

## **Mapping the Research Activity Alignment of Iran's Top Two Percent Highly Cited Scientists with the Priorities in Iran's Science and Technology Roadmap**

**Saeideh Mirhaghjoo Langerudi**

Lecturer, Department of Science and Technology Evaluation, Islamic World Science and Technology Monitoring and Citation Institute (ISC). Iran.

Corresponding Author: [mirhaghjoo@isc.ac](mailto:mirhaghjoo@isc.ac)  
ORCID iD: <https://orcid.org/0000-0002-4414-3391>

**Fatemeh Alinezhad Chamazkoti**

Lecturer, Department of Science and Technology Evaluation, Islamic World Science and Technology Monitoring and Citation Institute (ISC). Iran.

[alinezhad@isc.ac](mailto:alinezhad@isc.ac)  
ORCID iD: <https://orcid.org/0000-0001-5207-5571>

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### **Abstract**

This study examines the alignment between the research domains of Iran's highly cited scientists and the priorities outlined in the Science and Technology Roadmap. Additionally, it examines patterns of scientific collaboration, the h-index, and the quality of scholarly journals across various impact levels within prioritized research areas. This applied descriptive study employs a scientometric approach to analyze the research output of Iran's highly cited scientists indexed in the Web of Science and Scopus databases. Data collection was conducted using Microsoft Excel, and statistical analyses—including independent t-tests, chi-square tests, and regression analysis—were performed using SPSS software. Findings indicate a significant alignment between the research activities of highly cited Iranian scientists and the priority areas defined in the Science and Technology Roadmap. Specifically, 78.6% of technology-related articles correspond with the roadmap's strategic priorities, reflecting researchers' attention to national needs and key challenges. Despite this strong alignment across technological fields, certain research areas remain underrepresented and warrant greater emphasis. Furthermore, the study finds that alignment with national priorities does not have a significant impact on researchers' h-index or international collaborations. Given that governments play a pivotal role in policymaking and shaping national strategic documents, ensuring that scientific capabilities are directed toward addressing national demands is essential. Aligning research activities with national priorities is crucial for enhancing a country's scientific impact and fostering sustainable development. This study identifies gaps in research focus and evaluates the extent to which the scientific contributions of Iran's top 2% of highly cited researchers align with national strategic objectives.

**Keywords:** Science and Technology Roadmap, Highly Cited Iranian Researchers, Journal Quality, H-index, International Collaboration, Scientometric Analysis.

### Introduction

In today's scientific communities, the publication of research articles is recognized as one of the most important indicators of research and development. Consequently, this indicator has been extensively examined by researchers and experts in scientometrics (Lewison et al., 1993). Various studies have examined scientific exchange and collaboration among researchers worldwide, as reflected in journal publications, to assess the production, growth, and development of science in each country or specific field. This information is instrumental in shaping policies for a country's education and research systems. One of the primary methods for evaluating the overall state of research is bibliometric analysis, which examines research articles published in scientific journals. These studies provide quantitative measures of scientific output, illuminating research trends at the national, institutional, disciplinary, and individual levels. They help identify preferred research areas, neglected fields, key researchers and institutions, levels of research support, and the overall impact of these studies on the scientific environment (Sharifi, 2003).

Prominent scientists such as Cole, Eales, and Holm have also used scientific publications as a criterion for comparing the scientific output of different countries. Through this approach, they have assessed and compared the quantitative and qualitative aspects of scientific production across nations, providing insight into their respective rankings in scientific output (Ensafi, 2002). It is worth noting that, alongside quantitative and qualitative assessments, a country's research system should also strive for diversification. In this regard, defining research priorities plays a fundamental and guiding role in science and technology policy-making. Establishing research priorities helps prevent the wastage of research resources, ensures better organization and coordination of research projects, optimally allocates research funding, mobilizes research capabilities, enables foresight in scientific endeavors, prevents impulsive and non-strategic decision-making, and, most importantly, facilitates the practical application of research findings by implementing necessary projects (Hosseini-Qolizadeh & Heidari, 2013).

One of the key initiatives undertaken in this regard is the Science and Technology Roadmap, a high-level strategic document for advancing science and technology. This document emphasizes specific scientific fields and subfields, recognizing that achieving the desired status in these domains by 2025 (1404 in the Iranian calendar) will be challenging without accounting for the country's needs and existing capabilities. The Science and Technology Roadmap is a strategic framework designed to guide Iran's long-term scientific and technological development. This document, formulated and approved by the Supreme Council of the Cultural Revolution, was developed in response to the need for synergy and coherence in the country's scientific and research planning. Its objective is to define the trajectory of scientific progress across disciplines, create favorable conditions for scientific and technological advancement, and enhance Iran's economic, social, and cultural status (Okhovati et al., 2013).

In addition to the Science and Technology Roadmap, the Comprehensive Scientific Map of Iran serves as a foundational policy document that delineates national research priorities across multiple disciplines. This comprehensive framework outlines strategic objectives and priority areas to effectively steer the country's scientific and technological development. Incorporating the Comprehensive Scientific Map into research evaluations ensures a more holistic alignment with national goals and facilitates the identification of gaps and opportunities in the research landscape. Hence, this study also considers the priorities and directives outlined in Iran's

Comprehensive Scientific Map alongside the Science and Technology Roadmap to provide a robust analysis of research alignment. This dual-framework approach strengthens the policy relevance of the findings and supports evidence-based decision-making to promote national scientific advancement.

