# Mechatronics Research Output: A Comparative Study of Global and G5 Contributions (2001-2020)

**Praveen B. Hulloli[1]\* and Manisha P. Hulloli[2]**
[1]Library and Information Centre, KLS Gogte College of Commerce, Belagavi, Karnataka, India
[2]Ravindra Kaushik e-Library, Belagavi, Karnataka, India
E-mail: manishaphulloli@gmail.com
\*Corresponding Author: praveenbhulloli@yahoo.com

*Abstract* - **This research examines the output productivity of mechatronics through a quantitative and qualitative analysis from 2001 to 2020, covering a total of 20 years. Data were downloaded from the Web of Science (WOS). Globally, 3,359 papers with 46,043 citations were published, while in G5 countries, 599 papers with 5,942 citations were published in the field of mechatronics. Compared to other subjects in science and technology, the field of mechatronics has seen a considerably lower number of publications. Statistics show that approximately 1% of global publications are in mechatronics, compared to 30-35% in other fields. In 2007, a total of 5,010 highly cited papers were published, with an average of 35.79 citations per paper and an h-index of 36. The highest Activity Index (AI) of 381 was recorded for South Africa in 2008, and South Africa also had the highest Attractive Index (AAI) of 706 in 2012. The maximum Relative Quality Index (RQI) for South Africa was 2.00, while China's RQI was lower than the global average, at 0.87. In the coming years, it is expected that G5 countries and the global research area of mechatronics literature will see an increase in production.**
*Keywords:* **Mechatronics, Research Productivity, Quantitative Analysis, G5 Countries, Citations and H-Index**

## I. INTRODUCTION

Mechatronics is a concept that originated in Japan in the 1980s and can be defined as the use of electronics and computer technologies to control mechanical system movements. The synergistic coupling of mechanical and electrical engineering is known as mechatronics. Mechatronics, also referred to as mechatronics engineering, is an interdisciplinary branch of engineering that focuses on the integration of mechanical, electronic, and electrical engineering systems, as well as robotics, electronics, computer science, telecommunications, systems, control, and product engineering. According to Mori (1969), "The word Mechatronics is composed of mecha from mechanics and tronics from electronics. In other words, technologies and developed products will be incorporating electronics more and more into mechanisms, intimately and organically, and making it impossible to tell where one ends and the other begins."
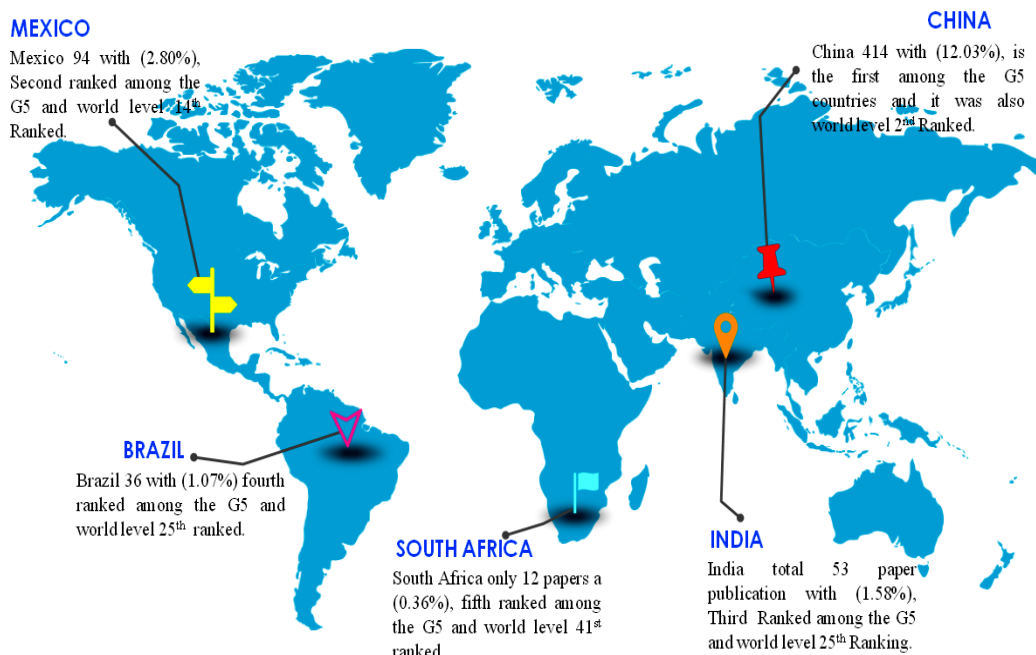


Fig. 1 World in G5 Countries Ranking Distribution

The five major emerging economies - Brazil, China, India, Mexico, and South Africa - all attended the G8 meeting in 2003. At the 2005 summit, the term "G8+5" was coined to refer to this assembly, and by 2007, these countries were known as the G5. The Group of Five (G5) is a coalition of five countries that have banded together to play an active role in the world's rapidly changing order. The G5 nations strive both individually and collectively to foster dialogue and understanding between developing and industrialized countries. The G5 aims to establish common ground on global issues. These countries are considered the five major rising economies of the 21st century. The term "Group of Five" or "G5" has been used in various contexts over different time periods, with the composition and meaning of the group interpreted differently. The name "Group of Five" or "G5" originally referred to the world's five most powerful economies, as illustrated in Figure 1.

