
International Journal of Production Economics	0925-5273	4.407	4.976	0.0226	0.865	1.57733	1.34871	2.75216	1.27875	0.22862	-1.17483	0.06996
International Journal of Machine Tools & Manufacture	0890-6955	5.106	5.905	0.0081	0.964	2.09015	1.8957	0.53279	1.56346	0.19445	1.55736	0.33224
Composites Part A-Applied Science and Manufacturing	1359-835X	4.514	4.483	0.018	1.235	1.65583	1.05837	2.04808	2.34283	0.59746	-0.39225	-1.28446
Technovation	0166-4972	4.802	5.407	0.00322	0.679	1.86712	1.60248	-0.21414	0.74383	0.26464	2.08126	0.85865
IEEE-Asme Transactions on Mechatronics	1083-4435	3.936	4.306	0.0111	0.833	1.23179	0.95421	0.99197	1.18672	0.27758	0.23982	-0.23251
Journal of Materials Processing Technology	0924-0136	3.647	3.817	0.01891	0.926	1.01976	0.66629	2.18737	1.45418	0.35347	-1.16761	-0.78789
Journal of Product Innovation Management	0737-6782	4.305	4.926	0.00562	0.571	1.5025	1.31927	0.1532	0.43323	0.18323	1.3493	0.88604
Computers & Operations Research	0305-0548	2.962	3.174	0.01751	0.809	0.51722	0.28764	1.97308	1.1177	0.22958	-1.45586	-0.83006
International Journal of Advanced Manufacturing Technology	0268-3768	2.601	2.748	0.02877	0.402	0.25237	0.03687	3.69654	-0.0528	0.2155	-3.44417	0.08967
Computers & Industrial Engineering	0360-8352	3.195	3.442	0.01514	0.463	0.68816	0.4455	1.61033	0.12263	0.24266	-0.92217	0.32287
Cirp Annals-Manufacturing Technology	0007-8506	3.333	4.074	0.00745	0.207	0.7894	0.81755	0.4333	-0.6136	-0.02815	0.3561	1.43115
International Journal of Physical Distribution & Logistics Management	0960-0035	4.215	4.181	0.00175	0.467	1.43647	0.88061	-0.43914	0.13413	0.55586	1.87561	0.74648
Robotics and Computer-Integrated Manufacturing	0736-5845	3.464	4.031	0.0042	1.097	0.88551	0.79224	-0.06414	1.94596	0.09327	0.94965	-1.15372
International Journal of Production Research	0020-7543	2.623	2.78	0.01699	0.69	0.26851	0.05571	1.89349	0.77546	0.2128	-1.62498	-0.71975
Journal of Manufacturing Systems	0278-6125	3.699	3.621	0.0037	0.486	1.05791	0.55089	-0.14067	0.18878	0.50702	1.19858	0.36211
International Journal of Precision Engineering and Manufacturing-Green Technology	2288-6206	3.774	3.949	0.00135	0.4	1.11294	0.74396	-0.50036	-0.05855	0.36898	1.6133	0.80251
Journal of Business Logistics	0735-3766	2.891	4.19	0.00137	1.353	0.46513	0.88591	-0.4973	2.68219	-0.42078	0.96243	-1.79628
Production and Operations Management	1059-1478	1.772	2.921	0.0095	0.379	-0.35582	0.13868	0.74708	-0.11895	-0.4945	-1.1029	0.25763
Flexible Services and Manufacturing Journal	1936-6582	2.346	3.129	0.00157	0.333	0.06529	0.2612	-0.46669	-0.25124	-0.19591	0.53198	0.51244
Journal of Manufacturing Processes	1526-6125	2.809	2.939	0.00339	0.547	0.40497	0.07279	-0.18812	0.36421	0.33218	0.59309	-0.29142
Applied Ergonomics	0003-6870	2.435	2.663	0.00666	0.777	0.13059	-0.01323	0.31239	1.02567	0.14382	-0.1818	-1.0389
Precision Engineering-Journal of The International Societies For Precision Engineering and Nanotechnology	0141-6359	2.582	2.684	0.00453	0.544	0.23843	-0.00081	-0.01363	0.35558	0.23924	0.25206	-0.35639
Journal of Quality Technology	0022-4065	2.306	2.636	0.00157	0.316	0.03595	-0.02907	-0.46669	-0.30013	0.06502	0.50264	0.27106
Research in Engineering Design	0934-9839	2.625	3.275	0.00081	0.5	0.26998	0.34711	-0.58301	0.22904	-0.07713	0.85299	0.11807
Journal of Engineering and Technology Management	0923-4748	2.686	3.213	0.00098	0.263	0.31473	0.31066	-0.55699	-0.45255	0.00407	0.87172	0.76321
Journal of Manufacturing Science and Engineering-Transactions of The Asme	1087-1357	2.578	2.574	0.00418	0.446	0.2355	-0.06564	-0.0672	0.07374	0.30114	0.3027	-0.13938
Industrial Management & Data Systems	0263-5577	2.948	2.724	0.00174	0.431	0.50695	0.02274	-0.44067	0.0306	0.48421	0.94762	-0.00786
IIE Transactions	0740-817X	1.759	2.152	0.00496	0.182	-0.36535	-0.31405	0.05218	-0.6855	-0.0513	-0.41753	0.37145
Ergonomics	0014-0139	2.019	2.183	0.00596	0.42	-0.17461	-0.29586	0.20524	-0.00103	0.12125	-0.37985	-0.29483
Production Planning & Control	0953-7287	2.33	2.933	0.00226	0.247	0.05356	0.14574	-0.36108	-0.49857	-0.09218	0.41464	0.64431
Decision Sciences	0011-7315	1.641	2.479	0.00207	0.243	-0.45192	-0.12151	-0.39016	-0.51007	-0.13041	-0.06176	0.38856
Journal of Manufacturing Technology Management	1741-038X	2.194	2.194	0.00067	0.429	-0.04622	-0.28932	-0.60444	0.02485	0.2431	0.55822	-0.31417
International Journal of Computer Integrated Manufacturing	0951-192X	1.995	2.016	0.00217	0.778	-0.19221	-0.39412	-0.37485	1.02854	0.20191	0.18264	-1.42266
Quality and Reliability Engineering International	0748-8017	1.604	1.821	0.00392	0.337	-0.47907	-0.50894	-0.107	-0.23973	0.02987	-0.37207	-0.26921
IEEE Transactions on Components Packaging and Manufacturing Technology	2156-3950	1.332	1.662?	0.00649	0.304	-0.67862		0.28637	-0.33464	-0.67862	-0.96499	0.33464
IEEE Transactions on Engineering Management	0018-9391	1.416	2.087	0.00173	0.196	-0.61699	-0.35232	-0.4422	-0.64524	-0.26467	-0.17479	0.29292
Engineering Economist	0013-791X	2	1.705	0.00038	0.056	-0.18855	-0.57724	-0.64883	-1.04787	0.38869	0.46028	0.47063
International Journal of Simulation Modelling	1726-4529	1.942	1.76	0.0008	0.15	-0.2311	-0.54486	-0.58455	-0.77753	0.31376	0.35345	0.23267
Journal of Scheduling	1094-6136	1.153	1.402	0.00214	0.209	-0.80994	-0.7557	-0.37944	-0.60785	-0.05424	-0.4305	-0.14785
International Journal of Industrial Ergonomics	0169-8141	1.429	1.607	0.00217	0.275	-0.60746	-0.63494	-0.37485	-0.41804	0.02748	-0.23261	-0.2169
International Journal of Design	1991-3761	1.161	1.938	0.00056	0.067	-0.80261	-0.44011	-0.62128	-1.01623	-0.3625	-0.18133	0.57612
Advances in Production Engineering & Management	1854-6250	1.596	1.596	0.0003	0.412	-0.48494	-0.64142	-0.66107	-0.02404	0.15648	0.17613	-0.61738
Machining Science and Technology	1091-0344	1.339	1.658	0.00069	0.061	-0.67348	-0.60497	-0.60138	-1.03349	-0.06851	-0.0721	0.42852
Journal of Computing and Information Science in Engineering	1530-9827	1.588	1.49	0.00072	0.145	-0.49081	-0.70383	-0.59679	-0.79191	0.21302	0.10598	0.08808
Advances in Manufacturing	2095-3127	1.706	1.325	0.00047	0.027	-0.40424	-0.80098	-0.63505	-1.13127	0.39674	0.23081	0.33029
Quality Engineering	0898-2112	1.238	1.351	0.00109	0.288	-0.74758	-0.78567	-0.54016	-0.38065	0.03809	-0.20742	-0.40502
IEEE Transactions on Semiconductor Manufacturing	0894-6507	1.336	1.199	0.00135	0.057	-0.67569	-0.87517	-0.50036	-1.04499	0.19948	-0.17533	0.16982
Industrial Robot-The International Journal of Robotics Research and Application	0143-991X	1.205	1.213	0.00097	0.096	-0.77179	-0.86693	-0.55852	-0.93283	0.09514	-0.21327	0.0659
Issues in Science and Technology	0748-5492	1.03	1.013	0.00086	0.147	-0.90018	-0.98474	-0.57536	-0.78616	0.08456	-0.32482	-0.19858
Ai Edam-Artificial Intelligence For Engineering Design Analysis and Manufacturing	0890-0604	1.045	1.288	0.00057	0.647	-0.88918	-0.82277	-0.61975	0.6518	-0.06641	-0.26943	-1.47457
Probability in The Engineering and Informational Sciences	0269-9648	0.803	0.816	0.00103	0.2	-1.06672	-1.10074	-0.54934	-0.63373	0.03402	-0.51738	-0.46701
European Journal of Industrial Engineering	1751-5254	1.085	1.056	0.00056	0.147	-0.85983	-0.95937	-0.62128	-0.78616	0.09954	-0.23855	-0.17321
IEEE Industry Applications Magazine	1077-2618	0.864	1.004	0.00092	0.575	-1.02197	-0.98998	-0.56618	0.44473	-0.03199	-0.45579	-1.43471
Soldering & Surface Mount Technology	0954-0911	1.137	1.057	0.00024	0.148	-0.82168	-0.95884	-0.67026	-0.78328	0.13716	-0.15142	-0.17556
Systems Engineering	1098-1241	0.797	1.176	0.00056	0.133	-1.07112	-0.88877	-0.62128	-0.82642	-0.18235	-0.44984	-0.06235
Human Factors and Ergonomics in Manufacturing & Service Industries	1090-8471	0.917	0.964	0.00063	0.111	-0.98308	-1.0136	-0.61057	-0.88969	0.03052	-0.37251	-0.12391
Quality Technology and Quantitative Management	1684-3703	0.662	1.006	0.0006	0.111	-1.17016	-0.98881	-0.61516	-0.88969	-0.18135	-0.555	-0.09912
International Journal of Industrial Engineering-Theory Applications and Practice	1943-670X	0.565	0.705	0.00035	0.022	-1.24132	-1.16609	-0.65342	-1.14565	-0.07523	-0.5879	-0.02044
Journal of Advanced Mechanical Design Systems and Manufacturing	1881-3054	0.503	0.54	0.00071	0.036	-1.28681	-1.26319	-0.59832	-1.10538	-0.02362	-0.68849	-0.15781
Engineering Management Journal	1042-9247	0.487	0.771	0.00008	0.091	-1.29855	-1.12717	-0.69475	-0.94721	-0.17138	-0.6038	-0.17996
South African Journal of Industrial Engineering	2224-7890	0.409	0.485	0.00026	0.043	-1.35577	-1.29563	-0.6672	-1.08525	-0.06014	-0.68857	-0.21038
Manufacturing Engineering	0361-0853	0.063	0.073	0.00007	0.013	-1.60961	2.71701	-0.69628	-1.17153	-4.32662	-0.91333	3.88854

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Chapter 7
Energy Engineering

This chapter uses a series of scientific methods to thoroughly understand the world's energy engineering-related journals. First, based on a literature survey and data collection, descriptions for energy engineering, energy engineers, energy efficiency, and energy systems are determined. Then, to classify the influence of each journal, starting from the five-year impact factor, a ranking of the journals is conducted and statistical software used to analyze and describe the relevant indexes. On the basis of the ranking report, the journals are then divided into four zones to clarify their impact. Finally, a statistical analysis of the energy-related papers published by the world's major countries/regions over the past five-years is conducted. The results of this comprehensive and systematic interpretation of energy-related journals identified possible research directions, thereby providing a journal selection channel for researchers.

7.1 Category Description

Energy engineering is a broad field of engineering dealing with energy efficiency, energy services, facilities management, plant engineering, environmental compliance and alternative energy technologies [13, 9]. This category combines knowledge of physics, math, and chemistry with economic and environmental engineering practices. Energy engineers apply their skill-

s to increase efficiency and further develop energy sources [11]. The main focus is on finding the most efficient and sustainable ways to operate buildings and manufacturing processes. Energy engineers audit the use of energy in these processes and suggest ways to improve the systems. This means suggesting such innovations as advanced lighting, better insulation, and more efficient heating and cooling properties for buildings [4]. Although an energy engineer is concerned about obtaining and using energy in the most environmentally friendly ways, their field is not strictly limited to renewable energy such as hydro, solar, biomass, or geothermal, as energy engineers are also employed in oil and natural gas extraction [16].

Energy systems are primarily designed to supply energy-services to the end-users [6]. Taking a structural viewpoint, the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report defined an energy system as "all components related to the production, conversion, delivery, and use of energy" [1]. The field of energy economics includes energy markets and treats the energy system as technical and economic systems that satisfy the consumer demand for energy in the forms of heat, fuel, and electricity [7]. The first two definitions allow for demand-side measures, such as daylighting, retrofitted building insulation, and passive solar building design, as well as socio-economic factors, such as energy demand management and telecommunications; however, the third does not and also does not account for the informal economy in traditional biomass that has become significant in many developing countries [15]. The analysis of energy systems therefore spans the engineering and economics disciplines [10]and seeks to merge ideas from both areas to form a coherent description, which can be particularly challenging when macroeconomic dynamics are involved [3, 8]. The concept of an energy system is still evolving as new regulations, technologies, and practices emerge; for example, emissions trading, the development of smart grids, and the greater use of energy demand management are changing the way energy is being managed.

Energy technology is an interdisciplinary engineering science that deals with the efficient, safe, environmentally friendly and economical extraction, conversion, transportation, storage and use of energy, with a focus on high efficiency and low side effects on humans, nature and the environment. For people, energy is an overwhelming need and as a scarce resource, it has been an underlying cause of political conflicts and wars. The gathering and use of

energy resources can be harmful to local ecosystems and may have global outcomes.

Energy efficiency can be seen in two ways. The first view is that more work is done with the same amount of energy, and the other is that the same amount of work can be accomplished using less energy. Some ways to get more work out of less energy are to "Reduce, Reuse, and Recycle" the materials used in daily life. The technological advancement has led to other uses for waste, with technology such as waste-to-energy facilities being established to convert solid wastes to liquid fuels using gasification or pyrolysis so they can be burned. The Environmental Protection Agency stated that the United States produced 250 million tons of municipal waste in 2010, of which roughly 54% ends up in landfills, 33% is recycled, and 13% goes to energy recovery plants [2]. Europe, however, pays more for fuel; for example, in Denmark the price of a gallon of gas was nearly $10 in 2010; therefore, there are more fully developed waste-to energy facilities [14]. In 2010, Denmark sent 7% of waste to landfills, 69% was recycled, and 24% was sent to waste-to-energy facilities. Several other developed Western European countries are also employing energy engineering processes [12]. Germany's "Energiewende", for example, is a policy to meet 80% of all energy needs from renewable energy sources by 2050 [5].

7.2 Ranking Report

Four indexes were selected to evaluate the quality and academic level of the journals: impact factor, five-year impact factor, eigenfactor score and article influence score. The impact factor, regarded as an internationally accepted journal evaluation index, refers to the frequency of a journal's articles being cited in a particular period, and is an important indicator to measure the influence of academic journals. The five-year impact factor refers to the total number of papers cited in the previous five years of a journal divided by the total number of papers published in the previous five years of the journal, which represents the average citation rate for the papers. The eigenfactor score measures the citation of papers published in the past five years in the JCR statistical year. The eigenfactor score is the ratio of the citation frequency to the total number of papers, and also establishes a mathemati-

cal model for the time spent by researchers on each journal. The eigenfactor score considers citations five years after the publication of the journal papers, while the impact factor only counts the citation times for two years and therefore does not objectively reflect the peak year for the citation of journal articles. The article influence score measures the relative importance of journals based on each paper, and is calculated by dividing the article influence score by the standardized ratio of papers published in the journal. The average paper impact score is 1, therefore a score greater than 1.00 indicates that the influence of each paper in the journal is higher than average, and a score less than 1.00 indicates that the influence of each paper in the journal is lower than average.

Therefore, these four indexes were used to build a new evaluation model, with the weights of each index expertly scored: impact factor (0.3), five-year impact factor (0.3), eigenfactor score (0.2) and article influence score (0.2). As these four indexes have different dimensions, the data were standardized, as shown in Table 7.1, to compute the comprehensive journal scores. The comprehensive scores directly characterized the level of the journals; therefore, the 65 energy engineering journals were divided into four zones: A, B, C, and D. Journals with comprehensive scores in the top 5% were allocated to Zone A, scores between 6% and 20% were allocated to Zone B, scores between 21% and 50% were allocated to Zone C, and the remaining 50% were allocated to Zone D.

As shown in Table 7.2, 3 journals; *Nature Energy, Energy & Environmental Science*, and *Renewable & Sustainable Energy Reviews*; were in Zone A. *Nature Energy* is a monthly, online-only journal that publishes the best research on energy from generation and distribution to the impacts energy technologies and policies have on society. *Energy & Environmental Science* links all aspects of the chemical, physical, and biotechnological sciences relating to energy conversion and storage, alternative fuel technologies and environmental science. *Renewable & Sustainable Energy Reviews* shares problems, solutions, novel ideas, and technologies to support the transition to a low-carbon future and achieve the global emissions targets established by the United Nations Framework Convention on Climate Change.

As can be seen in Table 7.3, there were 10 journals in Zone B. *Applied Energy* includes research and development on energy conversion and conservation, the optimal use of energy resources, the optimization of energy processes, the mitigation of environmental pollutants, and sustainable

Table 7.1: Comprehensive scores of "energy engineering" journals

Rank	Full Journal Title	ISSN	JCR Data			Eigenfactor Metrics		Standardization				Comprehensive score
			Impact Factor	Five-Year Impact Factor	Eigenfactor Score	Article Influence Score	Z-Impact Factor	Z-5-Year Impact Factor	Z-Eigenfactor Score	Z-Article Influence Score		
1	Nature Energy	2058-7546	46.859	46.87	0.02043	16.117	6.45845	6.49769	-0.05291	7.19636	5.315532	
2	Energy & Environmental Science	1754-5692	30.067	28.924	0.18032	7.072	3.91641	3.74897	4.26946	2.87687	3.72888	
3	Renewable & Sustainable Energy Reviews	1364-0321	9.184	10.093	0.10857	1.735	0.75505	0.86469	2.32982	0.32816	1.017518	
4	Journal of Power Sources	0378-7753	6.945	6.686	0.14072	1.200	0.41611	0.34286	3.19894	0.07267	0.882013	
5	Applied Energy	0306-2619	7.9	7.888	0.10398	1.310	0.56068	0.52696	2.20573	0.1252	0.792478	
6	Bioresource Technology	0960-8524	5.807	5.978	0.10945	0.973	0.24383	0.23441	2.35361	-0.03574	0.607046	
7	Energy	0360-5442	4.968	5.582	0.07658	0.951	0.11682	0.17376	1.46502	-0.04624	0.37093	
8	Energy Conversion and Management	0196-8904	6.377	6.161	0.05542	1.007	0.33012	0.26244	0.89299	-0.0195	0.352466	
9	Journal of Cleaner Production	0959-6526	5.651	6.352	0.05542	0.816	0.22021	0.2917	0.89299	-0.11071	0.310029	
10	IEEE Transactions on Sustainable Energy	1949-3029	6.235	7.261	0.01859	1.922	0.30862	0.43093	-0.10265	0.41746	0.284827	
11	International Journal of Hydrogen Energy	0360-3199	4.229	4.064	0.08137	0.570	0.00495	-0.05875	1.59451	-0.22819	0.257124	
12	Renewable Energy	0960-1481	4.9	4.981	0.04828	0.925	0.10653	0.08171	0.69997	-0.05866	0.184734	
13	Environmental Science & Technology Letters	2328-8930	5.869	6.687	0.00627	1.978	0.25322	0.34301	-0.4357	0.44421	0.180571	
14	Energy Policy	0301-4215	4.039	5.038	0.04668	0.994	-0.02382	0.09044	0.65672	-0.02571	0.146188	
15	Global Change Biology Bioenergy	1757-1693	5.415	5.788	0.00833	1.523	0.18449	0.20531	-0.38002	0.22692	0.08632	
16	Energy and Buildings	0378-7788	4.457	4.779	0.03447	0.683	0.03946	0.05077	0.32664	-0.17423	0.057551	
17	Applied Thermal Engineering	1359-4311	3.771	3.929	0.04757	0.675	-0.06439	-0.07942	0.68078	-0.17805	0.057403	
18	Building and Environment	0360-1323	4.539	5.221	0.02166	0.902	0.05188	0.11847	-0.01966	-0.06964	0.033245	
19	Solar Energy	0038-092X	4.374	4.831	0.02783	0.799	0.0269	0.05873	0.14714	-0.11883	0.031351	
20	Energy & Fuels	0887-0624	3.024	3.622	0.04650	0.744	-0.17747	-0.12644	0.65185	-0.1451	0.010177	
21	Resources Conservation and Recycling	0921-3449	5.12	5.228	0.00862	0.807	0.13983	0.11954	-0.37218	-0.11501	-0.019627	
22	IEEE Transactions on Energy Conversion	0885-8969	3.767	4.582	0.01243	1.351	-0.06499	0.02059	-0.26918	0.14478	-0.0382	
23	Biomass & Bioenergy	0961-9534	3.358	4.232	0.02322	0.888	-0.12691	-0.03301	0.02251	-0.07633	-0.05874	
24	Biofuels Bioproducts & Biorefining-Biofpr	1932-104X	3.376	5.289	0.00434	1.198	-0.12418	0.12888	-0.48788	0.07171	-0.081824	
25	International Journal of Life Cycle Assessment	0948-3349	4.195	4.881	0.00708	0.773	-0.0002	0.06639	-0.41381	-0.13125	-0.089155	
26	Ecological Engineering	0925-8574	3.023	3.43	0.02070	0.647	-0.17762	-0.15585	-0.04561	-0.19142	-0.147447	
27	IET Renewable Power Generation	1752-1416	3.488	3.76	0.00548	0.794	-0.10723	-0.10531	-0.45706	-0.12122	-0.179418	
28	Bioenergy Research	1939-1234	2.938	3.482	0.00724	0.840	-0.19049	-0.14789	-0.40948	-0.09925	-0.20326	
29	Energies	1996-1073	2.676	3.045	0.01847	0.468	-0.23015	-0.21482	-0.1059	-0.2769	-0.210051	
30	Journal of the Energy Institute	1743-9671	4.217	3.063	0.00196	0.595	0.00313	-0.21206	-0.55222	-0.21625	-0.216373	
31	Journal of Natural Gas Science and Engineering	1875-5100	2.803	2.815	0.01498	0.616	-0.21093	-0.25005	-0.20024	-0.20622	-0.219586	
32	Wind Energy	1095-4244	2.938	3.297	0.00554	0.747	-0.19049	-0.17622	-0.45544	-0.14366	-0.229833	
33	Energy Science & Engineering	2050-0505	3.553	3.216	0.00099	0.647	-0.09739	-0.18863	-0.57844	-0.19142	-0.239778	
34	Journal of Petroleum Science and Engineering	0920-4105	2.382	2.739	0.01376	0.667	-0.27466	-0.26169	-0.23322	-0.18187	-0.243923	
35	Energy Technology	2194-4288	3.175	2.938	0.00465	0.656	-0.15461	-0.23121	-0.4795	-0.18712	-0.24907	
36	Energy for Sustainable Development	0973-0826	2.658	3.221	0.00358	0.691	-0.23288	-0.18786	-0.50842	-0.17041	-0.261988	
37	Energy Journal	0195-6574	2.132	2.675	0.00330	1.038	-0.31251	-0.27149	-0.51599	-0.00469	-0.279336	
38	International Journal of Energy Research	0363-907X	3.009	2.671	0.00553	0.493	-0.17974	-0.27211	-0.45571	-0.26496	-0.279689	
39	Stochastic Environmental Research and Risk Assessment	1436-3240	2.668	2.645	0.00589	0.608	-0.23136	-0.27609	-0.44598	-0.21004	-0.283439	
40	Wiley Interdisciplinary Reviews-Energy and Environment?	2041-8396	2.514	2.857	0.00160	0.640	-0.25468	-0.24362	-0.56195	-0.19476	-0.300832	
41	Journal of the American Water Resources Association?	1093-474X	2.16	2.338	0.00451	0.629	-0.30827	-0.32311	-0.48328	-0.20001	-0.326072	
42	Energy Strategy Reviews	2211-4672	2.164	2.547	0.00143	0.648	-0.30766	-0.2911	-0.56655	-0.19094	-0.331126	
43	Petroleum Exploration and Development	1000-0747	2.065	2.464	0.00424	0.567	-0.32265	-0.30381	-0.49058	-0.22962	-0.331978	
44	Combustion Theory and Modelling	1364-7830	1.744	2.029	0.00205	0.729	-0.37124	-0.37044	-0.54979	-0.15226	-0.362914	
45	Greenhouse Gases-Science and Technology	2152-3878	1.991	2.312	0.00160	0.496	-0.33385	-0.32709	-0.56195	-0.26353	-0.363378	
46	Journal of the Air & Waste Management Association	1096-2247	1.742	1.95	0.00442	0.501	-0.37155	-0.38254	-0.48572	-0.26114	-0.375599	
47	Journal of Energy Resources Technology-Transactions of The Asme	0195-0738	2.197	2.091	0.00176	0.313	-0.30267	-0.36094	-0.55762	-0.35092	-0.380791	
48	Energy Sustainability and Society	2192-0567	1.625	1.625	0.00081	0.818	-0.38926	-0.43232	-0.58331	-0.10976	-0.385088	
49	Energy Efficiency	1570-646X	1.634	2.035	0.00163	0.379	-0.38789	-0.36952	-0.56114	-0.3194	-0.403331	
50	Journal of Solar Energy Engineering-Transactions of the Asme	0199-6231	1.367	1.859	0.00223	0.353	-0.42831	-0.39648	-0.54492	-0.33182	-0.422785	
51	Biomass Conversion and Biorefinery	2190-6815	1.31	1.31	0.00077	0.665	-0.43694	-0.48056	-0.58439	-0.18282	-0.428692	
52	Journal of Environmental Science and Health Part A-Toxic/Hazardous Substances & Environmental Engineering	1093-4529	1.561	1.469	0.00381	0.294	-0.39895	-0.45621	-0.50221	-0.36	-0.42899	
53	Environmental Progress & Sustainable Energy	1944-7442	1.326	1.721	0.00337	0.286	-0.43452	-0.41761	-0.5141	-0.36382	-0.431223	
54	Journal of Renewable and Sustainable Energy	1941-7012	1.337	1.342	0.00446	0.264	-0.43286	-0.47566	-0.48463	-0.37432	-0.444346	
55	Journal of Energy Engineering	0733-9402	1.346	1.632	0.00115	0.287	-0.43149	-0.43125	-0.57412	-0.36334	-0.446314	
56	SPE Production & Operations	1930-1855	1.162	1.244	0.00096	0.407	-0.45935	-0.49067	-0.57925	-0.30603	-0.462062	
57	International Journal of Low-Carbon Technologies	1748-1317	0.837	0.837	0.00102	0.716	-0.50855	-0.55301	-0.57763	-0.15847	-0.465688	
58	International Journal of Green Energy	1543-5075	1.171	1.333	0.00148	0.207	-0.45799	-0.47704	-0.56519	-0.40154	-0.473855	
59	Energy Exploration & Exploitation	0144-5987	1.204	1.223	0.00092	0.254	-0.45299	-0.49389	-0.58033	-0.3791	-0.47595	
60	Energy Sources Part B-Economics Planning and Policy	1556-7249	0.976	1.125	0.00083	0.176	-0.48751	-0.5089	-0.58277	-0.41635	-0.498747	
61	Frontiers in Energy	2095-1701	0.753	0.753	0.00050	0.409	-0.52126	-0.56588	-0.59169	-0.30508	-0.505496	
62	Proceedings of the Institution of Civil Engineers-Energy	1751-4223	0.771	0.978	0.00034	0.276	-0.51854	-0.53142	-0.59601	-0.36859	-0.507908	
63	Journal of Energy in Southern Africa	1021-447X	0.6	0.801	0.00030	0.122	-0.54443	-0.55853	-0.59709	-0.44214	-0.538734	
64	International Journal of Oil Gas and Coal Technology	1753-3309	0.563	0.695	0.00050	0.150	-0.55003	-0.57476	-0.59169	-0.42876	-0.541527	
65	Energy Sources Part A-Recovery Utilization and Environmental Effects	1556-7036	0.555	0.576	0.00228	0.103	-0.55124	-0.59299	-0.54357	-0.45121	-0.542225	

Table 7.2: "Energy engineering" journals in Zone A zone

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year Impact Factor	Immediacy Index	Articles	Cited Half-life	Eigenfactor Score	Article Influence Score
1	Nature Energy	2058-7546	5072	46.859	46.87	7.854	95.830	1.400	0.02043	16.117
2	Energy & Environmental Science	1754-5692	71920	30.067	28.924	6.517	91.530	4.200	0.18032	7.072
3	Renewable & Sustainable Energy Reviews	1364-0321	67014	9.184	10.093	2.354	2.390	3.800	0.10857	1.735

energy systems. *The IEEE Transactions on Sustainable Energy* is a cross-disciplinary, internationally archived journal for research on sustainable energy that relates to, arises from, or deliberately influences energy generation, transmission, distribution and delivery. *Energy Conversion and Management* provides a forum for interdisciplinary and original contributions on all important energy topics. *Bioresource Technology* publishes original articles, review articles, case studies and short communications on the fundamentals, applications, and management of bioresource technologies. *The Journal of Cleaner Production* is an international, transdisciplinary journal focused on cleaner production, and environmental, sustainability research and practice.

Table 7.3: "Energy engineering journals" in Zone B zone

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year Impact Factor	Immediacy Index	Articles	Cited Half-life	Eigenfactor Score	Article Influence Score
1	Journal of Power Sources	0378-7753	113385	6.945	6.686	1.732	98.170	5.600	0.14072	1.200
2	Applied Energy	0306-2619	63669	7.9	7.888	2.151	98.540	3.600	0.10398	1.310
3	Bioresource Technology	0960-8524	101191	5.807	5.978	1.108	94.870	6.000	0.10945	0.973
4	Energy	0360-5442	52650	4.968	5.582	0.984	99.170	4.400	0.07658	0.951
5	Energy Conversion and Management	0196-8904	43333	6.377	6.161	1.652	97.280	4.100	0.05542	1.007
6	Journal of Cleaner Production	0959-6526	45454	5.651	6.352	1.364	94.710	3.200	0.05542	0.816
7	IEEE Transactions on Sustainable Energy	1949-3029	6151	6.235	7.261	1.425	100.000	3.700	0.01859	1.922
8	International Journal of Hydrogen Energy	0360-3199	75123	4.229	4.064	1.057	97.990	5.000	0.08137	0.570
9	Renewable Energy	0960-1481	34315	4.9	4.981	1.234	98.280	5.000	0.04828	0.925
10	Environmental Science & Technology Letters	2328-8930	1660	5.869	6.687	1.290	96.770	2.800	0.00627	1.978

Table 7.4 shows the 20 journals in Zone C. *Renewable Energy* is a a leading peer-reviewed platform and an authoritative source of original research and reviews related to renewable energy. *Energy & Fuels* publishes reports on technical research at the intersection of the disciplines of chemistry and chemical engineering and the application domain of non-nuclear energy and fuels. *Bioenergy Research* focuses on the growing area of feedstock biological research for biomass, biofuels, and bioenergy and publishes a wide range of articles, including peer-reviewed scientific research, reviews, perspectives, and commentary, industry news, and government policy updates. *Applied Thermal Engineering* disseminates novel applied research on the development and demonstration of components, equipment, technologies and systems involving thermal processes for energy production, storage, utilization, and conservation.

Table 7.5, shows the 32 journals in Zone D. *The Journal of Energy Engineering* publishes scientific and engineering research on the planning, development, management, and financing of energy-related programs primar-

Table 7.4: "Energy engineering" journals in Zone C zone

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year Impact Factor Factor	Immediacy Index	Articles	Cited Half-life	Eigenfactor Score	Article Influence Score
1	Energy Policy	0301-4215	41513	4.039	5.038	0.915	98.990	6.700	0.04668	0.994
2	Global Change Biology Bioenergy	1757-1693	3144	5.415	5.788	1.984	91.800	3.800	0.00833	1.523
3	Energy and Buildings	0378-7788	31865	4.457	4.779	0.851	94.740	5.200	0.03447	0.683
4	Applied Thermal Engineering	1359-4311	35677	3.771	3.929	1.145	99.390	4.200	0.04757	0.675
5	Building and Environment	0360-1323	21261	4.539	5.221	1.000	95.630	6.800	0.02166	0.902
6	Solar Energy	0038-092X	29151	4.374	4.831	0.752	97.840	6.800	0.02783	0.799
7	Energy & Fuels	0887-0624	39505	3.024	3.622	0.462	98.420	7.000	0.04650	0.744
8	Resources Conservation and Recycling	0921-3449	9946	5.12	5.228	1.238	90.040	6.600	0.00862	0.807
9	IEEE Transactions on Energy Conversion	0885-8969	10798	3.767	4.582	0.771	100.000	9.400	0.01243	1.351
10	Biomass & Bioenergy	0961-9534	19706	3.358	4.232	0.574	97.130	6.600	0.02322	0.888
11	Biofuels Bioproducts & Biorefining-Biofpr	1932-104X	2918	3.376	5.289	0.921	69.860	6.000	0.00434	1.198
12	International Journal of Life Cycle Assessment	0948-3349	7025	4.195	4.881	1.179	96.550	6.300	0.00708	0.773
13	Ecological Engineering	0925-8574	14459	3.023	3.43	0.907	97.630	4.900	0.02070	0.647
14	IET Renewable Power Generation	1752-1416	3251	3.488	3.76	0.548	97.620	4.400	0.00548	0.794
15	Bioenergy Research	1939-1234	2846	2.938	3.482	0.411	93.680	4.200	0.00724	0.840
16	Energies	1996-1073	11350	2.676	3.045	0.630	95.330	2.800	0.01847	0.468
17	Journal of the Energy Institute	1743-9671	973	4.217	3.063	0.758	96.700	2.500	0.00196	0.595
18	Journal of Natural Gas Science and Engineering	1875-5100	5475	2.803	2.815	0.718	96.570	2.300	0.01498	0.616
19	Wind Energy	1095-4244	3668	2.938	3.297	0.705	100.000	5.900	0.00554	0.747
20	Energy Science & Engineering	2050-0505	368	3.553	3.216	0.478	95.650	2.500	0.00099	0.647

ily for the civil engineering projects that are either directly related to, or can ultimately contribute to the production, distribution, and storage of energy. *The International Journal of Oil Gas and Coal Technology* is a multidisciplinary refereed journal focusing on the exploration, production, processing, refining, storage, and transportation of oil, natural gas, coal and petrochemicals as well as the manufacturing and refining of biofuels. *WIREs Energy & Environment* is a new review journal focused on energy policy, science and technology, and environmental and climate impacts.

7.3 Statistical Analysis

In this section, a statistical analysis of the journal indicators for the 65 journals is conducted using SPSS 21.0, a software package for logical batched and non-batched statistical analyses, the current version (2015) for which is officially called IBM SPSS Statistics. In the following, a total analysis and an analysis by zone are given.

Total analysis

As can be seen in Table 7.6, the total cites for the 65 energy engineering journals ranged from 155 to 113,385, a range of 113,230, with a statistical mean of 15979.6461538 and a standard deviation of 3177.83759285. The

Table 7.5: “Energy engineering” journals in Zone D zone

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year Impact Factor Factor	Immediacy Index	Articles	Cited Half-life	Eigenfactor Score	Article Influence Score
1	Journal of Petroleum Science and Engineering	0920-4105	8485	2.382	2.739	0.417	97.620	5.800	0.01376	0.667
2	Energy Technology	2194-4288	1792	3.175	2.938	1.104	91.300	2.400	0.00465	0.656
3	Energy for Sustainable Development	0973-0826	2333	2.658	3.221	0.612	94.030	5.600	0.00358	0.691
4	Energy Journal	0195-6574	2619	2.132	2.675	0.463	100.000	¿10.0	0.00330	1.038
5	International Journal of Energy Research	0363-907X	5260	3.009	2.671	0.668	86.100	7.100	0.00553	0.493
6	Stochastic Environmental Research and Risk Assessment	1436-3240	3307	2.668	2.645	0.831	97.670	4.500	0.00589	0.608
7	Wiley Interdisciplinary Reviews-Energy and Environment?	2041-8396	536	2.514	2.857	0.457	37.140	3.300	0.00160	0.640
8	Journal of the American Water Resources Association?	1093-474X	5472	2.16	2.338	1.125	96.880	¿10.0	0.00451	0.629
9	Energy Strategy Reviews	2211-467X	425	2.164	2.547	0.318	95.450	3.600	0.00143	0.648
10	Petroleum Exploration and Development	1000-0747	2163	2.065	2.464	0.214	99.110	5.000	0.00424	0.567
11	Combustion Theory and Modelling	1364-7830	1406	1.744	2.029	0.327	100.000	9.200	0.00205	0.729
12	Greenhouse Gases-Science and Technology	2152-3878	673	1.991	2.312	0.569	94.440	3.500	0.00160	0.496
13	Journal of the Air & Waste Management Association	1096-2247	5469	1.742	1.95	0.549	95.580	¿10.0	0.00442	0.501
14	Journal of Energy Resources Technology-Transactions of The Asme	0195-0738	1975	2.197	2.091	0.552	98.600	7.300	0.00176	0.313
15	Energy Sustainability and Society	2192-0567	327	1.625	1.625	0.143	88.570	3.500	0.00081	0.818
16	Energy Efficiency	1570-646X	1078	1.634	2.035	0.333	95.700	4.700	0.00163	0.379
17	Journal of Solar Energy Engineering-Transactions of the Asme	0199-6231	3571	1.367	1.859	0.287	97.700	¿10.0	0.00223	0.353
18	Biomass Conversion and Biorefinery	2190-6815	365	1.31	1.31	0.762	92.860	3.700	0.00077	0.665
19	Journal of Environmental Science and Health Part A-Toxic/Hazardous Substances & Environmental Engineering	1093-4529	4223	1.561	1.469	0.229	99.350	8.800	0.00381	0.294
20	Environmental Progress & Sustainable Energy	1944-7442	2016	1.326	1.721	0.299	97.200	3.900	0.00337	0.286
21	Journal of Renewable and Sustainable Energy	1941-7012	2166	1.337	1.342	0.314	98.740	4.200	0.00446	0.264
22	Journal of Energy Engineering	0733-9402	752	1.346	1.632	0.212	100.000	4.000	0.00115	0.287
23	SPE Production & Operations	1930-1855	642	1.162	1.244	0.240	98.000	7.100	0.00096	0.407
24	International Journal of Low-Carbon Technologies	1748-1317	544	0.837	0.837	0.256	92.310	4.800	0.00102	0.716
25	International Journal of Green Energy	1543-5075	1215	1.171	1.333	0.195	96.990	4.800	0.00148	0.207
26	Energy Exploration & Exploitation	0144-5987	500	1.204	1.223	0.163	100.000	4.700	0.00092	0.254
27	Energy Sources Part B-Economics Planning and Policy	1556-7249	732	0.976	1.125	0.514	98.550	4.500	0.00083	0.176
28	Frontiers in Energy	2095-1701	272	0.753	0.753	0.442	82.690	4.000	0.00050	0.409
29	Proceedings of the Institution of Civil Engineers-Energy	1751-4223	155	0.771	0.978	1.214	100.000	4.300	0.00034	0.276
30	Journal of Energy in Southern Africa	1021-447X	282	0.6	0.801	0.000	100.000	5.900	0.00030	0.122
31	International Journal of Oil Gas and Coal Technology	1753-3309	232	0.563	0.695	0.147	98.530	3.800	0.00050	0.150
32	Energy Sources Part A-Recovery Utilization and Environmental Effects	1556-7036	1854	0.555	0.576	0.167	98.030	5.600	0.00228	0.103

Table 7.6: Descriptive analysis of energy engineering journals

	N	Range	Minimum	Maximum	Sum	Mean		Std. Deviation	Skewness	
						Statistic	Std. Error		Statistic	Std. Error
Total_Cites	65	113230	155	113385	1038677	15979.64615	3177.837592	25620.54575582	2.103	0.297
Impact_Factor	65	46.304	0.555	46.859	272.761	4.1963231	0.81933806	6.60571462	5.287	0.297
5_Year_Impact_Factor	65	46.294	0.576	46.87	289.09	4.4475385	0.80980514	6.52885776	5.246	0.297
Immediacy_Index	65	7.854	0	7.854	61.792	0.95065	0.153106	1.234379	4.286	0.297
Articles_in_cited_item	65	97.610	2.39	100	6088.24	93.66523	1.788354	14.418169	-5.117	0.297
Cited_Half_life	65	8.6	1.4	10	337.3	5.18923	0.254187	2.049323	0.853	0.297
Eigenfactor_Score	65	0.18002	0.0003	0.18032	1.45517	0.0223872	0.0045882	0.03699124	2.431	0.297
Article_Influence_Score	65	16.014	0.103	16.117	68.109	1.04783	0.259729	2.093999	6.378	0.297

impact factor varied from 0.555 to 46.859, with a statistic mean of 4.19632. The five-year impact factor range was 46.294 from 0.576 to 46.859, the statistical mean was 4.1963231 and the standard deviation was 0.81933806. The immediacy index had a range of 7.854 from 0 to 7.854, a statistical mean of 0.95065 and a standard deviation of 1.234379. The articles in citable item ranged from 2.39 to 100, a range of 97.61, with a statistic mean of 93.6652 and a standard deviation of 14.41817. The cited half-life had a range of 8.6

from 1.4 to 10, a statistical mean of 5.18923 and a standard deviation of 2.049323. The eigenfactor score ranged from 0.00030 to 0.18032, a range of 0.18002, with a statistical mean of 0.0223872 and a standard deviation of 0.03699124. The article influence score ranged from 0.103 to 16.117, a range of 16.014, with a statistical mean of 1.04783 and a standard deviation of 2.093999.

Table 7.7: Extreme values for the total cites

			Case Number	Journal Title	Value
Total Cites	Highest	1	4	Journal of Power Sources	113385
		2	6	Bioresource Technology	101191
		3	11	International Journal of Hydrogen Energy	75123
		4	2	Energy & Environmental Science	71920
		5	3	Renewable & Sustainable Energy Reviews	67014
	Lowest	1	62	Proceedings of the Institution of Civil Engineers-Energy	155
		2	64	International Journal of Oil Gas and Coal Technology	232
		3	61	Frontiers in Energy	272
		4	63	Journal of Energy in Southern Africa	282
		5	48	Energy Sustainability and Society	327

Table 7.7 shows the extreme values for total cites and shows the five journals with the highest and lowest citations. *The Journal of Power Sources* had the highest citations at 113,385 followed by *Bioresource Technology* with 101,191 citations, *the International Journal of Hydrogen Energy* with 75,123, *Energy & Environmental Science* with 71,920 and *Renewable & Sustainable Energy Reviews* with 67,014. The five lowest journals were the *Proceedings of the Institution of Civil Engineers-Energy*, the *International Journal of Oil Gas and Coal Technology*, *Frontiers in Energy*, the *Journal of Energy in Southern Africa*, and *Energy Sustainability and Society*.

