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RESEARCH ARTICLE

A comparative analysis of textile schools by journal publications listed in Web of Science™

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ABSTRACT

In this study, a comparative analysis of textile schools around the world based on research journal publications is made using the most popular bibliometric evaluation methodology. The study benchmarks bibliometric evaluation of professional research institutions related to textile, apparel, fashion and clothing in recent years from 2014 to 2019. Based on **Web of Science™**, a total of 124,362 research publications (not counting conference papers) from 2014 to 2019 were found to be textile or fiber related. Out of more 1000 textile schools worldwide, 31 schools from 18 countries or territories were identified to be among the top 100 institutions contributing the textile or fiber related publications listed in Web of Science™. These 31 textile schools are ranked in terms of productivity and citation impact, including total number of publications, publication per staff, h-index, total citations, average citations, and citation per staff. While these bibliometric measures provide some insights of the trends of the research activities and influences of textile schools in the world, they should be interpreted with caution as the quality of research contributions in terms of originality, scientific rigor and societal impact may not be reflected by the publication counts and the cites they receive.

1. Introduction

Many universities and colleges around the world offer various multi-level textile-related majors which provide professional education in technology, art & design and business for the global textile industry. By searching the website using keywords including textile, apparel, fashion, clothing, etc., more than 1000 universities or colleges in different parts of the world, which are engaging in the textile-related professional education and research activities, were identified, as shown in Figure 1.

From a global perspective, textile related schools or institutions are mainly located in the densely populated regions of the northern temperate zone. Textile related specialisms are mainly categorized into (i) textile technology & engineering, (ii) fashion & design, (iii) materials science & engineering. The distribution of textile schools and specialisms is closely related to the history & size of the local textile industry and population, cultural traditions, climate, etc. As shown in Figure 1(a) and (b), most textile schools are in Asia, followed by Europe and North America. For the Asian countries which have the largest textile industries such as China and India, the universities and colleges mainly focus on textile technology & engineering, and materials science; for countries with relatively larger apparel markets and fashion industries, such as the USA, the UK, Italy, Romania and Poland, high-value-added fashion design and business related majors are developing as mainstream specialisms in

local universities and colleges (http://www.texindex.com.cn/Articles/2006-6-6/27087.html).

The number of textile related departments of major countries and their specialisms are shown in Figure 2. China has the most number of textile related schools/departments in educational institutions, owing to the manpower demand for being one of the most important suppliers of textiles in the world (Ma & Zhao, 2011). India has the second most number of textile related schools/departments in educational institutions. This is probably due to the fact that India is the third largest cotton-producing country in the world, and has a large-scale cotton related textile industry and associated strong technical and research strength in spinning, weaving, printing and dyeing. The textile and apparel industry has become a pillar one in India, accounting for 20% of the national manufacturing industry and employing 15 million people (http://www.texindex.com.cn/Articles/2006-6-6/27087.html). India's textile research institutions are mainly located in densely populated industrial areas. Many universities created strong collaboration in textile technology, textile engineering and other specialties, to deliver the relevant professional skills and expertise for the textile industry. USA and UK have the third and fourth most number of textile related schools/departments in educational institutions, respectively. As a result of globalization, the number of textile research institutions in both US and UK have decreased significantly, but their fashion design schools have shown a significant growth. This may
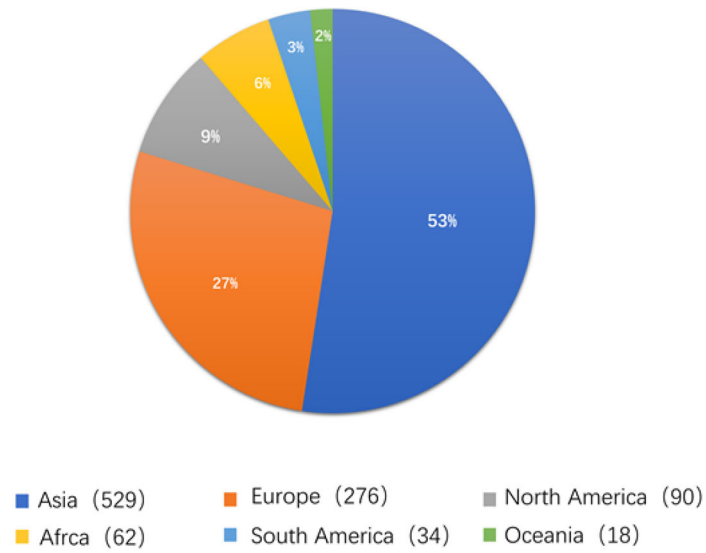
(a)
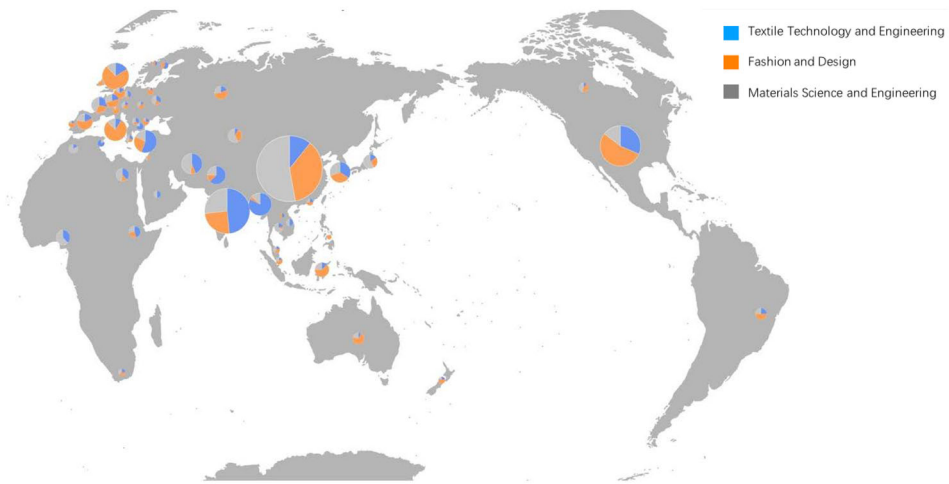
(b)