In recent years, researchers at Stanford University have used data from the Scopus database to develop a citation-based database and introduce a metric, the Composite Citation Index. This index is based on citation counts, authorship ranking (co-authorship patterns), and researchers' h-indexes. The dataset, widely known in Iran as the Stanford University List, has attracted significant attention from the media and academic institutions. The primary purpose of this database is to provide standardized citation metrics for assessing the citation impact of scientists across various disciplines and research fields globally. The Composite Citation Index, introduced and calculated by Stanford University researchers in their 2016 paper, integrates multiple distinct citation indicators, including the number of citations received, co-authorship ranking, and the h-index. The latest update of the Stanford University List, released in October 2023 (Mehr 1402 in the Iranian calendar), evaluates the citation performance of authors based on their research output from 1960 to 2022 across five major subject areas, 22 subfields, and 174 disciplines. This analysis identifies the top 2% most-cited researchers worldwide (ISC, Report on the Top 2% Most-Cited Iranian Researchers, 2023).

In scientometric analyses, several factors contribute to a comprehensive understanding of research performance and impact. Among these, the h-index has gained widespread recognition as a robust metric that reflects both researchers' productivity and citation impact. However, the h-index alone does not fully capture the nuances of research quality and collaboration patterns. Journal quality, often assessed through impact factors or quartile rankings, serves as an important indicator of the prestige and visibility of published work, influencing the dissemination and recognition of scientific outputs. Furthermore, international collaboration is increasingly acknowledged as a critical factor enhancing research quality, visibility, and innovation potential, often leading to higher citation rates and broader scientific impact.

Therefore, investigating the relationships between the h-index, journal quality, and international collaboration provides valuable insights into the multidimensional nature of scientific contributions. Incorporating these factors into the analysis allows for a more nuanced evaluation of research outputs beyond simple citation counts. This approach aligns with national research priorities by highlighting the roles of quality and collaboration in advancing scientific excellence and addressing complex societal challenges. Accordingly, this study explicitly evaluates these scientometric indicators to assess the alignment of the outputs of Iran's top 2% highly cited researchers with the priorities outlined in the Science and Technology Roadmap.

The list of Iran's top 2% most-cited researchers, based on 2022 citation performance, includes 2,135 researchers affiliated with Iranian institutions among 210,198 international researchers, placing them among the scientific elite (ISC, Highly Cited Researchers, 2023). Among the top subject areas, Clinical Medicine, Engineering, Chemistry, and Strategic Technologies (such as Artificial Intelligence, Nanotechnology, and Advanced Manufacturing Processes) rank first to fourth in terms of the highest concentration of highly cited researchers. Collectively, these four disciplines account for 81.55% of all highly cited Iranian researchers.

Aligning the scientific output of the top 2% most-cited researchers with national priorities is a strategic initiative to advance the country's scientific and technological development and

requires continuous, precise policymaking. The government and industry can guide research efforts by defining specific, high-priority projects and allocating resources to leading researchers. Additionally, the Ministry of Science and academic institutions should develop new regulations that prioritize research aligned with the Science and Technology Roadmap.

Despite the strategic significance of national science and technology policy documents, there is a lack of empirical studies evaluating whether the research output of Iran's most highly cited scientists is aligned with these national priorities. Existing scientometric studies often focus on general productivity or citation metrics without assessing alignment with strategic roadmaps. This gap highlights the need for a targeted analysis that connects high-impact research activity with defined national research priorities. The present study aims to address this gap by mapping and analyzing the research output of top Iranian scientists in relation to the strategic areas outlined in Iran's Science and Technology Roadmap. This evaluation can help policymakers better understand whether national investments and elite research efforts are moving in tandem toward shared scientific goals.

Given the importance of high-quality scientific output, research conducted by the top 2% most-cited researchers carries significant credibility. Therefore, analyzing and aligning their research outputs with national scientific priorities serves as the core objective of this study.

Stanford University has developed a comprehensive database that identifies and documents more than 100,000 distinguished scientists worldwide across 22 scientific fields and 176 subfields. Each year, a research team at Stanford identifies the most influential scholars in their respective disciplines based on scientometric criteria, classifying them as members of the top 1% and 2% of highly cited scientists globally. A study conducted by Stanford researchers, using data from the Scopus database, has compiled lists of the most highly cited scientists across all disciplines and the top 2% of scholars within specific scientific fields. Among these, the technology sector (with 419 researchers), basic sciences (with 287 researchers), and health sciences (with 159 researchers) rank first, second, and third, respectively, in terms of the highest concentration of highly cited authors.

Effective strategic planning for enhancing the quality of scientific output requires a comprehensive understanding of internal research capacities. Scientometrics, as a pivotal tool for science policy and decision-making, plays a critical role in evaluating the alignment of the research output of the top 2% of highly cited Iranian scientists with the priorities outlined in the Science and Technology Roadmap. Such an evaluation can provide valuable insights into the long-term strategic alignment of national research with developmental goals and help identify research gaps and underrepresented fields requiring further attention.

Globally, countries such as the United States, the United Kingdom, New Zealand, and Australia conduct nationwide assessments of their research performance to formulate effective research strategies (Norouzi Chakoli, 2011). In Iran, various funding organizations and research institutions have also initiated efforts to evaluate research impact, identify top-performing scientists, and assess the influence of national research output (Noorhidawati et al., 2017).

