Big Data-Driven Library Risk Governance: Connotation and Framework Postprint

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Abstract

[Objective/Significance] Modern risk society poses severe challenges to the development and management of the library sector; traditional library risk management models are no longer adequate for contemporary library development, urgently necessitating the exploration of new risk governance frameworks. [Method/Process] This study analyzes deficiencies in library risk governance research and practice, including unclear conceptual definitions, outdated research methodologies, and singular management subjects. Guided by risk society theory and governance theories and methods, and from a big data-driven perspective, it proposes the connotation of library risk governance and analyzes the big data application requirements, governance framework construction, as well as the content and processes of library risk governance under this framework. [Results/Conclusion] Regarding substantive risks in the library domain (buildings, public spaces, natural disasters), risks in specific business development (resource construction, service innovation, technology application and management), and industry risks arising from the external environment (developments in society, technology, policy, etc.), big data analytics can effectively identify, predict, and govern these risks, providing effective technical tools for library risk governance.

Full Text

Big Data-Driven Library Risk Governance: Connotation and Framework

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Abstract: [Purpose/Significance] Modern risk society poses severe challenges to the development and management of the library industry, rendering traditional library risk management models inadequate for current needs and ne-

cessitating exploration of new risk governance frameworks. [Method/Process] This paper analyzes shortcomings in library risk governance research and practice, including unclear conceptual definitions, lagging research methods, and singular management subjects. Guided by risk society theory and governance theory and methods, and from a big data-driven perspective, it proposes the connotation of library risk governance and examines big data application requirements, governance framework construction, and the content and processes of library risk governance within this framework. [Result/Conclusion] For physical risks (buildings, public spaces, natural disasters), business development risks (resource construction, service innovation, technology application and management), and industry risks arising from external environments (social, technological, and policy developments), big data analysis can effectively identify, predict, and govern these risks, providing effective technical tools for library risk governance.

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1. Problem Statement

Risks are ubiquitous, and modern society's various industries are filled with complex and diverse risks. Libraries similarly face operational risks, and risk management constitutes an important component of library management. The risks confronting today's libraries stem both from external environmental and information technology impacts and from shocks generated by their own transformation and development. These risks have shifted from singular to comprehensive, particularly during the current library transformation process, which harbors numerous risk factors and uncertainties in organizational restructuring, management, and business processes [1].

In recent years, a new round of "library obsolescence theory" has reignited a sense of crisis in the library profession and industry [2]. Facing library transformation, widespread attention has been paid to transformation risks. Chen Chuanfu et al. [3] surveyed risk perceptions among library professionals, finding that they are aware of potential risks, particularly internal ones. Meanwhile, the library community has institutionally emphasized various risks that may lead to safety issues. Article 44 of the 2015 revised *Regulations for Libraries of Regular Institutions of Higher Education* proposes that "higher education institutions should attach importance to public safety management in libraries, adopt multiple protective measures, formulate emergency response plans for sudden incidents, and protect personal safety" [4]. The *Public Library Law of the People's Republic of China*, implemented in early 2018, mentions the word "safety" four times and stipulates provisions regarding public library safety. Ma Haiqun [5] analyzed traditional and non-traditional security forms in public libraries. Traditional security forms include building safety, collection safety, equipment

safety, public space safety, and personal safety of staff. Non-traditional security forms include information network safety, digital library safety, user privacy safety, and cultural safety [5].

In an environment where information technology drives society toward networking, digitalization, and intelligence, the library community needs to break through traditional risk management concepts to reduce or avoid risk impacts and enhance preventive capabilities in library development. A new governance framework system must be explored to analyze and govern risks from a more comprehensive perspective, seeking more scientific and efficient methods and technologies to improve risk governance capabilities. Big data, as a new mode of thinking and methodology, provides new impetus for library risk governance. Applying big data to library risk management is essential for improving the scientific nature of library risk governance. Therefore, how to understand the connotation of big data-driven library risk governance and how to scientifically construct a data-driven library risk governance framework to effectively prevent risks from developing into crises in practical applications and to withstand various modern risks are questions worthy of research and consideration.

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2. Research Progress on Library Risk Governance

2.1 Connotation of Library Risk Governance

Risk refers to the uncertainty of ultimate losses caused by an event or behavior under specific circumstances and at a specific time. Risks are generally divided into three categories: natural risks (caused by natural disasters), social risks (caused by human factors), and technological risks (brought by information technology) [6]. Risk management is the decision-making process by which social organizations or individuals reduce the negative consequences of risk. Through risk identification, estimation, and evaluation, and based on selecting and optimizing risk management techniques, it implements effective risk control and properly handles loss consequences, thereby achieving maximum security at minimum cost [7]. With modern societal development and environmental changes, traditional risk management models no longer meet the requirements of today's risk society. In 2004, the United Nations Development Programme's Bureau for Crisis Prevention and Recovery published a report titled "Reducing Disaster Risk: A Challenge for Development" [8], which first used the term "risk governance." Compared with risk management, risk governance emphasizes the multiplicity of governance subjects, clear governance rules (clear responsibilities), risk communication and information sharing, and the participation of risk stakeholders and the public (broad cooperation) [9-10]. The primary difference between management and governance lies in the subject: management has a single subject, while governance has multiple subjects.