Scientometrics is the study of measuring and analyzing science and technology innovation. It is a branch of science that focuses on the measurement and analysis of academic publications. A subfield of scientometrics is informetrics. Major research topics in scientometrics include measuring the influence of research articles and academic journals, understanding scientific citations, and applying these metrics in policy and management contexts.

In practice, bibliometrics, which involves measuring the impact of scientific publications, is frequently used in scientometrics. The work of Derek J. de Solla Price and Eugene Garfield is largely responsible for the development of modern scientometrics. The Institute for Scientific Information, established by Garfield, is widely used for scientometric analysis. Qualitative, quantitative, and computational methodologies are employed in scientometric studies (Scientometrics, 2013).

## II. METHODOLOGY

The goal of this research is to use scientometric indices to assess and identify the quantitative and qualitative growth in the field of mechatronics in the G5 nations and globally. We extracted publications using the search string CU = G5 AND SU = (Mechatronics) from the Web of Science (WoS) for the period from 2001 to 2020, covering a span of 20 years. A total of 599 publications from the G5 countries, with 5,942 citations, and 3,359 publications worldwide, with 46,043 citations, were considered. The downloaded data were saved as plain-text and tab-delimited spreadsheets in MS Excel format. The tabulated data were then analyzed using several scientometric indices.

## III. STATEMENT OF THE PROBLEM

The development of knowledge has led to mechatronics emerging from the broad fields of electronics and computer technologies to control mechanical systems with interdisciplinary subjects. There is a significant need for the advancement of mechatronics at all levels of science and technology. Given the issues mentioned above, this research was conducted to evaluate studies published in the secondary database of the Web of Science (WoS). The research problem is stated as "Mechatronics Research in the G5 Countries: A Scientometric Analysis." The explanation of the terms and concepts used in the title is provided below, detailing the concepts and identifying the demonstration of the research findings, as shown in Figure 2.
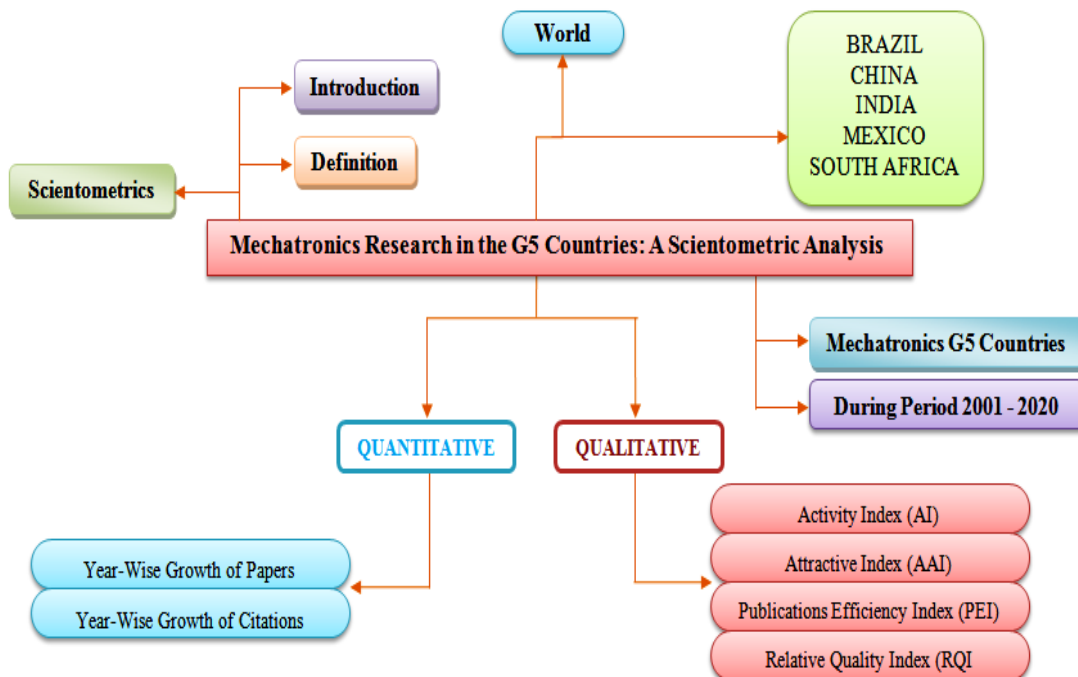


Fig. 2 Flow Chart of Statement of the study

## IV. OBJECTIVES OF THE STUDY

1. Year-wise growth of papers and citations in the G5 and globally.
2. Analysis of the Activity Index (AI) in the G5 countries compared to the global data.
3. Analysis of the Attractive Index (AAI) in the G5 countries compared to the global data.
4. Analysis of the Publications Efficiency Index (PEI) in the G5 countries compared to the global data.
5. Study of the Relative Quality Index (RQI) in the G5 countries.

## V. RESULTS AND DISCUSSION

*A. Year Wise Growth Publication and Citations G5 Countries and World*

The year-wise growth of publications in the field of mechatronics from 2001 to 2020 includes a total of 599 research papers published in the G5 countries and 3,359 globally.

Among the study period, the year 2020 contributed the greatest number of publications, with 104 (17.36%) papers and 300 (5.05%) citations.

