Identification of Emerging Technologies in the Metaverse and Prospective Research on the Development of Emerging Industries

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Abstract: This project will focus on the development frontier of the new round of scientific and technological revolution, and conduct in-depth research on the emerging technologies of the Metaverse and their profound impact on the development of emerging industries and technological changes in the Metaverse. Firstly, based on the theories and methods of scientometrics and patent metrology, this paper proposes the concepts and characteristics of emerging technologies in the Metaverse from the perspectives of emerging technology management and technology system evolution with the help of information visualization technology, establishes a visualization method for the identification of emerging technologies in the Metaverse, and explores the evolution mechanism of emerging technologies in the Metaverse. Then, combined with the actual situation of our province, systematic research will be carried out around the Metaverse-related scientific and technological fields such as blockchain, cloud computing, artificial intelligence, Internet of Things, extended reality, digital twins, etc., identify the emerging technologies of the Metaverse, construct the evolution path from its technical system to industrial development, and use the methods of scientific measurement and patent measurement, combined with expert consultation, etc., to improve and perfect the research conclusions. This project will draw on advanced experience at home and abroad, put forward the overall idea and development focus of the forward-looking layout of emerging industries in the field of the Metaverse, conduct prediction and analysis of emerging technologies in the Metaverse, and put forward countermeasures and suggestions, so as to provide support for the formulation of subsequent relevant policies. The research results of this project will help enrich and develop the theories and methods of emerging technologies related to the Metaverse, expand the theories, methods and applications of scientometrics, patent metrology, information visualization, etc., and provide decision-making support for the development of emerging industries related to the Metaverse.

Keywords: Metaverse, Emerging Technologies, Emerging Industries, Knowledge Metrology, Information Visualization

I. BACKGROUND

The Metaverse was first proposed by the famous American science fiction writer Danny Stephenson's science fiction novel "Snow Crash" in 1992[1]-[2], and in 2021, it became a hot word of the year that countries around the world paid attention to[3]-[5], referring to a virtual digital society that is interconnected with the real society through digital technology. The real society is the support and root of the cloud universe, and the Metaverse is the reflection or mirror image of the real society. With the development of blockchain, cloud computing, artificial intelligence, Internet of Things, extended reality, digital twins and other related digital technologies, human society has begun to enter the fourth stage of technological and industrial revolution, and the concept of Metaverse has further promoted the development and innovation of related industries. As an emerging power, China needs to give full play to its advantages as a major country, formulate scientific and reasonable strategies and goals for the development of emerging technologies and emerging industries, and promote the sustainable innovation and development of industries. Emerging technologies and emerging industries in the Metaverse have become an important symbol of the intelligent revolution, promoting sustainable, high-quality and innovative development to meet the requirements of the times, so it is of both theoretical and practical significance to discuss the emerging technologies and emerging industries of the Metaverse.

The emerging industry of the Metaverse is the deep integration of Metaverse technology and emerging industries, which not only represents the direction of scientific and technological innovation in the Metaverse, but also represents the direction of the development of the Metaverse industry. Metaverse technology is the driving

force to promote the structural upgrading of emerging industries in the Metaverse and lead social progress, and the identification, confirmation and selection of emerging technologies in the Metaverse are important decision-making bases for formulating macro policies and management for the development of emerging industries in the Metaverse. Based on this background, this project proposes the concept and characteristics of emerging technologies in the Metaverse, establishes a systematic visualization method for identifying emerging technologies in the Metaverse, and analyzes the path and mechanism of the evolution of emerging technologies in the Metaverse.