Library risk refers to the uncertainties faced by libraries as organizational entities in their management, operation, and business development processes amid

changing social, technological, and economic environments. In the broader context of socioeconomic and information technology development, future-oriented library transformation requires breaking through traditional risk management thinking models that focus solely on the library as a physical entity. It must consider not only single risk factors affecting physical libraries, such as natural disasters and public space safety, but also comprehensive risk factors—human, network-based, and others—brought by social environment and information technology development. Moreover, due to the multidimensional, complex, and uncertain nature of risks, the problems involved cannot be solved by libraries alone. Connections must be established with external entities including government, enterprises, and social organizations through collaborative cooperation. Only under multi-participant governance can libraries achieve sustainable and healthy development as "organisms" and as an industry. Therefore, this paper defines library risk governance as: under the participation of multiple governance subjects including government, social organizations, and individuals, libraries comprehensively identify, assess, monitor, predict, and optimize the entire process of risk governance to reduce or eliminate negative outcomes. This process requires continuous consideration of all factors related to library risks and effective coordination of relationships among parties affected by risks. Library risk governance focuses on risk identification and prediction under the concept of multi-subject cooperation for better decision-making, while crisis or emergency management emphasizes the disposal process after dangerous (sudden) events occur.

2.2 Literature Review

Currently, domestic scholars have conducted research mainly from three aspects: theoretical foundations of library risk management, specific business risks (resource construction, services, management, technology), and natural disaster-related risks. Theoretical research includes library risk management processes [11], the connotation and content of library crisis management, crisis prevention, control, and handling [12], and research on library risk early warning systems in big data environments [13]. Business risk research focuses on three areas: (1) Resource construction risks, such as e-book procurement risks and countermeasures [14], risks and avoidance strategies in patron-driven acquisition models [15], legal risk prevention in database subscription contracts [16], and digital library resource sharing risks [17]. (2) Service risks, including library social information service risks [18], copyright protection and risk prevention strategies in document delivery services [19], intellectual property risks [20-23], risk management mechanisms in microblog information services [24], and business outsourcing risks and avoidance strategies [25]. (3) Management and technology risks, such as business process reengineering risks [26], crowdfunding model risks [27], cognitive mapping for multi-agent library risk management [28], library alliance risks and prevention [29], user personal information security risks and governance countermeasures [30], library emergencies and emergency plans [31-32], and environmental risk assessment [33].

Foreign research and practice in library risk management are relatively limited, focusing mainly on library collection risk assessment, information security, and risk management systems. The Online Computer Library Center (OCLC) report *Research Libraries, Risk and Systemic Change, 2010* [34] categorized risks into five types: "value orientation," "human resources," "hardware facilities," "traditional technology," and "intellectual property." Liu Dan [35] examined the risk management framework of the National Library of Australia and its implications. Lin Xu [36] noted that many American university libraries have established comprehensive information security management systems with sound management systems and organizational structures to effectively address various sudden information security issues. T. Segaetsho [37] assessed and investigated collection risks at the University of Botswana Library, concluding that while challenges included funding shortages and staff and equipment shortages, most observed risks resulted from lack of guidelines and policies. S. Chabchoub et al. [38] further analyzed the connection between risk management and performance evaluation systems using university libraries as examples.

In summary, library risk management research has produced numerous 成果, and some scholars have conducted related research from emergency and crisis management perspectives. These studies have advanced library risk governance to a new stage and laid a foundation for research in the big data context. However, existing research has several problems: conceptually, the relationships among library risk governance, emergency governance, and crisis governance have not been clarified, with mixed usage. Risk governance emphasizes proactive identification, prediction, and prevention of relevant risks under multi-subject cooperation—a pre-event prevention process—while crisis or emergency governance emphasizes passive emergency response after events occur [39]. Theoretically, there is a lack of application of risk society theory and governance theory to analyze library risk governance issues, and insufficient use of big data theory to analyze library risk governance. In fact, big data and risk governance have inherent compatibility: risk is quantifiable and predictable uncertainty, while the core of big data analysis is predictability, thus providing a theoretical foundation for library risk governance. Methodologically, traditional risk management research relies mainly on historical and structured data analysis. Although quantitative and empirical studies are common, using mathematical statistics, surveys, sampling, and modeling, the data sources are primarily historical structured data. Practically, risk management subjects focus on unilateral library management, neglecting the responsibilities and roles of social organizations and individuals. Libraries have certain problems and deficiencies in risk prevention before occurrence and risk disposal after occurrence, resulting in unsatisfactory governance effectiveness and efficiency. Risk prediction capabilities are weak, unable to meet the prediction and prevention needs of emerging risks. Moreover, existing risk early warning system data often comes from limited internal library historical data, making timely and accurate pre-event risk warnings impossible.

