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Fashion Technology Research: A Scientometric Analysis

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Abstract – **The paper brings out the results of a scientometric analysis of research publications in the field of fashion technology research during the period 1970-2013. It analyses 1,52,681 articles in the field of Fashion technology. It examines year wise distribution of articles, country wise distribution, languages distribution and bibliographic form of articles, doubling time, relative growth rate, high productive Institutes etc. inferences and findings are shown with relevant data analysis.**

Keywords: **Scientometrics, Fashion Technology, RGR & DT**

I. Introduction

Traditional textiles today are unable to cope with cost of production for various reasons like fast technological obsolescence, high cost of modernization, power, etc. Fashion Technology offers new ways, means and opportunity to the Indian textile industry to sustain the present growth and thrive in near future. It would offer not only an opportunity for augment the growth, but also a new direction for advancement of the industry. The field of fashion technology had not received adequate importance in Indian context so far; however, it is a potential area where the fashion technology can excel. Present product mixes of traditional textiles are not remunerative enough and therefore, more and more ideas of value-addition to textile products is gaining momentum. Fashion technology in this context, are just perfect.

A few highlights of the Indian market scenario for Fashion Technology are as below:

- India is an emerging economy and whether fashion textile can be indigenised, their markets are bound to grow on globalisation.
- The value addition in technical textiles is slowly but steadily shifting from raw materials and intermediate products to downstream industries in which India has a strong base and only needs strategic augmentation.

II. Scientometrics: An Overview

The term 'Scientometrics', often used synonymously as 'Bibliometrics', which originated in Russia, is quantitative methods of application in measuring science. The measurement involves counting artifacts to the production and use of information, and arriving conclusions from the counts[1]. The terms like 'Librametrics', 'Bibliometrics', 'Informetrics' and 'Scientometrics' have been used synonymously in order to study the growth of literature in a discipline and other aspects of literature quantitatively.

Scientometrics analyses, the quantitative aspects of science, the quantitative of the Science of Science, of Scientific Communication Studies and of Science Policy Studies. Scientometrics and Informetrics are bound through their mutual interest in scientific literature. Their statistical and mathematical orientation does not preclude analysis by qualitative methods.

Traditionally, bibliometrics has dealt with the study of print-based literature[2] while scientometrics has focused on the statistical analysis of research pattern. The major domains of study within metric analysis include:

A.Bibliometric Laws

Three laws became the corner stones of Bibliometrics and Scientometrics. They are:

- Lotka's law[3] deals about the productivity of authors
- Bradford's law[4] deals with the scattering of articles
- Zipf's law[5] deals with frequency occurrence of words in a text

III. Literature Review

The Scientometric study generally evaluate the research trend by investigating the publication outputs of different countries (Rahman, Haque, & Fukui, 2005)[6], research