Table 7.8: Extreme values for the impact factor

			Case Number	Journal Title	Value
Impact Factor	Highest	1	1	Nature Energy	46.859
		2	2	Energy & Environmental Science	30.067
		3	3	Renewable & Sustainable Energy Reviews	9.184
		4	5	Applied Energy	7.9
		5	4	Journal of Power Sources	6.945
	Lowest	1	65	Energy Sources Part A-Recovery Utilization and Environmental Effects	0.555
		2	64	International Journal of Oil Gas and Coal Technology	0.563
		3	63	Journal of Energy in Southern Africa	0.6
		4	61	Frontiers in Energy	0.753
		5	62	Proceedings of the Institution of Civil Engineers-Energy	0.771

Table 7.8 shows the extreme values for the impact factors for the five journals with the highest and lowest values. *Nature Energy* had an impact factor of 46.859, followed by *Energy & Environmental Science* with an impact factor of 30.067, *Renewable & Sustainable Energy Reviews*, with 9.184, *Applied Energy*, and *the Journal of Power Sources* ranked fourth and fifth. The five lowest impact factor journals were *Energy Sources Part A-Recovery Utilization and Environmental Effects*, the *International Journal of Oil Gas and Coal Technology*, the *Journal of Energy in Southern Africa*, *Frontiers in Energy*, and *the Proceedings of the Institution of Civil Engineers-Energy*.

Table 7.9: Extreme values for the five-year impact factor

			Case Number	Journal Title	Value
Five-Year Impact Factor	Highest	1	1	Nature Energy	46.870
		2	2	Energy & Environmental Science	28.924
		3	3	Renewable & Sustainable Energy Reviews	10.093
		4	5	Applied Energy	7.888
		5	10	IEEE Transactions on Sustainable Energy	7.261
	Lowest	1	65	Energy Sources Part A-Recovery Utilization and Environmental Effects	0.576
		2	64	International Journal of Oil Gas and Coal Technology	0.695
		3	61	Frontiers in Energy	0.753
		4	63	Journal of Energy in Southern Africa	0.801
		5	57	International Journal of Low-Carbon Technologies	0.837

Table 7.9 shows the extreme values for the five-year impact factor for the five journals with highest and lowest values. *Nature Energy*, with a five-year impact factor of 46.870 was the highest, followed by *Energy & Environmental Science* with 28.924, *Renewable & Sustainable Energy Reviews* with 10.093, *Applied Energy* with 7.888, and *IEEE Transactions on Sustainable Energy* with 7.261. The five lowest five-year impact factor journals were *Energy Sources Part A-Recovery Utilization and Environmental Effects*, *International Journal of Oil Gas and Coal Technology*, *Journal of Energy in Southern Africa*, and *International Journal of Low-Carbon Technologies*.

Table 7.10 shows the extreme values for the five highest and the lowest journal immediacy indexes. *Nature Energy* was the highest with an immediacy index of 7.854, followed by *Energy & Environmental Science* with an immediacy index of 6.517, *Renewable & Sustainable Energy Reviews*, with 2.354, *Applied Energy*, with 2.151, and *Global Change Biology Bioenergy*, with 1.984. The five lowest immediacy index journals were *Journal of Energy in Southern Africa*, *Energy Sustainability and Society*, *International*

Table 7.10: Extreme value for the immediacy index

			Case Number	Journal Title	Value
Immediacy Index	Highest	1	1	Nature Energy	7.854
		2	2	Energy & Environmental Science	6.517
		3	3	Renewable & Sustainable Energy Reviews	2.354
		4	5	Applied Energy	2.151
		5	15	Global Change Biology Bioenergy	1.984
	Lowest	1	63	Journal of Energy in Southern Africa	0
		2	48	Energy Sustainability and Society	0.143
		3	64	International Journal of Oil Gas and Coal Technology	0.147
		4	59	Energy Exploration & Exploitation	0.163
		5	65	Energy Sources Part A-Recovery Utilization and Environmental Effects	0.167

Journal of Oil Gas and Coal Technology, *Energy Exploration & Exploitation*, and *Energy Sources Part A-Recovery Utilization and Environmental Effects*.

Table 7.11: Extreme values for articles in citable item

			Case Number	Journal Title	Value
Articles citable item	in Highest	1	10	IEEE Transactions on Sustainable Energy	100
		2	22	IEEE Transactions on Energy Conversion	100
		3	32	Wind Energy	100
		4	37	Energy Journal	100
		5	44	Combustion Theory and Modelling	100
	Lowest	1	3	Renewable & Sustainable Energy Reviews	2.39
		2	40	Wiley Interdisciplinary Reviews-Energy and Environment?	37.14
		3	24	Biofuels Bioproducts & Biorefining-Biofpr	69.86
		4	61	Frontiers in Energy	82.69
		5	38	International Journal of Energy Research	86.1

Table 7.11 shows the extreme values for highest and lowest journals for the articles in citable item. *IEEE Transactions on Sustainable Energy*, *IEEE Transactions on Energy Conversion*, *Wind Energy*, *Energy Journal*, and *Combustion Theory and Modelling* were the five journals with highest articles in citable item. The five lowest were *Renewable & Sustainable Energy Reviews*, *Wiley Interdisciplinary Reviews-Energy and Environment*, *Biofuels Bioproducts & Biorefining-Biofpr*, *Frontiers in Energy*, and *International Journal of Energy Research*.

Table 7.12 shows the five highest and the lowest cited half-life values. *Energy Journal*, *Journal of the American Water Resources Association*, *Journal of the Air & Waste Management Association*, *Journal of Solar Energy*

Table 7.12: Extreme values for cited half-life

			Case Number	Journal Title	Value
Cited Half life	Highest	1	37	Energy Journal	10
		2	41	Journal of the American Water Resources Association?	10
		3	46	Journal of the Air & Waste Management Association	10
		4	50	Journal of Solar Energy Engineering-Transactions of the Asme	10
		5	22	IEEE Transactions on Energy Conversion	9.4
	Lowest	1	1	Nature Energy	1.4
		2	31	Journal of Natural Gas Science and Engineering	2.3
		3	35	Energy Technology	2.4
		4	33	Energy Science & Engineering	2.5
		5	30	Journal of the Energy Institute	2.5

Engineering-Transactions of the ASME, and *IEEE Transactions on Energy Conversion* were the five highest journals, and *Nature Energy*, *Journal of Natural Gas Science and Engineering*, *Energy Technology*, *Journal of the Energy Institute*, and *Energy Science & Engineering* were the five lowest.

Table 7.13: Extreme values for the eigenfactor score

			Case Number	Journal Title	Value
Eigenfactor Score	Highest	1	2	Energy & Environmental Science	0.18032
		2	4	Journal of Power Sources	0.14072
		3	6	Bioresource Technology	0.10945
		4	3	Renewable & Sustainable Energy Reviews	0.10857
		5	5	Applied Energy	0.10398
	Lowest	1	63	Journal of Energy in Southern Africa	0.0003
		2	62	Proceedings of the Institution of Civil Engineers-Energy	0.00034
		3	64	International Journal of Oil Gas and Coal Technology	0.0005
		4	61	Frontiers in Energy	0.0005
		5	51	Biomass Conversion and Biorefinery	0.00077

Table 7.13 shows the five highest and the lowest eigenfactor score values. The highest was for *Energy & Environmental Science* with an eigenfactor score of 0.18032, followed by *Journal of Power Sources*, with a score of 0.14072, *Bioresource Technology*, with 0.10945, *Renewable & Sustainable Energy Reviews*, with 0.10857, and *Applied Energy*, with 0.1039. The five lowest were *Journal of Energy in Southern Africa*, *Proceedings of the Institution of Civil Engineers-Energy*, *International Journal of Oil Gas and Coal Technology*, *Frontiers in Energy*, and *Biomass Conversion and Biorefinery*.

Table 7.14 shows the five highest and the lowest article influence score values. *Nature Energy*, with an article influence score of 16.117 was the highest, followed by *Energy & Environmental Science*, with a score

Table 7.14: Extreme values for the article influence score

		Case Number	Journal Title	Value
Article Influence Score	Highest 1	1	Nature Energy	16.117
	2	2	Energy & Environmental Science	7.072
	3	13	Environmental Science & Technology Letters	1.978
	4	10	IEEE Transactions on Sustainable Energy	1.922
	5	3	Renewable & Sustainable Energy Reviews	1.735
	Lowest 1	65	Energy Sources Part A-Recovery Utilization and Environmental Effects	0.103
	2	63	Journal of Energy in Southern Africa	0.122
	3	64	International Journal of Oil Gas and Coal Technology	0.15
	4	60	Energy Sources Part B-Economics Planning and Policy	0.176
	5	58	International Journal of Green Energy	0.207

of 7.072, *Environmental Science & Technology Letters*, with 1.978, *IEEE Transactions on Sustainable Energy*, with 1.922, and *Renewable & Sustainable Energy Reviews*, with 1.735. The five lowest article influence scores were for *Energy Sources Part A-Recovery Utilization and Environmental Effects*, *Journal of Energy in Southern Africa*, *International Journal of Oil Gas and Coal Technology*, *Energy Sources Part B-Economics Planning and Policy*, and *International Journal of Green Energy*.

Zone analysis

SPSS 21.0 software was employed to conduct a statistical descriptive analysis of the energy engineering-related journals in the different zones. The descriptive results are shown in Tables 7.15-7.22, and the visual box diagrams are shown in Fig. 7.1-7.8.

Table 7.15: 2017 total cites statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	3	48002	37259.30600535	67014	144006	71920	5072	66848	1388255884
B	10	53693.1	36358.46325273	49052	536931	113385	1660	111725	1321937850.1
C	20	14744.95	13761.89017187	10372	294899	41513	368	41145	189389621.103
D	32	1963.78125	1983.67678712	1310.5	62841	8485	155	8330	3934973.596
Total	65	15979.64615385	25620.54575582	3307	1038677	113385	155	113230	656412364.826

Table 7.15 gives the statistical results for the total energy engineering journal cites in 2017 in each zone. The mean for total cites in Zone A was 144,006, in Zone B was 53,693.1, with the range being from 1660 to

113,385, and in Zone C zone was 14,744.95, with the range from 368 to 41,513. The total cites in Zone D varied from 155 to 8485, the mean was 1963.78125 and the variance was 3,934,973.596. Therefore, the total cites in all zones ranged from 155 to 113,385.

Table 7.16: 2017 impact factor statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	3	26.82633	21.834121	30.06700	80.479	46.859	3.553	43.306	476.729
B	10	4.48099	3.092461	4.62245	44.810	9.184	1.162	8.022	9.563
C	20	4.03735	1.616197	4.30150	80.747	6.377	0.563	5.814	2.612
D	32	2.08516	0.865466	2.14600	66.725	4.217	0.555	3.662	0.749
Total	65	4.19632	6.605715	2.93800	272.761	46.859	0.555	46.304	43.635

Table 7.16 gives the statistical results for the impact factors in 2017 for the journals in each zone. The 2017 impact factors in Zone A ranged from 3.553 to 46.859 with a mean of 26.82633, the 2017 impact factors in Zone B ranged from 1.162 to 9.184 with a mean of 4.48099, the 2017 impact factors in Zone C ranged from 0.563 to 6.377 with a mean of 4.03735 and a variance of 2.612, and the 2017 impact factors in Zone D ranged from 0.555 to 4.217 with a mean of 2.08516. The mean impact factor for all zones was 4.19632.

Table 7.17: 2017 five-year impact factor statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	3	28.629	18.39027463	28.924	85.887	46.87	10.093	36.777	338.202
B	10	6.164	1.10251027	6.2565	61.64	7.888	4.064	3.824	1.216
C	20	4.1764	0.91422498	4.0805	83.528	5.788	2.815	2.973	0.836
D	32	1.8135938	0.75500933	1.79	58.035	3.221	0.576	2.645	0.57
Total	65	4.4475385	6.52885776	3.045	289.09	46.87	0.576	46.294	42.626

Table 7.17 gives the statistical results for the five-year impact factor in 2017 for the journals in each zone. The five-year impact factor in Zone A ranged from 10.093 to 46.87 with a mean of 28.629 and a variance of 338.202, in Zone B it ranged from 4.064 to 7.888 with a mean of 6.164 and a variance of 1.216, in Zone C it ranged from 2.815 to 5.788 with a mean of 4.1764 and a variance of 0.836, and in Zone D it ranged from 0.576 to 3.221 with a mean of 1.8135938 and a variance of 0.57. The mean for the five-year impact factor for all zones was 4.4475385.

Table 7.18: 2017 immediacy index statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	3	4.94933	3.930422	6.51700	14.848	7.854	0.477	7.377	15.448
B	10	1.11800	0.809434	1.10550	11.180	2.354	0.142	2.212	0.655
C	20	0.97290	0.428951	0.99200	19.458	1.984	0.147	1.837	0.184
D	32	0.50947	0.297497	0.45950	16.303	1.214	0	1.214	0.089
Total	65	0.95060	1.234400	0.66800	61.789	7.854	0	7.854	1.524

Table 7.18 gives the statistical results for the immediacy index in 2017 for the journals in each zone. The immediacy index in Zone A ranged from 0.477 to 7.854 with a mean and variance of 4.94933 and 15.448, in Zone B it ranged from 0.142 to 2.354 with a mean and variance of 1.118 and 0.655, in Zone C it ranged from 0.147 to 1.984 with a mean and variance of 0.9729 and 0.184, and in Zone D it ranged from 0 to 1.214 with a mean and variance of 0.50947 and 0.089. The immediacy index mean for all zones was 0.9506.

Table 7.19: 2017 articles in citable item statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	3	94.3367	2.43231	95.6500	283.01	95.83	91.53	4.30	5.916
B	10	84.5160	30.25838	97.3850	845.16	100.00	2.39	97.61	915.570
C	20	96.0900	4.05613	97.4500	1921.80	100.00	82.69	17.31	16.452
D	32	94.9459	10.97135	97.4100	3038.27	100.00	37.14	62.86	120.371
Total	65	93.6652	14.41817	97.2000	6088.24	100.00	2.39	97.61	207.884

Table 7.19 gives the statistical results for the articles in citable item in 2017 for the journals in each zone. The articles in citable item in Zone A ranged from 91.53 to 95.83 with a mean and variance of 94.3367 and 5.916, in Zone B it ranged from 2.39 to 100 with a mean and variance of 84.516 and 915.57, in Zone C it ranged from 82.69 to 100 with a mean and variance of 96.09 and 16.452, and in Zone D it ranged from 37.14 to 100 with a mean and variance of 94.9459 and 120.371. The mean for the articles in citable item for all zones was 93.6652.

Table 7.20 gives the statistical results for cited half-life in 2017 for the journals in each zone. The cited half-life in Zone A ranged from 1 to 4, and its mean and variance were 2.7 and 1.99, in Zone B it ranged from 3 to 7, and its mean and variance were 4.45 and 1.856, in Zone C it ranged from 3 to 9, and its mean and variance were 5.34 and 2.306, and in Zone D it

Table 7.20: 2017 cited half-life statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	3	2.70	1.411	2.50	8	4	1	3	1.990
B	10	4.45	1.362	3.75	45	7	3	4	1.856
C	20	5.34	1.518	5.00	107	9	3	6	2.306
D	32	5.56	2.379	4.85	178	10	2	8	5.658
Total	65	5.19	2.049	4.70	337	10	1	9	4.200

ranged from 2 to 10, and its mean and variance were 5.56 and 5.658. The mean cited half-life for all journals in all zones was 5.19.

Table 7.21: 2017 eigenfactor score statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	3	3.3669133	5.65837514	0.1803200	10.10074	9.89999	0.02043	9.87956	32.017
B	10	3.9318110	4.29452743	2.2403600	39.31811	9.60000	0.00627	9.59373	18.443
C	20	1.0634335	2.31362166	0.0479250	21.26867	8.30000	0.00548	8.29452	5.353
D	32	0.2060978	0.78708070	0.0040250	6.59513	3.40000	0.00102	3.39898	0.619
Total	65	1.1889638	2.71460178	0.0149800	77.28265	9.89999	0.00102	9.89897	7.369

Table 7.21 gives the statistical results for eigenfactor score in 2017 for the journals in each zone. The eigenfactor score in Zone A ranged from 0.02043 to 9.89999, and its mean and variance were 3.3669133 and 32.017, in Zone B it ranged from 0.00627 to 9.6, and its mean and variance were 3.931811 and 18.443, in Zone C it ranged from 0.00548 to 8.3, and its mean and variance were 1.0634335 and 5.353, and in Zone D it ranged from 0.00102 to 3.4, and its mean and variance were 0.2060978 and 0.619. The mean eigenfactor score for all zones was 1.1889638.

Table 7.22: 2017 article influence score statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	3	7.94533	7.771889	7.07200	23.836	16.117	0.647	15.470	60.402
B	10	1.14870	0.610509	1.19900	11.487	1.978	0.254	1.724	0.373
C	20	0.80830	0.327667	0.81150	16.166	1.523	0.150	1.373	0.107
D	32	0.51938	0.221279	0.58100	16.620	1.038	0.103	0.935	0.049
Total	65	1.04783	2.093999	.66700	68.109	16.117	0.103	16.014	4.385

Table 7.22 shows the statistical results for the article influence score in 2017 for the journals in each zone. The article influence score in Zone A

ranged from 0.647 to 16.117, and its mean and variance were 7.94533 and 60.402. In Zone B it ranged from 0.254 to 1.978, and the mean and variance were 1.1487 and 0.373. In Zone C it ranged from 0.15 to 1.523, and the mean and variance were 0.8083 and 0.107. In Zone D it ranged from 0.103 to 1.038, and the mean and variance were 0.51938 and 0.049. The mean article influence score in all zones for all journals was 1.04783.

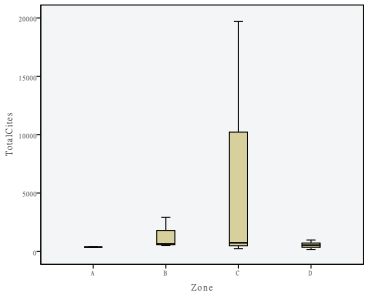

Fig. 7.1: Box diagram for total cites

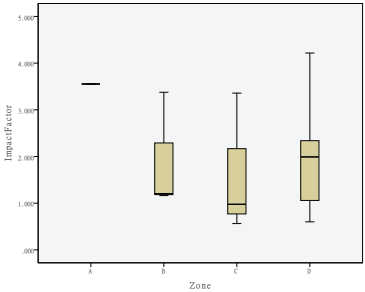

Fig. 7.2: Box diagram for impact factor

As shown in Fig. 7.1, the Zone C total citations had the largest range, followed by Zone B, Zone D and Zone A, and there were extreme values in Zones A and C. As shown in Fig. 7.2, the impact factor for Zone A was much higher than in the other zones, the maximum and minimum in Zone B were higher than in Zone C and Zone D, and the maximum and minimum in Zone D were higher than in Zone C.

As shown in Fig. 7.3, the five-year impact factor range in Zone B was the largest, followed by Zones C, D and A zone. As shown in Fig. 7.4, the immediacy index in all zones ranged from 0.2 to 0.7. The lowest immediacy index was in Zone B and the highest in Zone D.

As shown in Fig. 7.5, the articles in citable item value for all zones was between 80 and 100. The highest articles in citable item value was in Zone D and the lowest was in Zone B; however, the Zone B range was the largest of all zones. As shown in Fig. 7.6, Zones B and C had the largest cited half-life range and Zone A had the smallest. The Zone B had the highest cited half-life and Zone A had the smallest.

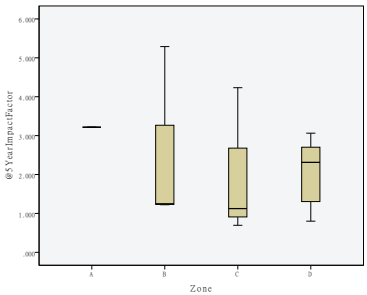

Fig. 7.3: Box diagram for five-year impact factor

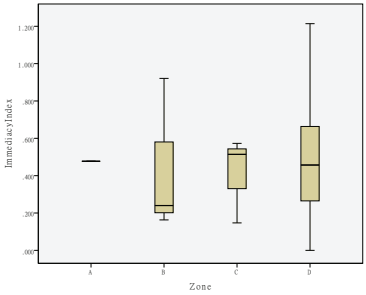

Fig. 7.4: Box diagram for immediacy index

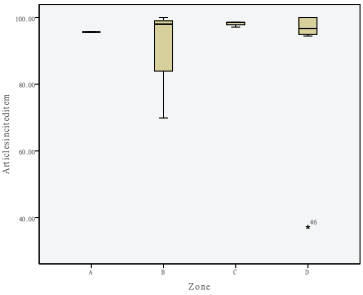

Fig. 7.5: Box diagram for articles in citable item

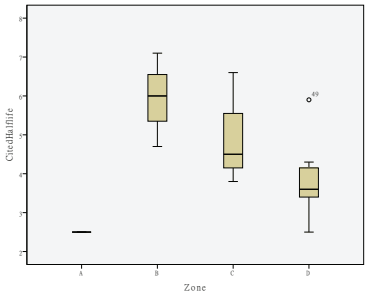

Fig. 7.6: Box diagram for cited half-life

As shown in Fig. 7.7, the median, maximum, and minimum eigenfactor scores decreased gradually from Zone A to Zone D. As shown in Fig. 7.8, The largest eigenfactor score range was in Zone C, followed by Zone B, Zone D, and Zone A. As shown in Fig. 7.8, the article influence score in all zones was between 0.1 to 0.8, with the highest being in Zone B and the lowest in Zone C.

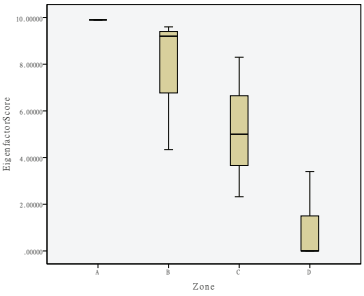

Fig. 7.7: Box diagram for eigenfactor score

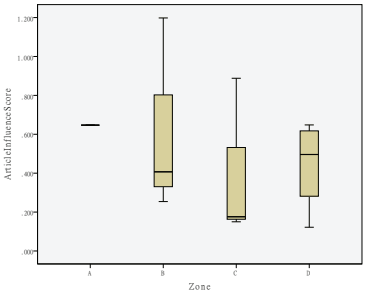

Fig. 7.8: Box diagram for article influence score

7.4 Comprehensive Discussion

Impact factor changes

Fig. 7.9 shows the impact factor changes for the journals in Zone A from 2013 to 2017. Three journals in Zone A all had an upward trend; however, *Nature Energy* was a new journal and the only journal that had an impact factor greater than 40. The *Energy & Environmental Science* impact factor rose rapidly in the first four years with the five-year range being from 15.49 to 30.067. The *Renewable & Sustainable Energy Reviews* impact factor had major fluctuations, varying from 5.51 to 9.184.

Fig. 7.10 shows the impact factor changes for the Zone B journals from 2013 to 2017, from which it can be seen that ten journals had differing fluctuations. The *Journal of Power Sources* and *Applied Energy* both had strong upward trends; over the five-years the impact factor for the *Journal of Power Sources* increased from 5.211 to 6.945 and the impact factor for *Applied Energy* increased from 5.261 to 7.9. The impact factor for Energy Conversion and Management also had an upward trend from 3.59 to 6.377. *Bioresource Technology* had minor impact factor fluctuations, with a maximum of 5.807 and a minimum of 4.494, and *Renewable Energy*'s increased from 3.361 to 4.9, with a slight decline in 2015.

Fig. 7.11 shows the impact factor changes for the Zone C journals from 2013 to 2017, from which it can be seen that twenty journals had differing

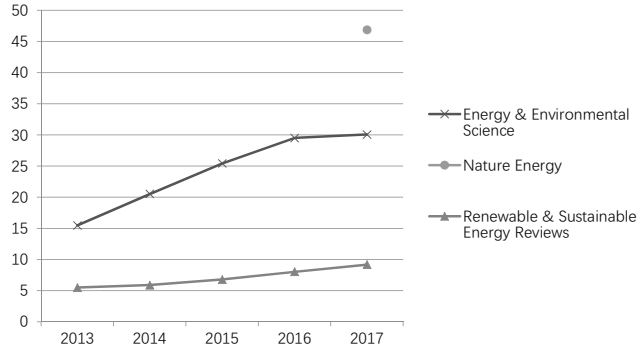

Fig. 7.9: Impact factor changes for Zone A journals from 2013 to 2017

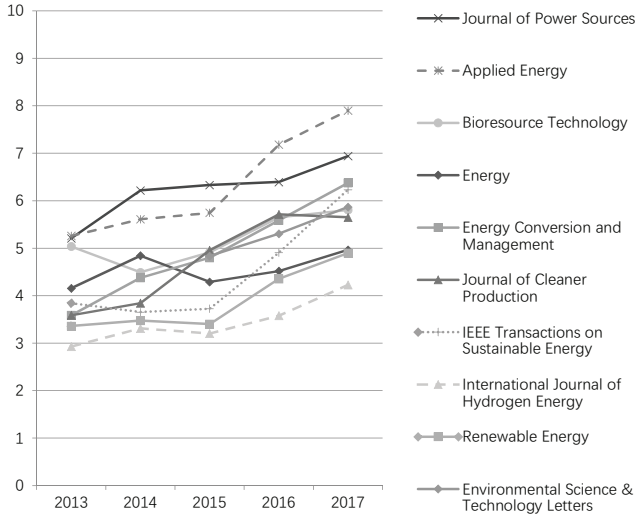

Fig. 7.10: Impact factor changes for Zone B journals from 2013 to 2017

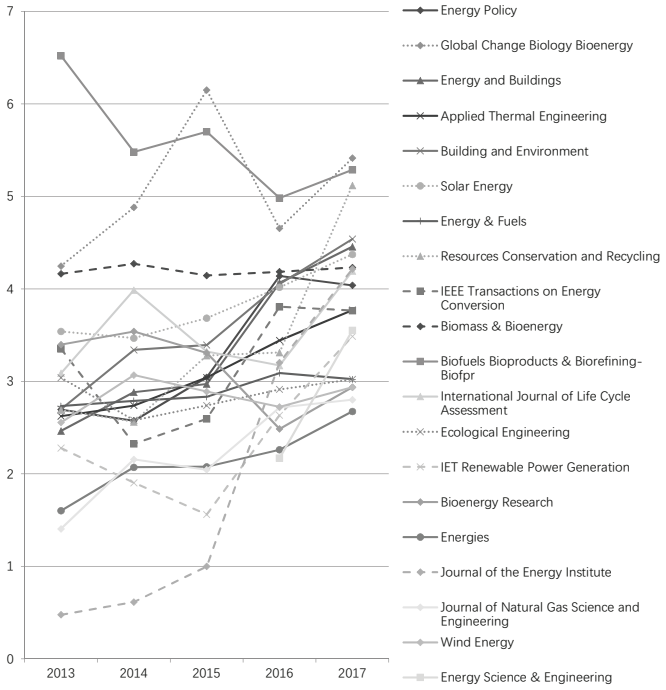

Fig. 7.11: Impact factor changes for Zone C journals from 2013 to 2017

fluctuations. The *IET Renewable Power Generation impact factor* had large fluctuations from 1.562 in 2015 to 3.488 in 2017. The *Biofuels Bioproducts & Biorefining- Biofpr* impact factor, however, had a downward trend decreasing from 6.522 to 5.289. The *Journal of the Energy Institute* impact factor had a strong upward trend, increasing from 0.477 in 2013 to 4.217 in 2017. However, the *Bioenergy Research* impact factor had a downward trend, decreasing from 3.398 to 2.938.

Fig. 7.12 shows the impact factor changes for the Zone D journals from 2013 to 2017, from which it can be seen that the 32 journals had differing fluctuations. *Greenhouse Gases-Science and Technology* had huge fluctuations, with a maximum of 3.067 and a minimum of 1.676. *Energy Sources Part A-Recovery Utilization and Environmental Effects* had minor impact

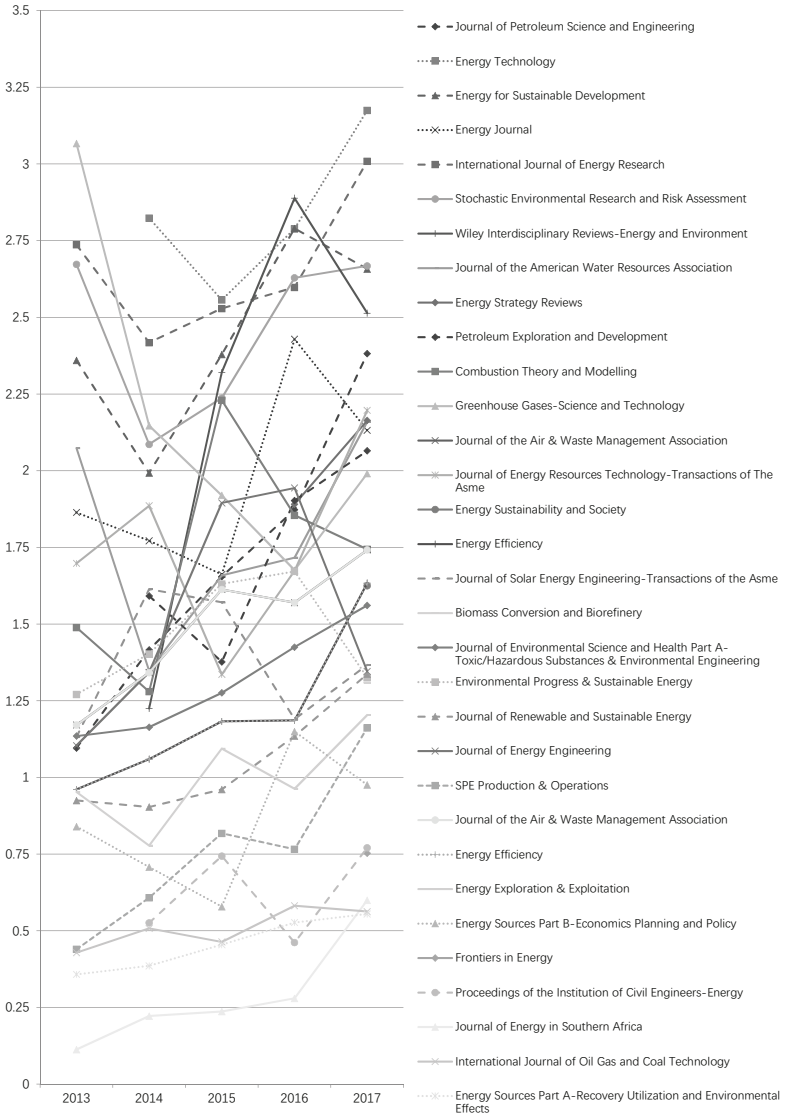

Fig. 7.12: Impact factor changes for Zone D journals from 2013 to 2017

factor fluctuations from 0.358 to 0.555. The *SPE Production & Operations* impact factor had a general upward trend although there was a slight decline from 2015 to 2016. *Energy Sustainability and Society* and *Biomass Conversion and Biorefinery* were the newest journals and had impact factors between 1 and 2. *Frontiers in Energy* was the only new journal in Zone D and had an impact factor of 0.753.

Major countries

In this part, as shown in Table 7.23, the statistical results for the energy engineering SCI/SSCI papers published by the major countries in the world from 2013 to 2017 are analyzed.

Table 7.23: Energy engineering SCI papers published in major countries in 2013-2017

Country	2013		2014		2015		2016		2017	
	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage
ALL	3470		3983		4693		5523		6395	
USA	1211	34.90%	1312	32.94%	1395	29.73%	1562	28.28%	1727	27.01 %
CHINA	831	23.95%	1010	25.36%	1251	26.66%	1581	28.63%	2033	31.79 %
GERMANY	228	6.57 %	262	6.58 %	362	7.71 %	427	7.73 %	415	6.49%
INDIA	208	5.99 %	247	6.20 %	319	6.80 %	404	7.31 %	444	6.94 %
UK	229	6.60 %	268	6.73 %	303	6.46 %	373	6.75 %	442	6.91 %
ITALY	179	5.16 %	193	4.85 %	238	5.07 %	284	5.14 %	281	4.39 %
SOUTH KOREA	159	4.58 %	182	4.57%	243	5.18 %	235	4.25 %	310	4.85 %
FRANCE	157	4.52 %	209	5.25 %	189	4.03 %	226	4.09 %	245	3.83 %
CANADA	133	3.83 %	152	3.82 %	200	4.26 %	240	4.35 %	246	3.85%
AUSTRALIA	135	3.89 %	148	3.72 %	193	4.11 %	191	3.46 %	252	3.94 %

Energy engineering journals published 6,395 papers in 2017, of which 2,033 (31.79%) were published by Chinese authors, ranking first in the world. American authors contributed 1,727 papers (27.01%), German authors produced 415 or 6.49%, Indian authors 444(6.94%), English authors 442 (6.91%), Italian authors 281 (4.39%), South Korean authors 310 (4.85%), French authors 245 (3.83%), Canadian authors 246 (3.85%), and Australian authors 252 papers (3.94%).

From Fig. 7.13, it can be seen that the number of papers published in the energy engineering journals almost doubled from 2013 to 2017, with the USA and China publishing the most papers in most years and significantly increasing their contributions each year. Other countries, however, published less over the years with only marginal increases in their contributions. For example, Germany authors published 6.49% in 2013 and 7.73% in 2017, In-

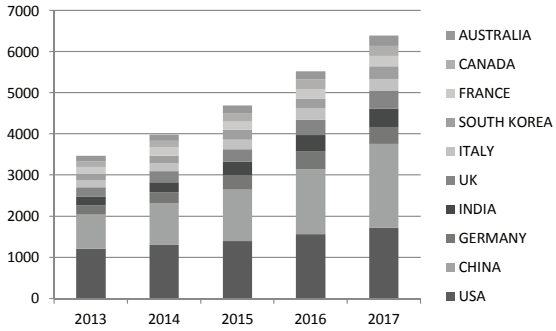

Fig. 7.13: Papers published by country in energy engineering journals from 2013-2017

dian authors published 208 (5.99%) papers in 2013 and 404 papers (7.31%) in 2016, and Italian authors published 5.16% of papers in 2013 and 4.39% in 2017.

Correlation analysis

To examine the relationship between the journal indicators, Pearson's correlation coefficient was employed to conducted bivariate correlation analyses using SPSS 21.0. In statistics, the Pearson's correlation coefficient, is widely used in the sciences. It was developed by Karl Pearson from a related idea introduced by Francis Galton in the 1880s, and is a measure of the linear correlation between two variables X and Y. Based on the Cauchy-Schwarz inequality, it has a value between +1 and -1, where 1 is a total positive linear correlation, 0 is no linear correlation, and -1 is a total negative linear correlation.

From Fig. 7.14, it can be seen that the total cites and the five-year impact factor had a correlation coefficient of 0.518, which indicates that they had a correlation. The impact factor and the five-year impact factor had a correlation coefficient of 0.998, indicating an extremely strong correlation. The Pearson's correlation coefficient for the five-year impact factor and article influence score was 0.975, also indicating a strong correlation. The immediacy index and the impact factor had a relatively significant correlation with

Correlations

		Total cites	Impact factor	Five-year impact factor	Immediacy index	Articles in citable item	Cited half-life	Eigenfactor score	Article influence score
Total cites	Pearson Correlation	1	.402	.518*	.143	.057	.466	-.137	.393
	Sig. (2-tailed)		.099	.028	.572	.824	.051	.589	.107
	N	18	18	18	18	18	18	18	18
Impact factor	Pearson Correlation	.402	1	.998**	.969**	-.082	-.273*	-.165	.972**
	Sig. (2-tailed)	.099		.000	.000	.517	.034	.190	.000
	N	18	65	65	65	65	61	65	65
Five-year impact factor	Pearson Correlation	.518*	.998**	1	.965**	-.097	-.260*	-.174	.975**
	Sig. (2-tailed)	.028	.000		.000	.440	.043	.166	.000
	N	18	65	65	65	65	61	65	65
Immediacy index	Pearson Correlation	.143	.969**	.965**	1	-.121	-.291*	-.179	.913**
	Sig. (2-tailed)	.572	.000	.000		.335	.023	.154	.000
	N	18	65	65	65	65	61	65	65
Articles in citable item	Pearson Correlation	.057	-.082	-.097	-.121	1	.160	.008	-.044
	Sig. (2-tailed)	.824	.517	.440	.335		.219	.947	.725
	N	18	65	65	65	65	61	65	65
Cited half-life	Pearson Correlation	.466	-.273*	-.260*	-.291*	.160	1	-.095	-.275*
	Sig. (2-tailed)	.051	.034	.043	.023	.219		.465	.032
	N	18	61	61	61	61	61	61	61
Eigenfactor score	Pearson Correlation	-.137	-.165	-.174	-.179	.008	-.095	1	-.113
	Sig. (2-tailed)	.589	.190	.166	.154	.947	.465		.372
	N	18	65	65	65	65	61	65	65
Article influence score	Pearson Correlation	.393	.972**	.975**	.913**	-.044	-.275*	-.113	1
	Sig. (2-tailed)	.107	.000	.000	.000	.725	.032	.372	
	N	18	65	65	65	65	61	65	65

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Fig. 7.14: Pearson's correlation coefficients for the JCR Data and Eigenfactor Metrics

a Pearson's correlation coefficient of 0.969. The Pearson's correlation coefficient for the articles in citable item and the cited half-life was 0.16, and for the cited half-life and the total cites was 0.466. The five-year impact factor and the immediacy index had a relatively significant correlation with a Pearson's correlation coefficient of 0.965. Finally, the five-year impact factor and article influence score had a correlation coefficient of 0.975.

Principal Component Analysis of the Journal Evaluation Indicators

Correlation studies have shown that as there are high correlation coefficients between these indicators, it is redundant to use them all because of the exclusiveness principle. However, which indicators should be adopted to evaluate a journal and what attributes do these indicators depict? To answer these questions, after the correlation analyses, this paper conducted a principal component analysis in IBM SPSS Statistics with the FACTOR command for the journal evaluation indicators for the 65 energy engineering journals. The objective of factor analyses is to identify the independent latent variables as adherents of these methods. We believe that the information gained about these interdependencies between the observed variables can be used to reduce the set of variables in a dataset. To track the information, the

last five years of impact factors, the five-year impact factors, the immediacy indexes, the article in citable item, the cited half-life, the eigenfactor score, and the article influence scores were considered concurrently.

Table 7.24: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure	of Sampling Adequacy.	0.739
Bartlett's Test of	Approx. Chi-Square	955.561
Sphericity	df	28
	Sig.	0.000

Table 7.24 shows the overall KMO and Bartlett's Test table for the factor output, with the value of the KMO being 0.739. The significance probability for the Bartlett's Test, which is used to test if the samples are from populations with equal variances, was 0.000, indicating that these indicators were suitable for the principal component analyses. KMO values greater than 0.8 are considered good; that is, the component or factor analyses are useful for these variables.

Table 7.25: Total variance explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.353	54.411	54.411	4.353	54.411	54.411
2	1.696	21.204	75.616	1.696	21.204	75.616
3	1.045	13.063	88.678	1.045	13.063	88.678
4	0.804	10.045	98.723			
5	0.071	0.890	99.613			
6	0.021	0.269	99.881			
7	0.008	0.094	99.976			
8	0.002	0.024	100.000			

After the principal component extraction procedure, a rotated quartimax transformation was used as this has been shown to have the best performance in making component loadings incline to 1 or 0; therefore, it can explain the factors' practical meanings. Quartimax rotation maximizes the variance of the squared factor loadings in each variable; that is, it simplifies the loading matrix rows. In other words, the quartimax minimizes the number of factors needed to explain each variable. In the quartimax rotation, as there are often many variables in the first rotated factor, this method is not always helpful.

The explained eigenvalue and total variance are shown in Table 7.25. Three components were extracted from all samples for the above variables.

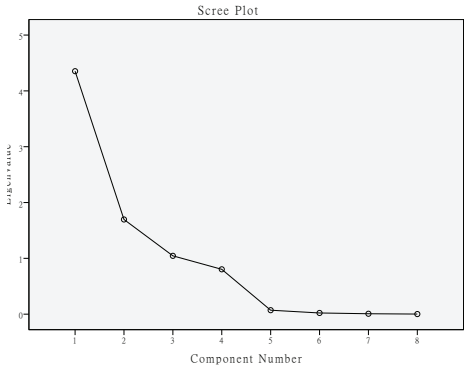

Fig. 7.15: Scree plot

As shown in the scree plot in Fig. 7.15, the eigenvalue for component 1 was 4.353, which dropped sharply to 1.045. From Fig. 7.15, two extracted components accounted for more than 75.616% of the total variance in the initial eigenvalues and the extraction sums of squared loadings, which was considered satisfactory. In this paper, three major components were chosen as the best explanations for the variability in the energy engineering journals data as together they explained 88.678% of the total variance.

As can be seen in Fig. 7.16, a threshold level of 0.7 allowed for a clear interpretation. The impact factor, five-year impact factor, immediacy index, and article influence score were included in the first component, total cites and the eigenfactor score were included in the second component, and the articles in citable item was included in the third component. A more detailed explanation is given in the following.

- The first component was related to the journals' integrated influence, which is made up of the impact factor and the five-year impact factor, and is useful in clarifying the significance of the absolute (or total) citation frequencies.
- The second component measured the citation situation for the journals.

Component Matrix[a]

	Component		
	1	2	3
Zscore(total cites)	.480	.838	.014
Zscore(impact factor)	.973	-.199	.077
Zscore (five year impact factor)	.971	-.200	.070
Zscore(immediacy index)	.976	-.110	.020
Zscore(articles in citable item)	-.158	-.211	.817
Zscore(cited half-life)	-.177	.414	.598
Zscore(eigenfactor score)	.628	.743	-.029
Zscore (Article influence score)	.911	-.366	.092

Extraction Method: Principal Component Analysis.
a. 3 components extracted.

Fig. 7.16: Quartimax rotated loading matrix for the "energy engineering" category journal indicators

- The third component related to articles published in the journal every year, an inherent attribute for each journal, and also showed the declining speed of a journal's influence.

7.5 Total Summary

Management science in energy engineering had 65 journals, with 3, 10, 20 and 32 journals respectively allocated to Zones A, B, C and D. Based on the journal ranking results in section 7.2, the top three most important journals, which had the highest comprehensive scores and were therefore ranked in Zone A, were *Nature Energy*, *Energy & Environmental Science*, and *Renewable & Sustainable Energy Reviews*. Based on the statistical analysis in section 7.3, the *Journal of Power Sources*, *Applied Energy*, *Energy*, and *Energy Conversion and Management* also had significant influence.

The comprehensive discussion in section 7.4 showed that the impact factors for the Zone A and B journals from 2013 to 2017 had an upward trend, indicating that there was an obvious increase in the average paper quality and journal influence. While the impact factors for the Zone C journals were relatively steady, those in Zone D varied significantly. Further, based on the major contributing country analysis in this section, it was revealed

that the USA, China, Germany, Canada, India, and UK were the most productive countries in management science in energy engineering publishing from 2013 to 2017, and the contributions from France, Canada, and Australia were emerging.

Journal developing trends

Table 7.26 gives the differences between the impact factor, the five-year impact factor, the immediacy index, and the eigenfactor score when evaluating journal quality and shows the energy engineering journal development tendencies. The data from the four indexes were standardized as they are from different dimensions.

