Scientific Research Status in Sudan until 2020

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Abstract

This report aims to highlight the scientific research situation in Sudan for it is considered the most important scientific, intellectual, and cognitive university outcomes and production, and has several contributions in different aspects of the social development field. The following question represents the report's main problem: What is the scientific research fact in Sudan? This report is divided based on the following elements: Scientific research facts in Sudan according to the global database; and scientific research facts as seen by Sudanese researchers.

Keywords: Scientific research, Sudan, Higher education, Reality, and Challenges.
Scientific research has a significant role in society’s evolution and prosperity, its aid in solving society’s problems, and helps with suitable strategies and plans to lead societies to development. Developed countries give great concern for the scientific research sector, besides great funding, also trains students, universities, and academics to be researchers. Scientific research considers the most vital higher education pillars and most important indicator for state development, so the state is keen to develop its institutions, increase in scientific research and allocate a high budget [1].

Compared with the developed world, there is a visible great gap in the scientific research system despite conducting various research and results in publishing, this means that in Sudan we concentrate on theoretical science more than applied science, which leads to less scientific and research level in a country.

First the understanding of the concept of scientific research, in order to be able to state scientific research facts in Sudan, some researchers define it as “trial of discover, search for, develop and examine the knowledge, then investigate it with accuracy and critically, then presented it completely and cleverly to contribute in civilization developing”. Others say “ways of systematic thinking depend on scientific observation, facts and digits in substantive studying of socio-economic phenomena with honest, without personal influences, biases and gains, thus scientific research solves all different society problems and participates in society stabilization and happiness of individuals [2]. So, countries pursue strategic planning for its ability to build strategies that specify developing methods and enhance scientific research practices to face challenges.

Ministry of higher education and scientific research strategies in Sudan 2020 – 2030

This 10-year strategy was prepared to reform higher education and scientific research section, and it relies on higher education and scientific research policies document, which done by the ministry in April 2020 with collaboration with World Bank and contains the following [3]:

1. Poor academic attainment, target age decreasing the number of higher tertiary institutions.
2. Less available resources for higher education and its imbalance with student numbers.
3. Non-conducive educational environment in universities, non-availability of modern education supply and Internet, limited use of modern teaching methods.
4. Absence of quality standard in programmatic and systematic levels, ineffectiveness of Quality Assurance Committee in institutions.
5. Increasing unemployment rate among graduates due to the United Nation (UN) fit between academic programs and needs of society and the job market.

6. Deficiency of Governance, institutions independency, flexibility process, good planning because of inadequate institution councils.

7. Less interaction of institutions participation in society and community development programs, institutions non-differentiation and bad geographic distribution.

8. Shortage outputs of scientific research especially in innovation and building high value-added institutions.

The brief of most important higher education and scientific research strategy, which comes as a response for big challenges that the sector faces, in a conference in 19 August, ministry of higher education and scientific research announced its strategy for next 10 years (2020-2030), universities and research managers have been call to acknowledge the strategy and express their opinion on it, experts and specialized in higher education fields introduced to Minister of higher education and scientific research and to Under-Secretary, evaluating vision of the strategy, this strategy that linked to December revolutionary slogans is consider a unique step in short-term action plan building (10 years) with clear goals to rise higher education and scientific research level in Sudan, in their evaluation they said that strategy distinguished by ambitious goals but without clarifying procedures or measures for effectiveness of changes and suggested policies [3].

This paper [4] discusses and evaluates the strategy policies by highlighting its features and introducing specific suggestions to include in the strategy plan to be more effective and cope with the present reality of universities and scientific research institutions and problems that paralyze it. Some observations and suggestions could improve strategy drafts like: the strategy did not clarify the link between new strategy with transition government strategy and country future plans, to build ministry plans according to it. It was expected to be built by a wide contribution from all ministry components and varied representatives from all different universities to form based on the reality of universities and research foundations.

Also leaked information states that the present strategy plan developed by a team formed by the ministry and by help from similar reports and experts made by UNESCO for west Saharan African states [5]. The strategy discussion was unfortunately limited by calling universities and research centers managers to brief discussion in terms of perception and discussion time, most other university leaders did not participate in planning, determine priorities and procedures for this strategy, which made it unsuitable for universities' realities, many did not know about it until the final draft was released. For example, the visions included in new strategies like tertiary institution
reform by governance, good management, evolving partnership, collaboration and funding modalities require present leaders' participation in determining it and planning for this transformation.

The strategy did not determine how to build tertiary institutions independently and how to reform them, specify their roles and authorities and relation between institutions and the Ministry and Higher Education National Council that was mentioned in the new strategy priorities.

The vision mainly focuses on: scientific research support strategy, organizing priorities, providing communication methods for Sudanese universities to communicate with international and regional universities and research centers.

The following should be part of new strategy priorities and did not elaborate: Scholarships and external training policies, offer sustainable research and science collaboration opportunities with international universities and conventions building.

