IIAI Open Conference Publication Series
IIAI Letters on Institutional Research
Vol. 005, LIR332
DOI: https://doi.org/10.52731/lir.v005.332

The Practical Application of Cluster Analysis of Academic Fields in Bibliometric Information to Enhance Research Performance Evaluation

Satoshi Ozeki *

Abstract

In recent years, the research capabilities of Japanese universities have declined compared to other countries, highlighting the need for effective evaluation of research performance. Due to the diversity of academic disciplines and the rise of interdisciplinary research, identifying comparable researchers presents a challenge. Therefore, this paper presents a method for identifying comparable researchers by classifying research fields through the application of bibliometrics. Specifically, using the Scopus database, this study conducted cluster analysis on the research topic profiles of researchers from multiple universities within the same field to group them. Additionally, this paper demonstrates how the results of cluster analysis can be applied to enhance the evaluation of research performance.
Keywords: research evaluation, bibliometrics, Scopus, cluster analysis

1 Introduction

1.1 Faculty Evaluation in Japanese Higher Education

The faculty evaluation system in Japan was introduced in conjunction with the incorporation of national universities in 2004. The system aims to improve the educational and research activities of faculty members and has expanded beyond national universities to public and private universities as well. Within this context, the evaluation system in university education started to be discussed in literature and advanced examples of evaluation systems at several universities were introduced [1]. By 2014, approximately 50% of higher education institutions in Japan had implemented faculty evaluation systems, up from about 30% in 2008 [2]. However, comprehensive research summarizing the effectiveness of these systems and identifying the characteristics of effective systems remains lacking.

1.2 Research Evaluation and Bibliometrics

Faculty evaluation in Japanese higher education typically encompasses education, research, and university administration. Amid growing concerns about the decline in research capabilities at Japanese universities [3], this paper focuses on evaluating research performance. Research performance is a broad term with no clear definition due to its diversity; it is essential to evaluate these capabilities from various quantitative and qualitative perspectives [4]. Because the indicators for measuring research performance have become increasingly complex, assessment

* University of Miyazaki, Miyazaki, Japan

becomes challenging, but one area that has gained attention in recent years due to technological advancements is bibliometrics. Bibliometrics involves the quantitative analysis of academic literature, utilizing various databases and tools [5]. Among these, Scopus, one of the major databases for bibliometrics, offers extensive coverage of over 90 million records from more than 27,950 active serial titles and 292,000 books. Key features include citation analysis tools, detailed author profiles, advanced search capabilities, and journal metrics like CiteScore.

Even with accurate bibliometrics data, however, one of the issues in research evaluation is finding the suitable comparison groups. With the increasing specialization of academic fields and the rise of interdisciplinary research, identifying suitable subjects for comparing research capabilities is not easy. For instance, even within programs that share the same department name, there is considerable diversity in faculty expertise, making it challenging to directly compare faculty members from similarly named programs at different universities. Additionally, researchers with similar research areas may be found in programs with different names, yet they might not be considered comparable solely due to the differing program titles. Identifying comparable subjects within the same research field based on program names is not straightforward.

1.3 Purpose of This Study

Evaluating research performance and identifying comparable subjects in equivalent research fields can be challenging. However, with the advancement of bibliometrics, various information related to research performance has become more accessible. This paper introduces a method for identifying subjects to compare research capabilities within a specific faculty (engineering field) using bibliometric information. By utilizing the subject topic information of academic papers available in bibliometric data, this study demonstrates how to create topic profiles for researchers and classify researcher groups by topic to identify comparable subjects. Furthermore, based on these classifications, this paper provides an example of a comparison method with other universities, showcasing a practical application of cluster analysis results to enhance faculty evaluation.

