



## Bibliometric Analysis of Scientific Productivity of Selçuk University in Academic Studies: WoS Case (2019-2023)

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Selçuk University  
Bibliometric Analysis  
Density Map  
Network Map  
VOSviewer

### Abstract

This study was conducted to reveal the structure of Selçuk University's (SU) scientific productivity in academic studies. Scientific articles in English associated with SU were obtained from the Web of Science (WoS) database for the period 2019-2023 and analyzed with VOSviewer Statistical Analysis Program. Performance analysis indicated that SU is most frequently associated with academic articles indexed in the "SCI-EXPANDED" index in the fields of "Chemistry", "Engineering", "General Internal Medicine", "Agriculture" and "Food Technology" in "2021". The analysis of SU's scientific productivity was carried out in the context of co-authorship, authors, universities, and countries. The findings indicated that "Zengin, G.," "SU," and "Turkey" ranked first in terms of articles, citations, and total link strength. It was also concluded that "Zengin, G." had the highest number of scientific collaborations with "Mahomoodally, M.F.," "SU" with "Necmettin Erbakan University" and "Turkey" with "Italy".

### Research Article

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## 1. Introduction

Higher education institutions in developed countries are moving towards entrepreneurship each day [1]. It is stated that academic studies, initiatives and designs in universities/institutions that provide education and training services in various disciplines are the most impressive way to raise countries to scientifically important economic levels [2].

According to the statistics of the Higher Education Information System for the years 2022-2023, in addition to 129 state universities, 75 foundation universities and 4 foundation vocational schools continue to provide education and training services in Turkey. In the relevant universities; 114508 doctoral students, 434485 master's degree students, 3754095 undergraduate, 2647054 associate degree students receive education [i]. Selçuk University (SU) is one of the universities providing

education and training services as a state university.

SU was established under Law No. 1873 on the "Establishment of Four Universities," which came into effect on April 1, 1975. In the 1976-1977 academic year, SU began its educational activities with two faculties (Faculty of Literature and Faculty of Science), seven departments, 327 students, and two full-time faculty members. Today, SU is one of Turkey's largest universities, providing educational services with eight institutes, 24 faculties, five schools, 53 research centers, 22 vocational schools, and approximately 7,000 academic staff members [ii]. According to the 2022-2023 statistical data of the higher education institution, SU hosts a total of 67,791 students, including 986 male and 813 female doctoral students; 2,735 male and 2,641 female first-cycle students, 929 male and 461 female second-cycle students, and 103 male and 23 female distance learning master's students;

13,078 male and 16,524 female first-cycle students, 5,515 male and 4,608 female second-cycle undergraduate students; 8,952 male and 6,627 female first-cycle students, and 2,249 male and 1,544 female second-cycle associate degree students [ii]. Additionally, many national and international academic studies and projects are conducted by the academic staff serving at SU, and the university supports its academics in these endeavors.

In recent years, the terms such as bibliographic record, bibliometrics, bibliometric methods, and bibliometric analysis have become more prevalent in academic studies. Bibliometrics can be described as a statistical method used to analyze the distribution and characteristics of research [3]. A bibliographic record consists of a set of fields utilized to index the main text, its topics, and descriptive information [4]. According to Moral-Muñoz et al. (2020), bibliometrics is a significant tool for evaluating and analyzing researchers' outputs, the network of relationships between universities, the impact of government science funding on national research and development performance, and educational efficiency [5]. Bibliometric methods are used to conduct quantitative analyses of scientific research documented in the literature [6]. Bibliometric analysis involves the quantitative investigation of bibliographic documents and provides an overview of the research field that can be grouped by researchers, journals, and articles [7].

Scientists have conducted various research studies, indexed in different databases, that have been subjected to bibliometric analysis [8-12]. Additionally, bibliometric analyses have been conducted on universities worldwide that provide educational services and contribute to the scientific community [13-17]. In this context, it has been identified that there is no comprehensive academic research explaining the changes and developments in the social network structure and scientific productivity of SU within the framework of scientific actors (year and language of publication, publication type, field index, and research areas). Therefore, scientific articles published in English by SU members between 2019 and 2023 and indexed in the Web of Science (WoS) database were tested and analyzed using the VOSviewer Statistical Analysis Program within the framework of determined scientific actors to determine the social network structure and scientific productivity.

In the study, a literature review was conducted first, followed by the methodology related to the study. Subsequently, analyses were performed based on the obtained data, and

finally, the findings were explained and interpreted.

## 2. Method

### 2.1. Literature review

Higher education institutions/universities worldwide that provide educational services strive to generate new knowledge through research, projects, experiments, and similar activities within their respective fields and disciplines. Moreover, by producing and presenting this new knowledge to the public, they contribute to socio-economic advancements and effective performances [18]. Thus, universities play a critical role as entrepreneurs not only in knowledge production but also in disseminating the knowledge they generate. Universities that adopt entrepreneurship as a principle strive to be the most efficient/effective in all their activities with a common strategy (such as having effective financial resources, selecting productive students and researchers, conducting quality studies, etc.) and succeed in competitive fields. They also endeavor to be more productive and innovative in establishing a relationship between education and practice [19].

A review of the international literature indicates that different databases (WoS, PubMed/Medline, Scopus, Google Scholar, Web of Knowledge, Science Direct, Embase, Psycinfo, SocINDEX, Embase, Ovid Health STAR) have been used in the academic studies conducted by scientists [20-24]. It is observed that in the bibliometric analyses employed by scientists in their research, Scopus [25-30] and Wos [31-36] databases are more frequently utilized. Additionally, Güler (2021) mentions that the oldest database in the world is WoS and that it is widely used [37]. WoS database includes a variety of published scientific studies in different research fields and topics, indexed in SCI-EXPANDED, ESCI, CPCI-S, SSCI, CPCI-SSH, IC, A&HCI, BKCI-S, BKCI-SSH, and CCR-EXPANDED indexes.

Bibliometrics, which involves the analysis of different research studies indexed in various databases, is an increasingly popular method in the scientific world, attracting more interest from researchers. This is because bibliometrics represents a comprehensive integration and intersection of philology, mathematics, information science, and statistics within a specified scientific research area [38]. Defined as "the application of mathematical and statistical methods to books and other communication media," bibliometrics is used to quantitatively

evaluate the productivity of scientific studies [39].

It is noted that the first study related to bibliometric research was conducted by Cole and Eales in 1917 [40]. The term "statistical bibliography" was first used by E.W. Hulme in 1923 to refer to the application of quantitative techniques to libraries. Additionally, it is stated that Alan Pritchard introduced the term "bibliometrics" into the literature in 1969, using it in his scientific article [41].

Bibliometrics is a method used to analyze documents/scientific outputs (such as thesis, articles, conference papers, books, etc.) from universities, institutions, or sectors outside the academic realm through statistical methods and techniques [42]. Bibliometric analysis is a quantitative analysis performed to facilitate the evaluation of research performance in the literature [43]. It also shows the evolutionary trends in the changes and developments of a specific research field or topic, both historically and in the future [44-45]. Research studies in the literature can offer different services to scientists in various functions [46].

A review of the literature shows that bibliometric analyses have been conducted based on analytical data related to research topics [47-49], academic journals [50-53], theses [54-58], and universities [59-62].

## 2.2. Research methodology

A review of the international literature reveals that researchers often obtain ethical committee approval or consent for their studies [63-69]. However, some studies indicate that ethical committee approval is not required, and thus, was not obtained [70-78]. Additionally, researchers indicate that no ethical committee approval was obtained for bibliometric analyses used in their studies [79-82]. In this context, tests and analyses conducted on datasets containing analytical data related to the scientific papers of SU indexed in WoS database, based on the characteristics and quantitative indicators of scientific actors, are entirely based on literature review. Therefore, since the study is not related to any living subjects, it was concluded that **there is no need to obtain ethical committee approval** from any institution or organization for the research.

The methodology to be followed in demonstrating the scientific productivity of SU's related scientific paper studies within the framework of relevant scientific actors is described below.

## 2.3. Aim and significance of the study

No comprehensive scientific study reflecting the scientific productivity of SU between 2019 and 2023 has been found in the international literature. To address this gap in the international literature, the aim is to identify SU's scientific productivity through bibliometric analysis based on its related articles indexed in WoS database. The study has two objectives. These are shown below;

- ✓ to assess SU's performance in scientific productivity by examining its status in relation to scientific actors based on the publication year and language of the works, the indexed databases, and research areas.

- ✓ to illustrate the status of the social network structure of academic articles from SU reflected in WoS database.

The first objective was pursued through performance analysis based on qualitative and quantitative indicators of scientific actors related to SU's articles indexed in WoS database. The second objective was addressed by conducting bibliometric analyses on the outputs (tables, scientific networks, and density maps) derived from tests and analyses performed in a relevant statistical analysis program on the dataset (Fast 5000) containing analytical data associated with the identified scientific actors.

The bibliometric analysis results concerning the scientific productivity of SU, based on its related studies and scientific actors, hold several significant implications for the international literature. These include as follow:

- 1) Revealing the performance of the university in scientific productivity within the framework of identified scientific actors.

- 2) Identifying the research orientations of the higher education institution within the specified scientific actors.

- 3) Determining the scientists who contribute the most to the university's scientific productivity.

- 4) Identifying the universities and countries with which the institution has the most scientific collaboration.

- 5) Highlighting academic studies that could be contributed to the literature based on the publication year and language of the related articles, research areas, indexed databases, etc., associated with the university's publications.

## 2.4. Universe and sample of the study

Based on the studies related to SU, the articles indexed in WoS database have been designated as the population for the study in order to reveal scientific productivity within the framework of

the relevant scientific actors. Scientific articles in English, associated with SU and reflected in the international literature, have been identified as the sample for the research. In this context, English-language scientific articles related to SU's scientific productivity have been analyzed in terms of their publication year, language, indexed databases, and research areas.

## **2.5. Stages, procedures and techniques of the study**

In the process of reflecting SU's academic articles in the international literature within the framework of relevant scientific actors, the articles were searched in WoS database, and necessary filters were applied. Following this, tests and analyses were conducted based on the obtained data set, including relevant tables. The steps of the "Bibliometric Analysis," which include reporting and recommendations, are presented as shown in Figure 1.