Table I Yearwise Growth

S.No.	YEAR	TP	%	CTP	C%	RoG
1	1970	238	0.16	238	0.16	1.00
2	1971	278	0.18	516	0.34	1.17
3	1972	295	0.19	811	0.53	1.06
4	1973	592	0.39	1403	0.92	2.01
5	1974	697	0.46	2100	1.38	1.18
6	1975	856	0.56	2956	1.94	1.23
7	1976	811	0.53	3767	2.47	0.95
8	1977	886	0.58	4653	3.05	1.09
9	1978	946	0.62	5599	3.67	1.07
10	1979	1116	0.73	6715	4.40	1.18
11	1980	1228	0.80	7943	5.20	1.10
12	1981	1300	0.85	9243	6.05	1.06
13	1982	1381	0.90	10624	6.96	1.06
14	1983	1546	1.01	12170	7.97	1.12
15	1984	1770	1.16	13940	9.13	1.14
16	1985	1988	1.30	15928	10.43	1.12
17	1986	1879	1.23	17807	11.66	0.95
18	1987	2082	1.36	19889	13.03	1.11
19	1988	2322	1.52	22211	14.55	1.12
20	1989	2379	1.56	24590	16.11	1.02
21	1990	2705	1.77	27295	17.88	1.14
22	1991	2837	1.86	30132	19.74	1.05
23	1992	2925	1.92	33057	21.65	1.03
24	1993	3195	2.09	36252	23.74	1.09
25	1994	3476	2.28	39728	26.02	1.09
26	1995	3653	2.39	43381	28.41	1.05
27	1996	4692	3.07	48073	31.49	1.28
28	1997	4565	2.99	52638	34.48	0.97
29	1998	4634	3.04	57272	37.51	1.02
30	1999	4530	2.97	61802	40.48	0.98
31	2000	4576	3.00	66378	43.47	1.01
32	2001	4760	3.12	71138	46.59	1.04
33	2002	4988	3.27	76126	49.86	1.05
34	2003	5287	3.46	81413	53.32	1.06
35	2004	5668	3.71	87081	57.03	1.07
36	2005	6540	4.28	93621	61.32	1.15
37	2006	6889	4.51	100510	65.83	1.05
38	2007	7462	4.89	107972	70.72	1.08
39	2008	7308	4.79	115280	75.50	0.98
40	2009	7142	4.68	122422	80.18	0.98
41	2010	7587	4.97	130009	85.15	1.06
42	2011	7536	4.94	137545	90.09	0.99
43	2012	7642	5.01	145187	95.09	1.01
44	2013	7494	4.91	152681	100.00	0.98
		152681	100.00			
	CAGR	8.33				

institutes (Rajendram, Lewison, & Preedy, 2006)[7], journals (Dannenberg, 1985)[8], subjects (Rajendran , Ramesh Babu , & Gopalakrishnan , 2005)[9] and research fields(Davis & Gonzalez, 2003[10] , Krishnamoorthy, Ramakrishnan, & Devi, 2009[11]) Tribology research output among BRIC countries (Elango et al (2013)[12] 'MEMS' Microelectromechanical systems for the period 2005-2012 (Bathrinaryanan and Tamizhchelvan (2012))[13] are few subject based scientometric studies.

IV. Methodolgy and Data Source

This study uses Scopus database for drawing publications data on Fashion technology. Scopus is an international multidisciplinary database indexing over 15000 international peer reviewed journals in science and technology, besides more than 500 international conference/seminar proceedings. The study uses 44 Years publications data from 1970 to 2013 on fashion technology. A total of 1,52,681 records were identified in the field of 'fashion technology'. The collected data has been classified by using Excel software and the same has been loaded in to SPSS (Statistical Package for Social Sciences) for the purpose of analysis.

V. Objectives

Objectives of the study are as follows:

- To identify the Annual distribution and growth of fashion technology research during the period 1970-2013
- To identify the type of documents in the field of fashion technology.
- To identify and analyse the country-wise contribution of research output in the field of fashion technology.
- To identify the languages of the output of publications.
- To identify most high productive institutions on fashion technology
- To compare and measure the growth rate of literature published in USA and India in relation to other countries.

VI. Collection of Data

For this study, the literature on fashion technology data has been downloaded from 'Scopus', multidisciplinary online database, which is an international indexing and abstracting database, using the search term "Fashion Technology". For this study, publications commencing from 1970-2013 (44 years) has been downloaded from the database. A total of 1,52,681 data has been identified.

The collected data has been classified by using Excel and the same was loaded in to SPSS (statistical package for social sciences) for the purpose of analysis. Statistical tools such as frequency distribution and percentage analysis and Scientometric techniques such as Authorship pattern, Relative Growth Rate (RGR), Doubling time (dt) citation analysis etc will be used for the study.

VII. Analysis and Discussions

The annual distribution and growth pattern of articles during the period of 1970 to 2013 is given in Table I. The ratio of growth (RoG) has been calculated with the present year publications divided by previous year publications. The rario of growth (RoG) with each year is shown in table I.