2 Method

2.1 Sample and Procedure

This study utilizes data from Scopus. Elsevier (the company providing Scopus) provides APIs (Application Programming Interface) for non-commercial use at no charge, allowing access to data, but with certain restrictions. Universities that subscribe to Elsevier services can obtain data from the corresponding services using the Elsevier API without restrictions. Through the Elsevier API, various types of bibliometric information, such as titles, authors, publication dates, and subject fields, can be accessed. For this study, available data from 2011 to 2020 on subject areas, the number of publications, and citations were utilized. Because the purpose of this study is to provide an example of identifying suitable researchers for comparison within a specific academic discipline, a case is provided where a professor responsible for faculty research evaluation in an engineering program selects a group of similar engineering programs for comparison. Based on the professor’s knowledge and expertise, 27 engineering programs from 27 different universities in Japan were arbitrarily selected. Data on a total of 28 engineering programs, encompassing 5,549 researchers, were included in this study.

2.2 Measures

Scopus offers various subject classification systems. One of the most common schemes in Scopus is the All Science Journal Classification (ASJC), a hierarchical system that categorizes subjects into four broad areas: Life Sciences, Physical Sciences, Health Sciences, and Social Sciences and Humanities. These broad areas are further divided into 27 major subject areas, which are then broken down into over 300 minor subject areas. The Subject Area and Subject Area Classifications are listed in Table 1.

Table 1: ASJC Classification System

4 Subject Area	27 Subject Area Classifications	Abbreviations
Physical Sciences	Chemical Engineering	CENG
	Chemistry	CHEM
	Computer Science	COMP
	Earth and Planetary Sciences	EART
	Energy	ENER
	Engineering	ENGI
	Environmental Science	ENVI
	Material Science	MATE
	Mathematics	MATH
	Physics and Astronomy	PHYS
Health Sciences	Medicine	MEDI
	Nursing	NURS
	Veterinary	VETE
	Dentistry	DENT
	Health Professions	HEAL
Social Sciences	Arts and Humanities	ARTS
	Business, Management and Accounting	BUSI
	Decision Sciences	DECI
	Economics, Econometrics and Finance	ECON
	Psychology	PSYC
	Social Sciences	SOCI
Life Sciences	Agricultural and Biological Sciences	AGRI
	Biochemistry, Genetics and Molecular Biology	BIOC
	Immunology and Microbiology	IMMU
	Neuroscience	NEUR
	Pharmacology, Toxicology and Pharmaceutics	PHAR
	Multidisciplinary	MULT

According to Elsevier, in-house experts conduct classifications based on the aims and scope of the title and the content of the publication [6]. Each publication in Scopus can be assigned to one or more categories in the ASJC. For instance, a single publication can be classified under both CENG and ENER. Therefore, if a researcher has two publications, with one classified as CENG and ENER, and the other as CENG and MEDI, the ASJC profile of the researcher will be 50% in CENG, 25% in ENER, and 25% in MEDI. In our study, all ASJC profiles in the sample were obtained using the Elsevier API.

2.3 Statistical Analysis

All statistical analyses were conducted using the JMP® software package (version 17.1.0, SAS Institute Inc.). Means were calculated to describe the characteristics of the data in the sample. Cluster analysis, a statistical method for grouping similar objects based on their features, was also conducted. This includes techniques like hierarchical clustering, which creates a tree-like structure, and non-hierarchical clustering, such as K-means, which requires pre-specifying the number of clusters. In this study, JMP was used to perform hierarchical clustering on a sample of 5,027 researchers across 27 quantitative subject areas, utilizing Ward's method.

3 Results

3.1 Characteristics of the Sample

Table 2 presents the average subject topic profiles of the selected 28 engineering programs from 28 different universities. The last row displays the average values for each subject across all programs at different universities, providing an overall trend. As observed in the last row, the highest average value is 24.6% in ENGI, ranging from 16.8% to 45.4%, indicating a general emphasis on engineering programs and confirming their selection. Additionally, the overall trend shows that PHYS (17.1%), MATE (12.4%), and CHEM (9.7%) are relatively high, indicating their significant presence in science and technology-related fields. Conversely, no publications were observed in NURS and VETE, with low values in non-Physical Sciences areas such as ARTS, DENT, ECON, HEAL, and PHYC.