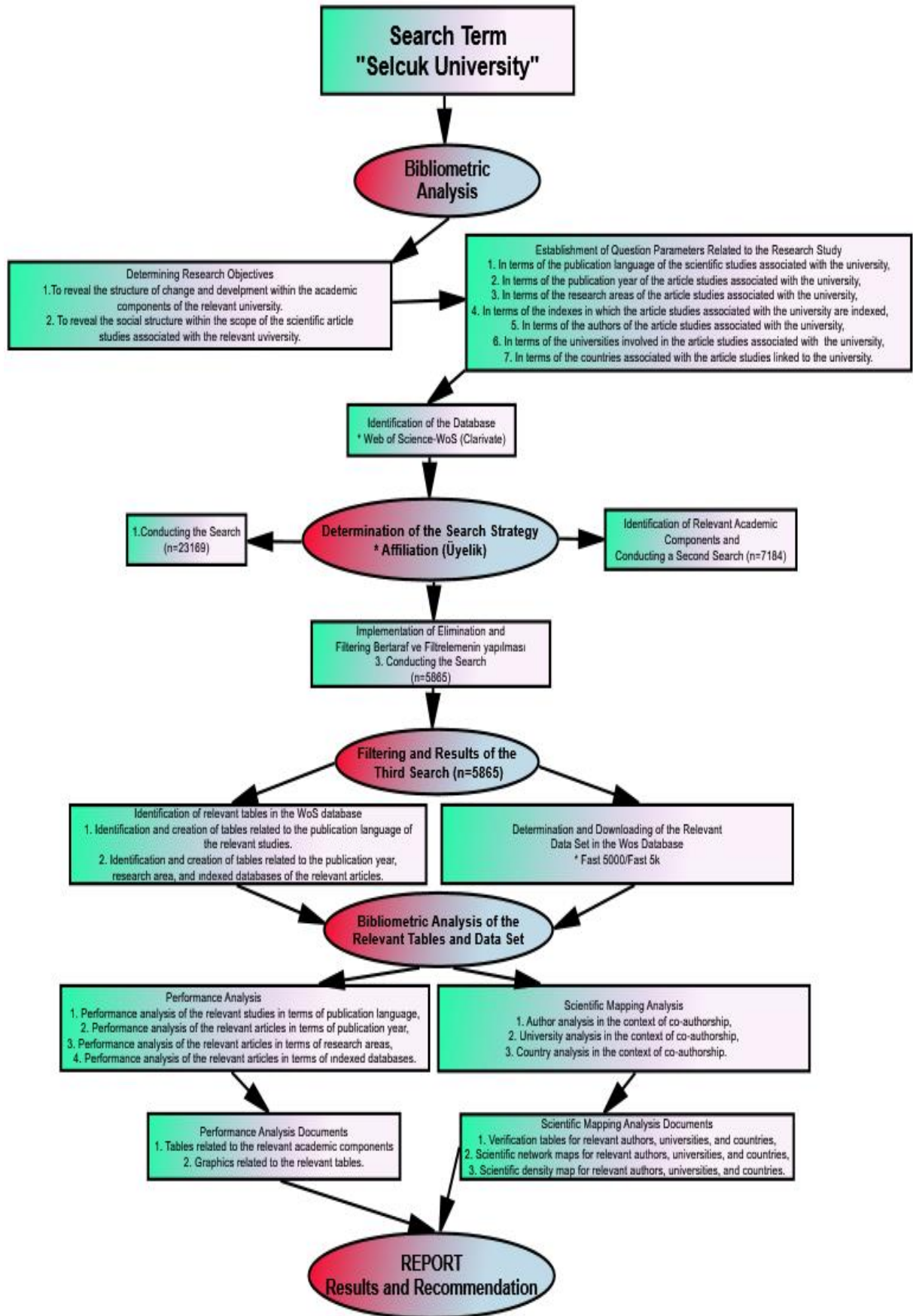


Figure 1. Bibliometric analysis steps

To accurately determine the scientific productivity of the relevant university or institution through bibliometric analyses, it is crucial to follow a specific sequence and set of steps. Therefore, the "Bibliometric Analysis" of SU's scientific productivity from 2019 to 2023 was conducted in accordance with the steps outlined in Figure 1 above.

## 2.6. Formulating research questions

In line with the objectives of the study, seven questions have been formulated to explore SU's scientific productivity within the framework of relevant scientific actors (publication language and year, research areas, and indexed databases). The questions are outlined below.

Here are the questions formulated to explore SU's scientific productivity within the framework of relevant scientific actors:

- ✓ What is the status of the publication language of SU's associated scientific works (articles, books, conference papers, book chapters, etc.)? (Q<sub>1</sub>)
- ✓ How has the evolutionary change and development of the publication years of SU's associated scientific articles progressed? (Q<sub>2</sub>)
- ✓ What is the status of the research areas of SU's associated scientific articles? (Q<sub>3</sub>)
- ✓ What is the status of the indexes where SU's associated scientific articles are indexed? (Q<sub>4</sub>)
- ✓ What is the state of the social network structure among authors in terms of co-authorship for SU's associated scientific articles? (Q<sub>5</sub>)
- ✓ What is the state of the social network structure among universities in terms of co-authorship for SU's associated scientific articles? (Q<sub>6</sub>)
- ✓ What is the state of the social network structure among countries in terms of co-authorship for SU's associated scientific articles? (Q<sub>7</sub>)

## 2.7. Conducting research related screenings and obtaining the data set

To obtain the research data, a three-stage search was conducted in WoS database by entering "SU" into the search field to determine SU's scientific productivity. In the first search, 23,169 results were found. In the second search, focusing on the years 2019-2023, 7,184 scientific works (books, book chapters, conference papers, articles, etc.) were identified. In the third search, which was narrowed down to the specific scientific actors (articles, publication year (2019-2023), language (English), research areas, and

indexes), 5,865 scientific articles were obtained. Subsequently, work was carried out to obtain the tables and data files needed for testing and analysis. The steps of these activities can be described as follows:

- ✓ Filtering was performed by applying exclusion criteria to the attributes of the relevant scientific actors.
- ✓ Following the filters, tables (publication year and publication language, index and research field) containing the quality and quantity indicators of the scientific actors of the articles associated with SU were obtained and edited.
- ✓ Analytical data for the articles associated with SU, within the scope of the relevant scientific actors, were downloaded from the Fast 5000 data file.

The acquisition of the aforementioned tables (Tables 1, 2, 3, and 4) and the download of the Fast 5000 dataset were completed on **May 19, 2024, at 20:49**.

In accordance with the study's objectives, the answers corresponding to the first four parameters (P<sub>1</sub>, P<sub>2</sub>, P<sub>3</sub>, and P<sub>4</sub>) were obtained from WoS and derived from the performance analyses conducted on the data presented in Tables 1, 2, 3, and 4. For the remaining three questions (P<sub>5</sub>, P<sub>6</sub>, and P<sub>7</sub>), the Fast 5000 (Fast 5k) dataset downloaded from WoS was subjected to testing within the framework of specified threshold values using the relevant statistical analysis program. The results of these tests, concerning authors, universities/institutions, and countries, were analyzed through scientific mapping analyses based on the generated scientific networks and density maps.

## 3. Results

### 3.1. Research findings and analysis

The tests and analyses conducted on the Fast 5000 dataset obtained from WoS database were performed using the statistical analysis program VOSviewer version 1.6.20. To ensure the feasibility of performance analyses on the tables and to facilitate the understanding of the tests and analyses performed, the tables were labeled with sequence numbers identified by the letters "K," "L," "M," and "N." The tests and analyses applied to reveal the scientific productivity of SU within the scope of WoS database are presented in the following sections.

### 3.2. Performance analysis

In the context of revealing the scientific productivity of SU within the scope of the identified scientific actors, Tables 1, 2, 3, and 4,

obtained from the relevant database, were organized to address the question parameters formulated in line with the research objectives. The performance analysis explanations conducted on the qualitative and quantitative indicators of the scientific actors related to SU's article studies in WoS database are provided below.

### 3.2.1. Performance analysis in terms of languages of publication

Within the scope of the publication language, the qualitative and quantitative indicators used to reveal the performance of SU's scientific productivity in terms of its related scientific studies in WoS database are presented in Table 1.

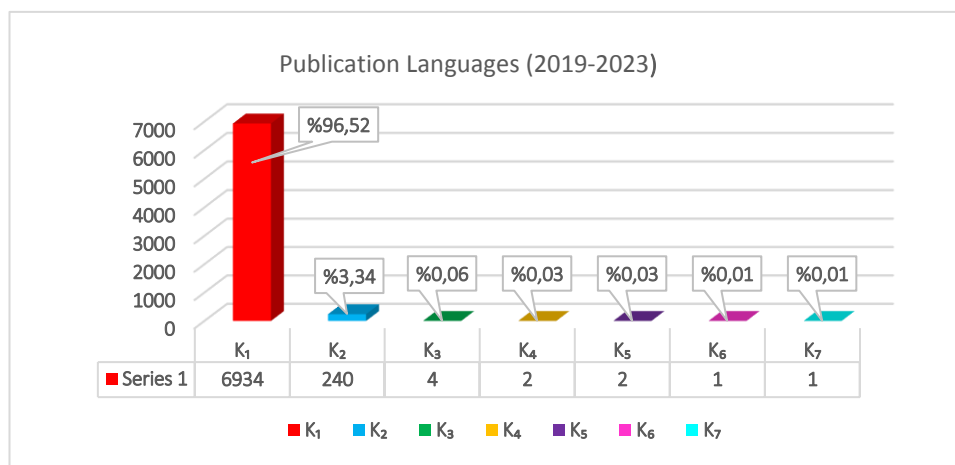
**Table 1.** Distribution of articles with SU affiliation in terms of language of publication (2019-2023)

Sn	Publication Languages	n
K <sub>1</sub>	English	6934
K <sub>2</sub>	Turkish	240
K <sub>3</sub>	Spanish	4
K <sub>4</sub>	German	2
K <sub>5</sub>	Hungarian	2
K <sub>6</sub>	Arabic	1
K <sub>7</sub>	Russian	1

Sn: Sequence number; K: Sort letter symbol; n: Number of articles

To address the question parameter (P<sub>1</sub>) designed to reveal the status of the publication language of SU's related scientific studies (articles, books, papers, book chapters, etc.), Table 1 presented above has been examined. It has been determined that the scientific studies associated with SU for the period 2019-2023 were published in 7 different languages. The languages and the number of scientific studies published are as follows: "English" (K<sub>1</sub>) 6934, "Turkish" (K<sub>2</sub>) 240, "Spanish" (K<sub>3</sub>) 4, "German" and "Hungarian" (K<sub>4</sub> and K<sub>5</sub>) 2, "Arabic" and "Russian" (K<sub>6</sub> and K<sub>7</sub>) 1. In this context, it has been identified that SU's scientific studies during the specified years were mostly published in "English" (K<sub>1</sub>) and the least in "Arabic" (K<sub>6</sub>) and "Russian" (K<sub>7</sub>).