Figure 1. (a) Geographical distribution and (b) specialism distribution of textile schools.
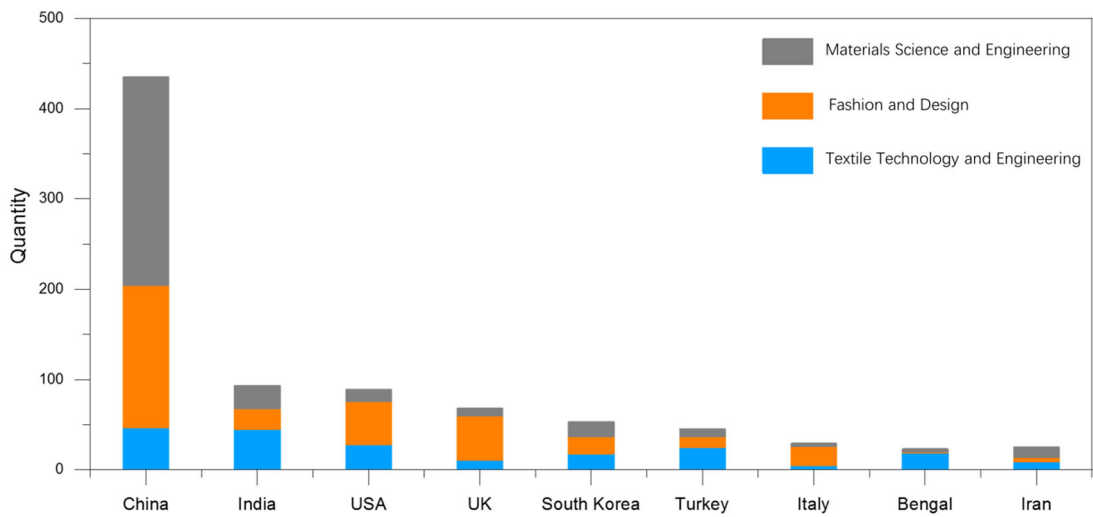

Figure 2. The number and specialization of textile departments/schools of major countries

be due to the fact that developed countries embraced outsourcing to taking advantage of lower labor costs in developing countries, resulting in a shrinkage of the manpower demand for the textile and apparel manufacturing industry. For example, the U.S. textile and apparel industries lost 76.5% of its workforce, or 1.2 million jobs, between 1990 and 2012 (Ulferts et al., 2018).

This study benchmarks bibliometric evaluation of professional research institutions related to textile, apparel, fashion and clothing in recent years from 2014 to 2019. A total of 124,362 research publications of journal articles and reviews in the database of the Web of Science^{TM} were identified as textile related through the powerful search function of the Web of Science^{TM} based on the address or keywords in the title of the publication. The Web of Science^{TM} is one of the world's largest and most comprehensive academic information resources covering more than 12,000 core academic journals in the most influential fields of natural science, engineering technology, biomedicine, social sciences and other research fields. Details about the data source, methodology, bibliometric indicators, comparator analysis etc., are given below.

2. Data and methodology

This section discusses bibliometrics, data sources and summarized the methodology used in this study.

2.1. Bibliometrics and citation analysis

Publication of research outcomes is an integral part of the research process. Bibliometrics has been increasingly used for the evaluation of research performance. Bibliometrics is defined as the analysis of data derived from publications and their citations. Nevertheless, indicators derived from bibliometrics based on publication and citation data should be used and interpreted with great caution, especially for the multi-disciplinary field of textiles. This is because some fields publish at faster rates than others and citation rates also vary. Citation counts must be carefully normalized to account for such variations by field. Because citation counts naturally grow over time it is essential to account for growth by year. Normalization is usually done by reference to the relevant global average for the field and for the year of publication.

Bibliometric indicators have been found to be more relevant for core natural sciences, especially for basic science, than for applied and professional areas and for social sciences. In professional and technological areas, the range of publication modes used by leading researchers is likely to be diverse as they target a diverse, nonacademic audience. In social sciences there is also a diversity of publication modes and citation rates are typically much lower than in natural sciences.

Bibliometrics work best with large data samples. As the data are disaggregated, so the relationship weakens. Average indicator values (e.g. of citation impact) for small numbers of publications can be skewed by single outlier values. At a finer scale, when analyzing the specific outcome for individual departments, the statistical relationship is rarely a sufficient guide by itself. For this reason, bibliometrics are best used in support of, but not as a substitute for, expert decision processes. Well-founded analyses can facilitate conclusions to be reached more rapidly and with greater certainty and are therefore an aid to management and to increased confidence among stakeholders, but they are not a substitute for a review by well-informed and experienced peers.

2.2. Data source

For this evaluation, bibliometric data were sourced from the Web of Science^{TM}, which is widely acknowledged to be the world's leading source of citation and bibliometric data for science and technology. It focuses on research published in journals and conferences in science, medicine, arts, humanities and social sciences. The authoritative, multidisciplinary content covers over 12,000 of the highest impact journals worldwide, including Open Access journals and over 160,000 conference proceedings. Coverage is both current and retrospective in the sciences, social sciences, arts and humanities, and goes across disciplines.

This report compiled data from seven citation indexes in the Web of Science^{TM} Core Collection, including:

- Science Citation Index Expanded (SCI-EXPANDED) –1970-present
- Social Sciences Citation Index (SSCI) –1970-present
- Arts & Humanities Citation Index (A&HCI) –1975-present
- Conference Proceedings Citation Index- Science (CPCI-S) –1990-present
- Conference Proceedings Citation Index- Social Science & Humanities (CPCI-SSH) –1990-present
- Emerging Sources Citation Index (ESCI) –2015-present

Besides the bibliometric indicators sourced from Web of Science^{TM}, the number of academic staff in each of the relevant institute was obtained from their website.

2.3. Data collection

This report was compiled from the articles related to textiles and clothing from 2014 to 2019. It analyzed publications within the date range containing the keywords of "textile", "fashion", "cloth" or "apparel" in ADDRESS or "textile", "fashion", "cloth" or "apparel" or "fiber" in TITLE.

The keywords were selected based on the understanding that 1) most publications by textile schools will be identified by their address containing keywords of "textile", "fashion", "cloth" or "apparel" even if the publications do not contain "textile", "fashion", "cloth" or "apparel" or "fiber" in their TITLE; 2) For an organization whose address does not contain keywords of "textile", "fashion", "cloth" or "apparel", its publication having the keywords of "textile", "fashion", "cloth" or "apparel" or "fiber" in the TITLE will also be included. This avoids missing some textile schools/

departments merged into materials sciences, design, human ecology or other schools/departments.