Table 2: The Average of Research Profiles of the Sample at Each Program [1)]

	27 Subject Area Classifications																										
University	AGRI	ARTS	BIOC	BUSI	CENG	CHEM	COMP	DECI	DENT	EART	ECON	ENER	ENGI	ENVI	HEAL	IMMU	MATE	MATH	MEDI	MULT	NEUR	NURS	PHAR	PHYS	PSYC	SOCI	VETE
1	0.9%	0.2%	2.3%	0.4%	4.8%	11.8%	3.7%	0.2%	0.0%	3.8%	0.1%	3.1%	28.5%	2.2%	0.1%	0.3%	12.3%	3.6%	0.9%	1.6%	0.2%	0.0%	0.3%	17.7%	0.0%	1.1%	0.0%
2	0.9%	0.4%	8.5%	0.5%	4.7%	9.7%	13.0%	0.4%	0.6%	0.3%	0.0%	2.7%	26.1%	0.3%	0.1%	0.8%	8.9%	2.6%	2.5%	1.9%	0.7%	0.0%	1.2%	11.1%	0.3%	1.5%	0.0%
3	1.9%	0.6%	1.6%	0.3%	1.1%	3.3%	8.2%	0.3%	0.0%	3.0%	0.0%	0.8%	35.6%	2.7%	0.1%	0.0%	14.2%	4.1%	1.5%	0.9%	0.3%	0.0%	0.1%	19.3%	0.0%	0.2%	0.0%
4	2.0%	0.0%	6.2%	0.2%	5.1%	11.5%	7.3%	0.3%	0.0%	4.9%	0.2%	2.7%	22.4%	2.3%	0.1%	0.6%	9.9%	5.5%	2.1%	1.4%	0.6%	0.0%	1.3%	12.7%	0.2%	0.5%	0.0%
5	2.5%	0.0%	6.5%	0.3%	4.4%	7.3%	12.9%	0.1%	0.0%	2.9%	0.2%	1.9%	18.9%	4.9%	0.2%	0.6%	8.8%	6.3%	2.8%	1.0%	0.3%	0.0%	0.4%	16.2%	0.0%	0.6%	0.0%
6	2.8%	0.3%	9.2%	0.8%	5.5%	14.9%	3.6%	0.0%	0.0%	0.2%	0.3%	1.4%	19.2%	1.5%	0.0%	1.6%	15.0%	0.8%	1.5%	2.3%	1.0%	0.0%	0.7%	15.7%	0.2%	1.1%	0.0%
7	1.7%	0.0%	2.2%	0.1%	3.5%	5.8%	8.4%	0.2%	0.0%	8.8%	0.2%	1.7%	27.4%	5.7%	0.4%	0.3%	8.8%	7.3%	1.9%	1.2%	0.3%	0.0%	0.5%	11.3%	0.0%	2.2%	0.0%
8	0.4%	0.0%	3.7%	0.0%	3.7%	10.1%	11.9%	0.1%	0.2%	2.1%	0.1%	2.7%	26.1%	1.8%	0.2%	0.3%	10.7%	4.9%	1.2%	0.9%	1.9%	0.0%	0.6%	15.6%	0.0%	0.7%	0.0%
