Research Paper

Thematic Comparison of Research in Civil Engineering at Ferdowsi University of Mashhad and World's Top Universities

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ABSTRACT

Development of different scales and methods to evaluate and compare research performance of individuals, institutes and universities has a significant role to enhance scientific policy-making procedures. Unfortunately, thematic evaluation as a tool for qualitative evaluation, has not received much attention for high-level policy-making of science and technology in the world. It seems that monitoring research trends (in specific research centers) and their similarity with those of top research institutes in the world presents a new perspective to research policy-makers and is essentially effective to find strengths and weaknesses of research approaches and future policies. In this research, the articles of the three years (2018-2019-2020) of the top five universities (in the 2021 QS ranking) and Ferdowsi University of Mashhad in the field of Civil and Environmental Engineering are extracted from the Scopus database. The priority of research topics is analyzed and compared based on several indicators for five top universities and Ferdowsi University of Mashhad. To validate the thematic-comparison process, researches of London College (as the sixth top research institute in the field of Civil Engineering) are also included. The results show that research topics (and their priorities) of London College, compared to Ferdowsi University, are much closer to those of the top five universities of the world. Also, in order to better evaluate the research compatibility, thematic comparison of Ferdowsi University's researches with those of the top five universities has been examined for different subfields of Civil Engineering separately. The results show that inconsistency in some sub-disciplines is very high, and research policy reconsideration is earnestly recommended.

Keywords:
Civil Engineering; Keyword co-occurrence network; Ranking; Research output; Thematic comparison

1. Introduction

For any country, a better regulation for more effective policy-making that can accelerate science and technology is a fundamental goal. Science and technology policy is known as general measures and decisions by the government to encourage, conduct and manage the trends of scientific research and technology development, as well as to organize procedures to employ research results for the sake of enhancing social, economic and politic qualities [1]. Scientometric studies on research productions have an important role in scientific policy making. Scientometric studies can help research policymakers in allocating budget, creating a balance between budget and costs, appointing appointments, and promoting researchers and ranking academic institutes [2]. The rich array of insights, methods and indicators developed by the field of bibliometric research over the last 30 years, has been avidly used by policy-makers in their quest for "objective, reliable and valid" methodologies to assess the performance of basic science [3-4]. For example, the Flemish government has used bibliometric indicators to decide on the allocation of research funds [5]. Romanian policymakers in particular have made extensive use of quantitative measures of research output in order to conduct evaluations that have guided, among others, policy decisions regarding the allocation of public funds to universities [6]. another example, global progress and quantitative trends in health systems research (HSR) provide evidence for the current status and trends of HSR worldwide, as well as clues to the impact and efficiency of this popular topic [7]. Therefore, it helps scientific researchers and policy makers to understand the panorama of HSR and predict the dynamic directions of research. Scientometric authors can contribute to the study of science, technology and innovation from a quantitative perspective by modeling and measuring these developments [8].

Discovering research topics of interest to researchers, or research trends, is certainly an important issue. The ability to quickly identify new research trends is strategic for many stakeholders, including universities, institutional funding bodies, academic publishers, and companies. An approach is developed to detect emerging topics that were in the embryonic stage, that is, when they have not yet been tagged or are not associated with a significant number of publications [9]. This study shows that the emergence of a new topic is predicted by a significant increase in the speed of collaboration between related research areas, which can be considered as the ancestors of a new topic.

It is also very important to pay attention to the research topics of top universities and research institutes that usually follow a specific policy. For example, in a recent study, the number of articles and scientific productions in Iran and the world are compared, and it is concluded that the growth rate of scientific production in Iran is one of the fastest in the world; however, due to its weakness in interdisciplinary fields, country's scientific policy should be conducted to strengthen them [10]. The study has not, however, performed any qualitative and thematic review for scientific fields. Unfortunately, until now, such a study on subject comparison between universities has not been performed. In other words, the content and topics of the scientific outputs of the articles are not con- sidered for university rankings. It is obvious that considering the scientific output of researchers, research institutes, and universities to evaluate scientific productivity, regardless of scientific content, is somewhat challenging. This issue be- comes more important when it is noticed that the acceptance of research projects, the signing of contracts with researchers and the granting of scientific awards are currently influenced by the results of measuring, ranking and comparing scientific outputs [11]. Various rankings are published periodically by many institutions to evaluate the scientific production of universities and research institutions. These rankings are based on a number of evaluation criteria, none of which includes subject evaluation. The criteria for evalu-ating and comparing the scientific production of researchers are mostly peer reviews and biblio- metric indices such as g- and h- indices [12-13]. For example, in a study, the ranking of Romanian university groups in the three fields of political science, sociology, and marketing using the g-index was used to more closely examine the scientific results of Romanian scientists [6]. In another study, four types of groups from more than six Greek universities were considered to compare the various departments of different universities, and the academic staff were ranked using h-index [14].

The study presents a structured method for comparing academic research groups in the same field, using some bibliometric indices based on Hirsch (h). To be precise, note focused on Italian academic groups in the scientific sector of production technology and production systems. Precisely five different typologies of indicators were used to examine the bibliographic position of the groups in the scientific community. The five different h-based indicators include: The spectrum of h, hGROUP, h2, ch and hSINGLE is used in t his study in order to have a global view of scientific production [15]. Also, in the QS university ranking, the world's top universities are ranked according to separate subject areas. This ranking system covers 51 topics and uses scientific records, research citations and h-index with different weights for the task [16].

The present study is aimed at comparing the topics of a target university with some well-defined benchmark research subjects. This study evaluates and compares the scientific outputs of QS-ranking-based five top universities in the world in the field of civil and environmental engineering [17] with those of Ferdowsi University of Mashhad. The reason for choosing the field of Civil Engineering is that in recent years, many changes have been observed in the field of Civil Engineering in the world, and research in this field has found an increasing trend towards interdisciplinary studies and innovations, hosting various disciplines such as data mining, artificial intelligence, biology, chemistry, electronics, etc. Also, during the last decade, an increasing interest has been devoted to the field of environmental health and reducing harmful environmental effects in construction processes. Based on this, it is necessary to examine the status of this field in our country, and evaluate the synchronization of our country's researchers in this field with such increasing global changes and developments. This study aims to examine the compatibility of the research topics of interest of Ferdowsi University of Mashhad (as the target university) and the research topics of the top five universities at the international level (as benchmark topics) based on the indicators derived from the analysis of the information of financial sponsors and keyword co-occurrence networks. Also, as a verification of the method, the outputs of the top five universities are compared with those of the sixth top university in the QS ranking to examine the degree of closeness of the research topics of the sixth university to benchmark topics, compared with that of Ferdowsi University. In order to provide a better interpretation of the results, these research topic comparisons have been performed separately for different sub-disciplines of Civil Engineering. Surely, such studies can significantly contribute to research policy-making processes for universities, and facilitates research trend revisions according to the needs and technologies.

