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Systematic review

Emerging technologies and global health: a systematic review generating bibliometric evidence for innovation management

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ABSTRACT

Objective To obtain quantitative evidence for innovation management on Emerging Technologies and Global Health from existing scientific research with a bibliometric approach.

Design This study generates quantitative evidence for healthcare innovation policy making, offering new insights: first, innovation quality can be measured through dynamic interactions among key innovation elements; second, as emerging technologies are impacting global health in an interdisciplinary and fast-changing manner, new theories and tools that suit the planetary innovation ecosystem need to be established. The evidence contains two aspects, the intellectual base and the research front. The software used is Citespace V.6.1.R3 and Python.

Data source This study scanned the Web of Science Core Collection with an extensive range of research themed around emerging technologies and global health, resulting in a dataset of 9738 items of science literature between 2017 and 2021.

Eligibility criteria for selecting studies This dataset contains literature across sciences and social sciences in the form of journal research articles, excluding systematic reviews and surveys. The search includes literature in all languages.

Results This study presents the landscape of emerging technology and global health, depicts the quality of innovation, and reveals the innovation trends. It demonstrates the major players and major sources of innovation, captures innovation foci and detects research blanks.

Conclusion This bibliometric analysis, which is conducted on scientific research, outlines the quality and impact of innovation in Emerging Technologies and Global Health. It shows the importance of Research and Development for generating quantitative evidence for innovation management policy making.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ In the past decades, innovation has been measured and indexed by input and output, framed by the mainstream National Innovation System theory. The new state and features of healthcare innovation in the fourth Industrial Revolution, which is enabled by a new legion of emerging technologies, have not been fully explored and captured in existing research.

WHAT THIS STUDY ADDS

⇒ This study adopts a bibliometric approach to generate quantitative evidence for policy making by revealing the key makers of innovation. It gains new insights that innovation quality can be viewed through interactions of key innovation elements and proposes a theoretical framework for innovation management that goes beyond national boundaries, in response to the formulation of a planetary innovation ecosystem.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ It can be used as a new source of dynamic quantitative evidence to inform policy making both at the national and international levels. It shows the importance of Research and Development for generating quantitative evidence for innovation management policy making in response to the advent of the fourth Industrial Revolution.

OBJECTIVES

This study seeks evidence for innovation management policy making from the scientific research base. It aims to reflect the quality of innovation[1] and reveals its trends. It answers the following key

Box 1 Scope of keywords of emerging technologies (search keywords used in data collection in Web of Science)

Emerging Technologies Breakthrough Technologies
Artificial Intelligence/AI/Machine Learning/Deep Learning
Internet of Things IoT/IIOT/sensors and wearable
Mobile/social internet search/social/messaging/livestreams
Blockchain distributed ledger systems/cryptocurrencies/Dapps
Big data Apps/infrastructure/predictive analytics
Automation Information/task, process/machine, decision, action
Robots Cons./Comm./indus. Robots/drones/autonomous vehicles/robotic surgery
Immersive media VR/AR/MR/video/gaming/ virtual and augmented reality
Mobile Technologies infrastructure/networks/standards/services &devises
Cloud computing SaaS/IaaS, Paas/MESH Apps
3D printing additive manufacturing/rapid prototyping
CX customer journey/customer experience/commerce personalization
Energy Tech energy storage/decentralized grid
Cybersecurity security/ intelligence detection, remediation, adaptation
Voice assistants interfaces/ chatbots/ natural language processing
Nanotechnology computing/ machines+ smart dust
Collaborative tech crowd/sharing/open source platform+ tools
Health tech advance genomics/bionics/healthcare tech
Human-computer facial, gesture recognition/biometrics/gaze tracking interaction
Geospatial tech GIS/GPS/mapping/remote sensing, scanning, navigation
Advanced materials composites, Alloys, Polymers, biomimicry, nanomanufacturing
New touch interfaces touch screens, haptics, 3D touch, feedback+ exoskeleton
Wireless power
Cleantech Bio-/Enviro-materials+ solutions/ sustainability/ treatment, efficiency
Quantum computing
Smart cities' Infrastructure, transport
Edge computing fog computing
Faster, better internet broadband/ Fiber/5G/Li-Fi/LPN/Lo Ra
Proximity tech beacons, RFID, Wi-Fi, near-field near, geofencing
New screen Digital signage, OOH, micro LED +projections
Biotechnology CRISPR/gene therapy/gene editing

Source: MIT Technology Review (2010–2021), WHO website, Marr.[13–15]

questions: Who are the major innovation actors, and where are the major sources of innovation? Where are players focusing their efforts, and what are the research directions?[2] It also provides a perspective on how innovation impact can be quantified through interactions among innovation key elements at a global level.

The insights obtained to provide quantitative evidence for policy making include: first, that innovation impact can be measured through dynamic interactions among innovation key elements, in addition to the conventional calculation of innovation output; second, the emerging technologies are impacting global health in an interdisciplinary and fast-changing manner, therefore, new tools are needed in this field to generate evidence to inform innovation management and institution change.

MATERIAL AND METHODS

Identify emerging technologies in global health

Emerging technologies refer to technologies that are emerging into prominence, with development and applications still largely unrealised. The scope of emerging technologies is highly elastic and extensible.[3] A certain technology, such as artificial intelligence, is applied and evolves in different fields in highly diverse ways. When steering emerging technologies in a specific field, such as global health, it is important to start with a clear look at what emerging technologies are functioning in that specific field. Among a comprehensive list of emerging technologies (box 1), this analysis identifies the ones that obtain/or will obtain functioning and mainstream status in the global health field.

Information source

This study began with scanning the Web of Science (WoS) Core Collection with an extensive range of research themed around emerging technologies and global health, resulting in a dataset of 9738 items of science literature between the years 2017 and 2021. This dataset contains literature across sciences and social sciences in the form of journal research articles, excluding systematic reviews and surveys. The search finds literature in 30 languages. Based on this dataset, bibliometric analyses were conducted to detect and then track patterns and trends. The software used was Citespace V.6.1.R3, Excel and Python (figure 1).

Search and study selection

The data search was conducted in WoS Core Collection, by theme search: setting theme= (One row of search words in box 1+ 'global health' or 'public health'). This step was conducted 31 times with search words in 31 rows. The relation within each row of search words was set as 'or'. The time span was set as 'year 2017–2021'. The discipline was set as sciences and social sciences. Literature types are set as journal research articles.

The search language was set as 'all'. A dataset of 11 204 items was obtained. Excel and Python were used to filter the repetition within the 11 204 items, and the full-text relevance was manually checked. A total of 9738 items were obtained (as shown in figure 2).

Data process and data items

We imported the dataset into Citespace V.6.1.R3 setting 'Time Slicing=2017–2021', and 'Year per Slice=1'.

