Paradigm Shifts in Intelligence Studies and Trends in Data-Driven Intelligence Work: A Postprint

Authors: Liu Xiwen

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Abstract

[Purpose/Significance] This study reviews the connotation of the intelligence concept, the transformation of theoretical paradigms in intelligence science, and the connotation of intelligence work, thereby elucidating the inevitable trend of developing data-driven intelligence research. [Method/Process] Through literature review, this paper examines the evolution of the concepts of information and intelligence science and the objects of intelligence work from a historical perspective. Based on the interrelationship model of Data-Information-Intelligence-Knowledge-Wisdom (DIKIW), it illustrates the importance of data construction in intelligence work. The theoretical paradigms of intelligence science are categorized into four types, and the focus and development trends of intelligence work under each paradigm are elaborated. [Results/Conclusion] Under the basic understanding of the multi-paradigm nature of intelligence science and DIKIW, the strategic choice for future intelligence work should emphasize the development of data-based intelligence research, thereby establishing an intelligent-intelligence-centered decision support system to fully leverage the decision-making consultation function of intelligence research.

Full Text

Preamble

Publishing a special issue on “Frontiers of Library, Information and Archives Management” in the first issue each year has been a tradition of this journal. This year’s album features 19 articles, primarily contributed by experts from multiple online academic seminars organized or co-hosted by our journal, including “Knowledge Management and Knowledge Services,” “Formulation of University Library ‘14th Five-Year’ Plans and Innovative Development,” and “Library Marketing Promotion Strategies and Strategies,” as well as from the

"High-Quality Development Academic Forum on Library Discipline Construction and Talent Training in the New Era" hosted by Nanjing University. These contributions explore various frontier and hot topics such as discipline construction in library, information and archives management, knowledge management and services, library strategic planning, and library marketing promotion. We express our sincere gratitude to all experts for their dedicated contributions. We hope this first-issue album will continue to receive support from more experts and attract greater attention and readership.

Paradigm Transformation of Information Science and Development Trends of Data-Driven Intelligence Work

Liu Xiwen

National Science Library, Chinese Academy of Sciences, Beijing 100190
School of Economics and Management, University of Chinese Academy of Sciences, Beijing 100190

Abstract:
[**Purpose/Significance**] This paper examines the conceptual connotations of intelligence, paradigm transformations in information science theory, and the essence of intelligence work to elucidate the development trends of data-driven intelligence research.
[**Method/Process**] Through literature review, this study traces the conceptual evolution of information and intelligence and the transformation of intelligence work objects from a historical perspective. Based on the interrelationship model of Data-Information-Intelligence-Knowledge-Wisdom (DIKIW), it explains the importance of data construction in intelligence work. The theoretical paradigms of information science are classified into four categories, with key focuses and development trends of intelligence work under each paradigm elaborated.
[**Result/Conclusion**] Under the fundamental understanding of DIKIW and multiple paradigms of information science, future strategic choices for intelligence work should emphasize developing data-based intelligence research, establishing a decision support system with intelligent intelligence as its core, and fully leveraging the decision-making consultation function of intelligence research.

Keywords: information science paradigm; S&T intelligence work; data-driven; intelligence studies
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Introduction

Internationally, information science originated from documentation work or documentation studies and has evolved through documentation science, information technology, to information science as a discipline [1-2]. The birth and development of Chinese information science has also undergone a similar process, mirroring the progressive and integrated development trajectory of library services, S&T intelligence services, and information management technology and system construction. In the early period of the People's Republic of China, the intelligence enterprise modeled itself after the Soviet Union's S&T intelligence development model. In 1956, under the care of Premier Zhou Enlai, the Chinese Academy of Sciences established the Institute of Scientific Information of the Chinese Academy of Sciences and launched the *Library Work* journal, which continues to this day (now titled *Library and Information Service*). In 1958, the Chinese Academy of Sciences founded the University of Scientific Information of China through a work-study program combining teaching with productive labor, comprising three departments: S&T Intelligence, Compilation and Publishing, and Library Science [3], pioneering an integrated discipline development model of documentation and intelligence in China. That same year, the Institute of Scientific Information of the Chinese Academy of Sciences was renamed the Institute of Scientific and Technical Information of China (later merged into the State Science and Technology Commission), marking the beginning of a comprehensive effort to build China's professional and local S&T intelligence institution system, which has since experienced four stages: initial establishment, development, adjustment, and transformation [4]. The focus of intelligence work tasks has also undergone a historic shift from compilation and reporting, retrieval services, intelligence research, to intelligence decision-making.

