Research Trend of Marine Engineering in India and China during 2010-2019: a comparative scientometric analysis

Gulam Jilani[1] and Swapna Banerjee[2]

[1]Indian Maritime University, Kolkata Campus, P-19, Taratala Road, Kolkata – 700088, India
[2]Department of Library and Information Science, University of Calcutta, Kolkata – 700073, India

Abstract

The study aims to present a comparative scientometric analysis of the research trend of marine engineering in India and China from 2010 to 2019. In this study, 2909 publications of China and 585 publications of India were collected and analyzed. This scientometric study covers year-wise publication, preference of documents type, authorship pattern, author h-index, citation analysis, keyword analysis, and collaboration of both countries. The data has been extracted from the SCOPUS database for both countries China and India separately with limitations up to ten years. Document type of article is very popular in both countries and authors prefer to get published in journals. It is concluded that India needs more improvements in research output steadily to compete China. China and India can cooperate with each other to exploit the large marine resources for mutual benefits. Marine environment is more popular research area of marine engineering in both countries is a positive indication and may be effective in control of marine pollution. The annual growth of research publications is reported 14.24% for China and 17.69% for India. In terms of the authorship pattern, China published 21% of total papers by four authorship and India published 22.91% of total papers by two authorships. A number of results have cropped in through this study, which has been depicted through diagrams and tables here.

Keywords: Marine Engineering, Scientometrics, Research Trend, Authorships pattern, India, China, Bibliometrics, Environmental sciences

1. Introduction:

Marine engineering is the field of study that deals with life in oceans, biodiversity, marine natural resources, the design, development, production, and maintenance of the equipment used at sea and on board sea vessels like boats, ships, etc. This has been an emerging subject and a very important part of the shipping and ocean world and contains a massive possibility of research. The research in this area can provide the solutions of accidental and environmental problems of marine life. Through continuous research, a new paradigm in marine engineering emerged and worldwide standard and technological tools are

developed. Marine life is not concerned only with a single country but it is a global issue and affect all directly or indirectly. In this case, collaborations among many countries of the world are an indispensable requirement to spot the common objectives. Generally, international research began in the early 21st century and the numbers of publications have grown steadily every year and it is seen that the highest number of published documents in the world is environmental science and pollution research and play a crucial role in the development of the economy, natural resources, and livelihood of the countries. India and China have a vast sea area with long coastal boundaries, and research in both countries is growing rapidly and making a great contribution in expanding the economy. Latest researches are coming out by the efforts of the researchers, and new technologies are being used.

Day by day research activities and its coverage is extending in both countries and thereby producing an enormous publication in this arena by researchers, scientists, academicians and organizations that needs to be studied about their authorship pattern, collaboration, h-index, and citation analysis. For this purpose, scientometric analysis is used to find out the research trends in the subjects. Similarly, Scientometric study is conducted for the subjects of marine engineering research for India and China to investigate the research trends. This study has importance in view of the policy makers, researchers, and shipping industries that what research activities are going on in the marine engineering.

2. Review of literature:

There is a significant variation at the global level and focus of marine research required in India. They also studied about the authorship pattern, collaboration among countries, citation level of the documents, the trend of marine research, and publications and explained these through scientometric analysis (Rathika, Thanuskodi & Sudhakar, 2020). During 1989-2017, the marine drug research output was analyzed and found that the major publications in marine drug research output brought up from India in the form of articles with 416 records ranked with third positions (Jayasree and Baby, 2019). The study conducted for altmetric analysis of researchers of naval architecture and found that 65% of the researchers have an account in research gate and most of them received citations in a range of 1-50 and h-index of 1-5 (Sheeja and Susan, 2019). Authorship pattern was studied by many researchers as such and concluded that multi authored contributions are dominated in the field of marine sciences (Elango and Rajendran, 2012). Journals are major mediums to represent the latest research work which is selected by researchers and found that Marine Pollution Bulletin was the most active journal and environmental sciences were top popular subject categories (Sun, Wang and Ho, 2012). The research pointed out that annual publication output on phytoplankton had a rapid linear increasing tendency during the past two decades, and its contribution to total scientific articles remained below 10% (Wang, et al., 2015).