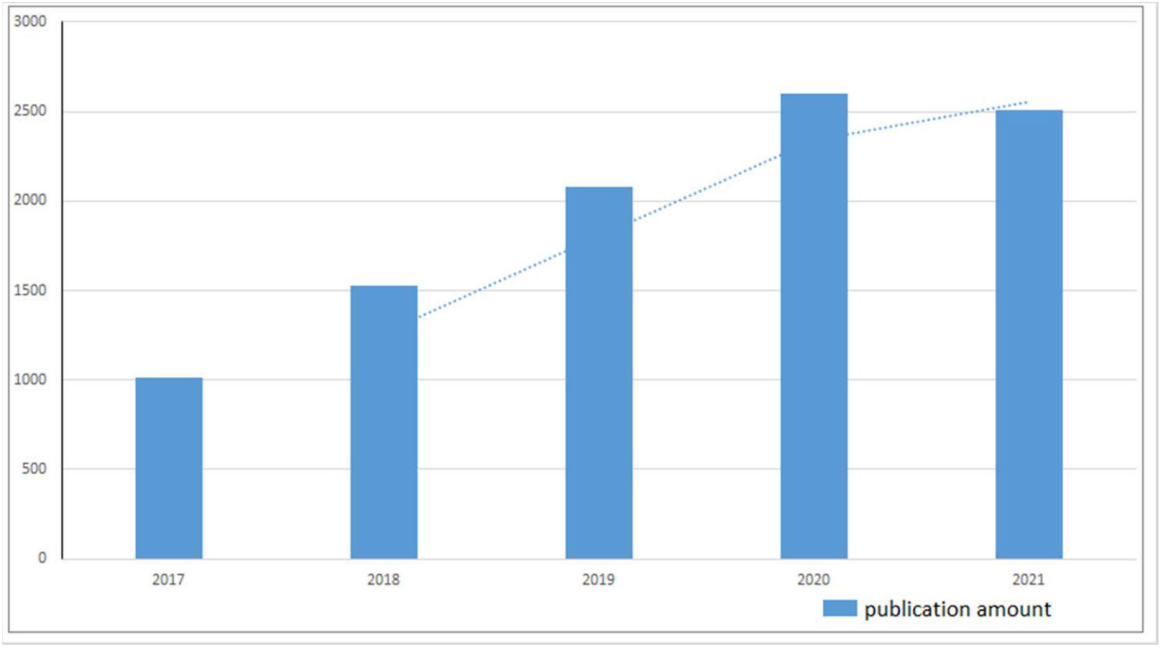

Figure 1 Science literature on emerging technologies and global health (2017–2021).

Other settings were adjusted according to different functions, elaborated in the following sections.

The data items included all science literature dated between the years 2017 and 2021. This dataset contains literature across sciences and social sciences in the form of journal articles and excludes systematic reviews and surveys. The search includes literature in all languages.

RESULTS AND DISCUSSION

Composition of the bibliometric evidence for policy making

Amid the current wave of emerging technologies, new evidence supporting strategy-making is needed. The internet evolved in a linear route, that is, from dial-up access to broadband, from 2G, 3G, 4G–5G, whereas the new legion of emerging technologies forms a

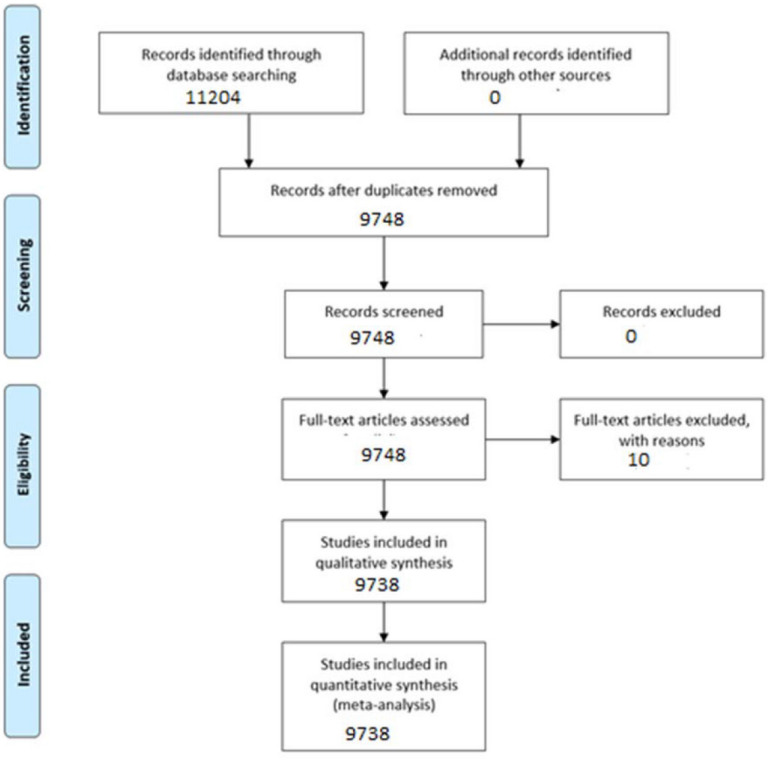

Figure 2 Search and study selection process.

Figure 3 Major Focus Areas in Emerging Technology and Global Health (by science publication quantity) (2017-2021). Source: WoS, author.

more dynamic compound (figure 3). Managing these technological innovations requires time-variant and wide-angle evidence. Using bibliometric analysis of scientific research, a time-variant mapping of emerging technologies and global health can be obtained from two aspects, the intellectual base and the research front (figure 4). The top 10 languages with the largest volume of literature are English, German, Spanish, French, Portuguese, Russian, Turkish, Italian, Chinese and Japanese.

Intellectual base and research front

The intellectual base is the state of a certain research area, which can be reflected by scientific publication records, research groups, citations and cocitation footprints in scientific literature. The research front refers

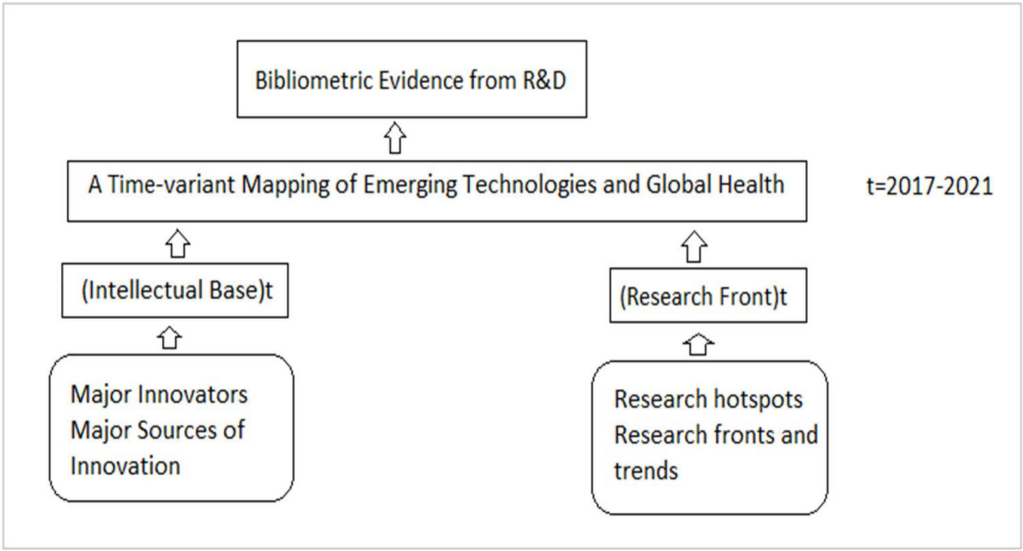

Figure 4 Composition of the Bibliometric Evidence. Source: author.