Entering the 21st century, the competing ideologies of globalization and anti-globalization have intensified international competition, with countries worldwide enacting national security laws that place information security at the core of national security. In this environment emphasizing national information security, concepts of information exchange and sharing policies may experience some degree of reversal, and issues such as information acquisition, intelligence extraction, information exchange, transmission, and utilization may once again become widespread concerns. Consequently, information collection, storage, comprehensive analysis, knowledge (intelligence) mining, and think tank research will become the primary intelligence service models supporting decision-making. The main battlefield of intelligence work will no longer be limited to scientific and technological innovation and security but will extend to all aspects of society, economy, culture, politics, and daily life. Grasping the development trends of scientific and technological innovation, comprehensively analyzing social development trends, and assessing patterns of international economic and trade changes have become the main tasks of intelligence services, with the roles of "eyes and ears, vanguard, and advisor" becoming increasingly prominent [5-6].

In the era of datafication and intelligence, a social information environment char-

acterized by data intensity, information intensity, technology intensity, knowledge intensity, and intellectual intensity has emerged. Developing information services, intelligence services, and knowledge services has become an inevitable choice for the entire society. This presents unprecedented challenges to intelligence work and the development of information science. Currently, China's S&T intelligence work faces multiple options stemming from service demands, showing a trend toward socialized intelligence and pan-intelligence. There is urgent demand for public opinion analysis, disciplinary intelligence, strategic intelligence, competitive intelligence, think tank intelligence, and decision-making intelligence. The characteristics of intelligence research are becoming increasingly defined in terms of knowledge orientation, engineering, intelligence, and datafication. In this era of pan-intelligence, every directional choice and emphasis in intelligence work represents a development strategy and positioning that will significantly impact the future development of China's S&T intelligence work. Understanding the implications of these choices requires examining the definitions and connotations of information (intelligence), the evolution of intelligence work objects, and changes in information science research paradigms to deduce the development trends of the intelligence enterprise under different theoretical paradigms of information science.

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1. Understanding the Evolution of Intelligence Work Objects and Their Impact

1.1 Re-examining the Connotations of Information and Intelligence Concepts

The connotations and definitions of information and intelligence have long been focal points of academic attention and debate, lacking unified understanding. Norbert Wiener, founder of information theory, proposed the assertion that "information is information, not matter or energy," laying the theoretical foundation for the information age. Shannon proposed and established the mathematical theory of communication, establishing the basic architecture of communication systems. The international academic community has conducted comprehensive research on the connotation of information [7], advocating its division into three domains: social, natural, and technical. In the social domain, information plays increasingly important and obvious functions, manifesting as a relationship between humans and reality, and can be said to form the basis of social institutions and existence through continuous information flow between people and organizations. In the natural domain, it is claimed that all things in the world exist because of information, with some physicists tending to define the physical world as constituted by information itself, viewing information as the foundation of life. In the technical domain, information plays an important role in technological processes, can be used for decision-making, and serves as a technical process for organization, execution, and control [7].