3. Connotation of Big Data-Driven Library Risk Governance

3.1 Essence of Data-Driven

Compared with "decision-driven," "goal-driven," and "business-driven" approaches, data-driven mainly uses data as a starting point or perspective to observe, control, and integrate other elements (decisions, goals, business, and models). Data refers to recordable and identifiable symbols of objective events, physical symbols that record the properties, states, and relationships of objective things. Information is purposeful and relevant data [40], including symbols, text, numbers, voice, images, and video. As societal datification deepens and everything becomes highly interconnected, data resources gradually accumulate to form big data resources. Data from different domains, through establishing connections and leveraging human cognitive abilities for organization, integration, and systematic analysis, generates relevance and influences decision-making, ultimately forming information and knowledge. Some scholars argue [41] that the essence of big data is information, and the core of big data-driven approaches lies in information-driven. Data-driven approaches require data sources first, followed by mining and analysis, including raw data collection, preprocessing and cleaning, data exploration, computational modeling, visualization and reporting, data product development, and decision support. This process involves transforming data into information, knowledge, and intelligence. American management scientist Russell Ackoff constructed the DIKW (data-information-knowledge-wisdom) system [42]. According to DIKW, the key to data processing is extracting information, and the connection of information constitutes knowledge. When information and knowledge extraction can be "automated" and knowledge completeness is greatly enhanced, automation of information perception, decision-making, and execution can be achieved, leading to wisdom. Zhong Yixin also proposed an integrated theory of information-knowledge-intelligence [43]. Data itself cannot drive and lead digital transformation success without extracting knowledge and information for effective utilization. Notably, correlations between data are crucial—only with associations can data be parsed and refined into information. With big data and numerous cases, useful information can be extracted, and information's core value lies in refining knowledge from it. With knowledge, intelligent prediction and decision-making become possible.

3.2 Big Data-Driven Thinking, Mode, and Process in Library Risk Governance

The essence of big data-driven library risk governance is integrating big data analysis processes (data collection, mining, organization, integration, refinement, etc.) into library risk governance to discover risk sources, predict risk development patterns, and ultimately provide solutions for managerial risk decision-making. Specifically, it involves collecting massive data related to library risks through various technical means, organizing, mining, and analyzing

this data to form risk information, integrating and refining this information into knowledge, thereby identifying correlations between library risks and their factors, assessing and predicting risk development patterns, and ultimately forming risk governance plans and intelligent governance processes (see Figure 1 [Figure 1: see original paper]) to achieve risk governance goals. It should be noted that "big data" here refers not only to internal library data but also to data from related fields or applications. Furthermore, the connotation of big data-driven library risk governance manifests in three aspects:

(1) **Transformation of thinking mode in big data-driven library risk governance.** Library risk managers need to shift from sampling-based analysis thinking to holistic thinking for full-sample, massive data analysis [44]. Management decision-makers should no longer focus solely on precise risk-related data but must accept massive, messy data. They should emphasize analyzing correlations rather than just causes behind risk management. Various data types must be regarded as important resources. Big data-based risk governance can identify and monitor library industry risks in real-time and dynamically, conduct dynamic risk assessments of their changes, expand decision-makers' thinking, avoid traditional subjective experience-based decisions, and enhance responsiveness.

(2) **Innovation in library risk governance mode under big data.** Big data encompasses unstructured and stream data processing. Methods based on big data analysis discover hidden relationships, characteristics, patterns, and modes from massive risk-related data to identify valuable risk information (knowledge) for prediction and decision-making [45]. Big data's driving force manifests in broad connectivity, trend prediction, and solution output. Big data can connect people, places, events, objects, and organizations; link data from different perspectives, channels, and sources including numbers, text, images, video, audio, temperature, and smell; and connect data from different time dimensions. Through broad connectivity, various data are organized into rich mines for creating knowledge and wisdom. Trend prediction provides powerful forecasting tools for risk trajectories through overall data analysis. Solution output combines big data with machine intelligence to compensate for human brain limitations in processing data, presenting hidden correlations, issue importance, and patterns as much as possible, and providing feasible solutions.

(3) **Big data analysis technology and methods run through the entire library risk governance process.** Whether risk identification, evaluation, disposition, or collaborative governance, all rely on big data analysis support. Applying big data analysis methods to each risk governance link can effectively assist in judging situations, determining risk governance decision rules, simplifying decision execution and supervision, and improving decision feedback and evaluation during dynamic decision-making processes [46].

4. Construction of Big Data-Driven Library Risk Governance Framework

4.1 Theoretical Foundation

(1) **Risk Society Theory.** Risk society theory, proposed by German sociologist Ulrich Beck, is a core concept for understanding modern society. Beck [47] argued that risk society has two prominent features: first, a constantly diffusing logic of man-made uncertainty; second, the transformation of existing social structures, institutions, and relationships toward more complex, contingent, and fragmented states. Giddens [48] introduced temporal-spatial characteristics in his analysis of modernity, arguing that modernity's distinguishing trait from pre-modernity is accelerated social change, expanded scope, and unprecedented depth. Beck and Giddens' discussions on risk society are highly complementary: Beck emphasizes technological risks, while Giddens focuses on institutional risks. In risk society, risks have several characteristics: In origin, risks are endogenous, resulting from human decisions, behaviors, and social system operations, with increased "humanization" of nature making this endogenous feature more pronounced. In impact and consequences, risks are extended—spatially global, transcending geographical and socio-cultural boundaries, and temporally continuous. In characteristics, most risk consequences are severe. In response methods, existing risk calculation methods cannot fundamentally solve problems; new mechanisms for addressing risks must be constructed through enhanced modernity reflexivity.