The vision mentions Sudanese universities ranking international and national, but did not indicate how to benefit from Sudanese universities graduates to rise to university level especially in scientific research and publication, besides supporting industry and economic institutions and cooperation between academic institutions, preparing scientific environment and alumni database construction.

1.1 Situation of Scientific Research in Sudan globally

Comparing with United State of America (USA) and based on expenditure index, scientific product, staff number in scientific research, found that expenditure volume of scientific research in Sudan does not equal 1 to 120 expenditure volume in united states, and Sudanese universities expenditure on scientific research does not exceed 1% while USA universities reaches 40% from total expenditure.

In 2003 [6], a United Nations Educational, Scientific and Cultural Organization (UNESCO) report mentioned that in Sudan, scientific research depends on government funding only – which is a great challenge to this sector, while the government expenditure in Canada reaches 40%, 30% in the USA, less than 20% in Japan. As for scientific publication we are not even close to neighboring countries where the participation of Saudi Arabia in this field reaches 0.1% in specialized journals while Sudan produces only 0.008%, according to the report. In developed country number of staff in scientific research fields in each million from population reach 3391 in USA, 3082 in Japan, 360 in Spain, 308 in Greece, it is important of quickly to upward scientific research field through hard work, states need huge investment in human and
obtaining technical capacity, it considers the key for progress and survive knowledge and mastering modern science, techniques and produce knowledge [6].

In the recent years, number of scientific research staff decrease in Sudan, according to Harby [7], the number of faculty members who migrate to Arabian Gulf countries and Europe increase continuously, some statistics indicate that from 12,000 faculty members, 3000 migrate, other statistics duplicate this number, New Arabi website rise the number to 13000 faculty members migrate to Gulf, Europe countries and the United States.

1.2 Scientific research facts in Sudan according to global database

12.1 Total Science Performance

The following is an overview on science performance in Sudan, (Table 1), in Scopus database archive until 2020, Sudan scientific products reach 8,425 under 8,393. Sudan publications number of citations compared with average number of citations for other similar publications is 1.18; quotation number for Sudan is 102,881 while the average quotation for each publication is 12.2 [8].

Table 1: Sudan scientific research performance according to Scopus website

| Total Scientific Product | 8425 |
|--------------------------|------|
| Citation Number          | 102881|
| Average citation for each publication | 12.2 |
| Field-weighted citation impact. | 1.18 |
| Authors                  | 8393 |

1.2.2 Scientific Publications

Scientific publication ratio based on 4 standards according to Scopus website, scientific publication ratio in higher 10% more citations globally, including 16.9% in 10% best journals [8]. Scientific publication accomplished by cooperation with foreign institutions, which is called international collaboration, reaches 70%, while publications achieved by alliance academic institutions and local companies is 1.7% shown in Table 2.
Table 2: scientific publication ratio based on four standards according to Scopus Website:

| Scientific publication ratio                                                                 | Percentage |
|---------------------------------------------------------------------------------------------|------------|
| Scientific publications in higher 10% citation globally                                     | 7.7%       |
| Scientific publication in higher 10% best journals                                         | 16.9%      |
| International collaboration                                                                 | 72.7%      |
| Scientific publication production by collaboration between companies and academic bodies    | 1.7%       |

1.2.3 Scientific publication through years

Sudan publication share in the highest 1% and 10% from most seen publication in years 2011-2020, except 2011 and 2013 when the number of publications were greatly decreased, number of publications in highest 1% was close ratio, also except 2011 number of publications in highest 10% were also close ratio, it’s important to acknowledge the reasons of less publication in specific period of time this study will probably be starting point for next year’s reports as indicated in Figure 1. Figures (2 – 3) represent citation number and average citation number in years 2011-2020, and Figure 4 represents scientific publication in years 1910-2020 [8].
Figure 1: Publication Share 2011-2020.

Figure 2: Citation number 2011-2020.

Figure 3: Average citation number 2011-2020.
1.2.4 Scientific publication by subject area

Figures 5 and 6 display number of scientific research by subject research, in Figure 5 Medicine is the most publication field in Sudan with 1750 publications and 16.7% ratio, followed by Engineering with less than 1205 publication (10.9%), then Biological and Agricultural Science (9.6%), Computer Science (8.1%), Biochemistry, Genetic and Molecular Biology (7.8%), small ratio increasing in Chemical (4.8%), comparing with Physics, Astronomy, Mathematics, Material Science, Ecology, Immunology, Microbiology, and Social Science with ratio 4.3% - 3.5%, then Pharmacy, Toxicology, Pharmaceutical Preparation, Chemical Engineering, Earth, Planet and Energy Sciences, Veterinary and other multi-specialized fields. The following fields had less than 250 publications with closed ratio, Business Administration, Accounting and Management, Economy, Econometric, Finance, Decision Making, Art and Humanities, Neuroscience, Dentistry, Nursing, Health Sub professions and Psychology Sciences. Medicine fields have higher field-weighted citation impact, but in Medicine fields there is not always positive correlation, for example, specialization like Ecology, in spite of being non-ranked among most publication fields Chemical Engineering and Neuroscience had a high impact [9].
Figure 5: Percentage ratio of scientific publication subjects until 2020
Figure 6: Classification of scientific publication numbers according to subject and field-weighted citation impact until 2020
1.2.5 Scientific publication according to Scopus references

ICCEEE Conference published the highest number of scientific publications in 2018, with 120 scientific publications, followed by numbers of conferences and scientific journals with 45 - 108 publications [10]. Average number of quotations depend on resource or scientific research publication subject area not publication numbers or authors numbers as tabulated in Table 3.