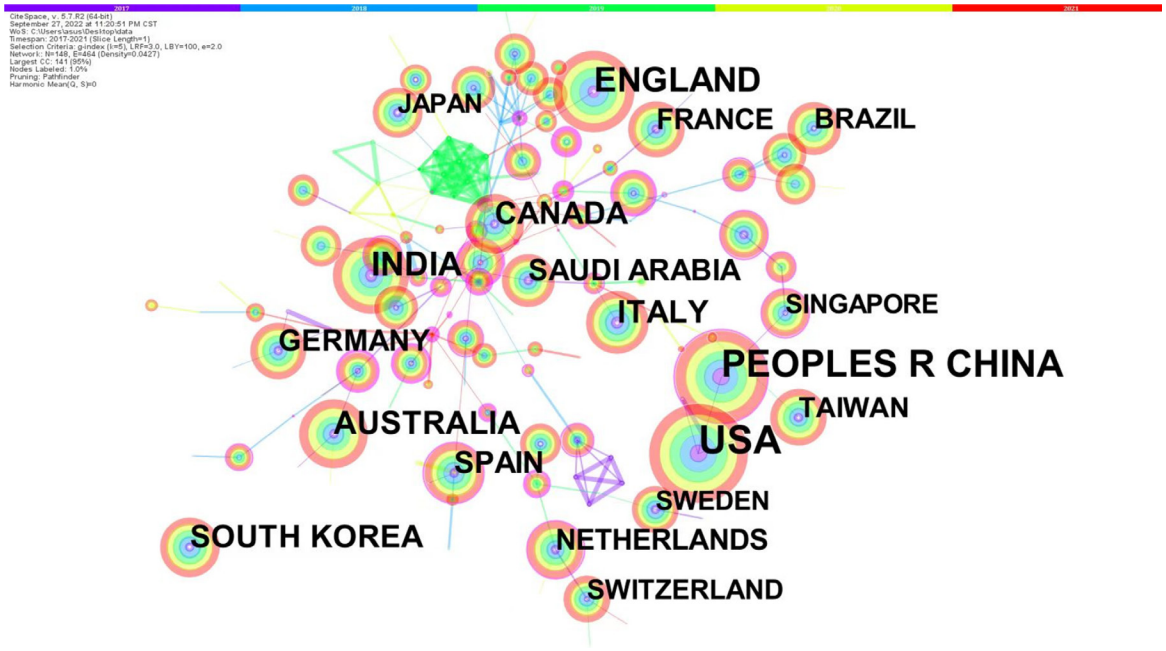

Figure 5 Active Countries (/regions) and Their Networks. Source: author.

to emerging trends and directions for the future.[2 4 5] These two aspects contain key information as evidence for policy making .

Intellectual base: major players and sources of innovation

The bibliometric evidence collection starts by analyzing emerging technologies and the global health field to show the centrality between each metric.[6 7] Major players and sources of innovation were identified by observing the bibliometric networks with the major indicators as follows:

- Pivotal node: high centrality (C≥0.1).
- Landmark node: large radius.
- Hub node: a large number of linking lines.

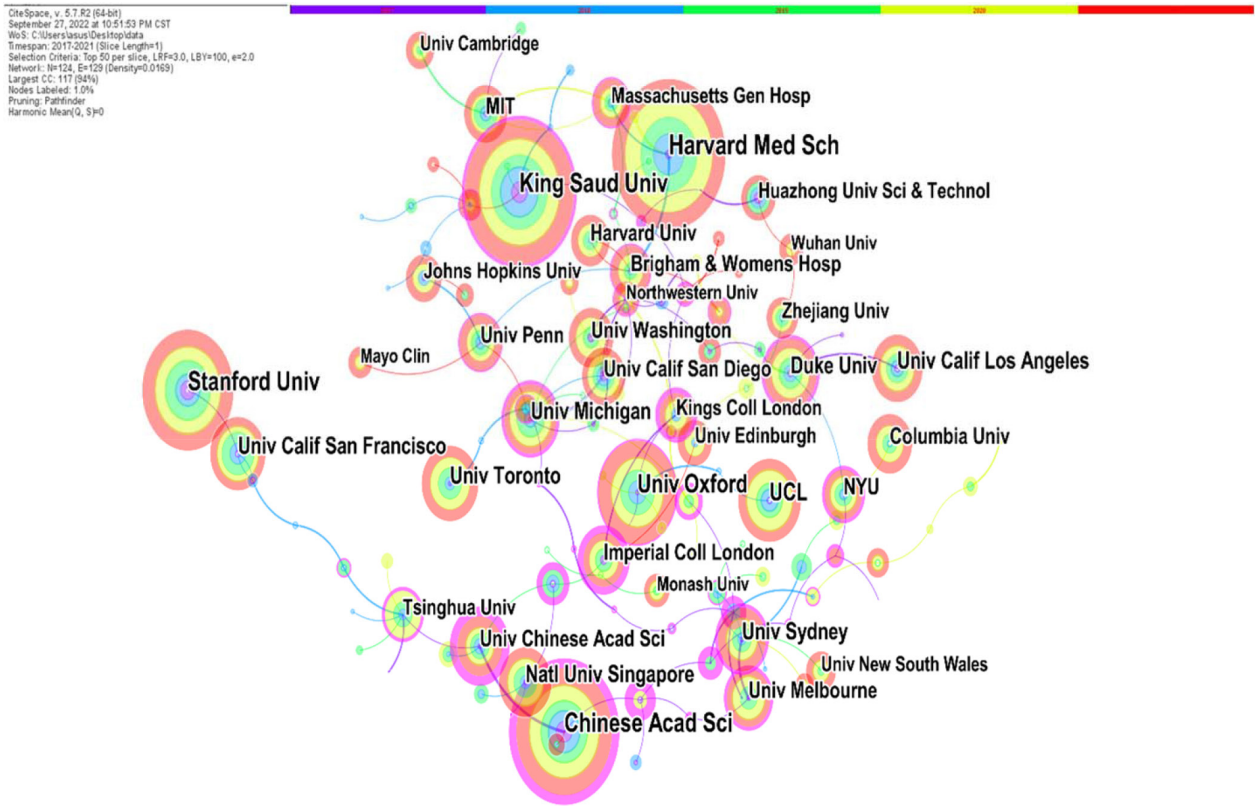

Figure 6 Active Institutes and Their Interactions. Source: author.