2. Research Method

2.1. Data

Scopus database was selected to collect bibliographic metadata of Civil Engineering articles. Scopus is known as the largest citation database of scientific journals, books and conference articles. In this study, bibliographic data for scientific output from six top universities in the world based on QS ranking, as well as those of Ferdowsi University of Mashhad, in the field of Civil and Environmental Engineering was extracted and analyzed. The top six universities in QS-ranking 2021, in the field of Civil Engineering, are reported in Table (1).

Since the purpose of this article is to identify new research topics that have scientific and

Table 1. Top six universities in the field of Civil Engineering based on QS-ranking 2021. https://www.topuniversities.com/university-rankings/university-subject-rankings/2021/engineering-civil-structural

Rank	University	Overall Score	H-index Citations	Citations per Paper	Academic Reputation	Employer Reputation
1	Massachusetts Institute of Technology (MIT)	96.2	88.5	94.9	100	95.5
2	National University of Singapore (NUS)	95	91.8	96.4	91.9	100
3	Delft University of Technology	93.2	93.1	85.7	97.7	91.1
4	University of California, Berkeley (UCB)	92.7	89	93.3	99.1	85.7
5	University of Cambridge	92.1	82.3	91.9	94.1	94.3
6	Imperial College London	91.9	91.9	94.1	94.3	87.4

* **Rank:** position among others

Overall score: Total score in Qs ranking based on the four indicators of academic reputation, employer reputation, research citations in each paper and h-index.

H-index: Is an indicator that measures the productivity and impact of a scientist or researcher's published work.

Citations per Paper: Citations as measured per article rather than per faculty member.

Academic Reputation: As a result of a global survey, based on responses from more than 100,000 academic respondents worldwide. Respondents are asked to list up to 10 domestic institutions and 30 international institutions that they believe are excellent for research in a given area.

Employer Reputation: Drawing on nearly 50,000 survey responses from graduate employers worldwide, employers are asked to identify up to 10 domestic and 30 international institutions that they consider excellent for graduate recruitment.

industrial potential, only the articles from 2018 to 2020 were reviewed in the desired field of knowledge. Another reason for this restriction is to facilitate the processing process. In fact, in this article, the aim is to identify and assess scientific and industrial-potential of topics in Civil Engineering by examining keywords of new articles, regardless of the history of their origin and evolution. It should be noted that in the preparation of this database, the keywords proposed by the authors are used rather than machine-produced keywords.

2.2. Refinement

After retrieving data, it is necessary to edit data by a suitable editor. A fundamental and very important, and of course time-consuming prerequisite for a well-behaved keyword map is a thesaurus for equivalent and synonymous terms; since different authors may describe a scientific concept (such as Finite Element Method) with different keywords (such as Finite Element Analysis, Finite Element Modeling, FEM, FEA, etc.). In this research, a synonym list with a number of about 2000 terms is provided for the task.

2.3. Process

In this study, keywords are identified, valued and ranked based on three indicators of development, investment, and ratio of investment-to-development (announced as technology potential). The index of development in the proposed method is obtained from the keyword co-occurrence network, and is defined as the degree (link strength) of any node (keyword) in the network. Various scientometric software including VOSViewer, make this index easily available for each keyword. Another indicator used in this research is the number of financial sponsors for any research topic. The amount of financial investment cannot be used due to the lack of access to its information. Number of financial sponsors for each keyword is calculated from the number of articles with the same keyword, as introduced by their authors. Thus, based on the keyword co-occurrence network, link strengths are extracted from VOSViewer software to introduce development indices. Also, by a simple VBA code in Excel, the number of sponsors for all keyword (investment indices) is determined. Since the main audiences of this article are researchers and academic institutions, which are interested in undeveloped and immature keywords with industrial potential and prospects for technological application, a newly introduced index of ratio of investment-to-development (technology potential) is also dealt with.

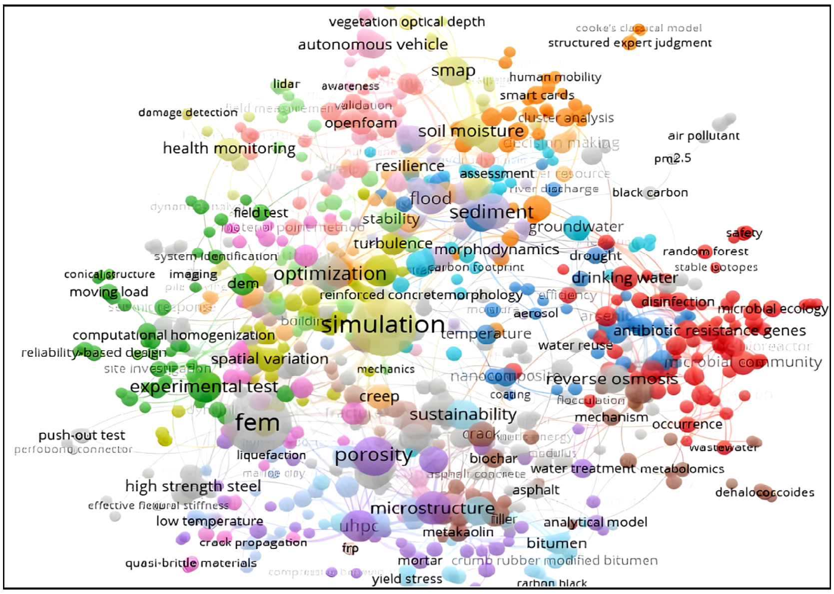
The keywords present in the target and standard/benchmark networks might be sorted according to any of the three indicators. Thus, any keyword in each network is given a numeric index value and a rank. It is then possible to compare the two index/rank sets. These comparisons can be performed in different ways:

1. Determining the number of shared and non-shared keywords
2. Examining the rank difference of shared keywords (with the help of different charts.)