Based on Table 1, which contains the qualitative and quantitative indicator data for the publication languages of SU's related scientific studies, Graphic 1 has been drawn.



**Graphic 1.** Status of scientific studies in terms of languages of publication

From Graphic 1, it is observed that 96.52% of SU's related scientific studies are published in "English" (K<sub>1</sub>), 3.34% in "Turkish" (K<sub>2</sub>), 0.06% in "Spanish" (K<sub>3</sub>), 0.03% in "German" (K<sub>4</sub>) and

"Hungarian" (K<sub>5</sub>), and 0.01% in "Arabic" (K<sub>6</sub>) and "Russian" (K<sub>7</sub>). In this context, it has been determined that SU demonstrates a high performance in publishing scientific studies in

English. Consequently, it can be inferred that in the coming years, SU will continue to have a significantly higher connection to scientific studies published in English ( $K_1$ ) compared to other languages.

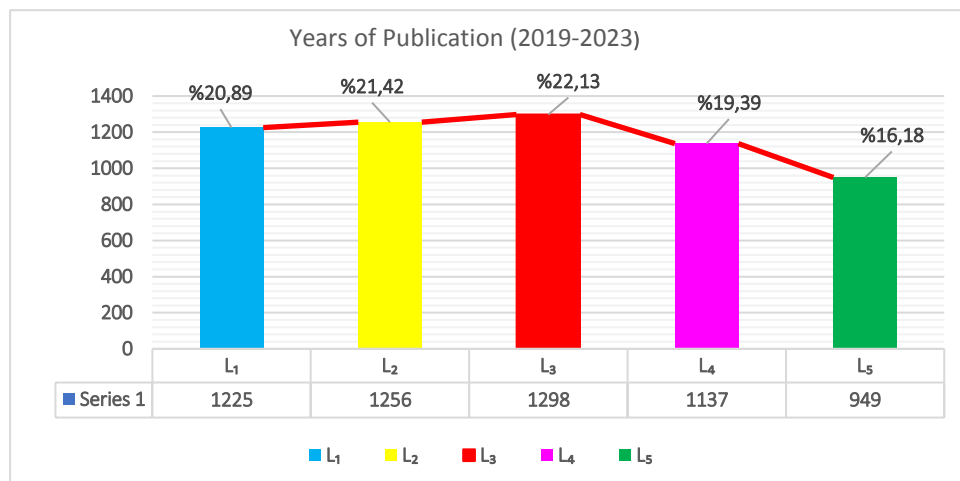
After the performance analysis regarding the publication languages of SU's related scientific studies between 2019-2023, the performance and scientific mapping analyses concerning the publication year, research area, and indexed databases of SU's scientific productivity have been conducted, focusing on scientific articles published in "English".

### 3.2.2. Performance analysis by year of publication

The qualitative and quantitative indicators used to reveal the performance of SU's scientific productivity, in terms of its related article studies in WoS database, are presented in Table 2.

**Table 2.** Distribution of articles that SU is associated with in terms of years of publication (2019-2023)

Sn	Years of Publication	n
L <sub>1</sub>	2023	1225
L <sub>2</sub>	2022	1256
L <sub>3</sub>	2021	1298
L <sub>4</sub>	2020	1137
L <sub>5</sub>	2019	949



**Graphic 2.** Status of scientific articles in terms of years of publication

From Graphic 2, it can be observed that 16.18% of SU's related scientific articles were published in "2019" (L<sub>5</sub>), 19.39% in "2020" (L<sub>4</sub>), 22.13% in "2021" (L<sub>3</sub>), 21.42% in "2022" (L<sub>2</sub>),

and 20.89% in "2023" (L<sub>1</sub>). In this context, it has been identified that SU has the highest connection with scientific articles contributed to the academic world in 2021 (L<sub>3</sub>) and 2022 (L<sub>2</sub>).

*Sn: Sequence number; L: Sort letter symbol; n: Number of articles*  
 To address the question parameter (P<sub>2</sub>) designed to reveal the evolutionary change and development status of SU's related scientific article studies in terms of publication year, Table 2 was examined. The year and number of related scientific studies published are as follows: 949 in "2019" (L<sub>1</sub>), 1137 in "2020" (L<sub>2</sub>), 1298 in "2021" (L<sub>3</sub>), 1256 in "2022" (L<sub>4</sub>), and 1225 in "2023" (L<sub>5</sub>). In this context, it was determined that most scientific article studies were published in 2021, and the fewest were published in "2019". Accordingly, it can be seen that the total number of scientific article studies on the research topic from 2019 to 2023 is 5865.

Based on Table 2, which contains the qualitative and quantitative indicator data of the publication years of SU's related scientific article studies, Graphic 2 has been drawn.



The performance related to SU's scientific productivity showed an upward trend from "2019" (L<sub>5</sub>) to "2021" (L<sub>3</sub>) and a downward trend after "2021" (L<sub>3</sub>).

**3.2.3. Performance analysis in terms of research areas**

In terms of research areas, the qualitative and quantitative indicators used to reveal SU's scientific productivity performance in relation to its affiliated articles in WoS database are presented in Table 3.

**Table 3.** Distribution of articles with which SU is associated in terms of research areas (2019-2023)

Sn	Research Areas	n
M <sub>1</sub>	Chemistry	642
M <sub>2</sub>	Engineering	438
M <sub>3</sub>	General Internal Medicine	397
M <sub>4</sub>	Agriculture	383
M <sub>5</sub>	Food Science Technology	374
M <sub>6</sub>	Veterinary Sciences	338
M <sub>7</sub>	Pharmacology Pharmacy	325
M <sub>8</sub>	Biochemistry- Molecular Biology	320
M <sub>9</sub>	Materials Science	319
M <sub>10</sub>	Physics	230
M <sub>11</sub>	Plant Sciences	227
M <sub>12</sub>	Environmental Sciences - Ecology	213
M <sub>13</sub>	Surgery	169
M <sub>14</sub>	Neurosciences -Neurology	163
M <sub>15</sub>	Pediatrics	163
M <sub>16</sub>	Science Technology Other Topics	162
M <sub>17</sub>	Computer Science	143
M <sub>18</sub>	Mathematics	140
M <sub>19</sub>	Oncology	115
M <sub>20</sub>	Psychiatry	111
M <sub>21</sub>	Nursing	106
M <sub>22</sub>	Urology- Nephrology	96
M <sub>23</sub>	Endocrinology- Metabolism	92
M <sub>24</sub>	Education- Educational Research	87
M <sub>25</sub>	Radiology -Nuclear Medicine- Medical Imaging	87
M <sub>26</sub>	Obstetrics -Gynecology	84
M <sub>27</sub>	Polymer Science	82
M <sub>28</sub>	Psychology	79
M <sub>29</sub>	Biotechnology- Applied Microbiology	78

M <sub>30</sub>	Public Environmental- Occupational Health	78
M <sub>31</sub>	Immunology	73
M <sub>32</sub>	Dentistry -Oral Surgery Medicine	71
M <sub>33</sub>	Cardiovascular System- Cardiology	70
M <sub>34</sub>	Research Experimental Medicine	66
M <sub>35</sub>	Energy Fuels	63
M <sub>36</sub>	Dermatology	59
M <sub>37</sub>	Business Economics	57
M <sub>38</sub>	Nutrition -Dietetics	52
M <sub>39</sub>	Orthopedics	49
M <sub>40</sub>	Infectious Diseases	48
M <sub>41</sub>	Emergency Medicine	47
M <sub>42</sub>	Optics	47
M <sub>43</sub>	Instruments- Instrumentation	44
M <sub>44</sub>	Sport Sciences	44
M <sub>45</sub>	Life Sciences- Biomedicine- Other Topics	43
M <sub>46</sub>	Otorhinolaryngology	43
M <sub>47</sub>	Toxicology	43
M <sub>48</sub>	Allergy	40
M <sub>49</sub>	Rheumatology	40
M <sub>50</sub>	Ophthalmology	39
M <sub>51</sub>	Health Care Sciences Services	38
M <sub>52</sub>	Cell Biology	37
M <sub>53</sub>	Social Sciences -Other Topics	36
M <sub>54</sub>	Respiratory System	35
M <sub>55</sub>	Physiology	34
M <sub>56</sub>	Metallurgy -Metallurgical Engineering	33
M <sub>57</sub>	Zoology	33
M <sub>58</sub>	Electrochemistry	32
M <sub>59</sub>	Microbiology	32
M <sub>60</sub>	Rehabilitation	31
M <sub>61</sub>	Anatomy- Morphology	29
M <sub>62</sub>	Water Resources	29
M <sub>63</sub>	Integrative-Complementary Medicine	28
M <sub>64</sub>	Reproductive Biology	28
M <sub>65</sub>	Thermodynamics	27
M <sub>66</sub>	Gastroenterology-Hepatology	26
M <sub>67</sub>	Genetics Heredity	26
M <sub>68</sub>	Geriatrics-Gerontology	26
M <sub>69</sub>	Hematology	26
M <sub>70</sub>	Mechanics	24
M <sub>71</sub>	Geology	23
M <sub>72</sub>	Nuclear Science Technology	22