Table 3: Scientific product in Sudan according to Scopus website references:

| Scopus Resource                                                                 | Scientific Publication | Quotation | Authors |
|--------------------------------------------------------------------------------|------------------------|-----------|---------|
| 2018 International Conference on Computer, Control, Electrical, and Electronics Engineering, ICCEEE 2018 | 120                    | 217       | 258     |
| Proceedings - 2013 International Conference on Computer, Electrical and Electronics Engineering: 'Research Makes a Difference', ICCEEE 2013 | 108                    | 487       | 184     |
| PLoS Neglected Tropical Diseases                                                | 194                    | 1666      | 208     |
| PLoS ONE                                                                        | 87                     | 1290      | 162     |
| Proceedings of the International Conference on Computer, Control, Electrical, and Electronics Engineering 2019, ICCEEE 2019 | 85                     | 46        | 173     |
| Proceedings - 2015 International Conference on Computing, Control, Networking, Electronics and Embedded Systems Engineering, ICCNEEEE 2015 | 74                     | 166       | 146     |
| BMC Research Notes                                                              | 61                     | 482       | 196     |
| Proceedings - 2017 International Conference on                                  | 59                     | 248       | 140     |
| Malaria Journal                                                                 | 45                     | 600       | 127     |

1.3 Collaboration

Table 4, expresses international collaboration at a high ratio compared with local and institutional collaboration, which appear clearly in science product and quotation number, while national and institutional collaboration are close in quotation and product. Individual authorship shows the scientific product hardship that faces by individual authors. High ratio of international
collaboration. This clarifies dependency of national scientific products, which rest greatly on international institutions and partnership. Scientific research independence in Sudan comes from national institution collaboration and individuals’ communication inside each institution.

Table 4: Research results in Sudan according to the global, national, and institutional collaboration.

| Scale                                    | Percentage % | Scientific Product | Citations | Number of citations for each page | Field-Weighted Citation Impact |
|------------------------------------------|--------------|---------------------|-----------|-----------------------------------|-------------------------------|
| Global Collaboration                     | 72.7         | 6121                | 93085     | 15.2                              | 1.44                          |
| National Collaboration                   | 9.5          | 803                 | 4154      | 5.2                               | 0.48                          |
| Institutional Collaboration              | 10.2         | 859                 | 3589      | 4.2                               | 0.63                          |
| Created Individually (without collaboration) | 7.6         | 641                 | 2052      | 3.2                               | 0.33                          |

1.3.1 Academic Institutions’ Collaboration

Table 5: Clarifies research results in Sudan according to academic and non-academic institutions’ collaboration.

| Scale                                      | Percentage | Scientific Product | Citations | Number of citations for each page | Field weighted citation impact |
|--------------------------------------------|------------|---------------------|-----------|-----------------------------------|-------------------------------|
| Academic Institutions collaboration        | 1.7        | 141                 | 11658     | 82.7                              | 9.72                          |
| Non-academic Institutions collaboration    | 98.3       | 8284                | 91223     | 11.0                              | 1.04                          |

According to the data in the table, the collaboration of non-academic institutions was 98.3% which is a high academic output compared to Academic institutions that did not exceed...
1.3.2 Research institutions listed in scopus datasets measuring tool (Scival)

According to Scival8, only 19 Sudanese research institutions are in the databases, most of which are universities. The list also included the National Research Center, the Federal Ministry of Health, the Sudanese Atomic Energy Commission, and the Sudan Veterinary Research Administration, as displayed in the previous table. According to the listed results, the University of Khartoum has the highest percentage of scientific products, number of authors, and citations. In second place is the University of Sudan, with a product difference of almost half. There is a direct relationship between the authors and the scientific products as shown in the prior table. However, the number of citations is not always like the number of the scientific product, as it is in the case of the Federal Ministry of Health, which has 20,267 citations compared to the scientific product 208. Sometimes the citation comes according to the type or topic of the published scientific research and not the number of published research. This result confirms the presentation previously that the scientific research in Medicine is one of the highest in the number of scientific publications and the number of citations as shown in Table 6.