The developments in energy engineering related journals have been relatively steady. The difference between the standardized impact factor and the standardized five-year impact factor indicates the journal article citation frequency variations. As shown in Table 7.26, the differences between most of IFminusIF5 were small, indicating that there has been a steady development in the energy engineering related journals. Some journals with lower impact factors have an upward trend such as *Energy & Environmental Science*, the *Journal of Power Sources*, and *Energy*; however, others have a downward trend, such as the *International Energy of Hydrogen Energy* and *Energy Science & Engineering*. Generally, the Z-IFminusZ-IF5 for the energy engineering journals varied between -0.2 and 2, indicating that the total cites in the most recent two years were not significantly different from the most recent five years.

The global influence of the energy engineering journals will continue to rise in the future as indicated by the difference between the standardized impact factors and the standardized immediacy indexes which show the development distance between the most recent two years and the current year. The impact factors for most energy engineering journals were larger than their respective immediacy indexes, with the maximum being 46.84 and the minimum being 0.555 as can be seen for *Nature Energy*, *Renewable & Sustainable Energy Reviews*, the *Journal of Energy Engineering*, and the *International Journal of Oil Gas and Coal Technology*. However, some journals' impact factors were lower than their immediacy index such as the Proceedings of the Institution of Civil Engineers- Energy.

Energy engineering journals have good development prospects. The difference between the standardized five-year impact factor and the standardized eigenfactor score indicated the journals' self-citation degree. The difference value and the journals' self-citation degree had a positive correlation; when the difference value is bigger, the journal has a higher self-citation degree. Many energy engineering journals had a negative Z-IF5MINUSZ-E value, which meant that they had a relatively low self-citation degree and inferred that these journals had been cited by other high-quality journals. Therefore, the energy engineering journals have good prospects.

Table 7.26: "Engineering engineering" Journals

Full Journal Title	ISSN	JCR Data				Standardized JCR data				Z-IF	Z-IF	Z-IF5
		Impact Factor	Five-Year Impact Factor	Immediacy Index	Eigenfactor Score	Z-IF	Z-IF5	Z-II	Z-E	minusZ-IF5	minusZ-II	minusZ-E
Nature Energy	2058-7546	46.859	46.87	7.854	0.02043	6.45845	6.49769	5.59257	-0.05291	-0.03924	0.86588	6.5506
Energy & Environmental Science	1754-5692	30.067	28.924	6.517	0.18032	3.91641	3.74897	4.50944	4.26946	0.16744	-0.59303	-0.52049
Renewable & Sustainable Energy Reviews	1364-0321	9.184	10.093	2.354	0.10857	0.75505	0.86469	1.13689	2.32982	-0.10964	-0.38184	-1.46513
Journal of Power Sources	0378-7753	6.945	6.686	1.732	0.14072	0.41611	0.34286	0.63299	3.19894	0.07325	-0.21688	-2.85608
Applied Energy	0306-2619	7.9	7.888	2.151	0.10398	0.56068	0.57244	0.97244	2.20573	0.03372	-0.41176	-1.67877
Bioresource Technology	0960-8524	5.807	5.978	1.108	0.10945	0.24383	0.23441	0.12748	2.35361	0.00942	0.11635	-2.1192
Energy	0360-5442	4.968	5.582	0.984	0.07658	0.11682	0.17376	0.02702	1.46502	-0.05694	0.0898	-1.29126
Energy Conversion and Management	0196-8904	6.377	6.161	1.652	0.05542	0.33012	0.26244	0.56818	0.89299	0.06768	-0.23806	-0.63055
Journal of Cleaner Production	0959-6526	5.651	6.352	1.364	0.05542	0.22021	0.2917	0.33487	0.89299	-0.07149	-0.11466	-0.60129
IEEE Transactions on Sustainable Energy	1949-3029	6.235	7.261	1.425	0.01859	0.30862	0.43093	0.38429	-0.10265	-0.12231	-0.07567	0.53358
International Journal of Hydrogen Energy	0360-3199	4.229	4.064	1.057	0.08137	0.00495	-0.05875	0.08616	1.59451	0.0637	-0.08121	-1.65326
Renewable Energy	0960-1481	4.9	4.981	1.234	0.04828	0.10653	0.08171	0.22955	0.69997	0.02482	-0.12302	-0.61826
Environmental Science & Technology Letters	2328-8930	5.869	6.687	1.29	0.00627	0.25322	0.34301	0.27492	-0.4357	-0.08979	-0.0217	0.77871
Energy Policy	0301-4215	4.039	5.038	0.915	0.04668	-0.02382	0.09044	-0.02888	0.65672	-0.11426	0.00506	-0.56628
Global Change Biology Bioenergy	1757-1693	5.415	5.788	1.984	0.00833	0.18449	0.20531	0.83714	-0.38002	-0.02082	-0.65265	0.58533
Energy and Buildings	0378-7788	4.457	4.779	0.851	0.03447	0.03946	0.05077	-0.08073	0.32664	-0.01131	0.12019	-0.27587
Applied Thermal Engineering	1359-4311	3.771	3.929	1.145	0.04757	-0.06439	-0.07942	0.15745	0.68078	0.01503	-0.22184	-0.7602
Building and Environment	0360-1323	4.539	5.221	1	0.02166	0.05188	0.11847	0.03998	-0.01966	-0.06659	0.0119	0.13813
Solar Energy	0038-092X	4.374	4.831	0.752	0.02783	0.0269	0.05873	-0.16093	0.14714	-0.03183	0.18783	-0.08841
Energy & Fuels	0887-0624	3.024	3.622	0.462	0.0465	-0.17747	-0.12644	-0.39586	0.65185	-0.05103	0.21839	-0.77829
Resources Conservation and Recycling	0921-3449	5.12	5.228	1.238	0.00862	0.13983	0.11954	0.23279	-0.37218	0.02029	-0.09296	0.49172
IEEE Transactions on Energy Conversion	0885-8969	3.767	4.582	0.771	0.01243	-0.06499	0.02059	-0.14554	-0.26918	-0.08558	0.08055	0.28977
Biomass & Bioenergy	0961-9534	3.358	4.232	0.574	0.02322	-0.12691	-0.03301	-0.30513	0.02251	-0.0939	0.17822	-0.05552
Biofuels Bioproducts & Biorefining-Biofpr	1932-104X	3.376	5.289	0.921	0.00434	-0.12418	0.12888	-0.02402	-0.48788	-0.25306	-0.10016	0.61676
International Journal of Life Cycle Assessment	0948-3349	4.195	4.881	1.179	0.00708	-0.0002	0.06639	0.18499	-0.41381	-0.06659	-0.18519	0.4802
Ecological Engineering	0925-8574	3.023	3.43	0.907	0.0207	-0.17762	-0.15585	-0.03536	-0.04561	-0.02177	-0.14226	-0.11024
IET Renewable Power Generation	1752-1416	3.488	3.76	0.548	0.00548	-0.10723	-0.10531	-0.32619	-0.45706	-0.00192	0.21896	0.35175
Bioenergy Research	1939-1234	2.938	3.482	0.411	0.00724	-0.19049	-0.14789	-0.43718	-0.40948	-0.0426	0.24669	0.26159
Energies	1996-1073	2.676	3.045	0.63	0.01847	-0.23015	-0.21482	-0.25976	-0.1059	-0.01533	0.02961	-0.10892
Journal of the Energy Institute	1743-9671	4.217	3.063	0.758	0.00196	0.00313	-0.21206	-0.15607	-0.55222	0.21519	0.1592	0.34016
Journal of Natural Gas Science and Engineering	1875-5100	2.803	2.815	0.718	0.01498	-0.21093	-0.25005	-0.18847	-0.20024	0.03912	-0.02246	-0.04981
Wind Energy	1095-4244	2.938	3.297	0.705	0.00554	-0.19049	-0.17622	-0.199	-0.45544	-0.01427	0.00851	0.27922
Energy Science & Engineering	2050-0505	3.553	3.216	0.478	0.00099	-0.09739	-0.18863	-0.3829	-0.57844	0.09124	0.28551	0.38981
Journal of Petroleum Science and Engineering	0920-4105	2.382	2.739	0.417	0.01376	-0.27466	-0.26169	-0.43232	-0.23322	-0.01297	0.15766	-0.02847
Energy Technology	2194-4288	3.175	2.938	1.104	0.00465	-0.15461	-0.23121	0.12424	-0.4795	0.0766	-0.27885	0.24829
Energy for Sustainable Development	0973-0826	2.658	3.221	0.612	0.00358	-0.23288	-0.18786	-0.27435	-0.50842	-0.04502	0.04147	0.32056
Energy Journal	0195-6574	2.132	2.675	0.463	0.0033	-0.31251	-0.27149	-0.39585	-0.51599	-0.04102	0.08254	0.2445
International Journal of Energy Research	0363-907X	3.009	2.671	0.668	0.00553	-0.17974	-0.27211	-0.22898	-0.45571	0.09237	0.04924	0.1836
Stochastic Environmental Research and Risk Assessment	1436-3240	2.668	2.645	0.831	0.00589	-0.23136	-0.27609	-0.09693	-0.44598	0.04473	-0.13443	0.16989
Wiley Interdisciplinary Reviews-Energy and Environment?	2041-8396	2.514	2.857	0.457	0.0016	-0.25468	-0.24362	-0.39991	-0.56195	-0.01106	0.14523	0.31833
Journal of the American Water Resources Association?	1093-474X	2.16	2.338	1.125	0.00451	-0.30827	-0.32311	0.14125	-0.48328	0.01484	-0.44952	0.16017
Energy Strategy Reviews	2211-467X	2.164	2.547	0.318	0.00143	-0.30766	-0.2911	-0.51252	-0.56655	-0.01656	0.20486	0.27545
Petroleum Exploration and Development	1000-0747	2.065	2.464	0.214	0.00424	-0.32205	-0.30381	-0.59077	-0.49058	-0.01884	0.27412	0.18677
Combustion Theory and Modelling	1364-7830	1.744	2.029	0.327	0.00205	-0.37124	-0.37044	-0.50523	-0.54979	-0.0008	0.13399	0.17935
Greenhouse Gases-Science and Technology	2152-3878	1.991	2.312	0.569	0.0016	-0.33385	-0.32709	-0.30918	-0.56195	-0.00676	-0.02467	0.23486
Journal of the Air & Waste Management Association	1096-2247	1.742	1.622	0.549	0.00442	-0.37155	-0.38254	-0.32538	-0.48572	0.01099	0.04617	0.10318
Journal of Energy Resources Technology-Transactions of The Asme	0195-0738	2.197	2.091	0.552	0.00176	-0.30267	-0.36094	-0.32295	-0.55762	0.05827	0.02028	0.19668
Energy Sustainability and Society	2192-0567	1.625	1.625	0.143	0.00081	-0.38926	-0.43232	-0.65429	-0.58331	0.04306	0.26503	0.15099
Energy Efficiency	1570-646X	1.634	1.035	0.333	0.00163	-0.38789	-0.36952	-0.50037	-0.56114	-0.01837	0.11248	0.19162
Journal of Solar Energy Engineering-Transactions of the Asme	0199-6231	1.367	1.859	0.287	0.00223	-0.42831	-0.39648	-0.53764	-0.54492	-0.03183	0.10933	0.14844
Biomass Conversion and Biorefinery	2190-6815	1.31	1.31	0.762	0.00077	-0.43694	-0.48056	-0.15283	-0.58439	0.04362	-0.28411	0.10383
Journal of Environmental Science and Health Part A-Toxic/Hazardous Substances & Environmental Engineering	1093-4529	1.561	1.469	0.229	0.00381	-0.39895	-0.45621	-0.58462	-0.50221	0.05726	0.18567	0.046
Environmental Progress & Sustainable Energy	1944-7442	1.326	1.721	0.299	0.00337	-0.43452	-0.41761	-0.52791	-0.5141	-0.01691	0.09339	0.09649
Journal of Renewable and Sustainable Energy	1941-7012	1.337	1.342	0.314	0.00446	-0.43286	-0.47566	-0.51576	-0.48463	0.0428	0.0829	0.00897
Journal of Energy Engineering	0733-9402	1.346	1.632	0.212	0.00115	-0.43149	-0.43125	-0.59839	-0.57412	-0.00024	0.1669	0.14287
SPE Production & Operations	1930-1855	1.162	1.244	0.24	0.00096	-0.45935	-0.49067	-0.57571	-0.57925	0.03132	0.11636	0.08858
International Journal of Low-Carbon Technologies	1748-1317	0.837	0.837	0.256	0.00102	-0.50855	-0.55301	-0.56275	-0.57763	0.04446	0.0542	0.02462
International Journal of Green Energy	1543-5075	1.171	1.333	0.195	0.00148	-0.45799	-0.47704	-0.61217	-0.56519	0.01905	0.15418	0.08815
Energy Exploration & Exploitation	0144-5987	1.204	1.223	0.163	0.00092	-0.45299	-0.49389	-0.63809	-0.58033	0.0409	0.1851	0.08644
Energy Sources Part B-Economics Planning and Policy	1556-7249	0.976	1.125	0.514	0.00083	-0.48751	-0.5089	-0.35374	-0.58277	0.02139	-0.13377	0.07387
Frontiers in Energy	2095-1701	0.753	0.753	0.442	0.0005	-0.52126	-0.56588	-0.41207	-0.59169	0.04462	-0.10919	0.02581
Proceedings of the Institution of Civil Engineers-Energy	1751-4223	0.771	0.978	1.214	0.00034	-0.51854	-0.53142	0.21335	-0.59601	0.01288	-0.73189	0.06459
Journal of Energy in Southern Africa	1021-447X	0.6	0.801	0	0.0003	-0.54443	-0.55853	-0.77014	-0.59709	0.0141	0.22571	0.03856
International Journal of Oil Gas and Coal Technology	1753-3309	0.563	0.695	0.147	0.0005	-0.55003	-0.57476	-0.65105	-0.59169	0.02473	0.10102	0.01693
Energy Sources Part A-Recovery Utilization and Environmental Effects	1556-7036	0.555	0.576	0.167	0.00228	-0.55124	-0.59299	-0.63485	-0.54357	0.04175	0.08361	-0.04942

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Chapter 8
Environmental Engineering

For this chapter we used a series of scientific methods to thoroughly understand the world's environmental engineering-related journals. First, based on a literature survey and data collection, the environmental engineering descriptions were determined. Then, to classify the influence of each journal, starting from the five year impact factors, a journal ranking was conducted and statistical software used to analyze and describe the relevant indexes. Based on the ranking report, the journals were divided into four zones to clarify their impact. Finally, a statistical analysis of the environmental engineering-related papers published by the world's major countries/regions over the past five-years was conducted. The results of this comprehensive and systematic interpretation of environmental engineering journals identified possible research directions, thereby providing a journal selection channel for environmental engineering researchers.

There were 90 journals in this category, which were divided into four zones in order to measure the specific journals' influence. An analysis of the impact factor changes in the most recent five years was conducted to indirectly reflect the journals' contributions. In the last section, statistical analyses, correlation analysis, principal component analysis and comparison analysis were conducted to elucidate the features of the journals in this category. In this chapter, a journal report on the environmental engineering contributions to MSE is given to assist readers in formulating answers to fundamental environmental engineering problems.

8.1 Category Description

Environmental engineering is the integration of science and engineering principles to improve the natural environment, provide healthy water, air, and land for human habitation and for other organisms, and to remediate pollution sites. Environmental engineering is also concerned with finding plausible solutions in the area of public health such as for arthropod-borne diseases and the promotion of adequate sanitation in urban, rural and recreational areas.

Environmental engineering crosses several practical and social science disciplines; mechanical engineering, management science, economics, environmental science, and meteorology. Environmental engineering focuses on the sustainable use and preservation of natural anthropogenic interactions in an increasingly urbanized world [13, 9], and also focuses on scientific and engineering applications to protect people and the environment from adverse environmental factors; therefore, it is involved in the protection of local and global environments from the potentially deleterious effects of natural and human activities, and improving environmental quality [11, 3].

The practice of environmental engineering dates back to the dawn of civilization [10]. In the early stages, environmental engineering was only focused on local pollution and end-of-pipe treatments. However, as pollution became more serious, environmental engineering expanded its applications to significantly wider fields of interest [5]. At the end of the 20th century, the development of science and technology followed an ecological path and in the 21st century, environmental engineering had begun to play an increasingly important role in the formation and development of green and sustainability sciences. Therefore, environmental engineering has become a leading discipline in the 21st century and is playing an even larger role in national environmental protection and sustainable development polices for the improvements in society, the economy, and the environment [14, 7].

Environmental engineering examines the effects of technological advances on the environment such as hazardous-waste management, treatment and containment, and assists in the development of regulations to prevent and reduce environmental damage, such as designing municipal water supplies and industrial waste-water treatment systems [8, 12]. Environmental engineering addresses local and global environmental issues such the effect-

s of climate change, acid rain, ozone depletion, and water and air pollution [2, 4, 6, 1].

8.2 Ranking Report

Four indexes were used to evaluate journal quality: the impact factor, the five-year impact factor, the eigenfactor score, and the article influence score. Specifically, the impact factor proposed by Garfield in 1972 is an internationally accepted periodical evaluation index that counts the average citation frequency of articles published in the previous two years to assess the relative importance of different journals in the same field of study. Similarly, the five-year impact factor assesses the average citation frequency of articles published in the previous five years to judge the relative importance of the different journals. The eigenfactor score reflects the overall importance of the journal as it indicates the quantity of citations in other journals and therefore does not include self-citation. The article influence score is similar to the five-year impact factor except for the inclusion of self-citations and is therefore also a reflection of the overall importance of the journal. The eigenfactor score and the article influence score are more scientific measurement standards as they both consider citation quality; however, this does not mean that the impact factor and five-year impact factor have no value. A certain degree of self-citation indicates that journals are concerned about their specific scopes and have representative contributions. The impact factor and the eigenfactor score assess journals in the previous two years while the five-year impact factor and article influence score assess journals in the previous five-years; therefore, the former indicate the current developments and the latter indicate the long-term journal contributions. As it would be one-sided to evaluate journals using only one index, in this paper, the four indexes are integrated to develop a comprehensive evaluation model with the weights for each index determined through expert scoring: impact factor (0.3), the five-year impact factor (0.3), the eigenfactor score (0.2), and the article influence score (0.2). To resolve the different dimensional problems, as shown in Table 8.1, the data were standardized to compute the comprehensive journal scores.

Table 8.1: Comprehensive scores of "environmental engineering" journals

Rank	Full Journal Title	ISSN	JCR Data		Eigenfactor Metrics		Standardization				Comprehensive score
			Impact Factor	Five-Year Impact Factor	Eigenfactor Score	Article Influence Score	Z-Impact Factor	Z-5-Year Impact Factor	Z-Eigenfactor Score	Z-Article Influence Score	
1	Environmental Science & Technology	0013-936X	6.653	7.25	0.18373	1.646	2.13479	1.9455	6.76854	1.52567	3.1957455
2	Annual Review of Environment and Resources	1543-5938	6.025	9.87	0.0045	3.266	1.77337	3.23343	-0.35601	4.36724	2.73261
3	Global Environmental Change-Human and Policy Dimensions	0959-3780	6.371	8.897	0.02564	2.785	1.9725	2.75513	0.48432	3.52354	2.59471
4	Water Research	0043-1354	7.051	7.621	0.0728	1.5	2.36384	2.12787	2.35898	1.26958	2.43532
5	Environment International	0160-4120	7.297	7.721	0.02993	1.811	2.50542	2.17703	0.65486	1.81509	2.2433765
6	Critical Reviews in Environmental Science and Technology	1064-3389	7.683	6.996	0.00577	1.519	2.72756	1.82064	-0.30553	1.30291	1.8629185
7	Environmental Science & Technology Letters	2328-8930	5.869	6.687	0.00627	1.978	1.6836	1.66874	-0.28565	2.10802	1.598523
8	Journal of Cleaner Production	0959-6526	5.651	6.352	0.05542	0.816	1.55814	1.50406	1.66811	0.06981	1.5635655
9	Journal of Toxicology and Environmental Health Part-B Critical Reviews	1093-7404	6.333	6.59	0.00175	1.637	1.95063	1.62105	-0.46532	1.50989	1.5291335
10	Science of the Total Environment	0048-9697	4.61	4.984	0.10865	1.032	0.95903	0.83158	3.78405	0.44869	1.5276125
11	Environmental Research Letters	1748-9326	4.541	5.288	0.04441	1.944	0.91932	0.98102	1.23045	2.04838	1.319653
12	Ecosystem Services	2212-0416	4.395	6.017	0.007	1.234	0.8353	1.33938	-0.25663	0.80301	0.9894055
13	Current Opinion in Environmental Sustainability	1877-3435	4.186	5.545	0.00946	1.586	0.71502	1.10736	-0.15884	1.42043	0.9494825
14	Ecological Applications	1051-0761	4.393	4.892	0.02037	1.711	0.83415	0.78636	0.27484	1.63969	0.9443465
15	Energy Policy	0301-4215	4.039	5.038	0.04668	0.994	0.63042	0.85813	1.32068	0.38203	0.9396315
16	Waste Management	0956-053X	4.723	5.262	0.0209	0.853	1.02407	0.96824	0.29591	0.13471	0.8707295
17	Building and Environment	0360-1323	4.539	5.221	0.02166	0.902	0.91817	0.94808	0.32612	0.22066	0.847814
18	Resources Conservation and Recycling	0921-3449	5.12	5.228	0.00862	0.807	1.25254	0.95153	-0.19224	0.05402	0.821182
19	Environmental Modelling & Software	1364-8152	4.177	4.99	0.01959	1.22	0.70984	0.83453	0.24383	0.77845	0.7957505
20	Climatic Change	0165-0009	3.537	4.436	0.03201	1.581	0.34152	0.5622	0.73754	1.41166	0.7428213
21	Atmospheric Environment	1352-2310	3.708	4.042	0.05429	0.965	0.43993	0.36851	1.62319	0.33117	0.6905475
22	Journal of Environmental Management	0301-4797	4.005	4.449	0.03586	0.878	0.61085	0.56859	0.89058	0.17856	0.67245
23	Journal of Industrial Ecology	1088-1980	4.356	5.068	0.0057	0.966	0.81286	0.87287	-0.30831	0.33292	0.668569
24	Ecological Indicators	1470-160X	3.983	4.391	0.02862	0.894	0.59819	0.54007	0.60278	0.20663	0.6010425
25	International Journal of Greenhouse Gas Control	1750-5836	4.078	4.542	0.01773	0.854	0.65287	0.6143	0.1699	0.13647	0.5574615
26	International Journal of Life Cycle Assessment	0948-3349	4.195	4.881	0.00708	0.773	0.7202	0.78095	-0.25345	-0.00561	0.5550035
27	Agriculture Ecosystems & Environment	0167-8809	3.541	4.354	0.02445	1.099	0.34382	0.52189	0.43702	0.56621	0.5364265
28	Sustainability Science	1862-4065	3.855	4.939	0.00282	0.961	0.52453	0.80946	-0.42279	0.32415	0.5261535
29	Environmental Science & Policy	1462-9011	3.826	4.209	0.01306	1.072	0.50784	0.45061	-0.01574	0.51885	0.4523365
30	J ENVIRON SCI HEAL C	1059-0501	4.586	4.235	0.00081	0.873	0.94522	0.46339	-0.50269	0.16979	0.4401915
31	Environmental and Experimental Botany	0098-8472	3.666	4.234	0.00989	0.983	0.41576	0.4629	-0.14175	0.36274	0.3822339
32	Environmental Research	0013-9351	4.732	4.744	0.02179	1.169	1.02925	0.7136	0.33128	0.68899	0.3619415
33	Environmental Reviews	1208-6053	3.328	4.262	0.00221	1.276	0.22124	0.47666	-0.44704	0.87668	0.346796
34	Ambio	0044-7447	3.616	3.88	0.00803	1.093	0.38698	0.28888	-0.21569	0.55568	0.300748
35	Environmental Science-Water Research & Technology	2053-1400	3.649	3.661	0.00201	0.854	0.40597	0.18122	-0.45499	0.13647	0.1418735
36	Ecological Engineering	0925-8574	3.023	3.43	0.0207	0.647	0.04571	0.06767	0.28796	-0.22662	0.071147
37	Journal of Environmental Informatics	1726-2135	4.521	2.9	0.00104	0.635	0.90781	-0.19287	-0.49355	-0.24767	0.0400475
38	Regional Environmental Change	1436-3798	2.872	3.273	0.00828	0.882	-0.04119	-0.00951	-0.20575	0.18558	-0.030425
39	Journal of Environmental Sciences	1001-0742	3.12	3.242	0.01245	0.601	0.10153	-0.02475	-0.03999	-0.30731	-0.0360105
40	International Journal of Environmental Research and Public Health	1660-4601	2.145	2.608	0.03305	0.651	-0.45959	-0.33641	0.77888	-0.21961	-0.1832475
41	Journal of Environmental Quality	0047-2425	2.405	2.962	0.01049	0.733	-0.30995	-0.16239	-0.1179	-0.07578	-0.209127
42	Mitigation and Adaptation Strategies For Global Change	1381-2386	3.585	2.971	0.00347	0.739	-0.20636	-0.15797	-0.39695	-0.06525	-0.2096705
43	Environmental Geochemistry and Health	0269-4042	2.994	2.793	0.00311	0.564	0.02902	-0.24547	-0.41126	-0.37221	-0.2521125
44	Aerosol and Air Quality Research	1680-8584	2.589	2.814	0.00663	0.486	-0.20406	-0.23514	-0.27134	-0.50903	-0.3094105
45	Stochastic Environmental Research and Risk Assessment	1436-3240	2.668	2.645	0.00589	0.608	-0.1586	-0.31822	-0.30076	-0.29503	-0.3110965
46	Environment	0013-9157	2.963	2.461	0.00067	0.646	0.01118	-0.40867	-0.50825	-0.22838	-0.336888
47	Environmental Conservation	0376-8929	2.293	2.52	0.00192	0.788	-0.37441	-0.37967	-0.45857	0.0007	-0.290767
48	Journal of Contaminant Hydrology	0169-7722	2.284	2.547	0.00474	0.673	-0.37959	-0.36639	-0.34647	-0.18102	-0.393519
49	Environmental Management	0364-152X	2.177	2.427	0.00842	0.62	-0.44117	-0.42538	-0.20019	-0.27398	-0.426176
50	Journal of Hydro-Environment Research	1570-6443	2.087	2.305	0.00162	0.622	-0.49296	-0.48536	-0.47049	-0.27047	-0.5252365
51	Climate Research	0936-577X	1.859	2.311	0.00355	0.703	-0.62418	-0.48241	-0.39377	-0.1284	-0.526473
52	Atmospheric Pollution Research	1309-1042	2.152	2.299	0.00303	0.495	-0.45556	-0.48831	-0.41444	-0.49324	-0.5376975
53	Integrated Environmental Assessment and Management	1551-3777	2.23	2.207	0.00252	0.541	-0.41067	-0.53353	-0.43472	-0.41255	-0.5387925
54	Sustainability	2071-1050	2.075	2.177	0.01377	0.322	-0.49987	-0.54828	0.01248	-0.79669	-0.5411085
55	Environmental Monitoring and Assessment	0167-6369	1.804	2.02	0.02006	0.398	-0.65583	-0.62546	0.26251	-0.66338	-0.556484
56	Greenhouse Gases-Science and Technology	2152-3878	1.991	2.312	0.0016	0.496	-0.54821	-0.48192	-0.47129	-0.49149	-0.5734045
57	Carbon Management	1758-3004	1.109	2.59	0.00173	0.758	-1.05581	-0.34526	-0.46612	-0.03192	-0.587385
58	International Journal of Environmental Science and Technology	1735-1472	2.017	2.152	0.00586	0.374	-0.52174	-0.56057	-0.31228	-0.70548	-0.605085
59	Journal of Environmental Health Science and Engineering	2052-336X	2.337	2.04	0.0015	0.334	-0.34909	-0.61562	-0.47526	-0.77564	-0.623935
60	Rangeland Ecology & Management	1550-7424	1.967	2.06	0.00216	0.451	-0.56203	-0.60579	-0.44903	-0.57042	-0.646873
61	Water Air and Soil Pollution	0049-6979	1.769	1.972	0.01171	0.373	-0.67598	-0.64905	-0.06941	-0.70723	-0.6472855
62	Wetlands	0277-5212	1.811	1.918	0.00427	0.543	-0.6518	-0.6756	-0.36515	-0.40905	-0.6677275
63	Bulletin of Engineering Geology and The Environment	1435-9529	1.825	1.971	0.00315	0.516	-0.64375	-0.64954	-0.40967	-0.4564	-0.6682869
64	Journal of Hydrologic Engineering	1084-0699	1.576	2.033	0.00631	0.521	-0.78705	-0.61907	-0.28406	-0.44763	-0.6696065
65	Journal of the Air & Waste Management Association	1096-2247	1.742	1.95	0.00442	0.501	-0.69151	-0.65987	-0.35919	-0.48272	-0.681634
66	Environmetrics	1180-4009	1.321	1.699	0.00315	0.958	-0.9338	-0.78325	-0.40967	0.31889	-0.7058655
67	Frontiers of Environmental Science & Engineering	2095-2201	1.961	1.877	0.00254	0.35	-0.56548	-0.69575	-0.43392	-0.74758	-0.71644
68	Waste Management & Research	0734-242X	1.631	1.955	0.00299	0.312	-0.7554	-0.65741	-0.41603	-0.81423	-0.7606655
69	Journal of Material Cycles and Waste Management	1438-4957	1.693	1.832	0.00151	0.296	-0.71971	-0.71787	-0.47486	-0.84223	-0.796165
70	Environmental Technology	0959-3330	1.666	1.666	0.00681	0.294	-0.73525	-0.79948	-0.26418	-0.8458	-0.800021
71	Wetlands Ecology and Management	0923-4861	1.581	1.588	0.00159	0.463	-0.78417	-0.83782	-0.47168	-0.54937	-0.8309025
72	Gaia-Ecological Perspectives For Science and Society	0940-5550	1.75	1.64	0.00075	0.308	-0.68691	-0.81226	-0.50507	-0.82125	-0.8364045
73	Environmental Engineering Science	1092-8758	1.547	1.56	0.00255	0.365	-0.80374	-0.85158	-0.43352	-0.72127	-0.8618065
74	Environmental Progress & Sustainable Energy	1944-7442	1.326	1.721	0.00337	0.286	-0.93092	-0.77244	-0.40093	-0.85984	-0.8784658
75	Environmental Engineering Research	1226-1025	1.5	1.5	0.00055	0.395	-0.83079	-0.88108	-0.51303	-0.66864	-0.8926779
76	Journal of Environmental Engineering	0733-9372	1.396	1.536	0.00295	0.308	-0.89064	-0.86338	-0.41762	-0.82125	-0.9055935
77	Water and Environment Journal	1747-6585	1.224	1.382	0.00108	0.277	-0.98963	-0.93908	-0.49196	-0.87562	-0.996164
78	Environmental Modeling & Assessment	1420-2026	1.117	1.241	0.001	0.302	-1.0512	-1.0084	-0.49514	-0.83177	-1.0433535
79	Journal of Integrative Environmental Sciences	1943-815X	1.216	1.021	0.00039	0.301	-0.99423	-1.11654	-0.51939	-0.83353	-1.0854465
80	Polish Journal of Environmental Studies	1230-1485	1.12	1.144	0.00303	0.164	-1.04948	-1.05608	-0.41444	-1.07383	-1.0868465
81	International Journal of Environmental Research	1735-6865	1.019	1.15	0.00159	0.204	-1.1076	-1.05313	-0.47168	-1.00367	-1.1037315
82	Environmental and Ecological Statistics	1352-8505	0.829	0.983	0.00116	0.473	-1.21695	-1.13522	-0.48878	-0.53183	-1.1102255
83	Environmental Engineering and Management Journal	1582-9596	1.334	1.021	0.00181	0.086	-0.92632	-1.11654	-0.46294	-1.21065	-1.1103515
84	Journal of Environmental Engineering and Landscape Management	1648-6897	1.068	1.013	0.00047	0.215	-1.0794	-1.12048	-0.51621	-0.98437	-1.1349575
85	Water Environment Research	1061-4303	0.825	0.852	0.0016	0.155	-1.21925	-1.19962	-0.47129	-1.08962	-1.223286
86	Water Science and Technology-Water Supply	1606-9749	0.674	0.699	0.00139	0.133	-1.30615	-1.27483	-0.47963	-1.12821	-1.2944175
87	Environment Protection Engineering	0324-8828	0.486	0.822	0.00044	0.116	-1.41435	-1.21437	-0.5174	-1.15803	-1.3086745
88	Environmental & Engineering Geoscience	1078-7275	0.318	0.73	0.00036	0.238	-1.51103	-1.25959	-0.52058	-0.94403	-1.3288245
89	Journal of Environmental Protection and Ecology	1311-5065	0.679	0.523	0.00048	0.033	-1.30328	-1.36135	-0.51581	-1.30361	-1.3703625
90	Journal of Environmental Science and Management	0119-1144	0.314	0.47	0.00011	0.073	-1.51334	-1.3874	-0.53052	-1.23345	-1.4388235

Based on the respective comprehensive scores, the 90 environmental engineering journals were separated into four zones, as shown in Table 8.2. Specifically, journals with scores in the top 5% were assigned to Zone A, those with scores between 6% and 20% were assigned to Zone B, those with scores between 21% and 50% were assigned to Zone C, and the remainder were assigned to Zone D.

As Table 8.2 shows, four journals: *Environmental Science & Technology*, *Annual Review of Environment and Resources*, *Global Environmental Change-Human and Policy Dimensions*, and *Water Research* were allocated to Zone A. Concretely, *Environmental Science & Technology* is a peer-reviewed scientific journal focused on contemporary environmental science and technology. The *Annual Review of Environment and Resources* is a leading environmental review journal that published articles on significant developments in the entomology, biochemistry, physiology, morphology and development, behavior and neuroscience, the ecology, agricultural entomology and pest management, biological controls, forest entomology, acarines and other arthropods, medical and veterinary entomology, pathology, plant disease vectors, genetics, genomics, systematics, evolution, and biogeography. *Global Environmental Change-Human and Policy Dimensions* is a peer-reviewed international journal that publishes high quality, theoretically and empirically rigorous articles that advance knowledge about the human and policy dimensions of global environmental change. *Water Research* is a first-class water science and technology journal published by the International Water Association. It focuses on original research papers on all aspects of the science and technology of water quality and its management worldwide.

Table 8.2: Environmental engineering journals in Zone A

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year pact Factor	Im- Immediacy Index	Articles	Cited Half-life	Eigenfactor Score	Article Influence Score
1	Environmental Science & Technology	0013-936X	156556	6.653	7.25	1.064	98.1%	7.7	0.18373	1.646
2	Annual Review of Environment and Resources	1543-5938	3537	6.025	9.87	0.48	0%	8.7	0.0045	3.266
3	Global Environmental Change-Human and Policy Dimensions	0959-3780	13945	6.371	8.897	3.128	99.08%	6.5	0.02564	2.785
4	Water Research	0043-1354	76647	7.051	7.621	1.066	94.89%	8.2	0.0728	1.5

Table 8.3 shows the 14 journals in Zone B, for which the five-year impact factors ranged from 5.12 to 7.29. *Environment International* is an international, multidisciplinary journal situated at the interface between the envi-

ronment and humans, which focuses on the complexity of the environment and spans the sources, pathways, fate and impacts associated with air, soil, water, food, and biota and their related interactions with ecosystems and human health. *Critical Reviews in Environmental Science and Technology*, which had a five-year impact factor of 6.996, is a peer-reviewed journal in the field of environmental science and serves as an international forum for the critical review of current knowledge on a broad range of environmental science topics. The *Journal of Toxicology and Environmental Health Part-B Critical Reviews* focuses on environmental sciences, and public and occupational health, as well as toxicology, but it also concentrates on specific interest fields. *Energy Policy*, which had a five-year impact factor of 5.038, is an international peer-reviewed journal addressing the policy implications of energy supply and use from economic, social, planning, and environmental aspects. *Resources Conservation and Recycling*, which had a five-year impact factor of 5.228, focuses on the sustainable management and conservation of resources and emphasizes the transformation processes involved in a transition toward more sustainable production and consumption systems.

Table 8.3: Environmental engineering journals in Zone B

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year pact Factor	Im- Immediacy Index	Articles	Cited Half-life	Eigenfactor Score	Article Influence Score
1	Environment International	0160-4120	19430	7.297	7.721	1.309	82.82%	6.1	0.02993	1.811
2	Critical Reviews in Environmental Science and Technology	1064-3389	4707	7.683	6.996	0.224	0%	7.1	0.00577	1.519
3	Environmental Science & Technology Letters	2328-8930	1660	5.869	6.687	1.29	96.77%	2.8	0.00627	1.978
4	Journal of Cleaner Production	0959-6526	45454	5.651	6.352	1.364	94.71%	3.2	0.05542	0.816
5	Journal of Toxicology and Environmental Health Part-B Critical Reviews	1093-7404	1665	6.333	6.59	1.381	0%	8.3	0.00175	1.637
6	Science of the Total Environment	0048-9697	71249	4.61	4.984	1.132	95.99%	4.9	0.10865	1.032
7	Environmental Research Letters	1748-9326	11797	4.541	5.288	0.842	96.88%	4.1	0.04441	1.944
8	Ecosystem Services	2212-0416	2637	4.395	6.017	0.876	94.12%	3	0.007	1.234
9	Current Opinion in Environmental Sustainability	1877-3435	3255	4.186	5.545	1.567	47.76%	4.4	0.00946	1.586
10	Ecological Applications	1051-0761	20577	4.393	4.892	0.934	100%	¿10	0.02037	1.711
11	Energy Policy	0301-4215	41513	4.039	5.038	0.915	98.99%	6.7	0.04668	0.994
12	Waste Management	0956-053X	20761	4.723	5.262	0.804	95.46%	6.4	0.0209	0.853
13	Building and Environment	0360-1323	21,261	4.539	5.221	1	0.96%	6.8	0.02166	0.902
14	Resources Conservation and Recycling	0921-3449	9946	5.12	5.228	1.238	90.04%	6.6	0.00862	0.807

Table 8.4 shows the 27 journals in Zone C, which have five-year impact factors ranging from 2.645 to 4.99. *Climatic Change*, which had a five-year impact factor of 4.436, publishes papers on the descriptions, causes and implications of climate change. The *Journal of Environmental Management*, which had a five-year impact factor of 4.449, is widely focused on all aspects of management and the managed use of the both the natural and the man-made environment. The *International Journal of Life Cycle Assessment*, which had a five-year impact factor of 4.881, is the first journal devoted

entirely to Life Cycle Assessment and associated methods. *Ecological Engineering*, which is published by the Journal of Ecosystem Restoration, focuses on the design of ecosystems for the mutual benefit of humans and nature and is meant for ecologists who are involved in designing, monitoring, or restoring ecosystems and serves as a bridge between ecologists and engineers. The *Journal of Environmental Sciences*, which is sponsored by the Research Center for Eco-Environmental Sciences and the Chinese Academy of Sciences and is jointly published by Elsevier and the Science Press, focuses on the fate and behavior of emerging contaminants, the human impact on the environment, the human exposure to environmental contaminants and their health effects, and environmental remediation and management. *Stochastic Environmental Research and Risk Assessment*, which had a five-year impact factor of 2.645, ranking it 45th out of the 90 environmental engineering journals and 27th in Zone C, is a comprehensive journal publishing research papers, reviews and technical notes on stochastic and probabilistic approaches to environmental sciences and engineering, including interactions between the earth and atmospheric environments.

Table 8.4: Environmental engineering journals in Zone C

Rank	Full Journal Title	ISSN	JCR Data							Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year pact Factor	Im- Immediacy Index	Articles	Cited Half-life		Eigenfactor Score	Article Influence Score
1	Environmental Modelling & Software	1364-8152	11551	4.177	4.99	0.853	96.1%	5.7		0.01959	1.22
2	Climatic Change	0165-0009	18223	3.537	4.436	1.042	98.85%	6.9		0.03201	1.581
3	Atmospheric Environment	1352-2310	51951	3.708	4.042	0.782	97.99%	8.9		0.05429	0.965
4	Journal of Environmental Management	0301-4797	27354	4.005	4.449	1.032	93.75%	5.8		0.03586	0.878
5	Journal of Industrial Ecology	1088-1980	5124	4.356	5.068	1.744	99.17%	6.5		0.0057	0.966
6	Ecological Indicators	1470-160X	13782	3.983	4.391	0.943	95.87%	3.8		0.02862	0.894
7	International Journal of Greenhouse Gas Control	1750-5836	10333	4.078	4.542	0.874	97.63%	4.5		0.01773	0.854
8	International Journal of Life Cycle Assessment	0948-3349	7025	4.195	4.881	1.179	96.55%	6.3		0.00708	0.773
9	Agriculture Ecosystems & Environment	0167-8809	19316	3.541	4.354	0.655	97.21%	8.1		0.02445	1.099
10	Sustainability Science	1862-4065	1687	3.855	4.939	1.548	96.77%	4.7		0.00282	0.961
11	Environmental Science & Policy	1462-9011	6731	3.826	4.209	0.703	92.44%	5.1		0.01306	1.072
12	Journal of Environmental Science and Health Part C-Environmental Carcinogenesis & Ecotoxicology Reviews	1059-0501	895	4.586	4.235	0.429	0%	8.3		0.00081	0.873
13	Environmental and Experimental Botany	0098-8472	8583	3.666	4.234	0.749	95.43%	7.9		0.00989	0.983
14	Environmental Research	0013-9351	13420	4.732	4.744	0.95	92.89%	5.8		0.02179	1.169
15	Environmental Reviews	1208-6053	1594	3.328	4.262	0.514	0%	7.4		0.00221	1.276
16	Ambio	0044-7447	7002	3.616	3.88	1.478	83.48%	7.8		0.00803	1.093
17	Environmental Science-Water Research & Technology	2053-1400	687	3.649	3.661	0.632	90.53%	1.8		0.00201	0.854
18	Ecological Engineering	0925-8574	14459	3.023	3.43	0.907	97.63%	4.9		0.0207	0.647
19	Journal of Environmental Informatics	1726-2135	513	4.521	2.9	0.611	100%	3.5		0.00104	0.635
20	Regional Environmental Change	1436-3798	3233	2.872	3.273	1.148	93.65%	3.6		0.00828	0.882
21	Journal of Environmental Sciences	1001-0742	10255	3.12	3.242	0.836	96.19%	6		0.01245	0.601
22	International Journal of Environmental Research and Public Health	1660-4601	1141	1.019	1.15	0.226	100%	5.4		0.00159	0.204
23	Journal of Environmental Quality	0047-2425	14507	2.405	2.962	0.817	96.57%	¿10		0.01049	0.733
24	Mitigation and Adaptation Strategies For Global Change	1381-2386	2402	2.585	2.971	0.79	98.39%	6.7		0.00347	0.739
25	Environmental Geochemistry and Health	0269-4042	2841	2.994	2.793	0.954	97.22%	7		0.00311	0.564
26	Aerosol and Air Quality Research	1680-8584	3692	2.589	2.814	0.734	99.27%	3.7		0.00663	0.486
27	Stochastic Environmental Research and Risk Assessment	1436-3240	3307	2.668	2.645	0.831	97.67%	4.5		0.00589	0.608

Table 8.5 shows the 45 journals in Zone D, which have five-year impact factors ranging from 0.47 to 2.461. With a five-year impact factor of 2.461,

Environment analyzes the problems, places, and people where the environment and development come together and illuminates local to global concerns. *Integrated Environmental Assessment and Management*, which had a five-year impact factor of 2.207, is published six times a year by the Society of Environmental Toxicology and Chemistry (SETAC), and is devoted to bridging the gap between scientific research and the application of science in decision making, policy and regulation, and environmental management. IEAM aims to be the premier scientific journal for presenting new information, promoting dialogue, and fostering new methods for the analysis of ecological, chemical, engineering, physical, and social science research for the advancement of environmental management strategies, policies and regulations, and problem solving. *Rangeland Ecology & Management* informs academics, ecosystem managers and policy makers on science-based information to promote sound rangeland stewardship, and publishes papers on ecology, management, socioeconomics and policies pertaining to global rangelands. The *Journal of the Air & Waste Management Association*, which is the official journal of the *Air & Waste Management Association*, is the oldest continuously published, peer-reviewed, technical environmental journal in the world and was first published in 1951 under the name Air Repair. The *Journal of the Air & Waste Management Association* is focused on air pollution control and waste management. The *Polish Journal of Environmental Studies*, which had an impact factor of 1.216, is aimed at environmental protection. *Water Environment Research* publishes peer-reviewed research papers, research notes, and critical state-of-the-art reviews on original, fundamental and applied research in all scientific and technical areas related to water quality, pollution control, and management.