By mapping the current state of scientific publications and research productivity of Iranian scientists ranked among the world's top 2% of highly cited researchers, it becomes possible to identify thematic research gaps, highlight potential strengths and weaknesses, and devise strategies to address existing shortcomings.

Furthermore, scientific output is widely recognized as a key indicator of a nation's development and global competitiveness. Higher education institutions strive to streamline

research activities, establish structured research agendas, and set national research priorities to contribute effectively to scientific and technological advancement. However, achieving these objectives requires strong institutional and governmental support. Therefore, it is imperative to implement a systematic framework for monitoring and evaluating researchers' scientific output, enabling policymakers to identify existing challenges and formulate evidence-based solutions.

A quantitative and qualitative analysis of research productivity across various scientific disciplines provides critical insights into the current status of national scientific output. The findings from such evaluations can guide science policymakers and research strategists in identifying key strengths and weaknesses, thereby facilitating improvements in research excellence and mitigating deficiencies.

Ultimately, scientific productivity and research impact are not only essential for the career sustainability of individual researchers but also crucial to the advancement of scientific communities, which underpin technological progress and innovation in any country.

### **Research questions**

1. To what extent do the research activities of highly cited Iranian scientists align with the technological priorities outlined in the Science and Technology Roadmap?

How well do the research activities of highly cited Iranian scientists in the technology domain correspond to the country's science and technology priorities (subcategories of Sections A, B, and C)?

To what extent do the international research collaborations of highly cited Iranian scientists in the technology sector align with the country's science and technology priorities in the specified domains?

Is there a relationship between the quality index of journals and the alignment of scientific output with the country's science and technology priorities in the technology domain?

Is there a relationship between the H-index of journals and the alignment of scientific output with the country's science and technology priorities in the technology domain?

### **Literature Review**

Mohammadzadeh et al. (2021) examined highly cited articles by Iranian researchers in the Web of Science database based on collaboration patterns from 2007 to 2017. This applied research, employing a scientometric approach, analyzed 1,475 articles retrieved from the Web of Science. Data analysis was conducted using the HistCite, NodeXL, and VOSviewer software, while the quality of journals publishing these articles was assessed using the Journal Citation Reports database, followed by Microsoft Excel. The study found that the number of highly cited articles increased over time, with engineering, chemistry, and mechanics, as well as Islamic Azad University and the University of Tehran, contributing the most to highly cited publications. The highest levels of research collaboration were observed with institutions such as Korea University, the University of Virginia, Boston University, and Johns Hopkins University. Additionally, Vanderbilt University, the University of Washington, the University of Valencia, the University of Trieste, the University of Tennessee, and the University of Tehran had the most influential collaborations based on eigenvector centrality. The study suggests that Iranian researchers should enhance collaborations with European researchers to increase citations. Furthermore, international collaboration significantly affects citation rates;

therefore, it is recommended that at least one international co-author be included in research projects.

Eghtesadifard and Shokouhi (2020) conducted a study titled "Evaluation, Ranking, and Selection of the Most Effective Research Projects in Universities Based on Research and Technology Policies (Case Study: Shiraz University of Technology)." The study proposed a four-stage approach for evaluating and ranking technology-driven research projects. In the first stage, key evaluation criteria for research projects were identified. In the second stage, the DEMATEL technique was used to identify interdependencies among the criteria, followed by the Analytic Network Process (ANP) to assess their relative importance. In the third stage, projects were ranked; in the fourth stage, the final ranking was determined using linear assignment, and results were compared, and sensitivity analysis was conducted across thirteen scenarios. Based on this framework, 23 technology-driven research projects at Shiraz University of Technology were evaluated and ranked using 19 criteria across seven dimensions. The results highlight the prioritization of financial, marketing, and technical aspects in selecting research and development projects. The application of a systematic method for selecting research projects in universities and research centers allows for more precise project definition and decision-making.

Janavi et al. (2020) assessed Iran's scientific publications based on key indicators outlined in the Science and Technology Roadmap over a five-year period (2013–2017). This descriptive-analytical study employed a policy research approach and applied scientometric tools. Data on eight key indicators of scientific publications from the Science and Technology Roadmap were extracted from relevant databases for the five-year period and analyzed. The findings indicated a promising upward trend in indicators such as "the number of articles per million people," "the ratio of university and seminary graduates to indexed articles in international databases," and "the ratio of internationally indexed articles to faculty members." The projected targets for these indicators by 2025 appear achievable given their current trajectory. However, for indicators such as "citations per publication," although there has been a positive trend in recent years, the current figures remain significantly below the 2025 target. The study ultimately concluded that the "National Monitoring and Evaluation System for Science, Technology, and Innovation," designed to assess the indicators of the Science and Technology Roadmap, is not an adequate tool for evaluating these indicators and requires a revision of its monitoring criteria.

Zavareqi and Hamdipour (2020) analyzed the scientific output of researchers affiliated with the University of Tabriz by mapping, identifying, and analyzing the intellectual, social, and cognitive structures of the university's research output. This study aimed to identify the university's human, intellectual, and scientific capital to facilitate development, grounded in internal capacities and investments aligned with its competitive advantages. The analysis of the social structure of the university's scientific output revealed that researchers were primarily active in analytical chemistry, applied chemistry, electrical engineering, physics, and polymer sciences. Furthermore, the study's findings on the intellectual structure indicated that the research landscape could be represented as a network comprising 23 distinct specialties, with the most prominent specializations being electromagnetics, decolorization, and thermodynamics.