<b>M<sub>73</sub></b>	Entomology	<b>18</b>
<b>M<sub>74</sub></b>	Parasitology	<b>17</b>
<b>M<sub>75</sub></b>	Arts Humanities Other Topics	<b>16</b>
<b>M<sub>76</sub></b>	Biophysics	<b>15</b>
<b>M<sub>77</sub></b>	Automation Control Systems	<b>14</b>
<b>M<sub>78</sub></b>	Developmental Biology	<b>14</b>
<b>M<sub>79</sub></b>	Forestry	<b>14</b>
<b>M<sub>80</sub></b>	Tropical Medicine	<b>14</b>
<b>M<sub>81</sub></b>	Biomedical Social Sciences	<b>13</b>
<b>M<sub>82</sub></b>	Spectroscopy	<b>13</b>
<b>M<sub>83</sub></b>	Transplantation	<b>13</b>
<b>M<sub>84</sub></b>	Evolutionary Biology	<b>12</b>
<b>M<sub>85</sub></b>	Telecommunications	<b>12</b>
<b>M<sub>86</sub></b>	Medical Laboratory Technology	<b>11</b>
<b>M<sub>87</sub></b>	Operations Research-Management Science	<b>11</b>
<b>M<sub>88</sub></b>	Pathology	<b>11</b>
<b>M<sub>89</sub></b>	Social Work	<b>11</b>
<b>M<sub>90</sub></b>	Substance Abuse	<b>11</b>
<b>M<sub>91</sub></b>	Archaeology	<b>10</b>
<b>M<sub>92</sub></b>	Communication	<b>10</b>
<b>M<sub>93</sub></b>	Crystallography	<b>10</b>
<b>M<sub>94</sub></b>	Imaging Science - Photographic Technology	<b>10</b>
<b>M<sub>95</sub></b>	Mathematical Computational Biology	<b>10</b>
<b>M<sub>96</sub></b>	Religion	<b>10</b>
<b>M<sub>97</sub></b>	Acoustics	<b>9</b>
<b>M<sub>98</sub></b>	Anesthesiology	<b>9</b>
<b>M<sub>99</sub></b>	Architecture	<b>9</b>
<b>M<sub>100</sub></b>	Construction Building Technology	<b>8</b>
<b>M<sub>101</sub></b>	Marine-Freshwater Biology	<b>8</b>
<b>M<sub>102</sub></b>	Remote Sensing	<b>8</b>
<b>M<sub>103</sub></b>	Fisheries	<b>7</b>
<b>M<sub>104</sub></b>	Meteorology -Atmospheric Sciences	<b>7</b>
<b>M<sub>105</sub></b>	Mycology	<b>7</b>
<b>M<sub>106</sub></b>	Behavioral Sciences	<b>6</b>
<b>M<sub>107</sub></b>	Legal Medicine	<b>6</b>
<b>M<sub>108</sub></b>	Virology	<b>6</b>
<b>M<sub>109</sub></b>	Government Law	<b>5</b>
<b>M<sub>110</sub></b>	Medical Informatics	<b>5</b>
<b>M<sub>111</sub></b>	Family Studies	<b>4</b>
<b>M<sub>112</sub></b>	Philosophy	<b>4</b>
<b>M<sub>113</sub></b>	Social Issues	<b>4</b>
<b>M<sub>114</sub></b>	Area Studies	<b>3</b>
<b>M<sub>115</sub></b>	Audiology- Speech Language Pathology	<b>3</b>

<b>M<sub>116</sub></b>	Criminology- Penology	<b>3</b>
<b>M<sub>117</sub></b>	History	<b>3</b>
<b>M<sub>118</sub></b>	International Relations	<b>3</b>
<b>M<sub>119</sub></b>	Linguistics	<b>3</b>
<b>M<sub>120</sub></b>	Microscopy	<b>3</b>
<b>M<sub>121</sub></b>	Public Administration	<b>3</b>
<b>M<sub>122</sub></b>	Sociology	<b>3</b>
<b>M<sub>123</sub></b>	Transportation	<b>3</b>
<b>M<sub>124</sub></b>	Women Studies	<b>3</b>
<b>M<sub>125</sub></b>	Art	<b>2</b>
<b>M<sub>126</sub></b>	Asian Studies	<b>2</b>
<b>M<sub>127</sub></b>	Astronomy- Astrophysics	<b>2</b>
<b>M<sub>128</sub></b>	Geography	<b>2</b>
<b>M<sub>129</sub></b>	Information Science- Library Science	<b>2</b>
<b>M<sub>130</sub></b>	Mining -Mineral Processing	<b>2</b>
<b>M<sub>131</sub></b>	Robotics	<b>2</b>
<b>M<sub>132</sub></b>	Biodiversity Conservation	<b>1</b>
<b>M<sub>133</sub></b>	Cultural Studies	<b>1</b>
<b>M<sub>134</sub></b>	Development Studies	<b>1</b>
<b>M<sub>135</sub></b>	Film- Radio- Television	<b>1</b>
<b>M<sub>136</sub></b>	History Philosophy of Science	<b>1</b>
<b>M<sub>137</sub></b>	Literature	<b>1</b>
<b>M<sub>138</sub></b>	Medical Ethics	<b>1</b>
<b>M<sub>139</sub></b>	Paleontology	<b>1</b>

*Sn: Sequence number; M: Sort letter symbol; n: Number of articles*

To determine the research areas of SU's affiliated scientific articles, the qualitative and quantitative indicators were analyzed, as presented in Table 3. The analysis revealed that SU's scientific articles published between 2019 and 2023 covered 139 different research areas. The top five research areas with the highest number of articles were identified as: "Chemistry" (M<sub>1</sub>) with 642 articles, "Engineering" (M<sub>2</sub>) with 438 articles, "General Internal Medicine" (M<sub>3</sub>) with 397 articles, "Agriculture" (M<sub>4</sub>) with 383 articles, and "Food Technology" (M<sub>5</sub>) with 374 articles. Conversely, the fifteen research areas with the fewest articles were found to be: "Paleontology," "Medical Ethics," "Literature," "History of Philosophy of Science," "Film-Radio-Television," "Development Studies," "Cultural Studies," and "Conservation of Biodiversity" (M<sub>132</sub> to M<sub>139</sub>, each with one article), along with "Robotics," "Mining-Mineral Processing," "Information Science-Library Science," "Geography," "Astronomy-Astrophysics," "Asian Studies," and "Art" (M<sub>125</sub> to M<sub>131</sub>, each with two articles).

In the relevant years, it was found that SU had a stronger connection with scientific articles in the "Chemistry" ( $M_1$ ) research area in the international literature. Accordingly, it was determined that SU's performance in terms of scientific productivity is significantly higher in the "Chemistry" ( $M_1$ ) research area compared to other research areas. Based on this, it can be anticipated that SU will continue to maintain its high performance in scientific articles published in the "Chemistry" research area in the coming years.

### 3.2.4. Performance analysis in terms of indexes scanned

In terms of indexed databases, the performance indicators used to reveal SU's scientific productivity, based on the articles related to it in WoS database, are presented in Table 4.

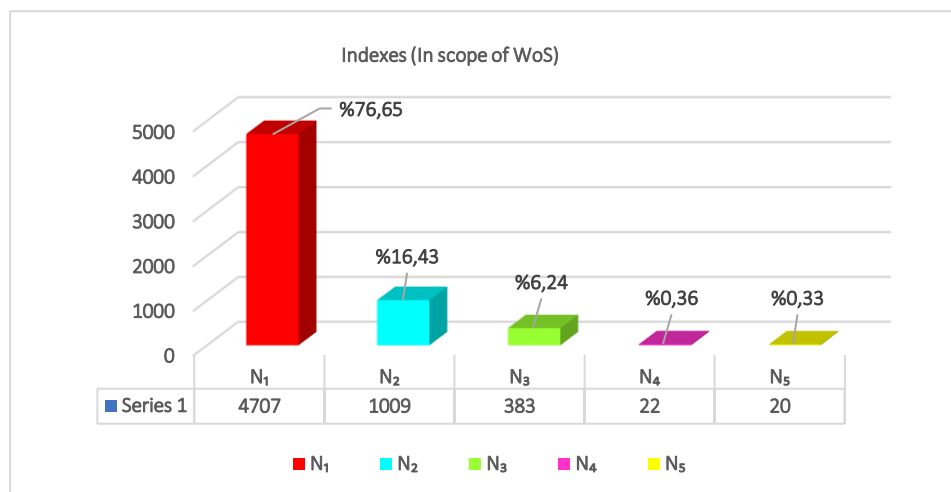
**Table 4.** Distribution of articles with which SU is associated in terms of Indexes (2019-2023)

Sn	Indexes (In Scope of WoS)	n
N <sub>1</sub>	Science Citation Index Expanded (SCI-EXPANDED)	4707
N <sub>2</sub>	Emerging Sources Citation Index (ESCI)	1009
N <sub>3</sub>	Social Sciences Citation Index (SSCI)	383
N <sub>4</sub>	Index Chemicus (IC)	22
N <sub>5</sub>	Arts & Humanities Citation Index (A&HCI)	20

Sn: Sequence number; N: Rank letter symbol; n: Number of articles

To determine the status of the journals where SU's related scientific articles are published in terms of indexed databases, the answers to the question parameter ( $P_4$ ) were obtained by examining Table 4. This analysis revealed that, between 2019 and 2023, SU's related scientific works were published in journals indexed by five different databases within WoS database. The indexes and the number of journals in which these scientific works were published are as follows: "Science Citation Index Expanded/SCI-EXPANDED" ( $N_1$ ) with 4707, "Emerging Sources Citation Index/ESCI" ( $N_2$ ) with 1009, "Social Sciences Citation Index/SSCI" ( $N_3$ ) with 383, "Index Chemicus/IC" ( $N_4$ ) with 22, and "Arts & Humanities Citation Index/A&HCI" ( $N_5$ ) with 20. In this context, it was found that SU's related scientific articles were most frequently published in journals indexed by "SCI-EXPANDED" ( $N_1$ ) and least frequently in those indexed by "A&HCI" ( $N_5$ ) and "IC" ( $N_4$ ).

Based on the quantitative indicator data for the indexes of journals where SU's related scientific articles are published, presented in Table 4, Graphic 3 was created.



**Graphic 3:** Status of Scientific Article Studies in terms of Indexing

From Graphic 3, it can be observed that 76.65% of SU's related scientific articles were published in journals indexed in "SCI-EXPANDED" ( $N_1$ ), 16.43% in "ESCI" ( $N_2$ ), 6.24% in "SSCI" ( $N_3$ ), 0.36% in "IC" ( $N_4$ ), and 0.33% in

"A&HCI" ( $N_5$ ). It has been determined that SU's scientific articles have the strongest connection with journals indexed in "SCI-EXPANDED" ( $N_1$ ). In this context, it has been found that SU shows higher performance in scientific articles

published in journals indexed in "SCI-EXPANDED" ( $N_1$ ). Therefore, it can be anticipated that in the coming years, SU will have a more significant connection with scientific articles published in journals indexed in "SCI-EXPANDED" ( $N_1$ ) compared to those indexed in other databases.

### 3.3. Scientific mapping analysis

In the context of revealing SU's scientific productivity within the framework of the identified scientific actors, the responses to the question parameters formulated according to the research objectives were obtained by testing the Fast 5000 dataset, downloaded from WoS database, using the statistical analysis program VOSviewer. As a result of the test, verification tables, scientific networks, and density maps related to authors, universities, and countries in the context of co-authorship were obtained as data outputs from the analysis program. Explanations related to the scientific mapping analyses performed on these data outputs are provided in the following section.

#### 3.3.1. Analysis in the context of co-authorship

To reveal the scientific productivity of SU within the framework of the identified scientific actors, the Fast 5000 data file was introduced to the statistical analysis program. For the co-authorship analysis, the following threshold values were set: **analysis type:** co-authorship, **unit of analysis:** authors, counting method: full counting method, **minimum number of articles per author:** 5, and **minimum number of citations per author:** 1. Thus, the Fast 5000 data file was subjected to the test.