8.3 Statistical Analysis

For this section, a statistical analysis of the journal indicators for the 90 environmental journals was conducted using SPSS 21.0, a software package for logical batched and non-batched statistical analyses. The current version (2015) is officially called IBM SPSS Statistics. In the following, a total analysis and an analysis by zone are given.

Table 8.5: Environmental engineering journals in Zone D

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year Impact Factor	Im- Immediacy Index	Articles	Cited Half-life	Eigenfactor Score	Article Influence Score
1	Environment	0013-9157	997	2.963	2.461	0.722	100%	>10	0.00067	0.646
2	Environmental Conservation	0376-8929	3346	2.293	2.52	0.667	79.49%	>10	0.00192	0.788
3	Journal of Contaminant Hydrology	0169-7722	4917	2.284	2.547	0.275	100%	>10	0.00474	0.673
4	Environmental Management	0364-152X	9307	2.177	2.427	0.397	97.44%	>10	0.00842	0.62
5	Journal of Hydro-Environment Research	1570-6443	705	2.087	2.305	0.548	100%	4.5	0.00162	0.622
6	Climate Research	0936-577X	4410	1.859	2.311	0.946	96.43%	>10	0.00355	0.703
7	Atmospheric Pollution Research	1309-1042	1236	2.152	2.299	0.442	99.17%	3.1	0.00303	0.495
8	Integrated Environmental Assessment and Management	1551-3777	1780	2.23	2.207	1.725	93.75%	6	0.00252	0.541
9	Sustainability	2071-1050	8904	2.075	2.177	0.483	94.5%	2.4	0.01377	0.322
10	Environmental Monitoring and Assessment	0167-6369	16174	1.804	2.02	0.203	99.07%	6.4	0.02006	0.398
11	Greenhouse Gases-Science and Technology	2152-3878	673	1.991	2.312	0.569	94.44%	3.5	0.0016	0.496
12	Carbon Management	1758-3004	629	1.109	2.59	0.278	97.22%	4.7	0.00173	0.758
13	International Journal of Environmental Science and Technology	1735-1472	3789	2.037	2.152	0.404	90.42%	3.9	0.0056	0.374
14	Journal of Environmental Health Science and Engineering	2052-336X	676	2.337	2.04	0.333	95.83%	3.3	0.0015	0.334
15	Rangeland Ecology & Management	1550-7424	1846	1.967	2.06	1.022	98.92%	6.8	0.00216	0.451
16	Water Air and Soil Pollution	0049-6979	13524	1.769	1.972	0.241	97.63%	8.8	0.01171	0.373
17	Wetlands	0277-5212	4119	1.811	1.918	0.178	93.07%	>10	0.00427	0.543
18	Bulletin of Engineering Geology and The Environment	1435-9529	2135	1.825	1.971	0.697	100%	7.2	0.00315	0.516
19	Journal of Hydrologic Engineering	1084-0699	4270	1.576	2.033	0.366	100%	7.1	0.00631	0.521
20	Journal of the Air & Waste Management Association	1096-2247	5469	1.742	1.95	0.549	95.58%	>10	0.00442	0.501
21	Environmetrics	1180-4009	1644	1.321	1.699	0.111	97.22%	>10	0.00315	0.958
22	Frontiers of Environmental Science & Engineering	2095-2201	1335	1.961	1.877	0.573	90.63%	3.7	0.00254	0.35
23	Waste Management & Research	0734-242X	3654	1.631	1.955	0.379	88.71%	7.6	0.00299	0.312
24	Journal of Material Cycles and Waste Management	1438-4957	1199	1.693	1.832	0.369	93.29%	4.5	0.00151	0.296
25	Environmental Technology	0959-3330	5987	1.666	1.666	0.502	100%	6.1	0.00681	0.294
26	Wetlands Ecology and Management	0923-4861	1547	1.581	1.588	0.224	100%	9.7	0.00159	0.463
27	Gaia-Ecological Perspectives For Science and Society	0940-5550	612	1.75	1.64	1.111	100%	5.4	0.00075	0.308
28	Environmental Engineering Science	1092-8758	2245	1.547	1.56	0.317	97.5%	8.4	0.00255	0.365
29	Environmental Progress & Sustainable Energy	1944-7442	2016	1.326	1.721	0.299	97.2%	3.9	0.00337	0.286
30	Environmental Engineering Research	1226-1025	397	1.5	1.5	0.019	94.23%	4.4	0.00055	0.395
31	Journal of Environmental Engineering	0733-9372	5360	1.396	1.536	0.25	97.66%	¿10	0.00295	0.308
32	Water and Environment Journal	1747-6585	750	1.224	1.382	0.2	100%	5.6	0.00108	0.277
33	Environmental Modeling & Assessment	1420-2026	838	1.117	1.241	0.159	100%	7.9	0.001	0.302
34	Journal of Integrative Environmental Sciences	1943-815X	167	1.216	1.021	0	100%	5.3	0.00039	0.301
35	Polish Journal of Environmental Studies	1230-1485	3471	1.12	1.144	0.177	97%	6.9	0.00303	0.164
36	International Journal of Environmental Research	1735-6865	1141	1.019	1.15	0.226	100%	5.4	0.00159	0.204
37	Environmental and Ecological Statistics	1352-8505	818	0.829	0.983	0.154	100%	¿10	0.00116	0.473
38	Environmental Engineering and Management Journal	1582-9596	2128	1.334	1.021	0.054	98.66%	3.6	0.00181	0.086
39	Journal of Environmental Engineering and Landscape Management	1648-6897	292	1.068	1.013	1	87.5%	4.6	0.00047	0.215
40	Water Environment Research	1061-4303	2802	0.825	0.852	0.091	98.7%	>10	0.0016	0.155
41	Water Science and Technology-Water Supply	1606-9749	789	0.674	0.699	0.179	99.44%	4.3	0.00139	0.133
42	Environment Protection Engineering	0324-8828	412	0.486	0.822	0.029	100%	5.6	0.00044	0.116
43	Environmental & Engineering Geoscience	1078-7275	432	0.318	0.73	0.188	100%	>10	0.00036	0.238
44	Journal of Environmental Protection and Ecology	1311-5065	810	0.679	0.523	0.096	99.44%	4	0.00048	0.033
45	Journal of Environmental Science and Management	0119-1144	94	0.314	0.47	0.036	100%	/	0.00011	0.073

Total analysis

SPSS 21.0 was used to conduct the statistical descriptive analysis, the results for which are shown in Table 8.6. Specifically, the 2017 total cites for these journals was between 94 and 156,556, with a mean of 10200.57. The impact factors ranged from 0.314 to 7.683, which was a wide range, which was also the case for the five-year impact factors, which had a range of 9.400, from a minimum of 0.470 to a maximum of 9.870. The immediacy index, which measures the ratio of journal citations in a single calendar year and the importance of the works published, ranged from 0.000 to 3.128. The cited half-life was 566, and the eigenfactor scores ranged from 0.00011 to 0.18373, which indicated the importance of one journal in terms of the origin of incoming citations. The article influence scores, an index that mea-

sures the average level of the articles' influence in the journals, ranged from 0.003 and 3.266.

Table 8.6: Descriptive analysis of environmental engineering journals

	N	Range	Minimum	Maximum	Sum	Mean		Std. Deviation	Skewness	
						Statistic	Std. Error		Statistic	Std. Error
Total_Cites	90	156462	94	156556	918051	10200.57	2193.322	20807.677	4.822	0.254
Impact_Factor	90	7.369	0.314	7.683	263.796	2.93107	0.184197	1.747444	0.742	0.254
5_Year_Impact_Factor	90	9.400	0.470	9.870	294.853	3.27614	0.215620	2.045550	0.936	0.254
Immediacy_Index	90	3.128	0.000	3.128	62.363	0.69292	0.053228	0.504967	1.444	0.254
Articles_in_citable_item	90	100.00	0.00	100.00	8047.96	89.4218	2.61868	24.84297	-3.218	0.254
Cited_Half_life	89	8	2	10	566	6.36	0.242	2.284	0.184	0.255
Eigenfactor_Score	90	0.18362	0.00011	0.18373	1.17958	0.0131064	0.00264576	0.02509985	4.526	0.254
Article_Influence_Score	90	3.233	0.03	3.266	69.411	0.77123	0.060415	0.573150	1.724	0.254

Table 8.7 gives the extreme values for the total cites. The top five journals with total cites between 45,454 and 156,556 were *Environmental Science & Technology*, *Water Research*, *Science of the Total Environment*, *Atmospheric Environment*, and *Journal of Cleaner Production*. The journals with the lowest cites between 94 and 412 were the *Journal of Environmental Science and Management*, *Journal of Integrative Environmental Sciences*, *Journal of Environmental Engineering and Landscape*, *Environmental Engineering Research*, and *Environment Protection Engineering.*

Table 8.7: Extreme values of total cites

			Case Number	Journal Title	Value
Total Cites	Highest	1	1	Environmental Science & Technology	156556
		2	4	Water Research	76647
		3	10	Science of the Total Environment	71249
		4	21	Atmospheric Environment	51951
		5	8	Journal of Cleaner Production	45454
	Lowest	1	90	Journal of Environmental Science and Management	94
		2	79	Journal of Integrative Environmental Sciences	167
		3	84	Journal of Environmental Engineering and Landscape	292
		4	75	Environmental Engineering Research	397
		5	87	Environment Protection Engineering	412

Table 8.8 gives the extreme values for the impact factor. The top five journals with impact factors ranging from 6.371 to 7.683 were *Critical Reviews in Environmental Science and Technology*, *Environment International*, *Water Research*, *Environmental Science & Technology*, *Global Environmental Change-Human*, and *Policy Dimensions*. The journals with the lowest impacts ranging from 0.318 to 0.679 were *Journal of Environmental Science and Management*, *Environmental & Engineering Geoscience*, *Environment*

Protection Engineering, *Water Science and Technology-Water Supply*, and *Journal of Environmental Protection and Ecology.*

Table 8.8: Extreme value of impact factor

			Case Number	Journal Title	Value
Impact Factor	Highest	1	6	Critical Reviews in Environmental Science and Technology	7.683
		2	5	Environment International	7.297
		3	4	Water Research	7.051
		4	1	Environmental Science & Technology	6.653
		5	3	Global Environmental Change-Human and Policy Dimensions	6.371
	Lowest	1	90	Journal of Environmental Science and Management	0.314
		2	88	Environmental & Engineering Geoscience	0.318
		3	87	Environment Protection Engineering	0.486
		4	86	Water Science and Technology-Water Supply	0.674
		5	89	Journal of Environmental Protection and Ecology	0.679

Table 8.9 gives the extreme values for the five-year impact factors. The top five journals with five-year impact factors ranging from 7.250 to 9.870 were the *Annual Review of Environment and Resources*, *Global Environmental Change-Human and Policy Dimensions*, *Environment International*, *Water Research*, and *Environmental Science & Technology*. The journals with the lowest five-year impact factors ranging from 0.470 to 0.822 were the *Journal of Environmental Science and Management*, *Journal of Environmental Protection and Ecology*, *Water Science and Technology-Water Supply*, *Environmental & Engineering Geoscience*, and *Environment Protection Engineering*.

Table 8.9: Extreme value of five-year impact factor

			Case Number	Journal Title	Value
5 Year Impact Factor	Highest	1	2	Annual Review of Environment and Resources	9.870
		2	3	Global Environmental Change-Human and Policy Dimensions	8.897
		3	5	Environment International	7.721
		4	4	Water Research	7.621
		5	1	Environmental Science & Technology	7.250
	Lowest	1	90	Journal of Environmental Science and Management	0.470
		2	89	Journal of Environmental Protection and Ecology	0.523
		3	86	Water Science and Technology-Water Supply	0.699
		4	88	Environmental & Engineering Geoscience	0.730
		5	87	Environment Protection Engineering	0.822

Table 8.10 gives the extreme values for the immediacy index. The top five journals with immediacy index values ranging from 1.548 to 3.128 were

Global Environmental Change-Human and Policy Dimensions, *Journal of Industrial Ecology*, *Integrated Environmental Assessment and Management*, *Current Opinion in Environmental Sustainability*, and *Sustainability Science*. The lowest five journals with immediacy index values ranging from 0.000 to 0.054 were the *Journal of Integrative Environmental Sciences*, *Environmental Engineering Research*, *Environment Protection Engineering*, *Journal of Environmental Science and Management*, and the *Environmental Engineering and Management Journal*.

Table 8.10: Extreme value of immediacy index

			Case Number	Journal Title	Value
Immediacy Index	Highest	1	3	Global Environmental Change-Human and Policy Dimensions	3.128
		2	23	Journal of Industrial Ecology	1.744
		3	53	Integrated Environmental Assessment and Management	1.725
		4	13	Current Opinion in Environmental Sustainability	1.567
		5	28	Sustainability Science	1.548
	Lowest	1	79	Journal of Integrative Environmental Sciences	0.000
		2	75	Environmental Engineering Research	0.019
		3	87	Environment Protection Engineering	0.029
		4	90	Journal of Environmental Science and Management	0.036
		5	83	Environmental Engineering and Management Journal	0.054

Table 8.11 gives the extreme values for the articles in citable item. The top five journals with the highest articles in citable item values were *Ecological Applications*, *Journal of Environmental Informatics*, *International Journal of Environmental Research and Public Health*, *Environment*, and *Journal of Contaminant Hydrology*. The five journals with the lowest articles in citable item values were *Environmental Reviews*, the *Journal of Environmental Science and Health Part C-Environmental Carcinogenesis & Ecotoxicology Review*, the *Journal of Toxicology and Environmental Health Part-B Critical Reviews*, *Critical Reviews in Environmental Science and Technology*, and the *Annual Review of Environment and Resources*.

Table 8.12 gives the extreme values for the cited half-life. The five journals with the highest cited half-life of 10 were *Ecological Applications*, the *Journal of Environmental Quality*, *Environment*, *Environmental Conservation*, and the *Journal of Contaminant Hydrology.* The five journals with the lowest cited half-life from 2 to 3 were *Environmental Science-Water Research & Technology*, *Sustainability*, *Environmental Science & Technology Letters*, *Ecosystem Services*, *Atmospheric Pollution Research*.

Table 8.11: Extreme value of articles in citable item

			Case Number	Journal Title	Value
Articles in citable item	Highest	1	14	Ecological Applications	100%
		2	37	Journal of Environmental Informatics	100
		3	40	International Journal of Environmental Research and Public Health	100
		4	46	Environment	100
		5	48	Journal of Contaminant Hydrology	100
	Lowest	1	33	Environmental Reviews	0.00
		2	30	Journal of Environmental Science and Health Part C-Environmental Carcinogenesis & Ecotoxicology Review	0.00
		3	9	Journal of Toxicology and Environmental Health Part-B Critical Reviews	0.00
		4	6	Critical Reviews in Environmental Science and Technology	0.00
		5	2	Annual Review of Environment and Resources	0.00

Table 8.12: Extreme value of cited half-life

			Case Number	Journal Title	Value
Cited Half-life	Highest	1	14	Ecological Applications	10
		2	41	Journal of Environmental Quality	10
		3	46	Environment	10
		4	47	Environmental Conservation	10
		5	48	Journal of Contaminant Hydrology	10
	Lowest	1	35	Environmental Science-Water Research & Technology	2
		2	54	Sustainability	2
		3	7	Environmental Science & Technology Letters	3
		4	12	Ecosystem Services	3
		5	52	Atmospheric Pollution Research	3

Table 8.13 gives the extreme values for the eigenfactor score. The five journals with the highest eigenfactor scores ranging from 0.05542 to 0.18373 were *Environmental Science & Technology*, *Science of the Total Environment*, *Water Research*, *Journal of Cleaner Production*, and *Atmospheric Environment*. The five journals with the lowest eigenfactor scores ranging from 0.00011 to 0.00047 were the *Journal of Environmental Science and Management*, *Environmental & Engineering Geoscience*, *Journal of Integrative Environmental Sciences*, *Environment Protection Engineering*, and *Journal of Environmental Engineering and Landscape Management*.

Table 8.14 gives the extreme values for the article influence score. The five journals with the highest article influence scores ranging from 1.811 to 3.266 were the *Annual Review of Environment and Resources*, *Global Environmental Change-Human and Policy Dimensions*, *Environmental Science & Technology Letters*, *Environmental Research Letters*, and *Environment International*. The five journals with the lowest article influence scores ranging from 0.033 to 0.133 were the *Journal of Environmental Protection and E-*

Table 8.13: Extreme value of eigenfactor score

			Case Number	Journal Title	Value
Eigenfactor Score	Highest	1	1	Environmental Science & Technology	0.18373
		2	10	Science of the Total Environment	0.10865
		3	4	Water Research	0.07280
		4	8	Journal of Cleaner Production	0.05542
		5	21	Atmospheric Environment	0.05429
	Lowest	1	90	Journal of Environmental Science and Management	0.00011
		2	88	Environmental & Engineering Geoscience	0.00036
		3	79	Journal of Integrative Environmental Sciences	0.00039
		4	87	Environment Protection Engineering	0.00044
		5	84	Journal of Environmental Engineering and Landscape Management	0.00047

cology, *Journal of Environmental Science and Management*, *Environmental Engineering and Management Journal*, *Environment Protection Engineering*, and *Water Science and Technology-Water Supply*.

Table 8.14: Extreme value of article influence score

			Case Number	Journal Title	Value
Article Influence Score	Highest	1	2	Annual Review of Environment and Resources	3.266
		2	3	Global Environmental Change-Human and Policy Dimensions	2.785
		3	7	Environmental Science & Technology Letters	1.978
		4	11	Environmental Research Letters	1.944
		5	5	Environment International	1.811
	Lowest	1	89	Journal of Environmental Protection and Ecology	0.033
		2	90	Journal of Environmental Science and Management	0.073
		3	83	Environmental Engineering and Management Journal	0.086
		4	87	Environment Protection Engineering	0.116
		5	86	Water Science and Technology-Water Supply	0.133

Zone analysis

In this section, a descriptive analysis is conducted to examine the index differences between the journals in each zone.

Table 8.15 gives the 2017 journal statistical results for total cites in each zone. The largest mean (62671.25), standard error of skewness (70429.101), median (45296.00), range (153019), maximum (156556), minimum (3537) and variance (4960258277.583) were all in Zone A; Zone B had the largest sum (275912).

Table 8.16 gives the 2017 journal statistical results for the impact factor in each zone. The largest mean (6.52500), median (6.51200), and minimum

Table 8.15: Statistical results of 2017 total cites in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	4	62671.25	70429.101	45296.00	250685	156556	3537	153019	4960258277.583
B	14	19708.00	20372.405	15613.50	275912	71249	1660	69589	415034865.692
C	27	9689.19	10836.504	7002.00	261608	51951	513	51438	117429827.080
D	45	2885.47	3407.127	1644.00	129846	16174	94	16080	11608516.436
Total	90	10200.57	20807.677	3408.50	918051	156556	94	156462	432959421.911

(6.025) were in Zone A, the largest standard error of skewness (1.163616), maximum (7.683), and variance (1.354) were in Zone B, and the largest sum (94.634) and range (3.713) were in Zone C.

Table 8.16: Statistical results of 2017 impact factor in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	4	6.52500	0.434655	6.51200	26.100	7.051	6.025	1.026	0.189
B	14	5.24136	1.163616	4.66650	73.379	7.683	4.039	3.644	1.354
C	27	3.50496	0.816724	3.64900	94.634	4.732	1.019	3.713	0.667
D	45	1.54851	0.583042	1.63100	69.683	2.963	0.314	2.649	0.340
Total	90	2.93107	1.747444	2.37100	263.796	7.683	0.314	7.369	3.054

Table 8.17 gives the 2017 journal statistical results for the five-year impact factor in each zone. The largest mean (8.40950), standard error of skewness (1.202343), median (8.25900), maximum (9.870), minimum (7.250) and variance (1.446) were in Zone A and the largest sum (103.497) and range (3.918) were in Zone C.

Table 8.17: Statistical results of 2017 five-year impact factor in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	4	8.40950	1.202343	8.25900	33.638	9.870	7.250	2.620	1.446
B	14	5.84436	0.886036	5.41650	81.821	7.721	4.892	2.829	0.785
C	27	3.83322	0.930146	4.20900	103.497	5.068	1.150	3.918	0.865
D	45	1.68660	0.594285	1.83200	75.897	2.590	0.470	2.120	0.353
Total	90	3.27614	2.045550	2.56850	294.853	9.870	0.470	9.400	4.184

Table 8.18 gives the 2017 statistical results for the immediacy index in each zone. The largest mean (1.43450), standard error of skewness (1.162193), maximum (3.128), minimum (0.480), range (2.648) and vari-

ance (1.351) were in zone A, the largest median (1.06600) was in Zone B and the biggest sum (23.961) was in Zone C.

Table 8.18: Statistical results of 2017 immediacy index in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	4	1.43450	1.162193	1.06500	5.738	3.128	0.480	2.648	1.351
B	14	1.06257	0.338605	1.06600	14.876	1.567	0.224	1.343	0.115
C	27	0.88744	0.329371	0.83600	23.961	1.744	0.226	1.518	0.108
D	45	0.39529	0.344117	0.29900	17.788	1.725	0.000	1.725	0.118
Total	90	0.69292	0.504967	0.66100	62.363	3.128	0.000	3.128	0.255

Table 8.19 gives the 2017 statistical results for the articles in citable item in each zone. The largest mean (96.8920), median (98.6600), sum (4360.14), maximum (100.00), and minimum (79.49) were in Zone D; the largest standard error of skewness(48.71121) and variance (2372.782) were in Zone A, while Zone B and Zone C had the largest range (100.00).

Table 8.19: Statistical results of 2017 Articles in citable item in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	4	73.0175	48.71121	96.4950	292.07	99.08	0.00	99.08	2372.782
B	14	71.0357	40.48524	94.4150	994.50	100.00	0.00	100.00	1639.055
C	27	88.9352	25.85997	96.5700	2401.25	100.00	0.00	100.00	668.738
D	45	96.8920	4.23333	98.6600	4360.14	100.00	79.49	20.51	17.921
Total	90	89.4218	24.84297	97.2050	8047.96	100.00	0.00	100.00	617.173

Table 8.20 gives the statistical 2017 cited half-life results in each zone. The largest mean (7.73), median (7.90), and minimum (7) were in Zone A; and Zone D had the largest standard error of skewness (2.562), sum (294), maximum (10), range (8), and variance (6.563).

Table 8.20: Statistical results of 2017 Cited Half-life in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	4	7.73	0.896	7.90	31	9	7	2	0.803
B	14	5.74	2.113	6.25	80	10	3	7	4.464
C	27	5.94	1.903	5.80	161	10	2	8	3.623
D	44	6.69	2.562	6.25	294	10	2	8	6.563
Total	89	6.36	2.284	6.30	566	10	2	8	5.218

Table 8.21 gives the statistical 2017 the eigenfactor score results in each zone. The largest mean (0.0716675), standard error of skewness (0.07997768), median (0.0492200), minimum (0.00450), range (0.17923) and variance (0.006) were in Zone A; Zone B had the largest sum (0.38689).

Table 8.21: Statistical results of 2017 Eigenfactor Score in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	4	0.0716675	0.07997768	0.0492200	0.28667	0.18373	0.00450	0.17923	0.006
B	14	0.0276350	0.02887764	0.0206350	0.38689	0.10865	0.00175	0.10690	0.001
C	27	0.0133185	0.01294596	0.0082800	0.35960	0.05429	0.00081	0.05348	0.000
D	45	0.0032538	0.00381436	0.0019200	0.14642	0.02006	0.00011	0.01995	0.000
Total	90	0.0131064	0.02509985	0.0043450	1.17958	0.18373	0.00011	0.18362	0.001

Table 8.22 shows the statistical 2017 the article influence score results in each zone. The largest mean (2.29925), standard error of skewness (0.863345), median (2.21550), maximum (3.266), minimum (1.500), range (1.766), and variance (0.745) were in Zone A; Zone C had the largest sum(23.610).

Table 8.22: Statistical results of 2017 Article Influence Score in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	4	2.29925	0.863345	2.21550	9.197	3.266	1.500	1.766	0.745
B	14	1.34457	0.440743	1.37650	18.824	1.978	0.807	1.171	0.194
C	27	0.87444	0.280195	0.87800	23.610	1.581	0.204	1.377	0.079
D	45	0.39511	0.204435	0.36500	17.780	0.958	0.033	0.925	0.042
Total	90	0.77123	0.573150	0.64050	69.411	3.266	0.033	3.233	0.329

Fig. 8.1, indicates that the citation times in Zone A had the largest range followed by Zone B, C, and D. The median total cites in each zone varied with the maximum in Zone A and the minimum in Zone D, there was one extreme value in Zone B, one in Zone C, and three in Zone D. Fig. 8.2 shows that the median impact factors in each zone decreased in turn with Zone B having the largest range. The median impact factor in each zone also varied with the maximum in Zone A and the minimum in Zone D.

Fig. 8.3 shows the environmental engineering journals' five-year impact factor in each zone. While there was little difference between the four zones, Zone A had the maximum range, Zone D had the smallest range, and the mean in each zone decreased in turn. Fig. 8.4 shows the immediacy index

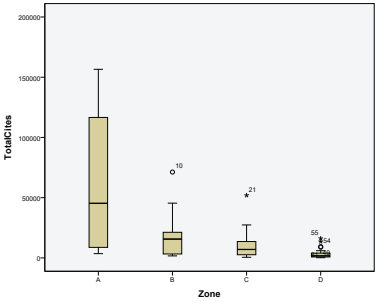

Fig. 8.1: Box diagram of total cites

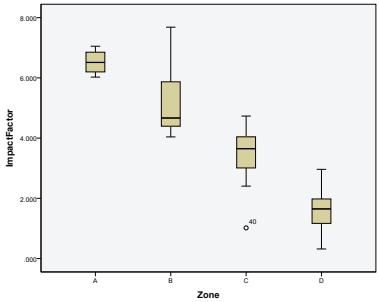

Fig. 8.2: Box diagram of impact factor

in each zone, from which it can be seen that Zone A had the largest range and Zone C had the smallest, with the mean in each zone first increasing and then decreasing slightly.

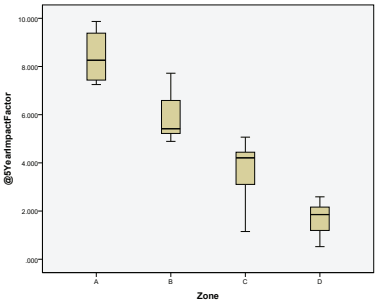

Fig. 8.3: Box diagram of five-year impact factor

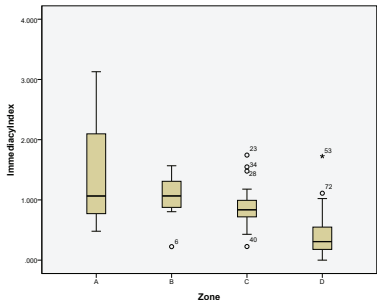

Fig. 8.4: Box diagram of immediacy index

Fig. 8.5 shows that the article in citable item for each zone was between 50 and 100, with some extreme values in Zone C and Zone D; Zone A had the largest range, followed by Zone B, with Zone C having the smallest. Fig. 8.6 shows that the largest cited half-life range was in Zone D, followed by Zone B, with the smallest being in Zone A, which also had the largest mean.

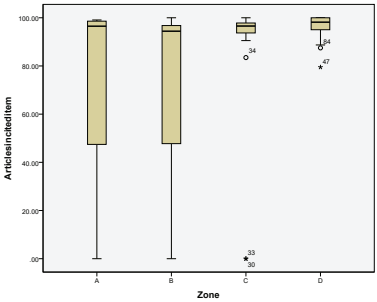

Fig. 8.5: Box diagram of articles in citable item

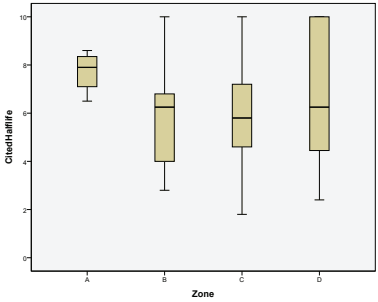

Fig. 8.6: Box diagram of cited half-life

Fig. 8.7 indicates that the eigenfactor score range varied from zone to zone, with the largest range in Zone A and the smallest in Zone D, and with some extreme values in Zones B, C, and D. Fig. 8.8 indicates that the mean article influence scores in each zone were less than 4, and the highest value was about 3.

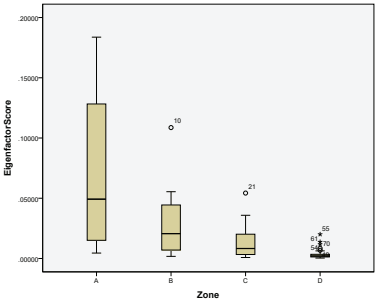

Fig. 8.7: Box diagram of eigenfactor score

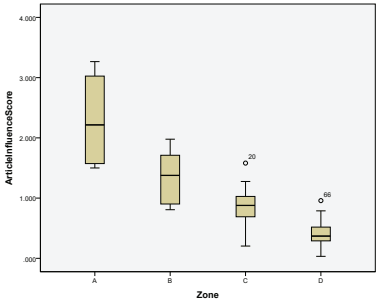

Fig. 8.8: Box diagram of articles influence score

8.4 Comprehensive Discussion

Impact factor changes

Fig. 8.9 shows the impact factor for the four environmental engineering journals in Zone A between 2013 and 2016 ranged from 6.025 to 7.051 with some slight fluctuations. For example, the *Annual Review of Environment and Resources* and *Global Environmental Change-Human, Policy Dimensions* had opposite trends before 2015, with the former first rising then falling and the latter first falling and then rising; however, since 2016, they both showed an increasing trend. *Environmental Science & Technology, Water Research* also had rising impact factors.

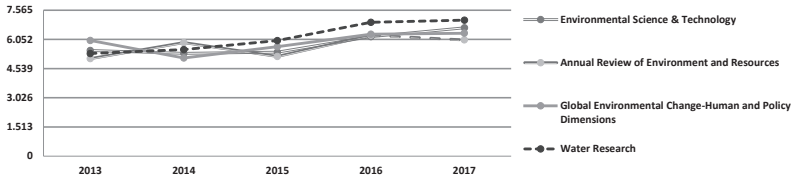

Fig. 8.9: Impact factors change of journals in A zone in 2013-2017

Fig. 8.10 shows that the impact factors changes for the 14 journals in Zone B from 2013 to 2017 ranged from 4.039 and 7.683 with fluctuations. For instance, the 2013-2017 impact factors for *Environmental International, Energy Policy*, and the *Journal of Cleaner Production* increased slightly between 2013 and 2015, reached a maximum in 2016, then fell slightly. The impact factors for the *Journal of Toxicology, Environmental Health Part-B Critical Reviews*, and *Waste Management* had a continuous increase. *Environmental Science & Technology Letters*, and *Ecosystem Services*, which only commenced in 2015, had impact factor changes ranging from 4.072 to 5.869. *Resources Conservation and Recycling* and *Current Opinion in Environmental Sustainability* almost had the same starting point and rose continuously, with the former reaching a peak in 2016 and the latter reaching its maximum in 2015 then falling. *Ecological Applications* and *Environmental Research Letters* had minor fluctuations, but overall their 2013-2017 impact factors remained between 3.906 and 4.393.

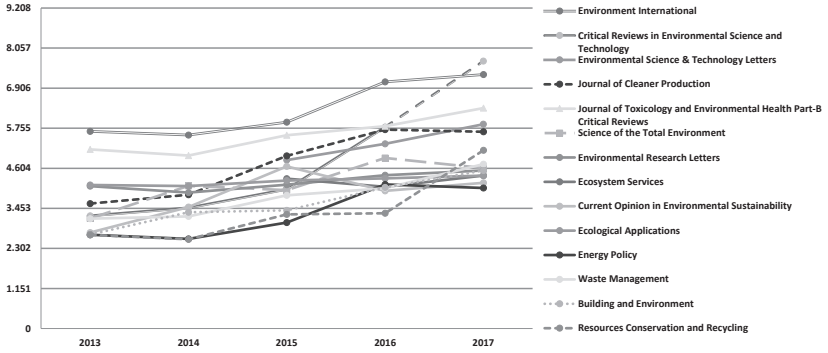

Fig. 8.10: Impact factors change of journals in B zone in recent five years

Fig. 8.11 shows that the impact factor changes for the 27 journals in Zone C ranged from 1.922 to 5.562 with most experiencing fluctuations. *Environmental Modeling & Software* and *Climatic Change and Atmospheric Environment* had higher impact factors, with obvious up and down fluctuations and the *Journal of Environmental Informatics*' impact factor increased rapidly from 2014 and reached the highest value in Zone C of 5.562 in 2016, then declined a little in 2017. There were only slight impact factor changes in the *International Journal of Environmental Research, Public Health, Ecological Engineering*, and *Atmospheric Environment*. *Science-Water Research & Technology* only commenced in 2016, but the impact factor over the two years had a continuous increase from 2.817 to 3.649.

Fifty percent of these environmental engineering journals were allocated to Zone D, as shown in Fig. 8.12. The Zone D journal impact factor scores had the widest range from 0.129 to 3.067 but were generally lower and there were significant fluctuations without any regular patterns. For instance, *Greenhouse Gases-Science and Technology* had an impact factor of 3.067 in 2013 which fell to 1.676 in 2016, and the 2013-2017 impact factors for *Environment* had a rapid fluctuating increase from 1.353 to 2.963, between 2016 and 2017. *Environmental Monitoring and Assessment*, *Environmental Management*, *Wetlands*, *Bulletin of Engineering Geology and The Environment*, *Frontiers of Environmental Science & Engineering*, *Environmental Engineering Science*, and *Gaia-Ecological Perspectives For Science and Society*

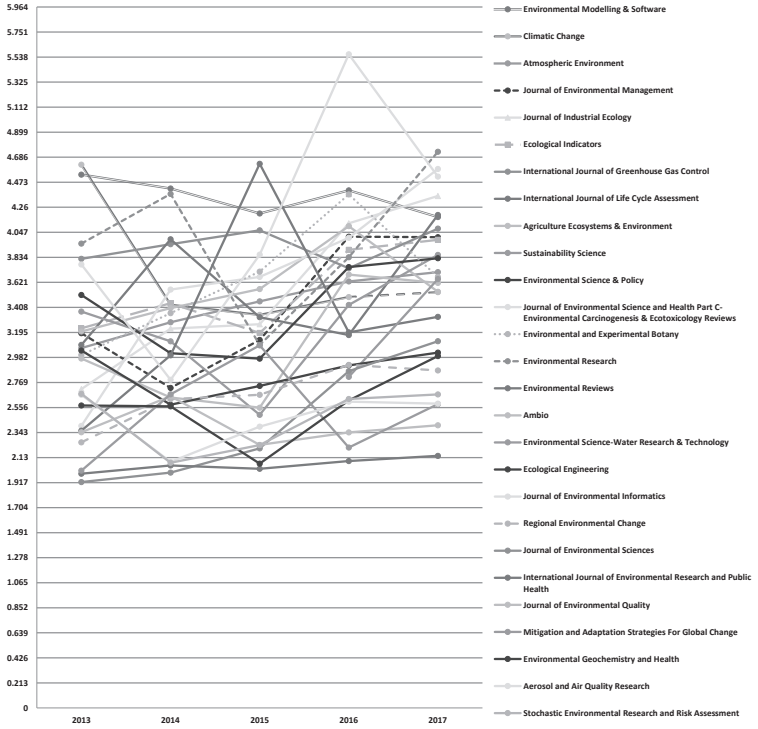

Fig. 8.11: Impact factors change of journals in C zone in recent five years

had rising impact factors, and the *Journal of Hydro-Environment Research*, *Climate Research*, *Greenhouse Gases-Science and Technology*, and *Environmental and Ecological Statistics* had a recent downward trend. The other journals in Zone D had steady changes; however, the journals with lower impact factors and no upward trend could face a situation in which the papers are not included in the Science Citation Index or the Social Science Citation Index if no actions are taken to improve the quality of these publications.

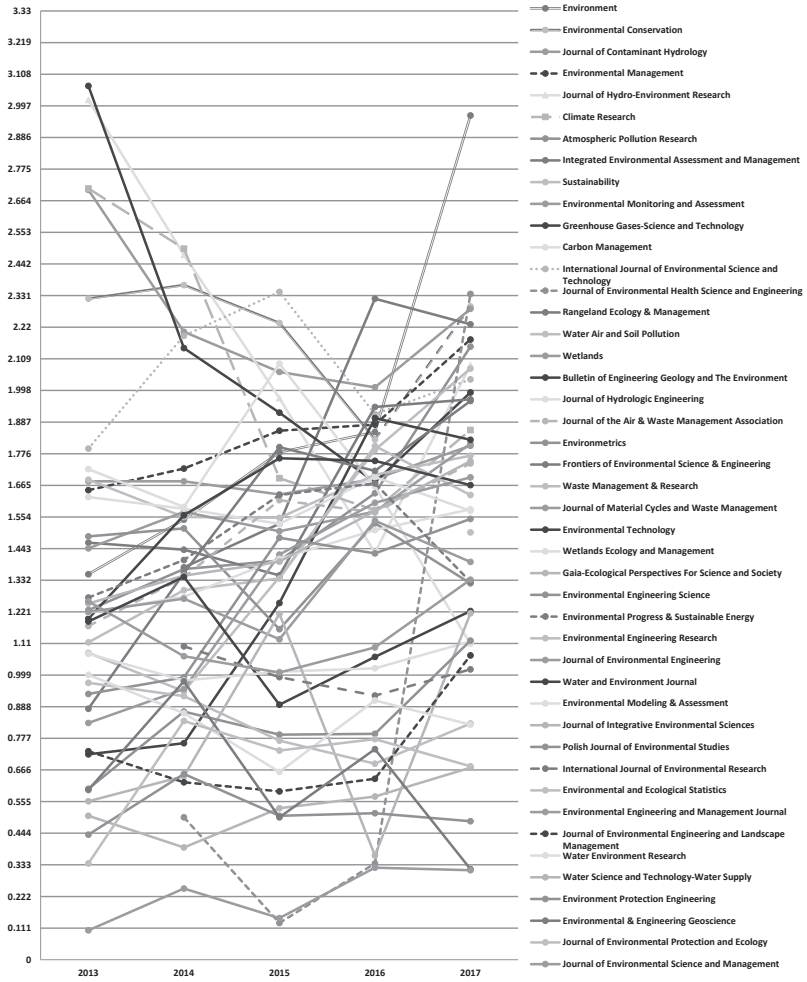

Fig. 8.12: Impact factor changes of journals in D zone in the most recent five years

Major countries

Table 8.23 shows the statistical analysis for the SCI/SSCI environmental engineering papers published in the major countries of the world from 2013 to 2017.

Table 8.23: Environmental engineering SCI papers published in major countries in 2013-2017

Country	2013		2014		2015		2016		2017	
	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage
ALL	1680		1859		2189		2596		2699	
USA	633	37.68%	651	35.02%	710	32.43%	848	32.67%	830	30.75%
CHINA	367	21.85%	353	18.99%	489	22.34%	546	21.03%	645	23.9%
ENGLAND	121	7.2%	130	6.99%	165	7.54%	198	11.48%	219	8.11%
GERMANY	99	5.89%	127	6.83%	136	6.21%	149	5.74%	166	6.15%
ITALY	87	5.18%	108	5.81%	152	6.94%	172	6.63%	147	5.45%
AUSTRALIA	81	4.82%	95	5.11%	129	5.89%	115	4.43%	156	5.78%
INDIA	66	3.93%	76	4.09%	109	4.98%	157	6.05%	167	6.19%
SPAIN	64	3.81%	131	7.05%	95	4.34%	151	5.82%	117	4.33%
CANADA	91	5.42%	97	5.22%	97	4.43%	139	5.35%	119	4.41%
FRANCE	71	4.23%	91	4.9%	107	4.89%	121	4.66%	133	4.93%

Environmental engineering journals published 2699 papers in 2017, of which 830 (30.75%) were published by US authors, ranking first in the world, 645 (23.90%) by Chinese authors, 219 (8.11%) by Britsh authors, 167 (6.19%) by Indian authors, 166 (6.15%) by German authors, 156 paper (5.78%) by Australian authors, 147 (5.45%) by Italian authors, 133 (4.93%) by French authors, 119 (4.41%) by Canadian authors, and 117 (4.33%) by Spanish authors.

As shown in Fig. 8.13, the number of papers published in environmental engineering journals changed little from 2013 to 2017, with the fewest articles, 1680, being published in 2013. The U.S.A and China published the most environmental engineering papers in all years. In 2016, US authors published the highest number of articles, 848 or 32.67% of all environmental engineering journals and a minimum of 633 articles out of the 1680 articles in 2013. Chinese scholars account for over 23.9% of the 2699 articles published in 2017 and a minimum of 353 (18.99%) out of 1859 articles in 2014. Other countries published relatively fewer articles; British authors accounted for between 7.20% and 11.48%, Canadian authors published 139 articles or 5.35% in 2016, Indian authors contributed a rising proportion, from 3.93% in 2013 to 6.19% in 2017, Australian scholars contributed from

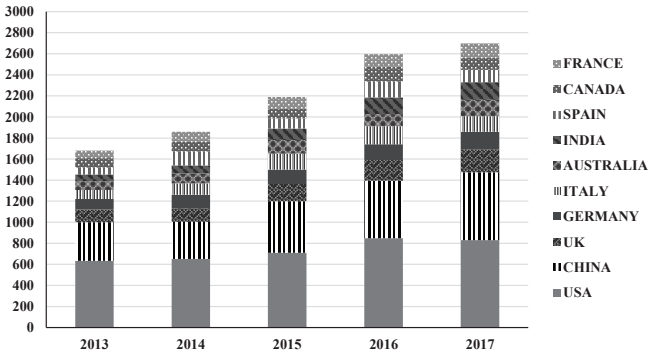

Fig. 8.13: Papers published in the environmental engineering journals in 2013-2017

4%-6%, Spanish scholars had a peak in 2014 (131/7.05%), and French and Italian authors had similar publication percentages at around 5%-6%.

Correlation analysis

To determine the journal influence relationships between the indicators, Pearson's correlation coefficient, which is widely used in the sciences, was applied, with the bivariate correlation analyses conducted using SPSS 21.0. In statistics, Pearson's correlation coefficient was developed by Karl Pearson, it is the covariance of two variables divided by the product of their standard deviations. The Pearson's correlation coefficient is a measure of the linear correlation between two variables X and Y, and has a value between $+1$ and -1, where 1 indicates a total positive linear correlation, 0 indicates no linear correlation, and -1 indicates a total negative linear correlation.