The study depicted that the USA, Europe, and China are in the leading position in the field of marine energy research, and the University of Chinese Academy of Sciences, Oregon State University, and Harbin Engineering has played a

significant role in the research and development of university energy research field (Lyu et al., 2011). It was discussed in the work that represent the status of India's collaboration with China in S & T, and analyzed the collaborative research between India and China (Gupta and Dhawan, 2003). It is found from the study of marine biology and revealed that about 270855 research articles have been produced, and also discussed the analysis about relative growth rate and doubling time of fauna of marine biology publication at the international level using time series data from 1980 to 2004 (Sundararajan and Ponnudurai, 2011). Maritime surveillance research and marine engineering research clusters were identified as developing clusters that expanded and received increased interest and identified areas of current research interests which allowed the quantification and visualization of changes in the entire body of shipping literature over a short period (Fiskin and Cerit, 2020).

3.   Objectives of the Study:

This comparative study through scientometrics was conducted in the field of marine engineering research in India and China for the period 2010-2019 with the following objectives:
- To find out year-wise production, source wise productivity, and document type production.
- To analyze authorship pattern, the top author's production and authors impact h-index
- To find out most cited documents and collaborative coefficient
- To find out world collaboration maps and most relevant affiliations
- To find out the most relevant countries by corresponding authors
- To analyze Trend Topic- Author Keywords usage pattern

4.   Methodology:

The comparative study was conducted for the research trend of marine science in India and China using the scientometric approach. The advanced search strategy was defined by the researcher to extract the data in such a way that maximum accuracy could be maintained.
The data in csv, ris and bibtex formats has been extracted on 06th August 2020 from SCOPUS for China and India separately through following search criteria TITLE ("Marine Engineering" OR "Marine Technolog*" OR "Marine Environm*" OR "Marine Corros*" OR "Marine Auxiliary Machinery" OR "Marine Communicat*" OR "Marine Diesel Engines" OR "Marine Ballast Systems" OR "Marine Engine Room Simulator" OR "Marine Equipmen*" OR "Marine Gas Turbin*" OR "Marine Fuel Injection System" OR submarines OR "Marine Geographical Informat*" OR "Marine Thermodynamics" OR "Marine Phytoplankt*" OR "Marine Propulsio*" OR "Marine Science" OR "Marine Vehicles" OR "Oceanography" OR "Ship

Stabili*" OR "Naval Architect*" OR "Marine Engine*" OR "Shipping and Marine Engineering" OR "Marine Renewab*" OR "Fuel Cell Syst*" OR "Ship Design" OR "Marine Steam Boil*" OR "Marine Safety and Secur*" OR "Marine Firefight*") limited to document type (article, conference proceedings, reviews, chapters and book), language (English) during 2010-2019 The data were analyzed by using the scientometric tools to find the pattern in publishing, authorship, collaboration, country production, and contributions, etc in the research trend of marine engineering in India and China during 2010-2019. The bibliometric tools like Biblioshiny, Bibexcel, and MS Excel have been used in data analysis for finding the accuracy of results by maximum extent.

SCOPUS is a platform of comprehensive, curated abstract and citations which provides enriched data and linked scholarly content. The researcher can quickly find relevant and trusted research; identify experts, and access reliable data, metrics, and analytical tools for confident research strategy decisions – all from one database. For marine engineering research trend, data extracted from almost 350 journals which are related to marine environment, marine engineering, maritime, oceanography, ocean engineering, and other marine related subjects. SCOPUS is picked up for data extraction for the reason that of superior quality and large coverage of highly cited research papers. Researchers trust the information and data they discover with such database because the content on Scopus come from numerous highly reputed publishers.

Data Analysis:
5.1 Year-wise Growth of Publications

Table-1 shows that in marine engineering, China has produced 2909 publications with the continuous growth of publication during the period 2010-2019 which reported the 14.24 % annual growth rate whereas India has produced 585 publications with fluctuation in the growth of publication during this period which reported 17.69% annual growth rate. As per the annual growth rate, India is ahead of China. In 2019, China's production leads with 18.91% whereas India could produce 15.56%. However, from 2014 to 2018, India had led to the growth of papers like 10.43%, 9.40%, 10.43%, 13.85%, and 16.24% respectively in comparison to China. Interestingly, China's paper production is high but growth rate less than India.

Table 1: Year-wise Growth of Publications

	China			India	
Years	No. of Papers	%		No. of Papers	%
2010	166	5.71		21	3.59
2011	192	6.6		37	6.32
2012	225	7.73		38	6.5
2013	245	8.42		45	7.69
2014	285	9.8		61	10.43

2015	246	8.46	55	9.4
2016	256	8.8	61	10.43
2017	302	10.38	81	13.85
2018	442	15.19	95	16.24
2019	550	18.91	91	15.56
	2909	100	585	100

5.2 Documents Types of Publications

Authors express their knowledge and thoughts as creativity in the form of articles. It is found by studying the trend of documents type in India and China, that authors prefer their papers format of article type. Out of 585, 415 papers in India and Out of 2909, 1673 papers in China have been published in the document type of articles which is 70.94 % and 57.51 % respectively. In terms of Conference Papers, China's share is 35.58% with 1035 no. of papers more than India's share of 17.26 % with 101 no. of papers. Table-2 illustrates that India has more preference for articles than China and China has a better trend of conference papers publishing more than India. With 14 Books, China leads in documents type of book in comparison to India.