As a result of the test, it was found that out of a total of 12,490 authors, 1,166 authors met the specified threshold criteria. The verification table of authors (Verify selected authors), which includes the number of related scientific articles, citation counts, and total link strengths for these 1,166 authors, was obtained as a data output from the statistical analysis program. The values for the top twenty authors are shown in Table 5 below.

**Table 5.** Inter-author verification (number of articles, citation numbers and link strength values) table of scientific articles with which SU is associated (2019-2023)

Selected	Author	Documents
<input checked="" type="checkbox"/>	zengin, gokhan	494
<input checked="" type="checkbox"/>	mahomoodally, mohamad fawzi	161
<input checked="" type="checkbox"/>	ozcan, mehmet musa	140
<input checked="" type="checkbox"/>	sinan, kouadio ibrahime	121
<input checked="" type="checkbox"/>	uslu, nurhan	86
<input checked="" type="checkbox"/>	yildizdagay, evren	76
<input checked="" type="checkbox"/>	ak, gunes	75
<input checked="" type="checkbox"/>	uney, kamil	69
<input checked="" type="checkbox"/>	ghafoor, kashif	66
<input checked="" type="checkbox"/>	ahmed, isam a. mohamed	66
<input checked="" type="checkbox"/>	babiker, elfadil e.	63
<input checked="" type="checkbox"/>	ferrante, claudio	62
<input checked="" type="checkbox"/>	menghini, luigi	57
<input checked="" type="checkbox"/>	mollica, adriano	54
<input checked="" type="checkbox"/>	orlando, giustino	52
<input checked="" type="checkbox"/>	corum, orhan	50
<input checked="" type="checkbox"/>	cziaiky, zoltan	47
<input checked="" type="checkbox"/>	jeko, jozsef	47
<input checked="" type="checkbox"/>	patir, imren hatay	47
<input checked="" type="checkbox"/>	unlu, ali	47

Selected	Author	Citations
<input checked="" type="checkbox"/>	zengin, gokhan	5424
<input checked="" type="checkbox"/>	mahomoodally, mohamad fawzi	1909
<input checked="" type="checkbox"/>	sinan, kouadio ibrahime	1354
<input checked="" type="checkbox"/>	ozcan, mehmet musa	1232
<input checked="" type="checkbox"/>	onifade, stephen taiwo	1132
<input checked="" type="checkbox"/>	kuntoglu, mustafa	1130
<input checked="" type="checkbox"/>	ak, gunes	1094
<input checked="" type="checkbox"/>	mollica, adriano	1059
<input checked="" type="checkbox"/>	stefanucci, azzurra	866
<input checked="" type="checkbox"/>	ghafoor, kashif	857
<input checked="" type="checkbox"/>	babiker, elfadil e.	844
<input checked="" type="checkbox"/>	ahmed, isam a. mohamed	769
<input checked="" type="checkbox"/>	yazman, sakir	761
<input checked="" type="checkbox"/>	uslu, nurhan	732
<input checked="" type="checkbox"/>	erdemir, serkan	724
<input checked="" type="checkbox"/>	menghini, luigi	680
<input checked="" type="checkbox"/>	ferrante, claudio	650
<input checked="" type="checkbox"/>	patir, imren hatay	640
<input checked="" type="checkbox"/>	gemi, lokman	627
<input checked="" type="checkbox"/>	orlando, giustino	619

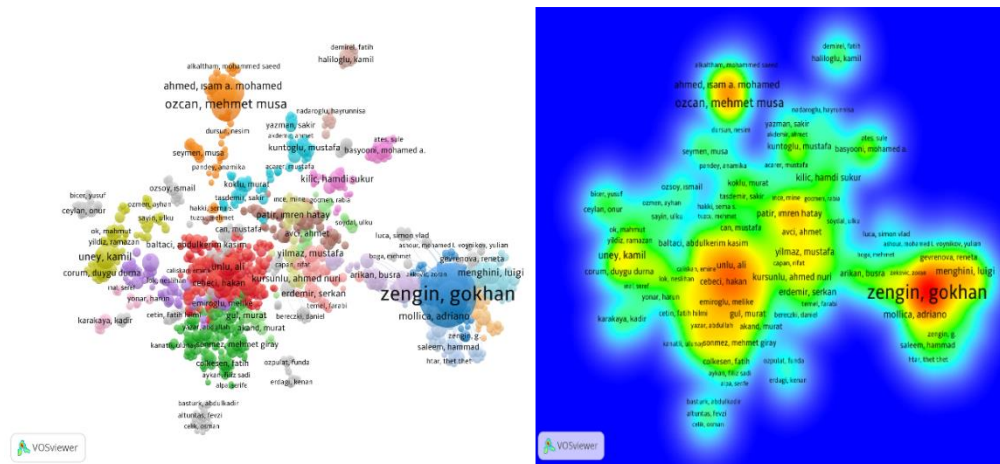
  

Selected	Author	Total link strength
<input checked="" type="checkbox"/>	zengin, gokhan	2616
<input checked="" type="checkbox"/>	mahomoodally, mohamad fawzi	1214
<input checked="" type="checkbox"/>	sinan, kouadio ibrahime	932
<input checked="" type="checkbox"/>	ferrante, claudio	711
<input checked="" type="checkbox"/>	menghini, luigi	681
<input checked="" type="checkbox"/>	ak, gunes	654
<input checked="" type="checkbox"/>	orlando, giustino	646
<input checked="" type="checkbox"/>	chiavaroli, annalisa	571
<input checked="" type="checkbox"/>	leone, sheila	566
<input checked="" type="checkbox"/>	recinella, lucia	566
<input checked="" type="checkbox"/>	brunetti, luigi	551
<input checked="" type="checkbox"/>	ozcan, mehmet musa	493
<input checked="" type="checkbox"/>	yildizdagay, evren	437
<input checked="" type="checkbox"/>	cziaiky, zoltan	414
<input checked="" type="checkbox"/>	jeko, jozsef	412
<input checked="" type="checkbox"/>	ghafoor, kashif	354
<input checked="" type="checkbox"/>	babiker, elfadil e.	343
<input checked="" type="checkbox"/>	uslu, nurhan	342
<input checked="" type="checkbox"/>	di simone, simonetta cristina	334
<input checked="" type="checkbox"/>	ahmed, isam a. mohamed	328

\* Not: The data in the validation table obtained from VOSviewer has been organized by us from largest to smallest in terms of number of articles, number of citations and total connection power values.

Table 5 lists the number of articles, citations, and total link strength values for the authors with the highest scientific collaboration in the scientific works related to SU. It was found that some of the 1,166 authors meeting the threshold criteria had no connections with each other. In this context, the scientific network and density

map, showing the largest connection network among the authors ( $n=1057$ ) and clusters ( $n=31$ ), was obtained from the relevant program and is illustrated in Figure 1 below.



\* Not: Due to the large number of nets, in Figure 1 these network lines can only be seen when the image is enlarged.  
**Figure 1.** Scientific network and density map of scientific network and density map of SU-associated article studies in the context of co-authorship (2019-2023)

To reveal the social network structure among authors in the context of co-authorship, the question parameter (P<sub>5</sub>) was formulated. By examining Table 5 and Figure 1 above, it was determined that the network consists of 20 clusters of authors with different colors and sizes, 7,012 links, and a total link strength value of 26,133. In this context, it was found that SU has scientific collaborations with 1,057 authors, representing the largest connection network on an international scale (Figure 1).

In the examination of the clusters in Figure 1 with different colors, it was found that: in Cluster 1 (red) there are 197 authors; in Cluster 2 (green) there are 127 authors; in Cluster 3 (blue) there are 63 authors; in Cluster 4 (light green) there are 59 authors; in Cluster 5 (purple) there are 58 authors; in Cluster 6 (turquoise blue) there are 55 authors; in Cluster 7 (orange) there are 49 authors; in Cluster 8 (brown) there are 49 authors; in Cluster 9 (pink) there are 39 authors; and in Cluster 10 (light pink) there are 37 authors.

In the clusters made up of circular shapes of the same color but different sizes, the authors are the scientists who have published the most papers through their scientific collaborations. The size of the spheres/circles represents the number of papers associated with the scientists, while the thickness and thinness of the lines/edges denote the number of co-authorships (collaborations).

Based on Table 5 and Figure 1, when examining the number of papers, the top authors are as follows: 1st place - "Zengin, G." (494), 2nd place - "Mahomoodally, M.F." (161), and 3rd place - "Özcan, M.M." (140). Among the top three, "Zengin, G." has the most scientific collaborations with "Mahomoodally, M.F." (157),

"Mahomoodally, M.F." has the most scientific collaborations with "Zengin, G." (157), and "Özcan, M.M." has the most scientific collaborations with "Uslu, N." (79).

Based on the same table and figure, when examining the number of citations for the scientific papers contributed by the authors, the top authors are as follows: 1st place - "Zengin, G." (5424), 2nd place - "Mahomoodally, M.F." (1909), and 3rd place - "Sinan K.İ." (1354).

When examining the total connection strength values of the scientific papers contributed by the authors, the rankings are as follows: 1st place - "Zengin, G." (2616), 2nd place - "Mahomoodally, M.F." (1214), and 3rd place - "Sinan K.İ." (932).

In the density map on the right side of Figure 1, it can be observed that the names of the authors "Zengin, G.", "Mahomoodally, M.F.", "Özcan, M.M.", and "Sinan K.İ." are more prominent, with colors (red) being more concentrated in the areas where these names are located.

It has been determined that "Zengin, G.", "Mahomoodally, M.F.", "Özcan, M.M.", and "Sinan K.İ.", who stand out in terms of publication counts, citations, and total connection strength values, have contributed high-quality scientific papers to the international literature through journals indexed in various international databases. In this context, it has been found that SU has the most scientific collaborations with "Zengin, G.", "Mahomoodally, M.F.", "Özcan, M.M.", and "Sinan K.İ." in terms of connection networks. Additionally, these prominent authors have made significant contributions to SU's scientific productivity, as evidenced by their publication counts, citations of these publications, and the scientific collaboration network relationships

they have established, compared to other authors.

### 3.3.2. Analysis of universities in the context of common authorship

To analyze SU's scientific productivity within the framework of designated scientific actors, the Fast 5000 data file was introduced to the relevant statistical analysis program. For the dataset, threshold values for the analysis of universities in terms of co-authorship were set as follows: **analysis type:** co-authorship, **unit of analysis:** universities, **counting method:** full counting, **minimum number of articles for a university:**

6, and **minimum number of citations for a university:** 1. Subsequently, the Fast 5000 data file was subjected to testing.