Including publications having the keyword of "fiber" in the title is debatable, as many publications with the keyword "fiber" may belong to the field of optical communication (e.g. optical fibers), composite materials (e.g. fiber composites), sensing (e.g. fiber sensors), or health (fiber nutrients and nerve fibers). However, we decided to include them for 1) Many colleagues in the textile field is developing or applying optical fibers or fiber sensors in the development of smart wearables, which is becoming an important research trend in fashion and textiles; 2) Many textile schools are well known in fiber composite research; 3) Many colleagues in the textile field has expanded or established their research related to health. With the inclusion of publications having the keyword of "fiber" in the title, non-textile schools, but active in optical fibers, fiber composites, or other fiber related research may be shortlisted for the productivity of their research publications. But they were easily identified for having no textile programmes and were omitted in the comparative analysis. From the outputs of the search, it was evident that most research active textile schools are included in the 31 schools for the comparative analysis.

With the above keywords in publication address and title, one possible limitation is that, if the publication is about a specific fiber or fibers such as polyester and cotton, but does not contain the keyword of "fiber" in its title, and the publication is from a non-textile organization whose address or name does not contain "textile", "fashion", "cloth" or "apparel", such a publication is not included. However, we believe such publications are very small in quantity if any.

The result was limited to the document type of Articles and Reviews. The following code was employed to access the data:

ADDRESS: (text* or fashion* or cloth* or apparel*) OR TITLE: (text* or fashion* or cloth* or apparel* or fiber*) AND Timespan: 2014–2019.

Refined by: DOCUMENT TYPES: (Article OR Review)

Followed refined by: ORGANIZATIONS-ENHANCED: ("name of ranked universities")

Indexes: SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI.

There were 124,362 relevant publications identified (retrieved on May 1, 2020) and the data analyzed by "Organization-enhanced" in the Web of Science™ to identify the comparators used in this report.

The data was limited to the document type of Articles and Reviews. Based upon the total number of textile related research articles and reviews listed in the Web of Science™, the top 100 academic or research institutions were identified, among which 31 institutions located in 18 countries or territories were textile schools (i.e. institutions having the textile-related discipline in their programmes). These 31 textile schools were further analysed and compared, while the non-textile schools were excluded from the top 100 institutions for further analysis.

In accounting the number of academic staff in each institution, only principal investigators in the field of textile and/or clothing engineering and technology as listed in the website of respective institutions are counted. It is highly possible that researchers in other fields (e.g. materials, management or design) may also contribute to the publications related to textiles or fibers, they are excluded due to the difficulty in identifying these researchers consistently across different institutions as a result of very diverse organizational structures. For example, textile management is included in management departments in some schools and included in textile departments in others. Fashion design is included in art and design departments in some schools, but included in textile and clothing departments in others. Only counting the number of principal investigators (PI) in the field of textile, clothing or fashion engineering/technology, which contribute the most of these textile related publications, makes it consistent to all textile schools.

Although fashion related papers are included in the analysis, academic staff in fashion design and business are not counted because 1) most these fashion related papers listed in Web of Science™ are fashion technology related or are co-authored with a technologist; 2) many fashion design and business academic staff conduct practice-based scholarship or publish their papers in journals not listed in Web of Science™ such as Fashion Theory-The Journal of Dress Body & Culture, Fashion Practice-The Journal of Design, Creative Process & the Fashion Industry, Journal of fashion marketing and management; 3) as shown in Annex I, no fashion specific journals are among the highly cited journals, indicating fashion related journals included in Web of Science™ do not make significant contribution towards citations in this analysis; 4) the purpose of counting the number of PI was to estimate the research productivity per active researcher. It is however true that some fashion design and business staff may have contributed the publications analysed in this study. Nevertheless, it is considered that, the inclusion of these non-technologists in accounting the number of academic staff in each institution would make an very unfair comparision between an institution with only textile technology activities and the one with significant components of fashion design and business. In this analysis, we have already included PIs in fashion technology and technical apparel design, making the research productivity measures in terms of citations per staff and publications per staff slightly in favor of institutions without fashion design and business.

Due to the complexity in determining the number of active researchers and counting the research outputs, the number of academic staff listed in this analysis should be treated as an indicator of the relative size of textile activities in an institution, instead of the absolute number of researchers contributing to textile publications.

2.4. Bibliometric indicators

Total publications: The record of an article that were indexed by Web of Science™, a database of records of articles from more than 12,000 scholarly journals. The terms 'paper' and 'publication' are often used interchangeably in this report.

% Documents in the selected subject area: Number of articles in the selected subject area (that is, textiles, fashion, apparel and clothing) produced by an institution divided by the total number of publications in the analyzed area.**h-index**: the h-index value is based on a list of publications ranked in descending order by the Times Cited count. An index of h means that there are h papers that have each been cited at least h times. The h-index is based on the number of years of your products subscription and your selected timespan. Source items that are not part of your subscription will not be factored into the calculation.

Sum of times cited: This is the total number of citations for all items in the results set. This equals the sum of the total column in Table 1. **Without self-citations:** this is the total number of citations, but with citations from other items in the citation report not counted.

Average citations per item: This is the average number of citing articles for all items in the results set. It is the sum of the times cited count divided by the number of items in the set.

Total number of research active academic staff in each textile school: The number of research active academic staff in the analysis is counted as those research active academic staff currently employed by the organization in the area of textile technology, textile chemistry, textile materials, and clothing technology, but not counting those colleagues in fashion design and fashion business. The number of research active academic staff was determined by accessing the website of each textile school in May 2020.

Publication per staff: This is the average publication of the academic staff for all items in the result set. It is the total number of publications divided by the total number of research active academic staff.

Citation per staff: This is the average citation of the academic staffs for all items in the result set. It is the total citation divided by the number of research active academic staff.

3. Comparative bibliometrics

This section analyzed the institutions' performance in textiles, fashion, apparel and clothing studies. The indicators employed in the analysis include the number of total publications, the percentage of the documents in the subject area, h-index, sum of time cited and average citations per item (citation impact) relative to subject area.