This was followed by 2019, with 100 (16.69%) papers and 503 (8.47%) citations. In the years 2001 to 2018, fewer than 60 publications were produced annually. Notably, in 2018, 56 (9.35%) papers were published, receiving 644 (10.84%) citations, which is a strong indicator of the quality of research in the field of mechatronics.

TABLE I YEAR WISE GROWTH PUBLICATION AND CITATIONS G5 COUNTRIES AND WORLD

| Year | G5 Countries | | World | | | |
|------|--------|-----------|--------|-----------|------|---------|
| | Papers | Citations | Papers | Citations | ACPP | H-Index |
| 2001 | 6 (1) | 78 (1.31) | 62 (1.85) | 1575 (3.42) | 25.40 | 20 |
| 2002 | 6 (1) | 83 (1.4) | 92 (2.74) | 1681 (3.65) | 18.27 | 21 |
| 2003 | 10 (1.67) | 77 (1.3) | 93 (2.77) | 1227 (2.66) | 13.19 | 19 |
| 2004 | 4 (0.67) | 34 (0.57) | 98 (2.92) | 1630 (3.54) | 16.63 | 22 |
| 2005 | 8 (1.34) | 124 (2.09) | 106 (3.16) | 2524 (5.48) | 23.81 | 29 |
| 2006 | 11 (1.84) | 59 (0.99) | 119 (3.54) | 2726 (5.92) | 22.91 | 22 |
| 2007 | 17 (2.84) | 502 (8.45) | 140 (4.17) | 5010 (10.88) | 35.79 | **36** |
| 2008 | 13 (2.17) | 193 (3.25) | 14 (4.38) | 2280 (4.95) | 15.51 | 28 |
| 2009 | 13 (2.17) | 168 (2.83) | 137 (4.08) | 2529 (5.49) | 18.46 | 29 |
| 2010 | 16 (2.67) | 384 (6.46) | 178 (5.3) | 2990 (6.49) | 16.80 | 27 |
| 2011 | 25 (4.17) | 219 (3.69) | 184 (5.48) | 2422 (5.26) | 13.16 | 26 |
| 2012 | 20 (3.34) | 337 (5.67) | 182 (5.42) | 2644 (5.74) | 14.53 | 27 |
| 2013 | 30 (5.01) | 309 (5.2) | 186 (5.54) | 2798 (6.08) | 15.04 | 23 |
| 2014 | 30 (5.01) | 416 (7) | 206 (6.13) | 3251 (7.06) | 15.78 | 29 |
| 2015 | 30 (5.01) | 387 (6.51) | 215 (6.4) | 2854 (6.2) | 13.27 | 29 |
| 2016 | 58 (9.68) | 585 (9.85) | 236 (7.03) | 2528 (5.49) | 10.71 | 23 |
| 2017 | 42 (7.01) | 540 (9.09) | 184 (5.48) | 2017 (4.38) | 10.96 | 22 |
| 2018 | 56 (9.35) | 644 (10.84) | 209 (6.22) | 1590 (3.45) | 7.61 | 19 |
| 2019 | 100 (16.69) | 503 (8.47) | 253 (7.53) | 1121 (2.43) | 4.43 | 15 |
| 2020 | 104 (17.36) | 300 (5.05) | 332 (9.88) | 637 (1.38) | 1.92 | **8** |
| Total | 599 | 5942 | 3359 | 46043 | 13.71 | 80 |

A total of 3,359 papers with 46,043 citations were published globally, with an average of 13.71 citations per paper (ACPP) and a total h-index of 80. In 2020, the highest number of papers was published, with 332 (9.88%) papers contributing 637 (1.38%) citations.

This was followed by 2019, with 253 (7.53%) documents published and 1,121 (2.43%) citations received. The maximum ACPP of 35.79, along with an h-index of 36, was also recorded during this period.

In 2007, a total of 140 (4.17%) papers were published, receiving 5,010 (10.88%) citations, which was the highest for that year, along with an h-index of 36. In the years 2005, 2009, 2014, and 2015, the highest h-index of 29 was recorded, as shown in Figure 3.
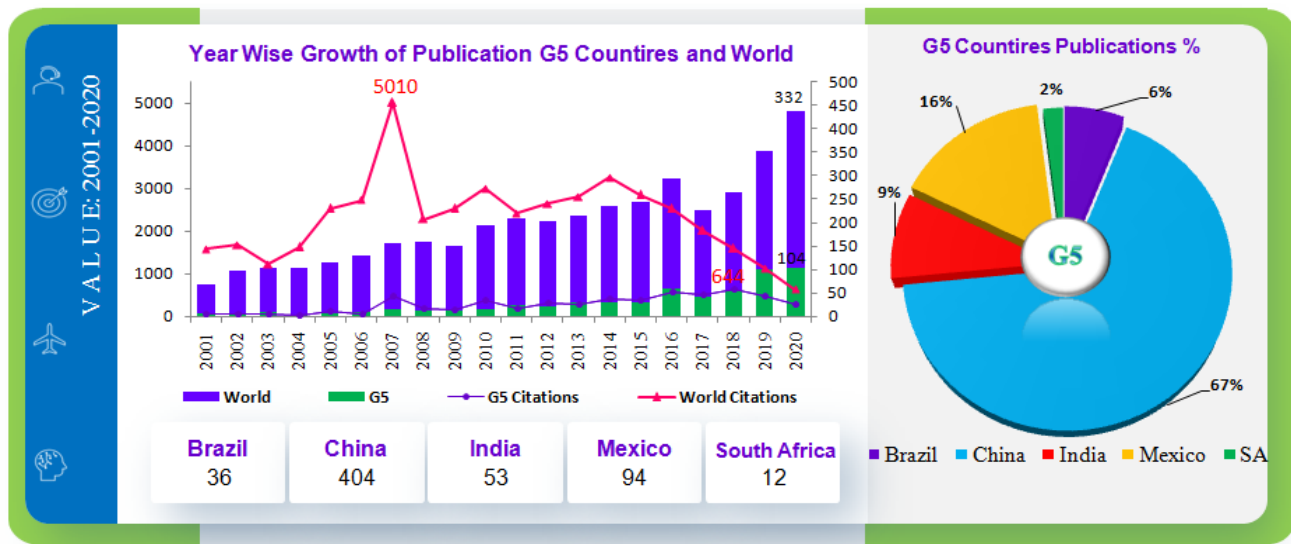
Fig. 3 Year Wise Growth publication and citations G5 Countries and World