As a result of the test conducted, it was determined that out of a total of 2969 universities, 328 universities met the specified threshold values. The verification table for inter-university validation (**Verify selected organizations**), which includes the number of related scientific articles, citations, and total link strengths for these 328 universities, was obtained from the analysis program. The values for the top twenty universities are shown below in Table 6.

**Table 6.** Inter-university validation (number of articles, citation numbers and link strength values) table of scientific articles with which SU is associated (2019-2023)

Selected	Organization	Documents
<input checked="" type="checkbox"/>	selcuk univ	4881
<input checked="" type="checkbox"/>	necmettin erbakan univ	1010
<input checked="" type="checkbox"/>	konya tech univ	338
<input checked="" type="checkbox"/>	univ mauritius	194
<input checked="" type="checkbox"/>	ankara univ	184
<input checked="" type="checkbox"/>	hacettepe univ	182
<input checked="" type="checkbox"/>	univ hlth sci	169
<input checked="" type="checkbox"/>	erciyes univ	163
<input checked="" type="checkbox"/>	gazi univ	156
<input checked="" type="checkbox"/>	karamanoglu mehmetbey univ	132
<input checked="" type="checkbox"/>	ito karatay univ	119
<input checked="" type="checkbox"/>	king saud univ	114
<input checked="" type="checkbox"/>	akdeniz univ	106
<input checked="" type="checkbox"/>	istanbul univ	100
<input checked="" type="checkbox"/>	aksaray univ	98
<input checked="" type="checkbox"/>	marmara univ	96
<input checked="" type="checkbox"/>	ataturk univ	86
<input checked="" type="checkbox"/>	dicle univ	83
<input checked="" type="checkbox"/>	baskent univ	83
<input checked="" type="checkbox"/>	ege univ	81

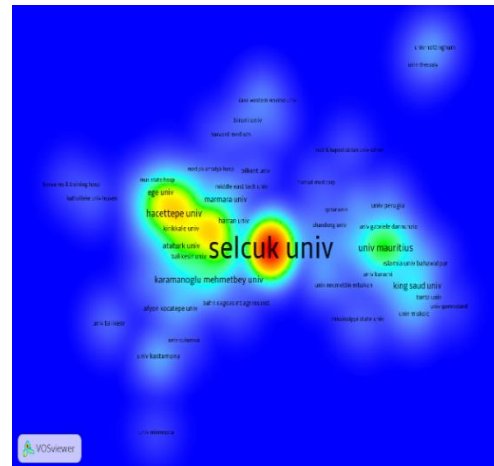
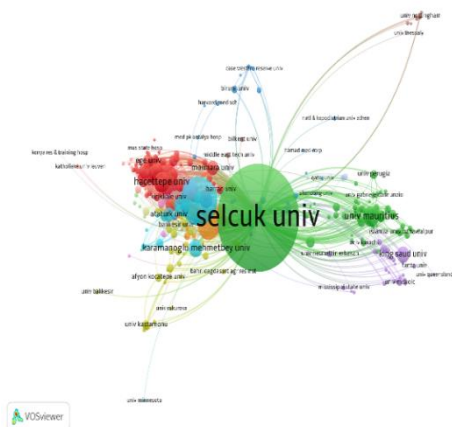
Selected	Organization	Citations
<input checked="" type="checkbox"/>	selcuk univ	33211
<input checked="" type="checkbox"/>	necmettin erbakan univ	5633
<input checked="" type="checkbox"/>	konya tech univ	3568
<input checked="" type="checkbox"/>	univ mauritius	2476
<input checked="" type="checkbox"/>	south ural state univ	1371
<input checked="" type="checkbox"/>	erciyes univ	1353
<input checked="" type="checkbox"/>	king saud univ	1345
<input checked="" type="checkbox"/>	karamanoglu mehmetbey univ	1267
<input checked="" type="checkbox"/>	hacettepe univ	1225
<input checked="" type="checkbox"/>	ankara univ	1097
<input checked="" type="checkbox"/>	ito karatay univ	1071
<input checked="" type="checkbox"/>	marmara univ	922
<input checked="" type="checkbox"/>	univ g dannunzio	897
<input checked="" type="checkbox"/>	univ hlth sci	892
<input checked="" type="checkbox"/>	istanbul univ	834
<input checked="" type="checkbox"/>	istanbul gelisim univ	780
<input checked="" type="checkbox"/>	gazi univ	753
<input checked="" type="checkbox"/>	ataturk univ	753
<input checked="" type="checkbox"/>	imonu univ	700
<input checked="" type="checkbox"/>	cyprus int univ	697

Selected	Organization	Total link strength
<input checked="" type="checkbox"/>	selcuk univ	6992
<input checked="" type="checkbox"/>	necmettin erbakan univ	1918
<input checked="" type="checkbox"/>	hacettepe univ	931
<input checked="" type="checkbox"/>	erciyes univ	917
<input checked="" type="checkbox"/>	ankara univ	904
<input checked="" type="checkbox"/>	istanbul univ	856
<input checked="" type="checkbox"/>	univ mauritius	803
<input checked="" type="checkbox"/>	marmara univ	799
<input checked="" type="checkbox"/>	gazi univ	797
<input checked="" type="checkbox"/>	univ hlth sci	717
<input checked="" type="checkbox"/>	akdeniz univ	702
<input checked="" type="checkbox"/>	ege univ	697
<input checked="" type="checkbox"/>	cukurova univ	605
<input checked="" type="checkbox"/>	ondokuz mayis univ	588
<input checked="" type="checkbox"/>	dicle univ	554
<input checked="" type="checkbox"/>	uludag univ	540
<input checked="" type="checkbox"/>	dokuz eylul univ	494
<input checked="" type="checkbox"/>	imonu univ	483
<input checked="" type="checkbox"/>	ataturk univ	436
<input checked="" type="checkbox"/>	pamukkale univ	424

\* Not: The data in the verification table obtained from VOSviewer has been organized by us from largest to smallest in terms of number of articles, number of citations and total connection power values.

In Table 6, the number of articles, citations, and total link strength values for the universities that have the most scientific collaborations in scientific articles associated with SU are listed. It was determined that all 328 universities meeting the threshold values have link relationships with each other.

In this context, the university (328) and clusters (14) representing the largest network relationships among these universities are shown in the scientific network and density map, which was obtained from the relevant program and is illustrated below in Figure 2.



**Figure 2.** Inter-university scientific network and density map of SU-associated article studies in the context of co-authorship (2019-2023)

In order to uncover the social network structure among universities with regard to the scientific article collaborations associated with SU, the answers to the question parameter ( $P_6$ ) were obtained by examining Table 6 and Figure 2 presented above. It was determined that there are 14 clusters of universities represented by circles of various colors and sizes, with 5626 links and a total link strength value of 22737. The total number of universities within these 14 clusters is 328. In this context, it was found that SU has scientific collaborations with 327 universities in terms of the largest network connection on an international scale (Figure 2).

In these clusters composed of circular shapes of the same color but different sizes, the universities represent those most frequently associated with scientific collaborations. The sizes of the circles indicate the number of articles associated with the universities, while the thickness and thinness of the lines/networks represent the number of co-authorships (collaborations). Upon examining the clusters of different colors, it was found that Cluster 1 (red) contains 85 universities, Cluster 2 (green) contains 66 universities, Cluster 3 (blue) contains 32 universities, Cluster 4 (light green) contains 31 universities, Cluster 5 (purple) contains 27 universities, Cluster 6 (turquoise) contains 23 universities, Cluster 7 (orange) contains 13 universities, Cluster 8 (brown) contains 13 universities, Cluster 9 (pink) contains 12 universities, and Cluster 10 (light pink) contains 10 universities.

Based on Table 6 and Figure 2, an examination of the universities in terms of the number of articles reveals that "SU" ranks first (4881 articles), followed by "Necmettin Erbakan University" in second place (1010 articles), and

"Konya Technical University" in third place (338 articles). In terms of the number of articles, "SU" collaborates most frequently with "Necmettin Erbakan University" (438 articles), "Necmettin Erbakan University" collaborates most frequently with "SU" (438 articles), and "Konya Technical University" collaborates most frequently with "SU" (204 articles).

Based on the same table and figure, when examining the number of citations received by the scientific article studies associated with the universities, it is found that "SU" ranks first (33,211 citations), "Necmettin Erbakan University" ranks second (5,633 citations), and "Konya Technical University" ranks third (3,568 citations).

Similarly, when examining the universities in terms of the total link strength values generated by their associated scientific article studies, "SU" ranks first (6,992), "Necmettin Erbakan University" ranks second (1,918), and "Hacettepe University" ranks third (931).

The density map on the right side of Figure 2 shows that the names "SU," "Necmettin Erbakan University," "Konya Technical University," and "Hacettepe University" are more prominent, and the areas where these names appear have higher color intensity (red).

In terms of the number of articles, citations, and total link strength values, it has been determined that "SU," "Necmettin Erbakan University," "Konya Technical University," and "Hacettepe University" have contributed numerous significant scientific articles to the international literature. In this context, it has been identified that SU has the most extensive scientific collaboration network with "Necmettin Erbakan University," "Konya Technical University," and "Hacettepe University."

Furthermore, these universities have been found to support the academic world with their scientific productivity in terms of the citations received by their associated scientific article studies, the number of articles, and the collaborative/link relationships they have established.

### 3.3.3. Analysis of countries in the context of co-authorship

To reveal the scientific productivity of SU within the framework of the identified scientific actors, the Fast 5000 data file was introduced to the relevant statistical analysis program. The data set, in the context of countries in co-authorship, was analyzed with the following

threshold values: **analysis type:** co-authorship, **analysis unit:** countries, **counting method:** full counting method, **minimum number of articles per country:** 5, and **minimum number of citations per country:** 2. Subsequently, the Fast 5000 data file was subjected to testing.

As a result of the test conducted, it was determined that out of a total of 107 countries, 76 countries met the specified threshold values. The inter-country verification table (**Verif selected countries**), which includes the number of scientific articles, citations, and total connection strengths for these 76 countries, was obtained as a data output from the statistical analysis program. The values for the top twenty countries are presented in Table 7 below.