Fig. 8.14 shows that the impact factor variable and the five-year impact factor had a correlation coefficient of 0.958, which meant that the two factors had an extremely strong correlation, with all data points lying on a line and increasing or decreasing together. The total cites and the eigenfactor score variables had a correlation coefficient of 0.976, which meant they had an extremely strong correlation. The Pearson's correlation coefficient for impact factor and total cites was 0.478, which indicated a strong correla-

Correlations

		Total cites	Impact factor	Five-year impact factors	Immediacy index	Articles in citable item	Cited half-life	Eigenfactor scores	Article influence scores
Total cites	Pearson Correlation	1	.478**	.454**	.258*	.064	.106	.976**	.314**
	Sig. (2-tailed)		.000	.000	.014	.551	.318	.000	.003
	N	90	90	90	90	90	90	90	90
Impact factor	Pearson Correlation	.478**	1	.958**	.641**	-.426**	-.016	.504**	.821**
	Sig. (2-tailed)	.000		.000	.000	.000	.885	.000	.000
	N	90	90	90	90	90	90	90	90
Five-year impact factors	Pearson Correlation	.454**	.958**	1	.668**	-.431**	.005	.485**	.911**
	Sig. (2-tailed)	.000	.000		.000	.000	.960	.000	.000
	N	90	90	90	90	90	90	90	90
Immediacy index	Pearson Correlation	.258*	.641**	.668**	1	-.063	-.078	.302**	.594**
	Sig. (2-tailed)	.014	.000	.000		.553	.463	.004	.000
	N	90	90	90	90	90	90	90	90
Articles in citable item	Pearson Correlation	.064	-.426**	-.431**	-.063	1	-.137	.073	-.423**
	Sig. (2-tailed)	.551	.000	.000	.553		.198	.492	.000
	N	90	90	90	90	90	90	90	90
Cited half-life	Pearson Correlation	.106	-.016	.005	-.078	-.137	1	.025	.119
	Sig. (2-tailed)	.318	.885	.960	.463	.198		.816	.263
	N	90	90	90	90	90	90	90	90
Eigenfactor Score	Pearson Correlation	.976**	.504**	.485**	.302**	.073	.025	1	.369**
	Sig. (2-tailed)	.000	.000	.000	.004	.492	.816		.000
	N	90	90	90	90	90	90	90	90
Article influence scores	Pearson Correlation	.314**	.821**	.911**	.594**	-.423**	.119	.369**	1
	Sig. (2-tailed)	.003	.000	.000	.000	.000	.263	.000	
	N	90	90	90	90	90	90	90	90

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Fig. 8.14: Pearson correlation coefficients of the JCR Data and Eigenfactor Metrics

tion, and total cites had a correlation coefficient of 0.314 with the article influence score factor. The Pearson's correlation coefficient for the impact factor and immediacy index was 0.641, and for the impact factor and eigenfactor score was 0.504. The impact factor and article influence score had a relatively significant correlation with a Pearson's correlation coefficient of 0.821. The Pearson's correlation coefficient for the five-year impact factor and the eigenfactor score was 0.485, and for the five-year impact and article influence score was 0.911, indicating an extremely strong correlation. Finally, the eigenfactor score had a correlation coefficient of 0.369 with the article influence score.

Principal Component Analysis of Journal Evaluation Indicators

Correlation studies have shown that as there are high correlation coefficients between these indicators, it is redundant to use them all because of the exclusiveness principle. However, which indicators should be adopted to evaluate a journal and what attributes do these indicators depict? To answer these questions, after the correlation analyses, this paper conducted a principal component analysis in IBM SPSS Statistics with the FACTOR command (Analyze > Dimension Reduction > Factor) of the journal evaluation indicators for the 90 environmental engineering journals. The objective of the factor analyses was to identify the independent latent variables; adherents

of these methods believe that the information gained about the interdependencies between the observed variables can be used to reduce the set of variables in a dataset. To track the information, the last five-year IFs, the five-year impact factors, the immediacy indexes, and the article, cited half-life, eigenfactor, and article influence scores were concurrently considered.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling		.834
Bartlett's Test of Sphericity	Approx. Chi-Square	2004.620
	df	78
	Sig.	0.000

Fig. 8.15: KMO and Bartlett's test

Fig. 8.15 shows the overall KMO and Bartlett's Test table for the factor output, with the value of the KMO being 0.834. The significance probability for the Bartlett's Test, which is used to test if k samples are from populations with equal variances, was 0.000, indicating that these indicators were suitable for the principal component analyses. KMO values greater than 0.8 are considered good; that is, the component or factor analyses are useful for these variables.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.308	63.905	63.905	8.308	63.905	63.905
2	1.637	12.589	76.494	1.637	12.589	76.494
3	1.153	8.871	85.365	1.153	8.871	85.365
4	.751	5.777	91.142			
5	.421	3.241	94.382			
6	.318	2.443	96.825			
7	.218	1.674	98.499			
8	.084	.647	99.146			
9	.041	.319	99.465			
10	.032	.243	99.708			
11	.024	.185	99.893			
12	.012	.090	99.983			
13	.002	.017	100.000			

Extraction Method: Principal Component Analysis.

Fig. 8.16: Total variance explained

After the principal component extraction procedure, a rotated quartimax transformation was used as this has been shown to have the best performance in making component loadings incline to 1 or 0, and can therefore explain the factors' practical meanings. Quartimax rotation maximizes the variance of the squared factor loadings in each variable; that is, it simplifies the loading matrix rows. In other words, the quartimax minimizes the number of factors needed to explain each variable. In the quartimax rotation, there are often many variables in the first rotated factor; therefore, this method is not always helpful. The explained eigenvalue and total variance are shown in Fig. 8.16.

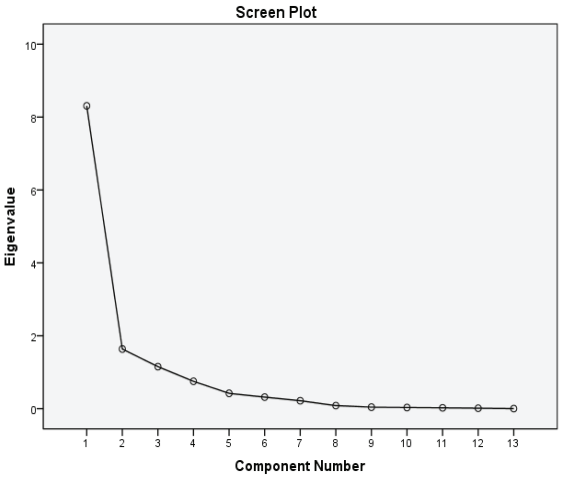

Fig. 8.17: Scree plot

Three components were extracted from all samples for the above variables. As shown in the scree plot in Fig. 8.17, as the eigenvalues for the first three components were above 1, all were included. The eigenvalue for component 1 was 8.309, which dropped sharply to 1.637 and then fell slightly to 1.153. Both extracted components accounted for more than 85.365% of the total variance in the initial eigenvalues and the extraction sums of squared loadings, which was considered satisfactory. In this paper, three

major components were chosen as the best explanations for the variability in the data for the environmental engineering journals as together they explained 85.365% of the total variance.

Component Matrix[a]

	Component		
	1	2	3
Total cites	.574	.764	.162
Impact factor	.961	-.096	-.076
Five-year impact factors	.966	-.131	-.066
Immediacy index	.677	-.048	-.364
Articles in citable item	-.396	.620	-.315
Cited half-life	.049	-.031	.910
Eigenfactor scores	.605	.753	.077
Article influence score	.874	-.229	.045
2013 impact factor	.878	.035	.103
2014 impact factor	.906	-.003	.154
2015 impact factor	.958	-.088	-.056
2016 impact factor	.969	-.050	-.069
2017 impact factor	.962	-.095	-.077

Extraction Method: Principal Component Analysis.
a. 3 components extracted.

Fig. 8.18: Quartimax rotated loading matrix for the "environmental engineering" category journal indicators

As can be seen in Fig. 8.18, a threshold level of 0.67 led to a clear interpretation. The impact factor, five-year impact factor, article influence score, immediacy index and all IF indicators were included in the first component; total cites, eigenfactor scores and articles in citable item were included in the second component; only cited half-life was included in the third component. These are explained in more detail in the following.

- The first component related to the journal's integrated influence because the indicators that made up the first component all measured aspects of the impact each year.
- The second component related to the topic influence as the eigenfactor scores and articles provided measures of the relationship between the articles published in the journals and current popular topics.
- The third component related to the citation quality or features of a journal in one specific field because the cited half-life was an indication of the turnover rate of the body of work on a subject.

8.5 Total Summary

There were 90 management science in environmental engineering journals ranked close together, with 4, 14, 27, and 45 respectively distributed in Zones A, B, C, and D. Based on the journal ranking results in section 8.2, the top four most important journals with the highest comprehensive scores were *Environmental Science & Technology*, the *Annual Review of Environment and Resources*, *Global Environmental Change-Human and Policy Dimensions*, and *Water Research* which were placed in Zone A. The statistical analysis in 8.3 found that *Water Research*, *Environment International*, and *Global Environmental Change-Human and Policy Dimensions* had outstanding performances for the eigenfactor score, immediacy index and five-year impact factor, reflecting the fact that they also had significant influence in this category.

In section 8.4, it was found that the impact factor changes for the Zones A and B journals from 2013 to 2017 had an upward trend, indicating the obvious increase in average paper quality and journal influence. However, the impact factor changes in the journals in Zones C and D varied significantly, demonstrating the instability of the quality and quantity of published articles. Based on the published SCI/SSCI management science in environmental engineering papers, the US, China, England, Germany and Italy were the most productive countries from 2013 to 2017.

Journal developing trends

To determine the development trends for journals in this category, Table 8.24 shows the impact factor, five-year impact factor, immediacy index, eigenfactor score, and article influence score differences.

Most environmental engineering-related journals showed a downward trend. The average of IFminusIF5 was -0.758, indicating that the impact factor was lower than the five-year impact factor, which was primarily because the cited frequency in the two most recent years was lower than that in the first three years. Overall, therefore, most environmental engineering journals showed a downward trend.

The global influence of environmental engineering is likely to continue to grow in the following future. The difference between the impact factor and immediacy index showed the development distance in the past two years and

the current year, from which it can be seen that the impact factors for all environmental engineering journals were larger than their immediacy indexes, with the average being -2.287.

The environmental engineering journal development trend is promising. The difference between the impact factor and eigenfactor score showed the journals' self-citations. When the difference is larger, this indicates a higher self-citation degree. For environmental engineering, the average difference was 1.529, with Zone A journals having higher values. Similarly, the difference between the five-year impact factor and article influence score showed the journals' self-citation degree in the past five years, for which there was an average difference of 2.505.

Table 8.24: Journals in the category of “environmental engineering”

Full Journal Title	ISSN	JCR Data			Eigenfactor Metrics		IFminusIF5	IFminusE	IFminusII	IF5minusA
		Impact Factor 2017	Five-Year Impact Factor	Immediacy Index	Eigenfactor Score	Article Influence Score				
Environmental Science & Technology	0013-936X	6.653	7.25	1.064	0.18373	1.646	-1.46227	3.10827	-4.57054	5.604
Annual Review of Environment and Resources	1543-5938	6.025	9.87	0.48	0.0045	3.266	-3.2615	6.5275	-9.789	6.604
Global Environmental Change-Human and Policy Dimensions	0959-3780	6.371	8.897	3.128	0.02564	2.785	-2.75936	5.54436	-8.30372	6.112
Water Research	0043-1354	7.051	7.621	1.066	0.0728	1.5	-1.4272	2.9272	-4.3544	6.121
Environment International	0160-4120	7.297	7.721	1.309	0.02993	1.811	-1.78107	3.59207	-5.37314	5.91
Critical Reviews in Environmental Science and Technology	1064-3389	7.683	6.996	0.224	0.00577	1.519	-1.51323	3.03223	-4.54546	5.477
Environmental Science & Technology Letters	2328-8930	5.869	6.687	1.29	0.00627	1.978	-1.97173	3.94973	-5.92146	4.709
Journal of Cleaner Production	0959-6526	5.651	6.352	1.364	0.05542	0.816	-0.76058	1.57658	-2.33716	5.536
Journal of Toxicology and Environmental Health Part-B Critical Reviews	1093-7404	6.333	6.59	1.381	0.00175	1.637	-1.63525	3.27225	-4.9075	4.953
Science of the Total Environment	0048-9697	4.61	4.984	1.132	0.10865	1.032	-0.92335	1.95535	-2.8787	3.952
Environmental Research Letters	1748-9326	4.541	5.288	0.842	0.04441	1.944	-1.89959	3.84359	-5.74318	3.344
Ecosystem Services	2212-0416	4.395	6.017	0.876	0.007	1.234	-1.227	2.461	-3.688	4.783
Current Opinion in Environmental Sustainability	1877-3435	4.186	5.545	1.567	0.00946	1.586	-1.57654	3.16254	-4.73908	3.959
Ecological Applications	1051-0761	4.393	4.892	0.934	0.02037	1.711	-1.69063	3.40163	-5.09226	3.181
Energy Policy	0301-4215	4.039	5.038	0.915	0.04668	0.994	-0.94732	1.94132	-2.88864	4.044
Waste Management	0956-053X	4.723	5.262	0.804	0.0209	0.853	-0.8321	1.6851	-2.5172	4.409
Building and Environment	0360-1323	4.539	5.221	1	0.02166	0.902	-0.88034	1.78234	-2.66268	4.319
Resources Conservation and Recycling	0921-3449	5.12	5.228	1.238	0.00862	0.807	-0.79838	1.60538	-2.40376	4.421
Environmental Modelling & Software	1364-8152	4.177	4.99	0.853	0.01959	1.22	-1.20041	2.42041	-3.62082	3.77
Climatic Change	0165-0009	3.537	4.436	1.042	0.03201	1.581	-1.54899	3.12999	-4.67898	2.855
Atmospheric Environment	1352-2310	3.708	4.042	0.782	0.05429	0.965	-0.91071	1.87571	-2.78642	3.077
Journal of Environmental Management	0301-4797	4.005	4.449	1.032	0.03586	0.878	-0.84214	1.72014	-2.56228	3.571
Journal of Industrial Ecology	1088-1980	4.356	5.069	1.744	0.0057	0.966	-0.9603	1.9263	-2.8866	4.102
Ecological Indicators	1470-160X	3.983	4.391	0.943	0.02862	0.894	-0.86538	1.75938	-2.62476	3.497
International Journal of Greenhouse Gas Control	1750-5836	4.078	4.542	0.874	0.01773	0.854	-0.83627	1.69027	-2.52654	3.688
International Journal of Life Cycle Assessment	0948-3349	4.195	4.881	1.179	0.00708	0.773	-0.76592	1.53892	-2.30484	4.108
Agriculture Ecosystems & Environment	0167-8809	3.541	4.354	0.655	0.02445	1.099	-1.07455	2.17355	-3.2481	3.255
Sustainability Science	1862-4065	3.855	4.939	1.548	0.00282	0.961	-0.95818	1.91918	-2.87736	3.978
Environmental Science & Policy	1462-9011	3.826	4.209	0.703	0.01306	1.072	-1.05894	2.13094	-3.18988	3.137
Journal of Environmental Science and Health Part C-Environmental Carcinogenesis & Ecotoxicology Reviews	1059-0501	4.586	4.235	0.429	0.00081	0.873	-0.87219	1.74519	-2.61738	3.362
Environmental and Experimental Botany	0098-8472	3.666	4.234	0.749	0.00989	0.983	-0.97311	1.95611	-2.92922	3.251
Environmental Research	0013-9351	4.732	4.744	0.95	0.02179	1.169	-1.14721	2.31621	-3.46342	3.575
Environmental Reviews	1208-6053	3.328	4.262	0.514	0.00221	1.276	-1.27379	2.54979	-3.82358	2.986
Ambio	0044-7447	3.616	3.88	1.478	0.00803	1.093	-1.08497	2.17797	-3.26294	2.787
Environmental Science-Water Research & Technology	2053-1400	3.649	3.661	0.632	0.00201	0.854	-0.85199	1.70599	-2.55798	2.807
Ecological Engineering	0925-8574	3.023	3.43	0.907	0.0207	0.647	-0.6263	1.2733	-1.8996	2.783
Journal of Environmental Informatics	1726-2135	4.521	2.9	0.611	0.00104	0.635	-0.63396	1.26896	-1.90292	2.265
Regional Environmental Change	1436-3798	2.872	3.273	1.148	0.00828	0.882	-0.87372	1.75572	-2.62944	2.391
Journal of Environmental Sciences	1001-0742	3.12	3.242	0.836	0.01245	0.601	-0.58855	1.18955	-1.7781	2.641
International Journal of Environmental Research and Public Health	1660-4601	1.019	1.15	0.226	0.00159	0.204	-0.20241	0.40641	-0.60882	0.946
Journal of Environmental Quality	0047-2425	2.405	2.962	0.817	0.01049	0.733	-0.72251	1.45551	-2.17802	2.229
Mitigation and Adaptation Strategies For Global Change	1381-2386	2.585	2.971	0.79	0.00347	0.739	-0.73553	1.47453	-2.21006	2.232
Environmental Geochemistry and Health	0269-4042	2.994	2.793	0.954	0.00311	0.564	-0.56089	1.12489	-1.68578	2.229
Aerosol and Air Quality Research	1680-8584	2.589	2.814	0.734	0.00663	0.486	-0.47937	0.96537	-1.44474	2.328
Stochastic Environmental Research and Risk Assessment	1436-3240	2.668	2.645	0.831	0.00589	0.608	-0.60211	1.21011	-1.81222	2.037
Environment	0013-9157	2.963	2.461	0.722	0.00067	0.646	-0.64533	1.29133	-1.93666	1.815
Environmental Conservation	0376-8929	2.293	2.52	0.667	0.00192	0.788	-0.78608	1.57408	-2.36016	1.732
Journal of Contaminant Hydrology	0169-7722	2.284	2.547	0.275	0.00474	0.673	-0.66826	1.34126	-2.00952	1.874
Environmental Management	0364-152X	2.177	2.427	0.397	0.00842	0.62	-0.61158	1.23158	-1.84316	1.807
Journal of Hydro-Environment Research	1570-6443	2.087	2.305	0.548	0.00162	0.622	-0.62038	1.24238	-1.86276	1.683
Climate Research	0936-577X	1.859	2.111	0.946	0.00355	0.703	-0.69945	1.40245	-2.1019	1.608
Atmospheric Pollution Research	1309-1042	2.152	2.299	0.442	0.00303	0.495	-0.49197	0.98697	-1.47894	1.804
Integrated Environmental Assessment and Management	1551-3777	2.23	2.207	1.725	0.00252	0.541	-0.53848	1.07948	-1.61796	1.666
Sustainability	2071-1050	2.075	2.177	0.483	0.01377	0.322	-0.30823	0.63023	-0.93846	1.855
Environmental Monitoring and Assessment	0167-6369	1.804	2.02	0.203	0.02006	0.398	-0.37794	0.77594	-1.15388	1.622
Greenhouse Gases-Science and Technology	2152-3878	1.991	2.312	0.569	0.0016	0.496	-0.4944	0.9904	-1.4848	1.816
Carbon Management	1758-3004	1.109	2.59	0.278	0.00173	0.758	-0.75627	1.51427	-2.27054	1.832
International Journal of Environmental Science and Technology	1735-1472	2.037	2.152	0.404	0.0056	0.374	-0.3684	0.7424	-1.1108	1.778
Journal of Environmental Health Science and Engineering	2052-336X	2.337	2.04	0.333	0.0015	0.334	-0.3325	0.6665	-0.999	1.706
Rangeland Ecology & Management	1550-7424	1.967	2.06	1.022	0.00216	0.451	-0.44884	0.89984	-1.34868	1.609
Water Air and Soil Pollution	0049-6979	1.769	1.972	0.241	0.01171	0.373	-0.36129	0.73429	-1.09558	1.599
Wetlands	0277-5212	1.811	1.918	0.178	0.00427	0.543	-0.53873	1.08173	-1.62046	1.375
Bulletin of Engineering Geology and The Environment	1435-9529	1.825	1.971	0.697	0.00315	0.516	-0.51285	1.02885	-1.5417	1.455
Journal of Hydrologic Engineering	1084-0699	1.576	2.033	0.366	0.00631	0.521	-0.51469	1.03569	-1.55038	1.512
Journal of the Air & Waste Management Association	1096-2247	1.742	1.95	0.549	0.00442	0.501	-0.49658	0.99758	-1.49416	1.449
Environmetrics	1180-4009	1.321	1.699	0.111	0.00315	0.958	-0.95485	1.91285	-2.8677	0.741
Frontiers of Environmental Science & Engineering	2095-2201	1.961	1.877	0.573	0.00254	0.35	-0.34746	0.69746	-1.04492	1.527
Waste Management & Research	0734-242X	1.631	1.955	0.379	0.00299	0.312	-0.30901	0.62101	-0.93002	1.643
Journal of Material Cycles and Waste Management	1438-4957	1.693	1.832	0.369	0.00151	0.296	-0.29449	0.59049	-0.88498	1.536
Environmental Technology	0959-3330	1.666	1.666	0.502	0.00681	0.294	-0.28719	0.58119	-0.86838	1.372
Wetlands Ecology and Management	0923-4861	1.581	1.588	0.224	0.00159	0.463	-0.46141	0.92441	-1.38582	1.125
Gaia-Ecological Perspectives For Science and Society	0940-5550	1.75	1.64	1.111	0.00075	0.308	-0.30725	0.61525	-0.9225	1.332
Environmental Engineering Science	1092-8758	1.547	1.56	0.317	0.00255	0.365	-0.36245	0.72745	-1.0899	1.195
Environmental Progress & Sustainable Energy	1944-7442	1.326	1.721	0.299	0.00337	0.286	-0.28263	0.56863	-0.85126	1.435
Environmental Engineering Research	1226-1025	1.5	1.5	0.019	0.00055	0.395	-0.39445	0.78945	-1.1839	1.105
Journal of Environmental Engineering	0733-9372	1.396	1.536	0.25	0.00295	0.308	-0.30505	0.61305	-0.9181	1.228
Water and Environment Journal	1747-6585	1.224	1.382	0.2	0.00108	0.277	-0.27592	0.55292	-0.82884	1.105
Environmental Modeling & Assessment	1420-2026	1.117	1.241	0.159	0.001	0.302	-0.301	0.603	-0.904	0.939
Journal of Integrative Environmental Sciences	1943-815X	1.216	1.021	0	0.00039	0.301	-0.30061	0.60161	-0.90222	0.72
Polish Journal of Environmental Studies	1230-1485	1.12	1.144	0.177	0.00303	0.164	-0.16097	0.32497	-0.48594	0.98
International Journal of Environmental Research	1735-6865	1.019	1.15	0.226	0.00159	0.204	-0.20241	0.40641	-0.60882	0.946
Environmental and Ecological Statistics	1352-8505	0.829	0.983	0.154	0.00116	0.473	-0.47184	0.94484	-1.41668	0.51
Environmental Engineering and Management Journal	1582-9596	1.334	1.021	0.054	0.00181	0.086	-0.08419	0.17019	-0.25438	0.935
Journal of Environmental Engineering and Landscape Management	1648-6897	1.068	1.013	1	0.00047	0.215	-0.21453	0.42953	-0.64406	0.798
Water Environment Research	1061-4303	0.825	0.852	0.091	0.0016	0.155	-0.1534	0.3084	-0.4618	0.697
Water Science and Technology-Water Supply	1606-9749	0.674	0.699	0.179	0.00139	0.133	-0.13161	0.26461	-0.39622	0.566
Environment Protection Engineering	0324-8828	0.486	0.822	0.029	0.00044	0.116	-0.11556	0.23156	-0.34712	0.706
Environmental & Engineering Geoscience	1078-7275	0.318	0.73	0.188	0.00036	0.238	-0.23764	0.47564	-0.71328	0.492
Journal of Environmental Protection and Ecology	1311-5065	0.679	0.523	0.096	0.00048	0.033	-0.03252	0.06552	-0.09804	0.49
Journal of Environmental Science and Management	0119-1144	0.314	0.47	0.036	0.00011	0.073	-0.07289	0.14589	-0.21878	0.397

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Chapter 9
Information Engineering

This chapter used a series of scientific methods to thoroughly understand the information engineering-related journals from around the world. First, based on a literature survey and data collection, descriptions for information engineering, information engineers, information engineering methodology, and information engineering industry are given. Then, to classify the influence of each journal, starting from the comprehensive store, a ranking of journals is described that was conducted using statistical software to analyze and describe the relevant indexes. Based on the ranking report, the journals were divided into four zones to clarify their impact. In addition, a statistical analysis of the information engineering-related papers published by the world's major countries and regions between 2013 and 2017 was conducted. Finally, we compared the journals with those published in 2017 including some additions and deletions. The results of this comprehensive and systematic interpretation of information-engineering journals identified possible research directions, thereby providing a journal selection channel for researchers.

9.1 Category Description

Information engineering (IE), also known as Information technology engineering (ITE) or information engineering methodology (IEM), is a software engineering approach to designing and developing information systems [3].

Information technology engineering involves an architectural approach to planning, analyzing, designing, and implementing applications. Steven M Davis defined this field as, “an integrated and evolutionary set of tasks and techniques that enhance business communication throughout an enterprise enabling it to develop people, procedures and systems to achieve its vision” [7]. The information engineering components include more theoretical fields such as machine learning, artificial intelligence, control theory, signal processing and information theory, and more applied fields such as computer vision, natural language processing, bioinformatics, medical image computing, cheminformatics, autonomous robotics, mobile robotics, and telecommunications [2]. Many of these originate from computer science, as well as other branches of engineering such as computer engineering, electrical engineering and bioengineering. Information engineers often hold a degree in information engineering or a related area, and are often part of a professional body such as the Institution of Engineering and Technology or the Institute of Measurement and Control [6]. They are employed in almost all industries due to the widespread use of information engineering. IEM consists of a set of coordinated concepts and methods for the integrated development of commercial software [5]. IEM is predominantly applied to the design of information systems from the planning to the generation of programs and databases. IEM supports the entire software development process within the scope of a phase concept with the following main phases: strategic information planning, user-level system analysis, technical system design, and implementation. IEM requires a development database in which all results derived from the various methods are counterchecked and consolidated so that the development database only comprises assessed and consistent information [1]. Due to world economic integration, the information engineering industry has been developing continuously. However, the current status of information engineering modernization technology is that many enterprises do not have much core technology and are dependent on labor, which is not conducive to the development of the information engineering industry [8]. With the rapid development of information technology, the role of information engineering in enterprise development has become increasingly important. Some traditional enterprises are gaining a new understanding of information engineering, and have begun to harness the power of information engineering. The rise of new platforms and new businesses has laid the foundation for traditional enterprises to increase market share, and has

also promoted enterprise development. Some excellent traditional enterprises have realized the importance of information disclosure and have begun to establish digital, networked, intelligent management platforms [4], thereby accelerating the pace of information and industrial integration. Industrial and information technology can enhance industrial upgrading, improve traditional industries, and enable strategic industries to develop and promote high-end development.

9.2 Ranking Report

The impact factor, five-year impact factor, eigenfactor score, and article influence score are the four key academic indexes for evaluating journal quality. The impact factor proposed by Garfield in 1972 is an internationally accepted periodical evaluation index that measures the average citation frequency of articles published in the previous two years to assess the relative importance of different journals in the same research area. The five-year impact factor is used to measure the average citation frequency of articles published in the previous five years to assess the relative importance of different journals. The eigenfactor score is the score related to the quoted quantity, excluding self-citation, and reflects the overall importance of referencing journals. Except for the addition of self-citations, the article influence score is similar to the five-year impact factor and reflects the overall importance of the journals. The eigenfactor score and the article influence score are considered more scientific measures as they both consider citation quality; however, this does not mean that the impact factor and five-year impact factor have no value. A certain degree of self-citation indicates that journals are focusing on their specific scopes and have representative contributions. The impact factor and eigenfactor score evaluate journals in the previous two years while the five-year impact factor and article influence score evaluate journals in the previous five years, as the former shows current developments and the latter shows the long-term contribution of the journals; therefore, using only one index to evaluate journals could be one-sided. For this reason, in this paper, a new evaluation model has been developed by integrating the four indexes, with the weights of each index being determined through expert scoring: impact factor (0.3), the five-year impact

factor (0.3), the eigenfactor score (0.2), and the article influence score (0.2). To resolve the problems with the different dimensions in these four indexes, to compute the comprehensive journal scores, the data were standardized, as shown in Table 9.1.

Table 9.1: Comprehensive scores of "information engineering" journals

			JCR Data		Eigenfactor Metrics		Standardization				Compre
Rank	Full Journal Title	ISSN	Impact Factor	five-year Impact Factor	Eigenfactor Score	Article Influence Score	Z-Impact Factor	Z-five-year Impact Factor	Z-Eigen -factor Score	Z-Article Influence Score	-hensive score
1	IEEE Transactions on Fuzzy Systems	1063-6706	8.415	9.34	0.02128	2.432	3.63345	3.79852	0.11917	3.43347	2.940
2	Information Sciences	0020-0255	4.305	4.378	0.4814	1.06	1.19802	1.03758	6.69725	0.81912	2.174
3	Information Fusion	1566-2535	6.639	6.574	0.00613	1.53	2.58106	2.25947	-0.09742	1.71471	1.776
4	IEEE Transactions on Information Forensics and Security	1556-6013	5.823	5.517	0.01991	1.565	2.09753	1.67134	0.09958	1.7814	1.507
5	Information Systems Research	1047-7047	2.301	5.153	0.00846	2.241	0.01053	1.46881	-0.06411	3.06952	1.045
6	Information Systems Journal	1650-1917	4.267	4.482	0.00164	1.063	1.1755	1.09545	-0.16161	0.82484	0.814
7	International Journal of Information Management	0268-4012	4.516	4.81	0.0041	0.717	1.32305	1.27796	-0.12644	0.16554	0.788
8	Journal of Information Technology	0268-3962	4.535	3.745	0.0015	1.069	1.33431	0.68537	-0.16362	0.83627	0.740
9	European Journal of Information Systems	0960-085X	3.197	4.236	0.00279	1.139	0.54146	0.95857	-0.14517	0.96966	0.615
10	Journal of Management Information Systems	0742-1222	2.744	4.262	0.00366	1.265	0.27303	0.97304	-0.13273	1.20975	0.589
11	Journal of the Association for Information Systems	1536-9323	2.839	3.717	0.0023	1.101	0.32933	0.66979	-0.15218	0.89725	0.449
12	Journal of Informetrics	1751-1577	3.484	3.238	0.00452	0.804	0.71153	0.40327	-0.12044	0.33131	0.377
13	Business & Information Systems Engineering	1867-0202	2.596	3.586	0.00116	0.731	0.18533	0.5969	-0.16848	0.19221	0.239
14	Information Processing & Management	0306-4573	3.444	2.641	0.00306	0.624	0.68783	0.07109	-0.14131	-0.01168	0.197
15	Journal of the Association for Information Science and Technology	2330-1635	2.835	2.931	0.00602	0.739	0.32696	0.23245	-0.099	0.20746	0.190
16	International Journal of Computer-Supported Collaborative Learning	1556-1607	3.273	2.903	0.00068	0.536	0.5865	0.21687	-0.17534	-0.17936	0.170
17	Information and Software Technology	0950-5849	2.627	2.768	0.00547	0.683	0.2037	0.14176	-0.10686	0.10075	0.102
18	International Journal of Geographical Information Science	1365-8816	2.37	2.866	0.00498	0.613	0.05141	0.19628	-0.11386	-0.03264	0.045
19	Information Systems	0306-4379	2.551	2.439	0.00313	0.613	0.15867	-0.0413	-0.14031	-0.03264	0.001
20	Cartography and Geographic Information Science	1523-0406	1.785	2.705	0.00134	0.654	-0.29523	0.1067	-0.1659	0.04549	-0.081
21	Knowledge and Information Systems	0219-1377	2.247	1.996	0.00508	0.669	-0.02147	-0.2878	-0.11243	0.07407	-0.100
22	Information Society	0197-2243	1.889	2.321	0.00107	0.698	-0.23361	-0.10696	-0.16976	0.12933	-0.110
23	Journal of Information Science	0165-5515	1.939	2.075	0.0017	0.442	-0.20398	-0.24384	-0.16076	-0.35848	-0.238
24	MIS Quarterly Executive	1540-1960	1.862	1.987	0.00055	0.519	-0.24961	-0.2928	-0.1772	-0.21175	-0.241
25	Online Information Review	1468-4527	1.675	2.05	0.0013	0.36	-0.36042	-0.25775	-0.16647	-0.51473	-0.322
26	International Journal of Information Security	1615-5262	1.658	1.683	0.00095	0.428	-0.37049	-0.46195	-0.17148	-0.38516	-0.361
27	International Journal of Information Technology & Decision Making	0219-6220	1.755	1.67	0.0011	0.304	-0.31301	-0.46919	-0.16933	-0.62144	-0.393
28	Information Technology & Management	1385-951X	1.635	1.805	0.00051	0.29	-0.38412	-0.39407	-0.17777	-0.64811	-0.399
29	Aslib Journal of Information Management	2050-3806	1.461	1.591	0.00057	0.38	-0.48722	-0.51314	-0.17691	-0.47662	-0.431
30	Journal of Computer Information Systems	0887-4417	1.557	1.665	0.00071	0.286	-0.43034	-0.47197	-0.17491	-0.65574	-0.437
31	International Journal on Semantic Web and Information Systems	1552-6283	0.793	1.595	0.00059	0.584	-0.88306	-0.51092	-0.17663	-0.0879	-0.471
32	Journal of Computing and Information Science in Engineering	1530-9827	1.588	1.49	0.00072	0.257	-0.41197	-0.56934	-0.17477	-0.711	-0.472
33	Information and Computation	0890-5401	1.077	1.091	0.00297	0.636	-0.71477	-0.79135	-0.1426	0.01119	-0.478
34	Journal of Intelligent Information Systems	0925-9902	1.107	1.477	0.00152	0.463	-0.69699	-0.57658	-0.16333	-0.31846	-0.478
35	Information Technology for Development	0268-1102	1.387	1.554	0.00039	0.222	-0.53107	-0.53373	-0.17948	-0.77769	-0.511
36	Information Systems and E-Business Manage	1617-9846	1.032	1.316	0.00046	0.251	-0.74143	-0.66616	-0.17848	-0.72243	-0.602
37	Journal of Aerospace Information Systems	1940-3151	1.095	0.889	0.00067	0.273	-0.7041	-0.90375	-0.17548	-0.68051	-0.654
38	Journal of Global Information Technology Management	1097-198X	1	1.05	0.00012	0.147	-0.7604	-0.81417	-0.18334	-0.9206	-0.693
39	Frontiers of Information Technology & Electronic Engineering	2095-9184	0.91	0.91	0.00038	0.141	-0.81373	-0.89206	-0.17963	-0.93203	-0.734
40	Information Development	0266-6669	0.905	0.913	0.00042	0.121	-0.81669	-0.89039	-0.17906	-0.97014	-0.742
41	Information Research-An International Electronic Journal	1368-1613	0.762	0.897	0.00072	0.151	-0.90142	-0.8993	-0.17477	-0.91298	-0.758
42	Information Technology and Control	1392-124X	0.8	0.751	0.00031	0.116	-0.87891	-0.98053	-0.18063	-0.97967	-0.790
43	Data Base for Advances in Information Systems	0095-0033	0.4	0.803	0.00021	0.224	-1.11593	-0.9516	-0.18206	-0.77388	-0.811
44	Journal of Global Information Management	1062-7375	0.613	0.667	0.0001	0.102	-0.98972	-1.02727	-0.18363	-1.00635	-0.843
45	International Journal of Wavelets Multiresolution and Information Processing	0219-6913	0.54	0.548	0.00071	0.171	-1.03297	-1.09349	-0.17491	-0.87487	-0.848
46	Computer Science and Information Systems	1820-0214	0.613	0.375	0.00069	0.146	-0.98972	-1.18975	-0.1752	-0.92251	-0.873
47	International Arab Journal of Information Technology	1683-3198	0.466	0.662	0.00034	0.056	-1.07682	-1.03005	-0.1802	-1.094	-0.887

To more directly characterize the level of the journals in the energy engineering field, the 47 information engineering journals were divided into four

zones based on their respective comprehensive scores, from which partitions were created to deepen the understanding of the information engineering journals in Zones A, B, C, and D. Journals with scores in the top 5% were allocated to Zone A, those with scores between 6% and 20% were allocated to Zone B, those between 21% and 50% were allocated to Zone C, and the remaining 50% were allocated to Zone D.

Table 9.2 indicates that two journals were allocated to Zone A; *IEEE Transactions on Fuzzy Systems* and *Information Sciences*. The impact factor for the *IEEE Transactions on Fuzzy Systems* was significantly higher, at 8.415. *IEEE Transactions on Fuzzy Systems* publishes technical papers on the theory, design and application of fuzzy systems, with the main focus being on engineering systems and scientific applications. The impact factor for Information Sciences was 4.305. This journal serves researchers, developers, managers, strategic planners, graduate students and others interested in state-of-the art research activities in information, knowledge engineering and intelligent systems.

Table 9.3 indicates that seven journals with a five-year impact factor ranging from 3.745 to 6.547 were allocated to Zone B. According to the JCR, Information Fusion had a higher impact factor of 6.639 but a lower eigenfactor score of 0.00613. *Information Fusion* presents within a single forum all developments in the areas of multi-sensor, multi-source, and multi-process information fusion and promotes synergy across the main disciplines contributing to its growth. *IEEE Transactions on Information Forensics and Security* covers the sciences, technologies, and applications relating to information forensics, information security, biometrics, surveillance and systems applications that incorporate these features. *Information Systems Research* had a lower impact factor of 2.301 but a higher five-year impact factor at 5.153, which indicated that there had been a significant reduction in the impact factor in recent years. Information Systems Research covers a wide variety of topics related to the design, management, use, valuation, and impact of information technologies at different levels of analysis. *Information Systems* publishes articles on the design and implementation of languages, data models, process models, algorithms, software and hardware for information systems.

Table 9.4 shows the 15 journals with five-year impact factors ranging from 1.987 to 4.262 allocated to Zone C. *The Journal of Management Information Systems*, which had a five-year impact factor of 2.744, investigates

Table 9.2: Information engineering journals in Zone A

Rank	Full Journal Title	ISSN	JCR Data							Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-year pact Factor	Im- Immediacy Index	Articles	Cited Half-life		Eigenfactor Score	Article Influence Score
1	IEEE Transactions on Fuzzy Systems	1063-6706	12946	8.415	9.34	2.273	100	6.4		0.02128	2.432
2	Information Sciences	0020-0255	25329	4.305	4.378	1.377	99.83	4.7		0.4814	1.06

Table 9.3: Information engineering journals in Zone B

Rank	Full Journal Title	ISSN	JCR Data							Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-year pact Factor	Im- Immediacy Index	Articles	Cited Half-life		Eigenfactor Score	Article Influence Score
1	Information Fusion	1566-2535	3303	6.639	6.574	3.571	93.51	3.8		0.00613	1.53
2	IEEE Transactions on Information Forensics and Security	1556-6013	7294	5.823	5.517	1.466	99.55	4.1		0.01991	1.565
3	Information Systems Research	1047-7047	6640	2.301	5.153	0.217	97.83	>10		0.00846	2.241
4	Information Systems Journal	1650-1917	1580	4.267	4.482	1.4	96	8.4		0.00164	1.063
5	International Journal of Information Management	0268-4012	3626	4.516	4.81	0.663	92.39	8.7		0.0041	0.717
6	Journal of Information Technology	0268-3962	1170	4.535	3.745	0.429	100	8.4		0.0015	1.069
7	European Journal of Information Systems	0960-085X	2597	3.197	4.236	0.656	90.63	9		0.00279	1.139

new modes of information delivery and the changing landscape of information policy making, and the practitioners and executives managing the information resource. The Journal of the Association for Information Systems reflects all aspects of global information Systems. The focus of the *Journal of Informetrics* is bibliometrics, scientometrics, webometrics, and altmetrics. *Business & Information Systems Engineering* is sponsored by the "Information Systems" Section (Wirtschaftsinformatik, WKWI) of the German Association for Business Research (VHB) and the special interest group "Business Informatics" (GI-FB WI) of the Gesellschaft für Informatike. V. (GI) with more than 1200 members. *Information Processing & Management* focuses on publishing peer-reviewed original research on the theory, methods, or application of information science.

The *Journal of the Association for Information Science and Technology*, with an impact factor of 2.835, publishes original research focused on the production, discovery, recording, storage, representation, retrieval, presentation, manipulation, dissemination, use, and evaluation of information and on the tools and techniques associated with these processes. The *International Journal of Computer-Supported Collaborative Learning* is a professional journal founded in 2006 by the International Society of the Learning Sciences (ISLS). Information and Software Technology, with an impact factor of 2.627, focuses on improvements in software development practices. The *International Journal of Geographical Information Science* provides a forum for the exchange of original ideas, techniques, approaches, and ex-

periences in the rapidly growing fields of geographical information science (GISc) and geocomputation. *Information Systems* publishes articles on the design and implementation of languages, data models, process models, algorithms, software, and hardware for information systems. Cartography and *Geographic Information Science* is a forum for the exchange of original concepts, techniques, approaches on cartography, geographical information systems, and related geospatial technologies. *Knowledge and Information Systems* focuses on knowledge systems and advanced information systems, including their theoretical foundations, infrastructure, and enabling technologies. *Information Society*, published since 1981, focuses on the relationships between information technology and social and organizational change. The *Journal of Information Science* covers topics of interest on information and knowledge management. The quarterly *MIS Quarterly Executive*, which was founded in 2002, covers information systems management.

Table 9.4: Information engineering journals in Zone C

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-year pact Factor	Im- Immediacy Index	Articles	Cited Half-life	Eigenfactor Score	Article Influence Score
1	Journal of Management Information Systems	0742-1222	4560	2.744	4.262	0.256	94.87	>10	0.00366	1.265
2	Journal of the Association for Information Systems	1536-9323	1842	2.839	3.717	0.321	100	>10	0.0023	1.101
3	Journal of Informetrics	1751-1577	2334	3.484	3.238	0.869	98.81	4.9	0.00452	0.804
4	Business & Information Systems Engineering	1867-0202	696	2.596	3.586	0.478	100	4.8	0.00116	0.731
5	Information Processing & Management	0306-4573	3250	3.444	2.641	0.737	96.05	9.7	0.00306	0.624
6	Journal of the Association for Information Science and Technology	2330-1635	1904	2.835	2.931	0.757	94.55	2.4	0.00602	0.739
7	International Journal of Computer-Supported Collaborative Learning	1556-1607	721	3.273	2.903	0.647	100	6.8	0.00068	0.536
8	Information and Software Technology	0950-5849	3567	2.627	2.768	0.562	89.52	6.4	0.00547	0.683
9	International Journal of Geographical Information Science	1365-8816	5019	2.37	2.866	0.93	96.52	8.2	0.00498	0.613
10	Information Systems	0306-4379	1790	2.551	2.439	0.436	98.18	5.6	0.00313	0.613
11	Cartography and Geographic Information Science	1523-0406	1032	1.785	2.705	0.795	94.87	7.8	0.00134	0.654
12	Knowledge and Information Systems	0219-1377	2343	2.247	1.996	0.368	94.4	6.1	0.00508	0.669
13	Information Society	0197-2243	1174	1.889	2.321	0.304	100	>10	0.00107	0.698
14	Journal of Information Science	0165-5515	1792	1.939	2.075	0.528	98.11	8.8	0.0017	0.442
15	MIS Quarterly Executive	1540-1960	459	1.862	1.987	0.375	100	7.3	0.00055	0.519

Table 9.5 shows the 23 journals in Zone D, which had five-year impact factors ranging from 0.375 to 2.050. *Online Information Review* had an impact factor of 1.675 and the highest five-year impact factor in Zone D. The *International Journal of Information Security* covers systems security, network security, content protection, applications and foundations. *Information Technology & Management* explores the many different technologies in information technology and their impact on information systems design, functionality, operations, and management.