## B. Activity Index (AI)

The Activity Index (AI) is used to compare the scientific production of a country with that of the global context. The Activity Index was first suggested by (Frame, 1977).

Mathematically:

$$\text{Activity Index, } AI_i^t = \frac{P_i^t/\Sigma P}{TP^t/\Sigma TP}$$

Where $P_i^t$ is the Publication of $i^{th}$ Country in the $t^{th}$ year, $\Sigma P$ is the total publications of the $i^{th}$ country during the entire period. $TP^t$ is the total publication output of the world in the $t^{th}$ year, and $\Sigma TP$ is the total Publication of the world during the entire period. The activity indices of all the G5 countries are shown in the following Table II and figure 4 shows an increase in the number of publications compared to world production.

TABLE II ACTIVITY INDEX OF THE G5 COUNTRIES

| Activity Index | | | | |
|---|---|---|---|---|
| Year | Brazil | China | India | Mexico | South Africa |
| 2001 | 0 | 67 | 102 | 0 | 0 |
| 2002 | 0 | 45 | 0 | 39 | 0 |
| 2003 | 0 | 72 | 68 | 0 | 301 |
| 2004 | 0 | 17 | 0 | 36 | 286 |
| 2005 | 176 | 31 | 0 | 67 | 0 |
| 2006 | 0 | 42 | 107 | 60 | 235 |
| 2007 | 67 | 77 | 45 | 51 | 0 |
| 2008 | 0 | 62 | 0 | 0 | **381** |
| 2009 | 0 | 55 | 93 | 52 | 0 |
| 2010 | 52 | 23 | 142 | 100 | 157 |
| 2011 | 203 | 54 | 138 | 97 | 0 |
| 2012 | 103 | 55 | 35 | 79 | 154 |
| 2013 | 50 | 89 | 34 | 115 | 301 |
| 2014 | 91 | 81 | 62 | 104 | 0 |
| 2015 | 43 | 81 | 88 | 83 | 0 |
| 2016 | **237** | 127 | 161 | 136 | 119 |
| 2017 | 51 | 127 | 103 | **194** | 0 |
| 2018 | 223 | 143 | 182 | 137 | 134 |
| 2019 | 74 | **260** | 125 | 184 | 111 |
| 2020 | 225 | 180 | **210** | 140 | 0 |
| Avg. | 80 | 84 | 85 | 84 | 109 |

The highest Activity Index (AI) 381 is recorded for South Africa in the year 2008 followed by 301 in the year 2003 in 2013 average of 109 which is higher than the G5 country. In China the highly Activity Index was 260 in 2019, but in the years from 2001 to 2015 Activity Index was consistent below 100.

In Brazil, the Activity Index was 237 in 2016 and 225 in 2020, with an average of 80. In India, the Activity Index reached 210 in 2020, followed by 182 in 2018, resulting in an average of 85. Mexico recorded its highest Activity Index of 194 in 2017, followed by 184 in 2019. Notably, Mexico consistently recorded an Activity Index below 100 from 2001 to 2009.
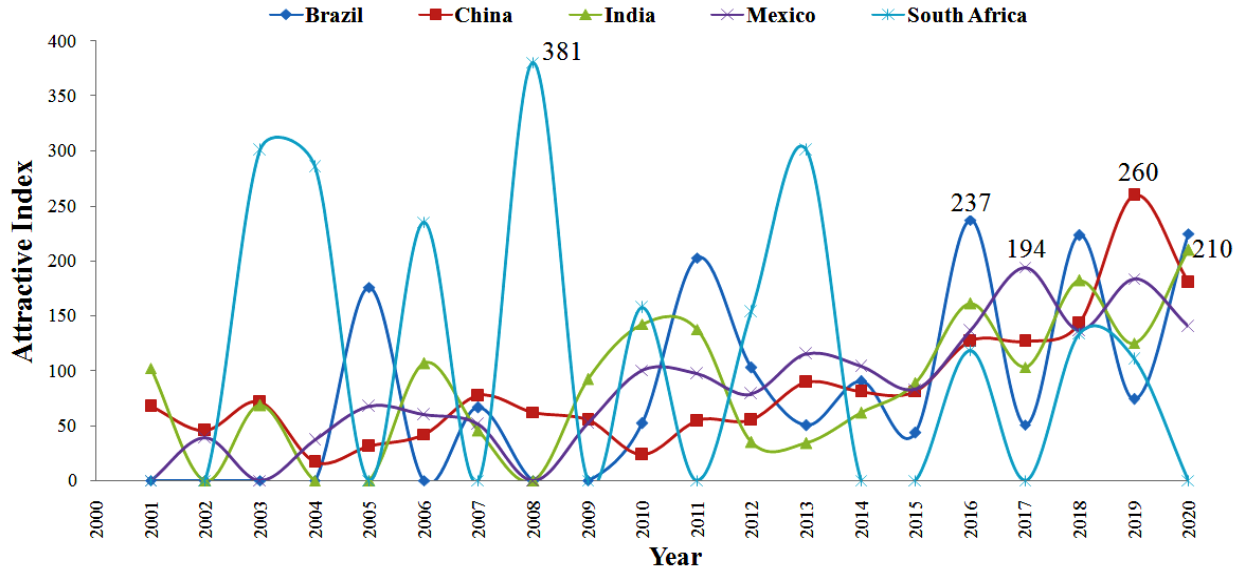