Table 2: Documents Types of Publications

	China		India	
Document Type	**No. of papers**	**% of papers**	**No. of Papers**	**% of papers**
Article	1673	57.51	415	70.94
Conference Paper	1035	35.58	101	17.26
Review	103	3.54	34	5.81
Book Chapter	84	2.89	30	5.13
Book	14	0.48	5	0.85
	2909	100.00	585	100.00

5.3 Authorship Pattern:

Authorship pattern is an important part of the scientometric analysis that explained the trend of authorship during the period 2010-2019. China's authorship pattern shows in Tavle-3 that a single author contribution is 1.38%, but they produced 6.02 % papers of total and India's authorship pattern shows that a single author is 3.18 %, but they produced 12.65 % papers of the total. China's highest four author's participation is 19.33 % and they contributed 21.00 % papers of the total; similarly, India's highest four authors' participation is 16.84 % and they contribute 16.75 % papers of the total. In terms of more than 10 author's patters, China's ten author's pattern is 6.82 % and they contribute 1.82 % papers of the total; however, India's more than 10 authorship pattern is 14.13% and they contribute 2.56% papers of the total. China's 12641 authors produced 2909 publications and India's 2328 authors produced 585

publications. India's double authorship pattern is 11.51 % and produces 22.91 % papers of the total which is more than China.

Table 3 : Authorship Pattern - Period (2010-2019)

	China				India			
No. of Authors	No. of Papers	% of papers	Total Authorship	% of authors	No. of Papers	% of papers	Total Authorship	% of authors
One	175	6.02	175	1.38	74	12.65	74	3.18
Two	396	13.61	792	6.27	134	22.91	268	11.51
Three	597	20.52	1791	14.17	118	20.17	354	15.21
Four	611	21.00	2444	19.33	98	16.75	392	16.84
Five	464	15.95	2320	18.35	52	8.89	260	11.17
Six	291	10.00	1746	13.81	48	8.21	288	12.37
Seven	170	5.84	1190	9.41	22	3.76	154	6.62
Eight	76	2.61	608	4.81	13	2.22	104	4.47
Nine	47	1.62	423	3.35	5	0.85	45	1.93
Ten	29	1.00	290	2.29	6	1.03	60	2.58
>Ten	53	1.82	862	6.82	15	2.56	329	14.13
Total	2909	100.00	12641	100.00	585	100.00	2328	100.00

5.4 Collaborative Coefficient (CC)

The Collaboration Coefficient (CC) is a single measure of degree of collaboration which measures the numbers of authors per paper as well as the proportion of multi authored papers. The formula for calculation of CC can be used;

$$CC = 1 - \frac{\sum_{j=1}^{k}\left(\frac{1}{j}\right)f_j}{N}$$

Where, f_j = the number of j-authored papers published in a discipline during a certain period of time; N = the total number of papers published in a discipline during certain period of time; j = the number of authors in a paper; and k = the greatest number of authors per paper in a discipline. Or simply it can be calculated as;

$$CC = 1 - \frac{f_1 + \left(\frac{1}{2}\right)f_2 + \left(\frac{1}{3}\right)f_3 + \dots\dots\dots\dots\dots + \left(\frac{1}{k}\right)f_k}{N}$$

The table-4 show that China's Collaborative Coefficient (CC) is 0.68 and India's CC is 0.60 which is less than China. It indicates that trend of authorship pattern inclined to multi-authorship is high in China than India.