Table 9.5: Information engineering journals in Zone D

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-year pact Factor	Im- Immediacy Index	Articles	Cited Half-life	Eigenfactor Score	Article Influence Score
1	Online Information Review	1468-4527	1218	1.675	2.05	0.127	92.06	6.4	0.0013	0.36
2	International Journal of Information Security	1615-5262	526	1.658	1.683	0.297	100	5.5	0.00095	0.428
3	International Journal of Information Technology & Decision Making	0219-6220	852	1.755	1.67	0.4	100	5.6	0.0011	0.304
4	Information Technology & Management	1385-951X	501	1.635	1.805	0.6	100	6.2	0.00051	0.29
5	Aslib Journal of Information Management	2050-3806	193	1.461	1.591	0.386	97.73	7.4	0.00057	0.38
6	Journal of Computer Information Systems	0887-4417	928	1.557	1.665	0.225	95	7.9	0.00071	0.286
7	International Journal on Semantic Web and Information Systems	1552-6283	309	0.793	1.595	0.355	96.77	6.6	0.00059	0.584
8	Journal of Computing and Information Science in Engineering	1530-9827	752	1.588	1.49	0.145	96.36	7.5	0.00072	0.257
9	Information and Computation	0890-5401	2119	1.077	1.091	0.162	100	>10	0.00297	0.636
10	Journal of Intelligent Information Systems	0925-9902	794	1.107	1.477	0.152	100	7.6	0.00152	0.463
11	Information Technology for Development	0268-1102	410	1.387	1.554	0.313	100	5.8	0.00039	0.222
12	Information Systems and E-Business Manage	1617-9846	315	1.032	1.316	0.188	100	5.4	0.00046	0.251
13	Journal of Aerospace Information Systems	1940-3151	166	1.095	0.889	0.114	100	2.9	0.00067	0.273
14	Journal of Global Information Technology Management	1097-198X	200	1	1.05	0.071	100	7.9	0.00012	0.147
15	Frontiers of Information Technology & Electronic Engineering	2095-9184	237	0.91	0.91	0.344	87.5	1.7	0.00038	0.141
16	Information Development	0266-6669	331	0.905	0.913	0.378	100	3	0.00042	0.121
17	Information Research-An International Electronic Journal	1368-1613	905	0.762	0.897	0.055	100	8.4	0.00072	0.151
18	Information Technology and Control	1392-124X	229	0.8	0.751	0.143	100	4.4	0.00031	0.116
19	Data Base for Advances in Information Systems	0095-0033	501	0.4	0.803	0.333	95.24	>10	0.00021	0.224
20	Journal of Global Information Management	1062-7375	297	0.613	0.667	0.24	96	>10	0.0001	0.102
21	International Journal of Wavelets Multiresolution and Information Processing	0219-6913	368	0.54	0.548	0.06	98.51	6.5	0.00071	0.171
22	Computer Science and Information Systems	1820-0214	359	0.613	0.375	0.111	97.78	4.6	0.00069	0.146
23	International Arab Journal of Information Technology	1683-3198	524	0.466	0.662	0.073	100	5.2	0.00034	0.056

The *Aslib Journal of Information Management* covered areas such as social media, data protection, search engines, information retrieval, digital libraries, information behavior, intellectual property and copyright, the information industry, digital repositories and information policy, and governance. With an impact factor of 1.557, the quarterly *Journal of Computer Information Systems* is a forum for IACIS members and other information systems and business professionals. *Computing Science and Engineering (JCSE)* is a quarterly journal focused on all aspects of computing science and engineering. The *Journal of Intelligent Information Systems* examines theoretical aspects, systems architecture, analysis and design tools and techniques, and implementation experiences for intelligent information systems. *Information Systems and E-Business Management* focuses on the core tasks of information systems management; conceptual analysis, design, and deployment of information systems; and all e-business related topics. The *Journal of Aerospace Information Systems* is devoted to describing new theoretical developments, novel applications, and case studies regarding advances in

aerospace computing, information, and networks and communication systems that address aerospace-specific issues. *Frontiers of Information Technology & Electronic Engineering*, formerly known as the *Journal of Zhejiang University SCIENCE C (Computers & Electronics) (2010-2014)*, is an international peer-reviewed journal launched by the Chinese Academy of Engineering (CAE) and Zhejiang University and co-published by Springer & Zhejiang University Press. The *Journal of Information Development* deals with both the development of information systems, services and skills, and the role of information in personal and national development with an emphasis on the information needs and problems in developing countries. *Information Research-An International Electronic Journal*, which is focused on a wide range of information-related disciplines, is published by the University of Boras, Sweden, with financial support from a NOPHS Scientific Journal Grant. *Information Technology and Control*, with an impact factor of 0.800, covers computer science and control systems related problems. *Computer Science and Information Systems* covers both the theoretical foundations of computer science and commercial, industrial, or educational aspects. The *International Arab Journal of Information Technology*, with an impact factor of 0.466, is the official journal of the Colleges of Computing and Information Society (CCIS) for the Association of Arab Universities and is published by Zarqa University, Jordan.

9.3 Statistical Analysis

In this section, a statistical analysis of the journal index is conducted using SPSS 21.0, a software package for logical batched and non-batched statistical analyses. The current version (2015) is officially called IBM SPSS Statistics. In the following, a total analysis and an analysis by zone are given.

Total analysis

As shown in Table 9.6, the total citations for the information engineering journals were between 166 and 25,329, with the average being 2340.47. The minimum impact factor was 0.400 and the maximum was 8.415. The five-year impact factors for these 47 journals also had a large range, with a

minimum of 0.375 and a maximum of 9.340. The immediacy index, which measures the ratio between the citations in a single calendar year and the recent citable items published at that time by these 47 journals in different situations, had a small deviation of 0.091167. The articles in citable item for these 47 journals was 4578.57, and the cited half-life for seven journals was above 10.0, but the minimum was 1.7. The eigenfactor score, which was between 0.00010 and 0.48140, measures the importance of a journal to the scientific community by considering the origin of the incoming citations and reflects how frequently an average researcher accesses content from the journal. The article influence score, which ranged from 0.056 and 2.432, with an average level of 0.63013, measures the average influence of articles in a journal.

Table 9.6: Descriptive analysis of information engineering journals

	N	Range	Minimum	Maximum	Sum	Mean		Std. Deviation	Skewness	
						Statistic	Std. Error		Statistic	Std. Error
Total Cites	47	25163	166	25329	110002	2340.47	605.489	4151.026	4.257	0.347
Impact Factor	47	8.015	0.400	8.415	107.312	2.28323	0.246160	1.687588	1.638	0.347
Five Year Impact Factor	47	8.965	0.375	9.340	118.122	2.51323	0.262151	1.797219	1.567	0.347
Immediacy Index	47	3.516	0.055	3.571	25.687	0.54653	0.091167	.625012	3.134	0.347
Articles in citable item	47	12.50	87.50	100.00	4578.57	97.4164	0.46799	3.20840	-1.283	0.347
Cited Half life	47	8.3	1.7	10.0	318.8	6.783	0.3281	2.2497	-0.260	0.347
Eigenfactor Score	47	0.48130	0.00010	0.48140	0.60839	0.0129445	0.01020288	0.06994740	6.816	0.347
Article Influence Score	47	2.376	0.056	2.432	29.616	0.63013	0.076549	0.524796	1.682	0.347

The extreme values for total cites, impact factor, five-year impact factor, immediacy index, articles in citable item, cited half-life, eigenfactor score, and article influence score for the information engineering journals were then examined.

Table 9.7 shows the extreme values for the total cites. The journals with the five highest total cites were *Information Sciences* (25329) *IEEE Transactions on Fuzzy Systems* (12946), *IEEE Transactions on Information Forensics and Security* (7294), *Information Systems Research* (6640), and the *International Journal of Geographical Information Science* (5019). The journals with the lowest total cites between 166 and 237 were the *Journal of Aerospace Information Systems*, the *Aslib Journal of Information Management*, the *Journal of Global Information Technology Management*, *Information Technology and Control*, and *Frontiers of Information Technology & Electronic Engineering*.

Table 9.8 shows the extreme values for the impact factor. The journals with the five highest impact factors were *IEEE Transactions on Fuzzy Sys-*

Table 9.7: Extreme values for total cites

			Case Number	Journal Title	Value
Total Cites	Highest	1	2	Information Sciences	25329
		2	1	IEEE Transactions on Fuzzy Systems	12946
		3	4	IEEE Transactions on Information Forensics and Security	7294
		4	5	Information Systems Research	6640
		5	18	International Journal of Geographical Information Science	5019
	Lowest	1	37	Journal of Aerospace Information Systems	166
		2	29	Aslib Journal of Information Management	193
		3	38	Journal of Global Information Technology Management	200
		4	42	Information Technology and Control	229
		5	39	Frontiers of Information Technology & Electronic Engineering	237

tems with an impact factor value of 8.415, *Information Fusion* with 6.639, *IEEE Transactions on Information Forensics and Security* with 5.823, the *Journal of Information Technology* with 4.535, and the *International Journal of Information Management* with 4.516. The journals with the lowest impact factors from 0.400 to 0.613 were the JData Base for *Advances in Information Systems*, the *International Arab Journal of Information Technology*, the *International Journal of Wavelets Multiresolution and Information Processing*, *Computer Science and Information Systems*, and the *Journal of Global Information Management*.

Table 9.8: Extreme values for the impact factor

			Case Number	Journal Title	Value
Impact Factor	Highest	1	1	IEEE Transactions on Fuzzy Systems	8.415
		2	3	Information Fusion	6.639
		3	4	IEEE Transactions on Information Forensics and Security	5.823
		4	8	Journal of Information Technology	4.535
		5	7	International Journal of Information Management	4.516
	Lowest	1	43	Data Base for Advances in Information Systems	0.400
		2	47	International Arab Journal of Information Technology	0.466
		3	45	International Journal of Wavelets Multiresolution and Information Processing	0.540
		4	46	Computer Science and Information Systems	0.613
		5	44	Journal of Global Information Management	0.613

Table 9.9 shows the extreme values for the five-year impact factor. The journals with the five highest five-year impact factors were *IEEE Transactions on Fuzzy Systems* with the five-year impact factor value of 9.340, *Information Fusion* with 6.574, *IEEE Transactions on Information Forensics and Security* with 5.517, *Information Systems Research* with 5.153, and the *International Journal of Information Management* with 4.810. The

journals with the five lowest five-year impact factors from 0.375 to 0.751 were *Computer Science and Information Systems*, the *International Journal of Wavelets Multiresolution and Information Processing*, the *International Arab Journal of Information Technology*, the *Journal of Global Information Management*, and *Information Technology and Control*.

Table 9.9: Extreme values for the five-year impact factor

			Case Number	Journal Title	Value
Five-year pact Factor	Im- Highest	1	1	IEEE Transactions on Fuzzy Systems	9.340
		2	3	Information Fusion	6.574
		3	4	IEEE Transactions on Information Forensics and Security	5.517
		4	5	Information Systems Research	5.153
		5	7	International Journal of Information Management	4.810
	Lowest	1	46	Computer Science and Information Systems	0.375
		2	45	International Journal of Wavelets Multiresolution and Information Processing	0.548
		3	47	International Arab Journal of Information Technology	0.662
		4	44	Journal of Global Information Management	0.667
		5	42	Information Technology and Control	0.751

Table 9.10 shows the extreme values for the immediacy index. The journals with the five highest immediacy indexes were *Information Fusion* with an immediacy index of 3.571, *IEEE Transactions on Fuzzy Systems* with 2.273, *IEEE Transactions on Information Forensics and Security* with 1.466, *Information Systems Journal* with 1.400, and *Information Sciences* with 1.377. The journals with the five lowest immediacy indexes from 0.055 to 0.111 were *Information Research-An International Electronic Journal*, the *International Journal of Wavelets Multiresolution and Information Processing*, the *Journal of Global Information Technology Management*, the *International Arab Journal of Information Technology*, and *Computer Science and Information Systems*.

Table 9.11 shows the extreme values for the articles in citable item. The journals with the five highest articles in citable item values at100.00 were *IEEE Transactions on Fuzzy Systems*, the *Journal of Information Technology*, the *Journal of the Association for Information Systems*, *Business & Information Systems Engineering*, and the *International Journal of Computer-Supported Collaborative Learning*. The journals with the lowest five articles in citable item from 87.50 to 92.39 were *Frontiers of Information Technology & Electronic Engineering*, *Information and Software Technology*, the

Table 9.10: Extreme values for the immediacy index

			Case Number	Journal Title	Value
Immediacy Index	Highest	1	3	Information Fusion	3.571
		2	1	IEEE Transactions on Fuzzy Systems	2.273
		3	4	IEEE Transactions on Information Forensics and Security	1.466
		4	6	Information Systems Journal	1.400
		5	2	Information Sciences	1.377
	Lowest	1	41	Information Research-An International Electronic Journal	0.055
		2	45	International Journal of Wavelets Multiresolution and Information Processing	0.060
		3	38	Journal of Global Information Technology Management	0.071
		4	47	International Arab Journal of Information Technology	0.073
		5	46	Computer Science and Information Systems	0.111

European Journal of Information Systems, *Online Information Review*, and the *International Journal of Information Management*.

Table 9.11: Extreme values for the articles in citable item

			Case Number	Journal Title	Value
Articles in cited item	Highest	1	1	IEEE Transactions on Fuzzy Systems	100.00
		2	8	Journal of Information Technology	100.00
		3	11	Journal of the Association for Information Systems	100.00
		4	13	Business & Information Systems Engineering	100.00
		5	16	International Journal of Computer-Supported Collaborative Learning	100.00
	Lowest	1	39	Frontiers of Information Technology & Electronic Engineering	87.50
		2	17	Information and Software Technology	89.52
		3	9	European Journal of Information Systems	90.63
		4	25	Online Information Review	92.06
		5	7	International Journal of Information Management	92.39

Table 9.12 shows the extreme values for cited half-life. The journals with the five highest cited half-life, all of which were above 10.0, were *Information Systems Research*, the *Journal of Management Information Systems*, the *Journal of the Association for Information Systems*, *Information Society*, and *Information and Computation*. The journals with the five lowest cited half-life at between 1.7 and 3.8 were *Frontiers of Information Technology & Electronic Engineering*, the *Journal of the Association for Information Science and Technology*, the *Journal of Aerospace Information Systems*, *Information Development*, and *Information Fusion*.

Table 9.13 shows the extreme eigenfactor scores. The journals with the five highest eigenfactor scores were *Information Sciences* with an eigenfactor score of 0.48140, *IEEE Transactions on Fuzzy Systems* with 0.02128, *IEEE Transactions on Information Forensics and Security* with 0.01991,

Table 9.12: Extreme values for cited half-life

			Case Number	Journal Title	Value
Cited Half-life	Highest	1	5	Information Systems Research	10.0
		2	10	Journal of Management Information Systems	10.0
		3	11	Journal of the Association for Information Systems	10.0
		4	22	Information Society	10.0
		5	33	Information and Computation	10.0
	Lowest	1	39	Frontiers of Information Technology & Electronic Engineering	1.7
		2	15	Journal of the Association for Information Science and Technology	2.4
		3	37	Journal of Aerospace Information Systems	2.9
		4	40	Information Development	3.0
		5	3	Information Fusion	3.8

Information Systems Research with 0.00846, and *Information Fusion* with 0.00613. The journals with the five lowest eigenfactor scores from 0.00010 to 0.00034 were the *Journal of Global Information Management*, the *Journal of Global Information Technology Management*, the *Data Base for Advances in Information Systems*, *Information Technology and Control*, and the *International Arab Journal of Information Technology*.

Table 9.13: Extreme values for the eigenfactor score

			Case Number	Journal Title	Value
Eigenfactor Score	Highest	1	2	Information Sciences	0.48140
		2	1	IEEE Transactions on Fuzzy Systems	0.02128
		3	4	IEEE Transactions on Information Forensics and Security	0.01991
		4	5	Information Systems Research	0.00846
		5	3	Information Fusion	0.00613
	Lowest	1	44	Journal of Global Information Management	0.00010
		2	38	Journal of Global Information Technology Management	0.00012
		3	43	Data Base for Advances in Information Systems	0.00021
		4	42	Information Technology and Control	0.00031
		5	47	International Arab Journal of Information Technology	0.00034

Table 9.14 shows the extreme values for the article influence score. The journals with the five highest article influence scores were *IEEE Transactions on Fuzzy Systems* with an article influence score of 2.432, *Information Systems Research* with of 2.241, *IEEE Transactions on Information Forensics and Security* with 1.565, *Information Fusion* with 1.530, and the *Journal of Management Information Systems* with 1.265. The journals with the five lowest article influence scores from 0.056 to 0.141 were the *International Arab Journal of Information Technology*, the *Journal of Global Information Management*, *Information Technology and Control*, and *Information Development and Electronic Engineering*.

Table 9.14: Extreme values for the article influence score

		Case Number	Journal Title	Value
Article Influence Score	Highest 1	1	IEEE Transactions on Fuzzy Systems	2.432
	2	5	Information Systems Research	2.241
	3	4	IEEE Transactions on Information Forensics and Security	1.565
	4	3	Information Fusion	1.530
	5	10	Journal of Management Information Systems	1.265
	Lowest 1	47	International Arab Journal of Information Technology	0.056
	2	44	Journal of Global Information Management	0.102
	3	42	Information Technology and Control	0.116
	4	40	Information Development	0.121
	5	39	Frontiers of Information Technology & Electronic Engineering	0.141

Zone analysis

SPSS 21.0 software was employed for the statistical descriptive analysis of the information engineering related journals in the different zones, some of the descriptive results for which are shown Tables 9.15-9.22, and the visual box diagrams for which are shown in Figures 9.1-9.8.

Table 9.15 gives the 2017 total cites statistical results for each zone. The Zone A journals had by far the greatest number of total cites at 19137.50 compared to only 3744.29, 2165.53, and 566.70 respectively for Zones B, C, and D. The standard error of skewness for the total cites was also significantly greater in Zone A at 8756.103 than in the other zones, and the Zone A range at 12,383 accounted for half the total range for the total cites. The sum total cites were 38,275 in Zone A, followed by 32,483 in Zone C, 26,210 in Zone B and 13,034 in Zone D, even though this zone had the largest number of journals.

Table 9.15: 2017 total cites statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	2	19137.50	8756.103	19137.50	38275	25329	12946	12383	76669344.500
B	7	3744.29	2374.226	3303.00	26210	7294	1170	6124	5636950.238
C	15	2165.53	1387.596	1842.00	32483	5019	459	4560	1925422.695
D	23	566.70	441.123	410.00	13034	2119	166	1953	194589.858
Total	47	2340.47	4151.026	928.00	110002	25329	166	25163	17231013.950

As shown in Table 9.16, the average impact factor for journals in Zone A zone was 6.36000, with a variance of 8.446, which was much greater than

the average impact factors of 2.151, 0.314, 0.185 in Zones B, C, and D. The impact factor range, however, at 4.338, was greater in Zone B than in Zone A (4.110), but the ranges in Zones C and D were much lower at only 1.699 and 1.355. The sum of the impact factor was 38.485 in Zone C, followed by 31.278 in Zone B, 24.829 in Zone D, and 12.720 in Zone A.

Table 9.16: 2017 impact factor statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	2	6.36000	2.906209	6.36000	12.720	8.415	4.305	4.110	8.446
B	7	4.46829	1.466730	4.51600	31.278	6.639	2.301	4.338	2.151
C	15	2.56567	0.560235	2.59600	38.485	3.484	1.785	1.699	0.314
D	23	1.07952	0.430381	1.03200	24.829	1.755	0.400	1.355	0.185
Total	47	2.28323	1.687588	1.78500	107.312	8.415	0.400	8.015	2.848

Table 9.17 gives the 2017 five-year impact factor statistical results in each zone. The average five-year impact factor for Zone A was 6.85900, with a variance of 12.311, which was markedly different from the other zones at only 0.866, 0.431, and 0.218 for Zones B, C, and D. The five-year impact factor standard error of skewness in Zone A was 3.508664, which was also far greater than the 0.930770, 0.656592, and 0.466824 in Zones B, C, and D. The sum of the five-year impact factor was 42.435 in Zone C, followed by 34.517 in Zone B, 27.452 in Zone D, and 13.718 in Zone A.

Table 9.17: 2017 five-year impact factor statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	2	6.85900	3.508664	6.85900	13.718	9.340	4.378	4.962	12.311
B	7	4.93100	0.930770	4.81000	34.517	6.574	3.745	2.829	0.866
C	15	2.82900	0.656592	2.76800	42.435	4.262	1.987	2.275	0.431
D	23	1.19357	0.466824	1.09100	27.452	2.050	0.375	1.675	0.218
Total	47	2.51323	1.797219	1.99600	118.122	9.340	0.375	8.965	3.230

Table 9.18 gives the 2017 immediacy index statistical results in each zone. The average immediacy index for Zone B was 1.20029 with the variance of 1.313, which was significantly higher than the 0.401, 0.048, and 0.020 in Zones A, C, and D. The immediacy index standard error of skewness in Zone B was also much higher at 1.145821, compared to 0.633568, 0.219498, and 0.141052 in Zones A, C, and D. The sum of the immediacy

index was 8.402 in Zone B, followed by 8.363 in Zone C, 5.272 in Zone D, and 3.650 in Zone A.

Table 9.18: 2017 immediacy index statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	2	1.82500	0.633568	1.82500	3.650	2.273	1.377	0.896	0.401
B	7	1.20029	1.145821	0.66300	8.402	3.571	0.217	3.354	1.313
C	15	0.55753	0.219498	0.52800	8.363	0.930	0.256	0.674	0.048
D	23	0.22922	0.141052	0.18800	5.272	0.600	0.055	0.545	0.020
Total	47	.54653	0.625012	0.36800	25.687	3.571	0.055	3.516	0.391

Table 9.19 gives the 2017 articles in citable item statistical results in each zone. The mean for the articles in citable item in Zone A was 99.9150, with a variance 0.014, 95.7014 in Zone B with a variance of 13.233, 97.0587 in Zone C with a variance of 9.269, and 97.9543 in Zone D with a variance of 10.122. The sum of articles in citable item was 2252.95 in Zone D followed by 1455.88 in Zone C, 669.91 in Zone B, and 199.83 in Zone A.

Table 9.19: 2017 articles in citable item statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	2	99.9150	0.12021	99.9150	199.83	100.00	99.83	0.17	0.014
B	7	95.7014	3.63768	96.0000	669.91	100.00	90.63	9.37	13.233
C	15	97.0587	3.04453	98.1100	1455.88	100.00	89.52	10.48	9.269
D	23	97.9543	3.18153	100.0000	2252.95	100.00	87.50	12.50	10.122
Total	47	97.4164	3.20840	98.5100	4578.57	100.00	87.50	12.50	10.294

Table 9.20 gives the 2017 cited half-life statistical results in each zone. The mean cited half-life in Zone A was 5.550 with the smallest variance of 1.445, compared with the 6.135, 5.166, and 4.931 variances in Zones B, C, and D. The maximum cited half-life in all other groups except Zone A was 10.0. The sum of the cited half-life was 146.5 in Zone D, which was the greatest, followed by 108.8 in Zone C, 52.4 in Zone C, and only 11.1 in Zone A.

Table 9.21 gives the 2017 eigenfactor score statistical results in each zone. The mean eigenfactor score was the greatest in Zone A at 1.74600 with a variance of 0.941, compared to the 0.246, 0.046, and 0.023 variances in Zones B, C, and D. The eigenfactor score range in Zones A-D was from 1.372 to 0.580. The sum of eigenfactor scores was greatest in Zone C

Table 9.20: 2017 cited half-life statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	2	0.2513400	0.32535397	0.2513400	0.50268	0.48140	0.02128	0.46012	0.106
B	7	0.0063614	0.00647837	0.0041000	0.04453	0.01991	0.00150	0.01841	0.000
C	15	0.0029813	0.00188339	0.0030600	0.04472	0.00602	0.00055	0.00547	0.000
D	23	0.0007157	0.00060385	0.0005900	0.01646	0.00297	0.00010	0.00287	0.000
Total	47	.0129445	.06994740	.0011600	.60839	.48140	.00010	.48130	.005

at 10.691, followed by Zone B at 9.324, Zone D at 6.109, and Zone A at 3.492.

Table 9.21: 2017 eigenfactor score statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	2	1.74600	0.970151	1.74600	3.492	2.432	1.060	1.372	0.941
B	7	1.33200	0.496115	1.13900	9.324	2.241	0.717	1.524	0.246
C	15	0.71273	0.214042	0.66900	10.691	1.265	0.442	0.823	0.046
D	23	0.26561	0.152604	0.25100	6.109	0.636	0.056	0.580	0.023
Total	47	0.63013	0.524796	0.53600	29.616	2.432	0.056	2.376	0.275

Table 9.22 gives the 2017 article influence statistical results in each zone. The mean article influence score was highest in Zone A at 1.74600 with a variance of 0.941, compared to the variances of 0.246, 0.046, 0.023 in Zones B, C, and D. The range for the article influence in Zone B was the largest at 1.524. The sum of the article influence score was the highest in Zone C at 10.691, followed by Zone B at 9.324, Zone D at 6.109, and Zone A at 3.492.

Table 9.22: 2017 article influence score statistical results in each zone

Zone	N	Mean	Std. Error of Skewness	Median	Sum	Maximum	Minimum	Range	Variance
A	2	1.74600	0.970151	1.74600	3.492	1.060	2.432	1.372	0.941
B	7	1.33200	0.496115	1.13900	9.324	0.717	2.241	1.524	0.246
/SC	15	0.71273	0.214042	0.66900	10.691	0.442	1.265	0.823	0.046
D	23	0.26561	0.152604	0.25100	6.109	0.056	0.636	0.580	0.023
Total	47	0.63013	0.524796	0.53600	29.616	0.056	2.432	2.376	0.275

Figures 9.1-9.8 show the information engineering boxplots analyses for total cites, impact factor, five-year impact factor, immediacy index, articles in citable item, cited half-life, eigenfactor score, and article influence score for the different zones. As can be seen, there were few outliers in Zone

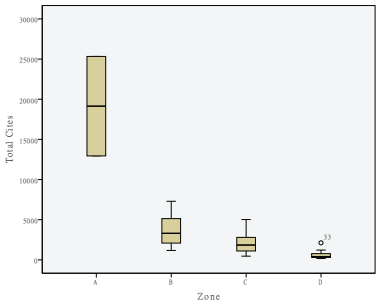

Fig. 9.1: Box diagram for total cites

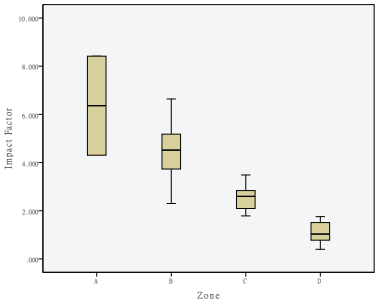

Fig. 9.2: Box diagram for impact factor

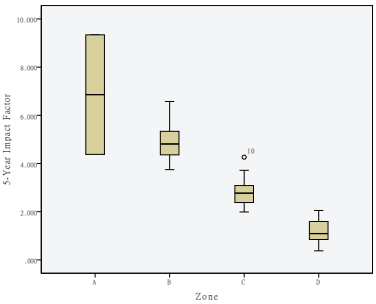

Fig. 9.3: Box diagram for the five-year impact factor

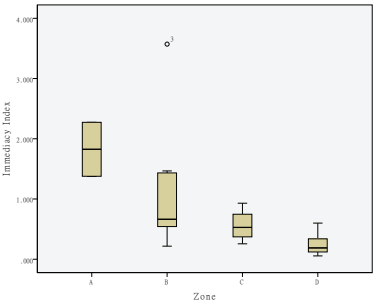

Fig. 9.4: Box diagram for the immediacy index

A. The total cites (Fig. 9.1) were relatively high for the IEEE Transactions on Fuzzy Systems and Information Sciences. The impact factors (Fig. 9.2), five-year impact factors (Fig. 9.3), and immediacy indexes (Fig. 9.4) decreased in order of the zone, and there was an outlier in Zone C for the five-year impact factor, indicating that the Journal of Management Information Systems had an higher five-year impact factor than the other journals in Zone C. The outlier in the Zone B immediacy index indicated that *Information Fusion* had a higher immediacy index than the other journals in Zone B. The articles in citable item (Fig. 9.5) was highest in Zone A and lowest in Zone B; however, the cited half-life (Fig. 9.6) was highest in Zone B and

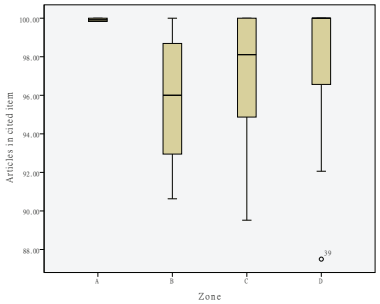

Fig. 9.5: Box diagram for the articles in citable item

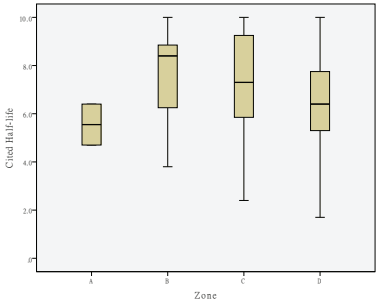

Fig. 9.6: Box diagram for the cited half-life

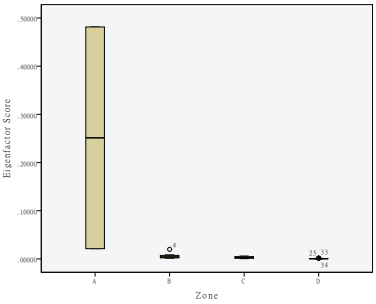

Fig. 9.7: Box diagram for the eigenfactor score

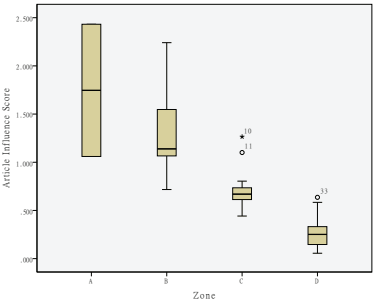

Fig. 9.8: Box diagram for the article influence score

lowest in Zone A. The eigenfactor score (Fig. 9.7) was relatively high and there were outliers in both Zones B and D. The article influence (Fig. 9.8) decreased in zone order and there were two outliers in Zone C and one in Zone D.

9.4 Comprehensive Discussion

Impact factor changes

Fig. 9.9 shows the impact factor changes for the journals in Zone A from 2013 to 2017. The two journals in this zone had high fluctuating impact factors from 3.364 and 8.746. The impact factors for the *IEEE Transactions on Fuzzy Systems* were significantly higher than for *InformationSciences*. However, the impact factors for both *IEEETransactionsonFuzzySystems* and *InformationSciences* decreased in 2015 but were increasing at other times.

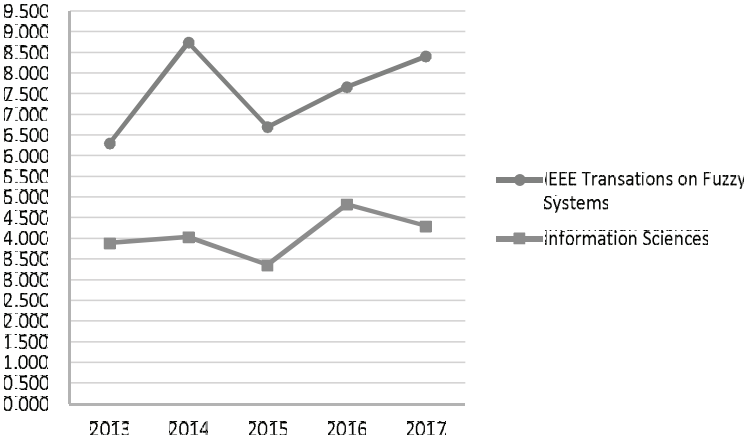

Fig. 9.9: Impact factor changes in Zone A from 2013 to 2017

Fig. 9.10 shows the fluctuating impact factor changes for the seven journals in Zone B from 2013 to 2017, which changed from 1.333 to 6.953. Information Systems Research had the strongest fluctuations, with the impact factor beginning to decline after 2015. The *Journal of Information Technology* had higher impact factors, except in 2017, and had obvious up and down fluctuations. *Information Fusion*'s impact factor was rising over the five years and in 2017 surpassed the *Journal of Information Technology* with

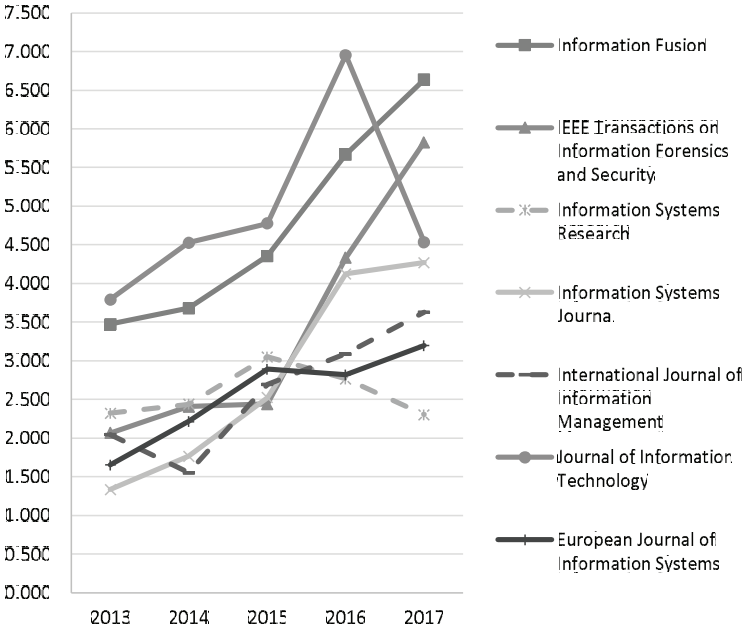

Fig. 9.10: Impact factor changes in Zone B from 2013 to 2017

the highest Zone B impact factor. *IEEE Transactions on Information Forensics and Security* had a large impact factor increase in 2016 and 2017, and the *Information Systems Journal*, the *European Journal of Information Systems*, and the *International Journal of Information Management* also had upward trends.

Figure 9.11 shows the mostly fluctuating impact factor changes for the 15 Zone C journals, which varied from 0.500 to 3.58. The impact factors for both the *Journal of Informetrics and Knowledge and Information Systems* both decreased in 2014 and then rose from 2015. The impact factors for *Business & Information Systems Engineering*, *Cartography and Geographic Information Science*, the *International Journal of Computer-Supported Collaborative Learning*, *Information Systems*, and the *International Journal of Geographical Information Science* first rose and then fell in 2017.

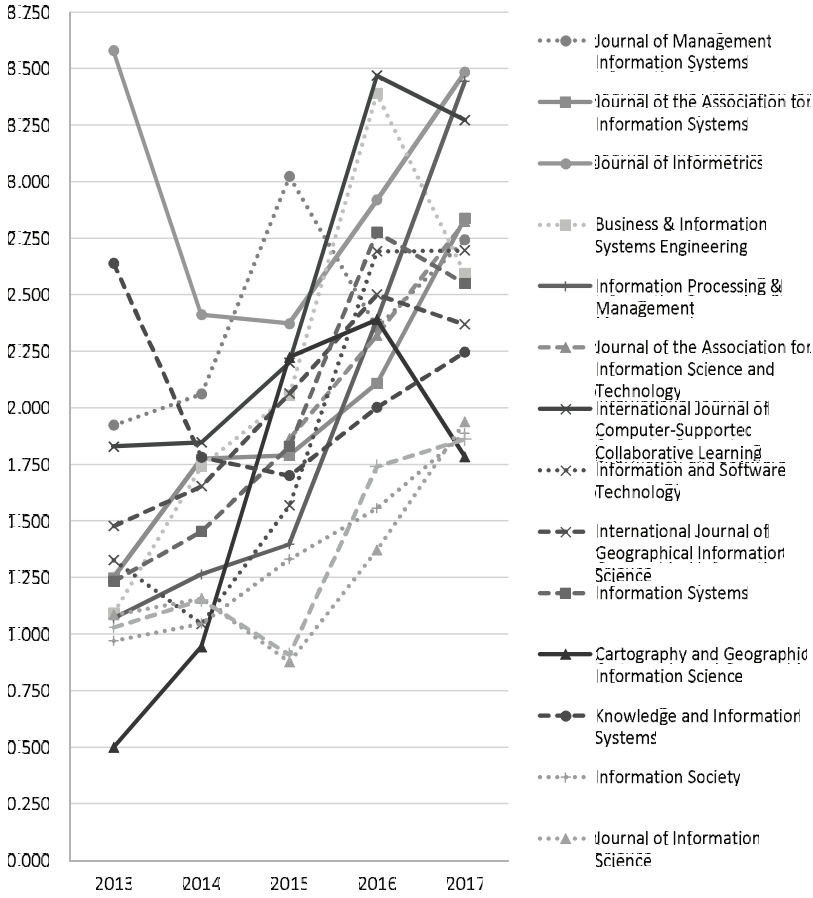

Fig. 9.11: Impact factor changes in Zone C from 2013 to 2017

However, the impact factors for *Information Processing & Management*, the *Journal of the Association for Information Science and Technology*, *Information Processing & Management*, the *Journal of the Association for Information Systems*, and *Information Society* all increased over the five years. The impacts for the *MIS Quarterly Executive* and the *Journal of Information Science* were relatively low in 2015, and were the lowest at 0.909 and 0.878.

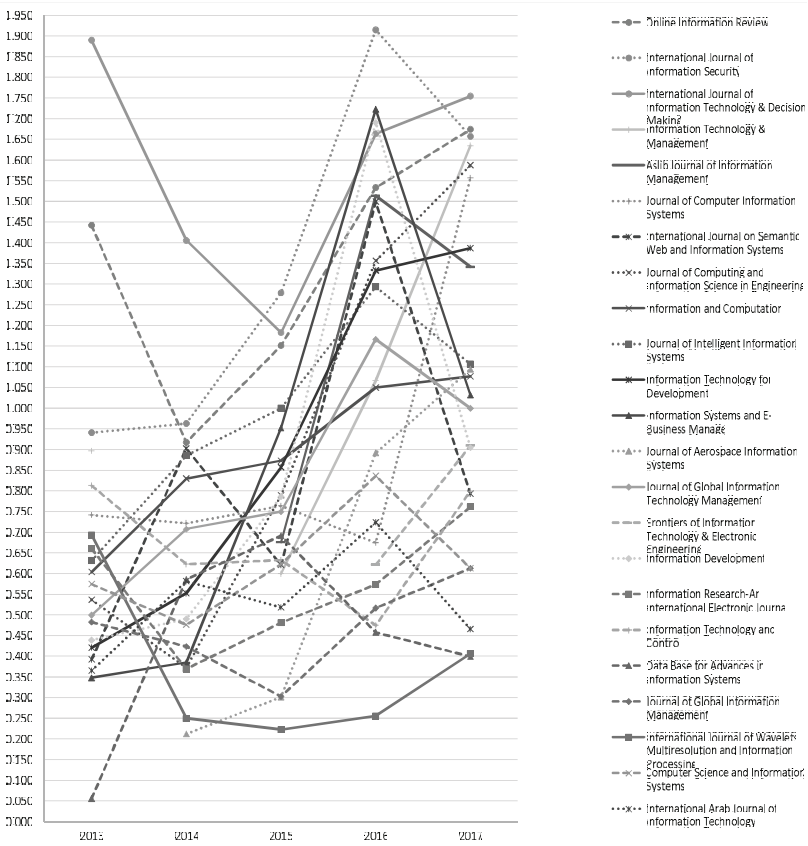

Fig. 9.12: Impact factor changes in Zone D from 2013 to 2017

As shown in Fig. 9.12, 50 percent of the journals were allocated to Zone D, with the impact factor scores ranging from 0.056 to 1.915, and with most fluctuating over the five years, with some fluctuating more than others which fluctuated with a regular pattern. Information Systems and E-Business Management had a significantly increasing impact factor from 2013 to 2016, but in 2017, it decreased to 1.032. The *International Journal on Semantic Web and Information Systems*, *Information Technology and Control* and the *International Arab Journal of Information Technology* had constant fluctuations, and the impact factor for the *International Journal on Semantic Web* and *Information Systems* had the greatest fluctuations from 0.393 in 2013 to 0.903 in 2014 to 0.621 in 2015 to a high of 1.500 in 2016 and falling again to 0.793 in 2017. Almost half the Zone D journals increased from 2013-2016 and then fell in 2017. The falls in the impact factors for *Information Technology & Management*, the *Journal of Computing and Information Science in Engineering*, the *Journal of Computer Information Systems*, and *Information Technology for Development* were noticeable.

Major countries

Table 9.23 gives the statistical results for the major countries that contributed to the published information engineering SCI papers from 2013 to 2017.

Table 9.23: SCI information engineering papers published by major countries from 2013 to 2017

Country	2013		2014		2015		2016		2017	
	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage
ALL	3222		3439		4017		4591		4648	
USA	1115	34.61%	1178	34.25%	1201	29.90%	1355	29.51%	1360	29.26%
PEOPLES R CHINA	667	20.70%	744	21.63%	883	21.98%	1047	22.81%	1216	26.16%
GERMANY	279	8.66%	294	8.55%	363	9.04%	380	8.28%	374	8.05%
ENGLAND	242	7.51%	247	7.18%	337	8.39%	353	7.69%	361	7.77%
SPAIN	189	5.87%	242	7.04%	257	6.40%	326	7.10%	262	5.64%
ITALY	140	4.35%	165	4.80%	268	6.67%	251	5.47%	253	5.44%
CANADA	186	5.77%	149	4.33%	177	4.41%	236	5.14%	204	4.39%
INDIA	119	3.69%	146	4.25%	187	4.66%	247	5.38%	253	5.44%
FRANCE	163	5.06%	133	3.87%	184	4.58%	202	4.40%	186	4.00%
AUSTRALIA	122	3.79%	141	4.10%	160	3.98%	194	4.23%	179	3.85%

Information engineering journals published 4,648 papers in 2017, of which 1,360 or 29.26% were published by U.S authors, ranking first in the world. Chinese authors contributed 1,216 papers (26.61%) German au-

thors produced 374 (8.28%), British authors 361 (7.77%), Spanish authors 262 (5.64%), Indian authors 253 (5.44%), Canadian authors 204 (4.39%), French authors 186 (4.00%); and Australian authors 179 papers (3.85%).

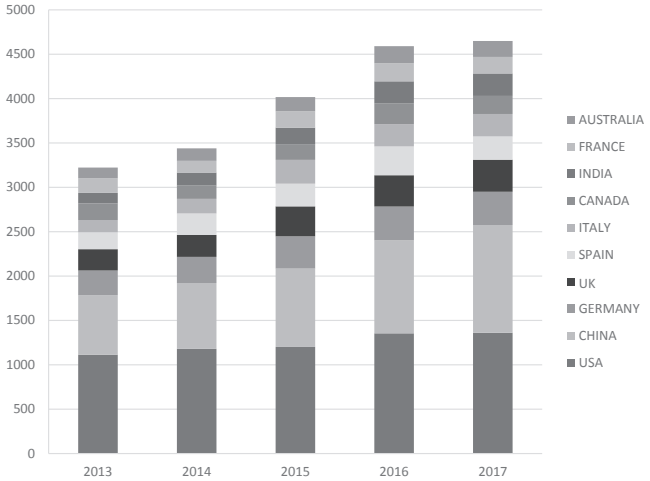

Fig. 9.13: Papers published in information engineering journals from 2013 to 2017

As shown in Fig. 9.13, the fewest articles, at 3,222, were published in 2013, which by 2017 had risen by more than 50% to 4,648. In all years, the USA and China published the most papers in information engineering journals. U.S. authors published 1,115 in 2013 and 1,360 articles in 2017. Between 2013 and 2017, the information engineering contributions by Chinese scholars doubled from 667 to 1,216 articles or 26.16%. The percentage contributions by other countries rose marginally over the five years.