Regarding the concepts and connotations of intelligence, Chinese academia also holds different cognitions, with numerous controversies concerning the scope of information science and the objects of intelligence work [8-9]. In traditional Chinese S&T intelligence work, both S&T information work and intelligence research work were inherently included, forming a clear correspondence with the Western contexts of *information* and *intelligence* [10]. Qian Xuesen was among the earliest Chinese scientists to systematically propose developing S&T intelligence work and establishing a national intelligence system. The intelligence he advocated possessed clear *intelligence* connotations. During his research on aerodynamics, rockets, and missiles with his mentor Theodore von Kármán, Qian Xuesen was exposed to Western S&T intelligence systems and the complete process of systematic collection, organization, and production of complex S&T intelligence, leading him to deeply understand the importance of establishing intelligence thinking and systems [11]. In the national S&T intelligence system advocated by Qian Xuesen, he first defined what intelligence is, then clearly defined the connotation of intelligence work: "Intelligence is the knowledge needed to solve a specific problem, containing two concepts: first, it is knowledge, not speculation or random guessing; second, it is for specific requirements, that is, for specific problems [12]." Qian Xuesen proposed that intelligence work includes four aspects: first, collecting, organizing, and providing timely and relevant intelligence; second, promoting and introducing intelligence services to users; third, establishing retrieval systems for intelligence materials; and fourth, transforming data and knowledge into useful intelligence. Qian Xuesen's intelligence thought clarified the intelligence workflow and system, proposing the basic framework of intelligence collection-storage-retrieval-service-analysis-research-transmission-service [13]. Therefore, it can be considered that information science based on information management is a generalization of intelligence science based on *intelligence*, and the current framework of information science naturally contains the conceptual connotations of both *information* and *intelligence*.

1.2 On the Interrelationships Among Data-Information-Intelligence-Knowledge-Wisdom

Currently, data, information, intelligence, knowledge, and wisdom are all concepts with complex and non-unified connotations that intertwine to form the overall characteristics of information science and intelligence work in the digital era. Various relevant social organizations and institutions, such as information centers, consulting agencies, libraries, and documentation centers, must first address these interrelationships when formulating development strategies to grasp their key directions and tasks. Although these fundamental concepts currently lack clear and precise definitions, from the perspective of information science, data can be understood as a representation and record of objects and targets—a collection of symbols and the result of observing targets. Information is the meaningful expression of data, manifested as the structure of data or structured data. Knowledge is the result of cognition, representing the expression of *Know-How* content, and is structured information after formalization and

transformation—the structural form of integrated and synthesized information [7,14]. Intelligence (*intelligence*) is understood as the flow of knowledge, aiming to improve the efficiency of information exchange [15-16]. Wisdom is manifested as the value-added appreciation of information understanding and value [15-16].

In 1988, R.L. Ackoff proposed an evolutionary and transformation model from data to intelligence [17], defining the interrelationships among wisdom, data, knowledge, information, intelligence, and knowledge systems and information systems. In 2006, S. Ahsan and A. Shah constructed a DIKW knowledge management model based on data-information-knowledge-wisdom, demonstrating how data transforms into knowledge and wisdom [14]. A. Liew [18] modified the DIKW model, comprehensively 梳理 ed the relationships among various elements, introduced the intelligence element, and constructed the DIKIW model, outlining the interrelationships among these elements. The DIKIW model is a universal model applicable to domains such as information science, knowledge management, information decision-making, and information consulting, completely presenting the transformation relationships among data, information, knowledge, intelligence, and wisdom, as well as the embedded relationships among information systems, knowledge management systems, decision support systems, and data management systems. "Wisdom" sits at the top of the DIKIW and DIKW models, forming correct understanding and judgment through intelligence integration to support appropriate actions for achieving established strategic goals.

1.3 Positioning and Choices of Intelligence Work Connotations

Information (intelligence) is a fundamental concept of information science. Understanding and distinguishing its conceptual connotations also determines the value orientation and strategic direction of intelligence service institutions. Throughout the evolution of information science and intelligence work, the objects of intelligence work have continuously evolved and transformed with changing times. Information science, born from documentation science, focused in the early 20th century on abstract compilation, literature retrieval tools, literature reporting, subject classification, and scientific journal editing. In the mid-20th century, it emphasized index tool compilation, information storage and retrieval systems, intelligence research and service systems, and S&T knowledge dissemination. From the 1960s to 1980s, information retrieval systems, online retrieval systems, and academic information services became key research areas, with the extensive application of computers in documentation and information service industries forming the core of information science research and service work. In the late 20th century, the arrival of the information society became reality, with digitalization, informatization, and networking becoming new development trends. Information became a resource supporting development, and intelligence became the basis for scientific decision-making, with information and information systems becoming ubiquitous. This posed significant challenges to information science and intelligence work.