Fig. 4 Activity Index of G5 Countries

TABLE III ATTRACTIVE INDEX OF THE G5 COUNTRIES

| Attractive Index | | | | | |
|---|---|---|---|---|---|
| Year | Brazil | China | India | Mexico | South Africa |
| 2001 | 0 | 48 | 38 | 0 | 0 |
| 2002 | 0 | 39 | 0 | 116 | 0 |
| 2003 | 0 | 59 | 65 | 0 | 0 |
| 2004 | 0 | 14 | 0 | 67 | 0 |
| 2005 | 248 | 22 | 0 | 17 | 0 |
| 2006 | 0 | 16 | 29 | 3 | 274 |
| 2007 | 7 | 81 | 147 | 30 | 0 |
| 2008 | 0 | 93 | 0 | 0 | 109 |
| 2009 | 0 | 54 | 97 | 27 | 0 |
| 2010 | **410** | 17 | 360 | 102 | 250 |
| 2011 | 274 | 40 | 52 | 140 | 0 |
| 2012 | 49 | 105 | 73 | 86 | **706** |
| 2013 | 16 | 97 | 0 | 172 | 44 |
| 2014 | 382 | 75 | 53 | 91 | 0 |
| 2015 | 10 | 131 | 77 | 39 | 0 |
| 2016 | 131 | 150 | **415** | 151 | 148 |
| 2017 | 5 | 234 | 72 | 378 | 0 |
| 2018 | 98 | 361 | 117 | **426** | 0 |
| 2019 | 66 | 415 | 160 | 325 | 444 |
| 2020 | 58 | **482** | 83 | 133 | 0 |
| Avg. | **88** | **127** | **92** | **115** | **99** |

## C. Attractive Index (AAI)

The Attractive Index is used to measure the impact of a country compared to the world based on the number of citations it receives during a given year.

$$\text{Attractive Index, } AAI_i^t = \frac{\dfrac{C_i^t}{\Sigma C}}{\dfrac{TC^t}{\Sigma TC}}$$

Where $C_i^t$ is the Citations received by the $i^{th}$ Country in the $t^{th}$ year, $\Sigma C$ is the total Citations of the $i^{th}$ country period the entire during. The year $TC^t$ is the overall Citations of the world in the $t^{th}$ year, and $\Sigma TC$ is the overall Citations of the world during the entire period.

The Attractive Index (AAI) of all G5 countries is shown in Table III. South Africa had the highest AAI of 706 in 2012, followed by 444 in 2019, resulting in a total average of 99. China had an AAI of 482 in 2020, with an average of 127, which is higher than that of the other G5 countries. It is noteworthy that China's AAI was below 100 from 2001 to 2011. Mexico's highest AAI was 426 in 2018, with a total average of 115. India recorded its highest AAI of 415 in 2016 and 360 in 2010, resulting in an average of 92. Brazil had an AAI of 410 in 2010 and 382 in 2014, with an average of 88.
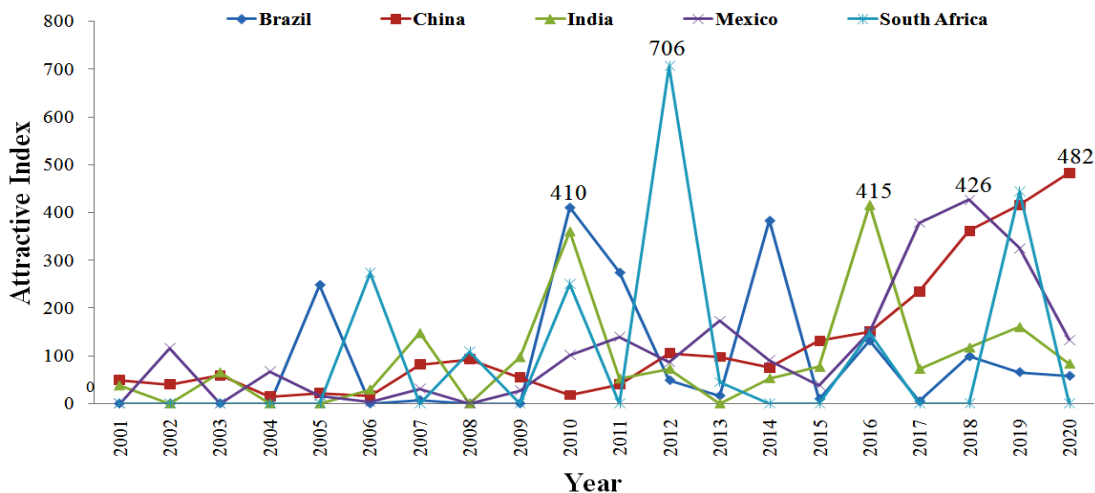


