INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact Factor: 6.078

(Volume 7, Issue 4 - V7I4-1496)
Available online at: https://www.ijariit.com

Evolution of research collaboration in Indian automobile industry– A Scientometric Analysis with Reference to SIAT during 2001 to 2017

Joshi Ashutosh Gopal
joshi.ashutosh@mahindra.com
Mahindra Research Valley, Chengalpattu, Tamil Nadu

S. Santhosh
s.santhosh2@mahindra.com
Mahindra Research Valley, Chengalpattu, Tamil Nadu

E. Priyan
e.priyan2@mahindra.com
Mahindra Research Valley, Chengalpattu, Tamil Nadu

ABSTRACT

The objective of this research paper on research productivity in Indian Automotive Industry is to present the transformation of research community of Indian automotive Industry in a progressively responsible way, with reference to SIAT conferences held so far. It reveals dynamic nature of automotive research in the country. Exhibits research outcome is dominated by specific domains and specific organizations in a dynamic way. It is also elaborating the countries and scientists preferred to collaborate with and their impact on the Indian automotive Industry.

Keywords: *SIAT, Indian Automotive Industry, Research publications, technical paper, Scientometrics.*

1. INTRODUCTION

India has a long tradition of Learning & Knowledge Centers and has contributed significantly to intellectual property levels across globe, especially patronizing o the advanced economies. After globalization of Indian Economy, this brain power had also beating the retreat to development of Indian Economy in a big way. The Indian auto industry is one of the beneficiaries of this reverse brain drain.

The objective of paper is to present scientometric study of different research domains & publications output in Indian Automotive Industry in SIAT - (Symposium of International Automotive Technology) conferences for last 17 years. The several authors and research scholars from Indian automotive Industry, now a day searching for opportunity to publish, as publish or perish is the mantra. The desire comes from a fact that it is a self-recognition for the real work they do.

The analysis includes year wise distribution of the research publications, major contributing authors, and organizations thereof. The study elaborates growth of publications, authorship trends & Contribution to different scientometric Indicators like Volume of Collaboration, Degree of Collaboration, Co-authorship index, Relative growth rate, Doubling time, most prolific author, most prolific institution etc., for Indian automotive industry. The study indicates the patterns of research priorities among different domains and elaborates extent of concentration and scattering of their research output. Analyses the strong and weak areas of research. (Sangam 2015).

2. LITERATURE REVIEW

Authors have accessed the databases in different media form Different combination of key words, technological terms were used. Major searches Author conducted are in energy, medical, health, biotechnology, science & Technology, Engineering, Research, innovation, food & spices domain. Author have also searched it with parameters like type of Industry, country of origin, status of publications, type of research, source of publications, etc., Several papers on each topic were selected and scanned. It was found that there are several papers in different domain of knowledge available in this regard except the Indian automotive industry.

Having started with atomic energy, Kar and Mondal (2014) elaborated a bibliometric study of atomic energy archives, for a period of 2006-2010. Normal impact factor of the paper is determined, it concluded with growth of publications, collaboration pattern, and quality of publications was the parameters studied.

In another paper on wind energy research publications, Thirumagal, (2014) observed individual author's contribution, geographical distribution, year wise research in the domain and citation of article s in an effective way. The study was conducted during for publications during 1999-2011.

In other paper Ingerwersen (2013) studied the contribution of proceedings on citation in energy research domain. In the cancer research domain Satish Munnoli (2014) underlined that major portion of cancer research get published in Indian journals, but it needs to improve the quality and publication output in regional cancer's information

Prakash (2012) studied using descriptive research methodology the highlights of R&D efforts in steel making area are being, He suggested that more stress to be given on reduction on energy consumption and co2 emissions to improve the processes of iron making In the Iron making domain,

In the domain of innovation, Gobble (2010) of Industrial Research institute come up with idea of industry defined fundamental research proposals. There is very less basic or fundamental research happen, here the initiative of US government suggests that it's priorities on basic research and encouragement is provided by the government a literature review of innovation research.