Compound Annual Growth Rate (CAGR)

The growth rate was measured with Compound Annual Growth Rate (CAGR)[7]. The mathematical formula of CAGR is

$$\text{CAGR} = \left(\frac{\textit{Ending Value}}{\textit{Begining Value}} \right)^{\frac{1}{n-1}} - 1$$

In the year 1970 total number of publications in fashion technology are only 238. In the year 2013 it raised to 7494. During the period 2007 to 2013 the average number of publications in fashion technology is above 7250. Their exist uniform and study growth of publication in Fashion Technology research year after year. Hence it can be stated that there exist a parabolic growth of publication output in the field of research of Fashion Technology. The RoG (Ratio of Growth) ranges between 0.97 and 2.02 . This indicates that the publications are in increasing.

The block year wise distribution has been shown in table II. The RoG and CGAR thus calculated based on the formula said above, were also shown in table II.

Table II Blockyearwise Distribution

S.No.	YEAR	TP	%	CTP	C%	RoG	CGAR
1	1970-1980	7943	5.20	7943	5.20	1.00	17.83
2	1981-1991	22189	14.53	30132	19.73	2.79	8.12
3	1992-2002	45994	30.12	76126	49.86	2.07	5.48
4	2003-2013	76555	50.14	152681	100.00	1.66	3.44
		152681					

Relative Growth Rate (RGR)

The mean Relative Growth Rate (R) over the specific period of interval can be calculated from the following equation:

$$1\text{-}2\ \bar{R} = \frac{Log_{e\ 2}W - log_{e\ 1}W}{{}_2T - {}_1T}$$

whereas

$1\text{-}2\ \bar{R}$ = mean relative growth rate over the specific period of interval

$log_{e\ 1}W$ = log of initial number of articles/pages

$log_{e\ 2}W$ = log of final number of articles/pages after a specific period of interval

${}_2T - {}_1T$ = the unit difference between the initial time and the final time

The year can be taken here as the unit of time. The RGR for both articles and pages can be calculated separately.

Therefore

$1\text{-}2\ \bar{R}$ (aa -1 year -1) can represent the mean relative growth rate per unit of articles per unit of year over a specific period of interval and

$1\text{-}2\ \bar{R}$ (pp -1 year -1) can represent the mean relative growth rate per unit of pages per unit of year over a specific period of interval.

Doubling Time (Dt)

There exists a direct equivalence between the relative growth rate and the doubling time[21]. If the number of articles/pages of a subject doubles during a given period then the difference between the logarithms of numbers at the beginning and end of this period must be the logarithms of number 2. If natural logarithm is used this difference has a value of 0.693. Thus the corresponding doubling time for each specific period of interval and for both articles and pages can be calculated by the following formula:

$$\text{Doubling time (Dt)} = \frac{0.693}{\bar{R}}$$

Therefore

$$\text{Doubling time for articles Dt (a)} = \frac{0.693}{1\text{-}2\ \bar{R}\ (\text{aa-1 year-1})}$$

and

$$\text{Doubling time for pages Dt (p)} = \frac{0.693}{1\text{-}2\ \bar{R}\ (\text{pp-1 year-1})}$$

The relative growth rate (RGR) and doubling time (Dt) has been canculated and the same is shown in Table III.

The countrywise distribution has identified and top countries contribution that have more than 1000 publications were shown in Table IV. Further Ratio of growth with respect to United States (RoG(US)) and Ratio of Growh with respect to India (RoG(IN)) has also been calculated and the same is shown in Table IV.

Nearly 55% of the outputs were provided by three countries such as USA, United Kingdom, and Germany. The top 21 countries provide nearly 92.47% of the total contribution in Fashion Technology Research. USA contributes nearly 41.81%. It is followed by United Kingdom (6.71%) and Germany (6.28%). India stands Eleventh place with the contribution of 1.88%. The contributions were compared with USA as base country and the ratio of growth [RoG(US)] is also shown in Table 4. It can be seen that nearly 12 countries are providing nearly two times of the contribution equivalent to USA. India contributes 4% of USA contributions. The contributions were compared with India as a base country and the ratio of growth [RoG (In)]. USA contributes 22.29 times of Indian contributions. The other eight countries are providing more than Indian contributions. UK, Germany and Canada provides three times of the Indian contributions. Canada, Italy and France provides twice that of Indian contributions.