Table 6: The research institutions included in Scival, their scientific products, the number of researchers in each institution, and the number of citations obtained in these publications.

| Institution                                | Scientific Product | Authors | Citations  |
|--------------------------------------------|--------------------|---------|------------|
| 1 University of Khartoum                   | 3121               | 2180    | 30866      |
| 2 Sudan university of Science and Technology| 1007               | 820     | 6,624      |
| 3 Al-Jazeera university                    | 594                | 498     | 5228       |
| 4 Al-Neelain University                    | 512                | 392     | 3444       |
| 5 Omdurman Islamic University              | 306                | 228     | 2265       |
| 6 National Research Center                 | 264                | 206     | 2577       |
| 7 Bahri University                         | 221                | 153     | 1724       |
| 8 the Federal Ministry of Health           | 208                | 219     | 20267      |
| 9 Ahfad University for Women                | 157                | 114     | 1205       |
| 10 Alzaiem Alazhari University             | 150                | 116     | 2149       |
| 11 Karari University                       | 147                | 120     | 816        |
| 12 the Sudanese Atomic Energy Commission   | 135                | 88      | 803        |
| 13 Kasala University                       | 120                | 70      | 1073       |
1.3.3 Scientific publications by research institutions

There are 55 research institutions in Sudan, as stated by Scopus's databases, which were listed in Table 7. The University of Khartoum occupies first place for the number of published scientific researches (7361 publications), followed by the University of Sudan and the University of Al-Jazeera under 1311 and 1030 consecutively. It is noteworthy that only The Faculty of Medicine at the University of Khartoum issued 1018 publications, which is close to the scientific product of some universities (such as Al-Neelain University) and even more than the scientific product of other universities and research centers. The five universities occupy the first places compared to research centers. However, there is a noticeable weakness in the scientific publication of scientific research centers such as (the National Research Center, Sudan Veterinary Research Administration, Agricultural Research Corporation, etc.) and other scientific research centers.

Table 7: Research institutions in Sudan according to Scopus database

| No. | Institute                                      | City            | Number of Scientific Publications |
|-----|-----------------------------------------------|-----------------|----------------------------------|
| 1   | University of Khartoum                        | Khartoum        | 7361                             |
| 2   | Sudan university of Science and Technology    | Khartoum        | 1311                             |
| 3   | Al-Jazeera university                         | Wad Madani      | 1030                             |
| 4   | Faculty of Medicine – University of Khartoum  | Khartoum        | 1018                             |
| 5   | Al-Neelain University                         | Khartoum        | 694                              |
| 6   | Faculty of Veterinary Medicine - University of Khartoum | Khartoum | 636                              |
| 7   | National Research center                      | Khartoum        | 447                              |
| 8   | The Federal Ministry of Health                | Khartoum        | 433                              |
| 9   | Omdurman Islamic University                   | Omdurman        | 393                              |
| 10  | Institute of Endemic Diseases, Sudan          | Khartoum        | 341                              |
| No. | Institution Name                                         | City          | Code |
|-----|---------------------------------------------------------|---------------|------|
| 11  | Sudan Agricultural Research Corporation                | Wad Madani    | 308  |
| 12  | Bahri University                                       | Khartoum      | 254  |
| 13  | Ahfad University for Women                             | Omdurman      | 237  |
| 14  | Alzaime Alazhari University                            | Khartoum      | 198  |
| 15  | the Sudanese Atomic Energy Commission                  | Khartoum      | 198  |
| 16  | Karari University                                      | Khartoum      | 182  |
| 17  | University of Nyala                                     | Nyala         | 166  |
| 18  | Central Veterinary Research Laboratory - Sudan          | Khartoum      | 165  |
| 19  | National Ribat University                              | Khartoum      | 159  |
| 20  | Kasala University                                      | Kasala        | 153  |
| 21  | Sudan Tropical Medicine Research Institute             | Khartoum      | 142  |
| 22  | AL-Gadrif University                                   | AL-Gadarif    | 93   |
| 23  | Wadi Al-Neel University                                | Khartoum      | 85   |
| 24  | Red sea University                                     | Port-Sudan    | 79   |
| 25  | Sudan National Health Laboratory                        | Khartoum      | 76   |
| 26  | Al-Watania University - Sudan                          | Khartoum      | 71   |
| 27  | Zalinji University                                     | Zalinji       | 65   |
| 28  | Sudan National Research Council                         | Khartoum      | 64   |
| 29  | Welcome Tropical Research Laboratories in Khartoum      | Khartoum      | 53   |
| 30  | Sudan Veterinary Research Administration               | Khartoum      | 42   |
| 31  | Sudan International University                         | Khartoum      | 39   |
| 32  | Omdurman Al-ahlia University, Sudan                    | Omdurman      | 35   |
| 33  | Sudan Academy of Medical Sciences and Technology       | Khartoum      | 29   |
| 34  | Ministry of Animal Resources and Fisheries - Sudan     | Khartoum      | 26   |
| 35  | Bahr Al-Ghazal University                              | Khartoum      | 25   |
| 36  | Institute of Environmental Studies - Sudan             | Khartoum      | 24   |
| 37  | Al Jazeera Agricultural Research Station – Sudan        | Wad Madani    | 20   |
2. Materials and Methods

Field Inquiry Procedures

After processing the theoretical framework, the research team resorted to the field study to clarify the reality of scientific research in Sudan.

Research Methodology

The research team followed the descriptive-analytical approach as it fits the nature of the data and objectives of this research because it depends on collecting facts and analyzing, interpreting, and drawing conclusions from them, which also includes studying the characteristics related to the reality of scientific research in Sudan.
The research community consists of university employees, workers in scientific research centers, and those interested in scientific research.