Rajesh Pillania (2012) taken up with multi-disciplinary domains is being taken up and key disciplines are being outlined in India, six journals are declared as most prolific journals in this regard.

Considering new technology & innovation, how technology Horizon is being opened for Indian automotive industry is needing to be explored here. There are several studies on different facets of Indian auto industry has been done, but on research publications a study is yet to be taken up.

3. OBJECTIVES OF THE STUDY

1. To ascertain the year wise growth of research.
2. To examine authorship and productivity patterns.
3. To determine research output of each domain.
4. To identify prolific author/s, organization/s, institution/s, and countries involved in research programmes in India.
5. To study collaborative pattern at national & international level.

4. SCOPE

The Symposium on International Automotive Technology {SIAT} is being held from 1985, at Automotive Research Association of India {ARAI} in India. From meager 30 odd in 1st conference, now it has reached 214 papers. These papers are being published by Society of Automotive Engineering {SAE} International from 1996. The present study explores the literature growth, authorship pattern, degree of national and international collaboration from the data available in SAE Mobilus. The papers published between 2001 to 2017 SIAT conferences are being considered, Total 1122 papers are considered here for this study.

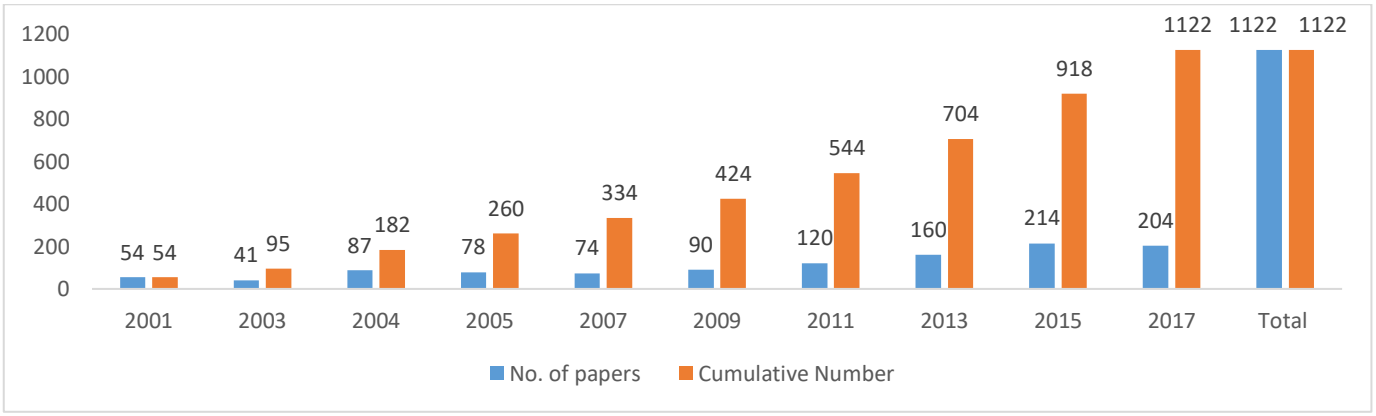
5. METHODOLOGY

Bibliographic details of aforesaid publications was downloaded from the SAE Mobilus Database on the date on the date 06/03/2017 for a period of 2001 to 2017.from SAE Mobilus database of SAE International Denver USA Detailed strategy for downloading with keyword "SIAT" & other relevant keywords which yielded better results than other keywords like symposium etc., The data is transferred to MS-Excel worksheets and analyzed to meet the aforesaid objectives.