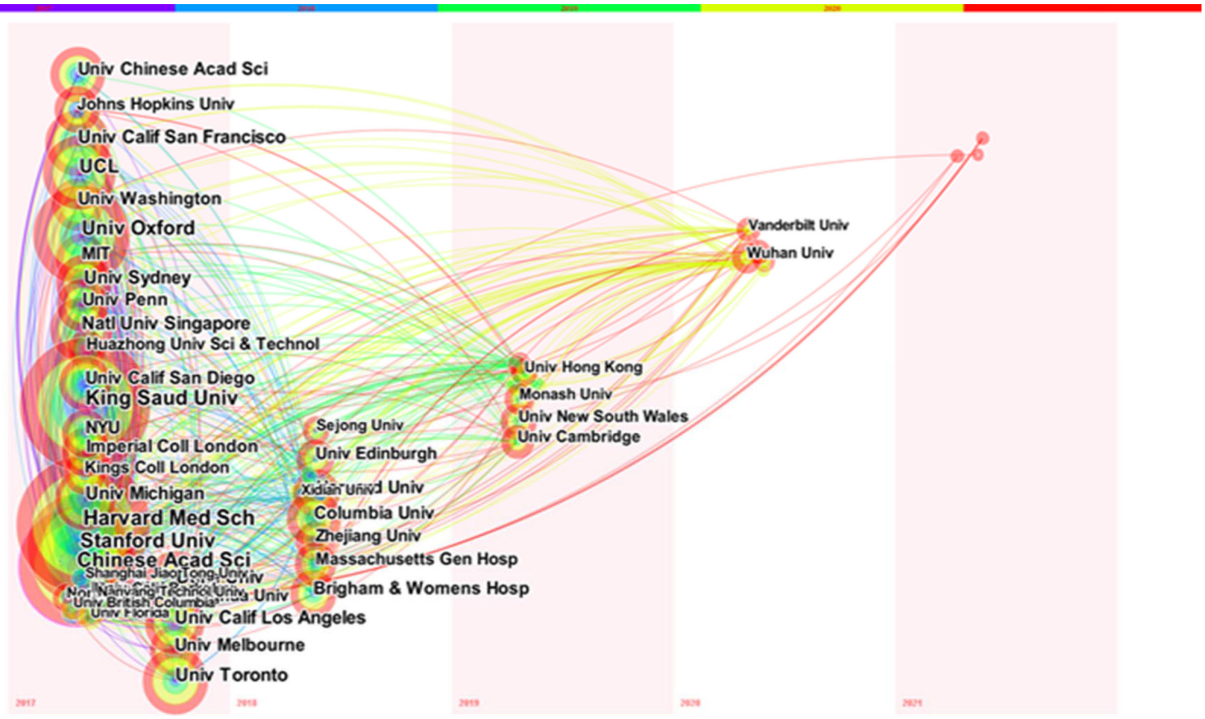

Figure 7 Active Institutes Time Zone View. Source: author.

- Structural hole node (if any): brokerage position in connection.

The colour of the rings of a node indicates the publication time. The colour of the linking lines marks the first interaction time.

In Citespace V.6.1.R3, we set 'node type' as 'countries' and 'institutes', 'cite reference', set selection criteria as 'top 50', and set 'pruning' as 'pathfinder' and 'pruning the merged network' and kept other options as default. We ran Citespace V.6.1.R3 to generate figures 5–7.

Active countries

The active countries in the emerging technologies and global health research field are listed in table 1, and

Table 1 Active countries

Country	Centrality	Amount
Sweden*	0.37	176
USA*	0.29	2463
UK*	0.27	1027
Canada*	0.21	514
Saudi*	0.17	363
Pakistan*	0.13	270
Finland*	0.12	108
Belgium*	0.12	150
Mexico*	0.12	150
India	0.08	147
Brazil	0.08	147
Italy	0.08	382
Turkey	0.08	156
Australia	0.07	612
Spain	0.07	432
Netherlands	0.06	293
Germany	0.06	358
France	0.06	220
Singapore	0.03	399
P.R.China	0.02	1860

(Pivotal points: C≥0.1).

Table 2 Active Institutes

Institutes	Centrality	Amount
University of Michigan*	0.27	121
Oxford University*	0.24	123
University of Colombia*	0.24	52
Chinese Academy of Sciences*	0.21	180
King Saud University*	0.14	168
Harvard University Medical School*	0.11	177
Duke University*	0.1	85
MIT*	0.1	74
New York University	0.07	65
Johns Hopkins University	0.07	95
Stanford University	0.06	150
University of Melbourne	0.06	74
Imperial College London	0.06	82
University of Cambridge	0.05	55
National University Singapore	0.04	87
Yale University	0.04	57
University of Toronto	0.03	100
Washington University	0.03	72
Vanderbilt University	0.03	49
Wuhan University	0.03	50

(Pivotal points: C≥0.1).

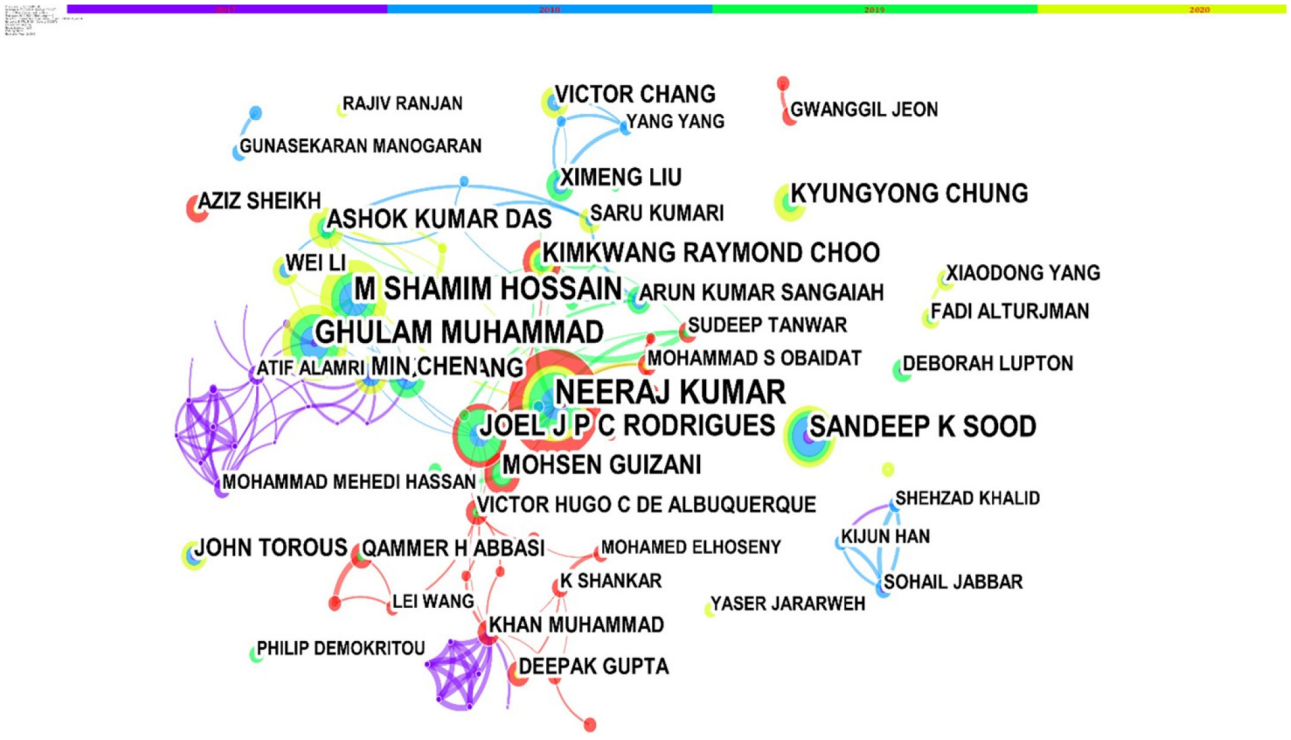

Figure 8 Active Researchers and Their Interactions. Source: author.