Research Sample

The number of the research sample individuals was 224, from the research community, which is the amount available to the research team. A survey has been conducted to see their opinions about scientific research in Sudan. Below is a description of the characteristics of the individuals in the research sample (personal data). They are classified according to gender, educational qualification, occupational degree, and employer.

Questionnaire description

The research team designed a questionnaire to be the fundamental research tool. The research team used the five-point Likert scale: (Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree) to choose the appropriate answer.

Questionnaire components

The questionnaire consists of two sections:

Section one: Includes basic data, like gender, academic qualification, job grade and employer.

Section two: The research team designed a five-choice questionnaire to let each examinee answer the questionnaire's phrases according to what suits his/her opinion.

Research tool

The research tool is the means that the research team used to collect the necessary information about the research subject -the reality of scientific research in Sudan-. The research team used the questionnaire as a tool for collecting data from the research sample because it is the appropriate tool for the research problem and its questions.

Questionnaire application

The research team contacted the members of the research community after obtaining their approval to participate, introducing them to the research they are doing and explaining the procedures to be implemented. They showed significant cooperation, then they sent the link to them to fill out the questionnaire. There were 224 complete and analyzable questionnaires, then it emptied their contents and converted their variables into numbers to facilitate analyzing the
The Likert Scale was relied on in the Questionnaire scale, and its correction was as follows:

Table 8 Shows the distribution and correction of the Questionnaire scale.

| Range     | The barrier estimation that the phrase measures            |
|-----------|-----------------------------------------------------------|
| 2.50 and less | After estimation, low barrier                             |
| 3.50-2.51 | After estimation, medium barrier                           |
| 5.00-3.51 | After estimation, High barrier                            |

Statistical methods

Analysis of the information and data obtained by the research team through the questionnaire. The data was entered into the computer using the Statistical Package for Social Science- (SPSS), and then a set of statistical methods were applied:

1) Figures
2) Frequency Tables
3) Arithmetic mean
4) Standard deviation
5) Percentages of total responses
3. Results and Discussion

Survey Analysis

Gender

From the survey analysis results the frequency distribution of the research sample members according to the gender variable, indicates 116 individuals with a rate of 52.8% males versus 108 females with 48.2% percentage. The number of female research sample members is close to the number of males, which is a good sign of the reality of scientific research in Sudan, regardless of the gender of the responder.

Academic Qualification

The frequency distribution of the research sample individuals according to the educational qualification variable indicated that 119 individuals, with a percentage of 53.1% hold a doctorate degree which was the highest frequency among the categories of academic qualifications followed by 81 individuals with a percentage of 36.2% hold a master’s degree, while the percentage of bachelor degree holders was 10.7% as the lowest among all categories. It can be said that the scientific qualification of the research sample individuals was in favor with the research topic.

Occupational degree

Table 9: Distribution of the research sample members according to the occupational degree variable

| Occupational degree    | Frequency | Percentage % |
|------------------------|-----------|--------------|
| Student                | 12        | 5.4          |
| Teaching assistant     | 3         | 1.3          |
| Lecturer               | 61        | 27.2         |
| Assistant Professor    | 62        | 27.7         |
| Co-professor           | 23        | 10.3         |
| Teacher                | 10        | 4.5          |
| Researcher             | 16        | 7.1          |
| Assistant Researcher   | 4         | 1.8          |
Table 8 shows the occupational degree distribution for the research sample individuals, as it is noted: for the employees in the teaching staff in the universities, the results showed that 62 individuals (27.7%) were assistant professors, followed by 61 individuals (27.2%) were lecturers in universities with the highest frequency in the occupational degree categories, while the lowest percentage was 1.3% as teaching assistants, while the percentage of students was 5.4%.

For workers in research centers, the results showed that 16 individuals, with a rate of (7.1%) working as a researcher, had the highest frequency in the occupation degree categories. On the contrary, the lowest percentage reached 1.3% for research associates, while the percentage of those occupying other positions was 11.6%.

**The Employer**

The distribution of the research sample individuals according to the employer was found that 167 of the sample individuals were from universities, which represent 74.6% of the sample, followed by 44 of the sample individuals at a rate of 19.6% who are working in other employers, then 13 of the sample members with 5.8% rate, worked in research centers.