A total of 195 related data were retrieved on the search platform of CNKI database in China, using "Metaverse technology" as the "subject" search (search date 2022.5.11), including: academic journals 157, master's dissertations 3, conferences 1, newspapers 20, Chinese patents 5, academic journals 1, and featured journals 8. Except for the 5 unrelated papers with the same name of the Metaverse from 1974 to 2020, the first domestic research literature related to "Metaverse Technology" appeared in the CNIK database with 39 articles in 2021 and 134 articles in 2022. Among them, the main research institutions are: Tsinghua University 7, Chinese Renmin University 6, Fudan University, Beijing Normal University, Wuhan University, East China Normal University 5 each, Institute of Philosophy of the Chinese Academy of Social Sciences, Central South University, Xinhua News Agency, Peking University 3 each, Chinese Academy of Social Sciences 2 each. The main researchers are: Liu Yongmou (Chinese University of China)4, Lu Peng (Central South University)3, Lu Minfeng (Nanjing University of Technology), Chen Changfeng (Tsinghua University), Huang Xinrong (Southwestern University of Finance and Economics), Shenyang (Tsinghua University), Wang Defu (Wuhan University), Fang Lingzhi (Fudan University), Guo Quanzhong (Minzu University of China), DuanWeiwen (Institute of Philosophy, Chinese Academy of Social Sciences), Guo Yajun and Li Shuai (Zhengzhou Institute of Aeronautical Industry Management), Su Yu (Chinese People's Public Security University), Zhang Xiaheng and Li Xiang (Northwest University of Political Science and Law) and Xu Xin (East China Normal University) each have 2.

It can be seen from the search results of "Metaverse technology" in the CNKI database that the overall research on Metaverse technology in China has shown a significant upward trend, especially in the past two years. At the same time, it can also be seen that the research of domestic scholars on Metaverse technology mainly focuses on the macro level of Metaverse technology strategy [6]-[9], organizational innovation of Metaverse technology [10]-[13], empirical application of Metaverse technology [14]-[17], and the transformation potential of Metaverse technology into emerging industries [18]-[21]. However, there is almost no research on the identification and evolution of emerging technologies in the Metaverse at the micro level, especially from the perspective of knowledge econometrics. A total of 123 academic articles from 1995 to 2021 were retrieved from the Web of Science data platform with "Metaverse" as the "subject" (search date 2021.11.12), and the focus of the research content was similar to that in China [22].

Based on the theory of knowledge metrics and technology management, this project will apply information visualization technology to identify the emerging technologies of the Metaverse in the emerging industries of the Metaverse, and display the visual map, establish a methodology for identifying the emerging technologies of the emerging industries related to the Metaverse, study the formation and development path of the emerging technologies of the Metaverse, analyze the evolution path and management methods of the technical system by using the theory of scientometrics and patent measurement and information visualization technology, and then put forward the overall ideas and development priorities of the forward-looking layout of the emerging industries of the Metaverse in combination with the actual situation of Shandong Province, and make prediction and analysis of the emerging technologies of the Metaverse and put forward countermeasures and suggestions。

The research on this topic has rich theoretical and practical significance. On the one hand, from the theoretical significance of the research, the concept of emerging technologies in the Metaverse is proposed, the management theory of emerging technologies in the Metaverse is enriched and developed, the identification method of emerging technologies in the Metaverse is established, and a new perspective of technology management theory is opened, and the theory and research methods of knowledge metrics are enriched and expanded. On the other hand, from the practical significance of the research, it is necessary to promote the construction of an innovative basic platform for the development of emerging industries in the Metaverse, to serve the selection and management of emerging technologies in the emerging industries related to the Metaverse in Shandong, and to provide decision-making support for government departments to develop and manage emerging technologies in the Metaverse.

II. RESEARCH IDEAS AND RESEARCH OBJECTIVES

A. Research ideas

Based on the theoretical foundations of knowledge metrics and the evolution of technology systems, this project aims to explore the creation and evolution mechanism of Metaverse technology by applying information visualization technology and visualizing software systems. Combined with the statistical analysis of key nodes and emerging nodes in the literature and patent citation network and their related measurement indicators, this paper uses the structural hole theory to identify and confirm the emerging technologies of the Metaverse, and constructs an evolution path from the emerging technology system of the Metaverse to the development of emerging industries in the Metaverse according to the principle of knowledge flow. Taking the emerging industry of the Metaverse as an example, this paper conducts empirical research to identify emerging technologies in the core fields of emerging industries, explores the evolution mechanism of their technical systems, and improves and perfects the research methods and conclusions by combining expert consultation and other methods. Forward-looking layout, technology prediction and countermeasure suggestions are put forward for the emerging industries of the Metaverse.