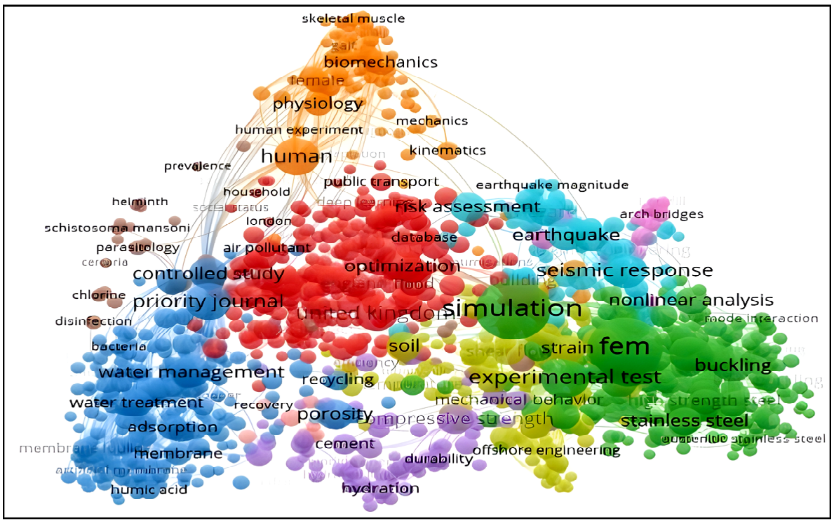
3. Findings

3.1. General Comparison

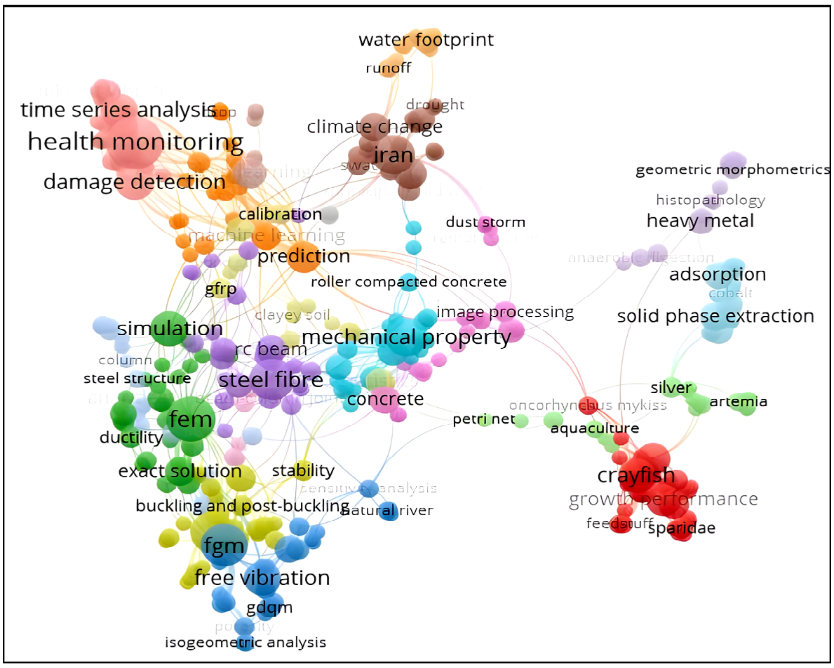
Keyword co-occurrence networks for First five Universities (F5U), Royal College of London (ICL), and Ferdowsi University of Mashhad (FUM), illustrated by VOSViewer, are shown in Figure (1). In these networks, keywords with more than three occurrences are included. In such networks, general research topics are mainly located in the middle of the stack; the more the number of co-occurrence links, the more the keyword is drawn towards the center. Usually, keywords with more links have more occurrences. The larger nodes (the size of a node represents the number of occurrences of a keyword) actually represent research topics that are usually formed by gathering a number of research concepts. In contrast, smaller nodes are research concepts. The coloring of the networks indicates the clusters suggested and displayed by VOSViewer [18-19]. VOSViewer uses the smart local moving algorithm to solve an optimization problem for the task of clustering [20]. However, these clusters are not dealt with in this paper. From a more detailed examination of the keywords of these clusters, it can be seen that some larger ones might somewhat be considered as existing sub-disciplines of Civil and Environmental Engineering. However, such



(a) F5U



(b) ICL



(c) FUM

Figure 1. Civil and environmental engineering keyword networks in 2018-2020.

clustering are not very reliable from an expert point of view, and as will be discussed in section 2-3, in order to more accurately compare target and benchmark researches based on sub-disciplines, we will use human, rather than automatic, clustering.

In Table (2), statistics on total number of keywords, as well as shared and non-shared keywords between FU5, FUM, and ICL keyword-sets are reported. It can be seen that despite the lower total number of ICL keywords compared with FUM, it has more shared keywords with F5U, being nearly three times greater than that of FUM.

Table 2. Total number of shared and non-shared keywords among F5U, FUM, and ICL keyword-sets.

University	FUM	F5U	ICL
No. of Keywords	731	750	412
No. of Shared Keywords	92		121
	13%		29%
No. of Non- Shared Keywords	639		291
	87%		71%

If F5U keywords are considered as benchmark, it is appropriate to comment on the quality of shared and non-shared keywords of ICL and F5U. In other words, the number of shared/non-shared keywords is not the only indicator to evaluate the thematic proximity of researches and maybe despite the greater number of keywords shared between two institutions, their prioritization and ranking may greatly differ. In the following, ranking of shared keywords for FUM and ICL with that of F5U is investigated qualitatively based on the indicators of technological potential, development and investment.

Figure (2) illustrates the comparison of rankings for F5U-FUM shared keywords based on the indicators of technology potential, development and investment, respectively. In all these figures, keywords that around and near the bisector of the graph indicate similarity of prioritization between F5U and FUM based on the selected index. The keywords at further distances represent dissimilarity of topic priority; e.g. in Figure (2a), keywords above and far away from bisector, such as genetic algorithm or PIV, have some high rank and priority by FUM in terms of technological potential, while they are significantly disregarded by F5U.