Countries	Table 4: Collaborative Coefficient – 2010-2019											Total Papers	Total Authorship	CC
	One	*Two*	*Three*	*Four*	*Five*	*Six*	*Seven*	*Eight*	*Nine*	*Ten*	*>Ten*			
China	175	396	597	611	464	291	170	76	47	29	53	2909	12641	0.68
India	74	134	118	98	52	48	22	13	5	6	15	585	2328	0.60

5.5 Authors Impact h-Index

The author level metric is called h-index which measures both the productivity and citation impact of the publications of a researcher. The index is designed to improve upon simpler measures such as the total number of citations or publications. The table-5 shows that China's top three authors Wang, X. of china has 18 h-index and got 804 citations in 79 no. of papers since 2011; Li, J. has 17 h-index with 774 citations in 72 papers since 2010; and Wang, Y. has 15 h-index with 737 citations in 73 papers. Moreover, Li, X. has 14 h-index with 820 citations in 86 publications since 2010. It is interesting that Li, X. has 820 citations in 86 papers, but h-index is lower than top three authors. In terms of India's top three authors, Hodgson, D.M. has a h-index of 6 with 280 citations in 7 papers since 2011, Karthikeyan, S. has a h-index of 5 with 50 citations in 7 papers since 2012 and Prathima, A. has 3 h-index with 34 citations in 5 papers since 2014. It is pointed out that China's author Du, J. has less h-index but higher citation per paper than others. In the overall study regarding h-index, it is found that Hodgson, D.M. has the highest citation per paper i.e. 40, and no Indian authors crossed double-digit of h-index in the field of marine engineering. India is far behind China in terms of h-index because of very less publications.

Authors Impact - h-Index

Table 5 (a): Top 10 Authors h Index - China

Rank	Author	h index	Total Citation	No. of papers	per paper citation	PY start
1	Wang, X	18	804	79	10.18	2011
2	Li, J	17	774	72	10.75	2010
3	Wang, Y	15	737	73	10.10	2010
4	Li, X	14	820	86	9.53	2010
4	Li, Y	14	640	65	9.85	2010
5	Zhang, L	13	448	50	8.96	2010
5	Li, Z	13	493	48	10.27	2010
6	Zhang, J	12	500	76	6.58	2010
6	Du, J	12	297	21	14.14	2012
7	Wang, J	11	625	58	10.78	2010

Table 5 (b): Top 10 Authors h-Index - India

Rank	Author	h index	Total Citation	No. of Papers	per paper citation	PY start
1	Hodgson, D.M.	6	280	7	40.00	2011
2	Karthikeyan, S.	5	50	7	7.14	2012
3	Prathima, A.	3	34	5	6.80	2014
3	Elango, A	3	34	4	8.50	2014
3	Brunt, R.L.	3	68	3	22.67	2014
3	Canals, M.	3	58	3	19.33	2012
3	Flint, S.S.	3	82	3	27.33	2011
3	Garcia-Orellana, J.	3	36	3	12.00	2013
3	Ishizuka, O.	3	45	3	15.00	2015
3	Koteswara, Rao S.	3	34	3	11.33	2015

5.6 Top 10 Most Global Cited Documents

Table 6 a & b shows the citation pattern of marine engineering research in China and India during the period of 2010-2019. India's citation data of all 585 publications have been analyzed, and it is found that 448 publications are cited and got the total number of citation 10076 and remaining 137 papers have not been cited in any publication. However, the average citation per paper during the period in India is 17.23. On the other hand, China's citation of 2909 publications are analyzed, it is found that 1918 publications are cited and got the total number of citation 26686 and 959 publication have not been cited in any publication. However, the average citation per paper during the period in China is 9.17. It is also found from the study that the top three most global cited documents belong to India by receiving 1703, 1119, and 497 citations respectively. In terms of most global cited documents, India is dominant over China.

Table 6 (a) : Top 10 Most Global Cited Documents – China

Rank	Titles	Authors	Sources	Total Citations
1	Distribution and importance of microplastics in the marine environment: A review of the sources, fate, effects, and potential solutions	Auta, H. S., Eminike, C.U. and Fauziah, S.H.	Environment International	370

2	Descriptive physical oceanography: An introduction: Sixth edition	Lynne D. Talley George L. Pickard William J. Emery James H. Swif	Descriptive Physical Oceanography	296
3	Plastic waste in the marine environment: A review of sources, occurrence and effects	LI, W.C., Tse, H. F. and Fok, L.	Science of The Total Environment	292
4	Microbial Surface Colonization and Biofilm Development in Marine Environments	Hongyue Dang, and Charles R. Lovell	Microbiology and Molecular Biology Reviews	284
5	The Fate of Terrestrial Organic Carbon in the Marine Environment	Neal E. Blair and Robert C. Aller	Annual Review of Marine Science	274
6	The Trace Metal Composition of Marine Phytoplankton	Benjamin S. Twining and Stephen B. Baines	Annual Review of Marine Science	210
7	Mediterranean climate and oceanography, and the periodic development of anoxic events (sapropels)	Rohling E.J., Marino G., Grant K.M.	Earth-Science Reviews	187
8	Applications of wireless sensor networks in marine environment monitoring: A survey	Xu, G., Shen, W., & Wang, X.	Sensors	171
9	Competitive sorption of persistent organic pollutants onto microplastics in the marine environment	Bakir A., Rowland S.J., Thompson R.C.	Marine Pollution Bulletin	167
10	Occurrence and effects of plastic additives on marine environments and organisms: a review	Hermabessiere, L., Dehaut, A., Paul-Pont, I., Lacroix, C., Jezequel, R., Soudant, P., & Duflos, G.	Chemosphere	165