B. Research objectives

(1) Propose the concept and characteristics of emerging technologies in the Metaverse;

(2) establish a visualization method for the identification of emerging technologies in the Metaverse;

(3) explore the evolution mechanism of the emerging technology system of the Metaverse in the development of emerging industries in the Metaverse;

(4) Put forward the forward-looking layout, technical prediction and countermeasure suggestions of the emerging industries of the Metaverse.

III. KEY PROBLEMS AND INNOVATIONS TO BE SOLVED

A. Key scientific questions to be solved

(1) Clarify the concept of emerging technologies in the Metaverse and establish a systematic identification method for emerging technologies in the Metaverse;

(2) explore the evolution path from the emerging technology system of the Metaverse to the emerging industries of the Metaverse;

(3) Put forward the identification, evolution and management countermeasures of emerging technologies in the emerging industries of the Metaverse in our province.

B. Innovation

(1) Establish and improve visualization methods for the identification of emerging technologies in the Metaverse

Propose the concept and characteristics of emerging technologies in the Metaverse. Based on scientometrics, patent metrology and information visualization technologies, establish and improve the visualization methods of the system for the creation and identification of emerging technologies in the Metaverse. It provides an intuitive visual research method to accurately grasp the creation and evolution of emerging technologies in the Metaverse and determine the priority development areas.

(2) Construct an evolution path from the emerging technology system of the Metaverse to the emerging industries of the Metaverse

Based on the visual identification and knowledge flow theory of emerging technologies in the Metaverse, the evolution path from the emerging technology system of the Metaverse to emerging industries is constructed. According to the close relationship between the evolution of the technology system and technological innovation, a knowledge-based platform is built for the creation of a technological innovation system for the development of emerging industries in the Metaverse.

(3) Put forward the forward-looking layout, technical prediction and countermeasure suggestions of the emerging industries of the Metaverse in Shandong Province

Taking the visual identification of Metaverse emerging technologies in the core field of Metaverse emerging industries in a province as an example, this paper puts forward the forward-looking layout, technology

prediction and countermeasures of Metaverse emerging industries on the basis of constructing the development and evolution path of Metaverse emerging technology system to Metaverse emerging industries.

IV. RESEARCH METHODS AND TECHNICAL ROUTES

A. Research methodology

(1) Combination of quantitative research and qualitative analysis

This project adopts a combination of quantitative research and qualitative analysis. The validity of the conclusions obtained is verified by comparing the results obtained from quantitative studies with those obtained from qualitative analysis. In addition, qualitative analysis of the visualization map allows for in-depth interpretation of quantitative research results. At the same time, knowledge measurement methods, including scientometrics and patent measurement methods, will be used. The technical means mainly use information visualization technology, and the application tools include CiteSpace visualization software, NetDraw network drawing software, SPSS statistical analysis software, etc.

✧ Scientometric methods

It is a research method that uses quantitative methods to deal with the inputs (e.g., scientific researchers, research funds), outputs (e.g., number of papers, number of cited) and processes (the formation of information dissemination and communication networks) of scientific activities, and to find out the laws of technological activities and development. Combined with information visualization technology, the results of scientific metrics are visually displayed.

✧ Patented measurement method

Transplant scientometrics to the analysis of information data on patents and other achievements. It is a research method that applies mathematical methods such as mathematical statistics and computing technology to quantitatively analyze technical activities and find out the laws of technological activities and development. Combined with information visualization technology, the patent measurement results are intuitively visualized.