9	1.6%	0.8%	2.7%	0.7%	5.0%	9.0%	3.7%	0.2%	0.0%	8.1%	0.3%	4.8%	20.1%	4.2%	0.1%	0.3%	11.6%	2.1%	1.7%	2.1%	0.8%	0.0%	0.5%	17.8%	0.6%	1.2%	0.0%
10	0.8%	0.0%	2.5%	0.1%	5.3%	9.9%	8.6%	0.2%	0.0%	1.6%	0.1%	2.2%	25.5%	5.5%	0.0%	0.1%	14.5%	4.6%	1.0%	0.9%	0.2%	0.0%	0.3%	15.4%	0.0%	0.7%	0.0%
11	0.2%	0.8%	3.5%	1.4%	4.1%	9.7%	15.1%	2.3%	0.2%	1.3%	0.7%	1.5%	26.0%	1.8%	0.1%	0.1%	7.6%	5.0%	1.7%	1.3%	0.4%	0.0%	0.7%	11.0%	0.1%	3.3%	0.0%
12	0.4%	0.1%	1.6%	0.4%	1.7%	2.0%	6.4%	0.1%	0.0%	2.0%	0.0%	2.3%	45.4%	3.5%	0.1%	0.2%	13.4%	1.5%	0.6%	0.6%	0.3%	0.0%	0.2%	16.4%	0.0%	0.9%	0.0%
13	1.0%	0.0%	3.3%	0.1%	6.0%	9.4%	4.6%	0.0%	0.0%	3.3%	0.1%	1.9%	31.7%	6.0%	0.0%	0.8%	12.0%	1.9%	1.9%	1.4%	1.8%	0.0%	0.4%	11.5%	0.3%	0.6%	0.0%
14	1.3%	0.4%	1.8%	0.1%	4.8%	9.0%	1.8%	0.1%	0.0%	2.3%	0.0%	2.2%	29.9%	3.0%	0.0%	0.4%	12.7%	5.8%	1.4%	1.3%	0.2%	0.0%	1.1%	19.1%	0.0%	1.2%	0.0%
15	1.2%	0.6%	3.0%	0.3%	1.5%	3.2%	12.4%	0.5%	0.0%	1.4%	0.1%	1.1%	33.4%	3.4%	0.3%	0.3%	6.8%	9.0%	3.8%	1.2%	0.8%	0.0%	0.7%	12.4%	0.3%	2.2%	0.0%
16	3.0%	0.2%	5.9%	0.4%	6.6%	13.2%	5.1%	0.3%	0.0%	0.9%	0.2%	2.2%	19.5%	3.7%	0.7%	1.1%	17.8%	3.3%	2.0%	1.9%	0.5%	0.0%	0.4%	10.7%	0.2%	0.3%	0.0%
17	0.3%	0.6%	2.4%	1.2%	4.0%	10.8%	4.8%	0.7%	0.0%	3.2%	0.4%	4.3%	30.5%	4.0%	0.0%	0.2%	10.1%	3.0%	2.2%	1.1%	0.1%	0.0%	0.6%	13.5%	0.1%	1.5%	0.0%
18	0.0%	2.4%	0.3%	0.0%	1.0%	1.2%	11.2%	0.5%	0.0%	0.3%	0.0%	1.8%	41.4%	1.1%	0.2%	0.0%	11.0%	3.7%	0.5%	0.2%	0.0%	0.0%	0.0%	20.0%	0.0%	3.2%	0.0%
19	1.0%	0.2%	3.4%	0.3%	3.9%	12.6%	2.5%	0.0%	0.0%	3.9%	0.0%	3.5%	29.2%	5.2%	0.0%	0.3%	12.8%	1.9%	1.1%	0.9%	0.0%	0.0%	0.9%	15.6%	0.0%	0.7%	0.0%