According to diagrams, development-, investment, and technology potential- based rankings for F5U are significantly different from FUM, which implies, in a way, a major gap between the approaches and research topics of the two. Moreover, a large number of top topics in F5U are not found in FUM keyword set, and as shown in Table (1), only about 12% of research subjects of F5U are shared with that of FUM, most of which have very different research rank and priority. Also, Figure (3) shows the comparative graphs of F5U with ICL.

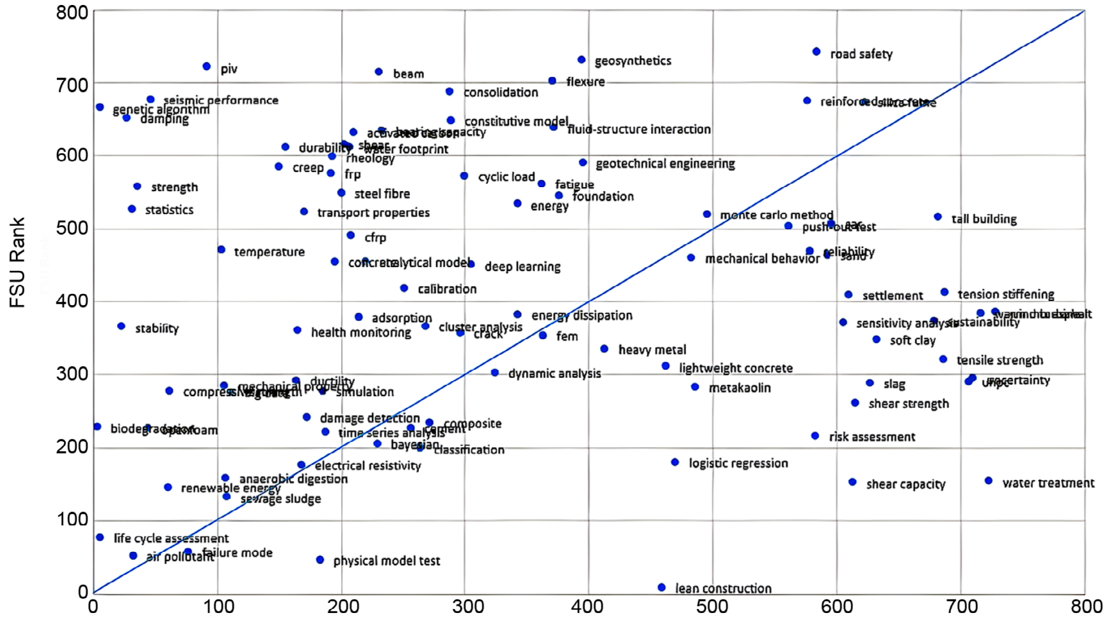
In order to better compare the thematic proximity, sorted values of ranking differences between FUM and ICL with F5U, in terms of the three indicators, are displayed in Figure (4). Generally, for all cases, ICL-F5U differences is less, compared to FUM-F5U.

The graphs in Figure (4) might be re-indicated as Figure (5), in the form of the distribution of the differences in subject ranks. It can be seen from Figure (5) that in general, the number of subjects with low rank difference in ICL is more than FUM. In other words, research topic prioritization in ICL is closer to F5U compared to FUM. It is also observed that prioritizations based on development and investment indicators are closer to each other compared to technology potential. This is due to the existence of general terms that usually appear in most researches in a specific field.

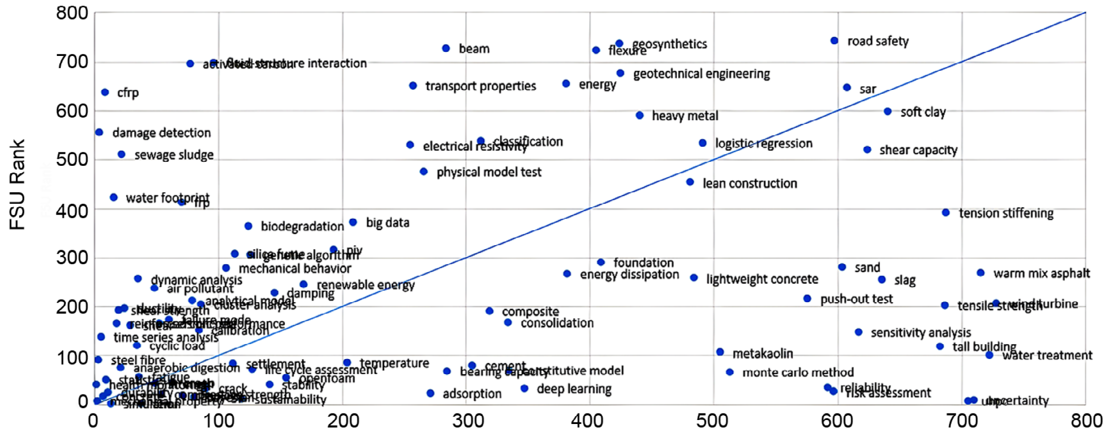
3.2. Sub-Discipline Comparisons

The main purpose of the study is to compare FUM with the top five ranking universities. ICL (as the sixth best research institution in the field of Civil Engineering) is just included to validate the subject-comparison process, which was verified in the previous section, where for all indicators, ICL experienced less difference with F5U than FUM.