Simultaneously, understanding the connotation of intelligence is the origin for understanding intelligence work and information science—the logical starting point for constructing intelligence workflows, designing intelligence systems, and planning key content and directions, as well as for mapping the direction and strategy of intelligence work. Reviewing the century-long development of information science, research objects have gradually expanded in terms of information carrier forms and continuously extended toward content, including academic papers, journals, subject classification systems, retrieval tools and methods, information storage and retrieval systems, information resource systems, information analysis and decision-making, scientometrics and informetrics, and knowledge mining. Intelligence work objects have also gradually covered intelligence, systems, services, users, and industry applications, including academic literature systems, documentation management systems, information storage and retrieval systems, intelligence service enterprises, intelligence research systems, competitive intelligence service systems, and decision-making intelligence service systems, promoting the application of intelligence work across all industries as a necessary means and method for gaining competitive advantage.

If the connotation of intelligence is chosen, it correspondingly determines the direction of intelligence work. For example, taking document literature as the management unit determines the basic attribute of library work—engaging in documentation management and services. In the digital era, this extends the objects of library work further to digital objects, developing digital library construction and digital scholarship services. Intelligence work based on the *information* concept determines its basic attribute as engaging in information management and services, transformation, and transmission. Intelligence institutions, based on information management, extend to develop information analysis and knowledge mining services, with information encompassing not just literature information but also market information and social information. Documentation intelligence work based on the *intelligence* concept determines its work attribute as information transformation work, ensuring the utility value of intelligence through the intelligence workflow—the cycle of intelligence—and primarily providing targeted comprehensive and in-depth analysis of thematic information to form intelligence for decision-making needs, support scientific decision-making, improve decision-making efficiency, and support effective competitive advantage.

From the perspective of grand intelligence in the digital, data-driven, and intelligent era, the connotation of the "intelligence" concept includes data, information, knowledge, intelligence, and wisdom. Under these conceptual frameworks, objective information spaces and knowledge spaces can be formed. Intelligence work based on the comprehensive intelligence concept has radiated and extended into all sectors of society, finding deep application in military affairs, national defense, social development, national security, S&T development, economic construction, enterprise management, and government administration [19-20]. Future development of information science and intelligence work needs to seek breakthroughs in the objective information space or knowledge space pre-

sented by British philosopher Popper [21], which encompasses both the objective and subjective worlds—that is, establishing scientific intelligence workflows in the objective knowledge world to achieve integrated connectivity among data-information-knowledge-intelligence-wisdom. Ultimately, with the service goal of obtaining wisdom and decision-making support, integrating relevant elements such as data, information, knowledge, and intelligence, and utilizing technical means such as big data, artificial intelligence, intelligent decision-making, and intelligent intelligence, high-level intelligence services can be completed.

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2. Paradigm Transformation in Information Science Theory and Its Impact on Information Science and Intelligence Work

According to Thomas Kuhn's exposition on the connotation of "paradigm" in *The Structure of Scientific Revolutions* [22], we can understand paradigm as the collection of common beliefs, common values, and commonly recognized methodologies within a scientific community—the theoretical foundation and practical norms commonly followed in conducting research in a particular field, representing the worldview and research behavior patterns adhered to by the scientific community. In the field of information science, numerous experts have discussed theoretical paradigm issues in depth, proposing relevant paradigms for information science research [23-24], such as the institutional paradigm, information movement paradigm, cognitive view paradigm, hermeneutics paradigm, and genetic paradigm. They have also proposed soft science paradigms based on *intelligence*, library and information science paradigms based on *information*, and management science paradigms based on information resource management and knowledge management [25-26]. Simultaneously, from the perspective of the interdisciplinary characteristics of information science, they have proposed documentation paradigms, computational paradigms, and economics paradigms, and constructed theoretical systems for information science based on the basic connotations of intelligence concepts and theoretical paradigms. Wang Lin of Tianjin Normal University [27-28] and Yang Jianlin of Nanjing University [29] respectively wrote systematic reviews of information science theoretical paradigms, pointing out that discussions on research paradigms in information science theory suffer from oversimplification, simplistic naming, simple substitution, and lack of integration and correlation in connotations, leading to uncertain directions in theoretical research and weakening the guiding role of information science theory on intelligence work.