German authors published 279 papers in 2013 or 8.66% of all papers with the contribution rising to 374 in 2017 (though this was a smaller proportion of the total at 8.05%). British authors accounted for between 7.18% and 8.39% and Spanish and Italian scholars accounted for between 4% and 8%. Canadian contributions fluctuated from 186 (5.77%) in 2013 to only 149 in 2014 to 204 (4.39%) in 2017, Indian authors contributed a rising proportion

from 3.69% in 2013 to 5.44% in 2017, French scholars published a similar number of articles, and Australian scholars contributed between 3.79% and 4.23%.

Correlation analysis

Correlations

		Total Cites	Impact Factor	5-Year Impact Factor	Immediacy Index	Articles in cited item	Cited Half-life	Eigenfactor Score	Article Influence Score
Total Cites	Pearson Correlation	1	.573**	.595**	.475**	.044	-.040	.856**	.577**
	Sig. (2-tailed)		.000	.000	.001	.770	.789	.000	.000
	N	47	47	47	47	47	47	47	47
Impact Factor	Pearson Correlation	.573**	1	.944**	.832**	-.078	-.041	.224	.816**
	Sig. (2-tailed)	.000		.000	.000	.604	.785	.129	.000
	N	47	47	47	47	47	47	47	47
5-Year Impact Factor	Pearson Correlation	.595**	.944**	1	.770**	-.109	.075	.202	.930**
	Sig. (2-tailed)	.000	.000		.000	.465	.616	.174	.000
	N	47	47	47	47	47	47	47	47
Immediacy Index	Pearson Correlation	.475**	.832**	.770**	1	-.144	-.207	.233	.626**
	Sig. (2-tailed)	.001	.000	.000		.335	.162	.114	.000
	N	47	47	47	47	47	47	47	47
Articles in cited item	Pearson Correlation	.044	-.078	-.109	-.144	1	.003	.111	-.047
	Sig. (2-tailed)	.770	.604	.465	.335		.986	.459	.756
	N	47	47	47	47	47	47	47	47
Cited Half-life	Pearson Correlation	-.040	-.041	.075	-.207	.003	1	-.143	.169
	Sig. (2-tailed)	.789	.785	.616	.162	.986		.336	.257
	N	47	47	47	47	47	47	47	47
Eigenfactor Score	Pearson Correlation	.856**	.224	.202	.233	.111	-.143	1	.170
	Sig. (2-tailed)	.000	.129	.174	.114	.459	.336		.254
	N	47	47	47	47	47	47	47	47
Article Influence Score	Pearson Correlation	.577**	.816**	.930**	.626**	-.047	.169	.170	1
	Sig. (2-tailed)	.000	.000	.000	.000	.756	.257	.254	
	N	47	47	47	47	47	47	47	47

**. Correlation is significant at the 0.01 level (2-tailed).

Fig. 9.14: Pearson's correlation coefficients for JCR Data and Eigenfactor Metrics

To determine the journal influence relationships between the indicators, Pearson's correlation coefficient, which is widely used in the sciences, was applied, with the bivariate correlation analyses conducted using SPSS 21.0. In statistics, Pearson's correlation coefficient was developed by Karl Pearson, it is the covariance of two variables divided by the product of their standard deviations. The Pearson's correlation coefficient is a measure of the linear correlation between two variables X and Y, and has a value between +1 and -1, where 1 indicates a total positive linear correlation, 0 indicates no linear correlation, and -1 indicates a total negative linear correlation.

Fig. 9.14 shows that the impact factor variable and the five-year impact factor had a correlation coefficient of 0.944, indicating an extremely strong correlation as all data points lie on a line and increase and decrease together. The five-year impact factor and article influence score variables had a correlation coefficient of 0.930 also indicating an extremely strong correlation.

The Pearson's correlation coefficient for total cites and the eigenfactor score was 0.856, and the impact factor had a correlation coefficient of 0.832 with the immediacy index and 0.816 with the article influence score, both being strong correlations. The Pearson's correlation coefficient for the immediacy index and the article influence score was 0.626, for total cites and the five-year impact factor, it was 0.595, for total cites and impact factor was 0.573, for total cites and article influence score, it was 0.577, and for the total cites and immediacy index, it was 0.475, which was a weak correlation.

Principal Component Analysis of the Journal Evaluation Indicators

Correlation studies have shown that as there are high correlation coefficients between these indicators, it is redundant to use them all because of the exclusiveness principle. However, which indicators should be adopted to evaluate a journal and what attributes do these indicators depict? To answer these questions, after the correlation analyses, this paper conducted a principal component analysis in IBM SPSS Statistics with the FACTOR command (Analyze > Dimension Reduction > Factor) of the journal evaluation indicators for the 47 information engineering journals. The objective of factor analyses is to identify the independent latent variables, with adherents of these methods believing that the information gained about these interdependencies between the observed variables can be used to reduce the set of variables in a dataset. To track the information, the last five years of impact factors, the five-year impact factors, the immediacy indexes, and the article, cited half-life, eigenfactor, and article influence scores were considered concurrently.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.770
Bartlett's Test of Sphericity	Approx. Chi-Square	727.706
	df	66
	Sig.	.000

Fig. 9.15: KMO and Bartlett's test

Fig. 9.15 shows the overall KMO and Bartlett's Test table for the factor output, with the value of the KMO being 0.770. The significance probability for the Bartlett's Test, which is used to test if k samples are from populations with equal variances, was 0.000, indicating that these indicators were suitable for the principal component analyses. KMO values greater than 0.8 are considered good; that is, the component or factor analyses are useful for these variables.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.466	62.217	62.217	7.466	62.217	62.217
2	1.613	13.440	75.658	1.613	13.440	75.658
3	1.120	9.330	84.987	1.120	9.330	84.987
4	.888	7.404	92.391			
5	.328	2.730	95.121			
6	.251	2.095	97.216			
7	.149	1.245	98.461			
8	.075	.627	99.089			
9	.049	.409	99.497			
10	.032	.265	99.762			
11	.019	.158	99.920			
12	.010	.080	100.000			

Extraction Method: Principal Component Analysis.

Fig. 9.16: Total variance explained

After the principal component extraction procedure, a rotated quartimax transformation was used as this has been shown to have the best performance in making component loadings incline to 1 or 0; therefore, it can explain the factors' practical meanings. Quartimax rotation maximizes the variance of the squared factor loadings in each variable; that is, it simplifies the loading matrix rows. In other words, the quartimax minimizes the number of factors needed to explain each variable. In the quartimax rotation, there are often many variables in the first rotated factor; therefore, this method is not always helpful. The explained eigenvalues and total variances are shown in Fig. 9.16.

Three components were extracted from all samples for the above variables. As shown in the scree plot in Fig. 9.17, as the eigenvalues for the first three components were above 1, all were included. The eigenvalue for

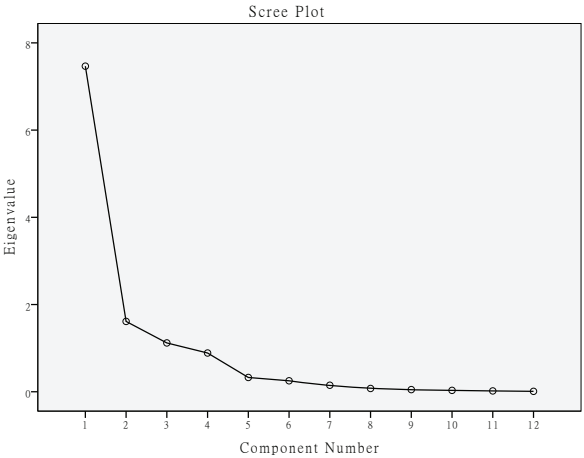

Fig. 9.17: Scree plot

component 1 was 7.466, which dropped sharply to 1.120. From Fig. 9.17, both extracted components accounted for more than 84.987% of the total variance in the initial eigenvalues and the extraction sums of the squared loadings, which was considered very satisfactory. In this paper, two major components were chosen as the best explanations for the variability in the data for the information engineering journals as together they explained 84.987% of the total variance.

As can be seen in Fig. 9.18, a threshold level of 0.5 led to a clear interpretation. Total cites, the five-year impact factor, the immediacy index, the article influence, and all impact factor indicators were included in the first component, the articles in citable item and the eigenfactor score were included in the second component, and the cited half-life was included in the third component. These are explained in more detail in the following.

- The first component related to the journal's integrated influence because the indicators that made up the first component all measured aspects of the impact each year.
- The second component related to the cited influence as the articles in the citable item and the eigenfactor score provided measures for the relationships between the articles published in the journals and the cited effect.

Component Matrix[a]

	Component		
	1	2	3
Total Cites	.713	.525	.428
5-Year Impact Factor	.951	-.206	.004
Immediacy Index	.806	-.043	-.203
Articles in cited item	-.095	.547	-.423
Cited Half-life	-.065	-.554	.666
Eigenfactor Score	.379	.774	.469
Article Influence Score	.879	-.220	.080
Impactfactor2013	.926	.052	-.038
Impactfactor2014	.948	.010	-.063
Impactfactor2015	.960	-.148	-.028
Impactfactor2016	.940	-.038	-.154
Impactfactor2017	.955	-.113	-.131

Extraction Method: Principal Component Analysis.
a. 3 components extracted.

Fig. 9.18: Quartimax rotated loading matrix for the "information engineering" category journal indicators

- The third component related to the aging speed of the journals, with the cited half-life providing the time span for the newer half of the cited papers published in a journal in a given year.

9.5 Total Summary

There were 47 management science in information engineering journals examined, with 2, 7, 15, and 23 being respectively distributed in Zones A, B, C, and D. Based on the journal ranking results in section 9.2, the top two most important journals which had the highest comprehensive score were *IEEE Transactions on Fuzzy Systems* and *Information Sciences*, which were ranked in Zone A. The statistical analysis conducted in 9.3 found that *Information Fusion* and *IEEE Transactions on Information Forensics and Security* had outstanding eigenfactor scores, immediacy indexes, and five-year impact factors, reflecting their significant influence in this category.

The comprehensive discussion in section 9.4 found that the impact factor changes in Zone A were relatively steady, those in Zones B and C had

remarkable upward trends, and those in Zone D varied significantly. These results indicated that the leading journals in Zone A maintained a steady development, the journals in Zones B and C had an increase in paper quality and journal influence, but that the journals zone D had unstable quality and quantity. The USA, China, Germany, UK, and Spain were the most productive information engineering countries from 2013 to 2017, with the number of papers from China increasing significantly, those from the USA increasing a little, and those from the other countries increasing marginally.

Journal development trends

To extract the development trends for the information engineering trends, Table 9.24 shows the differences in the impact factors, five-year impact factors, immediacy indexes, the eigenfactor scores, and the article influence scores.

As can be seen in Table 9.24, most information engineering-related journals had a downward trend for journal quality. The average IFminusIF5 was -0.2300, indicating that the impact factor was lower than the five-year impact factor, which was primarily because the cited frequency in the two most recent years was lower than in the first three years. Overall, therefore, most information engineering journals including the leading journals: *IEEE Transactions on Fuzzy Systems*, *Information Sciences*, and *Information Fusion*; showed a downward trend.

The global influence of the information engineering journals will continue to rise, however, in the future. The differences between the impact factors and immediacy indexes indicated the development distance in the past two years and the current year. The impact factors for all journals were larger than their immediacy indexes, and the average difference was 1.7367. The difference between the impact factor and eigenfactor score showed the journals' self-citation situations. When the difference is larger, it indicates that the journal had a higher self-citation degree. For the information engineering journals, the average difference was 2.2703, and *IEEE Transactions on Fuzzy Systems* had the highest values.

Table 9.24: “Information engineering” journals

Full Journal Title	ISSN	JCR Data			Eigenfactor Metrics		IFminusIF5	IFminusE	IFminusII	IF5minusA
		Impact Factor	Five-year Impact Factor	Immediacy Index	Eigenfactor Score	Article Influence Score				
IEEE Transactions on Fuzzy Systems	1063-6706	8.415	9.34	2.273	0.02128	2.432	-0.925	8.39372	6.142	5.983
Information Sciences	0020-0255	4.305	4.378	1.377	0.4814	1.06	-0.073	3.8236	2.928	3.245
Information Fusion	1566-2535	6.639	6.574	3.571	0.00613	1.53	0.065	6.63287	3.068	5.109
IEEE Transactions on Information Forensics and Security	1556-6013	5.823	5.517	1.466	0.01991	1.565	0.306	5.80309	4.357	4.258
Information Systems Research	1047-7047	2.301	5.153	0.217	0.00846	2.241	-2.852	2.29254	2.084	0.06
Information Systems Journal	1650-1917	4.267	4.482	1.4	0.00164	1.063	-0.215	4.26536	2.867	3.204
International Journal of Information Management	0268-4012	4.516	4.81	0.663	0.0041	0.717	-0.294	4.5119	3.853	3.799
Journal of Information Technology	0268-3962	4.535	3.745	0.429	0.0015	1.069	0.79	4.5335	4.106	3.466
European Journal of Information Systems	0960-085X	3.197	4.236	0.656	0.00279	1.139	-1.039	3.19421	2.541	2.058
Journal of Management Information Systems	0742-1222	2.744	4.262	0.256	0.00366	1.265	-1.518	2.74034	2.488	1.479
Journal of the Association for Information Systems	1536-9323	2.839	3.717	0.321	0.0023	1.101	-0.878	2.8367	2.518	1.738
Journal of Informetrics	1751-1577	3.484	3.238	0.869	0.00452	0.804	0.246	3.47948	2.615	2.68
Business & Information Systems Engineering	1867-0202	2.596	3.586	0.478	0.00116	0.731	-0.99	2.59484	2.118	1.865
Information Processing & Management	0306-4573	3.444	2.641	0.737	0.00306	0.624	0.803	3.44094	2.707	2.82
Journal of the Association for Information Science and Technology	2330-1635	2.835	2.931	0.757	0.00602	0.739	-0.096	2.82898	2.078	2.096
International Journal of Computer-Supported Collaborative Learning	1556-1607	3.273	2.903	0.647	0.00068	0.536	0.37	3.27232	2.626	2.737
Information and Software Technology	0950-5849	2.627	2.768	0.562	0.00547	0.683	-0.141	2.62153	2.065	1.944
International Journal of Geographical Information Science	1365-8816	2.37	2.866	0.93	0.00498	0.613	-0.496	2.36502	1.44	1.757
Information Systems	0306-4379	2.551	2.439	0.436	0.00313	0.613	0.112	2.54787	2.115	1.938
Cartography and Geographic Information Science	1523-0406	1.785	2.705	0.795	0.00134	0.654	-0.92	1.78366	0.99	1.131
Knowledge and Information Systems	0219-1377	2.247	1.996	0.368	0.00508	0.669	0.251	2.24192	1.879	1.578
Information Society	0197-2243	1.889	2.321	0.304	0.00107	0.698	-0.432	1.88793	1.585	1.191
Journal of Information Science	0165-5515	1.939	2.075	0.528	0.0017	0.442	-0.136	1.9373	1.411	1.497
MIS Quarterly Executive	1540-1960	1.862	1.987	0.375	0.00055	0.519	-0.125	1.86145	1.487	1.343
Online Information Review	1468-4527	1.675	2.05	0.127	0.0013	0.36	-0.375	1.6737	1.548	1.315
International Journal of Information Security	1615-5262	1.658	1.683	0.297	0.00095	0.428	-0.025	1.65705	1.361	1.23
International Journal of Information Technology & Decision Making	0219-6220	1.755	1.67	0.4	0.0011	0.304	0.085	1.7539	1.355	1.451
Information Technology & Management	1385-951X	1.635	1.805	0.6	0.00051	0.29	-0.17	1.63449	1.035	1.345
Aslib Journal of Information Management	2050-3806	1.461	1.591	0.386	0.00057	0.38	-0.13	1.46043	1.075	1.081
Journal of Computer Information Systems	0887-4417	1.557	1.665	0.225	0.00071	0.286	-0.108	1.55629	1.332	1.271
International Journal on Semantic Web and Information Systems	1552-6283	0.793	1.595	0.355	0.00059	0.584	-0.802	0.79241	0.438	0.209
Journal of Computing and Information Science in Engineering	1530-9827	1.588	1.49	0.145	0.00072	0.257	0.098	1.58728	1.443	1.331
Information and Computation	0890-5401	1.077	1.091	0.162	0.00297	0.636	-0.014	1.07403	0.915	0.441
Journal of Intelligent Information Systems	0925-9902	1.107	1.477	0.152	0.00152	0.463	-0.37	1.10548	0.955	0.644
Information Technology for Development	0268-1102	1.387	1.554	0.313	0.00039	0.222	-0.167	1.38661	1.074	1.165
Information Systems and E-Business Manage	1617-9846	1.032	1.316	0.188	0.00046	0.251	-0.284	1.03154	0.844	0.781
Journal of Aerospace Information Systems	1940-3151	1.095	0.889	0.114	0.00067	0.273	0.206	1.09433	0.981	0.822
Journal of Global Information Technology Management	1097-198X	1	1.05	0.071	0.00012	0.147	-0.05	0.99988	0.929	0.853
Frontiers of Information Technology & Electronic Engineering	2095-9184	0.91	0.91	0.344	0.00038	0.141	0	0.90962	0.566	0.769
Information Development	0266-6669	0.905	0.913	0.378	0.00042	0.121	-0.008	0.90458	0.527	0.784
Information Research-An International Electronic Journal	1368-1613	0.762	0.897	0.055	0.00072	0.151	-0.135	0.76128	0.707	0.611
Information Technology and Control	1392-124X	0.8	0.751	0.143	0.00031	0.116	0.049	0.79969	0.657	0.684
Data Base for Advances in Information Systems	0095-0033	0.4	0.803	0.333	0.00021	0.224	-0.403	0.39979	0.067	0.176
Journal of Global Information Management	1062-7375	0.613	0.667	0.24	0.0001	0.102	-0.054	0.6129	0.373	0.511
International Journal of Wavelets Multiresolution and Information Processing	0219-6913	0.54	0.548	0.06	0.00071	0.171	-0.008	0.53929	0.48	0.369
Computer Science and Information Systems	1820-0214	0.613	0.375	0.111	0.00069	0.146	0.238	0.61231	0.502	0.467
International Arab Journal of Information Technology	1683-3198	0.466	0.662	0.073	0.00034	0.056	-0.196	0.46566	0.393	0.41

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Chapter 10
Agricultural Engineering

This chapter used a series of scientific methods to thoroughly understand the world's agricultural engineering journals. First, based on a literature survey and data collection, the agricultural engineering description was determined. Then, to classify the impact of each journal, the journals were ranked according to the five-year impact factors, and statistical software employed to analyze and describe the relevant indicators. From the ranking report, the journals were divided into four zones based on impact. Finally, a statistical analysis of the agricultural engineering papers published in the past five years in major countries and regions of the world was conducted. The results of the comprehensive, systematic interpretation of the agricultural engineering journals identified possible research directions, thus providing researchers with a journal selection channel.

There were 21 agricultural engineering journals, which were divided into four zones to measure the journals' influence. An analysis of the impact factor changes in the most recent five years was conducted to indirectly reflect the journals' contributions. In the last part, correlation, principal component and comparison analyses were conducted to elucidate the features of the journals. In this chapter, MSE-related periodical reports for agricultural engineering are provided to assist readers formulate answers to basic agricultural engineering questions.

10.1 Category Description

Agricultural engineering is involved with cross-engineering technologies from several fields of practice and social science disciplines such as mechanical engineering, management science, economics, agronomy, and meteorology. Agricultural engineering in the 1960s encompassed five main branches: agricultural power and machinery; agricultural construction; farmland irrigation and drainage; soil and water conservation; and agricultural electrification. After the 1960s, it further diversified to include food engineering, rural energy projects, land use engineering, and agricultural production environmental engineering [1, 3].

Agricultural engineering involves many resources for agricultural engineering applications such as: machinery; equipment and building design; water and soil engineering; irrigation and drainage engineering; crop harvesting; processing and storage; animal production technology; housing and equipment; precision agriculture; post-harvest processing and technology; rural development; agricultural mechanization; and horticultural engineering. It also involves structural engineering, bio energy and water culture engineering [6, 9].

There are many associations and organizations dedicated to agricultural engineering, with many agricultural engineers working in academia or government agencies such as the U.S. Department of Agriculture or the National Agricultural Extension Service [4], as consultants in private engineering firms, as manufacturers of agricultural machinery, equipment, and processing technology, or in the structural development of livestock farming and storage crops [10]. Agricultural engineers work in production, sales, management, research and development, and applied science [7] and in the United Kingdom, the term “agricultural engineer” is also used to describe a person who repairs or modifies agricultural equipment [8]. The first agricultural engineering curriculum was established in 1903 at Iowa State University by Professor J. B. Davidson and has had a long evolution [2].

Agricultural engineering is based on soils, fertilizers, agrometeorology, breeding, and the agricultural economy, and therefore provides the various tools, facilities, and energy required for agricultural production using comprehensive engineering techniques to improve the employability of agricultural workers and improve living conditions through the development of the most suitable agricultural production environments. There are three

main characteristics for agricultural engineering [5]. First, due to new engineering technology developments, agricultural engineering is now widely used in automation and electronics for agricultural equipment automation technology, large greenhouse and farmland irrigation and drainage facilities, computer remote sensing technologies, systems engineering, business and agricultural production forecast management, pest prediction and prevention, and land use. Second, engineering science and biological science are closely integrated, and studies on the effect of self-propelling agricultural machinery on soil structure and crop growth have become increasingly important. Modern agricultural engineering encompasses engineering technologies, biology, and the law. Third, the wide application of various engineering technologies has promoted the comprehensive development of agricultural production. The production of plants and animals includes breeding, cultivation, harvesting, processing, storage, transportation, sales and management processes related to the construction, machinery, water conservation, electrical, electronic, chemical, and other scientific technological processes.

10.2 Ranking Report

There are many indexes used to evaluate journal quality, from which four typical indexes; the impact factor, the five-year impact factor, the eigenfactor score, and the article influence score were chosen. The impact factor proposed by Garfield in 1972 is an internationally accepted periodical evaluation index that measures the average citation frequency of articles published in the previous two years to assess the relative importance of different journals in the same field of study. The five-year impact factor measures the average citation frequency of articles published over the past five years to assess the relative importance of different journals. The eigenfactor score is the score related to the quoted quantity, excluding self-citation, and reflects the overall importance of the referencing journals. The article influence score is equal to the five-year impact factor except for self-citations and also reflects the overall importance of the journals. The eigenfactor score and the article influence score are considered more scientific measures because they both consider citation quality; however, this does not mean that the impact factor and five-year impact factors are of no value. A certain degree of self-

citation indicates that journals are focused on their specific scopes and have representative contributions. The impact factor and eigenfactor score are assessed in the previous two years' journals, while the five-year impact factor and the article impact score are assessed in the previous five years' journals, with the former indicating the current development and the latter indicating the long-term contribution of the journals.

As using only one index would lead to a one-sided evaluation, these four indexes were integrated to develop a new evaluation model, with the weights of each index being determined through expert scoring as follows; impact factor (0.3), the five-year impact factor (0.3), the eigenfactor score (0.2), and the article influence score (0.2). To resolve the problems with the different dimensions in these four indexes, the data were standardized before computing the comprehensive journal scores shown in Table 10.1.

Table 10.1: Comprehensive scores of "Agriculture engineering" journals

Rank	Full Journal Title	ISSN	JCR Data		Eigenfactor Metrics		Standardization				Comprehensive score
			Impact Factor	Five-Year Impact Factor	Eigenfactor Score	Article Influence Score	Z-Impact Factor	Z-5-Year Impact Factor	Z-Eigenfactor Score	Z-Article Influence Score	
1	Biomass & Bioenergy	0961-9534	3.358	4.232	0.02000	0.888	1.97149	2.15377	0.02000	3.80363	2.00230
2	Food Policy	0306-9192	3.111	4.091	0.00759	1.070	1.68323	2.01437	0.00759	0.98394	1.30759
3	Agricultural Systems	0308-521X	3.004	3.756	0.00644	0.872	1.55835	1.68318	0.00644	0.72264	1.11828
4	American Journal of Agricultural Economics	0002-9092	2.457	2.437	0.00612	0.971	0.91997	0.37917	0.00612	0.64993	0.52095
5	International Journal of Agricultural Sustainability	1473-5903	2.702	2.444	0.00096	0.600	1.20590	0.38609	0.00096	-0.52248	0.37329
6	Biosystems Engineering	1537-5110	2.132	2.325	0.00530	0.496	0.54068	0.26844	0.00530	0.46362	0.33652
7	Agricultural Economic	0169-5150	1.732	2.562	0.00386	0.813	0.07386	0.50275	0.00386	0.13644	0.20104
8	Journal of Agricultural Economics	0021-857X	2.000	2.526	0.00189	0.715	0.38663	0.46715	0.00189	-0.31117	0.19428
9	European Review of Agricultural Economics	0165-1587	1.667	2.241	0.00153	0.669	-0.00200	0.18539	0.00153	-0.39297	-0.02327
10	Journal of Irrigation and Drainage Engineering	0733-9437	1.616	1.714	0.00295	0.391	-0.06152	-0.33562	0.00295	-0.07033	-0.13262
11	Agricultural Engineering	0144-8609	1.490	2.111	0.00132	0.367	-0.20857	0.05687	0.00132	-0.44068	-0.13338
12	Applied Economic Perspectives and Policy	2040-5790	1.246	1.975	0.00184	0.848	-0.49333	-0.07758	0.00184	-0.32253	-0.23541
13	Australian Journal of Agricultural and Resource Economics	1364-985X	1.486	1.685	0.00103	0.446	-0.21324	-0.36429	0.00103	-0.50657	-0.27437
14	Journal of Agricultural Science	0021-8596	1.186	1.323	0.00211	0.354	-0.56335	-0.72218	0.00211	-0.26119	-0.43748
15	International Journal of Agricultural Biological Engineering	1934-6344	1.267	1.267	0.00112	0.220	-0.46882	-0.77754	0.00112	-0.48613	-0.47091
16	Journal of Agricultural and Resource Economics	0162-1912	1.094	1.402	0.00103	0.443	-0.67072	-0.64407	0.00103	-0.50657	-0.49555
17	Agribusiness	0742-4477	1.147	1.206	0.00065	0.288	-0.60887	-0.83785	0.00065	-0.59291	-0.55247
18	Agricultural and Food Science	1459-6067	0.580	1.494	0.00071	0.335	-1.27059	-0.55312	0.00071	-0.57928	-0.66283
19	China Agricultural Economic Review	1756-137X	0.718	0.876	0.00035	0.146	-1.10954	-1.16410	0.00035	-0.66108	-0.81424
20	International Food and Agribusiness Management Review	1559-2448	0.545	0.789	0.00061	0.147	-1.31144	-1.25011	0.00061	-0.60200	-0.88874
21	Applied Engineering in Agriculture	0883-8542	0.505	0.667	0.00104	0.164	-1.35812	-1.37072	0.00104	-0.50430	-0.91930

The 21 journals in the agricultural engineering category were divided into four zones based on their comprehensive scores. Journals with comprehensive scores in top 5% were allocated to Zone A zone, journals with comprehensive scores from 6% to 20% were allocated to Zone B, journals with comprehensive scores from 20% to 50% were allocated to Zone C and the remaining 50% were allocated to Zone D.

Table 10.2 shows that only one journal, Biosystems Engineering, was allocated to Zone A. Biosystems Engineering publishes research in engineering and the physical sciences that represent advances in understanding in

the modeling of the performance for biological systems for sustainable land use development, the environment, agriculture and amenities, bioproduction processes, and the food chain.

Table 10.2: Agricultural engineering journals in Zone A

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year Impact Factor	Immediacy Index	Articles	Cited Half-life	Eigenfactor Score	Article Influence Score
1	Biomass & Bioenergy	0961-9534	19706	3.358	4.232	0.574	97.13	6.6	0.02	0.888

Table 10.3 shows there were three journals in Zone B, with five-year impact factors ranging from 2.437 to 4.091. *Food Policy* is a multidisciplinary journal that publishes original research and new evidence on the formulation, implementation, and evaluation of policies for the food sector in developing, transitioning and advanced economies. *Agricultural Systems* is an international journal that deals with interactions between agricultural system components, hierarchical agricultural system levels, agriculture and other land use systems, and agricultural systems and their natural, social and economic environments. *The American Journal of Agricultural Economics* provides a forum for creative and scholarly work on the economics of agriculture and food, natural resources and the environment, and rural and community development throughout the world. *The Journal of Agricultural Economics* is a leading international professional journal that provides a forum for research into agricultural economics and related disciplines such as statistics, marketing, business management, politics, history and sociology, and their application in the agricultural, food and related industries, and rural communities and the environment. *Agricultural Economics* is the journal of the International Association of Agricultural Economists and disseminates some of the most important research results and policy analyses from around the world covering the economics of agriculture in its broadest sense, from food consumption and nutrition to land use and the environment at every analysis scale from households to markets and the macro-economy.

Table 10.4 shows the five journals in Zone C, which had five-year impact factors ranging from 2.241 to 2.444. The *International Journal of Agricultural Sustainability*, which had a five-year impact factor of 2.444, is a cross-disciplinary, peer-reviewed journal dedicated to advancing the understanding of agricultural and food system sustainability. The *International Journal of Agricultural Sustainability* publishes both theoretical developments and

Table 10.3: Agricultural engineering journals in Zone B

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year Impact Factor	Immediacy Index	Articles	Cited Half-life	Eigenfactor Score	Article Influence Score
1	Food Policy	0306-9192	5016	3.111	4.091	0.962	99.05	6.5	0.00759	1.07
2	Agricultural Systems	0308-521X	5624	3.004	3.756	0.944	97.53	8.5	0.00644	0.872
3	American Journal of Agricultural Economics	0002-9092	7088	2.457	2.437	0.38	100	>10.0	0.00612	0.971

critical appraisals of new evidence on what is unsustainable about current or past agricultural and food systems, as well as on transitions towards agricultural and rural sustainability at farm, community, regional, national and international levels through food supply chains. The *International Journal of Agricultural Sustainability* increases knowledge on which technologies and processes are contributing to agricultural sustainability, the policies, institutions and economic structures that are preventing or promoting sustainability, and the relevant lessons to be learned.

Table 10.4: Agricultural engineering journals in Zone C

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year Impact Factor	Immediacy Index	Articles	Cited Half-life	Eigenfactor Score	Article Influence Score
1	International Journal of Agricultural Sustainability	1473-5903	813	2.702	2.444	0.396	100	6.5	0.00096	0.6
2	Biosystems Engineering	1537-5110	5044	2.132	2.325	0.521	97.6	7.9	0.0053	0.496
3	Agricultural Economic	0169-5150	3036	1.732	2.562	0.282	100	9.4	0.00386	0.813
4	Journal of Agricultural Economics	0021-857X	1717	2.000	2.526	0.581	100	9.4	0.00189	0.715
5	European Review of Agricultural Economics	0165-1587	1290	1.667	2.241	0.323	100	9.8	0.00153	0.669
6	Journal of Irrigation and Drainage Engineering	0733-9437	3486	1.616	1.714	0.246	100	>10.0	0.00295	0.391

Table 10.4 shows the eleven journals in Zone D, which had five-year impact factors ranging from 0.667 to 1.714. With a five-year impact factor of 1.714, the *Journal of Irrigation and Drainage Engineering* covers all phases of irrigation, drainage, engineering hydrology, and related water management subjects, such as watershed management, weather modification, water quality, groundwater, and surface water. The journal emphasizes new developments and provides case studies and practical applications for agricultural engineering. *Applied Economic Perspectives and Policy* provides a forum for contemporary and emerging policy issues within an economic framework that informs the decision-making and policy-making communities. With a five-year impact factor of 1.685, the *Australian Journal of Agricultural and Resource Economics (AJARE)* provides a forum for innovative and scholarly work on agricultural and resource economics. First published in 1997, the journal succeeded the *Australian Journal of Agricultural E-*

conomics and the *Review of Marketing and Agricultural Economics*, and upholds the tradition of these long-established journals.

Table 10.5: Agricultural engineering journals in Zone D

Rank	Full Journal Title	ISSN	JCR Data						Eigenfactor Metrics	
			Total Cites	Impact Factor	Five-Year Impact Factor	Immediacy Index	Articles	Cited Half-life	Eigenfactor Score	Article Influence Score
1	Canadian Journal of Agricultural Economics - Revue Canadienned Economie Rurale	0008-3976	509	1.291	1.113	0.5	100.000	8.2	0.001050	0.492
2	Agribusiness	0742-4477	514	0.738	0.949	0.121	96.970	9.3	0.000770	0.326
3	Journal of the Korean Society for Applied Biological Chemistry	1738-2203	607	0.655	0.694	0.138	94.830	4.4	0.001440	0.148
4	China Agricultural Economic Review	1756-137X	120	0.609	0.574	0.263	100.000	3.5	0.000340	0.137
5	Journal of Agricultural and Resource Economics	1068-5502	632	0.523	0.868	0.083	100.000	>10.0	0.000820	0.376
6	International Food and Agribusiness Management Review	1559-2448	356	0.435	0.647	0.111	100.000	6.3	0.000510	0.132
7	Applied Engineering in Agriculture	0883-8542	1384	0.429	0.619	0.063	100.000	9.8	0.001430	0.178

10.3 Statistical Analysis

In this section, a statistical analysis of the journal index is conducted using SPSS 21.0, a software package for logical batched and non-batched statistical analysis. The current version (2015) is officially called IBM SPSS Statistics. In the following, a total analysis and an analysis by zone are given.

Total analysis

Table 10.2 gives the impact factors for the 21 SCI agricultural engineering journals from 2013 and 2017. Three journals had impact factors and five-year impact factors greater than 3; 14 had impact factors between 1 and 2; and 13 had five-year impact factors between 1 and 2. Four journals had impact factors less than 1 and five journals had five-year impact factors less than 1. The immediacy index range was 0.88, the minimum was 0.08700, the maximum was 0.96200, the mean was 0.37148, and the standard deviation was 0.23837.

The articles in citable item range was 9.00, the minimum and maximum were 91.00000 and 100.00000, the average value was 98.66667, and the standard deviation was 2.19848. The cited half-life range was 6.70, the minimum and maximum were 3.30000 and 10.00000, the mean was 8.06190, and the standard deviation was 2.03948. The article influence score range

was 1.549, the minimum and maximum were 0.037 and 1.586, the mean was 0.497, and the standard deviation was 0.327. The average eigenfactor score was 0.00326, the minimum was 0.00037, and the maximum was 0.02000. The article influence range was 1.549, the mean was 0.00326, and the standard deviation was 0.00440. The article influence score range was 0.92, the minimum and maximum were 0.14600 and 1.07000, the average was 0.53538, and the standard deviation was 0.29015.

Table 10.6: Descriptive analysis of agricultural engineering journals

	N	Range	Minimum	Maximum	Sum	Mean		Std. Deviation	Skewness	
						Statistic	Std. Error		Statistic	Std. Error
Impact Factor	21	2.85	0.50500	3.35800	35.04300	1.66871	0.18698	0.85686	0.54371	0.50119
Five-Year Impact Factor	21	3.57	0.66700	4.23200	43.12300	2.05348	0.22073	1.01149	0.84197	0.50119
Immediacy Index	21	0.88	0.08700	0.96200	7.80100	0.37148	0.05202	0.23837	1.35966	0.50119
Articles in citable item	21	9.00	91.00000	100.00000	2072.00000	98.66667	0.47975	2.19848	-2.36923	0.50119
Cited Half-life	21	6.70	3.30000	10.00000	169.30000	8.06190	0.44505	2.03948	-0.88506	0.50119
Eigenfactor Score	21	0.02	0.00035	0.02000	0.06845	0.00326	0.00096	0.00440	3.03685	0.50119
Article Influence Score	21	0.92	0.14600	1.07000	11.24300	0.53538	0.06332	0.29015	0.31481	0.50119
Comprehensive Score	21	2.92	-0.91930	2.00230	0.01369	0.00065	0.16504	0.75629	1.15738	0.50119

Table 10.7: Extreme values for the total cites

			Case Number	Journal Title	Value
Total Cites	Highest	1	1	Biomass & Bioenergy	19706
		2	4	American Journal of Agricultural Economics	7088
		3	3	Agricultural Systems	5624
		4	6	Biosystems Engineering	5044
		5	2	Food Policy	5016
	Lowest	1	19	China Agricultural Economic Review	244
		2	12	Applied Economic Perspectives and Policy	540
		3	18	Agricultural and Food Science	550
		4	20	International Food and Agribusiness Management Review	592
		5	17	Agribusiness	635

Table 10.7 shows the extreme values for total cites. The journals with the five highest total cites were *Biomass & Bioenergy* with total cites of 19,706, the *American Journal of Agricultural Economics* with total cites of 7088, *Agricultural Systems* with total cites of 5624, *Biosystems Engineering*, with total cites of 5044, and Food Policy, with total cites of 5016. The journals with the lowest total cites were the *China Agricultural Economic Review*, *Applied Economic Perspectives and Policy*, *Agricultural and Food Science*, *International Food and Agribusiness Management Review*, and *Agribusiness*.

Table 10.8: Extreme values for the impact factor

			Case Number	Journal Title	Value
Impact Factor	Highest	1	1	Biomass & Bioenergy	3.358
		2	2	Food Policy	3.111
		3	3	Agricultural Systems	3.004
		4	5	International Journal of Agricultural Sustainability	2.702
		5	4	American Journal of Agricultural Economics	2.457
	Lowest	1	21	Applied Engineering in Agriculture	.505
		2	20	International Food and Agribusiness Management Review	.545
		3	18	Agricultural and Food Science	.580
		4	19	China Agricultural Economic Review	.718
		5	16	Journal of Agricultural and Resource Economics	1.094

Table 10.8 shows the extreme values of the impact factor. The top five values of agricultural engineering-related journals are provided by *Biomass & Bioenergy*, *Food Policy*, *Agricultural Systems*, *International Journal of Agricultural Sustainability*, and *American Journal of Agricultural Economics*, and the lowest five values are provided by *Applied Engineering in Agriculture*, *International Food and Agribusiness Management Review*, *Agricultural and Food Science*, *China Agricultural Economic Review*, and *Journal of Agricultural and Resource Economics*.

Table 10.8 shows the extreme values for the impact factor. The journals with the highest impact factors were *Biomass & Bioenergy*, *Food Policy*, *Agricultural Systems*, the *International Journal of Agricultural Sustainability*, and the *American Journal of Agricultural Economics*, and the journals with the lowest impact factors were *Applied Engineering in Agriculture*, the *International Food and Agribusiness Management Review*, *Agricultural and Food Science*, the *China Agricultural Economic Review*, and the *Journal of Agricultural and Resource Economics*.

Table 10.9: Extreme values for the five-year impact factor

			Case Number	Journal Title	Value
Five-Year Impact Factor	Highest	1	1	Biomass & Bioenergy	4.232
		2	2	Food Policy	4.091
		3	3	Agricultural Systems	3.756
		4	7	Agricultural Economic	2.562
		5	8	Journal of Agricultural Economics	2.526
	Lowest	1	21	Applied Engineering in Agriculture	0.667
		2	20	International Food and Agribusiness Management Review	0.789
		3	19	China Agricultural Economic Review	0.876
		4	17	Agribusiness	1.206
		5	15	International Journal of Agricultural Biological Engineering	1.267

Table 10.9 shows the extreme values for the five-year impact factor. The journals with the five highest five-year impact factors were *Biomass & Bioenergy*, *Food Policy*, *Agricultural Systems*, *Agricultural Economics*, and the *Journal of Agricultural Economics*. The journals with the five lowest five-year impact factors were *Applied Engineering in Agriculture*, the *International Food and Agribusiness Management Review*, the *China Agricultural Economic Review*, *Agribusiness*, and the *International Journal of Agricultural Biological Engineering*.

Table 10.10: Extreme value for the immediacy index

			Case Number	Journal Title	Value
Immediacy Index	Highest	1	2	Food Policy	0.962
		2	3	Agricultural Systems	0.944
		3	8	Journal of Agricultural Economics	0.581
		4	1	Biomass & Bioenergy	0.574
		5	6	Biosystems Engineering	0.521
	Lowest	1	18	Agricultural and Food Science	0.087
		2	21	Applied Engineering in Agriculture	0.096
		3	16	Journal of Agricultural and Resource Economics	0.130
		4	17	Agribusiness	0.154
		5	13	Australian Journal of Agricultural and Resource Economics	0.167

Table 10.10 highest and lowest immediacy indexes. The journals with the five highest immediacy indexes were *Food Policy* with an immediacy index of 0.962, *Agricultural Systems*, with 0.944, the *Journal of Agricultural Economics*, with 0.581, *Biomass & Bioenergy* with 0.574, and, *Biosystems Engineering* with 0.521. The journals with the five lowest immediacy indexes were *Agricultural and Food Science*, *Applied Engineering in Agriculture*, the *Journal of Agricultural and Resource Economics*, *Agribusiness* and the *Australian Journal of Agricultural and Resource Economics*.

Table 10.11 shows the extreme values for the articles in citable item. The journals with the five highest articles in citable item were the *American Journal of Agricultural Economics*, the *International Journal of Agricultural Sustainability*, *Agricultural Economics*, the *Journal of Agricultural Economics*, and the *European Review of Agricultural Economics*. The journals with the five lowest articles in citable item were the *International Food and Agribusiness Management Review*, *Aquacultural Engineering*, the *Journal of Agricultural Science*, the *Australian Journal of Agricultural and Resource Economics*, and *Biomass & Bioenergy.*

Table 10.11: Extreme value of articles in citable item

			Case Number	Journal Title	Value
Articles in citable item	Highest	1	4	American Journal of Agricultural Economics	100.00
		2	5	International Journal of Agricultural Sustainability	100.00
		3	7	Agricultural Economic	100.00
		4	8	Journal of Agricultural Economics	100.00
		5	9	European Review of Agricultural Economics	100.00a
	Lowest	1	20	International Food and Agribusiness Management Review	91.00
		2	11	Aquacultural Engineering	96.00
		3	14	Journal of Agricultural Science	97.00
		4	13	Australian Journal of Agricultural and Resource Economics	97.00
		5	1	Biomass & Bioenergy	97.00

Table 10.12: Extreme value of cited half-life

			Case Number	Journal Title	Value
Cited Half-life	Highest	1	4	American Journal of Agricultural Economics	10.00
		2	10	Journal of Irrigation and Drainage Engineering	10.00
		3	11	Aquacultural Engineering	10.00
		4	14	Journal of Agricultural Science	10.00
		5	16	Journal of Agricultural and Resource Economics	10.00
	Lowest	1	15	International Journal of Agricultural Biological Engineering	3.30
		2	19	China Agricultural Economic Review	4.50
		3	12	Applied Economic Perspectives and Policy	5.20
		4	5	International Journal of Agricultural Sustainability	6.50
		5	2	Food Policy	6.50

Table 10.12 shows the extreme values for the cited half-life. The journals with the five highest cited half-life were the *American Journal of Agricultural Economics*, the *Journal of Irrigation and Drainage Engineering*, *Agricultural Engineering*, the *Journal of Agricultural Science*, and the *Journal of Agricultural and Resource Economics*, all of which had a cited half-life of 10.00. The journals with the five lowest cited half-life were the *International Journal of Agricultural Biological Engineering* with a cited half-life of 3.30, the *China Agricultural Economic Review* with 4.50, *Applied Economic Perspectives and Policy* with 5.20, *International Journal of Agricultural Sustainability* with 6.50, and *Food Policy* with 6.50.