(2) **Governance Theory.** The Commission on Global Governance defines governance as the sum of various ways in which individuals and institutions, public or private, manage common affairs. Governance has four characteristics [49]: Governance is not a set of rules or an activity but a process. Governance is based on coordination rather than domination. Governance involves both public and private sectors. Governance does not mean a formal system but indeed depends on continuous interaction. These characteristics mean that in public affairs, the state and society, government and market, and government and citizens jointly participate, forming cooperative, negotiated, and partnership relationships, creating an interactive, at least two-way, and possibly multi-dimensional management process. Governance theory is one of the hottest frontier theoretical issues in international academia, widely applied in various fields such as local governance, university governance, corporate governance, national governance, global governance, and public governance. In the governance context, "participation," "negotiation," and "consultation" are three key terms. Through reforms in politics, administration, and public management in many countries, governance theory has formed not only a relatively complete theoretical framework and logical system but also a set of value standards for evaluating social development and management quality. "Less government, more governance" has become a slogan for

government management reform and development in some countries [50].

(3) **Domestic and International Risk Management Standards/Guidelines.** At the organizational level, all organizational activities, including libraries, involve risks that must be managed through identification, analysis, evaluation, and control. Considering risk nature, importance, and complexity, establishing effective and universal risk management standards/guidelines is necessary. Numerous industry standards exist, with notable attention to ISO 31000:2018 Risk Management Guidelines, IEC 31010:2019 Risk Management—Risk Assessment Techniques, ISO/TR 31004:2013 Risk Management—Guidance for Implementation, and China's GB/T 24353-2009 Risk Management—Principles and Implementation Guidance. These standards clarify risk management principles, processes, and framework systems, providing theoretical foundations for in-depth industry risk management. Here, we mainly introduce ISO 31000:2018 and GB/T 24353-2009.

The ISO 31000:2018 risk management framework (see Figure 2 [Figure 2: see original paper]) aims to assist organizations in integrating risk management into important activities and functions. Risk management effectiveness depends on its integration into organizational governance and decision-making, requiring support from stakeholders, particularly top management. ISO 31000:2018 strengthens leadership responsibilities and integration importance, with leadership and commitment at its core, clarifying that senior management and supervisory bodies should ensure risk management is integrated into all organizational activities. ISO 31000:2018 manifests as five sequential steps: integration, design, implementation, evaluation, and improvement [51]. Its purpose is value creation and protection, with eight described principles—such as continuous improvement, effective information utilization, organizational customization, and consideration of human and cultural factors—serving as the foundation for managing risk.

GB/T 24353-2009 Risk Management—Principles and Implementation Guidance is a universal standard that coordinates existing and future risk management content in standards. It provides general methods to support the development of specific risk or industry standards. The risk management process is an organic component embedded in organizational culture and practice, running through operational processes. This standard's risk management framework consists of clarifying environmental information, risk assessment, risk response, and monitoring and review (see Figure 3 [Figure 3: see original paper]). Risk assessment includes three steps: risk identification, risk analysis, and risk evaluation.

These risk management frameworks basically follow risk management processes as the main line—from risk identification, analysis, and evaluation to risk decision-making and response—with relatively single frameworks targeted mainly at internal organizational, government, industry sector, or specific natural disaster risk management issues.

4.2 Requirements for Big Data-Driven Library Risk Governance

With socioeconomic and information technology development, new types of library risks continue to emerge, coupled with limitations in traditional risk analysis methods and technologies, necessitating new methods and tools for prevention. Demand for risk early warning and management in various industries is increasingly prominent. For library risk governance, the management object is future uncertainty; quantifying and analyzing risks and reasonably predicting the future are its core values and major challenges. Big data analysis brings new technologies, methods, and ideas, providing opportunities and strong support for library development. In the big data context, rapid and real-time data analysis, decision-making, and disposal can efficiently, accurately, and comprehensively prevent and predict library risks. Risk governance decisions require multi-department collaboration and should be based more on data, analysis, and facts rather than experience and intuition. Library risk governance decision-makers must consider comprehensive risk governance driven by big data, accounting for different types, regions, departments, and management levels of risk factors; comprehensively obtaining structured, semi-structured, and unstructured risk-related data through various channels; conducting risk correlation analysis of risk factors, accidents, and losses from a holistic perspective; and using professional data analysis tools to establish scientific and reasonable data models for real-time and historical data to achieve accurate and timely risk prediction, thereby taking timely measures to avoid risk events and losses.