6. RESULTS AND DISCUSSIONS

6.1 Year wise growth of research

6.1.1 To ascertain the year wise growth of research: Author have derived the data in a year wise format from 2001-2017 from SAE Mobilus portal, All the technical papers and journal Papers are being considered in SAE Mobilus database., From 2001 to 2017; total 15 SIAT conferences were held. The data in SAE Mobilus shows only 9 conferences with the "different relevant key words with SIAT" where total 1122 papers are published. The highest 214 papers published in 2015; followed by 204 papers in 2017, &120 papers published in 2011.The lowest 41 papers are published in 2003.An average of 106.88 papers published in SIAT so far during the years under review.



Graph 1.1.- Year wise growth and cumulative growth patterns

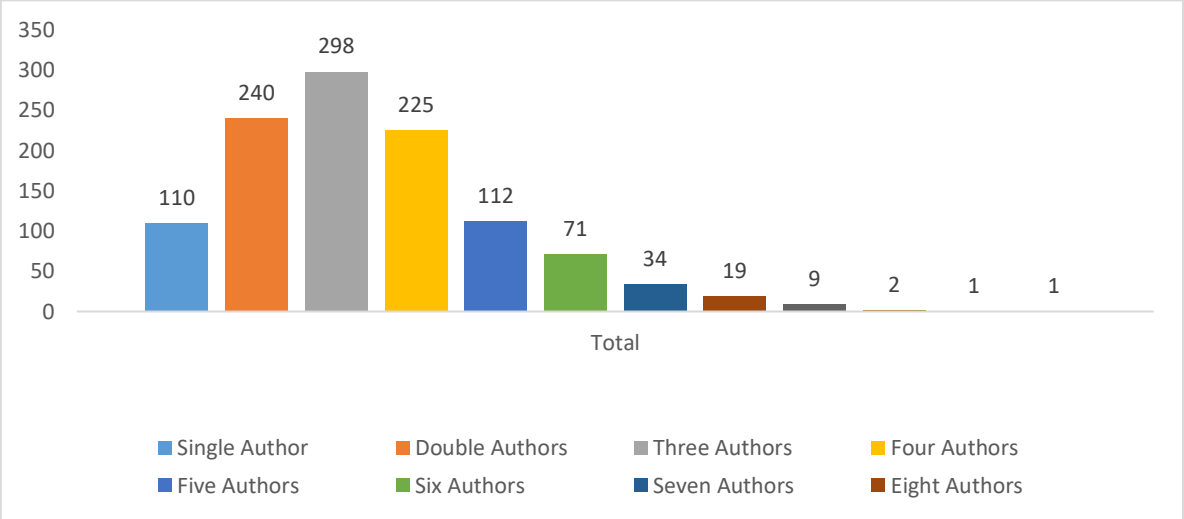
Growth trend and relative growth rate & doubling time: The growth trend is demonstrated below with help of relative growth rate which is calculated; Where the **Mean relative growth rate** is calculated using formula of R=W2-W1/T2-T1 (Sangam, 2015); Where R= Mean relative growth rate over the specific period of interval in which, W1 = LogW1 (natural log of initial number of publication); W2 = LogW2 (natural log of final number of publication); T2- T1 = the unit difference between the initial and final time which is Final **R** = 0.082349944 .

The doubling time is calculated using the formula: Doubling time DT= 0.693/0.082349944 = 8.415306313. Beyond this Authors have also tried to calculate the average growth rate on year-on-year basis based on the available data.

Authorship and productivity patterns:

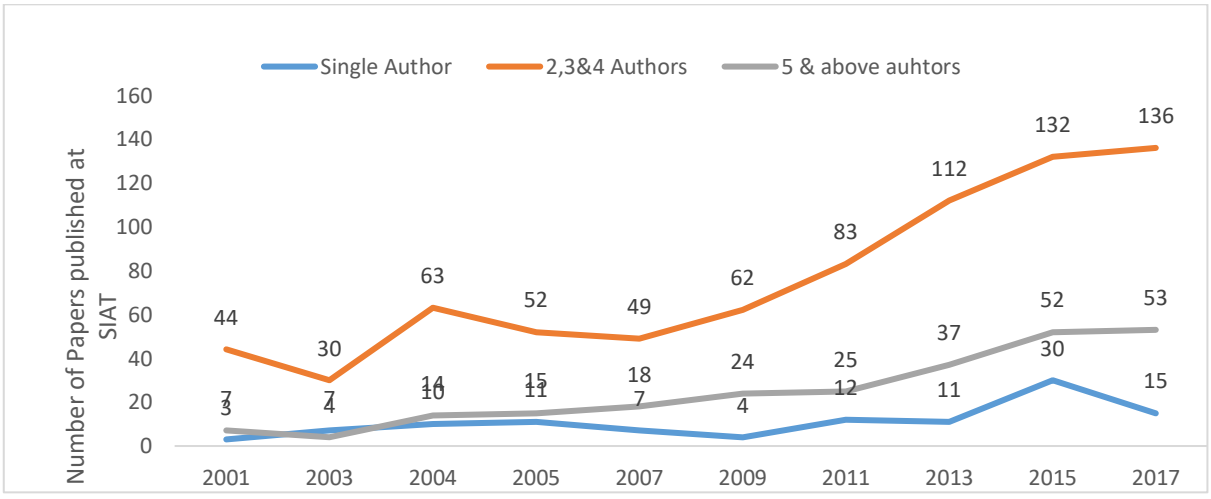
6.1.2 To examine authorship and productivity patterns

Authorship pattern of publications: The number of authors in team per paper is elaborated in graph 2.1. It is still significant part that 2,3 &4 no. of authors are still more than all other authors. It indicates that though the teamwork is growing, in the years to come, the individual authors are still holding good pie of the technical papers' authors' community.



Graph 2.1 : Author-wise collaboration for SIAT during 2001-2017

Author ship pattern over the Years: Over the year at SIAT single authors papers contribution is less than 10 %. However, the teams of 2,3, & 4 authors are dominant; it is the trend, Later the trend is strengthened over the years.