Table 6 (b) : Top 10 Most Global Cited Documents – India

Rank	Titles	Authors	Sources	Total Citation
1	Micro-plastics in the marine environment	Andrady, Anthony L.	Marine Pollution Bulletin	1703
2	Micro-plastics in the Marine Environment: A Review of the Methods Used for Identification and Quantification	Hindalgo-Ruz, Valeria, Gutow, Lars., Thompson‖, Richard C. and Thiel, Martin	Environmental Science and Technology	1119

3	The present and future of microplastic pollution in the marine environment	Ivar da Sul, Juliana A. and Coasta, Monica F.	Environment Pollution	497
4	Distribution and importance of microplastics in the marine environment: A review of the sources, fate, effects, and potential solutions	Auta, H. S., Eminike, C.U. and Fauziah, S.H.	Environment International	370
5	Plastic waste in the marine environment: A review of sources, occurrence and effects	LI, W.C., Tse, H. F. and Fok, L.	Science of The Total Environment	292
6	Microplastics in the Marine Environment: Distribution, Interactions and Effects	Lusher, Amy	Marine Anthropogenic Litter	226
7	The behaviors of microplastics in the marine environment	Wang, Jundong, Tan, Zhi, Peng, J., Qui, Q., and Li, M.	Marine Environmental Research	141
8	Marine Corrosion Protective Coatings of Hexagonal Boron Nitride Thin Films on Stainless Steel	Esam Husain, Tharangattu N. Narayanan, Jose Jaime Taha-Tijerina, Soumya Vinod, Robert Vajtai, and Pulickel M. Ajayan	ACS Applied Materials & Interfaces	116
9	Sedimentological criteria to differentiate submarine channel levee sub-environments: Exhumed examples from the Rosario Fm. (Upper Cretaceous) of Baja California, Mexico, and the Fort Brown Fm. (Permian), Karoo Basin, S. Africa	Ian A. Kane and David M. Hodgson	Marine and Petroleum Geology	114
10	The atmospheric corrosion kinetics of low carbon steel in a tropical marine environment	Ma Y., Li Y., Wang F.	Corrosion Science	105

5.7 Top 10 Most Relevant Affiliations

Table-7 indicates the most relevant affiliations in China and India during 2010-2019 study period. In this case, Harbin Engineering University, China contributes maximum no. of publications and occupied top positions with 176 out of 2909 publication. However, the Indian Institute of Technology, India contributes 22 out of 585 publications. As per the table, India's institutions are very less productive than China in the field of marine engineering research.

Table 7: Top 10 Most Relevant Affiliations

China	India

Rank	Affiliations	Country	Articles	Rank	Affiliations	Country	Articles
1	Harbin Engineering University	China	176	1	Indian Institute of Technology	India	22
2	Dalian Maritime University	China	121	2	AMET University	India	18
3	Ocean University of China	China	114	3	CSIR-National Institute of Oceanography	India	15
4	Wuhan University of Technology	China	109	4	Anna University	India	11
5	Tianjin University	China	82	5	University of Manchester	United Kingdom	9
6	Shanghai Jiotong University	China	75	5	VIT University	India	9
7	Dalian University of Technology	China	70	6	Syed Ammal Engineering College	India	8
8	Naval University of Engineering	China	68	7	Indian Institute of Sciences	India	7
9	Xiamen University	China	67	7	University of California	USA	7
10	Tsinghua University	China	63	8	China University of Geosciences	China	6

5.8 World Collaboration Maps

Table 8 reveals world collaborations maps of the countries in marine engineering research. It shows that the collaboration between China and the United States of America is highest in 128 publications, thus holding 1st rank; 2nd rank is the collaboration with the United Kingdom in 89 publications, and 3rd rank -collaboration with Australia in 62 publications. However, USA has equal collaboration with India and the United Kingdom for 13 papers for each. USA's collaboration with India and China is very productive. India's collaboration with Australia, China, and Germany are the same with 8 publications.