20	0.4%	0.1%	2.6%	0.1%	1.8%	2.6%	11.0%	0.0%	0.0%	3.3%	0.0%	1.4%	32.4%	0.4%	0.2%	0.0%	8.3%	2.7%	3.0%	2.5%	3.1%	0.0%	0.3%	22.6%	0.8%	0.2%	0.0%
21	2.2%	0.5%	6.2%	0.5%	3.2%	7.7%	5.4%	0.3%	0.0%	5.0%	0.5%	2.8%	22.1%	4.4%	0.0%	0.4%	10.1%	2.0%	1.8%	3.0%	0.5%	0.0%	0.5%	18.2%	0.1%	2.6%	0.0%
22	1.4%	0.2%	4.7%	0.1%	3.6%	10.1%	5.0%	0.2%	0.1%	1.8%	0.4%	2.1%	32.2%	4.7%	0.2%	0.4%	12.8%	2.2%	1.4%	1.6%	0.4%	0.0%	1.4%	12.2%	0.2%	0.5%	0.0%
23	0.7%	0.3%	3.2%	0.2%	3.7%	8.7%	2.5%	0.1%	0.2%	1.8%	0.1%	3.0%	20.0%	2.2%	0.1%	0.3%	16.9%	2.8%	2.4%	2.0%	0.4%	0.0%	0.2%	27.4%	0.1%	0.4%	0.0%
24	1.2%	0.1%	3.6%	0.1%	7.1%	13.3%	1.0%	0.0%	0.0%	5.6%	0.0%	5.4%	16.8%	7.7%	0.3%	0.9%	12.6%	1.6%	2.0%	1.5%	0.3%	0.0%	0.4%	17.6%	0.0%	0.9%	0.0%
25	4.3%	0.6%	3.0%	0.5%	5.4%	10.9%	3.8%	0.1%	0.3%	13.0%	0.0%	3.1%	20.6%	4.4%	0.2%	0.9%	9.4%	2.9%	1.3%	2.2%	0.4%	0.0%	0.7%	10.5%	0.1%	1.2%	0.0%
26	0.8%	0.1%	3.9%	0.7%	5.4%	14.5%	3.1%	0.6%	0.0%	2.1%	0.1%	2.4%	25.8%	1.6%	0.5%	0.2%	15.0%	2.9%	1.4%	1.3%	0.5%	0.0%	0.7%	15.6%	0.3%	0.4%	0.0%
27	0.5%	0.0%	4.0%	0.1%	6.0%	13.2%	3.3%	0.0%	0.0%	1.6%	0.0%	3.2%	20.8%	1.8%	0.1%	0.5%	15.4%	2.5%	1.3%	1.9%	0.1%	0.0%	0.2%	22.7%	0.0%	0.5%	0.0%
28	0.2%	0.5%	2.7%	0.7%	3.3%	9.0%	9.5%	0.3%	0.1%	0.8%	0.0%	3.1%	40.7%	2.0%	0.6%	0.1%	7.9%	4.3%	1.7%	0.7%	2.2%	0.0%	0.2%	8.5%	0.4%	0.4%	0.0%
Total	1.3%	0.3%	4.1%	0.4%	4.4%	9.7%	5.7%	0.3%	0.1%	3.4%	0.2%	2.8%	24.6%	3.3%	0.2%	0.5%	12.4%	3.3%	1.8%	1.7%	0.6%	0.0%	0.5%	17.1%	0.2%	1.1%	0.0%