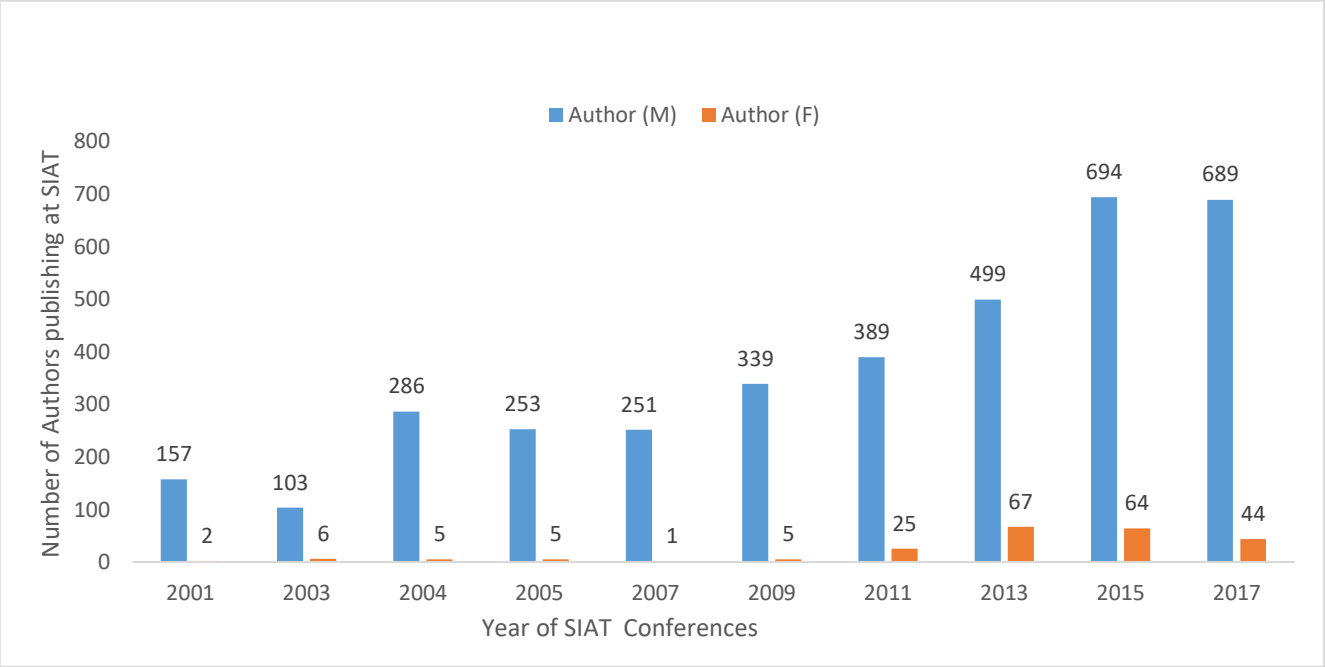


Graph 2.3 Authorship performance at SIAT

While in 2013, 2015 & 2017 the team papers have crossed 100 marks while in more than five authors it is a stable trend. single author's contribution is continued to be less than 10 %. While in multiple authors in 2017 there are highest 53 teams of Five and above authors, which is an all-time High team score as of now. The same reflects in terms of 2,3 & 4 authors. but single authors get reduced in 2017.

Author productivity: The data with reference to author productivity is in graph no. 2.4. It shows that total average number of authors per paper is 3.36 for 1122 technical papers. The .301 is average productivity per paper. It is observed that initially from 2001 to 2005 it was above .30. From 2007 onwards, it was below .30. **The collaborative index** is also another important parameter. It is defined as number of authors per paper by LALWANI, 1980) CI= Total No. of Authors / Total no. of papers CI = 3884 /1122 = 3.34

Gender wise pattern: This is a social indicator being observed keenly in the conferences. That it is male dominated domain, but in over the years 2013 better half representation is steadily increasing, which is a healthy sign of progress of Indian Automotive Industry. Many organisations from ARAI to the members of SIAM has women at the top is a point to be remembered. For 1122 paper published so far, in SIAT conferences from 2001, total 3660 authors have contributed to it. Out of which male contributors were 3660, i.e. 94.23 % and female contributors were 224 i.e. 5.76 % However both the ratios are evolving. The trend is clearer after 2011, that more women representation in the SIAT authors tribe. However still it is very thin representation of women's is observed.