Table 8: World Collaboration Maps

China				India			
Rank	From	To	Frequency	Rank	From	To	Frequency
1	China	USA	128	1	USA	India	13

2	China	United Kingdom	89		1	USA	United Kingdom	13
3	China	Australia	62		2	India	United Kingdom	11
4	China	Germany	37		2	USA	Germany	11
5	United Kingdom	USA	36		3	USA	China	10
6	China	Hong Kong	31		4	France	Spain	8
7	China	Japan	30		4	India	Australia	8
8	Germany	USA	27		4	India	China	8
9	China	Canada	25		4	India	Germany	8
9	China	France	25		4	United Kingdom	Germany	8

5.9 Most Relevant Countries by Corresponding Authors

Table 9 indicates most relevant countries by corresponding authors during the study period 2010-2019 in marine engineering publication, China contributes 925 papers in which 798 are single country publication and 127 are multiple country publications with multiple country publication ratio of 0.137 in its total publications. However, India contributes 93 papers in which 85 are single country publications and 8 multiple country publications with multiple country publication ratios of 0.086 in its total publication. China has 2nd rank in India's publications, thus contributing 28 papers in which 17 papers are single country publications, and 11 papers are multiple country publications with a ratio of 0.39. In terms of this table analysis, China is dominant for most relevant countries by correspondent authors with the highest single country and multi-country publications. Korea secure 3rd rank in the publication of both countries.

Table 9- Top 10 Most Relevant Countries by Corresponding Authors

China					India				
Rank	**Country**	**Articles**	**SCP**	**MCP**	**MCP Ratio**	**Rank**	**Country**	**Articles**	**SCP**	**MCP**	**MCP Ratio**
1	China	925	798	127	0.137	1	India	93	85	8	0.086
2	USA	56	32	24	0.429	2	China	28	17	11	0.393
3	Korea	48	35	13	0.271	3	Korea	14	8	6	0.429
4	United Kingdom	37	18	19	0.514	3	USA	14	9	5	0.357
5	Japan	31	23	8	0.258	4	Spain	13	7	6	0.462
6	Australia	27	13	14	0.519	5	Australia	9	5	4	0.444

6	France	27	9	18	0.667	5	Germany	9	3	6	0.667
7	Italy	23	18	5	0.217	6	United Kingdom	8	5	3	0.375
8	Germany	19	4	15	0.789	7	France	7	4	3	0.429
9	Canada	18	7	11	0.611	7	Italy	7	4	3	0.429

5.10 Trend Topic- Author Keywords

The study used Zipf's law to recognize the major research areas on the basis of the frequency of occurrence of keywords; for validation of frequency and rank of keywords, the study has used Zipf's formula of RXF=C, where F=frequency of the word in the text; R=Rank of the word when it is arranged in decreasing order of frequency; and C=Zipf's constant. China's publications have 7776 author's keywords and India's 1973 author's keywords. The top 15 author keywords are selected for analysis which are given in table 11 a & b. It is found from the analysis that the highest number of papers used Marine Environment in 1.54 % of the total keywords in 2016 as their author keywords; that means the maximum number of research belongs to Marine environment study in China. Similarly, the Marine environment keyword is also used in 1.42% of the total in 2016 as their author keywords that means the maximum number of research belongs to the Marine Environment in India. It also shows that India and China have the same research interest as revealed through their keywords. In China, Marine Diesel Engine is used in 1.34% of the total keywords in 2015 and Submarine Pipeline has been used in 1.29% of the total research papers in 2014. These keywords are also very popular. However, In India, Fuel Cell in 1.27 % of the total in 2017 and Submarine Ground Water Discharge has been used in 0.81 % of the total in 2016 and are popular keywords for research.

Trend Topic- Author Keywords

Table 10 (a) : Trend Topic- Author Keywords - China

Sl. No.	Author's Keywords (7776)	f= frequency of Keywords	Percentage %	r=Rank	c=f*r	year
1	Marine Environment	120	1.54	1	120	2016
2	Marine Diesel Engine	104	1.34	2	208	2015
3	Submarine Pipeline	100	1.29	3	300	2014
4	Submarine Groundwater Discharge	78	1.00	4	312	2016
5	Submarine	71	0.91	5	355	2014
6	Numerical Simulation	49	0.63	6	294	2015
7	Fault Diagnosis	37	0.48	7	259	2014
8	South China Sea	30	0.39	8	240	2017