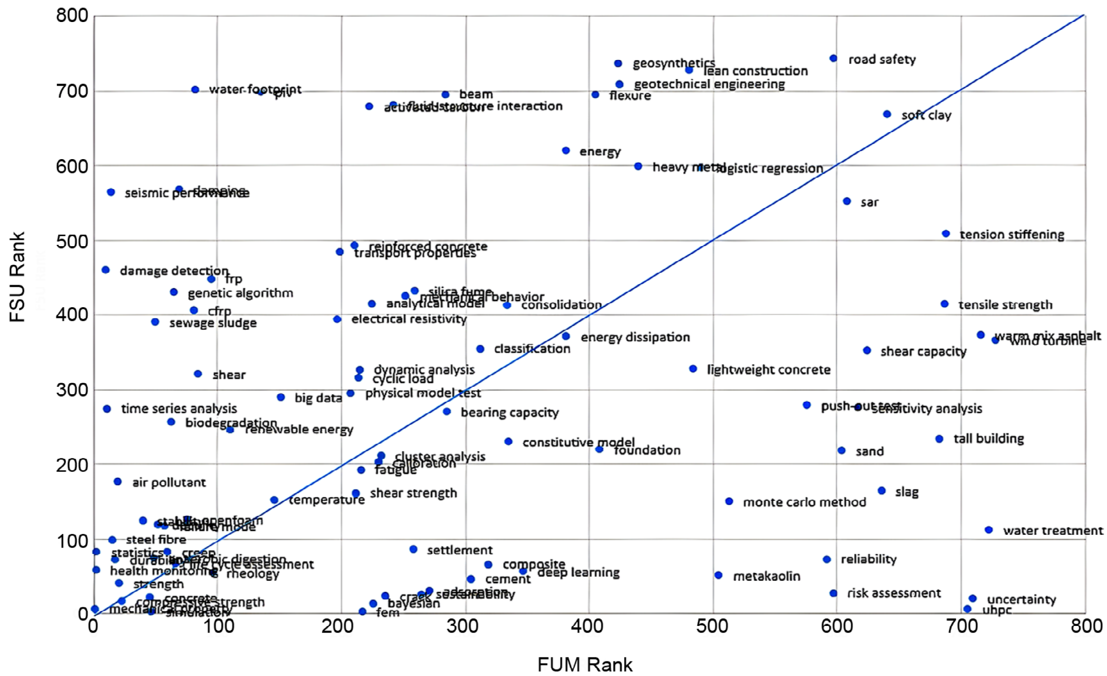
After examining the appropriate validity of the thematic comparison method in the previous section, due to the wide range of topics in Civil Engineering, it is necessary that research topics in different sub-disciplines are investigated separately. This will facilitate a better qualitative interpretation and understanding of the proposed diagrams, and depicts



(a) Technology Potential



(b) Development



(c) Investment

Figure 2. Comparative graphs of keyword ranks for F5U and FUM based.

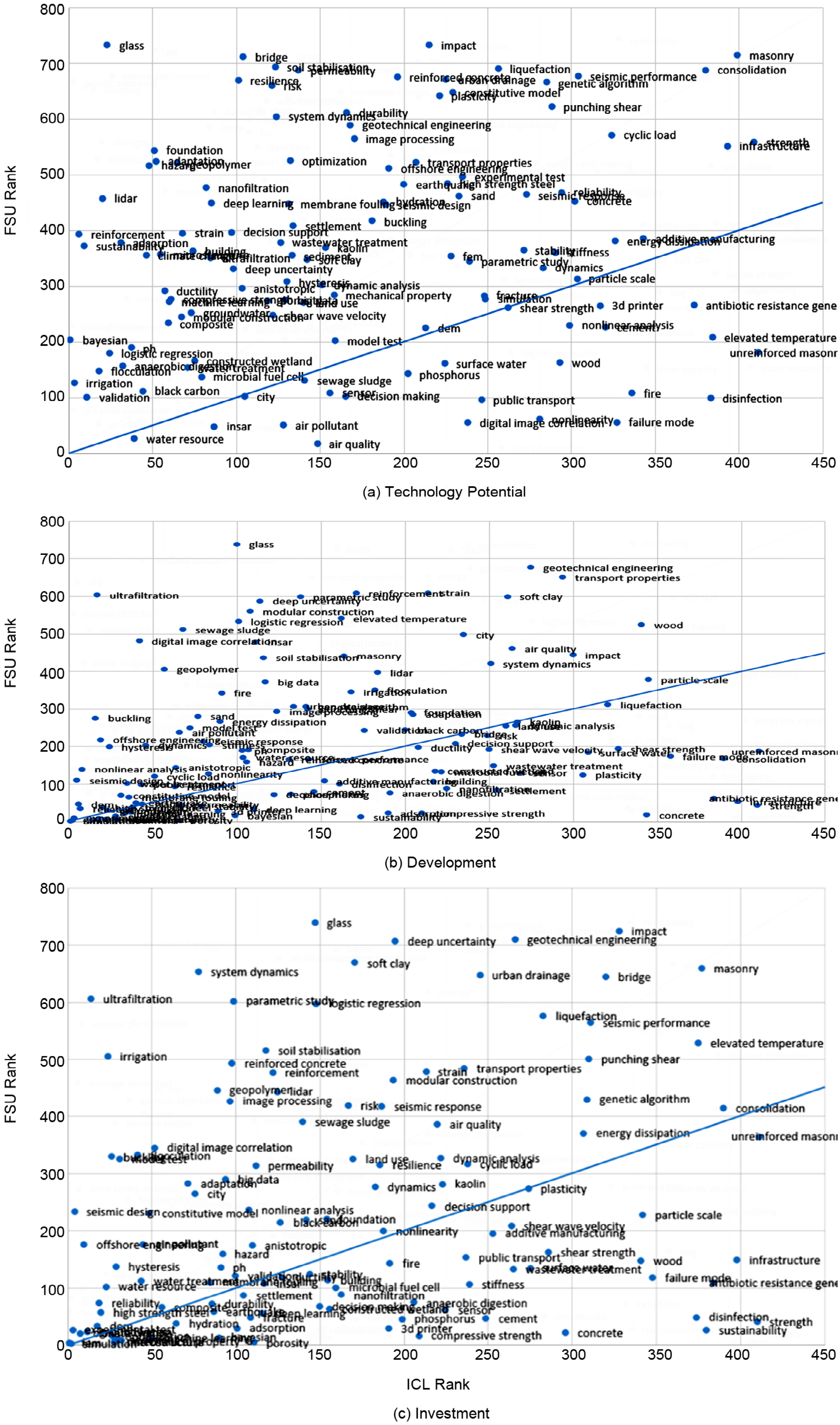


Figure 3. Comparative graphs of keyword ranks for F5U and ICL based.