4.3 Big Data-Driven Library Risk Governance Framework

Under the guidance of risk society theory and governance theory, big data-driven library risk governance subjects are multiple, including libraries, government, enterprises, social organizations, and individuals—who are also big data producers. Simultaneously, through collection, storage, and processing of library risk big data sources, followed by feature extraction and selection, risk data model construction, risk learning, and knowledge formation, these processes need to be integrated into all library risk governance links, including risk identification, assessment, and early warning, ultimately forming library risk governance solutions for decision-makers' reference. Combining these elements and processes, this paper constructs a big data-driven library risk governance framework system, as shown in Figure 4 [Figure 4: see original paper]:

(1) **Big Data Sources.** Library risk governance data sources can be categorized into three types: Social data: documents and information management system data from government departments, enterprise data, industry data from libraries, information institutions, archives, and museums, and user data. Physical space data: library entity attribute data, data from various sensing devices (cameras, RFID, facial recognition), etc. Network data: social media user-generated content, web logs, operational service data, financial service data, online shopping services, search engine and transaction behavior data, and rich media data (text, images,

audio/video). Big data collection is the cornerstone, using tools (sensing devices, wearable devices, network system logs, crawler software) to automatically collect information. After cleaning and extraction, these form a library risk big data repository—the crucial foundational resource for effective risk governance. Data authenticity, validity, and timeliness are important foundations for implementing and optimizing library risk governance models.

(2) **Feature Extraction and Selection for Library Risk Big Data.** This mainly uses mapping (transformation) methods to reduce original features to fewer new features through dimensionality reduction, and based on expert knowledge, screens and extracts representative, well-performing, and influential risk features from original features [52]. Feature extraction and selection are related to specific risk problems, and currently, there are no universal methods. In library risk big data, massive chaotic data are reduced in dimensionality (models, algorithms), organized, classified, and screened for regular, valuable data. For example, mining public impressions of librarians from social media to extract career-related data for analyzing librarian professional development issues. For macro-level risks, analyzing national macro-policy and industry development data through feature extraction and screening can predict industry trends and adjust library development strategies accordingly.

(3) **Library Risk Data Model (Rule) Construction.** Risk data models are mathematical transformations of real-world risk problems, enabling the transition from scattered, massive, multidimensional data to prediction and decision-making. Model generation requires understanding risk problems, determining rules, and setting parameters. In big data environments, machine computation can efficiently, accurately, and quickly obtain required parameters. This machine-based parameter determination is also automatic, using methods like clustering (automatically grouping objects), classification (grouping objects into preset categories), estimation (estimating object values), and association (understanding which objects occur simultaneously). In library risk data model construction, the main task is establishing a real-time updated library risk big database. For example, when responding to natural disaster risks, collecting library entity data, local natural disaster type data, and weather data forms a risk big database with set thresholds for real-time updates. Once data anomalies occur, the risk early warning system issues alerts. Over time, risk data models continuously iterate and optimize, scientifically and accurately analyzing relationships in risk big data to parse risk origins, classify risk levels, indicate threat severity, intelligently recommend and form risk early warning reports, reducing management costs and improving governance efficiency [53].

(4) **Risk Learning and Knowledge Fusion.** To reveal and track library risk change directions and discover potential, major, and extreme risks,

active testing of various risks and cross-industry/cross-domain learning are needed. This mainly involves data analysis, computer simulation of risk events and behaviors to acquire new knowledge or skills, and reorganizing existing risk knowledge structures to continuously improve performance. Integrating various machine learning methods builds a risk learning system. Knowledge fusion dynamically extracts, analyzes, integrates, and transforms multi-source big data into knowledge resources to find potential, correlated risk knowledge. Facing library risk governance decision-makers' needs and services, it explains relationships between library risk knowledge at different dimensions and granularities, making risk knowledge understandable to machines. Combined with risk knowledge in specific domains or contexts, executable solutions are generated through simulation. The library risk learning and knowledge fusion process, supported by the risk big database, discovers data relationships and mines data value through risk big data fusion, providing decision support for library risk identification, rating, and early warning.

4.4 Content and Process of Big Data-Driven Library Risk Governance

(1) **Content.** Based on risk classification and actual library risk problems, library risk governance includes internal and external risk governance. Internal governance mainly addresses physical risks and business risks. Physical risk governance covers library building risks from natural disasters and public space safety risks. Business risk governance targets risks in resource construction (procurement, contract signing), services (intellectual property, business outsourcing), technology application (information security, user privacy—such as two major risks in facial recognition technology: security and privacy), and management (human and institutional risks). External risks mainly involve industry and professional risks caused by changes and developments in social policy, information technology, and economic environments. In library risk governance, when addressing specific risks, relevant institutions must be identified, common risk governance rules (responsibilities) clarified, and through big data analysis, risks predicted and jointly decided upon.

Notably, risks do not necessarily bring losses but may also present development opportunities. When facing physical risks (natural or human-caused, public space safety), libraries should use big data analysis for timely avoidance to reduce losses. For career risks, user privacy, and network risks arising from information technology development, libraries should adapt through scientific planning rather than avoidance—such as formulating scientific strategic plans, enhancing librarian capabilities, using more advanced technologies, and innovating service solutions.

(2) **Process.** The big data-driven library risk governance process integrates library external and internal operations, big data analysis, and risk governance processes (identification, evaluation, control/early warning) to form

big data-based risk identification, evaluation and grading, and early warning and pre-control processes—from risk data collection, mining, and perception to analysis, prediction, control solution formation, and collaborative decision-making with other governance subjects.