3.1. Comparators

A comparative analysis of global textile schools was made according to the most popular bibliometric evaluation methodology (Ellegaard & Wallin, 2015). Totally 31,684 institutions made contribution to the 124,362 publications, and top 100 institutions were selected in terms of publication number. Among the top publication institutions, 31 textile schools from 18 countries or territories were identified.

Table 1. Total number of publications of the top 31 schools textile related (2014–2019).

Ranking	Institutions	Total publications
1	DONGHUA UNIVERSITY	2,829
2	ZHEJIANG SCI TECH UNIVERSITY	1,574
3	HONG KONG POLYTECHNIC UNIVERSITY	1,532
4	WUHAN TEXTILE UNIVERSITY	1,524
5	SUZHOU UNIVERSITY	1,252
6	TIANGONG UNIVERSITY	1,195
7	QINGDAO UNIVERSITY	1,139
8	JIANGNAN UNIVERSITY	1,094
9	ISLAMIC AZAD UNIVERSITY	913
10	SICHUAN UNIVERSITY	896
11	SHINSHU UNIVERSITY	806
12	AMIRKABIR UNIVERSITY OF TECHNOLOGY	794
13	NORTH CAROLINA STATE UNIVERSITY	793
14	INDIAN INSTITUTE OF TECHNOLOGY IIT DELHI	697
15	GHENT UNIVERSITY	564
16	NATIONAL RESEARCH CENTRE NRC	557
17	SEOUL NATIONAL UNIVERSITY SNU	551
18	ISFAHAN UNIVERSITY OF TECHNOLOGY	501
19	NATIONAL TEXTILE UNIVERSITY PAKISTAN	439
20	CORNELL UNIVERSITY	433
21	UNIVERSITY OF ZAGREB	430
22	HANYANG UNIVERSITY	411
23	UNIVERSITY OF MANCHESTER	409
24	RWTH AACHEN UNIVERSITY	400
25	CHUNGNAM NATIONAL UNIVERSITY	390
26	IOWA STATE UNIVERSITY	390
27	DEAKIN UNIVERSITY	388
28	GEORGIA INSTITUTE OF TECHNOLOGY	373
29	LODZ UNIVERSITY OF TECHNOLOGY	364
30	TECHNICAL UNIVERSITY LIBEREC	362
31	YONSEI UNIVERSITY	348

3.2. Institution output

Table 1 shows the total publications of the 31 schools with textile disciplines. This report collected 124,362 papers (journal papers and reviews) published by worldwide textiles, fashion, apparel and clothing institutions from 2014 to 2019. Among the 31 selected comparator institutions, Donghua University published the most papers (2,829 publications), then Zhejiang Sci Tech University (1,574 publications), followed by the Hong Kong Polytechnic University (1,532 publications), followed by Wuhan Textile University (1,524 publications) and Suzhou University (1,252 publications). It can be seen that the Donghua University published much more paper than any other institutions, accounting for 2.28% of total publications in textile and clothing area. In addition, it shows in Table 1 that most of the top institutions are located in Asia (primarily in China), indicating the region's greatest interest and enthusiasm in developing their professional knowledge and competencies in textiles and clothing.

3.3 H-index

The h-index is intended to measure the quality and quantity of scientific output simultaneously. It considers both the number of papers and the number of citations per paper and thus can provide insights to an author or an institution's overall performance in the research community. Table 2 shows the top 31 textile related institutions with h-index values. The Hong Kong Polytechnic University and Donghua University hold the highest h-index of 62,

followed by Suzhou University with 53, Zhejiang Sci Tech University and Qingdao University with 51, Wuhan Textile University with 46, and Georgia Institute of Tech with 45. The above textile schools rank top 5 in h-index.

Table 2. *h*-index of top 31 schools (2014–2019).

Ranking	Institutions	h-index
1	HONG KONG POLYTECHNIC UNIVERSITY	62
1	DONGHUA UNIVERSITY	62
3	SUZHOU UNIVERSITY	53
4	ZHEJIANG SCI TECH UNIVERSITY	51
4	QINGDAO UNIVERSITY	51
6	WUHAN TEXTILE UNIVERSITY	46
7	GEORGIA INSTITUTE OF TECHNOLOGY	45
8	NORTH CAROLINA STATE UNIVERSITY	44
9	NATIONAL RESEARCH CENTRE NRC	38
10	TIANGONG UNIVERSITY	38
11	AMIRKABIR UNIVERSITY OF TECHNOLOGY	37
12	SICHUAN UNIVERSITY	37
13	DEAKIN UNIVERSITY	35
14	ISLAMIC AZAD UNIVERSITY	35
15	CORNELL UNIVERSITY	32
16	JIANGNAN UNIVERSITY	32
17	INDIAN INSTITUTE OF TECHNOLOGY IIT DELHI	32
18	SHINSHU UNIVERSITY	31
19	HANYANG UNIVERSITY	31
20	SEOUL NATIONAL UNIVERSITY SNU	30
21	GHENT UNIVERSITY	29
22	UNIVERSITY OF MANCHESTER	28
23	RWTH AACHEN UNIVERSITY	28
24	YONSEI UNIVERSITY	26
25	ISFAHAN UNIVERSITY OF TECHNOLOGY	26
26	CHUNGNAM NATIONAL UNIVERSITY	25
27	IOWA STATE UNIVERSITY	24
28	NATIONAL TEXTILE UNIVERSITY PAKISTAN	19
29	LODZ UNIVERSITY OF TECHNOLOGY	19
30	TECHNICAL UNIVERSITY LIBEREC	18
31	UNIVERSITY OF ZAGREB	17

3.4. Citation impact

Average citations per item is the average number of citing articles for all items in the results set. It is the sum of the times cited count divided by the number of results in the set. It is an indication of the quality or influence of the publications from an institution. Table 3 shows the total number of citations (excluding self-citation) and average citations per item of top 31 schools with textile disciplines from 2014 to 2019.

Only 8 institutions in textile own the average citations per item more than 10, which can be seen from Table 3. Top 5 institutions are Georgia Institute of Technology (23.08), followed with Hong Kong Polytechnic University (14.79), Deakin University (11.86), North Carolina State University (11.60) and Qingdao University (11.48).