Abramo et al. (2019) examined the diversification versus specialization strategy in scientific output at the level of the researcher. Their findings indicate that based on the subject areas in which researchers publish, those in fields such as mathematics and earth sciences tend

to focus on a single domain (high specialization), whereas researchers in fields such as chemistry and industrial engineering are more inclined to engage in multiple domains (diversification). The study also found that various factors, including interdisciplinary scientific collaborations, gender, age, academic rank, and researcher evaluation policies, influence the diversity of researchers' scientific activities.

Hosseini-Moghaddam et al. (2019) proposed a foresight model for achieving scientific authority, with a case study on Guilan University of Medical Sciences. The study explored the origins of scientific authority in Iran, national and international experiences, and the specific case of Guilan University of Medical Sciences. The methodological approach of this study was foresight-based, with a central theme of "learning through participation and action." This approach ensured the active involvement of key stakeholders, including the strategic council, administrators, faculty members, students, alumni, and non-academic staff, in all processes related to identifying priorities for scientific authority. The research employed documentary and comparative studies to understand scientific authority and previous research. Additionally, expert panels and brainstorming techniques were used to develop future scenarios, identify driving and inhibiting factors, prioritize strategies, and validate conceptual and operational models for scientific authority. An online Delphi questionnaire was also used to gather the opinions of key stakeholders. The study applied modeling techniques to develop its proposed framework. The findings indicate that defining priority areas for achieving scientific authority at Guilan University of Medical Sciences requires active participation from all stakeholders. The most significant conclusion is that attaining scientific excellence and authority requires collective will and engagement within the university, transforming it into a discourse both internally and externally to ensure the credibility and sustainability needed to achieve a desirable future.

Cavasini (2016) investigated trends in scientific output among Middle Eastern countries, using data from 16 nations in the region, spanning 1996 to 2014, sourced from the Scopus database. The findings revealed that the occupying regime ranked highest in total citations and average citations per document. Turkey and Iran ranked first and second, respectively, in the total number of published documents in the region. Additionally, Turkey, Iran, Egypt, and Saudi Arabia emerged as leading countries in scientific output within the Middle East. However, in recent years, the occupying regime has been losing its share of global scientific production, a trend aligned with that of developed Western European countries. This decline is attributed to the rapid growth of scientific output in emerging nations.

Blessinger and Hrycaj (2010), in their study titled "The Most Cited Articles in Library and Information Science: A Content and Authorship Analysis," analyzed the most cited authors who had made a significant impact on scholarly communication in the field between 1992 and 2004. They selected 32 highly cited articles from the Web of Science Citation Reports and examined trends in authorship, citation patterns, and scholarly collaboration. Their findings were then compared with the most-cited scientific articles published during the same period.

Therefore, as demonstrated in the literature review, both domestic and international studies have pursued objectives that differ from those of the present research. This study aims not only to focus on the field of scientometrics and consider the Science and Technology Roadmap as a standard for analyzing and evaluating the country's scientific and educational activities, but also to assess the extent of alignment and conformity with the scientific output of the world's top 2% of scientists.

### Materials and Methods

The present study is an applied research study, guided by the nature of data collection and retrieval, following a documentary or library approach. This research employs scientometric methods and citation analysis. This study examines the scientific publications of Iranian researchers ranked in the top 2% in the field of health. Based on the Stanford University list, of the 64,845 researchers worldwide in the top 2% whose citation counts have been calculated, 866 are identified as highly cited researchers. From these, the field of technology accounts for the largest share with 419 researchers. The current study focuses on this group to examine the strategic orientation of research in one of Iran's most prioritized scientific fields.

Among these, 419 researchers are in the field of technology. The names of these researchers (the top 2% of scientists in health, basic sciences, and technology fields) are provided by Stanford University, and the researcher makes no modifications to the field-based categorization.

While the Stanford University list includes researchers across various scientific domains, including health, basic sciences, and technology, this study focuses exclusively on Iranian researchers categorized under the "technology domain". The earlier mention of the health field was intended solely to describe the broader scope of the Stanford classification and to provide context for the list. However, all processes, including sample selection, data retrieval, and analysis, are strictly limited to researchers in the field of technology. This clarification has been added to ensure consistency and transparency throughout the methodology.

Given the high volume of publications, researchers were sampled using Cochran's formula, yielding a sample of 270. The research population comprises all published works of the 270 top researchers in technology, indexed in Scopus during their years of service. Data analysis tools used in this study include Excel and SPSS software. The data collection platforms will be Scopus and Medline databases.

The research process will proceed as follows: the names of 270 Iranian highly cited researchers in the top 2% from the Stanford University list will be extracted. First, the names of all Iranian researchers in the top 2% in the field of technology, as listed in the Stanford University list published in October 2023, will be extracted. Each researcher's name will be searched in the author search section of Scopus, and the retrieved results will be cross-checked with the researcher's organizational affiliation to ensure accuracy. Once the match is confirmed, the researcher's Scopus Author ID will be saved. All verified Author IDs will be compiled to generate a unified search query in the Scopus advanced search interface.

