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A Visual Analysis Study on the Theory and Model of User Personal Information Security Protection

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Abstract: *In today's digital era, the rapid development of information technology has made the network closely connected with people's lives. While various network services provide convenience to users, they have also caused serious problems in user personal information security. The security of personal information not only causes serious infringement on personal rights and interests, but may also have a negative impact on corporate reputation, social stability and national security. In the network environment, strengthening the security protection of user personal information has become an urgent task. This article aims to deeply analyze the current situation, problems and internal laws of user personal information security protection, and conduct comprehensive and systematic visual analysis of relevant data through network metrology methods, thereby providing solid theoretical basis and practical and feasible suggestions for building a more complete user personal information security protection system.*

Keywords: *Network Security Protection; Personal Information Security; User Personal Information Security Protection*

1. Introduction

With the rapid development of information technology, the issue of security protection of users' personal information has attracted more and more attention. As an emerging research method, network metrology can help researchers analyze and visualize the relationship between user behavior and information security. This article will review the current research status of user personal information security protection at home and abroad, analyze existing theories and models, explore the relationship between research variables, and summarize the existing research results in the past.

1.1 Concept definition

In the Cybersecurity Law, personal information refers to "various information recorded electronically or otherwise that can identify the personal identity of a natural person alone or in combination with other information" [1]. User personal information refers to various information that can identify the personal identity of a natural person alone or in combination with other information, covering the natural person's name, date of birth, ID number, personal biometric information, address, telephone number, email address, bank account information, and network behavior data. This information is recorded electronically or otherwise, and is widely present and frequently used in today's digital society.

The security protection of personal information refers to the ability to ensure that the data is in a state of effective protection and legal use by taking necessary measures, and the ability to ensure a continuous security state. This includes measures such as data encryption, access control, and risk assessment[2]. The security protection of user personal information refers to taking a series of measures to ensure that these personal information are not leaked, tampered, damaged or illegally obtained or utilized in all aspects of collection, storage, transmission, processing and use, protecting the legitimate rights and interests of the information subject, maintaining personal privacy and security, and preventing the occurrence of adverse consequences such as identity theft, online fraud, property losses, reputation damage and even threats to personal safety caused by information leakage. Its core lies in building a comprehensive and multi-level protection system through the comprehensive role of technical means, management strategies, laws and regulations, and the improvement of social

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awareness to cope with the increasingly complex and changeable information security threat environment and keep personal information in a safe and controllable state.

1.2 Theory and Model

In the study of user personal information security protection, various theories and models have been proposed to explain the relationship between user behavior and information security. These theories and models provide powerful tools and frameworks for research.

Protective motivation theory (PMT): According to the protection motivation theory, users' protective behavior is affected by threat perception, coping ability and self-efficacy. Research shows that when users perceive high risks, they tend to take protective measures [3]. Privacy Computing Theory: This theory explores the trade-off between the privacy rights and the value of information in the process of information sharing. Researchers such as Culnan (1993) pointed out that when users decide to share personal information, they often consider potential benefits and privacy losses[4].

User information security protection model: Zhang Hua (2021) constructed a comprehensive user information security protection model, integrating three dimensions of law, technology and user behavior, emphasizing the importance of interaction, and proposing multi-level protection strategies [5]. Information security maturity model: The information security maturity model proposed by Li Jun (2022) is used to evaluate the maturity of an organization in personal information protection, emphasizing the interactive relationship between information security management and user behavior [6]. This model provides a theoretical basis for organizations to develop improvement strategies in personal information protection.

2. Literature Review

2.1 Research on the security protection of user personal information in China

Domestic research on the security protection of users' personal information mainly focuses on the following aspects: Legal and policy framework: Researchers have discussed the role of laws such as the "Cybersecurity Law" and the "Personal Information Protection Law" in the protection of user information. Researchers analyzed the effectiveness of current laws on user information protection and pointed out the problems of legal defects and insufficient enforcement[7]. User behavior and awareness: Some scholars have found through research that users generally lack awareness of personal information protection, especially in the use of social media and mobile applications, users often ignore the importance of privacy settings [8]. Technology and security measures: Some scholars have studied the application of technologies such as multi-factor authentication and data encryption in protecting user information, emphasizing the interactive relationship between technical measures and user behavior [9].