Thomas Kuhn defined paradigm as a set of exemplars commonly accepted within a specific academic community, including basic theories, basic viewpoints or hypotheses, basic principles, experimental means, research methods, and other aspects [22], providing theoretical models and problem frameworks for the community to gradually establish a common scientific tradition and enabling schol-

ars to expand research questions within specified categories. In 2009, Microsoft supported research on the fourth paradigm of scientific research activities [30], dividing scientific research activities from a methodological perspective into four paradigms: Experimental Science, Theoretical Science, Computational Science, and Data-intensive Science. The fourth paradigm based on data-intensive scientific research activities represents the mainstream model for future scientific research. Therefore, disciplinary paradigms represent a collection of community or disciplinary norms, including researchers, theories, hypotheses, methods, tools, and more.

Following the distinction methods of scientific paradigms by Thomas Kuhn and Microsoft's research team, the theoretical paradigms of information science can be divided into information theory and information system paradigm, academic information communication paradigm, decision intelligence service paradigm, and social information service paradigm. Information science based on information theory views information management and intelligence services as typical information systems (MIS), with the main function being information transmission and service. Academic information services based on the information management paradigm aim to promote academic communication and scientific exchange as the goals of information science and intelligence work, providing effective management and services for academic information and literature. Decision intelligence service paradigms in information science take management and decision-making consultation as core tasks, primarily meeting intelligence service needs for decision-making, establishing decision intelligence service models, and exploring mechanisms and methods for decision intelligence services. Social information service paradigms in information science take commercial intelligence services, enterprise competitive intelligence services, and social group intelligence services as development directions, with competitive intelligence at the core, widely absorbing theories and methods from mass information dissemination, social information dissemination, network information dissemination, and industrial intelligence services to establish relevant intelligence service systems, mechanisms, and methods, even introducing theoretical models of intelligence space into production and manufacturing service fields to develop social intelligence service models for smart manufacturing [31-32].

2.1 Development Trends of Information Science and Intelligence Work Based on Information Theory Paradigm

In 1948, Shannon proposed the concept of "information" in *A Mathematical Theory of Communication* and *Communication in the Presence of Noise*, establishing a general model of communication systems based on information transmission theory, viewing communication as the process of transmitting information from senders to receivers. Starting from the basis of information transmission, information science regards intelligence work and intelligence systems as information management systems (MIS) to meet needs for information collection, storage, query, and retrieval services. Under this theoretical guid-

ance, information science has focused on developing management information systems and computer-dominated information service systems, using structured information to support information processing and management system operation and management, semi-structured information to establish information management systems supporting tactical management, and unstructured information to establish decision support systems supporting strategic management. Modern information system development is no longer limited to understanding information transmission as a physical process but has formed an information ecology of data, software, and users to meet functions such as information integration, analysis, evaluation, and decision support, ultimately forming a knowledge management-centered approach that promotes knowledge sharing, multi-system integration and collaboration, and achieves full-process management of institutional informatization. Under the pan-information theory paradigm, information science and intelligence work take knowledge management systems as the main direction, focusing on developing standardized knowledge base construction, developing methods and technologies for integrating multi-source information fusion, establishing knowledge management frameworks and systems, developing knowledge representation technologies, and providing comprehensive knowledge services.

2.2 Development Trends Based on Academic Information Service Paradigm

Academic information service-based information science represents the first academic paradigm framework to emerge in the intelligence work field. British information scientist B.C. Brookes pioneered and constructed the foundational theoretical framework for information science [33-36], first unifying and standardizing the basic theories, methods, and quantitative models of information science, as well as knowledge equations. Soviet information scientist Mikhailov supported establishing an "information communication theory" based on "scientific communication and intelligence exchange." Defining intelligence as changes in knowledge structure and scientific communication, information science was standardized as a discipline studying the laws of scientific knowledge communication, with intelligence work defined as academic information services. Against the backdrop of deep computer application, theories, technologies, and methods based on information management systems were developed and formed. Under this paradigm, computerized information management and services became the focus of information science and intelligence work, forming unique information science connotations centered on information retrieval and services.