Then, by accessing the Scopus database, all the indexed articles by these 270 researchers will be searched within the service years of the researchers using the search method outlined below. First, the names of all Iranian researchers in the top 2% in the field of technology, as listed in the Stanford University list published in October 2023, will be extracted. Each researcher's name will be searched in the author search section, and the retrieved results will be matched with the researcher's organizational affiliation. Once the search results are confirmed, the author's ID will be saved. Finally, all author IDs will be compiled, and in the advanced search section under "Author ID," all the compiled IDs will be searched. The search year will not be limited. The final search formula is as follows:

AU-ID (26639699900) OR AU-ID (6602583920) OR AU-ID (7005400072) OR AU-ID (7005197760) OR AU-ID (24831040300) AND PUBYEAR > 2019 AND PUBYEAR < 2023

The data will be compiled and standardized in Excel, and for subsequent analysis of the impact and further evaluation of the scientific publications by Iranian top 2% researchers in technology, basic sciences, and health fields, SPSS software will be used. The collected data will be analyzed using descriptive statistics and presented in tables and charts. In addition to citation-based indicators such as h-index, journal quartile ranking, and international collaboration, a content analysis of the titles and abstracts of the retrieved articles will also be conducted. This step allows the identification of thematic clusters and research priorities, supplementing the Scopus subject area classification. This approach addresses the reviewer's concern and provides a more nuanced understanding of the extent to which the scientific outputs align with the Science and Technology Roadmap and the Comprehensive Scientific Map of Iran.

## Results

This study examines the alignment between the research activities of highly cited Iranian scientists and the science and technology priorities outlined in the Science and Technology Roadmap. In this context, data on 4,159 articles published by these highly cited Iranian scientists across different years were collected. This dataset includes the authors' names, organizational addresses, article titles, and the degree of alignment with the Science and Technology Roadmap's science and technology priorities. Additionally, this data has been analyzed and reported in accordance with priorities A, B, and C of the Science and Technology Roadmap.

Descriptive statistics, including indicators such as frequency and proportion of articles in various categories, and bar charts for data distribution, were provided. To compare the frequencies or proportions of articles in different groups, a proportion test (non-parametric test) was used. The null hypothesis in this test assumes that the frequencies or proportions are equal across groups. If the significance value (sig) is less than 0.05, the null hypothesis is rejected, meaning there is a significant difference in the frequencies or proportions among the groups.

### Results of the tests and analysis

#### Alignment of articles with science and technology priorities in the science and technology roadmap

Out of the 4,159 articles, 890 articles (21.4%) did not align with the science and technology priorities in the Science and Technology Roadmap, while 3,269 articles (78.6%) were aligned with the priorities (Table 1).

Table 1

*Qualitative research variables*

Research Priority Compliance	Yes	No
Count (Percentages)	3269 (78.6%)	890 (21.4%)

According to the proportion test, this difference was significant, indicating that the number of articles aligned with the science and technology priorities was significantly higher than that of those not aligned ( $p < 0.001$ ).

### Alignment of articles with priority a in the technology field

Out of the 3,269 articles aligned with science and technology priorities, 701 articles aligned with priority A in the technology field. These articles were predominantly published in the following subfields (Table 2): Information and Communication Technologies (19%), Biotechnology (7.1%), Environmental Technologies (10.7%), Nanotechnology and Microtechnology (22.6%), Nuclear Technologies (9.5%), and Aerospace Technology (21.4%). The proportion test showed a significant difference in the number of articles across different topics within priority A ( $\text{sig} < 0.001$ ).

Table 2

Priority A: Qualitative research variables

Technology Fields	Count (Percentages)
Information and Communication Technology	134 (19%)
Biotechnology	50 (7.1%)
Environmental Technologies	75 (10.7%)
Cultural Technologies	33 (4.8%)
Nanotechnology and Microtechnology	159 (22.6%)
Oil and Gas Technologies	34 (4.8%)
Nuclear Technology	66 (9.5%)
Aerospace Technology	150 (21.4%)

### Alignment of articles with priority b in the technology field

Of the 3,269 articles, 1,293 articles were aligned with Priority B in the technology field. These articles were mainly published in the fields of Polymers (17.4%), Automation and Robotics (12.2%), Photonics (11%), and Semiconductors (12.9%). At the same time, certain topics such as Chemical Sensors (1.9%) and Mechatronics (1.9%) had the lowest representation in the articles (Table 3). The proportion test revealed a significant difference in the number of articles across different topics within priority B ( $\text{sig} < 0.001$ ).

Table 3

Priority B: Qualitative research variables

Technology Fields	Count (Percentages)
Mineral Exploration and Extraction	67 (5.2%)
Polymers (Plastics)	225 (17.4%)
Civil Defense (Non-combat Defense)	109 (8.4%)
Earthquake and Flood Prediction and Mitigation	50 (3.9%)
Chemical Sensors	25 (1.9%)
Conservation and Restoration of Genetic Reserves	50 (3.9%)
Automation and Robotics	158 (12.3%)
Biosensors	92 (7.1%)
Photonics	142 (11%)
Shipbuilding	17 (1.3%)
Laser Technology	41 (3.2%)
Mechatronics	25 (1.9%)
New Composite Materials	125 (9.7%)
Semiconductors	167 (12.9%)

### Alignment of articles with priority c in the technology field

Out of the 3,269 articles, 1,275 articles were aligned with Priority C in the technology field. These articles were mostly published in the areas of Medical Engineering (32%), Traffic and Urban Planning (9.8%), and Lightweight and Resilient Construction Materials (8.5%). Additionally, areas such as Metallic Alloys (3.9%) and Rehabilitation of Rangelands and Forests (3.9%) had the least representation (Table 4). The proportion test indicated a significant difference in the number of articles across different sub-components of priority C ( $\text{sig} < 0.001$ ).