their interactions are visualised in figure 5. Despite a comparably small volume of publications (176), Sweden proportionally ranks first in terms of impact in the field and has the most linkages with others. With the largest volume of publications (2923), the USA stands out as among the landmark and hub players with the largest publication amount. The UK, Canada and Saudi Arabia are listed among the top five countries with the highest impact in the field.

With the second largest volume of publications (1860), China's impact/quantity ratio still remains comparatively lower than other countries. Five low/middle-income countries (Pakistan, Mexico, India, Brazil and Turkey) entered the top player list, surpassing some traditional developed countries' top players (such as France and Germany).

Countries and regions with high impact in the networks are highlighted by violet rings in figure 5. Countries marked with an asterisk (*) in table 1 are considered as players with the biggest impact in the field.

Active institutes

The active institutes in the emerging technologies and global health research field are listed in table 2, and their networks are visualised in figure 6.

University of Michigan, USA ranks first in impact. Among the top 10 most active and influential institutes, 7 are from the USA. The Chinese Academy of Sciences, the world's largest research organisation, has the largest number of publications (180) and is ranked fourth in centrality in the interaction. Among the list, one is a medical institute (Harvard Medical School) while the others are all comprehensive university/research institutes (Johns Hopkins University is traditionally in public health.)

Wuhan University is another institute in China that enters the list of institutes that have a high impact on interactions. A Time Zone View further reveals that the outbreak of the COVID-19 pandemic may have contributed to its increased impact in 2020 (figure 7).

The top 10 languages with the largest volume of literature are English, German, Spanish, French, Portuguese, Russian, Turkish, Italian, Chinese, Japanese and Russian. Japan did not enter the list of top active countries, and both Japan and Italy did not enter the list of top active institutes.

Institutes with high impact in the networks are highlighted by violet rings in figure 6.

Institutes marked with an asterisk (*) in table 2 are considered the most influential players .

Active researchers

The interaction among active individual researchers in emerging technologies and the global health research field is visualised in figure 8. Innovation is mainly reflected in the number of publications within their own focus areas. No researcher has claimed a pivotal position in the broad spectrum of this field yet.

As shown in figure 8, substantive networks between active researchers in different focus areas have not been formulated. Some scattered interaction has not gone beyond researchers' own focus areas, their own team or country boundaries.

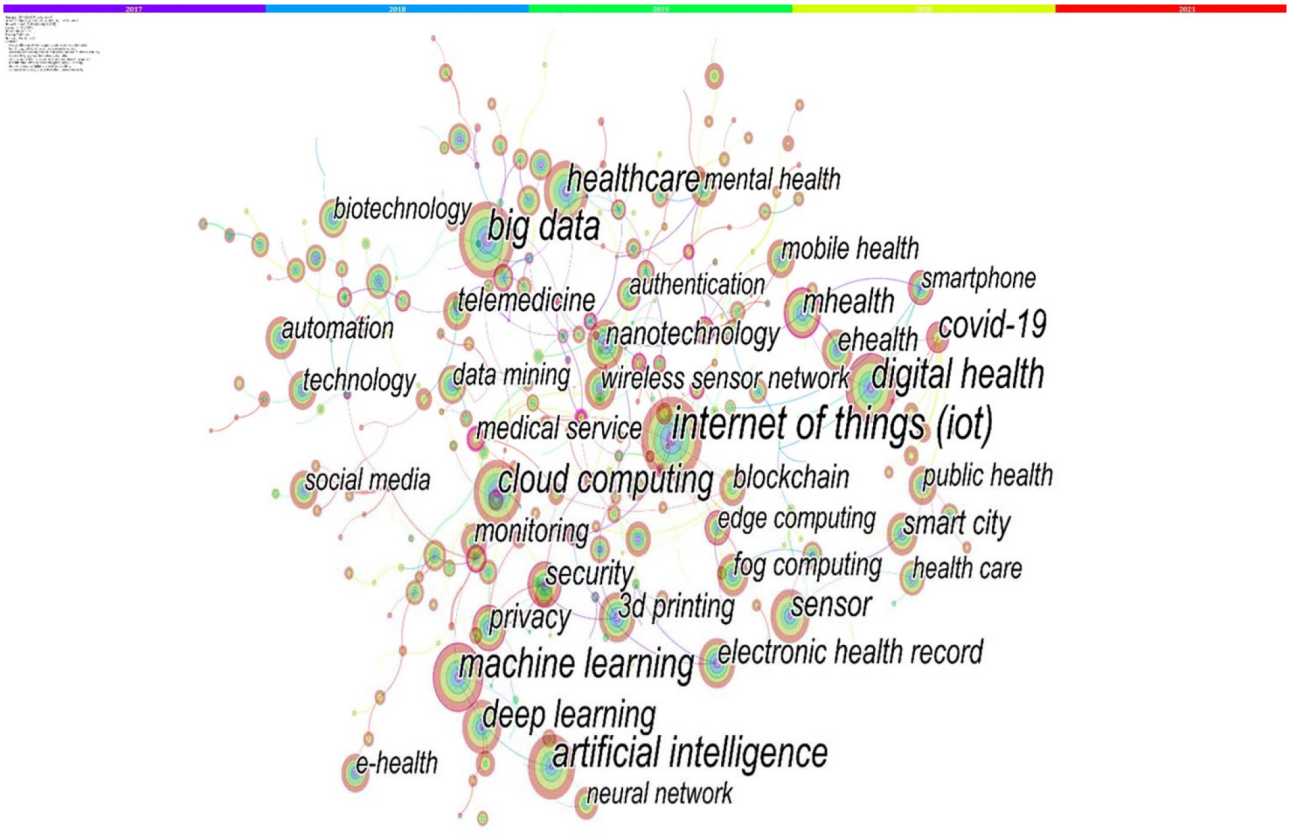

Figure 9 Keywords Co-occurrence. Source: author.

Figure 8 reveals an important fact that in the multidisciplinary field of emerging technologies and global health, interdisciplinary activities are lacking. The number of interdisciplinary individual players, who can effectively communicate with otherwise disconnected peers and address a broader work spectrum, is small .