TABLE III RGR AND DT

S.No.	YEAR	TP	%	CTP	w1	w2	RGR	Dt
1	1970	238	0.16	238		5.472271	5.47	0.13
2	1971	278	0.18	516	5.472271	6.246107	0.77	0.90
3	1972	295	0.19	811	6.246107	6.698268	0.45	1.53
4	1973	592	0.39	1403	6.698268	7.246368	0.55	1.26
5	1974	697	0.46	2100	7.246368	7.649693	0.40	1.72
6	1975	856	0.56	2956	7.649693	7.991592	0.34	2.03
7	1976	811	0.53	3767	7.991592	8.234034	0.24	2.86
8	1977	886	0.58	4653	8.234034	8.445267	0.21	3.28
9	1978	946	0.62	5599	8.445267	8.630343	0.19	3.74
10	1979	1116	0.73	6715	8.630343	8.812099	0.18	3.81
11	1980	1228	0.80	7943	8.812099	8.980046	0.17	4.13
12	1981	1300	0.85	9243	8.980046	9.131622	0.15	4.57
13	1982	1381	0.90	10624	9.131622	9.270871	0.14	4.98
14	1983	1546	1.01	12170	9.270871	9.406729	0.14	5.10
15	1984	1770	1.16	13940	9.406729	9.542518	0.14	5.10
16	1985	1988	1.30	15928	9.542518	9.675834	0.13	5.20
17	1986	1879	1.23	17807	9.675834	9.787347	0.11	6.21
18	1987	2082	1.36	19889	9.787347	9.897922	0.11	6.27
19	1988	2322	1.52	22211	9.897922	10.00834	0.11	6.28
20	1989	2379	1.56	24590	10.00834	10.1101	0.10	6.81
21	1990	2705	1.77	27295	10.1101	10.21446	0.10	6.64
22	1991	2837	1.86	30132	10.21446	10.31334	0.10	7.01
23	1992	2925	1.92	33057	10.31334	10.40599	0.09	7.48
24	1993	3195	2.09	36252	10.40599	10.49825	0.09	7.51
25	1994	3476	2.28	39728	10.49825	10.58981	0.09	7.57
26	1995	3653	2.39	43381	10.58981	10.67778	0.09	7.88
27	1996	4692	3.07	48073	10.67778	10.78048	0.10	6.75
28	1997	4565	2.99	52638	10.78048	10.87119	0.09	7.64
29	1998	4634	3.04	57272	10.87119	10.95557	0.08	8.21
30	1999	4530	2.97	61802	10.95557	11.03169	0.08	9.10
31	2000	4576	3.00	66378	11.03169	11.10312	0.07	9.70
32	2001	4760	3.12	71138	11.10312	11.17238	0.07	10.01
33	2002	4988	3.27	76126	11.17238	11.24015	0.07	10.23
34	2003	5287	3.46	81413	11.24015	11.30729	0.07	10.32
35	2004	5668	3.71	87081	11.30729	11.37459	0.07	10.30
36	2005	6540	4.28	93621	11.37459	11.44701	0.07	9.57
37	2006	6889	4.51	100510	11.44701	11.51801	0.07	9.76
38	2007	7462	4.89	107972	11.51801	11.58963	0.07	9.68
39	2008	7308	4.79	115280	11.58963	11.65512	0.07	10.58
40	2009	7142	4.68	122422	11.65512	11.71523	0.06	11.53
41	2010	7587	4.97	130009	11.71523	11.77536	0.06	11.53
42	2011	7536	4.94	137545	11.77536	11.83171	0.06	12.30
43	2012	7642	5.01	145187	11.83171	11.88578	0.05	12.82
44	2013	7494	4.91	152681	11.88578	11.93611	0.05	13.77
		152681	100.00					