9	Corrosion	30	0.39	8	240	2015
10	Simulation	30	0.39	8	240	2013
11	Marine	29	0.37	9	261	2014
12	Submarine Cable	28	0.36	10	280	2018
13	Submarine Landslide	27	0.35	11	297	2017
14	Nutrients	22	0.28	12	264	2016
15	Concrete	22	0.28	12	264	2013

Table 10 (b) : Trend Topic- Author Keywords - India

Sl. No.	Author's Keywords (1973)	f=frequency of keywords	percentage %	r=Rank	c=f*r	year
1	Marine Environment	28	1.42	1	28	2016
2	Fuel Cell	25	1.27	2	50	2017
3	Submarine Groundwater Discharge	16	0.81	3	48	2016
4	Marine	11	0.56	4	44	2018
5	Seawater	9	0.46	5	45	2015
6	Corrosion	8	0.41	6	48	2018
7	Submarine Canyons	7	0.35	7	49	2016
8	SGD	6	0.30	8	48	2017
9	Microplastics	6	0.30	8	48	2016
10	Performance	6	0.30	8	48	2016
11	Submarine Canyon	6	0.30	8	48	2013
12	Biodegradation	6	0.30	8	48	2015
13	Tsunami	6	0.30	8	48	2014
14	India	5	0.25	9	45	2019
15	Concrete	5	0.25	9	45	2018

5.11 Top Author's Production during 2010-2019:

Table-11 indicates that the top 10 authors are the top producer of publications in both countries. It is found that Wang, Y., Li, X. and Wang, X. affiliating to different institutions based China is producing 104, 100 and 92 papers respectively papers and received 1164, 919 and 867 citations respectively. However, Hodgson, D.M. affiliating to institution based in the United Kingdom, Karthikeyan, S. affiliating to institution based in India and Prathima, A. affiliating to institution based in India are producing 7, 7 and 5 respectively and received 280, 50 and 34 citations respectively. The study shows that China is dominant and top author's productions are much higher than India.

Table 11: Top Authors Production during 2010-2019

	China					India			
Rank	**Author**	**Affiliations**	**No. of Papers**	**TC**	**Rank**	**Author**	**Affiliations**	**No. of papers**	**TC**
1	Wang, Y.	Lanzhou Jiaotong University, China	104	1164	1	Hodgson, D.M.	University of Leeds, United Kingdom	7	280
2	Li, X.	Nanjing University, China	100	919	1	Karthikeyan, S.	Syed Ammal Engineering College, India	7	50
3	Wang, X	East China Normal University, China	92	867	2	Prathima, A.	Syed Ammal Engineering College, India	5	34
4	Zhang, J.	East China Normal University, China	86	528	2	Zhang, X.	University of Chinese Academy of Sciences, China	5	26
5	Li, J	Shanghai Maritime University, China	80	846	3	Bhaskaran, B.	AMET University, India	4	4
6	Li, Y	Institute of Metal Research, China	76	788	3	Das, S.	Jadavpur University, India	4	7
7	Wang, J	Shandong University, China	72	804	3	Elango, A.	Alagappa Chettiar College of Engineering and Technology, India	4	34
8	Zhang, Y.	North University of China, China	70	339	3	Flint, S.S.	University of Liverpool, United Kingdom	4	82
9	Wang, Z	CNOOC Research Institute, China	65	322	4	Bhartiya, S.	Indian Institute of Technology, India	3	6
10	Zhang, X	Qingdao University of Science and Technology, China	63	363	4	Brunt, R.L.	University of Manchester, United Kingdom	3	68

6   Findings Discussion:

A number of findings have emerged through this study. If we compare China and India's contribution in Marine Engineering and research, we can see many interesting facts. These are stated as follows.

China produced 2909 publications with a 14.24 % annual growth rate and India produced 585 publications with a 17.69% annual growth rate during 2010-2019 which is higher than China. Journals are more preferred in both India and China. Indian authors prefer to get publish 77.26 % of total papers in journals whereas Chinese authors publish 61.67 % of total papers in the journals and which is more preferable than China. Chinese authors like to get publish 57.51 % publications in articles form and Indian authors published 70.94 % publication in article form. It reveals that the article type document is more popular in India. China's highest four author's participation is 19.33 % and they contributed 21.00 % of total papers, similarly, India's highest four author's participation is 16.84 % and they contribute 16.75 % of total papers. China's 12641 authors produced 2909 publications and India's 2328 authors produced 585 publications. In this way, china's per author contribution is 0.23 papers, and India's per author contribution is 0.25 papers. It is also found that China's author h-index is higher than India. Citation analysis performed and it resulted in India's average citation of per paper is 17.23 and in China is 9.17. Institutions play a vital role in the research and development of any field; it is found that Chinese institutions are more productive than India. Collaboration between countries is analyzed and the result came out that collaboration between China and the USA is highest for 128 papers and collaboration between the USA and India is 13 which is far less than China. China's MCP ratio is 0.137 and India's MCP ratio is 0.086. In terms of overall research, India needs to produce more knowledge and extend research activities in the field of marine engineering.