Table 10.13 shows the extreme values for the eigenfactor score. The journals with the five highest eigenfactor scores were *Biomass & Bioenergy* with an eigenfactor score of 0.020000, *Food Policy* with 0.007590, *Agricultural Systems* with 0.006440, *American Journal of Agricultural Economics* with 0.006120, and *Biosystems Engineering* with 0.005300. The journals with the five lowest eigenfactor scores were the *China Agricultural Economic Review*, the *International Food and Agribusiness Management Review*, *A-*

Table 10.13: Extreme values for the eigenfactor score

			Case Number	Journal Title	Value
Eigenfactor Score	Highest	1	1	Biomass & Bioenergy	0.020000
		2	2	Food Policy	0.007590
		3	3	Agricultural Systems	0.006440
		4	4	American Journal of Agricultural Economics	0.006120
		5	6	Biosystems Engineering	0.005300
	Lowest	1	19	China Agricultural Economic Review	0.000350
		2	20	International Food and Agribusiness Management Review	0.000610
		3	17	Agribusiness	0.000650
		4	18	Agricultural and Food Science	0.000710
		5	5	International Journal of Agricultural Sustainability	0.000960

gribusiness, *Agricultural and Food Science*, and the *International Journal of Agricultural Sustainability*.

Table 10.14: Extreme value for the article influence score

			Case Number	Journal Title	Value
Article Influence Score	Highest	1	2	Food Policy	1.070
		2	4	American Journal of Agricultural Economics	0.971
		3	1	Biomass & Bioenergy	0.888
		4	3	Agricultural Systems	0.872
		5	12	Applied Economic Perspectives and Policy	0.848
	Lowest	1	19	China Agricultural Economic Review	0.146
		2	20	International Food and Agribusiness Management Review	0.147
		3	21	Applied Engineering in Agriculture	0.164
		4	15	International Journal of Agricultural Biological Engineering	0.220
		5	17	Agribusiness	0.288

Table 10.14 shows the extreme values for the article influence score. The journals with the five highest article influence scores were *Food Policy* with an article influence score of 1.070, the *American Journal of Agricultural Economics* with 0.971, *Biomass & Bioenergy* with 0.888, *Agricultural Systems* with 0.872, and the *Applied Economic Perspectives and Policy* with 0.848. The journals with the five lowest article influence scores were the *China Agricultural Economic Review*, the *International Food and Agribusiness Management Review*, *Applied Engineering in Agriculture*, the *International Journal of Agricultural Biological Engineering*, and *Agribusiness*.

Zone analysis

SPSS 21.0 software was employed for the statistical descriptive analysis of the agricultural engineering related journals in the different zones, some of the descriptive results for which are shown Tables 10.15-10.22, and the visual box diagrams for which are shown in Figures 10.1-10.8.

Table 10.15: 2017 total cites statistical results in each zone

Zone	Mean	N	Std. Deviation	Median	Sum	Minimum	Maximum	Range	Variance
A	19706.00	1		19706.00	19706	19706	19706	0.000	
B	5909.33	3	1065.062	5624.00	17728	5016	7088	2072	1134357.333
C	2380.00	5	1703.701	1717.00	11900	813	5044	4231	2902597.500
D	1371.25	12	1268.219	838.00	16455	244	4248	4004	1608379.114
Total	3132.81	21	4297.906	1590.00	65789	244	19706	19462	18471994.262

Table 10.15 shows that the range for total cites was 19,462, the minimum was 244, the maximum was 19,706, the mean was 3132.81, and the standard deviation was 4297.906. There was only one journal in Zone A, which had 19,706 total cites. The Zone B total cites range was 2072, the minimum was 5016, the maximum was 7088, the mean was 5909.33, and the standard deviation was1065.062. The Zone C total cites range was 4231, the minimum was 813, the maximum was 5044, the mean was 2380.00, and the standard deviation was 1703.701. The Zone D total cites range was 4004, the minimum was 244, the maximum was 4004, the mean was 1371.25, and the standard deviation was 4297.906.

Table 10.16: 2017 impact factors statistical results in each zone

Zone	Mean	N	Std. Deviation	Median	Sum	Minimum	Maximum	Range	Variance
A	3.35800	1		3.35800	3.358	3.358	3.358	0.000	
B	2.85733	3	0.35080	3.00400	8.572	2.457	3.111	0.654	0.123
C	2.04660	5	0.41294	2.00000	10.233	1.667	2.702	1.035	0.171
D	1.07333	12	0.39266	1.16650	12.880	0.505	1.616	1.111	0.154
Total	1.66871	21	0.85686	1.49000	35.043	0.505	3.358	2.853	0.734

Table 10.16 shows that the total impact factor range was 2.853, the minimum was 0.505, the maximum was 3.358, the mean was 1.66871, and the standard deviation was 0.85686. There was only one journal in Zone A, which had an impact factor of 3.35800. The Zone B impact factor range was 0.654, the minimum was 2.457, the maximum was 3.111, the mean

was 2.85733, and the standard deviation was 0.35080. The Zone C impact factor range was1.035, the minimum was 1.667, the maximum was 2.702, the mean was 2.04660, and the standard deviation was 0.41294. The Zone D impact factor range was 1.111, the minimum was 0.505, the maximum was 1.616, the mean was 1.07333, and the standard deviation was 0.39266. Zone D had the largest impact factor range, followed by Zone C, Zone B, and Zone A. The median impact factor in each zone varied but the maximum was in Zone A and the minimum was in Zone D.

Table 10.17: 2017 five-year impact factor statistical results in each zone

Zone	Mean	N	Std. Deviation	Median	Sum	Minimum	Maximum	Range	Variance
A	4.23200	1		4.23200	4.232	4.232	4.232	0.000	
B	3.42800	3	0.87442	3.75600	10.284	2.437	4.091	1.654	0.765
C	2.41960	5	0.13513	2.44400	12.098	2.241	2.562	0.321	0.018
D	1.37575	12	0.45369	1.36250	16.509	0.667	2.111	1.444	0.206
Total	2.05348	21	1.01149	1.97500	43.123	0.667	4.232	3.565	1.023

Table 10.17 shows that the five-year impact range was 3.565, the minimum was 0.667, the maximum was 4.232, the mean was 2.05348, and the standard deviation was 1.01149. The five-year impact factor for the Zone A journals was 4.23200. The Zone B range was 1.654, the minimum was 2.437, the maximum was 4.091, the mean was 3.42800, and the standard deviation was 0.87442. The Zone C five-year impact factor range was 0.321, the minimum was 2.241, the maximum was2.562, the mean was 2.41960, and the standard deviation was 0.13513. The Zone D five-year impact factor range was 1.444, the minimum was 0.667, the maximum was 2.111, the mean was 1.37575, and the standard deviation was 0.45369.

Table 10.18: 2017 immediacy index statistical results in each zone

Zone	Mean	N	Std. Deviation	Median	Sum	Minimum	Maximum	Range	Variance
A	0.5740	1		0.57400	0.574	0.574	0.574	0.000	
B	0.7620	3	0.33094	0.94400	2.286	0.380	0.962	0.582	0.110
C	0.4206	5	0.12762	0.39600	2.103	0.282	0.581	0.299	0.016
D	0.2365	12	0.10574	0.26150	2.838	0.087	0.400	0.313	0.011
Total	0.3715	21	0.23837	0.32300	7.801	0.087	0.962	0.875	0.057

Table 10.18 shows that the total immediacy index range was 0.875, the minimum was 0.087, the maximum was 0.962, the mean was 0.37148, and the standard deviation was 0.23837. The Zone B immediacy index had the

largest range at 0.582, followed by Zone D (0.313), Zone C (0.2999) and Zone A (0.000). The median immediacy index varied across the zones; the maximum was in Zone B and the minimum was in Zone D.

Table 10.19: 2017 articles in citable item statistical results in each zone

Zone	Mean	N	Std. Deviation	Median	Sum	Minimum	Maximum	Range	Variance
A	97.0000	1		97.0000	97.00	97.00	97.00	0.00	
B	99.0000	3	1.00000	99.0000	297.00	98.00	100.00	2.00	1.000
C	99.6000	5	0.89443	100.0000	498.00	98.00	100.00	2.00	0.800
D	98.3333	12	2.74138	100.0000	1180.00	91.00	100.00	9.00	7.515
Total	98.6667	21	2.19848	100.0000	2072.00	91.00	100.00	9.00	4.833

Table 10.19 shows that the total citable item range was 9.00, the minimum was 91.00, the maximum was 100.00, the mean was 98.6667, the standard deviation was 2.19848. The Zone A citable item was 97.00 for all as there was only one journal. The citable item range in Zone B was 2.00, the minimum was 98.00, the maximum was 100.00, the mean was 99.00, and the standard deviation was 1.0000. The citable item range in Zone C was 2.00, the minimum was 98.00, the maximum was 100.00, the mean was 99.6000, and the standard deviation was 0.89443. The Zone D range was 9.00, the minimum was 91.00, the maximum was 100.00, the mean was 98.3333, and the standard deviation was 2.74138.

Table 10.20: Statistical results of 2017 cited half-life in each zone

Zone	Mean	N	Std. Deviation	Median	Sum	Minimum	Maximum	Range	Variance
A	6.6000	1		6.6000	6.60	6.60	6.60	0.00	
B	8.3333	3	1.75594	8.5000	25.00	6.50	10.00	3.50	3.083
C	8.6000	5	1.38022	9.4000	43.00	6.50	9.80	3.30	1.905
D	7.8917	12	2.43552	8.7000	94.70	3.30	10.00	6.70	5.932
Total	8.0619	21	2.03948	8.5000	169.30	3.30	10.00	6.70	4.159

Table 10.20 shows that the total cited half-life range was 6.70, the minimum was 3.30, the maximum was 10.00, the mean was 8.0619, and the standard deviation was 2.03948. The Zone C cited half-life had the largest range at 6.70, followed by Zone D, Zone B and Zone A. The median for the total cited half-life in each zone varied but the maximum was in Zone C and the minimum was in Zone A.

Table 10.21 shows that the total eigenfactor score range was 0.01965, the minimum was 0.00035, the maximum was 0.0200, the mean was 0.00326,

Table 10.21: 2017 eigenfactor score statistical results in each zone

Zone	Mean	N	Std. Deviation	Median	Sum	Minimum	Maximum	Range	Variance
A	0.02000	1		0.02000	0.02000	0.02000	0.02000	0.00000	
B	0.00670	3	0.00077307	0.00644	0.02015	0.00612	0.00759	0.00147	0.000
C	0.00271	5	0.00181369	0.00189	0.01354	0.00096	0.00530	0.00434	0.000
D	0.00123	12	0.00073897	0.00104	0.01476	0.00035	0.00295	0.00260	0.000
Total	0.00326	21	0.00440118	0.00153	0.06845	0.00035	0.02000	0.01965	0.000

and the standard deviation was 0.00440. The Zone A eigenfactor score was 0.020000. The eigenfactor score range in Zone B was 0.00147, the minimum was 0.00759, the maximum was 0.00612, the mean was 0.00672, and the standard deviation was 0.00078. The eigenfactor score range in Zone C was 0.00434, the minimum was 0.00096, the maximum was 0.0053, the mean was 0.00271, and the standard deviation was 0.00181. The eigenfactor score range in Zone D was 9.00, the minimum was 0.00035, the maximum was 0.00295, the mean was 0.00326, and the standard deviation was 0.00440.

Table 10.22: 2017 article influence score statistical results in each zone

Zone	Mean	N	Std. Deviation	Median	Sum	Minimum	Maximum	Range	Variance
A	0.88800	1		0.88800	0.888	0.888	0.888	0.000	
B	0.97100	3	0.09900	0.97100	2.913	0.872	1.070	0.198	0.010
C	0.65860	5	0.11937	0.66900	3.293	0.496	0.813	0.317	0.014
D	0.34575	12	0.19212	0.34450	4.149	0.146	0.848	0.702	0.037
Total	0.53538	21	0.29014	0.44600	11.243	0.146	1.070	0.924	0.084

Table 10.22 shows that the total article influence score range was 0.924, the minimum was 0.924, the maximum was 1.070, the mean was 0.535380, and the standard deviation was 0.29014. The article influence score range in Zone D was the largest at 0.702, followed by Zone C at 0.317, Zone B at 0.198 and Zone A. The median article influence score in each zone varied but the maximum was in Zone B and the minimum was in Zone D.

Fig. 10.1 indicates that Zone C had the largest citation times range, followed by Zone D, Zone B and Zone A. The median total cites in each zone varied but the maximum was in Zone A and the minimum was in Zone D, and there was one extreme value in D.

Fig. 10.2 shows that the impact factor median in each zone decreased in turn but the impact factor range in Zone D was much larger than in the other zones.

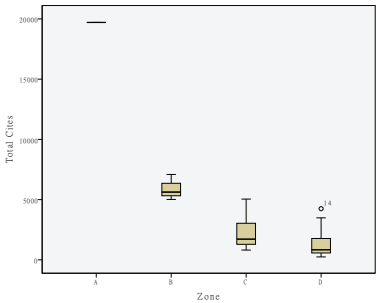

Fig. 10.1: Box diagram for total cites

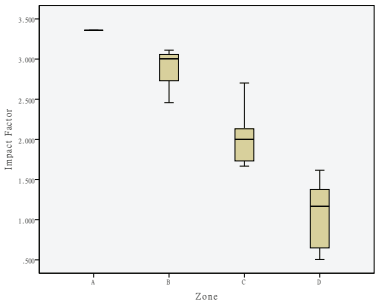

Fig. 10.2: Box diagram for impact factor

Fig. 10.3 shows that the five-year impact factor range differed across the zones, the mean in each zone decreased in turn, and five-year impact factor in Zone B had the largest range.

Fig. 10.4 shows the immediacy index for each zone, from which it can be seen that Zone B had the largest range and the largest mean.

Fig. 10.5 shows that the articles in citable item in all zones were between 96 and 100, and the Zone D articles in citable item had the largest range, followed by Zone B, Zone A, and Zone C.

Fig. 10.6 indicates that the Zone D cited half-life had the largest range, followed by Zone B, Zone C, and Zone A. The median cited half-life in each zone varied but the maximum was in Zone C and the minimum in Zone A.

Fig. 10.7 shows that the journal eigenfactor score range varied from zone to zone, with Zone C having the largest range followed by Zone D. Zone D journals had the highest concentration and Zone B had the lowest.

Fig. 10.8 shows that the article influence score in Zone D had the largest range, followed by Zone C, Zone B, and Zone A, and there were some extreme values in Zone D.

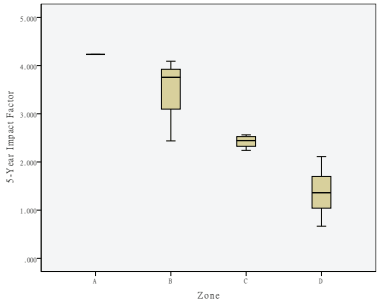

Fig. 10.3: Box diagram of total cites

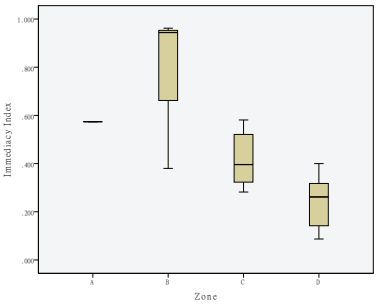

Fig. 10.4: Box diagram of immediacy factor

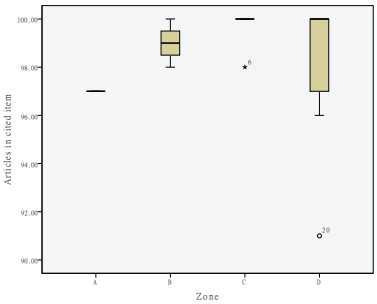

Fig. 10.5: Box diagram of articles in citable item

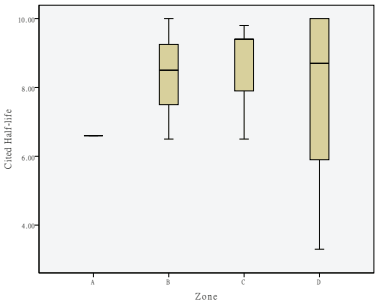

Fig. 10.6: Box diagram of cited half-life

10.4 Comprehensive Discussion

Impact factor changes

Fig. 10.9 shows the impact factor changes for the journal in Zone A from 2013 to 2017. The impact factor for the single journal, *Biomass & Bioenergy* varied from 3.22 and 3.41, with a somewhat downward trend from 2013 to 2016 and an upward trend from 2016 to 2017.

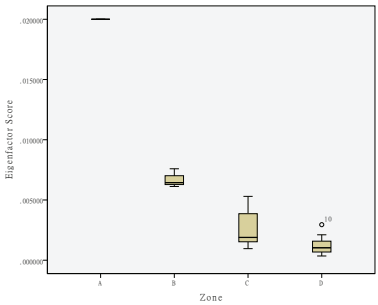

Fig. 10.7: Box diagram of eigenfactor score

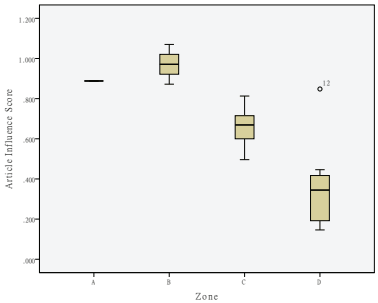

Fig. 10.8: Box diagram of article influence score

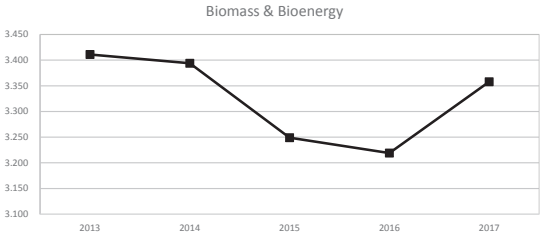

Fig. 10.9: Impact factor changes in Zone A from 2013 to 2017

Fig. 10.10 shows that the impact factors for the four journals in Zone B varied from 1.327 to 3.111. The impact factor for *Agricultural Systems and Food Policy* fluctuated over the five years, while the *American Journal of Agricultural Economics* and the *International Journal of Agricultural Sustainability* both had an upward trend.

Fig. 10.11 shows that the impact factor changes for the four journals in Zone C from 2013 to 2017 were between 0.974 and 2.044. Most journals had obvious upward fluctuating impact factors. *Biosystems Engineering* had higher impact factors that grew substantially, and the *European Review of Agricultural Economics* had the highest 2013 impact factor in Zone C at 1.467, but the lowest in 2017 at 1.667.

Fifty percent of the journals were allocated to Zone D, as shown in Fig. 10.12. The Zone D journal impact factors covered a larger range from 0.349

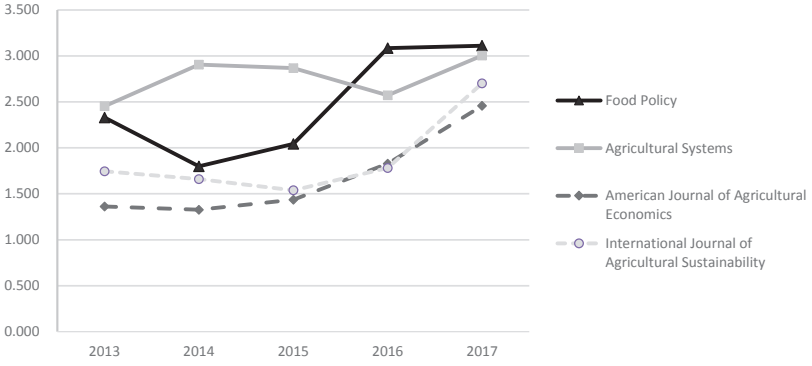

Fig. 10.10: Impact factor changes in Zone B from 2013 to 2017

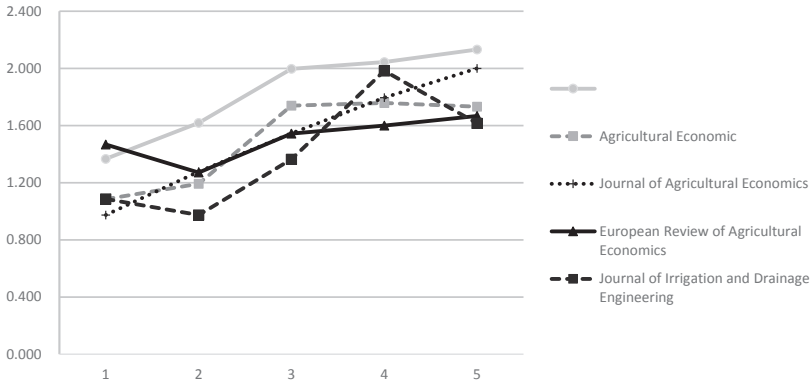

Fig. 10.11: Impact factor changes in Zone C from 2013 to 2017

2.891, with most journals having fluctuating impact factors over the five years. The impact factors of some Zone D journals fluctuated more noticeably without any regular pattern. The *Journal of Agricultural and Resource Economics* and *Agribusiness* had rising impact factors, and the impact factors for *Applied Engineering in Agriculture* and the *International Food and Agribusiness Management Review* were always lower than 0.600. Journals with lower impact factors and no upward trends could face a situation in

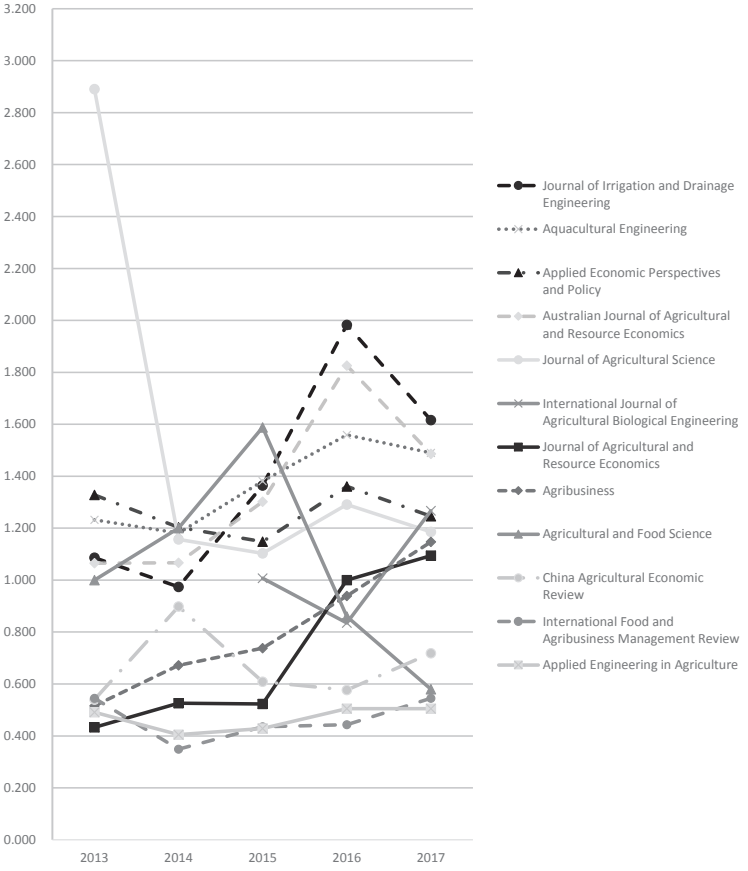

Fig. 10.12: Impact factor changes in Zone D from 2013 to 2017

which their papers will no longer be included in the Science Citation Index if no actions are taken to improve the publication quality. Many Zone D journals had undulating impact factors with no pattern.

Major countries

In this part, the statistical results of the major country contributors to the agricultural engineering SCI papers from 2013 to 2017 are analyzed and shown in Table 10.23.

Table 10.23: Agricultural engineering SCI papers published in major countries in 2013 to 2017

Country	2013		2014		2015		2016		2017	
	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage	Quantity	Percentage
USA	122	28.84 %	124	29.31 %	117	34.01 %	85	13.93 %	104	37.14 %
SPAIN	32	7.57 %	43	10.17 %	20	5.81 %	293	48.03 %	21	7.50 %
CHINA	97	22.93 %	86	20.33 %	79	22.97 %	63	10.33 %	49	17.50 %
INDIA	46	10.87 %	50	11.82 %	41	11.92 %	24	3.93 %	31	11.07 %
BRAZIL	15	3.55 %	20	4.73 %	14	4.07 %	53	8.69 %	10	3.57 %
GERMANY	19	4.49 %	19	4.49 %	16	4.65 %	24	3.93 %	15	5.36 %
ITALY	22	5.20 %	28	6.62 %	12	3.49 %	24	3.93 %	7	2.50 %
ENGLAND	25	5.91 %	21	4.96 %	15	4.36 %	16	2.62 %	13	4.64 %
CANADA	23	5.44 %	19	4.49 %	15	4.36 %	10	1.64 %	18	6.43 %
FRANCE	22	5.20 %	13	3.07 %	15	4.36 %	18	2.95 %	12	4.29 %

Agricultural engineering journals published 423 papers in 2017, of which 122 or 28.84% were by USA authors, ranking first in the world. Chinese authors contributed 97 papers or 22.93%, India contributed 46 or 10.87%, Spanish authors contributed 32 (7.57%), British authors contributed 25 (5.91%), Canadian authors contributed 23 (5.44%); Italian authors contributed 22 (5.20%), French authors contributed 22 (5.20%), German authors contributed 19 (4.49%), and Brazilian authors contributed 15 papers (3.55%).

From Fig. 10.13, it can be seen that the number of papers published in agricultural engineering journals increased from just under 300 in 2013 to just over 400 in 2017. However, in 2014, there was a large increase to over 600 papers. Over the five years, the USA and Spain contributed the most papers; the USA contributed a total of 522 articles or 26.54% and the Spanish contributed a total of 422, with 293 or 48.03% of these being published in 2014. China contributed between 22.97% and 10.33%, India contributed around 9%, Brazil's contribution rose from 3.57% in 2013 to 8.69% in 2016, Germany contributed between 3.93% and 4.65%, Italy contributed around 4.47%, with a higher proportion of 6.62% in 2014, UK contributed around 4%, with a higher proportion at 5.91% in 2013, Canada also contributed around 4% with a higher proportion at 6.43% in 2017, and France contributed from 2.95% to 5.20%.

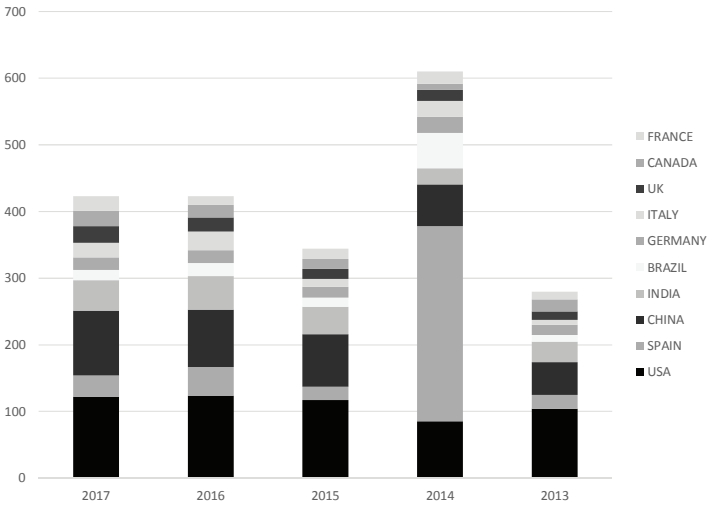

Fig. 10.13: Papers published in agricultural engineering journals from 2013-2017

Correlation analysis

To determine the journal influence relationships between the indicators, Pearson's correlation coefficient, which is widely used in the sciences, was applied, with the bivariate correlation analyses conducted using SPSS 21.0. In statistics, Pearson's correlation coefficient was developed by Karl Pearson, it is the covariance of two variables divided by the product of their standard deviations. The Pearson's correlation coefficient is a measure of the linear correlation between two variables X and Y, and has a value between +1 and -1, where 1 indicates a total positive linear correlation, 0 indicates no linear correlation, and -1 indicates a total negative linear correlation.

Fig. 10.14 shows that the impact factor variable and the five-year impact factor had a correlation coefficient of 0.939, indicating an extremely strong correlation, as all data points lie on a line and increase or decrease together. The total cites and the eigenfactor score had a correlation coefficient of

Correlations

		Total cites	Impact factor	Five-year impact factor	Immediacy index	Articles in citable item	Cited half-life	Eigenfactor score	Article influence score
Total cites	Pearson Correlation	1	.680**	.689**	.441*	-.144	.020	.979**	.512*
	Sig. (2-tailed)		.001	.001	.045	.533	.932	.000	.018
	N	21	21	21	21	21	21	21	21
Impact factor	Pearson Correlation	.680**	1	.939**	.783**	.083	-.015	.739**	.817**
	Sig. (2-tailed)	.001		.000	.000	.721	.948	.000	.000
	N	21	21	21	21	21	21	21	21
Five-year impact factor	Pearson Correlation	.689**	.939**	1	.806**	.061	-.012	.777**	.875**
	Sig. (2-tailed)	.001	.000		.000	.793	.958	.000	.000
	N	21	21	21	21	21	21	21	21
Immediacy index	Pearson Correlation	.441*	.783**	.806**	1	-.068	-.218	.536*	.661**
	Sig. (2-tailed)	.045	.000	.000		.769	.343	.012	.001
	N	21	21	21	21	21	21	21	21
Articles in citabel item	Pearson Correlation	-.144	.083	.061	-.068	1	.097	-.109	.244
	Sig. (2-tailed)	.533	.721	.793	.769		.675	.638	.287
	N	21	21	21	21	21	21	21	21
Cited half-life	Pearson Correlation	.020	-.015	-.012	-.218	.097	1	-.078	.077
	Sig. (2-tailed)	.932	.948	.958	.343	.675		.736	.741
	N	21	21	21	21	21	21	21	21
Eigenfactor score	Pearson Correlation	.979**	.739**	.777**	.536*	-.109	-.078	1	.601**
	Sig. (2-tailed)	.000	.000	.000	.012	.638	.736		.004
	N	21	21	21	21	21	21	21	21
Article influence score	Pearson Correlation	.512*	.817**	.875**	.661**	.244	.077	.601**	1
	Sig. (2-tailed)	.018	.000	.000	.001	.287	.741	.004	
	N	21	21	21	21	21	21	21	21

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Fig. 10.14: Pearson's correlation coefficients for the JCR Data and Eigenfactor Metrics

0.979, also indicating an extremely strong correlation. The Pearson's correlation coefficient for impact and total cites was 0.680, for total cites and article influence it was 0.512, for impact factor and immediacy index was 0.783, for impact factor and eigenfactor score was 0.739, for impact factor and article influence score 0.817, for five-year impact factor and the eigenfactor score 0.777, for five-year impact and article influence score 0.875, and for eigenfactor score and article influence score 0.601, all of which indicated strong to very strong correlations.

Principal Component Analysis of the Journal Evaluation Indicators

Correlation studies have shown that as there are high correlation coefficients between these indicators, it is redundant to use them all because of the exclusiveness principle. However, which indicators should be adopted to evaluate a journal and what attributes do these indicators depict? To answer these questions, after the correlation analyses, this paper conducted a principal component analysis in IBM SPSS Statistics with the FACTOR command (Analyze > Dimension Reduction > Factor) of the journal evaluation indicators for the 28 agricultural engineering journals. The objective of the factor analyses was to identify the independent latent variables; adherents of these methods believe that the information gained about these interde-

pendencies between the observed variables can be used to reduce the set of variables in a dataset. To track the information, the last five-year impact factors, the five-year impact factors, the immediacy indexes, and the article, cited half-life, eigenfactor, and article influence scores were considered concurrently.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.706
Bartlett's Test of Sphericity	Approx. Chi-Square	221.606
	df	66
	Sig.	.000

Fig. 10.15: KMO and Bartlett's test

Fig. 10.15 shows the overall KMO and Bartlett's Test table for the factor output, with the value of the KMO being 0.706. The significance probability for the Bartlett's Test, which is used to test if k samples are from populations with equal variances, was 0.000, indicating that these indicators were suitable for the principal component analyses. KMO values greater than 0.8 are considered good; that is, the component or factor analyses are useful for these variables.

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After the principal component extraction procedure, a rotated quartimax transformation was used as this has been shown to have the best performance in making component loadings incline to 1 or 0, and therefore can explain the factors' practical meanings. Quartimax rotation maximizes the variance of the squared factor loadings in each variable; that is, it simplifies the loading matrix rows. In other words, the quartimax minimizes the number of factors needed to explain each variable. In the quartimax rotation, there are often many variables in the first rotated factor; therefore, this

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.192	68.268	68.268	8.192	68.268	68.268
2	1.453	12.109	80.377	1.453	12.109	80.377
3	.954	7.949	88.326			
4	.731	6.089	94.415			
5	.268	2.232	96.647			
6	.173	1.439	98.087			
7	.141	1.176	99.263			
8	.046	.380	99.643			
9	.025	.209	99.852			
10	.014	.118	99.970			
11	.003	.025	99.995			
12	.001	.005	100.000			

Extraction Method: Principal Component Analysis.

Fig. 10.16: Total variance explained

method is not always helpful. The explained eigenvalue and total variance are shown in Fig. 10.16. Two components were extracted from all samples for the above variables.

As shown in the scree plot in Fig. 10.17, as the eigenvalues for the first two components were above 1, all were included. The eigenvalue for component 1 was 8.192, which dropped sharply to 1.453. From Fig. 10.17, both extracted components accounted for more than 68.268% of the total variance in the initial eigenvalues and the extraction sums of squared loadings, which was considered satisfactory. In this paper, two major components were chosen as the best explanations for the variability in the data for the agricultural engineering journals as together they explained 80.377% of the total variance.

As can be seen in Fig. 10.18, total cites, the five-year impact factor, the immediacy index, the eigenfactor score, and the article influence score were included in the first component, and articles and cited half-life were included in the second component. These are explained in more detail in the following.

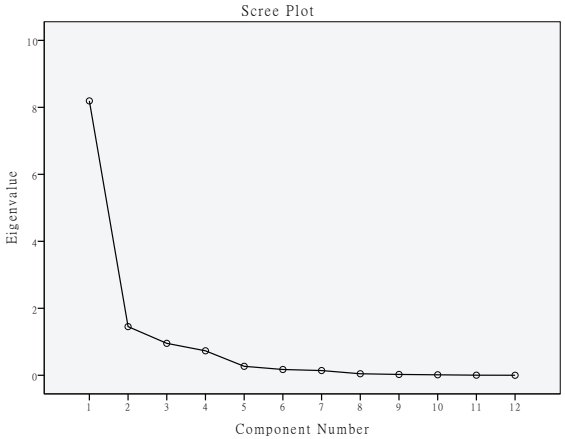

Fig. 10.17: Scree plot

Component Matrix[a]

	Component	
	1	2
Total cites	.838	-.379
Five year impact factor	.978	.152
Immediacy index	.753	.030
Articles in citable item	.029	.772
Cited half-life	.038	.613
Eigenfactor score	.879	-.341
Article influence score	.822	.375
2013 impact factor	.965	-.118
2014 impact factor	.944	-.088
2015 impact factor	.945	.056
2016 impact factor	.960	.124
2017 impact factor	.938	.127

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

Fig. 10.18: Quartimax rotated loading matrix for the “information engineering” category journal indicators

- The first component related to a journal's integrated influence because the indicators that made up the first component all measured aspects of the impact each year.
- The second component related to topic influence since the immediacy index and articles provided measures for the relationship between the articles published in the journals and current popular topics.

10.5 Total Summary

There were 21 journals focused on management science in agricultural engineering, with 1, 3, 6, and 10 being distributed in Zones A, B, C and D. Based on the journal ranking results in Section 10.2, the most important agricultural engineering journal was *Biomass & Bioenergy*, which had the highest comprehensive score and was therefore ranked in Zone A. The statistical analysis conducted in Section 10.3 found that *Food Policy*, *Agricultural Systems*, and the *American Journal of Agricultural Economics* had outstanding eigenfactor scores, immediacy indexes and five-year impact factor performances, which reflected these journals' influence in this category.

The comprehensive discussion in Section 10.4 indicates that the impact factor changes for the journal in Zone A had a downward trend, and the journals in Zones B, C, and D had upward trends, which indicated that the lead journal in Zone A had steady development and the journals in the other zones were increasing in average paper quality and journal influence. Based on the SCI focus on the management science in agricultural engineering papers published in the world, the USA, Spain, China, India and Brazil were the most productive countries from 2013 to 2017, with the number of papers from USA, China, and Canada slowly increasing each year.

Journal developing trends

To extract the agricultural engineering journal development trends, the impact factor, five-year impact factor, immediacy index, eigenfactor score, and article influence score differences were examined, as shown in Table 10.24.

Most agricultural engineering related journals showed a downward trend. Table 10.24 shows the differences between these four indexes for journal quality. The average of IFminusIF5 was -0.385, indicating that the impact factor was lower than the five-year impact factor, which was primarily because the cited frequency in the two most recent years was lower than that in the first three years. Overall, therefore, most agricultural engineering journals showed a downward trend. The difference between the impact factor and immediacy index showed the development distance of the past two years and the current year. The difference between the impact factor and the eigenfactor score showed the journals self-citation situation. When there is an obvious difference, it indicates that the journal has a higher self-citation degree. In the agricultural engineering category, the average for this difference was 1.665. Similarly, the difference between the five-year impact factor and the article influence score indicated a journal's self-citation degree in the most recent five-years. In this category, there was an average of 1.297 difference between the journals.

Table 10.24: "Agricultural engineering" Journals

Full Journals Title	ISSN	JCR Data			Eigenfactor metrics		IF minus IF5	IF minus E	IF minus II	IF minus A
		Impact Factor	Five-Year Impact Factor	Immediacy Index	Eigenfactor Score	Article Influence Score				
Biomass & Bioenergy	?0961-9534	3.358	4.232	0.574	0.02	0.888	-0.874	3.338	2.784	2.470
Food Policy	0306-9192	3.111	4.091	0.962	0.00759	1.07	-0.980	3.103	2.149	2.041
Agricultural Systems	0308-521X	3.004	3.756	0.944	0.00644	0.872	-0.752	2.998	2.060	2.132
American Journal of Agricultural Economics	0002-9092	2.457	2.437	0.38	0.00612	0.971	0.020	2.451	2.077	1.486
International Journal of Agricultural Sustainability	1473-5903	2.702	2.444	0.396	0.00096	0.6	0.258	2.701	2.306	2.102
Biosystems Engineering	1537-5110	2.132	2.325	0.521	0.0053	0.496	-0.193	2.127	1.611	1.636
Agricultural Economic	0169-5150	1.732	2.562	0.282	0.00386	0.813	-0.830	1.728	1.450	0.919
Journal of Agricultural Economics	?0021-857X	2.000	2.526	0.581	0.00189	0.715	-0.526	1.998	1.419	1.285
European Review of Agricultural Economics	0165-1587	1.667	2.241	0.323	0.00153	0.669	-0.574	1.665	1.344	0.998
Journal of Irrigation and Drainage Engineering	0733-9437	1.616	1.714	0.246	0.00295	0.391	-0.098	1.613	1.370	1.225
Aquacultural Engineering	?0144-8609	1.490	2.111	0.302	0.00132	0.367	-0.621	1.489	1.188	1.123
Applied Economic Perspectives and Policy	2040-5790	1.246	1.975	0.344	0.00184	0.848	-0.729	1.244	0.902	0.398
Australian Journal of Agricultural and Resource Economics	1364-985X	1.486	1.685	0.167	0.00103	0.446	-0.199	1.485	1.319	1.040
Journal of Agricultural Science	0021-8596	1.186	1.323	0.333	0.00211	0.354	-0.137	1.184	0.853	0.832
International Journal of Agricultural Biological Engineering	1934-6344	1.267	1.267	0.302	0.00112	0.22	0.000	1.266	0.965	1.047
Journal of Agricultural and Resource Economics	0162-1912	1.094	1.402	0.13	0.00103	0.443	-0.308	1.093	0.964	0.651
Agribusiness	0742-4477	1.147	1.206	0.154	0.00065	0.288	-0.059	1.146	0.993	0.859
Agricultural and Food Science	1459-6067	0.580	1.494	0.087	0.00071	0.335	-0.914	0.579	0.493	0.245
China Agricultural Economic Review	1756-137X	0.718	0.876	0.4	0.00035	0.146	-0.158	0.718	0.318	0.572
International Food and Agribusiness Management Review	1559-2448	0.545	0.789	0.277	0.00061	0.147	-0.244	0.544	0.268	0.398
Applied Engineering in Agriculture	?0883-8542	0.505	0.667	0.096	0.00104	0.164	-0.162	0.504	0.409	0.341

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Chapter 11
Future Trends

The unique footprint of management science in engineering (MSE) includes established excellence in diverse areas from civil engineering to engineering management, from industry engineering to information engineering, from energy engineering to environmental engineering, and from agricultural engineering to operations research. The goal of this journal report, therefore, was to elucidate the MSE research trends.

The MSE-2018 mission was recently established with the aim of developing a globally recognized journal ranking report for MSE that can identify emerging MSE disciplines that may have long-term academic impacts and reveal future trends. The MSE-2018 mission involved the support and participation of researchers, engineers, practitioners, and students as well as journals, publishers, universities, research institutes, and academic associations. We look forward to working with all of you to extract the best ideas as we venture into the future.

11.1 Future Emerging Categories

The MSE journal publication and citation data indicated that computer science, information engineering, and energy engineering are gaining greater attention and have a higher impact than the other fields. The statistical analyses in this journal report revealed three up-and-coming MSE journal cat-

egories: energy engineering, including energy efficiency, energy services, facility management, alternative energy technologies and so on; environmental engineering, such as waste water management, air pollution control, recycling, waste disposal, environmental sustainability, and public health; and information engineering, such as application technologies for research information systems and control systems.

Some civil engineering sub-categories are also developing rapidly, such as transportation engineering, in which frontier research is focused on connected and autonomous vehicles, data-driven transportation science, and sustainable transportation. To assist readers of this journal report identifying the most important research directions, a chapter is to be added in the subsequent version that will list and discuss the up-and-coming MSE journal categories. An index will also be developed to measure journal activity.

11.2 Future study

Fusion between existing categories. Another important MSE journal trend is the deepening fusion between relevant categories. With the development of big data technologies and information theories, the fusion between energy engineering and information engineering has triggered the development of a new discipline, the energy internet. Similarly, as a result of the integration of information engineering technologies such as GPS, multispectral/hyperspectral remote sensing (RS) and laser radar (LiDAR), high-efficiency resource environment dynamic monitoring technology systems and environmental engineering have been gaining increasing global attention. These similar fusions can be also found between civil engineering and information engineering in the development of smart cities, all of which may lead to changes in the scope of some traditional MSEM journals. To understand the development trends in the MSE disciplines, it is necessary to evaluate the fusion degree between the different categories. Therefore, an evaluation method is to be developed and reported on in a future version of the journal report to measure the fusion degree between categories.

Betweenness of the Journal Categories. The fusion between different journal categories has motivated quantitative research into fusion measurements, which could be helpful for journal selection. A typical measurement

for the betweenness of journal categories is the number of mutual authors. Some studies have found that two highly related journal categories tend to have a larger number of mutual authors than less related journal categories. We plan to investigate the number of mutual authors between each journal category and develop a trend index to evaluate the degree of fusion between different journal categories. A chapter will be developed to discuss these developments in the next journal report. The results could be helpful for researchers when making judgments about their future research directions and journal selections.