Table IV Countrywise Distribution

S.No.	COUNTRY	TP	%	∑ %	RoG(US)	RoG(IN)
1	United States	63829	41.81	41.81	1.00	22.29
2	United Kingdom	10239	6.71	48.52	0.16	3.58
3	Germany	9589	6.28	54.80	0.15	3.35
4	Japan	8448	5.53	60.33	0.13	2.95
5	Canada	7664	5.02	65.35	0.12	2.68
6	China	5355	3.51	68.86	0.08	1.87
7	Italy	5221	3.42	72.28	0.08	1.82
8	France	4674	3.06	75.34	0.07	1.63
9	Australia	3363	2.20	77.54	0.05	1.17
10	Netherlands	3146	2.06	79.60	0.05	1.10
11	India	2864	1.88	81.48	0.04	1.00
12	Spain	2633	1.72	83.20	0.04	0.92
13	Switzerland	2526	1.65	84.85	0.04	0.88
14	Sweden	2208	1.45	86.30	0.03	0.77
15	South Korea	1923	1.26	87.56	0.03	0.67
16	Taiwan	1483	0.97	88.53	0.02	0.52
17	Israel	1405	0.92	89.45	0.02	0.49
18	Brazil	1338	0.88	90.33	0.02	0.47
19	Belgium	1183	0.77	91.10	0.02	0.41
20	Austria	1057	0.69	91.79	0.02	0.37
21	Finland	1035	0.68	92.47	0.02	0.36
22	Others	11498	7.53	100.00	0.18	4.01
		152681	100		2.39	53.31

Table V Languagewise Distribution

S.No.	LANGUAGE	TP	%
1	English	142775	93.51
2	German	3357	2.20
3	French	1514	0.99
4	Chinese	1016	0.67
5	Japanese	934	0.61
6	Spanish	666	0.44
7	Italian	458	0.30
8	Russian	207	0.14
9	Portuguese	194	0.13
10	Turkish	107	0.07
11	Polish	102	0.07
12	Others	1351	0.88
		152681	100

It can be seen from the table V that Engilish has been used has a major communication language for fashion technology publications. Nearly 93.51% of publications appear in English language. It is followed by German (2.20%) and French (0.99%).

In order to identify the major sources of fashion technology publications, the articles that are published in different sources which has more than 300 publications are identified and the same is shown in Table VI.

Table VI Sources of Fashion Technology

S.No.	Source Title	TP	%
1	Journal of Biological Chemistry	1804	1.18
2	Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics	1220	0.80
3	Proceedings of SPIE the International Society for Optical Engineering	1037	0.68
4	Proceedings of the National Academy of Sciences of the United States of America	1032	0.68
5	Journal of Immunology	961	0.63
6	Textilwirtschaft	893	0.58
7	Journal of the American Chemical Society	886	0.58
8	Inorganic Chemistry	689	0.45
9	Textil Revue	647	0.42
10	Biochemistry	640	0.42
11	Endocrinology	543	0.36
12	Plos One	534	0.35
13	Biochemical and Biophysical Research Communications	524	0.34
14	Brain Research	496	0.32
15	Journal of Organic Chemistry	494	0.32
16	Blood	466	0.31
17	Cancer Research	451	0.30
18	Organometallics	450	0.29
19	Drapers	427	0.28
20	Journal of Pharmacology and Experimental Therapeutics	399	0.26
21	Acta Crystallographica Section E Structure Reports Online	385	0.25
22	Journal of Clinical Endocrinology and Metabolism	334	0.22
23	Investigative Ophthalmology and Visual Science	326	0.21
24	Inorganica Chimica Acta	314	0.21
25	Nature	312	0.20
26	European Journal of Pharmacology	311	0.20
27	Polyhedron	304	0.20
28	Journal of Clinical Investigation	302	0.20
29	FASEB Journal	301	0.20
30	Others	135199	88.54

Nearly 29 journals have more than 300 publications. 11.46% publications alone covered in these 29 journals. Among the 29 journals, “Journal of biological chemistry” has a major publication of 1804 (1.18%). It is followed by “Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics” (1220, 0.80%) and “Proceedings of SPIE the International Society for Optical Engineering” (1037, 0.68%).

The organization wise contributions of Fashion technology publications were identified and the same is shown in Table VII. The table shows that the organization those have more than 500 publications were listed.