7   Conclusion:

This is concluded from study that research output in marine engineering is higher in China than India and India needs to give focus in this field. The collaboration with other countries should be increased by India and at present there are few publications and the academicians, research organizations, companies must be encouraged for research activities in the subjects of marine engineering, environment pollution, shipping, nautical science, and oceanography. Researchers, scientist, and academicians should come forward and coordinate with each other to encourage the new research. It is found that China's output and collaboration with the USA and other countries is higher and its organizations actively participate in the research activities. China's research activities are very dynamic and vast. It will be advantageous for India to collaborate with China as well as with those countries that are developed in marine science at optimum level for knowledge & technology transfer and marine exploration.

Acknowledgement:

References:

Elango, B., & Rajendran, P., 2012. Authorship trends and collaboration pattern in the marine sciences literature: a scientometric study. *International Journal of Information Dissemination and Technology*, Vol. *2, no.* 3: 166-169. Available at: http://www.indianjournals.com/ijor.aspx?target=ijor:ijidt&volume=2&issue=3&article=003

Fiskin, C. S., & Cerit, A. G., 2020. Comparative bibliometric and network analysis of maritime transport/shipping literature using the Web of Science database. *61 Scientific Journals of the   Maritime University of Szczecin*, Vol. 61: 160-170. Available at: http://repository.scientific-journals.eu/handle/123456789/2591

Gupta, B., & Dhawan, S., 2003. India's collaboration with People's Republic of China in Science and Technology: A scientometric analysis of coauthored papers during 1994-1999. *Scientometrics*, Vol. *57, no.* 1: 59-74. Available at: https://akjournals.com/view/journals/11192/57/1/article-p59.xml

Jayasree, V., & Baby, M. D., 2019. A Scientometric Analysis of Indian Research Output in Marine Drugs during 1989-2017. *Asian Journal of Information Science & Technology (AJIST)*, Vol. *9, no.* 3: 25-30. Available at: https://www.trp.org.in/issues/a-scientometric-analysis-of-indian-research-output-in-marine-drugs-during-1989-2017

Lyu, S., Wang, W., Wang, C., & Zhang, J., 2011. The Knowledge Map of Marine Energy. *In IOP Conference Series: Earth and Environmental Science, Vol.* 295, no. 4: 042-067. Available at: https://iopscience.iop.org/article/10.1088/1755-1315/295/4/042067/meta

Ranganathan, C., 2014. Mapping of Oceanography Research Productivity in India: A Scientometric Analysis, *Library Philosophy and Practice*, 01-15 0_1. Available at: https://digitalcommons.unl.edu/libphilprac/1205/

Rathika, N., Thanuskodi, S., & Sudhakar, K., 2020. Lotka's Law and the Pattern of Scientific Productivity in the Marine Pollution Research. *International Journal of Emerging Technologies*, Vol. 11, no. 2: 332-341. Available at: https://www.researchgate.net/publication/341325455

Sheeja, N. K., & Mathew, S. K., 2019. ResearchGate Profiles of Naval Architecture Scientists in India: An Altmetric Analysis. *Library Philosophy and Practice*, 1-9. Available at: https://digitalcommons.unl.edu/libphilprac/2305/

Sun, J., Wang, M. H., & Ho, Y. S., 2012. A historical review and bibliometric analysis of research on estuary pollution. *Marine Pollution Bulletin*, Vol. *64, no.*1 :13-21. Available   at: https://www.sciencedirect.com/science/article/abs/pii/S0025326X11005741

Sundararajan, D. and Ponnudurai. R, 2011. Bibliometric study of Marine Biology Publications Output at International level. *International Journal of Recent Scientific Research, Vol.* 2, no. 11: 276 – 278. Available at : https://www.recentscientific.com/bibliometric-study-marine-biology-publication-output-international-level

Wang, C., Liu, Y., Li, X., Lai, Z., Tackx, M., & Lek, S., 2015. A bibliometric analysis of scientific trends in phytoplankton research. In *Annales de Limnologie-International Journal of Limnology*, Vol. 51,   no. 3: 249-259. Available at: https://www.limnology-journal.org/articles/limn/abs/2015/03/limn150036