3.2 Results of Cluster Analysis

Table 3 shows the results of the cluster analysis of the data for each cluster, with each column representing the proportion of data belonging to specific topic fields (e.g., AGRI, ARTS, BIOC, etc.). With the consultation of the engineering faculty member responsible for faculty research evaluation, 10 clusters were identified. In Cluster 1, the fields with the highest proportions are ENVI at 47.7% and ENGI at 15.8%, indicating a high proportion of environmental-related data. In Cluster 2, the fields with the highest proportions are BIOC at 16.4%, followed by ENGI at 11.3% and MEDI at 8.3%, highlighting a focus on biology and medicine research in engineering.

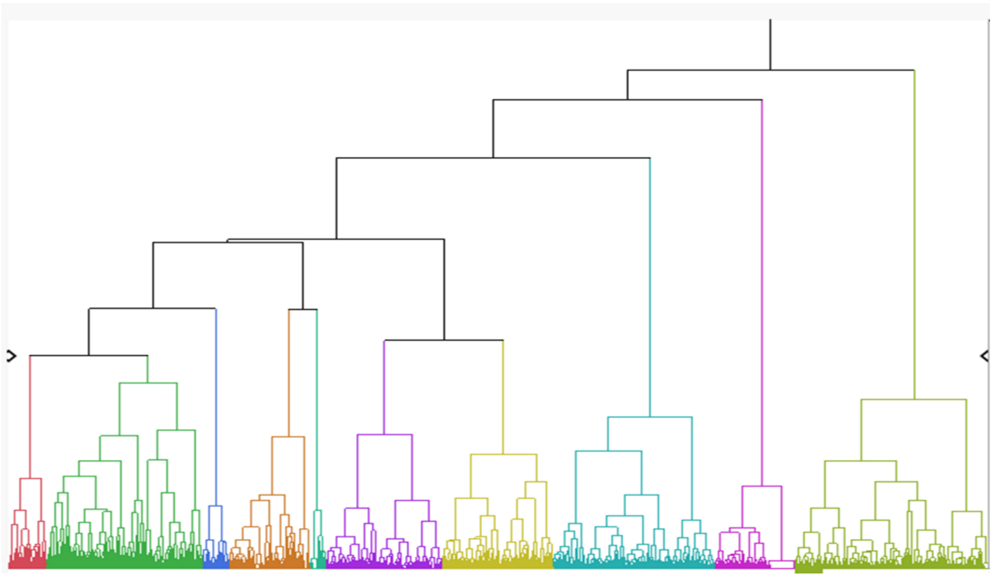
Cluster 3 has the highest proportion in EART at 66.6%, while Cluster 4 is dominated by COMP at 45.65%, and Cluster 5 by MATH at 81.0%. Cluster 6 shows the highest proportions in MATE at 37.9%, ENGI at 29.7%, and PHYS at 15.6%, indicating strength in materials science, engineering, and physics. In Cluster 7, the highest proportions are ENGI at 45.5%, PHYS at 12.4%, and COMP at 7.6%, showing a strong presence in computer science and engineering. Cluster 8 has the highest proportions in CHEM at 40.4%, MATE at 16.1%, and PHYC at 9.9%, indicating a focus on chemistry, materials science, and physics. Cluster 9 is predominantly ENGI at 85.0%, while Cluster 10 has the highest proportion in PHYS at 54.0%.