**Table 7.** Cross-country validation (number of articles, citation numbers and link strength values) table of scientific articles with which SU is associated (2019-2023)

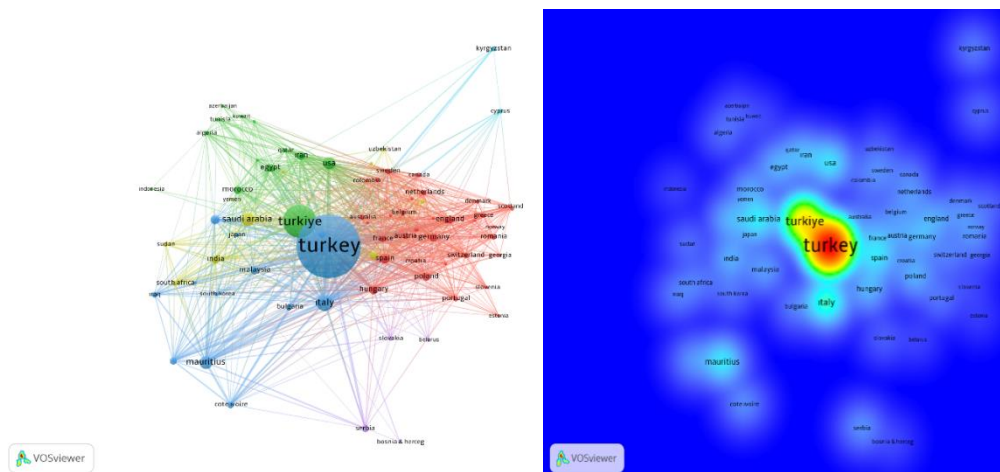
Selected	Country	Documents	Selected	Country	Citations	Selected	Country	Total link strength
<input checked="" type="checkbox"/>	turkey	4608	<input checked="" type="checkbox"/>	turkey	39180	<input checked="" type="checkbox"/>	turkey	2422
<input checked="" type="checkbox"/>	turkiye	1246	<input checked="" type="checkbox"/>	italy	6066	<input checked="" type="checkbox"/>	italy	1114
<input checked="" type="checkbox"/>	italy	309	<input checked="" type="checkbox"/>	usa	3703	<input checked="" type="checkbox"/>	mauritius	728
<input checked="" type="checkbox"/>	mauritius	194	<input checked="" type="checkbox"/>	saudi arabia	3551	<input checked="" type="checkbox"/>	turkiye	703
<input checked="" type="checkbox"/>	saudi arabia	186	<input checked="" type="checkbox"/>	spain	3500	<input checked="" type="checkbox"/>	spain	539
<input checked="" type="checkbox"/>	usa	174	<input checked="" type="checkbox"/>	england	3044	<input checked="" type="checkbox"/>	usa	531
<input checked="" type="checkbox"/>	spain	111	<input checked="" type="checkbox"/>	france	2851	<input checked="" type="checkbox"/>	saudi arabia	496
<input checked="" type="checkbox"/>	hungary	102	<input checked="" type="checkbox"/>	iran	2756	<input checked="" type="checkbox"/>	hungary	441
<input checked="" type="checkbox"/>	pakistan	96	<input checked="" type="checkbox"/>	mauritius	2476	<input checked="" type="checkbox"/>	england	435
<input checked="" type="checkbox"/>	poland	90	<input checked="" type="checkbox"/>	netherlands	2365	<input checked="" type="checkbox"/>	germany	399
<input checked="" type="checkbox"/>	india	90	<input checked="" type="checkbox"/>	switzerland	2315	<input checked="" type="checkbox"/>	france	372
<input checked="" type="checkbox"/>	iran	89	<input checked="" type="checkbox"/>	belgium	2165	<input checked="" type="checkbox"/>	poland	344
<input checked="" type="checkbox"/>	germany	80	<input checked="" type="checkbox"/>	qatar	2156	<input checked="" type="checkbox"/>	iran	333
<input checked="" type="checkbox"/>	egypt	80	<input checked="" type="checkbox"/>	canada	1845	<input checked="" type="checkbox"/>	sweden	325
<input checked="" type="checkbox"/>	england	74	<input checked="" type="checkbox"/>	colombia	1810	<input checked="" type="checkbox"/>	egypt	323
<input checked="" type="checkbox"/>	malaysia	72	<input checked="" type="checkbox"/>	russia	1787	<input checked="" type="checkbox"/>	india	322
<input checked="" type="checkbox"/>	russia	70	<input checked="" type="checkbox"/>	turkiye	1663	<input checked="" type="checkbox"/>	pakistan	296
<input checked="" type="checkbox"/>	morocco	68	<input checked="" type="checkbox"/>	denmark	1652	<input checked="" type="checkbox"/>	malaysia	288
<input checked="" type="checkbox"/>	vietnam	62	<input checked="" type="checkbox"/>	kuwait	1549	<input checked="" type="checkbox"/>	vietnam	285
<input checked="" type="checkbox"/>	france	61	<input checked="" type="checkbox"/>	poland	1254	<input checked="" type="checkbox"/>	switzerland	263

\* Not: The data in the validation table obtained from VOSviewer has been organized by us from largest to smallest in terms of number of articles, number of citations and total connection power values.

Table 7 lists the countries with the highest scientific collaboration in terms of article and citation counts, as well as total connection strength values, within the scope of SU's related scientific publications. It was found that all 76 countries meeting the threshold values are interconnected.

In this context, the country representing the largest network connection among the relevant countries (n=76) and the clusters (n=6) are shown in the scientific network and density map obtained from the program, as displayed in Figure 3 below.





**Figure 3.** Cross-country scientific network and density map of SU-associated article studies in the context of co-authors (2019-2023)

To reveal the inter-country social network structure within the scope of SU's related scientific publications, the data was analyzed based on the parameters outlined in Table 7 and Figure 3. It was found that the number of clusters (n=6), the number of links (n=1436), and the total connection strength value (n=8361) are represented by circles of varying colors and sizes. The total number of countries in these 6 clusters is 76. In this context, it was determined that SU has established scientific collaborations with 76 countries, representing the largest network connection in the international arena (Figure 3).

In the analysis of the clusters represented by different colors, it was found that the number of countries in each cluster is as follows: 1. cluster (red) contains 33 countries, 2. cluster (green) contains 14 countries, 3. cluster (blue) contains 13 countries, 4. cluster (light green) contains 10 countries, 5. cluster (purple) contains 4 countries, and 6. cluster (turquoise) contains 2 countries. Additionally, the countries in these clusters, characterized by circular shapes of the same color but different sizes, are the ones most closely associated with the highest number of articles due to their scientific collaborations. The size of the circles indicates the number of articles associated with the countries, while the thickness of the lines/edges represents the number of collaborative authorships.

Based on Table 7 and Figure 3, when examining the countries associated with SU in terms of article counts, it was found that the top three are: 1. "Turkey" (5854), 2. "Italy" (309), and 3. "Mauritius" (194). Among these, "Turkey" has the highest number of collaborative articles with "Italy" (262), Italy has the highest number with "Turkey" (262), and "Mauritius" has the highest number with "Turkey" (182).

Based on the same table and figure, when examining countries in terms of citation counts for their associated scientific articles, it was found that the top three are: 1. "Turkey" (39,180), 2. "Italy" (6,066), and 3. "the USA" (3,703).

Similarly, when examining countries in terms of their total connection strength values for associated scientific articles, it was found that the top three are: 1. "Turkey" (2,422), 2. "Italy" (1,114), and 3. "Mauritius" (728).

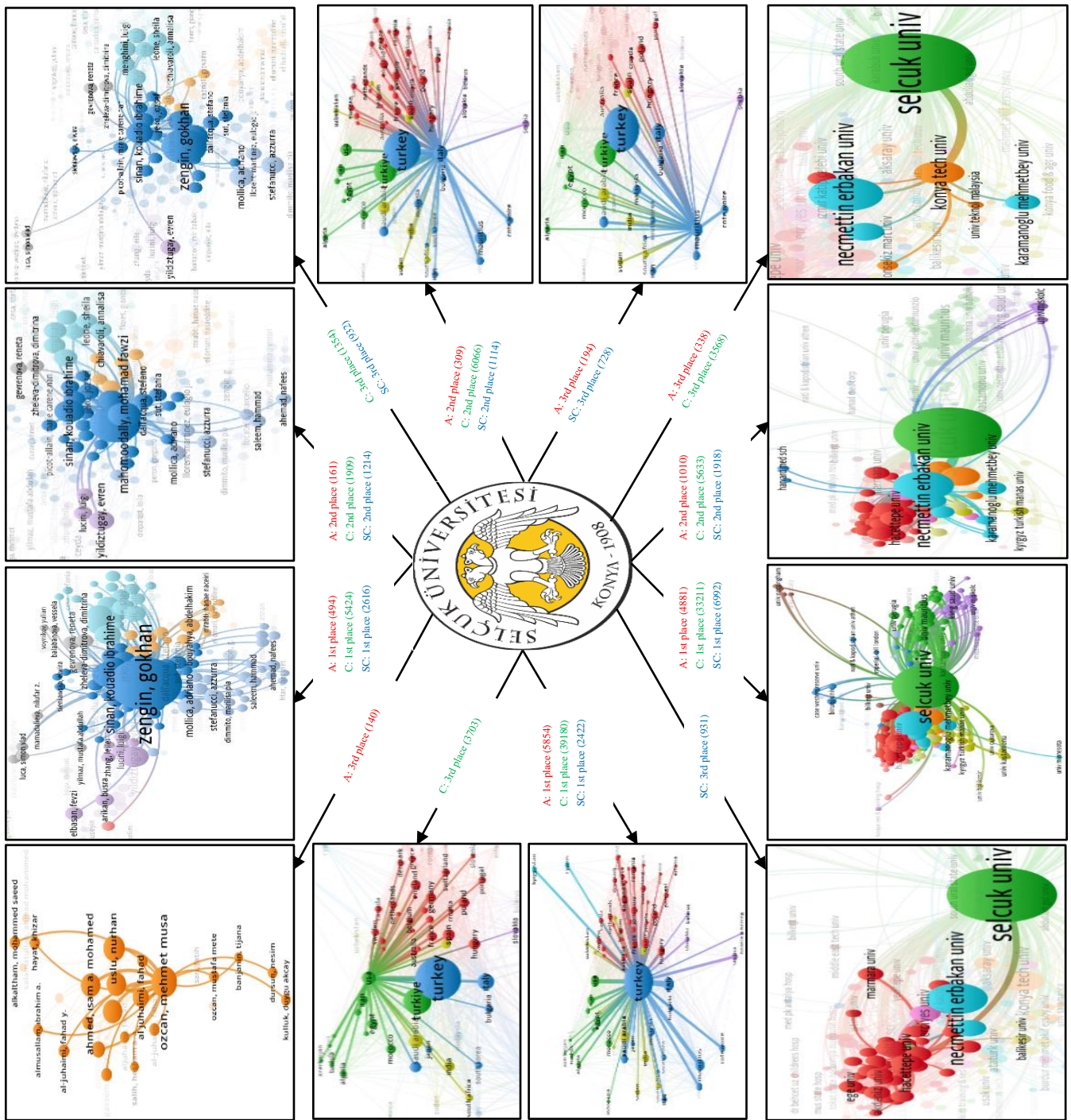
In the density map shown on the right side of Figure 3, it is observed that the name "Turkey" appears more prominently, and the region where it is located has a higher concentration of red colors. The observed density in the "Turkey" region is attributed to the fact that "SU," the subject of the study, provides education and training services in Turkey. Additionally, it is due to "SU" being the top institution in terms of article and citation counts as well as total connection strength values.