Table 4

Priority C: Qualitative research variables

Technology Fields	Count (Percentages)
Metal Alloys	50 (3.9%)
Optoelectronics	92 (4.2%)
Rehabilitation of Rangelands and Forests and Their Utilization	50 (3.9%)
Transport Safety	108 (8.5%)
Traffic and Urban Planning	125 (9.8%)
Rail Transport	42 (3.3%)
Marine Structures	92 (7.2%)
Indigenous Technologies	42 (3.3%)
Catalysts	59 (4.6%)
Light and Resilient Construction Materials	108 (8.5%)
Medical Engineering	408 (32%)
Magnetic Materials	99 (7.8%)

### Conclusion

The results of this study demonstrate that the research activities of highly cited Iranian scientists are generally aligned with the science and technology priorities outlined in the Science and Technology Roadmap. Furthermore, within priorities A, B, and C, differences were observed in the degree of alignment across their subcomponents, indicating the need for targeted policymaking to enhance scientific activities in fields with lower representation.

Impact of Researcher H-index Compliance with National Science and Technology Priorities in the Field of Technology. To answer this question, given that we have one categorical variable with two levels (compliance with priorities) and one continuous variable (H-index), two methods can be used: an independent-samples t-test and Logistic Regression.

The Independent T-test compares the means of two independent groups, and the null hypothesis is that the mean H-index is equal between the two groups: compliance with priorities and non-compliance with priorities. If the significance value ( $\text{sig}$ ) is less than 0.05, the null hypothesis is rejected, indicating that the mean H-index of articles that comply with priorities differs from those that do not comply. Three assumptions are necessary for this test: Independence between the two groups (which holds true). Normality of data or sufficient sample size (more than 30 observations in each group) (which holds true).

Equality of standard deviations, which will be tested using Levene's test. The null hypothesis for this test assumes equal standard deviations of H-index across the two groups. If the  $\text{sig}$  value is less than 0.05, we reject the null hypothesis of equal standard deviations and

use the Independent T-test under the assumption of unequal standard deviations. Linear regression is used to assess the effect of compliance with priorities on the H-index (Table 6), analogous to an independent-samples T-test. This method is used when the dependent variable is continuous.

Based on the collected data, the mean and standard deviation of the H-index for articles that complied with the priorities are 127.07 and 112.317, respectively, while the mean and standard deviation of the H-index for articles that did not comply with the priorities are 126.04 and 129.573, respectively (Table 5). According to Levene's test (for equality of variances), the standard deviations of the two groups are significantly different ( $\text{sig} = 0.004$ ). The standard deviation of the H-index is higher in the group that did not comply with the priorities than in the group that complied.

Table 5

*Independent T-test results for the h-index variable*

	Mean $\pm$ Standard Deviation	sig.
Variable	H-index Journal	
Compliant Mean	127.07 ( $\pm$ 112.317)	
Non-Compliant Mean	126.04 ( $\pm$ 129.573)	
Compliance with Priorities	127.07 $\mp$ 112.317	0.904
Yes	126.04 $\mp$ 129.573	
No		

Furthermore, according to the results of an independent t-test (assumed unequal variances) comparing the two groups (compliance vs. non-compliance with priorities), the mean H-index did not differ significantly ( $p = 0.904$ ) (Table 5). This means the mean H-index for the group that complied with the priorities is the same as that for the group that did not comply. In simpler terms, the alignment of scientific outputs with the priorities of the Science and Technology Roadmap does not affect the H-index.

It should be added that citation rates of articles typically depend on issues that have gained global scientific attention. Many priorities in the Science and Technology Roadmap may focus on local and regional issues that are not necessarily attractive to or citable by international researchers. For example, topics related to endemic diseases or specific environmental issues of a country may be of great national importance but attract less global attention. As a result, articles written in these areas might receive fewer citations, and therefore, the H-index of the researcher may not grow as much as it would for globally relevant topics.

On the other hand, internationally focused articles are often published in high-impact journals with broader audiences. If researchers' scientific outputs focus solely on the country's internal priorities and address issues of little international significance, these articles may be published in journals with lower impact factors, leading to fewer citations and, consequently, a reduced growth in the H-index. Additionally, the H-index is dependent on scientific prominence at the international level. If researchers' scientific outputs focus on global issues such as climate change, advanced technologies, or pandemics, they are more likely to achieve scientific

prominence, as these topics are important to researchers worldwide and attract more citations. In contrast, topics that align only with local and national priorities may achieve less international scientific prominence.

Therefore, the alignment of scientific outputs with the priorities of the Science and Technology Roadmap does not directly influence the H-index. This is because the H-index is primarily driven by citation rates at the international level and the global scientific community's interest in research topics. Citations tend to accumulate more for research on globally significant topics, whereas national and locally oriented studies that align with domestic priorities may receive comparatively less international recognition.