**Table 10: The axes of the questionnaire about scientific research barriers in Sudan**

| Axis         | Subject                              | Number of phrases |
|--------------|--------------------------------------|-------------------|
| First Axis   | Cognitive barriers                   | 7                 |
| Second Axis  | psychological barriers               | 3                 |
| Third Axis   | social barriers                      | 6                 |
| Fourth Axis  | Management Barriers                  | 6                 |
| Fifth Axis   | Financial Barriers                   | 6                 |
| Sixth Axis   | Barriers related to research institutions | 8               |
|              | Total phrases for the questionnaire  | 36                |
Validity and consistency of the questionnaire

Apparent validity means the ability of the tool to achieve the same results when it is re-applied and its ability to measure the purposes it was designed for. Apparent validity here means the extent to which the questionnaire's phrases are relevant to the purposes it was designed for, which refers to the general form of the questionnaire, the clarity in the formulation of its phrases and language integrity, clarity of instructions, and the correctness of the basic steps' order. The apparent validity of the questionnaire was verified by presenting its paragraphs to the peer reviewers to express their opinions and observations about the statements of each questionnaire and the formulation of its words. The research team made the modifications recommended by the peer reviewers. SPSS statistical software was used to measure the consistency and validity and to verify the validity of the questionnaire to be applied. Cronbach's alpha coefficient was calculated to measure the consistency coefficient, subjective validity coefficient = consistency coefficient √.

Table 11: The axes of the questionnaire about scientific research barriers in Sudan and the coefficients of Alpha Cronbach to measure the consistency of the questionnaire.

| Axis            | Subject                               | Number of phrases | Cronbach’s alpha coefficient | Subjective validity coefficient |
|-----------------|---------------------------------------|-------------------|-----------------------------|--------------------------------|
| First Axis      | Cognitive barriers                    | 7                 | 0.87                        | 0.93                           |
| Second Axis     | Psychological barriers                | 3                 | 0.53                        | 0.73                           |
| Third Axis      | Social barriers                       | 6                 | 0.81                        | 0.90                           |
| Fourth Axis     | Management Barriers                   | 6                 | 0.78                        | 0.88                           |
| Fifth Axis      | Financial Barriers                    | 6                 | 0.87                        | 0.93                           |
| Sixth Axis      | Barriers related to research institutions | 8               | 0.79                        | 0.89                           |
| Total phrases   |                                       | 36                | 0.92                        | 0.96                           |

The axes of the questionnaire about scientific research barriers in Sudan were all greater than (0.75) except for the second axis (0.53), which is the level of acceptance of the consistency coefficient of the application the axis of psychological barriers, and the total consistency of it reached (0.92). The total subjective validity coefficient reached 0.96, their validity and consistency are valid for the field application.
Presentation and analysis of the barriers to scientific research in Sudan questionnaire's data:

Presentation and analysis of the first axis data – Cognitive barriers

The results in Table 12 indicate that the lack of scientific communication through conferences, seminars and other ways are considered the highest cognitive barrier, followed by the lack of foreign languages, the weak scientific preparation of the researcher, and his lack of scientific research skills.

Although his ability to choose the research topic with a rate of more than 60%, his familiarity with his field of specialization, following up on developments, and possession of skills and tools that help him in analyzing and writing scientific research, such as computer skills.

Table 12: The values of the arithmetic mean, standard deviation, and percentage of the total responses, for the first axis phrases: cognitive barriers, arranged by the importance of the element in a descending order, measured by the arithmetic mean (n = 224)

| No | Elements                                                                 | Arithmetic mean | Standard deviation | Total responses% | Barrier Estimation |
|----|-------------------------------------------------------------------------|-----------------|--------------------|------------------|-------------------|
| 1  | The lack of scientific communication through conferences, seminars     | 4.25            | 0.914              | 85               | High              |
| 2  | The lack of foreign languages                                          | 3.80            | 1.107              | 76               | High              |
| 3  | The weak scientific preparation of the researcher                      | 3.76            | 1.162              | 75               | High              |
| 4  | The general average for the first axis cognitive barriers              | 3.64            | 0.836              | 73%              | High              |
| 5  | Lack of scientific research skills                                     | 3.62            | 1.094              | 72               | High              |
| 6  | The inability to choose the research topic                             | 3.45            | 1.147              | 69               | Medium            |
| 7  | Unfamiliarity with his field of specialization and his follow-up to the new and modern | 3.34            | 1.153              | 67               | Medium            |
| 8  | Lack of computer skills                                                | 3.29            | 1.175              | 66               | Medium            |
Presentation and analysis of data for the second axis - psychological barriers

It is notable that Table 13 below represents the psychological barriers that the Sudanese researcher suffers from. We find the lowest value of what motivates success financially and morally, followed by psychological pressures resulting from teaching, administrative and other burdens, and the sense of the futility of conducting the research he is doing came at a slightly lower rate than the previous elements.

Table 13: shows the arithmetic mean, standard deviation and percentage of the total responses, for the second axis phrases: psychological barriers, arranged by the importance of the element in descending order, measured by the arithmetic mean (n = 224)

| No | Elements                                                                 | Arithmetic Mean | Standard deviation | the total responses% | Barrier Estimation |
|----|--------------------------------------------------------------------------|-----------------|--------------------|----------------------|-------------------|
| 1  | The low value of what motivates success financially and morally          | 4.28            | 0.935              | 86                   | High              |
| 2  | Psychological pressures resulting from teaching, administrative burdens  | 4.08            | 1.051              | 82                   | High              |
| 3  | The sense of the futility of conducting the research                    | 3.53            | 1.238              | 71                   | High              |