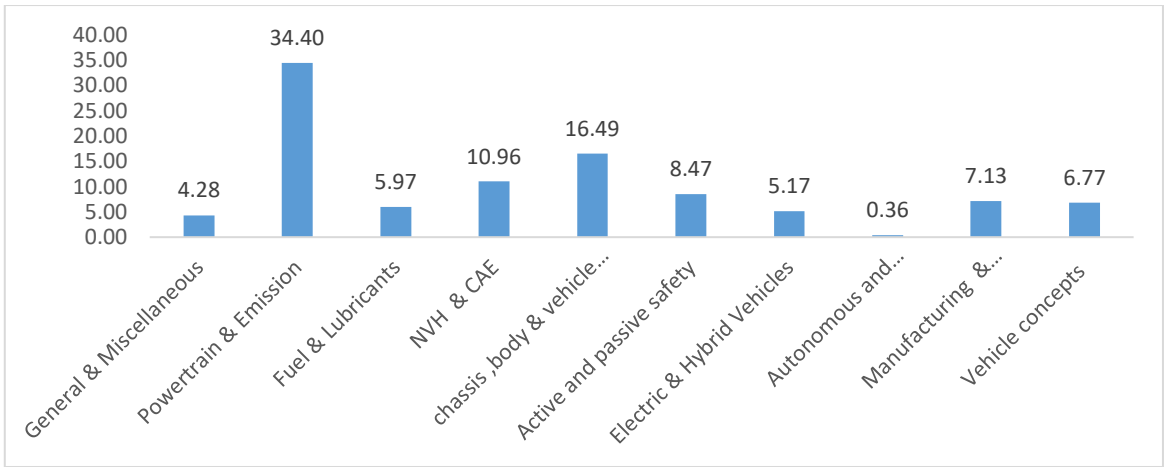


Graph 2A.1- Gender wise authors representation in SIAT conferences

6.1.3 To determine research output of each domain

It is observed that highest share of research in Indian auto industry is happening in Power train and emission domain i.e., 34.40 %. Followed by chassis, body and vehicle dynamics i.e., 16.49%. New area of growth in this industry is NVH & CAE which represents 10.96 % share. While in autonomous and connected vehicle area there is 0.36 % share. It may possible because of competition the publication is still at the business sensitive stage, hence not getting published.

Another lagging area is Electric and Hybrid vehicles i.e., 5.17 %. There is still opportunity to grow in Vehicle concepts, active and passive safety & Manufacturing.



Graph 3.1: Domain wise distribution of paper and % age thereof

In the year wise format of domain trends, the same picture replicates, like powertrain& emission group is ahead in all the years under review. While NVH & CAE started growing from 2007. The chassis and body & Active and passive safety group also started catching up from 2007. While manufacturing material started catching up from 2011. And autonomous and connected vehicle is yet to start and Hybrid and electric vehicles started catching up from 2015.

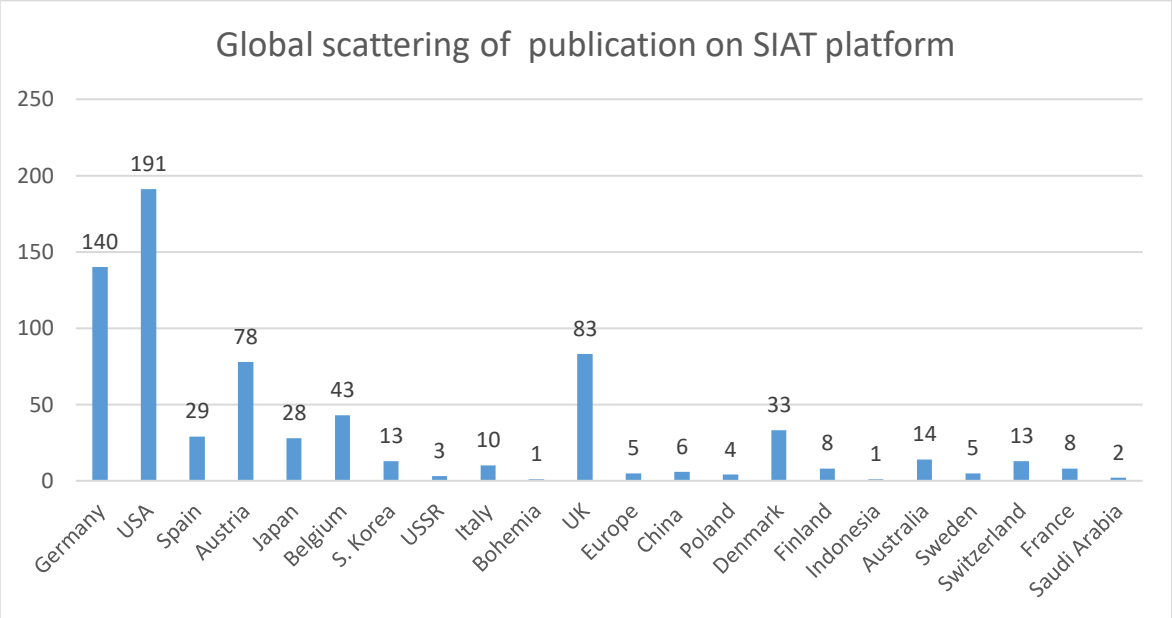
6.1.4 To identify prolific author/s, organization/s, institution/s, and countries involved in research programmes in India & states thereof.