Fig. 5 Attractive Index of G5 Countries

The results indicate that there was constant growth in the Attractive Index (AAI) for China from 2001 to 2020, in contrast to Brazil, India, Mexico, and South Africa. The average Attractive Index for the G5 countries - Brazil, India, China, Mexico, and South Africa - was more than 100.

## D. Publications Efficiency Index (PEI)

The Publication Efficiency Index (PEI) is a measure of the quality of research proposed by (Guan and Ma 2007), who stated, "It indicates whether the impact of publications in a country in a field of research is compatible with research efforts. A PEI value greater than 1 for a country indicates that the impact of publications exceeds the research effort devoted to that particular country and vice versa." The Publications Efficiency Index can be mathematically expressed as follows:

$$PEI = \frac{TNC_i / TNC_t}{TNP_i / TNP_t}$$

Where,
$TNC_i$ - Total number of citations of country i
$TNC_t$ - Total number of citations of all countries
$TNP_i$ - Total number of publications of country i and
$TNP_t$ - Total number of publications of all countries

TABLE IV PUBLICATIONS EFFICIENCY INDEX OF THE G5 COUNTRIES AND WORLD

| Countries | TP | TC | CPP | NCP | % PNC | PEI (G5) | PEI (World) |
|---|---|---|---|---|---|---|---|
| Brazil | 500 | 36 | 0.07 | 7 | 1.40 | 0.71 | 0.01 |
| China | 4168 | 404 | 0.10 | 70 | 1.68 | 0.96 | 0.01 |
| India | 693 | 53 | 0.08 | 9 | 1.30 | 0.76 | 0.01 |
| Mexico | 544 | 94 | 0.17 | 22 | 4.04 | 1.71 | 0.01 |
| SA | 37 | 12 | 0.32 | 5 | 13.51 | 3.22 | 0.02 |
| G5 | 5942 | 599 | 0.10 | TP-Total papers, TC-Total Citations, CPP-Citation per Paper, NCP- Non-Cited No. of Papers, %PNC-Percentile of Non-Cited Papers, SA-South Africa | | | |
| WORLD | 3359 | 46034 | 13.70 | | | | |

"%PNC is obtained by calculating the percentage of papers that were not cited during the time period considered" (Rinia *et al.,* 1998). South Africa had the highest Publication Efficiency Index (3.22) and a citation percentage of 0.02, followed by Mexico with an index of 1.71 and a citation percentage of 0.01.

China had a Publication Efficiency Index of 0.96 and a citation percentage of 0.01, while India had an index of 0.76 and a citation percentage of 0.01. Brazil recorded an index

of 0.71 and a citation percentage of 0.01, as shown in Table IV.

Observations indicated that publications from Mexico and South Africa have not received enough citations compared to their large number of publications. Therefore, it is recommended that Mexico and South Africa focus on publishing their research in high-impact journals in the field of Mechatronics.
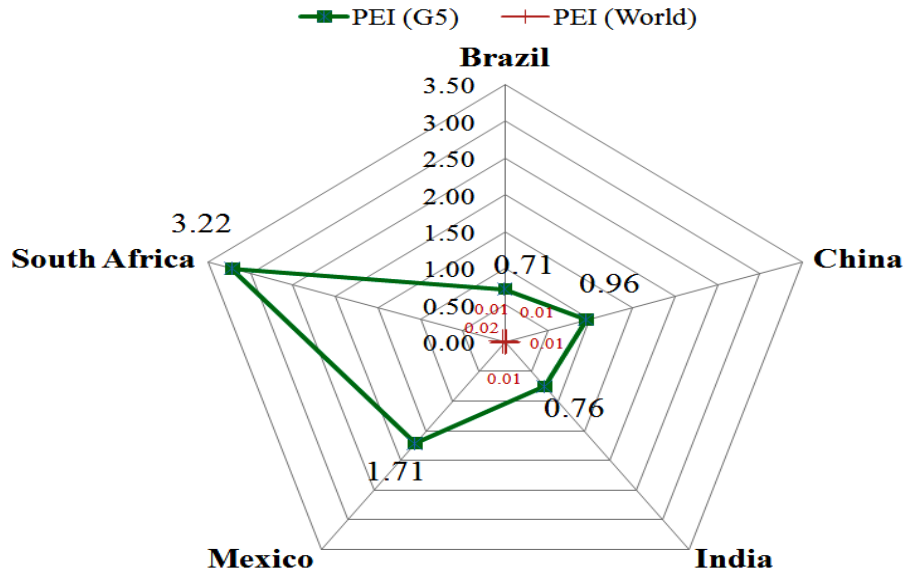