Table 6

Summary of simple linear regression results between compliance with priorities and h-index

	Standard Error of Prediction	Coefficient of Determination	Regression Coefficient	sig	Degrees of Freedom (df)	F
Scientific Priorities of the Science and Technology Roadmap	117.918	0.004	1.026	0.899	1	0.016

### Does the quality index of journals relate to the alignment of scientific outputs with the country's science and technology priorities in the field of technology?

Given that one of the variables is binary and the other is multinomial, we use the Chi-square independence test to answer this question. According to the data collected, among the articles that align with the priorities, 62.2% were published in journals ranked in Q1, 31.3% in journals ranked in Q2, 5.1% in journals ranked in Q3, 0.6% in journals ranked in Q4, and 0.9% in journals without a Q rank. Among the articles that do not align with the priorities, 51.1% were published in journals ranked Q1, 28.2% in journals ranked Q2, 7.4% in journals ranked Q3, 10.4% in journals ranked Q4, and 2.9% in journals with no Q rank (Table 7).

Table 7

Chi-square independence test for the variables of the science and technology roadmap

			Q					sig.
			Q1	Q2	Q3	Q4	-	
Alignment with Priorities	No	N (%)	790 (51.1)	435 (28.2)	115 (7.4)	160 (10.4)	45 (2.9)	< 0.001
	Yes		2150 (62.2)	1080 (31.3)	175 (5.1)	20 (0.6)	30 (0.9)	

According to the results of the Chi-square test (independence between the alignment with priorities and the Q index), alignment with priorities influences the publication of articles in journals with different rankings. Based on the percentages, it can be inferred that a higher proportion of articles that align with priorities are published in Q1-ranked journals than those that do not. Moreover, a lower percentage of articles that align with priorities are published in

Q4-ranked journals and journals without a Q rank compared to articles that do not align with the priorities ( $\text{sig} < 0.001$ ).

According to the results of the Chi-square test ( $\text{sig} < 0.001$ ), alignment with the priorities significantly influences the publication of articles in journals with different rankings. A higher percentage of articles that align with the priorities are published in Q1-ranked journals compared to those that do not align, while a higher percentage of articles that do not align with the priorities are published in Q4-ranked journals or journals without a Q ranking. The conclusion drawn from this research indicates that the journal quality index can play a significant role in aligning scientific outputs with national priorities in science and technology across the fields of technology, basic sciences, and health. In fact, the quality of journals directly affects scientific influence, the use of knowledge in macro-level decision-making, and the direction of research toward national needs and scientific priorities. Some factors that strengthen this connection include:

**Publication in Prestigious Journals:** Research published in reputable journals with high-quality indices usually has a higher scientific standard and can more effectively address the problems and needs of the country's science. These journals typically seek articles that bring innovation and practical applicability in specific areas such as health.

**Connection Between Journal Quality and Research Policies:** High-quality scientific journals can steer research toward significant and priority areas. For instance, research policies in fields such as technology, basic sciences, and health, which are grounded in national priorities such as combating indigenous diseases or developing health infrastructure, are more likely to be published in high-quality journals.

**Higher Citation of Articles in Prestigious Journals:** Articles published in journals with higher-quality indices are typically cited more frequently, thereby increasing their impact on shaping research directions and health and medical policies in the country.

**Impact on Scientific Policy-Making:** Scientific policymakers generally pay more attention to research published in high-quality, reputable journals. Such articles are more likely to play a significant role in decision-making and budget allocation for future research in areas like technology, basic sciences, and health.

Therefore, the quality index of journals, as a criterion for evaluating scientific impact, can play a crucial role in aligning scientific outputs with national priorities in science and technology, particularly in critical areas such as health.

## Discussion

The Science and Technology Roadmap serves as a strategic framework for guiding national research efforts, ensuring that scientific advancements align with key societal and economic needs. By prioritizing critical areas such as health, basic sciences, and technology, this roadmap provides a foundation for achieving sustainable development and global scientific competitiveness.

The findings of this study indicate a strong alignment between the research output of Iran's top 2% highly cited scientists and the priority areas outlined in the roadmap. This aligns with the conclusions of Janavi et al. (2020), who found upward trends in key scientometric indicators and supported the roadmap's role in shaping national research. Both studies affirm the positive trajectory of Iran's scientific productivity in relation to national goals.

A particularly noteworthy observation is the strong focus of research on health-related issues, which demonstrates the scientific community's responsiveness to urgent national demands. The emphasis on the prevention and treatment of non-communicable diseases and the advancement of health technologies reflects alignment with Hosseini-Moghaddam et al. (2019), who emphasized stakeholder-driven priority setting in the health sciences as essential for achieving scientific authority.

However, while these contributions are significant, it is essential to ensure that all priority areas receive adequate attention. Some research domains, despite being classified as high-priority, remain underdeveloped. Despite the demonstrated alignment of research activities with the Science and Technology Roadmap, a detailed analysis reveals discernible gaps in research coverage within several priority domains. Notably, emerging and strategically critical fields such as advanced materials science, renewable energy technologies, nanotechnology, and artificial intelligence appear underrepresented in the scientific output of Iran's top-cited researchers. This disparity suggests that while traditional fields—particularly health and foundational sciences—have been effectively cultivated, there remains an imperative to stimulate growth in these technologically pivotal areas.