Research front: hot thematic areas and emergent trends

In this section, the bibliometric evidence collection continues by analysing the emerging technologies and the global health field via a burst-detection algorithm.[26] Hot thematic spots and emergent trends are captured through the time zone and cluster views, by observing signal words with the major indicators as follows:

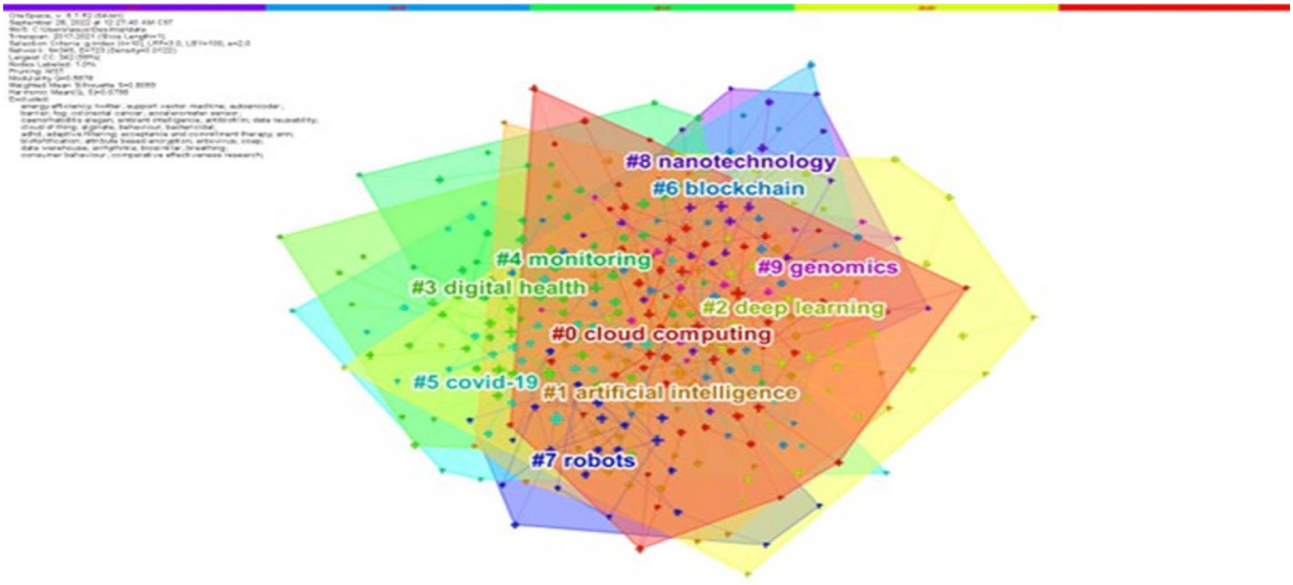

Figure 10 Clusters in Keywords Co-occurrence Networks. Source: author.

Table 3 Hot thematic areas

Keywords	Centrality	Frequency
big data*	0.41	1225
Internet of Things*	0.32	536
digital health*	0.27	697
could computing*	0.23	344
artificial intelligence*	0.21	269
monitoring*	0.18	497
machine learning*	0.15	267
neural network*	0.14	322
blockchain*	0.13	210
sensor*	0.12	625
electronic health record*	0.12	437
privacy*	0.12	181
robot	0.08	217
disease	0.04	461
diagnosis imaging	0.04	219
ecosystem	0.04	104
digital transformation	0.01	100
Health system	0.01	230
COVID-19	0.01	510

(Pivotal points: C≥0.1) Source: author.

- High frequency and high centrality signal words: keywords with the highest frequency or centrality (C≥0.1).
- Cluster of signal words: clusters formulated by a series of nodes of signal words.
- Burst terms: terms with an abrupt increase in frequency.

In Citespace V.6.1.R3, set 'node type' as 'keyword', selection criteria as 'top 50' and keep other options as default. We ran Citespace V.6.1.R3 and generated figure 8. Based on figure 8, we conducted EM clustering and generated figures 9 and 10.

Hot thematic areas

The hot thematic areas in the emerging technologies and global health research field, reflected by the high frequency and high centrality signal words in the keywords co-occurrence networks, are listed in table 3. The keywords co-occurrence networks are visualised in figure 9.

The size of the rings in figure 9, marks the frequency of keywords' co-occurrence, and the thickness of the rings reflects the keywords' centrality.

Big data analytics, artificial intelligence, cloud computing, blockchain and robots are at the centre of the hot thematic areas. Subjects that are based on these technologies, such as digital health, also become hotspots in research. COVID-19 stands as a hot theme in the network of technological interventions.

Major research and navigation directions

Based on the keyword's Co-occurrence Networks (figure 9), with cluster finding algorithms, the clusters of the keywords are obtained as in figure 10. It demonstrates the major research directions in emerging technologies and the global health field. There are 10 major research directions: cloud computing, artificial intelligence, digital health, monitoring, COVID-19, blockchain, robots and nanotechnology. A timeline of the evolution of these research directions is presented in figure 11.

Emergent trends

In Citespace V.6.1.R3, we set 'term type' as 'Burst Term', 'Node Types' as 'Cited Reference' and 'Terms',

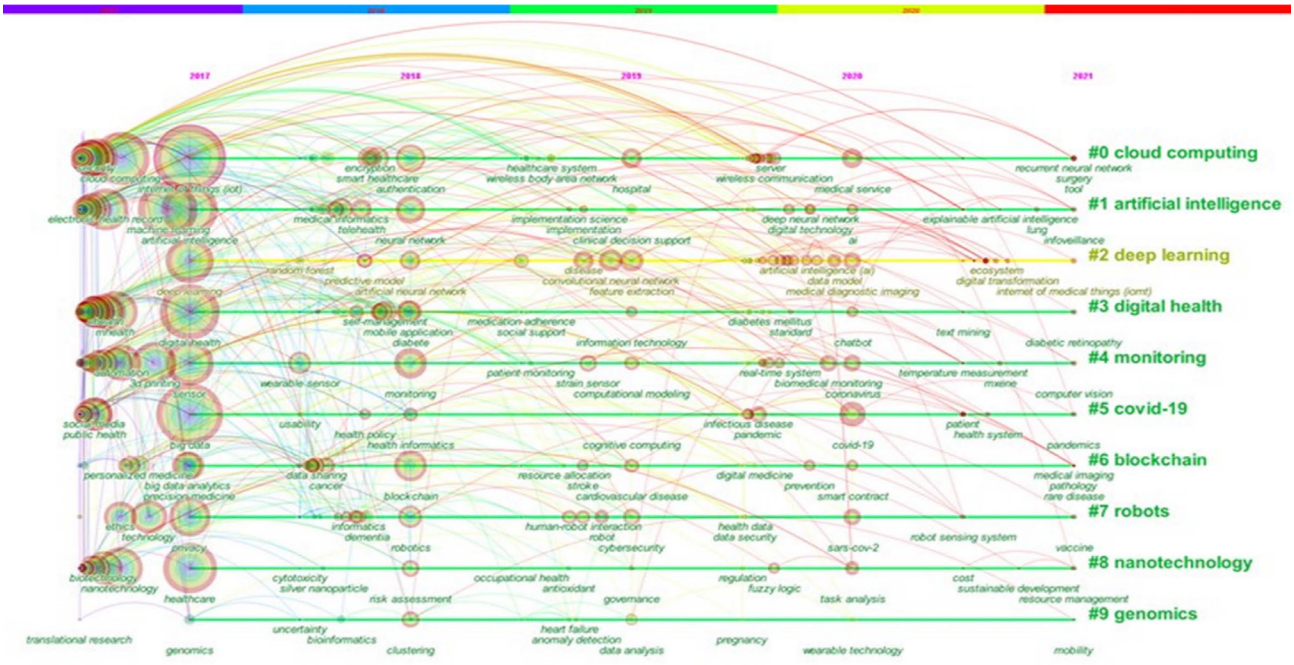

Figure 11 Evolution of Research Directions. Source: author.