Most prolific authors: In this scenario, Mr. N.V. Marathe from ARAI is most prolific author from India who had published 33 papers on SIAT platform. Followed by Dr. S.S. Thipse who had 26 papers, Mr. N.V. Karanth had 23 papers, Mr. M R Saraf had 19

papers, Dr. K.C. Vora had 15 papers, Mr. S. Raju who had published 15 papers on SIAT platform. Mr. S.D. Rairikar had 13 papers, K.P. Kavathekar had 12 papers, while Mr. M.K. Gajendra Babu had published 10 papers. In the less than 10 papers Mr. A.V. Mannikar, B.V. Shamsundara, Milind Amberdekar & A. D. Dani are also there.

Most prolific organizations in the Indian automotive Industry in Publishing the research papers: The data re-affirms that the ARAI is the highest paper publishing organization in India, followed by Mahindra & Mahindra ltd., & Tata Motors. The companies like Mahindra had put special efforts so that its authors can publish the paper not only in SIAT but other global conferences in their domain. The IIT's are the best contributors from academic space followed by universities. The AVL is one of the best contributors from overseas research consultancy organization on SIAT platform, while other Indian corporates like Maruti, Ashok Leyland & TVS are other groups are following the trend with considerable contribution.

Geographical Analysis: Continental perspective: The above table explains the details in continental wise manner. This also indicates the importance of SIAT as a one of the key global conference in the Automobile industry. The Europe is the highest contributor as a continent, while North and South America follows.



Graph 4.3 : Global scattering of SIAT publications

On SIAT platform during the years under review, as per aforesaid graph no. 4.3 it is crystal clear that USA (North America) is the highest contributing country, followed by Germany, UK, Austria Belgium & Denmark from Europe. While Japan Australia, had a considerable contribution and china had just started on the path. The Graph below explain in detail the situation. Australia and Asia excluding the India are the contributors at the bottom end.

6.1.5 To study collaborative pattern at national & international level.

There are national international, intra organizational, inter organizational, format is available in national and international projects are being carried out so far.

1. Year wise collaboration output. | National and international collaboration
2. Collaboration pattern international, National and no collaboration.
3. Domestic collaborative index (DCI) | International collaboration Index (ICI)

Collaborative activity in research in performing sector's Academic institutions and government research organizations and corp. org. are the major collaborative partners in Indian horizon. International collaboration in projects and papers thereof may always be seen from the strategic partnerships and gaining knowledge then research excellence or creating impact The Collaborative papers always attracts more citations in international area than domestic domain. Collaborative authorship National & international collaboration.

Degree of collaboration : It is always said that advances in research depend critically on interactions between a team of researchers. At the primary level it is the team members who collaborates and not the institution or corporations. As in commercial and applied research it is truer that rarely the competitors collaborate. The co-ordination between two or more researchers is the fundamental unit of collaboration.

To determine the strength of collaboration (DC) following formula us suggested by Subramanyam K is deployed.

DC = Nm/ Nm+Ns; where DC= Degree of collaboration; Nm=Number of Multi authored papers; Ns=Number of single authored paper.

DC = 759/759+107= 0.876 (For Domestic collaboration)

DC= 256/256+107 =0.705 (For International collaboration)

DC= 1015 / 1122 =0.904 (Degree of collaboration)

Collaboration co-efficient (CC): is measure of collaborative research that reflects both the mean of authors per paper as well as proportion of multi-authored papers. It lies between the value 0 and 1. If the number of "j" authored paper is given by n (j) in the sample population of articles or publications of Number N then collaboration coefficient is

$$\mathrm{CC} = 1 - \frac{F1 + \left(\frac{1}{2}\right)F2 + \left(\frac{1}{3}\right)F3 + \left(\frac{1}{4}\right)F4 + \left(\frac{1}{5}\right)F5 + \cdots \ldots \ldots \ldots \left(\frac{1}{k}\right)Fk}{N}$$