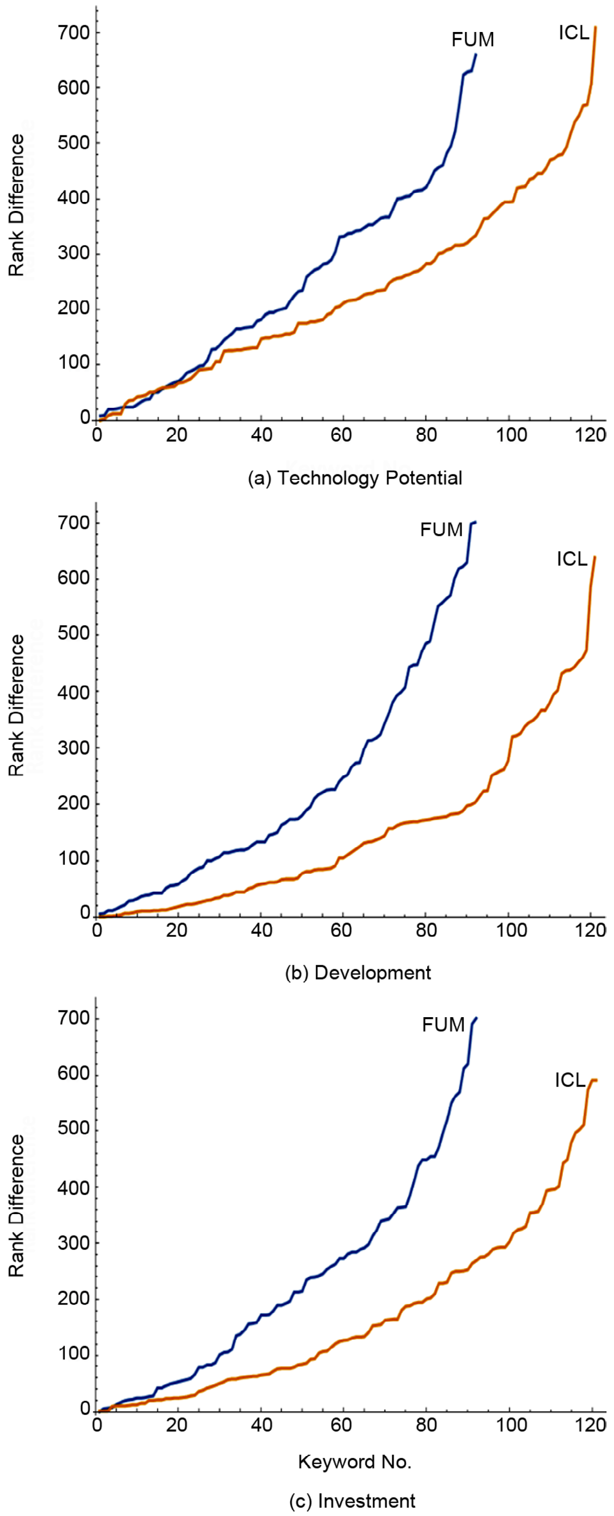


Figure 4. Sorted values of ranking differences between FUM and ICL with F5U, in terms of the three indicators.

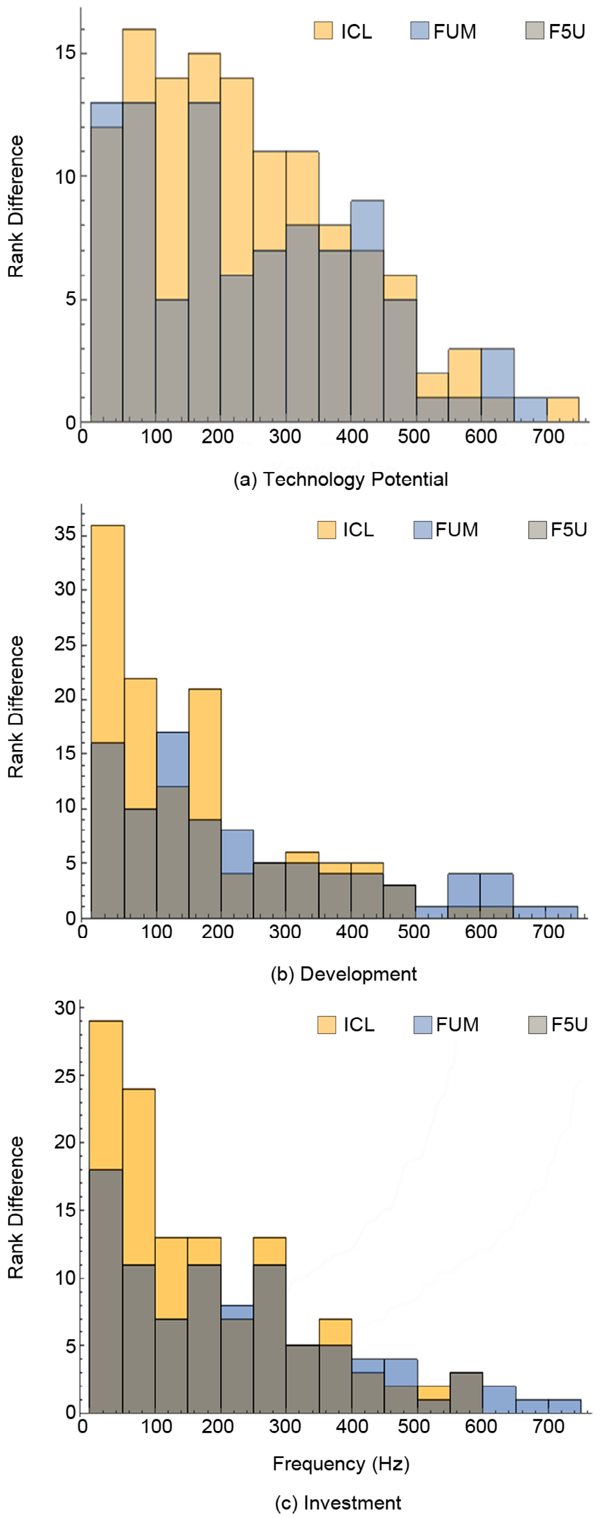


Figure 5. Histogram of differences in subject ranks for ICL and FUM with F5U according to indicators.

a clearer prospect of the strengths and weaknesses of researches in Civil Engineering at Ferdowsi University of Mashhad.