Keywords	Strength	Begin	End	2017 - 2021
big data	39.33	2017	2018	
nanotechnology	10.87	2017	2018	
clinical decision support system	6.5	2017	2018	
genomics	5.81	2017	2018	
clinical trial	5.58	2017	2018	
social network	4.27	2017	2019	
personal health record	3.94	2017	2019	
e-health	3.72	2017	2019	
primary care	2.91	2017	2019	
personalized medicine	2.64	2017	2018	
automation	2.25	2017	2018	
electronic medical record	2.23	2017	2018	
ontology	1.81	2017	2018	
privacy-preserving	6.36	2018	2019	
smart health	5.57	2018	2019	
bioinformatics	5.57	2018	2019	
data protection	5.17	2018	2019	
internet-of-thing	4.29	2018	2019	
mobile application	4.12	2018	2019	
technology	3.8	2018	2019	
cloud	3.6	2018	2019	
health policy	2.9	2018	2019	
predictive analytics	2.4	2018	2019	
clinical decision support	4.34	2019	2021	
healthcare system	3.55	2019	2021	
resource allocation	2.56	2019	2021	
pandemic	2.1	2020	2021	
covid 19	2.0	2020	2021	

Figure 12 Top 30 Keywords with the Strongest Citation Bursts. Source: author.

'Selection Criteria' as 'Top 50 per slice', and kept other options as default. Run Citespace V.6.1.R3, and generate figures 12 and 13.

A list of signal words with the strongest citation burst is obtained in figure 12.

Burst terms are signal words that have an abrupt increase in frequency within a certain time span. They reflect the rise and fading of trends in emerging technologies and the global health research field.

The emergent trends in the field are positioned in time zones to demonstrate the evolving stages and processes in figure 13 .

CONCLUSION

Philosophy of bibliometric evidence for strategy making

This study collects bibliometric evidence from scientific research to support innovation management policy making. It attempts to establish the philosophic chain linking the Three World Theory by Karl Popper, and the Scientometrics Theory by Derek Price, to provide a tool for supporting evidence-based strategy making. (figure 14)[8 9]

In the physical world and the human mental world, which are defined by Popper as World 1 and World 2, emerging technologies come with perplexing phenomena and subjective thoughts. In order to reach objectiveness in strategy making, the evidence sought in science, World 3, can be used as an objective base for decisions. The Science, World 3, contains science research, as a first-order subject, and Science of Science (for example, bibliometric study) as a second-order subject, as modelled by Price.[8] Therefore, this bibliometric analysis serves as a linkage tool between the objective science world and the objective policy making practice .

Contributions

This study presents the state of emerging technology and global health and reveals the research front and trends in this field. It reveals major players, major sources of innovation, thematic focuses, hot research spots and the white space in this field.

By adopting a bibliometric analysis approach, this study gained insights into innovation quality through the interaction of key innovation elements, which differs from the method that measures innovation input and output, which are adopted by most existing innovation indexes, such as the Global Innovation Index.[10] Furthermore, it established a theoretical framework that connects the Science world and innovation management policy making through the tool in Science of Science, bibliometric analysis. Conventionally, the national innovation system theory, which stresses that the flows of technology and information among people, enterprises and institutions in a country are key to the innovative process, is adopted as a foundation to analyse innovation.[10–12] The new theoretical framework in this study observes innovation across national boundaries and can better depict a global view. It can better respond to real-world changes that the innovation of emerging technologies and healthcare takes place beyond the national innovation system and a planetary innovation ecosystem is formulating. (Planetary Innovation Ecosystem is a phenomenon observed in this study, meaning the activities of the key makers of innovation go beyond the boundaries of countries and interactions among the key makers of innovation are taking place globally). The flow of technology and information among people, enterprises and institutions globally is key to the innovation of emerging technologies for healthcare. There is no literature being established on this phenomenon. The concept is defined by drawing on the existing concept of a national innovation system and intends to capture the innovation phenomenon and trend in global health. This concept will further enrich related terms, for example, Global Health, which is traditionally defined as the health of the populations in the worldwide context, can have added component of innovation in healthcare in the worldwide context.)

Last but not least, this bibliometric analysis method captures variables that are outside of the innovation input and output. For example, the outbreak of COVID-19 increased certain research institutes'