2.2 Research on the security protection of user personal information abroad

Foreign research is more diverse, mainly including the following aspects: Information privacy theory: Western scholar Solove has developed information privacy theory, explored the relationship between the privacy rights of personal information in a digital environment and legal protection, and proposed a multi-level privacy protection framework [10]. Psychological Perspective: Researchers analyze users' personal information protection behavior from a psychological perspective. Madden et al.'s research shows that users' perception of privacy is significantly related to their information sharing behavior [11]. Industry application case: Kumar conducted an in-depth analysis of personal information protection in the medical industry, pointed out the privacy risks and legal challenges faced by medical institutions when processing user health data, and put forward suggestions for improvement [12]. This study highlights the importance of industry-specific privacy needs and risk management strategies. Social impact and cultural differences: Research also focuses on the impact of social culture on user information protection behavior. Smith et al. proposed that there are significant differences in privacy expectations and information sharing behaviors of users in different countries, which is closely related to cultural background and social trust level[13].

2.3 Comparative study on the security protection of user personal information in China and abroad

Comparison of Chinese and foreign studies shows that although there are similarities in the research

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on user personal information security protection at home and abroad, there are obvious differences in research priorities and methods. Domestic research focuses more on the formulation and implementation of laws and regulations, while foreign research focuses more on user behavior, psychological factors and the application of technology in information protection. For example, through comparative analysis, Zhou Li found that European and American countries have more perfect legislation on the protection of user personal information and stronger legal enforcement, while China is relatively lagging behind in technology application and user education[14]. This discovery provides reference for my country to improve its personal information protection policy.

3. Visual analysis of user personal information security protection theory

3.1 Source of research data

The data in this study mainly come from multiple authoritative academic databases, such as China National Knowledge Infrastructure (CNKI), WebofScience, Scopus, etc. By setting specific search keywords in these databases, such as "user personal information security protection", "personal information privacy", "information security management", etc., relevant academic literature, research reports, dissertations and other materials are collected. Supplementary information is also obtained from policy documents and statistical data on personal information protection released by government departments and industry associations, as well as relevant security reports and monitoring data released by well-known network security companies to ensure the comprehensiveness, authority and timeliness of the data and provide a solid data foundation for subsequent visual analysis.

3.2 Metric visual analysis tools and charts

Visual analysis of user personal information security protection research. Intuitive analysis is carried out based on studies with high citation rates or representative citations among these theoretical achievements, including overall trend analysis, main topic distribution analysis, secondary topic distribution analysis, discipline distribution analysis, literature source distribution analysis, academic attention analysis, etc. The full text of China National Knowledge Infrastructure (CNKI) was searched and quantitatively analyzed with the theme of "User Personal Information Security Protection". The visual chart is presented as follows. Overall trend analysis is shown in Figure 1:

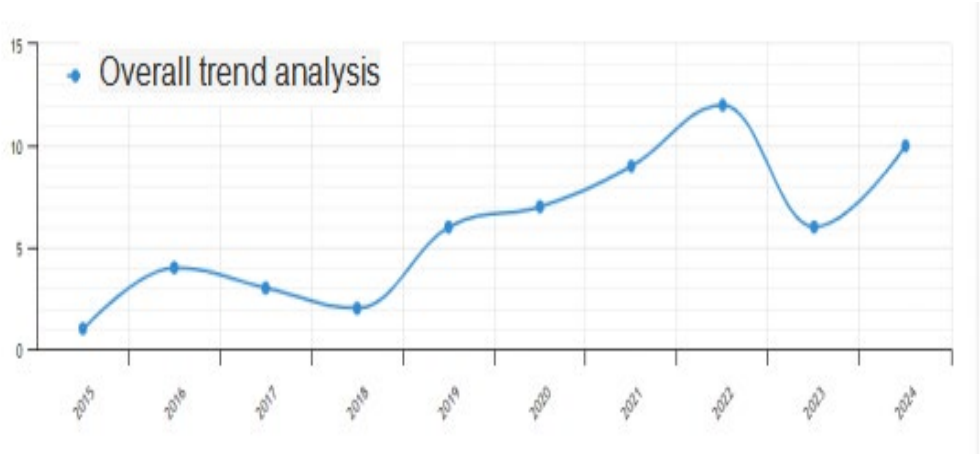

Figure 1 Overall trend analysis diagram

Overall trend analysis chart (Figure 1): Overall trend analysis chart (Figure 1): Based on the keyword "User Personal Information Security Protection" as the theme, the overall trend analysis is conducted, and the annual number of documents issuances are counted to show the overall trend of the research situation.