✧ Information visualization technology

Using computer visualization information processing software, through the intuitive dynamic image information processing, the complex phenomena of emerging technologies in related technical fields are displayed, so as to obtain detailed emerging technology information analysis results, understand and predict the evolution dynamics of emerging technologies, and open up new unknown areas in complex technical fields.

(2) Expert opinion consultation

This project intends to solicit opinions and suggestions from experts in Metaverse-related technologies and industries through face-to-face consultation, questionnaire interviews, email communication, etc., and combine them with methods such as preliminary knowledge measurement research to strengthen the objectivity and scientificity of the research results.

(3) Empirical analysis methods

On the basis of in-depth research on the emerging technologies and industries of the Metaverse, combined with the emerging technologies of the Metaverse and the emerging industries of the Metaverse in a certain province, the mechanism of creation and evolution is analyzed, and the rationality and scientificity of the visual identification method are verified.

(4) Data source and processing

✧ Source Database:

The data used in this project are mainly literature, patents and other data used for scientometrics and patent econometric analysis, scientific literature and patents are derived from CNKI database and international standardized databases SCI and SSCI, etc., and patent data are derived from CNKI database and the world's authoritative patent database "Derwent Innovation Index".

✧ **Establishment of research databases:**

Once the data is downloaded, the data is normalized and a corresponding database is established for analysis:

——Scientific Literature Database of Emerging Technologies in the Metaverse;

——Patent database of emerging technologies in the Metaverse;

——Scientific Literature Database of Metaverse Emerging Industries;

——Patent database of emerging industries in the Metaverse;

——Expert research database.

(5) Experimental methods

In the research process of this project, a variety of international scientific measurement and information visualization technology means will be comprehensively used, and a variety of international advanced measurement software and information visualization software will be used to carry out repeated testing, comparison and analysis. Under the consultation and advice of relevant experts, data selection, map drawing, map interpretation, method selection and adjustment, and application analysis calibration are carried out.

B. Technical route

(1) The overall design of the project

Through literature retrieval, research and expert consultation at home and abroad, the overall research objectives, research content and overall research plan of the project are determined.

(2) Establish a database and determine research methods and techniques

This project will establish a scientific literature, patent database and expert survey database of emerging technologies and emerging industries in the Metaverse. The main analysis methods of knowledge measurement, knowledge graph and information visualization technology were preliminarily determined.

(3) Establish a systematic approach to the identification of emerging technologies in the Metaverse

This paper proposes and clarifies the concepts and characteristics of emerging technologies in the Metaverse, and identifies the creation and evolution of emerging technologies in the Metaverse based on knowledge measurement methods and information visualization technologies. Combined with expert research data, improve and improve the feasibility of the identification method, and establish a systematic identification method for emerging technologies in the Metaverse.

(4) Explore the evolution mechanism of the emerging technology system of the Metaverse

On the basis of the identification of emerging technologies in the Metaverse, the evolution mechanism of the emerging technology system in the Metaverse is studied according to the technology creation and development path, namely "scientific knowledge base-emerging technology-key technology-core technology-common technology" and "technology gene-technology unit-technology chain-technology group-technology network-complex technology system".

(5) Application analysis of the identification method of emerging technologies in the Metaverse

Through the analysis of the identification of emerging technologies in the Metaverse in the core field of the Metaverse emerging industry in a province and the evolution mechanism of the technical system, the forward-looking layout, technology prediction and countermeasures of the Metaverse emerging industry are proposed.

V. CONCLUSION

This study will elucidate the concepts and characteristics of emerging technologies in the Metaverse, establish a visualization method for the identification of emerging technologies in the Metaverse, and study the evolution mechanism of the emerging technology system in the development of emerging technologies in the Metaverse. This paper puts forward the forward-looking layout and countermeasures of the actual emerging industries of the Metaverse, and makes reasonable predictions on the development trend of the Metaverse technology, so as to provide reference for relevant research and decision-making.

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