The general average of the second axis: psychological barriers: 3.96 0.777 67.79% High

Presentation and analysis of the third axis data - social barriers:

Table 14: shows the values of the arithmetic mean, standard deviation, and percentage of the total responses, for the third axis phrases: social barriers, arranged in descending order by the importance of the element, measured by the arithmetic mean (n = 224).

| No | Element                                                                 | Arithmetic mean | Standard deviation | Total responses% | Barrier estimation |
|----|--------------------------------------------------------------------------|-----------------|--------------------|------------------|-------------------|
| 1  | The weak coordination between researchers and beneficiaries             | 4.40            | 0.825              | 88               | High              |

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|   | The society's lack of appreciation for scientific research | 4.29 | 0.971 | %86 | High |
|---|----------------------------------------------------------|------|-------|-----|------|
| 3 | The lack of scientific atmosphere                         | 4.26 | 0.902 | %85 | High |
| 4 | The lack of scientific communication between colleagues   | 4.00 | 0.982 | %80 | High |
| 5 | The lack of collaboration between researchers              | 3.96 | 1.079 | %79 | High |
| 6 | Unwillingness to conduct joint research                    | 3.65 | 1.118 | %73 | High |

General average for the third axis, Social barrier | 4.09 | 0.704 | 82% | High |

About social obstacles Table 14, shows the total responses to all these barrier's elements came in close ratios. One of the most noticeable of these elements was the lack of collaboration between researchers and the beneficiary and funders of this research, then the absence of community appreciation in general for scientific research, which resulted in the lack of a suitable atmosphere to conduct this research, we found better social relations between researchers so that elements such as lack of communication, lack of spirit of cooperation, and unwillingness to conduct joint research came in lower ratios.
Table 15: shows the values of the arithmetic mean, standard deviation, and percentage of the total responses, for the fourth axis phrases: Administrative Barriers, arranged in descending order by the importance of the element, measured by the arithmetic mean (n = 224).

| Order | Element                                                  | Arithmetic mean | Standard deviation | Total responses % | Barrier Estimation |
|-------|----------------------------------------------------------|----------------|--------------------|-------------------|--------------------|
| 1     | Absence of policies oriented to scientific research      | 4.43           | 0.806              | %89               | High               |
| 2     | Lack of coordination and cooperation among scientific institutions | 4.38           | 0.753              | %88               | High               |
| 3     | Lack of cooperation from departments in facilitating the researcher's task | 4.38           | 0.875              | %88               | High               |
| 4     | Administrative complexity in publishing and evaluating research | 4.12           | 1.013              | %82               | High               |
| 5     | Administrative complexity in the promotion system        | 4.01           | 1.042              | %80               | High               |
| 6     | Holding administrative positions and not devoting himself to scientific research | 3.97           | 1.013              | %79               | High               |
|       | General average for the fourth axis, Administrative Barriers | 4.21           | 0.635              | 84%               | High               |
Table 16: Shows the arithmetic mean, standard deviation, and percentage of the total responses, for the fifth axis phrases: Financial Barriers, arranged in descending order by the importance of the item, measured by the arithmetic mean (n = 224).

| No | Element                                                                 | Arithmetic mean | Standard deviation | Total responses% | Barrier estimation |
|----|-------------------------------------------------------------------------|-----------------|--------------------|------------------|--------------------|
| 1  | The shortage of spending on scientific research                         | 4.76            | 0.617              | 95%              | High               |
| 2  | The researcher carries the costs of research and publication            | 4.71            | 0.643              | 94%              | High               |
| 3  | The Low salary of researchers                                          | 4.63            | 0.746              | 93%              | High               |
| 4  | Lack of scientific research budget                                     | 4.59            | 0.769              | 92%              | High               |
| 5  | Weakness of material and human capabilities                             | 4.59            | 0.734              | 92%              | High               |
| 6  | The shortage of returns from conducting research                       | 4.50            | 0.847              | 90%              | High               |

General average of the fifth axis, financial obstacles 4.63 0.567 93% High

As shown in Tables 15 & 16, all the elements in the financial barriers came in a high and close manner, starting with 95% representing the shortage of spending on scientific research and ending with 90% representing the shortage of the returns from conducting this research.
Table 17: Shows the values of the arithmetic mean, standard deviation, and percentage of the total responses, for the sixth axis phrases: Barriers related to the research institution, arranged in descending order by the importance of the element, measured by the arithmetic mean (n = 224).

| No | Elements                                                                 | Arithmetic mean | Standard deviation | Total responses% | Barrier estimation |
|----|--------------------------------------------------------------------------|-----------------|--------------------|------------------|-------------------|
| 1  | A lack of adequate budget allocation for the scientific research from the institution | 4.65            | 0.602              | 93%              | High              |
| 2  | The institution does not take the expenses needed by the researcher.     | 4.58            | 0.685              | 92%              | High              |
| 3  | Giving priority to teaching and administrative burdens over scientific research | 4.38            | 0.860              | 88%              | High              |
| 4  | Lack of full-time work for scientific research in the institution        | 4.34            | 0.919              | 87%              | High              |
| 5  | Not granting the researchers appreciation prizes for valuable research. | 4.33            | 0.868              | 87%              | High              |
| 6  | Charging researchers for arbitration fees and publishing research even in scientific journals issued by the institution | 4.31            | 0.942              | 86%              | High              |
| 7  | The institution follows strict regulations in dispatching researchers to attend conferences and scientific symposia | 4.26            | 0.935              | 85%              | High              |
|    | General average of the sixth axis: Barriers related to the research institution | 4.36            | 0.546              | 87%              | High              |