Risk Identification in specific library operations is reflected in resource construction, service innovation, and technology application. Through big data analysis, business risks are dynamically and continuously identified and analyzed to evaluate potential causes. Risk factor determination should follow principles for comprehensive, systematic, and scientific risk identification. First, adhere to the comprehensive systematic principle: library risk management is a long-term process involving not only internal factors (management, business, technology) but also external environmental factors (economic development, industry development, social policies). This requires comprehensive risk identification from a global perspective. Second, emphasize the importance principle: risk identification should focus on important risks with severe consequences. The comprehensive systematic principle ensures identification effectiveness, while the importance principle ensures efficiency [54]. Risk identification includes risk perception and analysis—understanding various objective risks (environmental, management, technical, service) and analyzing risk accident causes. Based on historical risk factors, big data analysis judges risk sources, nature, types, and scope. By analyzing and mining library risk big data for potential patterns and characteristics (risk screening and symptom identification), and conducting correlation analysis vertically with historically similar risk parameters and horizontally with mutually influential system elements, risk sources can be precisely identified and located. Identified risk sources are then analyzed to form library risk information (risk inventories). For example, comprehensive analysis of national policies, economic development, information technology development, public opinion and demand regarding libraries, and related industry development can identify risks in library career development and professional dilemmas to predict development directions.

Risk Evaluation relies mainly on correlation, association, and cluster analysis. Based on risk identification, evaluation standards are formulated for specific analysis, judgment, and ranking. According to three dimensions—probability of occurrence, severity, and sensitivity—big data-based risk evaluation and grading models are established. Through risk big data models and grading models, risk occurrence probability and potential losses are calculated to refine evaluation results into risk reports. Based on evaluation results, library risks are ranked and sorted. For example, for identified library risks (user privacy, intellectual property, building safety, career crises), statistical algorithms establish risk evaluation and grading models to analyze which risks have high occurrence probability, are relatively severe, and show clear development trends, enabling formulation of risk prevention strategies.

Risk Early Warning measures the degree of deviation from warning lines and issues alert signals. Through big data analysis, early warning indicator systems

are established to capture and monitor various subtle signs, issuing timely alerts for risks of different natures and severity levels to remind decision-makers to take preventive measures. **Risk Control** is the process of applying reasonable and effective response strategies. It implements risk analysis methods based on association rules, knowledge fusion, real-time interaction, and trend prediction, provides scientific solutions for existing risks, monitors implementation, and combines static and dynamic early warnings to provide scientific support for risk management decisions. In library risk governance, constructing scientific and reasonable early warning indicator systems is particularly important, as they can accurately reflect various library risk issues and provide references for managers to make scientific decisions.

Additionally, multi-dimensional, multi-level risk monitoring systems and effective data presentation require dynamic monitoring of risk big data—real-time monitoring of data changes, continuous identification of new risks, tracking changes in identified risks, timely optimization of risk data models based on risk changes, adjustment of risk decision solutions, and checking solution effectiveness and risk management mechanism normality. In the big data era, data presentation mainly uses visualization—using graphics, image processing, computer vision, and user interfaces to visually interpret data. Through expression, modeling, and various forms of 3D, surface, attribute, and animation displays, massive information and concepts are visualized from multiple angles to directly reveal underlying patterns [55]. Data visualization not only presents final risk data analysis results but also discovers new risk information and hidden patterns. It is also a reproduction method for risk knowledge, using combinations of graphics and processing elements to display massive information and explain relatively grand and abstract theories.

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5. Contributions and Limitations

5.1 Contributions

Big data-driven governance will become a new driving force for current library risk governance, bringing many new concepts to risk identification, assessment, prediction, monitoring, prevention, and efficiency improvement. In the big data-driven library risk governance process, governance subjects including libraries should fully recognize potential risks, explore risk development patterns, and govern them to jointly promote the healthy, innovative, and sustainable development of China's library industry. This paper's main contributions are:

(1) **Clarifying the connotation of big data-driven library risk governance.** Essentially, it uses data analysis processes to implement library risk governance, integrating massive library risk data, processing it to mine valuable information (knowledge), and applying this information to specific decisions.

(2) **Proposing a big data-driven library risk governance framework.** This framework overcomes traditional library risk management's passive, subjective, and imprecise risk prediction shortcomings. Its advantages include deep integration of various library risks through big data, collaborative operation, multi-subject innovation, and intelligent governance. This framework systematically proposes new theories and methods for using big data to achieve library risk identification, prediction, intelligent control, and proactive analysis, providing response ideas and solutions for accurate prediction, timely early warning, and rapid disposal in practical applications.

(3) **Improving governance subjects, content, and processes.** Traditional library risk management has relatively single subjects, content, and processes, analyzing resources, services, and technology separately with processes focusing on identification, analysis, and evaluation. Under the big data-driven framework, governance subjects shift from single libraries to multiple directions including government, society, and the public; governance content shifts from single governance of resources, services, management, and technology to comprehensive, holistic governance; governance processes incorporate big data mining technology and analysis methods into original processes.