Fig. 6 Publications Efficiency Index of the G5 Countries and World

*E. Relative Quality Index G5 Countries*

A Relative Quality Index (RQI) value greater than 1 indicates a quality higher sthan the average, while a value less than 1 indicates a quality lower than the average. "The

Relative Quality Index (RQI), suggested by Nagpaul (1985), represents the relationship between the proportion of high-quality articles (NHQ%) and the total number of articles (TNP%). RQI is used by Garg and Padhi (2001) for quality inter-comparison."

$$NHQ\% = \frac{Number\ of\ High\ Quality\ papers\ for\ a\ Country\ or\ an\ Institution}{Total\ Number\ of\ Quality\ Papers} \times 100$$

$$TNP\% = \frac{Total\ Publications\ output\ of\ a\ Country\ or\ an\ Institution}{Total\ Publications\ output\ of\ all\ Country\ or\ Institution} \times 100$$

$$RQI = \frac{NHQ\%}{TNP\%}$$

Table V presents the overall number of paper publications, total citations, citations per paper, number of high-quality papers, and the Relative Quality Index for the G5 countries during the study period from 2001 to 2020. A total of 599 papers with 5,942 citations were published in the G5 countries, with 75 of these being classified as high-quality papers.

The Table V also presents the distribution of citation analysis for the Mechatronics research output from the G5

countries, encompassing a total of 599 publications and 5,942 citations, with an average of 9.91 citations per article. The highest number of citations, totaling 4,168, was attributed to the 404 publications from China.

Table V indicates that the Relative Quality Index is highest in South Africa at 2.00, followed by Mexico at 1.36, while the Relative Quality Index for China is lower than the average at 0.87 (see Figure 7).

TABLE V COUNTRIES WISE RELATIVE QUALITY INDEX (RQI)

| Countries | TNP | TNC | CPP | NHQ | TNP% | NHQ% | RQI |
|---|---|---|---|---|---|---|---|
| Brazil | 36 | 500 | 13.89 | 5 | 6.01 | 6.67 | 1.11 |
| China | 404 | 4168 | 10.32 | 44 | 67.45 | 58.67 | 0.87 |
| India | 53 | 693 | 13.08 | 7 | 8.85 | 9.33 | 1.05 |
| Mexico | 94 | 544 | 5.79 | 16 | 15.69 | 21.33 | 1.36 |
| South Africa | 12 | 37 | 3.08 | 3 | 2.00 | 4.00 | 2.00 |
| Total | 599 | 5942 | | 75 | | | |
| TNP-Total No. of Papers, TNC-Total No. of Citation, CPP-Citations per Paper, NHQ-No. of High Quality Papers, TNP%-Total No. of Paper Percentage, NHQ%- No. of High Quality Paper Percentage, RQI-Relative Quality Index | | | | | | | |
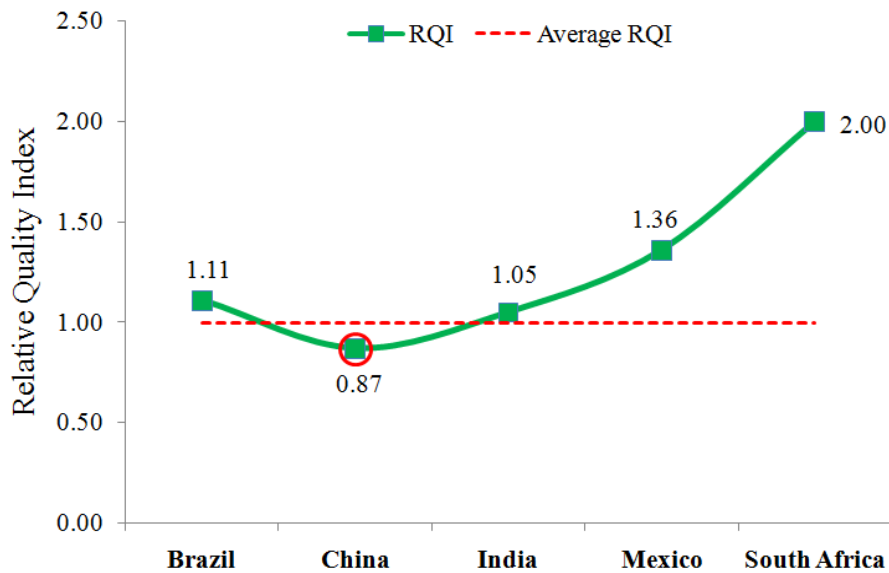


Fig. 7 Countries wise Relative Quality Index (RQI)

## VI. CONCLUSION

The current research study aims to highlight the contributions of publications in the field of Mechatronics within the G5 countries. The study focuses on 20 years of publication metrics, including the Activity Index, Attractive Index, Publications Efficiency Index, and Relative Quality Index. A total of 3,359 papers with 46,043 citations have been published globally, while the G5 countries account for 599 papers with 5,942 citations in the field of Mechatronics. In 2007, a total of 5,010 highly cited papers were published worldwide, with an average of 35.79 citations per paper and an h-index of 36. The highest Activity Index (AI) of 381 was recorded for South Africa in 2008, while the Relative Quality Index for China was lower than the average at 0.87. "Compared to other subjects in science and technology, the field of Mechatronics has seen a considerably lower number of published papers. Statistics show that approximately 1% of global publications are in Mechatronics, compared to 30% to 35% in other fields." The final implication of this research is that more scientists and researchers need to actively engage in research on Mechatronics concepts to enhance technical advancement and growth in this field.