There are 6 institutions have more than 10,000 citations including the Donghua University (25,189), Hong Kong Polytechnic University (22,654), Zhejiang Sci Tech University (15,766), Suzhou University (13,999), Qingdao University (13,078) and Wuhan Textile University (12,073).

3.5. Staff output

Using the number of staffs in each professional institute in textile and clothing technology, the number of publication per staff and citation per staff are shown in Tables 4 and 5. This items were intended to measure the publication productivity and research quality of the academic staffs in each of the institutions and thus to provide insights of academic ability of the academic staffs. The staff numbers in textile and clothing related technology of institutions

Table 3. Total number of citations (excluding self-citation) and average citations per item of top 31 schools (2014–2019).

Ranking	Institutions	Total number of citations	Average citations
1	GEORGIA INSTITUTE OF TECHNOLOGY	8,609	23.08
2	HONG KONG POLYTECHNIC UNIVERSITY	22,654	14.79
3	DEAKIN UNIVERSITY	4,603	11.86
4	NORTH CAROLINA STATE UNIVERSITY	9,197	11.60
5	QINGDAO UNIVERSITY	13,078	11.48
6	SUZHOU UNIVERSITY	13,999	11.18
7	HANYANG UNIVERSITY	4,363	10.62
8	ZHEJIANG SCI TECH UNIVERSITY	15,766	10.02
9	YONSEI UNIVERSITY	3,295	9.92
10	CORNELL UNIVERSITY	4,207	9.72
11	DONGHUA UNIVERSITY	25,189	8.90
12	UNIVERSITY OF MANCHESTER	3,427	8.38
13	SEOUL NATIONAL UNIVERSITY SNU	4,485	8.14
14	NATIONAL RESEARCH CENTRE NRC	4,490	8.06
15	AMIRKABIR UNIVERSITY OF TECHNOLOGY	6,368	8.02
16	WUHAN TEXTILE UNIVERSITY	12,073	7.92
17	SICHUAN UNIVERSITY	7,084	7.91
18	RWTH AACHEN UNIVERSITY	3,144	7.86
19	INDIAN INSTITUTE OF TECHNOLOGY IIT DELHI	5,470	7.85
20	IOWA STATE UNIVERSITY	3,012	7.72
21	GHENT UNIVERSITY	4,346	7.71
22	ISLAMIC AZAD UNIVERSITY	6,848	7.50
23	CHUNGNAM NATIONAL UNIVERSITY	2,888	7.41
24	SHINSHU UNIVERSITY	5,729	7.11
25	TIANGONG UNIVERSITY	7,719	6.46
26	ISFAHAN UNIVERSITY OF TECHNOLOGY	3,134	6.26
27	JIANGNAN UNIVERSITY	6,536	5.97
28	LODZ UNIVERSITY OF TECHNOLOGY	1,726	4.74
29	NATIONAL TEXTILE UNIVERSITY PAKISTAN	1,860	4.24
30	TECHNICAL UNIVERSITY LIBEREC	1,494	4.13
31	UNIVERSITY OF ZAGREB	1,273	2.96

Table 4. Average number of publications per staff of the 31 schools (2014–2019).

Ranking	Institutions	Total number of publications	Total number of Staff	Average number of Publications per Staff
1	ISLAMIC AZAD UNIVERSITY	913	9	101.44
2	IOWA STATE UNIVERSITY	390	4	97.50
3	YONSEI UNIVERSITY	348	4	87.00
4	HANYANG UNIVERSITY	411	5	82.20
5	GEORGIA INSTITUTE OF TECHNOLOGY	373	5	74.60
6	HONG KONG POLYTECHNIC UNIVERSITY	1,532	21	72.95
7	CORNELL UNIVERSITY	433	8	54.13
8	ISFAHAN UNIVERSITY OF TECHNOLOGY	501	10	50.10
9	SEOUL NATIONAL UNIVERSITY SNU	551	11	50.09
10	DEAKIN UNIVERSITY	388	10	38.80
11	UNIVERSITY OF MANCHESTER	409	11	37.18
12	INDIAN INSTITUTE OF TECHNOLOGY IIT DELHI	697	23	30.30
13	AMIRKABIR UNIVERSITY OF TECHNOLOGY	794	35	22.69
14	CHUNGNAM NATIONAL UNIVERSITY	390	18	21.67
15	RWTH AACHEN UNIVERSITY	400	19	21.05
16	ZHEJIANG SCI TECH UNIVERSITY	1,574	80	19.68
17	NORTH CAROLINA STATE UNIVERSITY	793	44	18.02
18	GHENT UNIVERSITY	564	33	17.09
19	WUHAN TEXTILE UNIVERSITY	1,524	98	15.55
20	DONGHUA UNIVERSITY	2,829	193	14.66
21	QINGDAO UNIVERSITY	1,139	89	12.80
22	JIANGNAN UNIVERSITY	1,094	92	11.89
23	SUZHOU UNIVERSITY	1,252	114	10.98
24	TIANGONG UNIVERSITY	1,195	112	10.67
25	SICHUAN UNIVERSITY	896	93	9.63
26	SHINSHU UNIVERSITY	806	91	8.86
27	UNIVERSITY OF ZAGREB	430	54	7.96
28	TECHNICAL UNIVERSITY LIBEREC	362	55	6.58
29	NATIONAL TEXTILE UNIVERSITY PAKISTAN	439	100	4.39
30	NATIONAL RESEARCH CENTRE NRC	557	130	4.28
31	LODZ UNIVERSITY OF TECHNOLOGY	364	94	3.87

Table 5. Total number of citation and average number of citation per staff of the 31 schools (2014–2019).