Since clustering provided by VOSViewer does not well match the sub-disciplines in Civil Engineering, the task is performed manually. Based on this, the following five main sub-disciplines in Civil Engineering are considered: (1) structure, (2) building materials, (3) construction management, (4) transportation, and (5) environment and water-resources management. These sub-disciplines are recognized as main clusters of both F5U and FUM keyword-sets, as a consequence of a survey by two experts on the keywords. Some other sub-disciplines are ignored due to their few numbers of keywords. The selected clusters are also well consistent with the main sub-disciplines known in Civil-Engineering community. It should be noted that the clusters automatically produced and proposed by VOSViewer (and displayed by different colors) are not well-consistent with known sub-disciplines in Civil Engineering.

As technology potential is the most interested index for researchers, the keywords in F5U and FUM sets are sorted based on it. Moreover, since the first-ranked keywords usually characterize the most important institute's research trends, and also to facilitate manual classification, the first 200 keywords from F5U and FUM keyword sets are only dealt with. It should be noted that some keywords were not included in the five categories of sub-disciplines and were left out. Thus, subsets of top research topics (from the technological potential point of view) are available for each institution. Now, the goal is to determine and evaluate the amount of each institution's attention to each keyword in different categories. Based on this, the keywords of each sub-discipline at both institutions are ranked based on the development index. In this way, the most developed topics that have technological potential are found in each sub-discipline for both institutions.

In Table (3), the number of keywords in different sub-disciplines along with their percentage to the total keywords is displayed. It is clear from the table that while the majority of FUM keywords belong to the structure and building-materials subsets (which are both practically related to structural engineering) (nearly 70%), most studies in F5U are directed towards the field of environment (nearly 45%). Also, studies in the field of transportation in F5U are significantly more than FUM.

Table 3. Table 3 Statistics for keywords in F5U and FUM sub-disciplines.

	F5U		FUM	
	No. of Keywords	%	No. of Keywords	%
Structure	33	**20**	64	**33**
Material	38	**23**	66	**34**
Construction	7	**4**	14	**7**
Transportation	16	**10**	4	**2**
Environment	74	**44**	47	**24**
Σ	168		195	

In the following, each sub-discipline will be investigated in particular. Due to the small number of shared keywords for each sub-discipline, comparative diagrams of shared keywords, as in Figures (2) and (3), are not indicative, and qualitative interpretation is rather preferred. For qualitative comparison, the first 10 keywords are compared for the two institutions. In Tables (4) to (8), these keywords are reported for the five sub-disciplines of Civil Engineering.

3-2-1. Structure

Number of keywords in Structure sub-discipline in F5U and FUM is 33 and 64, respectively. The only shared keywords are failure mode (with rank 2 at F5U and rank 20 at FUM), and physical model test (with rank 17 in F5U and rank 34 in FUM). This indicates that studies in this sub-discipline at FUM, are significantly different from those in F5U; e.g. health monitoring and damage detection are the most common subjects, considered to have technological potential at FUM; however, the two keywords rank 60^{th} and 570^{th} among the keywords of five top universities of the world.

3.2.2. Building Materials

The research status for building-materials sub-discipline at FUM is almost similar to that of structure sub-discipline, and is significantly different from that of F5U. FUM research trend in this field of study is mostly focused on traditional building materials such as concrete and polymer-based composite materials such as FRP. However, f5U have taken an approach towards bio- and nano- materials, especially single-layer crystals and 2D materials. For example, while FRP related studies seem to be among the first technological priorities of the researchers at FUM, it ranks beyond 200 at F5U. The only shared keyword in this sub-discipline is electrical resistivity (with the rank of 34 in F5U and 36 in FUM).

3.2.3. Construction Management

The field of construction management is a relatively newer sub-discipline among various branches of Civil Engineering. Therefore, the number of studies in this field is less, and there is also a smaller gap between the researches of FUM and the top five universities. The shared keyword in this field is multi-criteria decision analysis, which seems to have a relatively similar

Table 4. Top subjects in the field of structure for F5U and FUM.

Rank	Research Subject	Number of Sponsors	Development	Investment	Technology-Potential
			F5U		
1	Swash	18	0.091	0.128	1.404
2	Reverse Time Migration	13	0.068	0.092	1.352
3	Material Point Method	14	0.053	0.099	1.872
4	Hydrocarbon Storage	13	0.053	0.092	1.739
5	Kinetic Energy	11	0.053	0.078	1.471
6	Acoustic	10	0.053	0.071	1.337
7	Lattice Fracture Model	10	0.038	0.071	1.872
8	Turbulent Kinetic Energy	9	0.038	0.064	1.685
9	Heterogeneity	8	0.038	0.057	1.498
10	Failure Mode	14	0.030	0.099	3.277
			FUM		
1	Health Monitoring	8	1.000	0.889	0.889
2	Time Series Analysis	4	0.615	0.444	0.722
3	Damage Detection	4	0.558	0.444	0.797
4	Rc Beam	3	0.365	0.333	0.912
5	Unsupervised Learning	2	0.327	0.222	0.680
6	Bond Stress	2	0.288	0.222	0.770
7	Ductility	2	0.250	0.222	0.889
8	Feature Extraction	2	0.231	0.222	0.963
9	Non-Stationary Signal	3	0.212	0.333	1.576
10	Creep	2	0.212	0.222	1.051

Table 5. Top subjects in the field of building materials for F5U and FUM.

Rank	Research Subject	Number of Sponsors	Development	Investment	Technology-Potential
			F5U		
1	Silk	31	0.091	0.220	2.418
2	Phosphorus	22	0.091	0.156	1.716
3	Damage	17	0.091	0.121	1.326
4	Graphene	23	0.083	0.163	1.957
5	Biomaterial	16	0.083	0.113	1.362
6	Hydrogel	24	0.076	0.170	2.247
7	Carbonation	20	0.076	0.142	1.872
8	Iron	19	0.076	0.135	1.779
9	Ceramic Membrane	16	0.068	0.113	1.664
10	Wood	13	0.061	0.092	1.521
			FUM		
1	Mechanical Property	9	0.769	1.000	1.300
2	Concrete	2	0.385	0.222	0.578
3	Gfrp	2	0.365	0.222	0.608
4	Durability	3	0.346	0.333	0.963
5	Self-Compacting Concrete	3	0.327	0.333	1.020
6	Roller Compacted Concrete	2	0.308	0.222	0.722
7	Impedance Spectroscopy	6	0.231	0.667	2.889
8	Open Circuit Potential	6	0.231	0.667	2.889
9	Recycled Aggregate	2	0.212	0.222	1.051
10	Foam Concrete	6	0.192	0.667	3.467

priority for both institutions. As can be seen from Table (6), significant investment has been made on this issue in the top universities of the world.