## REFERENCES

[1] Bornmann, L., Wagner, C., &Leydesdorff, L. (2015). BRICS countries and scientific excellence: A bibliometric analysis of the most frequently cited papers. *Journal of the Association for Information Science and Technology, 66*(7), 1507-1513. https://doi.org/10.1002/asi.23264

[2] Chitra, V., Jeyshankar, R., & Abu, K. (2014). Lung cancer research in G7 and BRIC countries: A comparative analysis using scientometric methods. *International Journal of Advanced Library and Information Science, 2*(1), 72-81.

[3] Dhawan, S. M., & Gupta, B. M. (2007). Physics research in India: A study of institutional performance based on publication output. *DESIDOC Bulletin of Information Technology, 27*(1), 55-67. https://doi.org/10.14429/dbit.27.1.179

[4] Frame, J. D. (1977). Mainstream research in Latin America and the Caribbean. *Interciencia, 2*, 143-148.

[5] Garg, K. C., & Kumar, S. (2013). Citation impact of 'letters to the editor' published by Indian scientists in journals indexed by Science Citation Index Expanded (SCIE). *DESIDOC Journal of Library & Information Technology, 33*(1), 73-78. https://doi.org/10.14429/djlit.33.1.3808

[6] Guan, J., & Ma, N. (2007). A bibliometric study of China's semiconductor literature compared with other major Asian countries. *Scientometrics, 70*(1), 107-124. https://doi.org/10.1007/s11192-007-1726-y

[7] Hakkaraki, V. P. (2024). Exploring the evolution of bibliometric analysis: A comprehensive study of scientific publications from 1974 to 2024 using the Dimensions AI database. *Asian Journal of*

*Information Science and Technology, 14*(1), 24-31. https://doi.org/10.70112/ajist-2024.14.1.3878

[8] Hulloli, P. B. (2022). Research on funding agencies in the field of Mechatronics in a global scenario. *Asian Journal of Information Science and Technology, 12*(3), 8-12. https://doi.org/10.51983/ajist-2022.12.2.3166

[9] Hulloli, P. B., & Mani, C. (2021). Research on electric vehicles in India and the USA: A scientometric study. *Asian Journal of Information Science and Technology, 11*(1), 50-54.

[10] Hulloli, P. B., & Savanur, K. P. (2020). Thin film research output in BRICS countries: A scientometric dimension. *International Journal of Library and Information Studies, 10*(3), 54-67.

[11] Jan, R., Wani, W. R., & Hafiz, O. (2015). Scientometric analysis of cloud computing. *Library Philosophy and Practice (e-journal)*, 1-20.

[12] Kademani, B. S., Sagar, A., Kumar, V., & Gupta, B. M. (2007). Mapping of Indian publications in S&T: A scientometric analysis of publications in Science Citation Index. *DESIDOC Bulletin of Information Technology, 27*(1), 17-34. https://doi.org/10.14429/dbit.27.1.169

[13] Kumar, V., Sagar, R., &Narula, S. A. (2013). Researcher-guide networking: A case of renewable energy research. In *2013 IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining* (pp. 1132-1138). IEEE. https://doi.org/10.1109/ASONAM.2013.163

[14] Mondal, D. (2024). Impact of capital expenditures on academic excellence and institutional growth in NIRF-ranked universities. *Asian Journal of Information Science and Technology, 14*(2), 1-10. https://doi.org/10.70112/ajist-2024.14.2

[15] Mori, M. (1969). Mechatronics. *Yasakawa Internal Trademark Application Memo, 12*(7), 21.131.

[16] Nagpaul, P. S. (1985). Contribution of Indian universities to the mainstream scientific literature: A bibliometric assessment. *Scientometrics, 32*, 11-36. https://doi.org/10.1007/BF02016587

[17] Nandeesha, B., & Begum, K. J. (2023). Scientometric analysis of communication disorders. *Asian Journal of Information Science and Technology, 13*(2), 39-45. https://doi.org/10.51983/ajist-2023.13.2.3779

[18] Sagar, A., Kademani, B. S., &Bhanumurthy, K. (2014). Agriculture research in India: A scientometric mapping of publications. *DESIDOC Journal of Library & Information Technology, 34*(3), 206-222. https://doi.org/10.14429/djit.34.3.5609

[19] Varaprasad, S. J., & Ramesh, D. B. (2011). Activity and growth of chemical research in India during 1987-2007. *DESIDOC Journal of Library & Information Technology, 31*(5), 387-394. https://doi.org/10.14429/djit.31.5.2021

[20] Vasantha, B., &Sangeetha, M. (2023). Research productivity of Prof.Sunilkumar S. Manvi: A scientometric portrait. *Asian Journal of Information Science and Technology, 13*(2), 8-16. https://doi.org/10.51983/ajist-2023.13.2.3600

[21] Viswanathan, V., &Tamizhchelvan, M. (2015). Research publications on spacecrafts (1999-2013): A bibliometric study. *International Journal of Library Science, 5*(5), 1-10. https://doi.org/10.5923/j.library.20150505.01