Information retrieval and information services based on management information systems (MIS) have long been key directions in information science theory. Driven by intelligent technology and big data management technology, research directions such as intelligent question-answering systems, intelligent retrieval technology, and intelligent information service ecosystems have emerged. Intelligent retrieval technology development based on intelligent algorithms and se-

mantic technologies has further improved information and service management efficiency. Intelligent question-answering systems combine database management technology with intelligent technology to form information service models targeting specific needs, further integrating data, information systems, and service users to enable collaboration among databases, retrieval systems, knowledge systems, and user cognition, jointly constituting an intelligent information service ecosystem.

2.3 Development Trends Based on Decision Intelligence Service Paradigm

The theoretical thinking of decision intelligence service paradigms originated from the competitive and confrontational demands of national competition, commercial competition, and military activities, treating intelligence as important support for decision-making and as a crucial basis for national defense and security strategy formulation. M.C. Yovits [37] believed that "intelligence is valuable data and knowledge for decision-making," subsequently constructing a generalized information system model to support decision intelligence services, focusing on changes in decision states before and after intelligence acquisition to measure intelligence quantity, intelligence efficiency, and intelligence value. The connotation of intelligence in modern information science also strongly emphasizes the pertinence, confrontational nature, and decision support of intelligence, reflecting its value and role in decision-making. Intelligence work under the decision intelligence service paradigm takes providing systematic and in-depth research reports and consulting suggestions for strategic decision-making as its mission, integrating academic research perspectives and operational recommendations from across society to provide decision-making consulting services in forms such as information briefings, special reports, and consulting reports.

Intelligence research work takes decision-making consultation as its ultimate goal, forming think tank consulting reports through information aggregation, organization and analysis, in-depth observation, viewpoint collection, and solution development to provide references for leadership decision-making. In the digital, informatized, intelligent, and big data era, information analysis and data-driven decision support have become routine, with intelligence work based on information aggregation and data analysis becoming important support for decision-making services. Research reports are organized around key issues in strategic decision-making. Libraries, intelligence institutions, publishing database providers, and consulting agencies are vigorously constructing S&T information databases, literature databases, research databases, and patent literature databases to conduct scientometric analysis, S&T layout analysis, disciplinary evolution analysis, and development trend analysis, providing think tank consulting services. Disciplinary trends, hotspots, strategies, and scientific ideas have all become essential content of S&T intelligence research, decoding national S&T innovation strategies, national innovation systems and policies, and industrial technology trends and policies.

2.4 Development Trends Based on Social Information Service Paradigm

The business and social information service paradigm represents an important domain of information science and intelligence work, encompassing business intelligence, enterprise competitive intelligence, social intelligence, and public opinion dissemination. Applying concepts and methods of S&T intelligence work, national competitive intelligence, and network communication to enterprise management, competitive intelligence theories, technology competitive intelligence theories, and business intelligence theories have been established under the guidance of Porter's competitive advantage theory, providing competitive intelligence services for enterprise strategic consulting and decision-making. With the rapid development of digitalization, networking, and social informatization, applying network communication theory, communication theory, and interpersonal communication theory to information management has brought great convenience to the social dissemination of academic information, becoming a core element of innovative development in information science. When academic innovation becomes a driving factor for development, social intelligence and collective intelligence become the core driving forces for promoting innovation across society. Under the social information service paradigm, information science provides service solutions for business decision-making, enterprise competition, and consulting services.

The Internet of Things enables objects and between objects and people to transmit data through networks, progressively achieving "comprehensive perception, reliable transmission, and intelligent processing" and accumulating process and control management data. Simultaneously, the perception and intelligent processing processes of the Internet of Things generate massive amounts of data, providing intelligent services through data analysis. The Internet of Things can support full-process automation and intelligent control of production and management processes [39]. By integrating production processes, market information, and consumer information, the Internet of Things forms a business intelligence ecosystem that can effectively support business and production decision-making. Information science can play an advantageous role in this process, guiding comprehensive information analysis and intelligence extraction. Furthermore, the superposition of the Internet of Things, the World Wide Web, and mobile information networks integrates academic information, research data, business information, social information, and production process information, achieving integration of information, data, and wisdom. Under the influence of artificial intelligence technology, social intelligence and social intelligence have emerged.