5.2 Limitations

This paper's main limitation is that it only proposes a big data-driven library risk management framework at the theoretical level, awaiting further practical verification. Although deepening big data and artificial intelligence development accelerates library transformation, applying the big data-driven library risk governance framework faces many difficulties, such as existing infrastructure being unable to support library risk governance platform construction, and insufficient library big data and AI application levels to achieve risk governance. Future research should emphasize practice, applying big data analysis technology to actual library risk governance by proposing specific risk issues, collecting relevant risk data, and providing reasonable governance strategies.

References

[1] Chen Chuanfu, Chen Yi. Library transformation and its prospective risks [J]. Journal of Library Science in China, 2017(7): 32-49.

[2] Sullivan B T. Academic library autopsy report, 2050 [EB/OL]. [2019-05-30]. https://www.chronicle.com/article/Academic-Library-Autopsy/125767/.

[3] Chen Chuanfu, Chen Yi. Challenges and opportunities: a survey of practitioners' perceptions on risks in Chinese library transformation [J]. The Journal of Academic Librarianship, 2018, 44(1): 150-161.

[4] Regulations for Libraries of Regular Institutions of Higher Education [EB/OL]. [2019-05-30]. http://www.moe.gov.cn/srcsite/A08/moe_{736}/s3886/201601/t20160120_{228487}.

[5] Ma Haiqun. The security concept of the Public Library Law of the People's Republic of China [J]. Library Development, 2018(1): 37-43.

[6] Sha Yongzhong. Public Crisis Information Management [M]. Beijing: China Social Sciences Press, 2014: 3-4.

[7] Fan Daojin, Chen Weike. Risk Management Theory and Tools [M]. Tianjin: Tianjin University Press, 2010: 17.

[8] Reducing disaster risk, a challenge for development [EB/OL]. [2019-04-25]. http://www.undp.org/content/dam/undp/library/crisis%20prevention/disaster/asia_{pacific}/Reducing%20I

[9] Zhan Chengyu. Stage division and key elements of risk governance—analysis based on comprehensive emergency, food safety, and school safety [J]. Chinese Public Administration, 2016(6): 124-128.

[10] Zhang Chengfu, Chen Zhanfeng, Xie Yifan. Risk society and risk governance [J]. Teaching and Research, 2009(5): 5-11.

[11] Shi Shangyuan. On library risk management [J]. Library and Information Service, 2005, 49(8): 136-139.

[12] Liu Ziheng. Library Crisis Management Handbook [M]. Beijing: National Library of China Publishing House, 2010.

[13] Ma Xiaoting. Design of library risk early warning system based on big data analysis [J]. Library Theory and Practice, 2016(8): 81-84.

[14] Wu Yunshan. Risks and countermeasures of domestic e-book procurement in university libraries [J]. Library Tribune, 2011(1): 91-94.

[15] Zhang Lili. Risks and avoidance strategies of patron-driven acquisition in university libraries [J]. Library Science Research, 2013(23): 30-33.

[16] Xiang Jiali. Legal risk prevention in library database subscription contracts [J]. Library Journal, 2016(1): 57-61.

[17] Xu Longshun, Li Chan. Evolutionary game analysis of digital library resource sharing risks [J]. Library Development, 2017(12): 56-62.

[18] Li Pishi, Wang Lei, Liu Xia, et al. Classification and control of social information service risks in university libraries [J]. Journal of Intelligence, 2016(11): 179-182.

[19] Zheng Wenhui. Research on copyright protection and risk prevention strategies for document delivery services in university libraries [J]. Library Science Research, 2009(2): 33-38.

[20] Ran Congjing. Strategy analysis for avoiding intellectual property risks in digital libraries [J]. National Library of China Journal, 2015(3): 88-92.

[21] Wang Gen, Sun Hui. Research on intellectual property risk control in libraries based on crisis management thinking [J]. Library, 2012(6): 59-62.

[22] Cui Huimin. Empirical analysis of intellectual property risk assessment in university library alliances [J]. Library Work and Study, 2016(7): 36-40.

[23] Li Chan, Zhang Wende. Research on intellectual property risk management in digital libraries [J]. Information Theory and Practice, 2011(11): 31-35.

[24] Wang Jing. Research on risk management mechanisms of microblog information services in university libraries under Web 2.0 environment [J]. Library, 2012(4): 91-93.

[25] Chen Xinjie. Risks and avoidance strategies of library business outsourcing [J]. Journal of Academic Libraries, 2013(4): 36-39.

[26] Jiang Zhiyi. Library BPR project risk management [J]. Journal of Library Science in China, 2006(6): 45-49.

[27] Shi Yujuan, Zhao Xuemei. Research on risk prevention of library crowdfunding in the "Internet+" era [J]. Library and Information, 2016(2): 72-79.

[28] Xu Wenzhe, Zheng Jian. Construction of multi-agent cognitive maps for library risk management [J]. Library and Information Service, 2014, 58(9): 17-22.