Analysis of the main theme distribution (Figure 2): Based on the keyword "User Personal Information Security Protection" as the theme, the main theme distribution analysis was conducted, and the annual number of documents was counted, and most of the research shows that the topics of "personal information protection" and "personal information" were studied.

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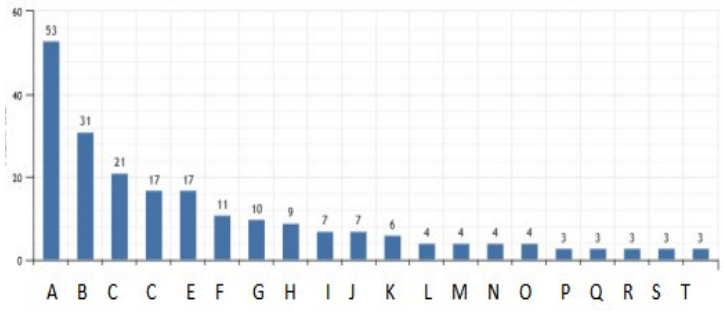

Figure 2 Main topic distribution diagram

Discipline distribution analysis (Figure 3): Most of the research and publications are published in disciplines such as "computer software and computer applications", "administrative law and local system", "civil and commercial law", "administrative science and national administrative management", and "public security". Analysis of the distribution of literature sources : According to the large number of literature, most of the journal "Information Security Research" has the content in security technology, application research, practical research, etc. Most of the research in other journals focuses on subject teaching, engineering and project management, safety technology and application research, etc.

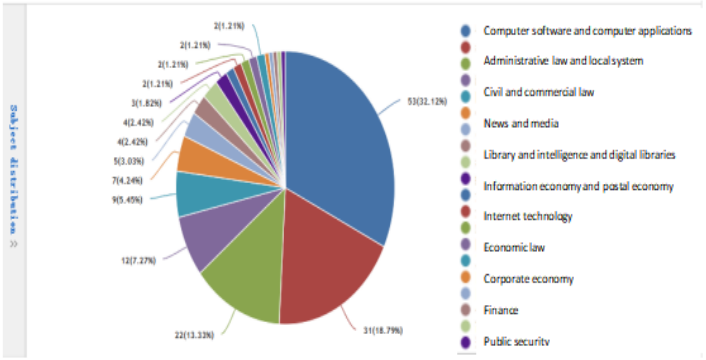

Figure 3 Discipline Distribution Analysis

Academic attention analysis (see Figure 4): Comparative analysis of the number of research keywords. From 2015 to 2024, with "personal information protection" as the keyword, representative high citations were selected for comparison and analysis. The research shows that based on the intuitive analysis of academic theoretical achievements, the overall trend of domestic and foreign countries was on the rise at the same time, further reflecting the current status and trend of studying the "personal information protection" of this topic.

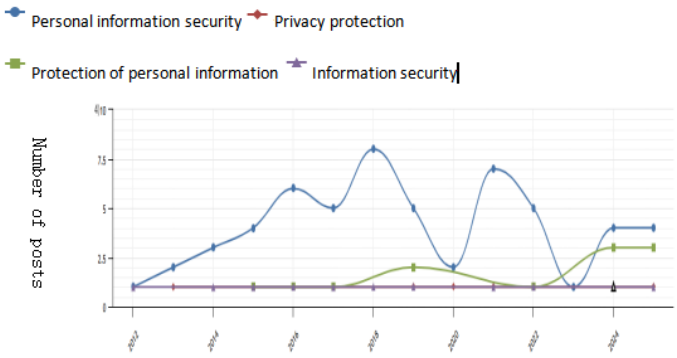

Figure 4 Keyword comparison analysis

In addition, many scholars in China use a variety of advanced visual analysis methods and tools. They use CiteSpace software to draw a knowledge graph, and by analyzing the citation relationship between literatures, it shows the knowledge structure, key research issues and the distribution of

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important research contributions in the field of user personal information security protection. The VOSviewer software is used to visually display the keyword co-occurrence network, and intuitively present the correlation intensity and frequency between different keywords, thereby revealing the core research topics and cutting-edge directions in this field. With the help of data analysis software such as Excel and SPSS, the collected data is statistically analyzed, correlation analysis, etc., and the laws and features behind the data are deeply explored in a quantitative manner, providing strong support for the conclusion of research conclusions.