3. Strategic Choices for S&T Intelligence Work Under Multiple Information Science Paradigms

After nearly a century of development, information science has formed a multi-paradigm, multi-modal interdisciplinary field. Currently, it is difficult to construct a standardized disciplinary theory to unify various understandings, and research on integrating multiple information science paradigms is scarce and not in-depth [29]. Library and information science is a practice-driven interdisciplinary field, where serious disconnects between theory and practice are a common phenomenon [40]. Apart from documentation and intelligence practitioners not frequently reading library and information science (LIS) research literature, academic theoretical research being detached from practical work needs should also be an important reason. The theoretical paradigms, cognitive models, and research models in library and information science have not yet established clear boundaries, similarly severely hindering the guiding role of LIS theory on practical work [41]. Through in-depth research by experts and scholars in information science and related disciplines, a cognitive model based on "facts-data-information-knowledge-intelligence-wisdom" has been constructed [42]. The foundation of intelligence work should be established on this value chain, extending from information management to data management and knowledge management to form a complete "data-information-intelligence" value-added chain, constructing the disciplinary relationships and ecology of library and information science, rather than expanding the connotation of information to include data or expanding the connotation of intelligence to include knowledge. The generation and use of disciplinary knowledge and research data fall within the work scope of disciplinary domain experts, while intelligence workers can leverage their advantages in information organization and exchange to improve academic communication efficiency—the original mission of developing library and information science.

3.1 Taking Data as the Starting Point of Intelligence Work, Emphasizing Data-Based Intelligence Analysis and Services

The core and goal of intelligence work is to assist and support scientific decision-making. Correct decisions depend on sufficient information and accurate judgment. In today's digital and networked social context, managers and decision-makers do not lack information or data but rather quantitative decision-making models and methods. The way intelligence research supports scientific decision-making is through quantitative and modeling methods to deeply analyze decision-making uncertainties, accurately estimate decision risks, and comprehensively excavate information value (intelligence) [43].

Generally, the starting point of intelligence service work is believed to begin with information collection. In the technology competitive intelligence service process, the starting point of intelligence research work is intelligence planning, which formulates information collection strategies based on intelligence work objectives to begin the intelligence cycle of intelligence planning-information

collection-information analysis-results delivery [44]. Intelligence service work aimed at decision-making information support needs to build a sufficient and necessary decision-making information environment and data environment for decision-making information support services, providing a sufficient and necessary information set and data set for intelligence analysis and research to support diverse information analysis and research relying on professional analysis models. Therefore, organizing effective intelligence research work, besides collecting rich relevant information, also requires attention to key data supporting information analysis conclusions, particularly the need to datafy and structure widely collected information to form a data-based intelligence workflow.

In intelligence work, data supporting intelligence analysis should be taken as the starting point of the intelligence cycle to develop data-based intelligence (*data-based intelligence*), establishing comprehensive data management facilities. Intelligence work should establish data thinking, form data intelligence analysis processes, establish specialized data intelligence analysis models, and provide data-based intelligence services and evidence-based strategic intelligence research services. Taking data construction as the starting point, the value chain of intelligence research services should be reconstructed to establish a data-information-intelligence-decision-evaluation intelligence value chain, extending information management to both ends—downward to data management, data exchange, and data services, and upward to form service value chains for intelligence management, think tank research, and decision-making effectiveness evaluation.

3.2 Making Full Use of Research Data in Professional Fields to Conduct Strategic Intelligence Research in Professional/Disciplinary Areas

The reason for decision-making risks in S&T policy lies in the lack of understanding of operational laws and the lack of cognition regarding the diversification of decision-influencing elements and their interaction relationships and complexity. Intelligence analysis supports the process of eliminating decision-making risks, manifesting in the intelligence value chain in the intelligence service process. In the S&T intelligence service system, macro decision-making intelligence services have basically formed fixed models and service paradigms built upon the complexity of decision-making problems and cross-domain decision-making requirements. Disciplinary information services and disciplinary intelligence research remain in an exploratory stage, having not yet formed a collaborative relationship between intelligence services and disciplinary domain decision-making. In the current information era where data is king, big data supporting macro decision-making has become a basic consensus among managers and leaders, and the value of big data analysis for policy research and scientific decision-making has become evident. In S&T innovation activities, especially in research work, small data focusing on disciplinary fields and directions has more explicit research significance and can support academic innovation activities based on

data analysis. In the library and intelligence service field, small data can clearly analyze user needs, grasp user characteristics, and reveal interrelationships and patterns among elements [45].