Ranking	Institutions	Total number of citations	Total number of Staff	Average number of Citation per Staff
1	GEORGIA INSTITUTE OF TECHNOLOGY	8,609	5	1721.80
2	HONG KONG POLYTECHNIC UNIVERSITY	22,654	21	1078.76
3	HANYANG UNIVERSITY	4,363	5	872.60
4	YONSEI UNIVERSITY	3,295	4	823.75
5	ISLAMIC AZAD UNIVERSITY	6,848	9	760.89
6	IOWA STATE UNIVERSITY	3,012	4	753.00
7	CORNELL UNIVERSITY	4,207	8	525.88
8	DEAKIN UNIVERSITY	4,603	10	460.30
9	SEOUL NATIONAL UNIVERSITY SNU	4,485	11	407.73
10	ISFAHAN UNIVERSITY OF TECHNOLOGY	3,134	10	313.40
11	UNIVERSITY OF MANCHESTER	3,427	11	311.55
12	INDIAN INSTITUTE OF TECHNOLOGY IIT DELHI	5,470	23	237.83
13	NORTH CAROLINA STATE UNIVERSITY	9,197	44	209.02
14	ZHEJIANG SCI TECH UNIVERSITY	15,766	80	197.08
15	AMIRKABIR UNIVERSITY OF TECHNOLOGY	6,368	35	181.94
16	RWTH AACHEN UNIVERSITY	3,144	19	165.47
17	CHUNGNAM NATIONAL UNIVERSITY	2,888	18	160.44
18	QINGDAO UNIVERSITY	13,078	89	146.94
19	GHENT UNIVERSITY	4,346	33	131.70
20	DONGHUA UNIVERSITY	25,189	193	130.51
21	WUHAN TEXTILE UNIVERSITY	12,073	98	123.19
22	SUZHOU UNIVERSITY	13,999	114	122.80
23	SICHUAN UNIVERSITY	7,084	93	76.17
24	JIANGNAN UNIVERSITY	6,536	92	71.04
25	TIANGONG UNIVERSITY	7,719	112	68.92
26	SHINSHU UNIVERSITY	5,729	91	62.96
27	NATIONAL RESEARCH CENTRE NRC	4,490	130	34.54
28	TECHNICAL UNIVERSITY LIBEREC	1,494	55	27.16
29	UNIVERSITY OF ZAGREB	1,273	54	23.57
30	NATIONAL TEXTILE UNIVERSITY PAKISTAN	1,860	100	18.60
31	LODZ UNIVERSITY OF TECHNOLOGY	1,726	94	18.36

were checked individually on relevant departments/faculties website.

In terms of publications per staff, as shown in Table 4, Islamic Azad University holds the highest staff output of 101.44, followed by Iowa State University of 97.50, Yonsei University of 30.93, Hanyang University of 82.20, Georgia Institute of Technology of 74.60, Hong Kong Polytechnic University of 72.95, Cornell University of 54.13, and so on

In terms of citations per staff, as shown in Table 5, Georgia Institute of Technology holds the highest citation per staff (1721.8) followed by Hong Kong Polytechnic University (1078.76), Hanyang University (872.60), Yonsei University (823.75), Islamic Azad University (760.89), Iowa State University of 753.00, Cornell University of 525.88, Deakin University of 460.30 and so on.

In brief (see Table 1), the Donghua University had the highest number of publications (2829), followed by the Zhejiang Science and Technology University (1574), and then the Hong Kong Polytechnic University (1532) during the six years. The Hong Kong Polytechnic University (PolyU) and Donghua University had the highest h-index (62), followed by Suzhou University, Zhejiang Science and Technology University, Qingdao University, Wuhan Textile University and Georgia Institute of Technology. In that order, Islamic Azad University ranks the first in publications per Staff, followed by Iowa State University, Yonsei University, Hanyang University and Hong Kong Polytechnic University. Once again in that order, Georgia Institute of Technology ranks the first in average citation (23.08) followed by Hong Kong Polytechnic University (14.79), Deakin University (11.86), North Carolina State University (11.60) and Qingdao University (11.48). Georgia Institute of Technology holds the highest citation per staff (1721.8) followed by Hong Kong Polytechnic University (1078.76), Hanyang University, Yonsei University, and Islamic Azad University.

4. Concluding remarks

The report benchmarked bibliometric evaluation of professional research institutions related to textile, apparel, fashion and clothing in recent years from 2014 to 2019. A total of 124,362 research publications of journal articles and reviews listed in Web of Science ^{TM} were fiber or textile related. Among the top 100 institutions in terms of number of publications, 31 schools located in 18 countries and territories were identified to have textile-related disciplines. These 31 textile schools are compared in terms of number of publications, publication per staff, h-index, total citations, average citations, and citation per staff of the top 31 schools with textile disciplines.

In summary, Donghua University holds the highest total publication, followed by Zhejiang Science and Technology University, and Hong Kong Polytechnic University in the past six years. Hong Kong Polytechnic University and Donghua University hold the highest h-index. Islamic Azad University ranks the first in publication per Staff, followed by Iowa State University, Yonsei University, Hanyang University, Georgia Institute of Technology and Hong Kong Polytechnic University. Georgia Institute of Technology ranks the first in average citation followed by Hong Kong Polytechnic University, Deakin University, North Carolina State University and Qingdao University. Georgia Institute

of Technology holds the highest citation per staff followed by Hong Kong Polytechnic University, Hanyang University, Yonsei University, and Islamic Azad University.

It must be noted that the bibliometric parameters compared in this study, although quantitative, should not be over-interpreted when evaluating the research contributions of an institution, especially in the highly interdisciplinary field of textiles. Each of these measures has its own merits and limitations. The number of publications is only a count of productivity, not quality. The number of citation and H-index are based on the assumption that the quality of a particular article is reflected by the frequency of its citations in other articles, which is not always true. Interpreted these bibliometric indicators as absolute measures of scientific outputs would present a biased story, as the quality of research contributions in terms of originality, scientific rigor and societal impact may not be reflected by the publication counts and the cites they receive. There are also huge differences in different areas of research in terms of productivity, citation habits, and citation dynamics. For example, a researcher or textile school more focused on textile materials or chemistry will tend to have more citations that those working on apparel product development.

Moreover, it cannot be over emphasized that research publications, although important as an indicator of scholarship, is only one aspect of the contributions of textile schools. A comprehensive ranking of textile schools should also cover other important areas, such as education, economic and social impact, etc. The present study can only reveal some aspects of the trends of the research activities and influences of textile schools in the world. Recognizing the limitations of the current study, it is recommended that the textile educational and professional community should consider a comprehensive benchmarking in order to promote the professionalism of the textile discipline.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Annex 1 provides the most cited journals.
Annex 2 provides the overall data for the top 100 publication institutions

Annex 1. Most cited journals.