Where F1 indicates single authored papers; F2 Indicates double authored papers; F3 indicates triple authored papers and so on and so forth while N is total no. of papers (Sangam, 2015)

Hence in this case 110+1/2(240) +1/3(298) +1/4(225) +1/5(112) +1/6(71) +1/7(34) +1/8(19) +1/9(9) +1/10(2) +1/11(1) +1/12(1)
=1- [110+120+99.33+56.25+22.40+11.83+4.85+2.37+1+0.2+.09+.83]/1122
=1- 428.40/ 1122
=1- .381
=0.619
Collaboration coefficient for SIAT platform under review is 0.619

7. FINDINGS

(a) Maximum no. of papers published in the year 2015 and minimum in 2003.
(b) The **Mean relative growth rate** (**R**) of SIAT conference is R = 0.082349944
(c) The doubling time DT of SIAT conference is =8.415306313
(d) The author productivity is .301 and the average number of authors per paper is 3.36 for SIAT conference held so far.
(e) The collaboration coefficient is 0.619 and Degree of collaboration is 0.904

8. CONCLUSION

The study describes growth contribution and impact of research carried out by scientists in the Indian automotive Industry. It could have been better, if the entire SIAT database would be available for the study inclusive of keynote papers and poster presentations thereof in the SIAT's happened so far, it indicates the need to develop indigenous databases in this research domain. It also reveals that research outcome is dominated by papers than other publications during the period. The study indicates the patterns of research priorities among different domains and elaborates extent of concentration and scattering of their research output. Analyses the strong and weak areas of research.

9. REFERENCES

[1] Gobble, M.M. (2010). Industry-defined fundamental research: Creating an agenda for basic research; Research Technology Management, 53(5), 55-62.
[2] Ingwersen, Peter (2013). Contribution and influence of proceedings papers to citation impact in seven conference and journal-driven sub-fields of energy research 2005-11 (RIP). Proceedings of ISSI 2013 - 14th International Society of Scientometrics and Informetrics Conference, paper presented at 14th International Society of Scientometrics and Informetrics Conference, Austria, 418-425, International Society for Scientometrics and Informetrics.
[3] Kar, Mahua, and Mondal, Tarun (2014). Bibliometric Analysis of Research publications of UGC-DAE Consortium for Scientific Research, Kolkata Centre. IASLIC Bulletin, 59(2), 119-128.
[4] Munnoli, Satish (2014). An Analysis of Cancer Research literature in India (Unpublished doctoral Thesis), Shivaji University, Kolhapur, Maharashtra, India.
[5] Pillania, Rajesh K. (2012). Innovation research in India: A multidisciplinary literature review, Technological Forecasting and Social Change, 79(4) 716-720.
[6] Prakash, Swatantra (2012). Research in iron making in India - Paving the way for a great future of the steel industry; 6th Int. Congress on the Science and Technology of Iron making 2012, ICSTI 2012 - Including Proceedings from the 42nd Iron making and Raw Materials Seminar, and the 13th Brazilian Sump. On Iron Ore, paper presented at 6th Int. Congress on the Science and Technology of Iron making 2012, ICSTI 2012 - Including Proceedings from the 42nd Iron making and Raw Materials Seminar, and the 13th Brazilian Sump. On Iron Ore, 4, 2830-2840, Associacao Brasileira de Metalurgia Materiais e Mineracao.
[7] Sangam, S.L. (2015). Scientometrics: Quantitative Methods for Library & information Science, (1st Edition) Bangalore: Content craft.
[8] Thirumagal, A. (2014) Bibliometric Investigation of Wind Energy in India: An Analytical Study. IASLIC Bulletin, 59(4), 207,223.