3.2.4. Transportation

There is a large thematic difference between F5U and FUM keyword subsets for the field of

Table 6. Top subjects in the field of Construction Management for F5U and FUM.

Rank	Research Subject	Number of Sponsors	Development	Investment	Technology-Potential
		F5U			
1	Decision Making	18	0.061	0.128	2.106
2	Robust Optimization	7	0.015	0.050	3.277
3	Multi-Criteria Decision Analysis	4	0.015	0.028	1.872
4	Quality Control	4	0.015	0.028	1.872
5	Evacuations	6	0.000	0.043	-
6	Benefit Assessment	2	0.000	0.014	-
7	Lean Construction	0	0.000	0.000	-
		FUM			
1	Integrated Solid Waste Management	3	0.096	0.333	3.467
2	Location-Routing Problem	3	0.096	0.333	3.467
3	Mixed-Integer Linear Programming	3	0.096	0.333	3.467
4	Simulated Annealing	3	0.096	0.333	3.467
5	Variable Neighbourhood Search	3	0.096	0.333	3.467
6	Data Aggregation	1	0.096	0.111	1.156
7	Geometry Of Interest (Goi)	1	0.096	0.111	1.156
8	Goi Quality Measurement Metrics	1	0.096	0.111	1.156
9	Landscape Management	1	0.096	0.111	1.156
10	Multi-Criteria Decision Analysis	1	0.077	0.111	1.444

Table 7. Top subjects in the field of Transportation for F5U and FUM.

Rank	Research Subject	Number of Sponsors	Development	Investment	Technology-Potential
			F5U		
1	Agent Based Simulation	17	0.038	0.121	3.183
2	Public Transport	12	0.038	0.085	2.247
3	Accessibility	6	0.030	0.043	1.404
4	Docked Bike-Sharing	14	0.023	0.099	4.369
5	Human Mobility	6	0.023	0.043	1.872
6	Traffic Control	5	0.023	0.035	1.560
7	Electric Vehicle	16	0.015	0.113	7.489
8	Urban Traffic	6	0.015	0.043	2.809
9	Shared Mobility	4	0.015	0.028	1.872
10	Logistic Regression	3	0.015	0.021	1.404
			FUM		
1	Aberrant Driving Behavior	1	0.077	0.111	1.444
2	Demographic Factors	1	0.077	0.111	1.444
3	Offending Driver	1	0.077	0.111	1.444
4	Personality Type	1	0.077	0.111	1.444

Table 8. Top subjects in the field of Environment and Water-Resource Management for F5U and FUM.

Rank	Research Subject	Number of Sponsors	Development	Investment	Technology-Potential
		F5U			
1	Arsenic	32	0.167	0.227	1.362
2	Constructed Wetland	19	0.091	0.135	1.482
3	Bacterial Community	17	0.083	0.121	1.447
4	Microbial Community	43	0.076	0.305	4.026
5	Anaerobic Digestion	17	0.076	0.121	1.591
6	Metagenomics	14	0.076	0.099	1.311
7	Volcanic Ash	25	0.068	0.177	2.600
8	Disinfection	21	0.068	0.149	2.184
9	Microbial Ecology	13	0.068	0.092	1.352
10	ph	13	0.068	0.092	1.352
		FUM			
1	Scanning Electron Microscopy	5	0.365	0.556	1.520
2	Municipal Solid Waste	3	0.346	0.333	0.963
3	Corrosion Resistance	6	0.192	0.667	3.467
4	Microbial Carbonate Precipitation	2	0.192	0.222	1.156
5	Protected Areas	1	0.192	0.111	0.578
6	Sewage Sludge	2	0.173	0.222	1.284
7	Anaerobic Digestion	2	0.173	0.222	1.284
8	Waste	1	0.154	0.111	0.722
9	Histopathology	1	0.154	0.111	0.722
10	Virtual Water Trade	1	0.154	0.111	0.722

Transportation. This significant difference is partly due to the small amount of research at FUM, and partly to the high financial and human investment, as well as organizing interdisciplinary studies at F5U. As it is clear from Table (7), a significant investment has been made by the industry on some keywords in the field of autonomous and clean transportation.

3.2.5. Environment

There are more shared keywords between FUM and F5U in the field of environment and water-resource management, compared to other sub-disciplines. These keywords are: life cycle assessment, anaerobic digestion, air pollutant, renewable energy and sewage sludge. However, the subjects with the most investment in the top universities of the world are not seen among the keywords of Ferdowsi University.

4. Conclusion

This article aimed to provide, in a simple and applicable way, a process to identify, rank and measure the research capacity of subjects in the field of Civil Engineering. It also arranged a comparison of thematic priorities in the field, between the top five universities in the world and Ferdowsi University of Mashhad. Thematic comparison was conducted for the whole field, as well as its sub-discipline. The results of the overall comparison showed that the method is suitably valid for characterizing thematic similarities. It confirmed, as a general conclusion, that topics and their priorities of the top five universities of the world are significantly closer to the sixth top university, compared to Ferdowsi University of Mashhad. However, for a better and qualitative conclusion, that will help research policy-making procedures for the university, it is necessary to examine and compare the subjects at the level of sub-disciplines. In this research, thematic priorities of researchers at both institutes (F5U and FUM) are evaluated and compared for different sub-disciplines. The results of these surveys show that except in the two sub-disciplines of Construction Management and Environment and Water-Resource Management (both of which are considered as new subfields of Civil Engineering), thematic differences as well as their priorities between FUM and F5U are striking. Surly there remains further investigation and study to clarify that this significant difference is due to the research reluctancy and uncreativity, or it follows an ordered organized scientific policy. Also, it deserves to note that in some subfields such as Construction Management, where FUM researchers deal with new issues, it is necessary to be careful about the efficiency and effectiveness of methods and technologies in solving real challenges and problems, so as to avoid luxury researches (with high cost and low efficiency). Generally, it seems that such studies may significantly enhance research policy-making procedures for universities and research institutes, and facilitate revisions on thematic trends in academic research to better match needs and promising technologies.

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