The elements of this Barrier came in varying ratios, the lack of adequate budgets allocation for the scientific research from the institution, and the institution's failure to carry the expenses needed by the researcher are among the main factors related to the research institution, whilst the other factors are less than these two factors by a small percentage.
Summary

After extrapolating the features of the reality of scientific research in Sudan, published in the Scopus platform database, Sudan database (for the period 2011-2020), and according to recent and brief statistics, the study concludes with some results, most notably:

Summary of the reality of scientific research in Sudan as stated in the international databases

In terms of the overall performance of Sudanese scientific production, it reached 8,425 from 8,393 authors. As for scientific publications, we find that 7.7% is the percentage of scientific publications in the top 10% most cited in the world, and about scientific publications co-authored by institutions in other countries/regions and in what is called international cooperation, it has a large percentage hits more than 70%, and the rate of scientific publications resulting from cooperation between academic institutions and local companies is 1.7%. Scientific publications according to Scopus sources: We find that the ICCEEE Conference issued the highest number of scientific publications in 2018 as for 120 scientific publications, followed by several conferences and scientific fields in which the number of publications ranged from 108 to 45 scientific publications, as stated in Scopus resources. In terms of global cooperation, we find it high compared to national and institutional cooperation, and it's clear from the scientific product and the number of citations. Talking about the cooperation between non-academic institutions, it was 98.3% and a high academic product compared to Academic institutions, which does not exceed 1.7%, which shows the weakness of partnerships and cooperation between Sudanese Academic institutions. Where, the research institutions included in Scival, only 19 Sudanese research institutions are included in the databases; most of them are universities. The list also included the National Research Center and others. Finally, there are 55 research institutions in Sudan, as stated in Scopus website databases. The University of Khartoum occupies the first place for the number of scientific research published (7361 publications), then the University of Sudan and the University of Gezira with 1311 and 1030, respectively. It turns out that there is a notable weakness in scientific publishing from scientific research centers Such as the National Research Center and others.
Summary of the reality of scientific research as realized by the Sudanese researcher

The reality showed there are barriers related to the researcher and other barriers. About the barriers related to the researcher, represented in cognitive barriers: one of them is the lack of scientific communication through conferences and seminars and others, are considered the highest cognitive barrier, then the barrier of lack of foreign languages, poor scientific preparation for the researcher and his lack of scientific research skills, also there are the psychological barriers Sudanese researcher suffer from, we find the low value of the motivation for success materially and morally, followed by psychological pressures resulting from teaching, administrative and other burdens, while the sense of the futility of his research came at a slightly lower rate than the previous elements. Other barriers, including social barriers, appear in the lack of scientific atmosphere, communication, lack of cooperation, and unwillingness to conduct joint research. Administrative barriers represented the lack of cooperation between departments to facilitate the researcher's task, which related to the administrative complications in publishing and arbitrating the research. And financial barriers represented by weak spending on scientific research. About the barriers related to the research institution, it was crystallized in the lack of adequate budget allocation for the scientific research by the institution, and the institution's failure to carry the expenses needed by the researcher, one of the main factors related to the research institution.

Summary of the Ministry of Higher Education suffers from the lack of strategic vision and clarity

The lack of financial funding, many research centers suffer from the absence of the latest precision equipment and the necessary funding for research. Scientific publishing in international periodicals is difficult for some researchers; some periodicals require amounts that may reach a thousand dollars to publish single scientific research, which is a big amount of money for many young researchers who spend their own money on their research.

Recommendations

- Research should have an applied objective that serves scientific development and society with its various aspects.
- Providing the financial support researchers need for publication due to their limited financial capabilities.
- Researchers must be enrolled in training courses in scientific writing and foreign languages development so that the researcher can deal with and keep pace with the various scientific authorities.
- Allocating valuable prizes for research that solves problems in some areas of society.
Providing a suitable environment for researchers to bring these researches to reality.

- Emphasis on patents by activating the research, authorship, translation, and scientific publishing, and motivating researchers financially and morally.
- Increasing government support and the importance of the private sector participation in funding scientific research.
- Establishing scientific publishing centers and units in universities and research centers that contribute to electronic publishing and the use of modern technology in facilitating and speeding publishing procedures.
- Overcoming all barriers and challenges facing researchers while conducting scientific research.
- Investments in scientific research in all fields.
- Publishing frequent reports on the performance of universities and research institutions in the scientific research field and its solution to societal problems and issues.
- Developing a database and information to encourage communication between researchers and various scientific research institutions and centers.

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