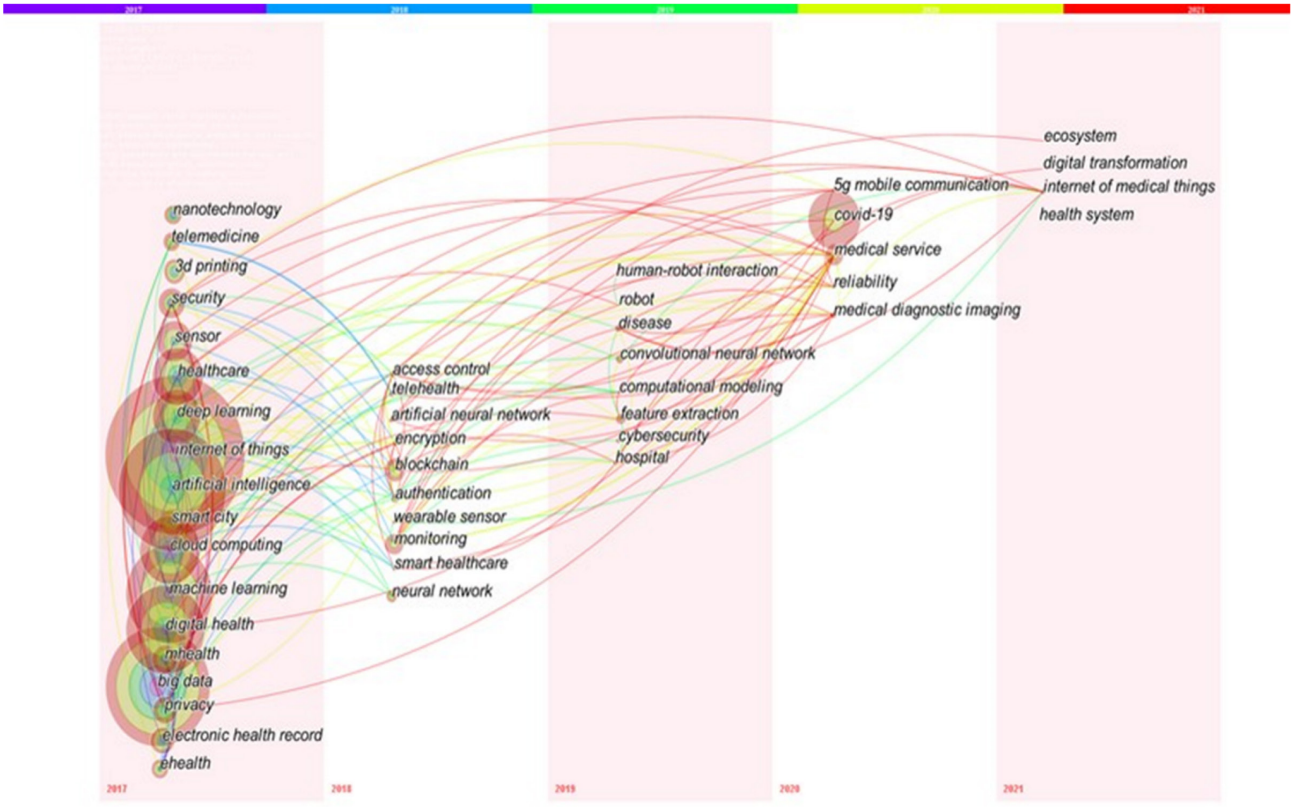

Figure 13 Emergent Trends Time Zone View. Source: author.

influence on others, such as Wuhan University. As innovation does not operate in a 'vacuum', this method can generate a more precise picture of innovation that accommodates variables outside of input and output.

Limitations

As research on emerging technologies in public health is fast-moving, some platforms have been established to accommodate preprint papers, to enable faster research result exchange (eg, the website of Engineering preprints (https://engrxiv.org/discover?q=health and MedRxiv https://www.medrxiv.org/content/about-medrxiv). In order to ensure a coherent selection standard, this study did not include literature in these preprint paper platforms. This led to an absence of some recent research information included in the analysis. Furthermore, this method only presents the state of innovation, without being able to explain its reason and formulation process. Other research methods are needed to further explore the reason behind these results and to better inform policy making. In future research, a combination of bibliometrics analysis with patent review will be explored to better depict the capacity of innovators in full scope.

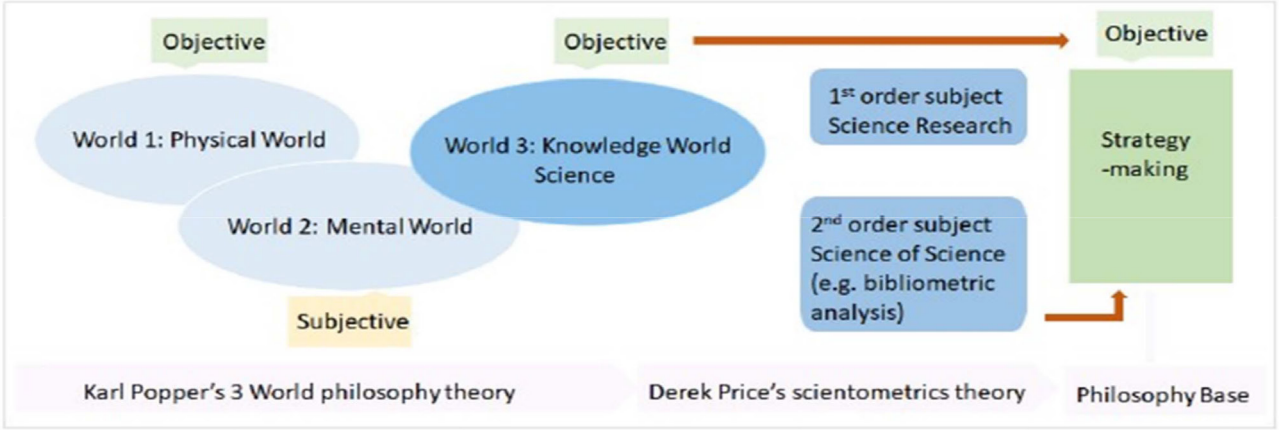

Figure 14 Philosophy Chain for Bibliometric Evidence-Based Strategy-making. Source: author.

Managerial implications

This study presents a perspective on quantifying innovation quality and impact through Research and Development (R&D) on the science ground and sharpens the signals from R&D to inform innovation management policy making.

The results from this analysis are impact-oriented and contextualised in dynamic interactions of innovation elements at the global level. It demonstrates the innovation fronts and directions simultaneously as R&D activities are carried out globally across economies, disciplines and industries. It can be used as a new source of dynamic quantitative evidence to inform policy making both at the national and international levels.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request.

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REFERENCES

1 Hauschildt J. Towards measuring the success of innovations technology management: the new international language. In: *IEEE*. 1991: 605–8.
2 Chen C. CiteSpace II: detecting and visualizing emerging trends and transient patterns in scientific literature. *J Am Soc Inf Sci* 2006;57:359–77. 10.1002/asi.20317 Available: http://doi.wiley.com/10.1002/asi.v57:3
3 Gunther RE. *Wharton on managing emerging technologies*. John Wiley & Sons, 2004: 3–5.
4 Ping Q, He J, Chen C. How many ways to use citespace? A study of user interactive events over 14 months. *JASIST* 2017;68:1234–56.
5 Chen C. Predictive effects of structural variation on citation counts. *J Am Soc Inf Sci* 2012;63:431–49.
6 Chen C, Song M, Glanzel W. Visualizing a field of research: a methodology of systematic scientometric reviews. *PLoS ONE* 2019;14:e0223994.
7 Leydesdorff L. Betweenness centrality as an indicator of the interdisciplinarity of scientific journals. *J Am Soc Inf Sci* 2007;58:1303–19.
8 Price DJDS. The scientific foundations of science policy. *Nature* 1965;206:233–8.
9 Martin JA, Popper KR. Objective knowledge: an evolutionary approach. *The Philosophical Review* 1975;84:103.
10 WIPO. Global innovation index. Available: www.wipo.int/global_innovation_index/en/ [Accessed 7 Sep 2022].
11 Godin B. National innovation system. *Sci Technol Human Values* 2009;34:476–501.
12 Lundvall BÅ. 54 national innovation systems: from list to freeman. In: *Elgar Companion to Neo-Schumpeterian economics*. 2007: 872.
13 MIT. MIT technology review. 2020-2021. Available: www.technologyreview.com/ [Accessed 7 Sep 2022].
14 World Health Organization. WHO website. Available: www.who.int [Accessed 7 Sep 2022].
15 Marr B. These 25 technology trends will define the next decade [Forbes]. 2020. Available: www.forbes.com/sites/bernardmarr/2020/04/20/these-25-technology-trends-will-define-the-next-decade/?sh=6ac5bad829e3