No.	Source Titles	records	% of 124362
1	OPTICS EXPRESS	2186	1.758
2	OPTICS LETTERS	1422	1.143
3	RSC ADVANCES	1164	0.936
4	TEXTILE RESEARCH JOURNAL	1161	0.934
5	FIBERS AND POLYMERS	1149	0.924
6	JOURNAL OF LIGHTWAVE TECHNOLOGY	1086	0.873
7	JOURNAL OF THE TEXTILE INSTITUTE	1059	0.852
8	APPLIED OPTICS	970	0.78
9	JOURNAL OF APPLIED POLYMER SCIENCE	906	0.729
10	CONSTRUCTION AND BUILDING MATERIALS	878	0.706
11	OPTIK	840	0.675
12	IEEE PHOTONICS TECHNOLOGY LETTERS	806	0.648
13	COMPOSITES PART B ENGINEERING	788	0.634
14	SCIENTIFIC REPORTS	766	0.616
15	ACS APPLIED MATERIALS INTERFACES	747	0.601
16	SENSORS	711	0.572
17	COMPOSITE STRUCTURES	689	0.554
18	MATERIALS	688	0.553
19	APPLIED SURFACE SCIENCE	674	0.542
20	OPTICS COMMUNICATIONS	669	0.538
21	POLYMER COMPOSITES	662	0.532
22	CELLULOSE	639	0.514
23	OPTICAL ENGINEERING	592	0.476
24	IEEE PHOTONICS JOURNAL	573	0.461
25	POLYMERS	570	0.458
26	OPTICAL FIBER TECHNOLOGY	568	0.457
27	IEEE SENSORS JOURNAL	550	0.442
28	JOURNAL OF COMPOSITE MATERIALS	546	0.439
29	PLOS ONE	540	0.434
30	COMPOSITES PART A APPLIED SCIENCE AND MANUFACTURING	493	0.396
31	CARBOHYDRATE POLYMERS	492	0.396
32	CERAMICS INTERNATIONAL	491	0.395
33	FIBRES TEXTILES IN EASTERN EUROPE	482	0.388
34	JOURNAL OF ALLOYS AND COMPOUNDS	482	0.388
35	MATERIALS LETTERS	477	0.384
36	JOURNAL OF MATERIALS CHEMISTRY A	454	0.365
37	JOURNAL OF MATERIALS SCIENCE	444	0.357
38	MATERIALS DESIGN	437	0.351
39	COMPOSITES SCIENCE AND TECHNOLOGY	436	0.351
40	JOURNAL OF INDUSTRIAL TEXTILES	427	0.343

Annex 2. Overall data table of the top 100 publication institutions.

No.	Institutions	Total publications	% of 124,362	h-index	Total citations	Average citations
1	CHINESE ACADEMY OF SCIENCES	3,802	3.057	87	51,551	13.56
2	DONGHUA UNIVERSITY	2,829	2.275	62	25,189	8.90
3	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	2,227	0.814	47	19,546	8.78
4	INDIAN INSTITUTE OF TECHNOLOGY SYSTEM IIT SYSTEM	1,814	0.814	42	14,709	8.11
5	ZHEJIANG SCI TECH UNIVERSITY	1,574	1.266	51	15,766	10.02
6	HONG KONG POLYTECHNIC UNIVERSITY	1,532	1.232	62	22,654	14.79
7	WUHAN TEXTILE UNIVERSITY	1,524	1.225	46	12,073	7.92
8	NORTHEASTERN UNIVERSITY CHINA	1,422	1.143	43	10,180	7.16
9	SUZHOU UNIVERSITY	1,252	1.007	53	13,999	11.18
10	RUSSIAN ACADEMY OF SCIENCES	1,222	0.983	30	5,782	4.73
11	TIANGONG UNIVERSITY	1,195	0.961	38	7,719	6.46
12	UNIVERSITY OF CALIFORNIA SYSTEM	1,179	0.948	52	14,641	12.42
13	QINGDAO UNIVERSITY	1,139	0.916	51	13,078	11.48
14	UNIVERSITY OF NORTH CAROLINA	1,134	0.912	46	12,190	10.75
15	JIANGNAN UNIVERSITY	1,094	0.88	32	6,536	5.97
16	HUAZHONG UNIVERSITY OF SCIENCE TECHNOLOGY	1,055	0.848	47	11,696	11.09
17	UNIVERSITY OF CHINESE ACADEMY OF SCIENCES CAS	1,053	0.847	44	10,978	10.43
18	HARBIN INSTITUTE OF TECHNOLOGY	1,012	0.814	49	12,032	11.89
19	ISLAMIC AZAD UNIVERSITY	913	0.734	35	6,848	7.50
20	SICHUAN UNIVERSITY	896	0.72	37	7,084	7.91
21	ZHEJIANG UNIVERSITY	849	0.814	41	8,958	10.55
22	TSINGHUA UNIVERSITY	821	0.814	43	9,362	11.40
23	SHINSHU UNIVERSITY	806	0.814	31	5,729	7.11
24	AMIRKABIR UNIVERSITY OF TECHNOLOGY	794	0.814	37	6,368	8.02
25	NORTH CAROLINA STATE UNIVERSITY	793	0.814	44	9,197	11.60
26	SHANGHAI JIAO TONG UNIVERSITY	752	0.814	35	7,292	9.70
27	UNIVERSITI MALAYA	743	0.814	35	5,771	7.77
28	TIANJIN UNIVERSITY	739	0.814	33	6,315	8.55
29	SOUTH CHINA UNIVERSITY OF TECHNOLOGY	702	0.814	38	7,447	10.61

Continued.