Meanwhile, S&T policy is an intervention in the S&T innovation system [46], having moved from general macro policy formulation to disciplinary domain policy research, primarily based on small datasets in professional fields, focusing on professional policies around S&T fields and industrial directions, such as management methods and measures formulated by various countries to promote the development of the artificial intelligence industry, and industrial policies formulated to advance the stem cell industry. Professional field strategic intelligence research is the main service method supporting the construction of S&T think tanks. Strategic intelligence and decision-making support research targeting disciplinary fields requires organizing professional disciplinary data, particularly constructing small datasets in professional fields, drawing on professional or disciplinary intelligence analysis models, and developing professional intelligence research products. For example, for 5G technology and industrial development, constructing small datasets of 5G technology patents and industrial chain datasets enables comparative analysis of international industrial technology competition patterns in the 5G field to provide industrial policy formulation. Nanotechnology paper databases, patent databases, and rare earth element industrial and technical databases can all be considered small datasets that occupy important positions in intelligence research services in disciplinary and professional fields. Through further in-depth intelligence research, research frameworks and thinking modes in professional fields can be gradually formed, establishing strategic intelligence terminology expression systems in professional disciplinary fields and developing strategic intelligence research and service products in professional fields.

3.3 Exploring Data-Driven Strategic Intelligence Research to Fully Leverage the Decision-Making Consultation Function of Intelligence Research

With the increasing complexity of decision-making in S&T, economy, and social development in the new era, think tank research supporting scientific decision-making will inevitably rise on a large scale, becoming an important foundation for supporting policy formulation and decision-making research. In December 2015, China officially launched the pilot construction of national high-end think tanks, initiating a wave of large-scale think tank construction in China. Currently, China has initially formed a think tank research system with multi-domain, multi-disciplinary, multi-type, and multi-level mutual supplementation and collaboration. S&T intelligence institutions are playing important roles in the construction of the national S&T think tank system, presiding over the construction of think tank service systems of the intelligence type, relying on the information advantages, technical platform advantages, information analysis advantages, and expert network advantages of intelligence institutions to

build think tank intelligence service systems and product systems.

To form critical support for S&T decision-making, S&T intelligence institutions must first transform their intelligence work models, breaking through the limitations of pure information monitoring, highlighting intelligence monitoring and intelligence analysis, and achieving differentiation from network information dissemination. Simultaneously, through information monitoring and collection, rich basic information and data can be accumulated to lay a solid foundation for subsequent in-depth intelligence analysis. Likewise, strategic intelligence research needs to break through the limitations of S&T strategy conversion and dissemination, focusing research attention on viewpoint mining and analyzing the connotations of S&T strategic thinking. The core object of S&T strategic intelligence research is S&T strategic thinking itself, rather than being limited to the transmission and dissemination of S&T strategies. Evidence-based strategic intelligence research based on data will become the mainstream of future intelligence research.

The revolutionary applications of big data and artificial intelligence in data mining, data analysis, and knowledge discovery are obvious and have significant advantages. However, current big data learning-based and training-based artificial intelligence remains weak AI, whose "ceiling effect" for deep application has already emerged, lacking complex cognition and efficient intelligent reasoning capabilities and unable to effectively meet the target demands of intelligence research as think tank support. Strategic intelligence research is a highly complex thinking activity that weak AI cannot support for mining implicit knowledge relationships, requiring strong AI reasoning model support. Additionally, strategic intelligence research can draw on virtual reality technology to complete intelligence mining and knowledge association construction under the guidance of modern information theories such as intelligence space and knowledge space, and construct decision intelligence service models, thereby establishing decision support systems with intelligent intelligence as the core.

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Note: Figure translations are in progress. See original paper for figures.