Table 3: Ten Clusters Identified by Cluster Analysis

		27 Subject Area Classifications																										
Cluster	N	AGRI	ARTS	BIOC	BUSI	CENG	CHEM	COMP	DECI	DENT	EART	ECON	ENER	ENGI	ENVI	HEAL	IMMU	MATE	MATH	MEDI	MULT	NEUR	NURS	PHAR	PHYS	PSYC	SOCI	VETE
1	212	5.3%	0.2%	2.2%	0.5%	2.1%	2.7%	0.9%	0.2%	0.0%	6.8%	0.3%	4.8%	15.8%	47.7%	0.0%	1.0%	0.9%	1.0%	1.8%	1.0%	0.0%	0.0%	0.6%	1.1%	0.1%	2.9%	0.3%
2	883	5.0%	1.2%	16.4%	1.5%	4.1%	6.2%	2.1%	0.9%	0.2%	1.9%	1.0%	4.5%	11.3%	4.3%	0.8%	2.4%	5.7%	1.4%	8.3%	4.4%	2.7%	0.3%	1.7%	6.0%	0.8%	4.9%	0.0%
3	148	3.8%	0.2%	0.5%	0.3%	0.7%	1.0%	0.9%	0.0%	0.0%	66.6%	0.0%	2.3%	8.3%	6.4%	0.0%	0.1%	1.2%	0.7%	0.5%	2.5%	0.0%	0.0%	0.1%	3.4%	0.0%	0.8%	0.0%
4	458	0.6%	0.7%	3.0%	0.5%	0.7%	0.5%	45.7%	0.5%	0.0%	0.5%	0.0%	0.3%	29.0%	0.5%	0.1%	0.0%	1.3%	8.6%	1.4%	1.3%	1.4%	0.0%	0.0%	1.9%	0.3%	1.1%	0.0%
5	92	0.8%	0.3%	0.3%	0.1%	0.0%	0.1%	6.2%	2.0%	0.0%	0.1%	0.3%	0.2%	3.0%	0.5%	0.1%	0.1%	0.3%	81.0%	0.9%	0.1%	0.0%	0.1%	0.0%	3.6%	0.0%	0.1%	0.0%
6	661	0.2%	0.0%	0.9%	0.3%	3.5%	6.5%	0.9%	0.0%	0.2%	0.4%	0.0%	1.1%	29.7%	0.5%	0.0%	0.1%	37.9%	0.6%	0.4%	0.9%	0.0%	0.0%	0.1%	15.6%	0.0%	0.1%	0.0%
7	627	0.7%	0.2%	0.9%	0.4%	4.6%	2.1%	7.6%	0.3%	0.0%	6.0%	0.1%	5.0%	45.5%	1.7%	0.1%	0.0%	6.3%	3.7%	0.7%	0.8%	0.2%	0.0%	0.1%	12.4%	0.1%	0.6%	0.0%
8	917	0.3%	0.0%	4.7%	0.0%	14.3%	40.4%	0.3%	0.0%	0.0%	0.2%	0.0%	3.7%	5.0%	1.5%	0.0%	0.1%	16.1%	0.3%	0.3%	1.3%	0.0%	0.0%	1.3%	9.9%	0.0%	0.0%	0.0%
9	454	0.1%	0.2%	0.1%	0.2%	0.4%	0.2%	3.2%	0.0%	0.0%	0.7%	0.0%	2.1%	85.0%	0.5%	0.0%	0.0%	3.2%	0.9%	0.1%	0.1%	0.0%	0.0%	0.0%	2.4%	0.0%	0.4%	0.0%
10	1097	0.1%	0.1%	0.9%	0.0%	1.1%	4.3%	0.7%	0.0%	0.0%	0.9%	0.0%	1.8%	15.6%	0.4%	0.0%	0.0%	15.9%	1.6%	0.4%	2.0%	0.0%	0.0%	0.0%	54.0%	0.0%	0.1%	0.0%

Figure 1 shows the dendrogram, created using Ward's method for hierarchical clustering. This illustrates the hierarchical relationships among the researchers based on their profiles on the subjects. The height of each branch reflects the dissimilarity between clusters, with lower branches indicating more similar clusters. The vertical axis shows the Euclidean distance, which measures the dissimilarity between clusters.

Figure 1: Dendrogram of hierarchical clustering using Ward's method



3.3 Application of the Results of Cluster Analysis in Faculty Evaluation

Based on the results of the cluster analysis, publication data can be organized around the identified clusters (common research areas). For example, Table 4 shows the number of publications, citations, and top 10% publications for a particular year. This table can be utilized in several ways. First, the research performance of the engineering programs at University 1 and University 2 can be directly compared within each cluster. Second, a faculty member in Cluster 1 at University 1 can be compared with other faculty members in the same cluster at the same university. This allows for the evaluation of a faculty member's research performance against their peers within the same cluster at the same university. Lastly, a faculty member in Cluster 1 at University 1 can be compared with faculty members in Cluster 1 at University 2. This helps identify the comparative research performance of faculty members across universities.

Table 4: Example of Comparison using Dummy Data

	University 1			University 2		
	Publications	Citations	Top 10 % publications	Publications	Citations	Top 10 % publications
Cluster 1	2.5	8.4	1.3	4.5	12.1	2.1
Cluster 2	3.1	9.5	2.1	2.3	9	0.5
Cluster 3	4.5	20.1	1.2	3.4	7.4	1.1
Cluster 4	2.3	4.5	1.6	2.1	4.3	0.3
Cluster 5	1.4	8.2	0.3	3.1	5.5	1.3
Cluster 6	5.3	4.3	2.5	2.6	6.4	0.8
Cluster 7	2.6	7.7	0.6	1.1	3.2	0.3
Cluster 8	2.3	8.5	0.9	4.5	15.4	3
Cluster 9	2.4	5.7	1.1	3.4	6.8	1.7
Cluster 10	3.3	6.4	2	2.1	4.3	1.3