Nearly 20,000 (13%) publications were contributed by top 30 organizations. Out of 30 organizations, VA Medical Center has a contribution of 0.95% (1454) of total fashion technology publications. It is followed by University of

TABLE VII ORGANISATIONWISE DISTRIBUTION

S.No.	AFFILIATION	TP	%
1	VA Medical Center	1454	0.95
2	University of Toronto	952	0.62
3	University of California, San Francisco	831	0.54
4	Harvard Medical School	813	0.53
5	University of California, San Diego	774	0.51
6	University of California, Los Angeles	764	0.50
7	University of Washington Seattle	763	0.50
8	Massachusetts Institute of Technology	741	0.49
9	UC Berkeley	694	0.45
10	University Michigan Ann Arbor	686	0.45
11	University of Wisconsin Madison	646	0.42
12	The University of British Columbia	644	0.42
13	University of Pennsylvania	643	0.42
14	Ohio State University	640	0.42
15	UC Davis	634	0.42
16	University of Minnesota Twin Cities	634	0.42
17	Stanford University	633	0.41
18	Brigham and Women's Hospital	617	0.40
19	The University of North Carolina at Chapel Hill	586	0.38
20	Massachusetts General Hospital	586	0.38
21	University of Florida	550	0.36
22	Washington University in St. Louis School of Medicine	550	0.36
23	University of Cambridge	542	0.35
24	University of Alberta	533	0.35
25	University of Tokyo	531	0.35
26	Johns Hopkins University	527	0.35
27	Kyoto University	523	0.34
28	McGill University	522	0.34
29	UCL	508	0.33
30	Duke University School of Medicine	504	0.33
	Total	20025	13.09

Toronto (952, 0.62%) and University of California, San Francisco (831, 0.54%). None of the Indian organizations find place in the top 30 organizations.

VIII. FINDINGS

The following were the some of the finding of the study.

- Their exist uniform and study growth of publication in Fashion Technology research year after year. Hence it can be stated that there exist a parabolic growth of publication output in the field of research of Fashion Technology. The RoG (Ratio of Growth) ranges between 0.97 and 2.02 . This indicates that the publications are in increasing.
- The relative growth rate is linear in nature. Similarly the doubling time also shows linear trend and few exceptions
- Nearly 55% of the outputs were provided by three countries such as USA, United Kingdom, and Germany. The top 21 countries provide nearly 92.47% of the total contribution in Fashion Technology Research. USA contributes nearly 41.81%. It is followed by United Kingdom (6.71%) and Germany (6.28%). India stands Eleventh place with the contribution of 1.88%.
- 12 countries are providing nearly two times of the contribution equivalent to USA.

- USA contributes 22.29 times of Indian contributions. The other eight countries are providing more than Indian contributions. UK, Germany and Canada provides three times of the Indian contributions. Canada, Italy and France provides twice that of Indian contributions.
- 93.51% of publications appear in English language. It is followed by German (2.20%) and French (0.99%).
- 29 journals have more than 300 publications. 11.46% publications alone covered in these 29 journals.
- "Journal of biological chemistry" has a major publication of 1804 (1.18%). It is followed by "Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics" (1220, 0.80%) and "Proceedings of SPIE the International Society for Optical Engineering" (1037, 0.68%).
- Nearly 20,000 (13%) publications were contributed by top 30 organizations.
- VA Medical Center has a contribution of 0.95% (1454) of total fashion technology publications. It is followed by University of Toronto (952, 0.62%) and University of California, San Francisco (831, 0.54%). None of the Indian organizations find place in the top 30 organizations

IX. Conclusion

It is evident that the fashion technology research has gaining momentum. Fashion technology research is a mixed field of many subjects viz Agriculture and Engineering. Fashion technology research gave us a remarkable improvement in garment production. It seems little contributions can be seen in textile research comparing to newer subjects such as nano technology, smart materials etc. The funding agencies must come forward for developing the research aspects in Fashion Technology. In India, the Ministry of Human Resources has established Fashion Technology Institutions throughout India and started implementing the textile park in various places especially in Tamil Nadu.

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