[29] Kong Fanchao. Research on the architecture of library alliance risk prevention systems [J]. National Library of China Journal, 2010(1): 73-79.

[30] Li Yi, Sun Jia. Security risks and governance countermeasures of user personal information in the cloud era [J]. Library, 2017(2): 86-90.

[31] Sun Xiao, Wei Yiyao. Emergencies and university library management [J]. Journal of Academic Libraries, 2005(5): 82-85.

[32] Wei Siting. Analysis of current status and countermeasures of library emergency plans [J]. Library Development, 2010(5): 74-76.

[33] Liu Na. Risk avoidance of library undertakings based on SWOT analysis [J]. Library and Information, 2007(6): 28-32.

[34] Michalko J, Malpas C, Arcolio A. Research libraries, risk and systemic change [R]. Dublin: OCLC Research, 2010.

[35] Liu Dan. Risk management framework of the National Library of Australia and its implications [J]. Library and Information Service, 2012, 56(13): 69-73.

[36] Lin Xin. Analysis and implications of information security management in American university libraries [J]. Library Development, 2014(3): 80-82.

[37] Segaetsho T. Preservation risk assessment survey of the University of Botswana Library [J]. African journal of library archives and information science, 2014, 24(1): 175-186.

[38] Chabchoub S, Hachicha W. Associating risk management with performance measurement system: case of academic libraries [C]//International conference on advanced logistics and transport. Hammamet: IEEE, 2014: 344-349.

[39] From crisis management to risk governance: time to change paradigms [EB/OL]. [2019-05-08]. http://ex.cssn.cn/zx/zx_{gjzh}/zhnew/201701/t20170118_{3389269}.html.

[40] Drucker P F. Knowledge Management [M]. Translated by Yang Kaifeng. Beijing: China Renmin University Press, 1999: 5.

[41] Zhang Haibo. Big data-driven social governance [J]. Comparative Economic & Social Systems, 2017(3): 64-73.

[42] Ackoff R L. From data to wisdom [J]. Journal of applied systems analysis, 1989, 16(1): 3-9.

[43] Zhong Yixin. Information transformation principle: an integrated theory of information, knowledge, and intelligence [J]. Chinese Science Bulletin, 2013(14): 1300-1306.

[44] Mayer-Schönberger V, Cukier K. Big Data: A Revolution That Will Transform How We Live, Work, and Think [M]. Translated by Sheng Yangyan, Zhou Tao. Hangzhou: Zhejiang People's Publishing House, 2013: 89.

[45] Lyu Xinen, Chen Huiling, Cai Zhennao. Research on personalized behavior information processing and prediction models in big data environments [J]. Information Science, 2019(10): 108-113.

[46] Cao Cejun, Li Congdong, Wang Yu, et al. Research on urban public safety risk governance models in the big data era [J]. Urban Development Studies, 2017(11): 76-82.

[47] Beck U. Risk Society [M]. Translated by He Bowen. Nanjing: Yilin Press, 2004: 89.

[48] Giddens A. The Consequences of Modernity [M]. Translated by Tian He. Nanjing: Yilin Press, 2000.

[49] Yu Keping. Governance and Good Governance [M]. Beijing: Social Sciences Academic Press, 2000: 16.

[50] Long Xianzhong, Yang Zhu. Governance theory: origins, academic origins, and connotation analysis [J]. Journal of Yunnan Normal University (Philosophy and Social Sciences Edition), 2007(4): 30-34.

[51] Lu Xinrui. Review and analysis of ISO 31000:2018 Risk Management Guidelines [J]. China Business Theory, 2018(20): 165-166.

[52] Big data feature extraction and feature selection [EB/OL]. [2019-07-14]. https://blog.csdn.net/hujie_{123}/article/details/79489509.

[53] Ma Xiaoting. Design of library risk early warning system based on big data analysis [J]. Library Theory and Practice, 2016(8): 81-84.

[54] Chen Yi. Identification and evolution assumptions of risk factors in China's library transformation [J]. Information and Documentation Services, 2019(2): 30-37.

[55] Chen Haiying, Guo Jiasu. Enlightenment of Big Data Applications [M]. Beijing: China Machine Press, 2016: 285.

Big Data Driven Library Risk Governance: Connotation and Framework

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Abstract: [Purpose/significance] Modern risk society has brought severe challenges to the development and management of the library industry. The traditional risk management model of libraries is no longer suitable for current library development, and there is an urgent need to explore a new risk governance framework. [Method/process] This paper analyzes the shortcomings in the research and practice of library risk governance, such as unclear concept definitions, lagging research methods, and single management subjects. Under the guidance of risk society theory and governance theory and methods, from the perspective of big data drive, it proposes the connotation of library risk governance and analyzes the big data application requirements, governance framework construction, and the content and process of library risk governance under this governance framework. [Result/conclusion] For the physical risks (buildings, public places, natural disasters), specific business development risks (resource construction, service innovation, technology application and management), and industry risks brought by the external environment (development of society, technology, policies, etc.) in the library field, big data analysis can effectively identify, predict, and manage the risks faced, providing effective technical tools for library risk governance.

Keywords: big data; library risk; risk governance; data-driven

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