3.3 Presentation and interpretation of visual analysis results

Through knowledge graph analysis, it was found that in the field of user personal information security protection research, early research mainly focused on the construction of basic theories and the discussion of legal policies. Over time, research on technology application and innovation has gradually increased, such as data encryption technology, access control technology, etc. have become research hotspots. From the perspective of keyword co-occurrence network, keywords such as "personal information", "information security", and "privacy protection" appear frequently and closely related to each other, indicating that these are the core concerns in this field. The keywords of emerging technologies such as "big data", "artificial intelligence" and "blockchain" are increasingly closely related to personal information security protection, showing that with the development of technology, the application and integration of these emerging technologies in personal information protection has become an important research trend. Through statistical analysis of the data, it was also found that there were certain differences in research priorities and methods in different regions and disciplines. For example, domestic research focuses more on analyzing in combination with domestic laws and regulations and actual cases, while foreign research has more in-depth explorations in technological innovation and international cooperation. These visual analysis results help to comprehensively and intuitively understand the current status and development trends of user personal information security protection research, and provide valuable reference for further research and decision-making.

4. Research Discovery and Discussion

In research based on network metrology, there are some representative studies, and their similarities and differences in research design, theoretical contribution, practical application, and visualization methods are as follows:

4.1 Research design

Some studies use network metrology methods for data analysis to identify research hotspots and trends in the field of information protection. These studies are often visually analyzed using bibliometric tools such as VOSviewer and CiteSpace. Sample selection: Some studies have selected specific areas (such as social media, e-commerce) for in-depth analysis, while others have adopted a broader perspective covering multiple areas.

4.2 Theoretical contributions

Different theoretical frameworks: Some studies have established a theoretical framework based on the technology acceptance model (TAM) to explore the user's acceptance of privacy protection technology (Johnson, 2020)[15]; while others focus more on the interaction between law and technology (Smith, 2019)[16]. Theoretical applicability: Some studies fail to verify the universal applicability of their theories in different cultural contexts, which needs to be considered in future research.

4.3 Practical application of policy recommendations

Some studies provide specific recommendations for policy makers, such as improving the implementation of information protection regulations , while others focus on promoting technological innovation and user education (Wang, 2022)[17].

Technology application: Some studies emphasize the key role of technology in protecting user privacy and propose specific technical solutions (Johnson, 2020)[15], while others pay more attention to changes in user behavior and enforcement of laws(Smith, 2019)[16].

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4.4 Visualization method

Visual analysis of user personal information security protection has been an important direction in network metrology research in recent years. By using charts and network diagrams, researchers can intuitively demonstrate the relationship between user behavior, information flow and safety risks. For example: Data visualization method: Zhang Jian (2022) uses network graph technology to show the user's information sharing mode on social media, and finds that the relationship between user information sharing behavior and privacy settings is not as expected (Zhang Jian, 2022)[18]. This study emphasizes the importance of visualization tools in information security research. Dynamic monitoring: Li Xiaoming (2023) uses big data analysis technology to dynamically monitor the privacy settings of social platform users, providing a framework for real-time monitoring of user behavior and information leakage risks (Li Xiaoming, 2023)[19]. Research shows that through visualization technology, researchers can promptly identify potential security threats and provide users with personalized security suggestions. Behavior pattern recognition: Wang Gang (2022) analyzed the user's behavior patterns online through machine learning algorithms and discovered the association between specific behavior patterns and information leakage risks. This research not only provides new insights in the field of information security, but also provides a basis for the formulation of user information protection strategies (Wang Gang, 2022)[20].

5. Conclusion

The security protection of user personal information is a complex and multi-dimensional topic, involving multiple aspects such as technology, law, social culture and user awareness. Effective information protection requires the synergy of these factors to establish a safe and reliable network environment. By improving the degree of perfection of laws and regulations, enhancing the public's security awareness, and promoting the combination of technology and laws, the security of user personal information can be effectively improved.

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