These underdeveloped sectors possess substantial potential to drive future scientific breakthroughs and economic development, given their global significance and transformative capabilities. Insufficient research activity in these areas may limit Iran's capacity to compete internationally and to capitalize on emerging technological paradigms.

The observed gaps underscore the need for dynamic, responsive research policies that extend beyond the current roadmap framework by incorporating mechanisms for continuous reassessment of priorities. Moreover, fostering interdisciplinary collaborations, increasing targeted funding allocations, and promoting academia-industry partnerships are strategic measures that can facilitate diversification of research portfolios and enhance innovation capacity.

These conclusions are consistent with findings by Abramo et al. (2019) and Eghtesadifard and Shokouhi (2020), which emphasize the risks associated with over-specialization and the strategic advantage of a balanced, diversified research ecosystem. Consequently, augmenting the national science agenda to address these neglected domains is essential for sustaining Iran's scientific leadership and ensuring long-term innovation-driven growth.

This concern is echoed in Janavi et al. (2020), who noted that some roadmap indicators—particularly citations per publication—remain below expected targets, suggesting a mismatch between quantity and quality in certain areas.

Beyond health sciences, the study also highlights the role of research in technological advancements and basic sciences. This aspect is consistent with Eghtesadifard and Shokouhi (2020), who emphasized the importance of systematic evaluation in selecting technology-driven projects, reinforcing the need for coherent policy mechanisms to support applied and technical research.

Despite substantial alignment across these fields, the extent to which research findings are translated into practical applications remains a concern. This echoes findings from Zavareqi and Hamdipour (2020), who identified a fragmentation in the intellectual structure of university research outputs, implying challenges in coherence and real-world integration of scientific knowledge. While our study demonstrates strong alignment of research activities with the priority areas outlined in the Science and Technology Roadmap, a detailed analysis reveals that

some emerging interdisciplinary fields remain underrepresented among Iran's top 2% highly cited researchers. Specifically, areas such as environmental technologies, data science, and renewable energy show limited research output despite their growing global significance and strategic relevance for sustainable development. These domains hold substantial potential for innovation and can address critical national challenges related to climate change, resource management, and digital transformation.

The relative underrepresentation of these fields may be due to current funding allocations, policy priorities, or institutional priorities that emphasize more traditional sectors, such as health and core technology disciplines. To harness the full scientific and economic potential of these emerging areas, it is imperative to adopt targeted policy measures that encourage interdisciplinary collaboration, enhance capacity building, and promote international partnerships.

Therefore, fostering diversification in research portfolios beyond the established priorities outlined in the roadmap will be crucial to achieving a comprehensive and forward-looking national science and technology strategy. This recommendation aligns with the need for dynamic policy frameworks that adapt to evolving global scientific trends and national development goals. Moreover, the findings suggest that aligning research activities with national priorities does not necessarily translate into higher international collaboration or improved citation metrics. This insight is strongly supported by Mohammadzadeh et al. (2021), who highlighted the critical role of international collaboration in enhancing citation impact and visibility. Their recommendation for Iranian researchers to strengthen ties with European collaborators underscores the current gap identified in this study.

Interestingly, while our study shows strong national alignment, the lack of impact on h-index and global visibility points to a divergence from global engagement trends emphasized by Cavasini (2016), who noted Iran's strong regional output but underrepresentation in high-impact international citations. This suggests a need for broader global integration beyond national alignment. Finally, although the roadmap has proven effective in directing research focus, the findings of Abramo et al. (2019) warn of potential risks in overly specialized research portfolios. The emphasis on diversification of scientific output, particularly through interdisciplinary collaborations, remains underdeveloped in the Iranian context, highlighting another area where future policy interventions may be beneficial.

### Conclusion

This study highlights the critical role of the Science and Technology Roadmap in shaping national research priorities and ensuring that scientific activities align with key societal and technological needs. The strong alignment observed in various research domains, particularly in health and technology, reflects the effectiveness of national policies in directing research efforts toward strategic goals. Nonetheless, the identification of underexplored yet strategically vital research areas, as highlighted in this study, calls for deliberate investment and policy interventions to promote balanced scientific development. Prioritizing these domains through enhanced funding, capacity building, and interdisciplinary approaches will be critical to harnessing their full potential and securing sustainable innovation outcomes for the country. However, despite these achievements, there remain areas that require additional focus to fully leverage the country's scientific potential. The continued alignment of research with national priorities necessitates a comprehensive strategy that integrates policy-making, funding

allocation, and institutional support. Strengthening communication between researchers and policymakers, fostering interdisciplinary collaboration, and enhancing industry-academia partnerships are essential steps toward maximizing the impact of research. Additionally, promoting international collaboration and increasing the global visibility of Iranian research will be crucial for positioning the country as a key player in the international scientific community.

Ultimately, the success of the Science and Technology Roadmap depends on sustained commitment from all stakeholders, including government agencies, academic institutions, and funding bodies. By fostering a research culture that prioritizes national challenges while embracing global scientific advancements, Iran can achieve its long-term vision of becoming a leading hub for scientific and technological innovation. Ensuring that research output remains strategically aligned with national objectives will not only strengthen Iran's scientific standing but also contribute to long-term economic growth and societal well-being.

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