No.	Institutions	Total publications	% of 124,362	h-index	Total citations	Average citations
30	INDIAN INSTITUTE OF TECHNOLOGY IIT DELHI	697	0.814	32	5,470	7.85
31	UNIVERSITY OF LONDON	692	0.814	37	6,578	9.51
32	NANYANG TECHNOLOGICAL UNIVERSITY	689	0.814	55	13,166	19.11
33	HELMHOLTZ ASSOCIATION	662	0.814	36	6,531	9.87
34	NATIONAL UNIVERSITY OF DEFENSE TECHNOLOGY CHINA	662	0.814	36	4,456	6.73
35	UNIVERSITY SYSTEM OF GEORGIA	640	0.814	46	10,120	15.81
36	STATE UNIVERSITY SYSTEM OF FLORIDA	639	0.814	41	7,025	10.99
37	UNIVERSITY OF TEXAS SYSTEM	638	0.814	39	8,075	12.66
38	PENNSYLVANIA COMMONWEALTH SYSTEM OF HIGHER EDUCATION PCSHE	606	0.814	39	6,463	10.67
39	BEIHANG UNIVERSITY	597	0.814	32	5,005	8.38
40	NORTHWESTERN POLYTECHNICAL UNIVERSITY	585	0.814	38	6,118	10.46
41	SHENZHEN UNIVERSITY	571	0.814	48	8,975	15.72
42	UNITED STATES DEPARTMENT OF ENERGY DOE	569	0.814	45	9,082	15.96
43	GHENT UNIVERSITY	564	0.814	29	4,346	7.71
44	NATIONAL RESEARCH CENTRE NRC	557	0.814	38	4,490	8.06
45	CNRS INSTITUTE FOR ENGINEERING SYSTEMS SCIENCES INSIS	554	0.814	29	4,176	7.54
46	SEOUL NATIONAL UNIVERSITY SNU	551	0.814	30	4,485	8.14
47	MINIST EDUC	549	0.814	31	4,285	7.81
48	DALIAN UNIVERSITY OF TECHNOLOGY	533	0.814	28	4,357	8.17
49	JILIN UNIVERSITY	525	0.814	30	5,125	9.76
50	HARVARD UNIVERSITY	524	0.814	45	7,847	14.98
51	COUNCIL OF SCIENTIFIC INDUSTRIAL RESEARCH CSIR INDIA	521	0.814	28	3,946	7.57
52	SHANDONG UNIVERSITY	518	0.814	36	5,439	10.50
53	NATIONAL UNIVERSITY OF SINGAPORE	507	0.814	48	9,324	18.39
54	ISFAHAN UNIVERSITY OF TECHNOLOGY	501	0.814	26	3,134	6.26
55	WUHAN UNIVERSITY OF TECHNOLOGY	494	0.814	27	3,877	7.85
56	CONSIGLIO NAZIONALE DELLE RICERCHE CNR	486	0.814	37	5,913	12.17
57	CHONGQING UNIVERSITY	480	0.814	36	6,015	12.53
58	XI AN JIAOTONG UNIVERSITY	470	0.814	33	4,694	9.99
59	HARBIN ENGINEERING UNIVERSITY	466	0.814	27	3,348	7.18
60	UNIVERSIDADE DE SAO PAULO	457	0.814	23	2,946	6.45
61	BEIJING UNIVERSITY OF POSTS TELECOMMUNICATIONS	446	0.814	31	3,164	7.09
62	NATIONAL TEXTILE UNIVERSITY PAKISTAN	439	0.814	19	1,860	4.24
63	PEKING UNIVERSITY	435	0.814	36	5,797	13.33
64	CORNELL UNIVERSITY	433	0.814	32	4,207	9.72
65	UNIVERSITI TEKNOLOGI MALAYSIA	430	0.814	27	3,281	7.63
66	UNIVERSITY OF ZAGREB	430	0.814	17	1,273	2.96
67	UNIVERSITY OF SOUTHAMPTON	423	0.814	31	4,430	10.47
68	MAX PLANCK SOCIETY	422	0.814	33	4,779	11.32
69	BEIJING JIAOTONG UNIVERSITY	415	0.814	24	2,433	5.86
70	UNIVERSITY OF TOKYO	414	0.814	27	3,922	9.47
71	HANYANG UNIVERSITY	411	0.814	31	4,363	10.62
72	UNIVERSITY OF MANCHESTER	409	0.814	28	3,427	8.38
73	UNIVERSITI PUTRA MALAYSIA	407	0.814	30	4,048	9.95
74	FUDAN UNIVERSITY	407	0.814	47	8,204	20.16
75	NANJING UNIVERSITY OF AERONAUTICS ASTRONAUTICS	402	0.814	29	3,292	8.19
76	TECHNISCHE UNIVERSITAT DRESDEN	402	0.814	24	2,845	7.08
77	RWTH AACHEN UNIVERSITY	400	0.814	28	3,144	7.86
78	UNIVERSITY OF SCIENCE TECHNOLOGY OF CHINA	397	0.814	36	5,059	12.74
79	SHANGHAI UNIVERSITY	394	0.814	25	2,552	6.48
80	UNIVERSITY OF ILLINOIS SYSTEM	393	0.814	28	3,571	9.09
81	UNIVERSITE PARIS SACLAY	393	0.814	24	3,106	7.90
82	FONDATION I SITE ULNE	393	0.814	22	2,341	5.96
83	CHUNGNAM NATIONAL UNIVERSITY	390	0.814	25	2,888	7.41
84	IOWA STATE UNIVERSITY	390	0.814	24	3,012	7.72
85	DEAKIN UNIVERSITY	388	0.814	35	4,603	11.86
86	CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS CSIC	379	0.814	29	3,866	10.20
87	UNIVERSITE DE LILLE	377	0.814	22	2,208	5.86
88	GEORGIA INSTITUTE OF TECHNOLOGY	373	0.814	45	8,609	23.08
89	CENTRAL SOUTH UNIVERSITY	372	0.814	26	3,510	9.44
90	UNIVERSITY OF NEW SOUTH WALES SYDNEY	370	0.814	27	3,245	8.77
91	LODZ UNIVERSITY OF TECHNOLOGY	364	0.814	19	1,726	4.74
92	TECHNICAL UNIVERSITY LIBEREC	362	0.814	18	1,494	4.13
93	SOUTHEAST UNIVERSITY CHINA	362	0.814	24	2,520	6.96
94	UNIVERSITY OF MICHIGAN SYSTEM	361	0.814	34	4,608	12.76
95	TONGJI UNIVERSITY	358	0.814	34	4,636	12.95
96	UNIVERSITY OF MICHIGAN	357	0.814	34	4,602	12.89
97	KING SAUD UNIVERSITY	352	0.814	36	5,636	16.01
98	STATE UNIVERSITY OF NEW YORK SUNY SYSTEM	352	0.814	26	3,233	9.18
99	YONSEI UNIVERSITY	348	0.814	26	3,295	9.92
100	UNIVERSITY OF TORONTO	348	0.814	30	4,276	12.29