The countries "Turkey," "Italy," "Mauritius," and "the USA," which stand out in terms of article counts, citations, and total connection strength values, have been identified as having numerous high-quality scientific publications associated with them. In this context, it has been determined that SU (SU) has the highest level of scientific collaboration with these countries in terms of connection networks. Additionally, these prominent countries have been found to contribute to global research productivity through their associated scientific publications, citations, and scientific collaboration.

The findings related to the scientific productivity of SU between 2019 and 2023, within the framework of the identified scientific actors, are presented collectively in the results shown in Figure 4. These findings are based on

bibliometric analyses with scientific mappings of authors, universities, and countries in the context of co-authorship.

**Figure 4.** Scientific mapping analysis results regarding the scientific productivity of SU in 2019-2023



Not: A: Article; C: Citation; SC: Scientific collaboration

**4. Conclusion**

There is a substantial number of scientific studies reflected in the international literature. These studies are indexed in various databases (such as Scopus, Web of Knowledge, Google Scholar, WoS, Dimensions, etc.). These databases provide various qualitative and

quantitative indicators related to scientific actors, including relevant institutions, countries, and sources, as well as publication language and year, research field, and indexed databases. Researchers can utilize these indicators to obtain analytical data on global scientific research, which helps in understanding the evolutionary changes and developments of the research topic. In this

context, this study was conducted to reveal the scientific productivity of SU, based on scientific papers indexed in WoS database, with the aim of elucidating its scientific output.

In analyzing the scientific productivity of SU in relation to its scientific papers and the identified scientific actors, performance analysis was conducted using tables obtained from WoS database. For the scientific mapping analysis of SU's productivity, the Fast 5000 dataset downloaded from WoS database was subjected to tests using the statistical analysis program VOSviewer.

In the context of the identified scientific actors, tables displaying the qualitative and quantitative indicators of the research papers have been created in alignment with the study's objectives. In this regard, performance analyses have been conducted on these tables to assess the scientific productivity of SU based on its associated research papers. The performance analyses were carried out with respect to the publication language of the scientific works, the publication years of the articles, research fields, and the indexed databases. The findings from these performance analyses of the relevant scientific actors are detailed separately below.

In the performance analysis conducted based on publication language, it was found that the majority of the scientific works associated with SU was published in "English," followed by "Turkish" and "Spanish." SU demonstrated a higher performance in "English" compared to other languages in its scientific works. In this context, it has been concluded that SU is more closely related to the international literature through scientific works published in "English" in terms of scientific productivity (see Table 1 and Figure 1). This trend is attributed to the global prevalence of the "English" language. It is anticipated that SU will continue to contribute scientific works to the international literature in "English" in the coming years.

In the performance analysis conducted based on publication year, it was found that the scientific papers associated with SU published in English were predominantly from the years "2021," "2022," and "2023." When considering the years 2019-2023, it was observed that the number of papers associated with SU showed an upward trend from "2019" to "2021." However, after "2021," a declining trend in the number of related papers was noted (see Table 2 and Figure 2). If this decline following the rise from "2019" to "2021" is interpreted as a potential indicator of a continuing downward trend in the coming years, it could be seen as a negative outcome for SU. In this context, it may be appropriate for the administration to undertake measures such as encouraging and rewarding researchers to address this issue.

In the performance analysis conducted based on research fields, it was found that the English-language scientific papers associated with SU are most prevalent in the research areas of "Chemistry," "Engineering," "General Internal Medicine," "Agriculture," and "Food Science and Technology," while they are least prevalent in the research areas of "Biodiversity Conservation," "Cultural Studies," "Development Studies," "Film, Radio, and Television," "Philosophy of History," "Literature,"

"Medical Ethics," and "Paleontology" (see Table 3). If this performance pattern continues similarly in the coming years, it would be advisable for SU administrators to encourage scholars in the research areas outside the top five ( $M_1$  and  $M_5$ ) to participate in this scientific productivity process.

In the performance analysis conducted based on index coverage, it was found that SU's English-language scientific papers in the international literature are most frequently published in the "Science Citation Index Expanded (SCI-EXPANDED)," "Emerging Sources Citation Index (ESCI)," and "Social Sciences Citation Index (SSCI)" indexes, while they are least frequently published in the "Index Chemicus (IC)" and "Arts & Humanities Citation Index (A&HCI)" indexes. Although SU's scientific papers are included in multiple indexes, those in the "SCI-EXPANDED" index showed higher performance (see Table 4 and Figure 3). Based on these findings, it is anticipated that SU will continue its relationship with high-quality publications in the "SCI-EXPANDED" and "ESCI" indexes. In this context, to enhance its scientific productivity, SU's researchers should also focus on contributing scientific work to other indexes, which will help increase SU's visibility in the academic world.

Based on the identified scientific actors, bibliometric analyses were conducted to reveal the social network structures of the scientific papers associated with SU. The dataset containing the relevant analytical data was tested, and the findings from the validation tables (covering authors, universities, and countries) and the visual scientific network and density maps are described below in detail.

In the analysis of authors within the context of co-authorship, it was determined that "Zengin, G.," "Mahomoodally, M.F.," and "Özcan, M.M." are the leading authors in the scientific papers associated with SU in the international literature. It was found that "Zengin, G." and "Mahomoodally, M.F." have collaborated extensively with each other, while "Özcan, M.M." has the most collaboration with "Uslu, N." Additionally, "Zengin, G.," "Mahomoodally, M.F.," "Özcan, M.M.," and "Sinan K.İ." are noted for their prominent positions in terms of publication, citation, and connection strength values (Table 5 and Figure 1). Based on these findings, it is assessed that these mentioned researchers not only demonstrate higher performance in the scientific productivity of SU but also make significant contributions to the academic world through their high-quality work. In this context, examining the most cited works of "Zengin, G.," "Mahomoodally, M.F.," "Özcan, M.M.," and "Sinan K.İ." could be beneficial for future researchers in the field.

In the context of co-authorship analysis of universities, it was found that in the international literature, "SU", along with "Necmettin Erbakan University" and "Konya Technical University," are the primary universities involved in the research. These three universities are identified as the ones with the highest level of scientific collaboration among themselves. Additionally, "SU", "Necmettin Erbakan University," "Konya Technical University," and "Hacettepe University" are noted for their prominence in

terms of publication, citation, and connection strength values (Table 6 and Figure 2). Based on these findings, it is assessed that, alongside "Necmettin Erbakan University," "Konya Technical University," and "Hacettepe University," these institutions have demonstrated significant performance in co-authorship and have facilitated the dissemination of high-quality work in the scientific community. In this context, analyzing the most cited and collaborative academic research from "SU," "Necmettin Erbakan University," "Konya Technical University," and "Hacettepe University" is expected to be beneficial for future studies and other researchers in the field.

In the context of co-authorship analysis of countries, it was found that in the international literature, "Turkey," along with "Italy" and "Mauritius," are the primary countries involved in the research. These three countries are identified as the ones with the highest level of scientific collaboration among themselves. Additionally, "Turkey," "Italy," and "Mauritius" are prominent in terms of publication, citation, and connection strength values (Table 7 and Figure 3). Based on these findings, it is assessed that, alongside "Turkey," "Italy" and "Mauritius" have demonstrated significant performance in co-authorship and have contributed to the international literature by facilitating the inclusion of high-quality research across various field indices. In this context, reviewing the most cited and collaborative scientific works from "Turkey," "Italy," and "Mauritius" is expected to provide support and guidance for researchers in other countries and universities in future high-quality research endeavors.

Based on the findings from the tests and analyses conducted on SU's scientific productivity in English-language publications from 2019 to 2023, several recommendations for the university, researchers, and the private sector are presented below.

Based on the notion that universities are the cradle of science and knowledge, the research conducted on SU's scientific productivity from 2019 to 2023 identified a decline in productivity following the year "2021". In this context, a key recommendation is to conduct a study that explores the causes and reasons behind the decline in scientific productivity after "2021", and to contribute this research to the literature.

Recommendations for the management of SU;

To address the declining trend in SU's scientific productivity after "2021" and to shift towards an upward trend, initiatives could be implemented to strengthen academic staff, such as providing rewards, academic incentives, plaques, and opportunities for international assignments and responsibilities.

It is essential to address any deficiencies in the equipment, tools, materials, and technical infrastructure used by SU's academic staff for their scientific research.

Additionally, developing collaboration networks can be facilitated by organizing symposiums, scientific studies, research protocols, project competitions, and similar events involving both SU academics and those from other institutions.

To elevate SU's international recognition and scientific productivity, it is recommended to host not only scientific research activities both domestically and

internationally but also to organize and host events such as entertainment activities, festivals, conferences, and workshops.

Recommendations for the relevant researchers;

Research can be conducted on the scientific productivity of "Necmettin Erbakan University," "Konya Technical University," and "Hacettepe University," which stand out in terms of articles, citations, and scientific collaboration regarding SU's scientific output. This research should be framed within the context of the identified scientific actors.

Bibliometric analyses can be conducted to uncover the evolutionary changes and developments in the scientific work of prominent researchers who have made significant contributions to SU's scientific productivity, such as "Zengin, G.," "Mahomoodally, M.F.," "Özcan, M.M.," and "Sinan K.I.," based on their ORCID numbers.

In terms of scientific productivity, studies can be conducted on research areas with the highest number of scientific publications, as well as on research areas with the least number of publications.

Research topics within the scope of the "Index Chemicus (IC)" and "Arts & Humanities Citation Index (A&HCI)" indices can be explored and added to the literature.

Bibliometric analyses can be performed on SU's related scientific works, including books, book chapters, conference papers, and research, within the framework of the identified scientific actors.

Recommendations for relevant private sector;

Researchers and studies in fields where SU demonstrates higher scientific productivity can be leveraged for further advancements.

Joint research projects can be initiated with universities that collaborate scientifically with SU.

Initiatives can be undertaken in areas such as consulting, research and development (R&D), information exchange, and collaborative projects with leading scientists in SU's scientific productivity.

## Author contributions

**Muhammet Paylı:** Data curation, methodology, writing-original draft preparation, investigation.

**Osman Çevik:** Writing-original draft preparation, methodology, writing and reviewing.

## Conflicts of interest

The authors declare no conflicts of interest.

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