4 Discussion

This study demonstrated the application of cluster analysis on bibliometric data from the Scopus database. By analyzing the subject profiles of all researchers in the sample, groups of researchers with similar profiles were identified. Specifically, 10 clusters were identified from the research profiles in the sample. Our analysis revealed that research topics within a single department can be diverse, although there was a common core component in engineering (ENGE). Additionally, using dummy data, an example of utilizing comparison groups was provided to offer insights for enhancing faculty evaluation. While there are studies utilizing quantitative analysis tools such as publication achievements [7], evaluation requires comparable subjects. This study has demonstrated one method to improve research evaluation. However, quantitative analysis alone is insufficient for evaluating research capabilities [8], and its side effects have also been reported [9]. It is expected that further studies of research evaluation will contribute to improving Japan's research capabilities.

This study has several limitations. First, the data obtained might be incomplete as it is internally created by referring to the Scopus database. Since the Scopus data and the list of engineering faculty are merged using Romanized names, data may be missing for researchers whose surnames have changed due to marriage or for those with variations in name spelling. Additionally, the same author may have multiple Scopus Author IDs, which can lead to inaccurate bibliometric data. Second, cluster analysis has its limitations. Determining the optimal number of clusters is challenging without clear-cut criteria, and this choice impacts subsequent decision-making. Additionally, outliers can disrupt the cohesion of clusters. Lastly, since various indicators must be used to analyze research capabilities, the case provided in this study is just one instance of research evaluation. Despite these limitations, this study offers a method to improve the evaluation of research performance by identifying appropriate comparison groups.

Note

1) To protect identifiable information. the number of researchers at each university was omitted.

Acknowledgment

This study was supported by JSPS KAKENHI Grant Number 24K16713.

References

[1] Higher Education Information Center, "Implementation of the Teacher Evaluation System and University Culture Reform," Regional Science Research Association, 2008

[2] M. Kishi, "The Current State of Faculty Evaluation in Japanese Universities (Based on Two Reports)," 2018; https://www.ide.go.jp/library/Japanese/Publish/Reports/InterimReport/2017/pdf/2017_2_40_018_ch05.pdf (in Japanese; accessed Oct. 14th, 2024).

[3] National Institution of Science and Technology Policy, "Current Status and Challenges of University Research Capabilities," 2022; https://www.mext.go.jp/kaigisiryo/content/000148080.pdf. (in Japanese; accessed Oct. 20th, 2024).

[4] R. Arreola, Developing a Comprehensive Faculty Evaluation System, Jossey-Bass, 2006.

[5] O. Ellegaard, J.A. Wallin, "The bibliometric analysis of scholarly production: How great is the impact?," Scientometrics 105, 2015, pp. 1809-1831.

[6] Elsevier "What are Scopus subject area categories and ASJC codes?," https://service.elsevier.com/app/answers/detail/a_id/12007/c/10547/supporthub/scopus/(accessed Oct. 30th, 2024)

[7] T. Ikeda, C. Ueda, M. Hansen, "Analysis for Research ability using Database: Introduction of analytical tools and their Application Examples," Proceedings of the Information Professionals Symposium, 2022, pp. 97-101.

[8] S. Nakajima, M. Okazaki, T. Kikuta, Y. Watanabe, "The purpose of research achievement analysis – How to use the right indexes for the proper purpose -," Proceedings of the Information Professionals Symposium, 2022, pp. 85-90.

[9] Hicks, D., Wouters, P., Waltman, L. et al., "Bibliometrics: The Leiden Manifesto for research metrics," Nature, 520, 2015, pp.429–431.