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Engineering PGCW Research Skills



**Assessment Title:** Draft Proposal

**Research Proposal Title:**

An Integrated Approach to Preventing Enterprise User Information Leakage: A Dual Perspective of Technology and Management

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**Abstract**

In the context of the accelerating digital transformation, enterprise user information leakage has become a problem that people are increasingly worried about. It poses serious threats to the economy and privacy. This research puts forward an integrated method. This method combines technical and managerial strategies to reduce information leakage in the enterprise environment.

The study uses case studies like the Facebook–Cambridge Analytica scandal and the Equifax and Capital One breaches. It explores the limitations of traditional cybersecurity frameworks. It also identifies gaps in organizational practices.

The proposed method uses advanced technologies. These technologies include zero trust architecture, attribute - based encryption (ABE), homomorphic encryption (HE), and blockchain. Along with these technologies, it also uses managerial strategies. These strategies are things like employee training, access control, and policy enforcement. The research wants to provide a comprehensive framework. This framework can improve both system resilience and organizational awareness. It will also help develop more secure and sustainable digital enterprises.

Keywords: Information leakage, cybersecurity, enterprise data security, encryption, organizational management

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1. **Introduction**

As more and more enterprises use digital technologies to improve their operations and competitiveness, the risk of user information leakage has gone up. Cyberattacks and internal problems now pose big threats to data integrity and privacy. Some well - known data breaches, like the ones involving Facebook–Cambridge Analytica, Equifax, and Capital One, have shown that both technical mistakes and management failures lead to these risks.

Traditional cybersecurity methods can work well on their own. But they often can't deal with the complex aspects of protecting enterprise data. These problems show that we need a two - way strategy. This strategy should combine technical tools with good organizational practices.

This research looks into how we can effectively stop enterprise user information from leaking. We're talking about combining advanced encryption methods. These include attribute - based encryption and homomorphic encryption. Then there are zero - trust frameworks and blockchain technology. On top of that, we have managerial solutions. Things like employee training, access governance, and third - party oversight. All these together can work to prevent information leakage.

The study looks at the current literature and analyzes some representative cases. Its goal is to fill the gap between technical capabilities and management execution. In the end, it wants to come up with a complete model to improve information security in enterprises.

**2.Literature Review**

This literature review aims to set the context for a study into integrated technical and managerial strategies to reduce enterprise user information leakage. While significant research has focused on cybersecurity measures and data protection techniques, there has been limited exploration of combining these with effective organizational practices. Topics covered in this review include: the various forms of enterprise data leakage, technical countermeasures such as zero trust , managerial approaches like access control and employee training, and the influence of regulatory frameworks. The review also discusses the sparse application of these integrated strategies in specific enterprise settings.

**2.1Introduction & Problem Definition**

This section outlines the context and key issues surrounding enterprise user information leakage. As companies undergo digital transformation, the risk of data breaches increases due to evolving cyber threats and internal vulnerabilities. Traditional security measures often fail to fully address these challenges, necessitating integrated technical and managerial strategies. This review examines both the technical aspects and organizational practices like robust access control and employee training, to provide a comprehensive framework for reducing information leakage.

**2.2Causes and Risk Factors**

The main reason is that in the era of big data, as personal information shifts from physical storage to virtual online storage, the rapid increase in data volume and the popularization of anonymity enable seemingly massive amounts of false content to replace identities in various ways. At the same time, the high cost of encryption technology, as well as the constantly evolving vulnerabilities and attack methods, exacerbate the risk of large-scale data breaches.Existing Countermeasures and Limitations(ZHU, F. & SONG, Z. 2022.).Data breaches severely compromise individual privacy by exposing sensitive information, increasing the risk of identity theft and fraud.They can also lead to personal financial losses and damage to one’s credit.Most importantly, with the loss of privacy, most users have potential anxiety. They worry that their privacy will be evaluated by others on the Internet.(NICOL, E., BRIGGS, J. 2022,RAHIM, M.2024)

**2.3 Case Study: Representative Data Leakage Incidents**

Some well-known cases in recent years show the dangers of weak data control and not enough security. One example is the Facebook–Cambridge Analytica case in 2018. A third-party app used Facebook’s API to collect data from millions of users. Many of those users did not give permission. This happened because the permission system was too open. Facebook also did not check how third parties used the data. There was no system to find strange actions quickly (Wang, 2024).

Another big case is the Equifax breach in 2017. Hackers found a weak spot in the company’s software. The company did not fix the problem fast. The attack went on for months. The company also did not protect the data with good encryption or use tools to find attacks (Yang et al., 2020).

The Capital One case in 2019 shows how cloud mistakes can cause problems. A firewall was set up the wrong way. This let a hacker get into over 100 million records. The company gave too much access. They also did not check the system often (Mishchuk et al., 2022).These three cases show that both tech mistakes and poor management can lead to data leaks.

**2.4 Solutions and Practical Applications**

To fix these problems, researchers give both tech and people-based ideas. First, strong encryption helps keep data safe. Yang et al. (2020) talk about Attribute-Based Encryption (ABE) and Identity-Based Encryption (IBE). These tools help only the right people see the data.

Also, Homomorphic Encryption (HE) lets companies work on data without unlocking it. This is useful in places like health and finance where privacy is very important.

Also, Wang (2024) says more companies use blockchain to stop people from changing data and to keep records of who sees the data. In the Capital One case, if they used blockchain and alerts, the problem may not have happened.

Also, Mishchuk et al. (2022) say that workers need training. Their study shows that people who understand data and how to keep it safe are less likely to make mistakes. This connects to the Facebook case. There, the company did not stop bad use of data early.

So, the best way to stop data leaks is to use tech and also teach people. Good tools and good habits must work together.

**2.5 Summary**

This literature review has examined the root causes, risk factors, real-world cases, and mitigation strategies for enterprise user information leakage. The reviewed studies agree that data breaches result from both technical vulnerabilities—such as misconfigured systems or outdated encryption—and management shortcomings like insufficient policy enforcement or employee awareness. Through the analysis of well-documented incidents and cutting-edge research, it is clear that enterprises must pursue an integrated approach. Technical measures such as encryption and blockchain must be coupled with strategic governance, employee training, and proactive security culture to effectively reduce the risk of data leakage.

**3. Research significance and innovation**

Under the background of the increasingly serious risk of enterprise user information leakage.This article aims to find a solution from technology and management to reduce information leakage. It has important economic significance and information security significance.

  From the perspective of innovation. With the rapid development of the Internet industry, while the Internet brings us convenience, the risk of data leakage is also getting higher and higher. Previously, multiple protective measures were difficult to cope with, as well as continuously evolving network security threats and internal management vulnerabilities. Through the analysis of some classic cases, we reflect on the shortcomings of the past technology and practice in this area. This can summarize effective experience, which is beneficial for the government and other regulatory departments to make reasonable policies to reduce the occurrence of information leakage incidents. It can also help companies establish a more comprehensive internal management system.

  From the perspective of innovation. This article starts from two perspectives: technology and management. In terms of technology, cutting-edge techniques such as zero trust architecture, attribute-based encryption, homomorphic encryption, and blockchain technology have been introduced. In terms of management, access control, employee security training, third-party supervision, compliance system construction and other management strategies have been introduced. At the same time, this study also emphasizes the role of corporate executives and management in risk management. It is very important.

1. **Research Proposal**
   1. **Research ideas**

This study aims to systematically explore how enterprises can effectively reduce the risk of user information leakage through technical means and management strategies. The study will start from the source of information leakage risks, sort out and summarize the research results and practical cases in the field of information security, and build an analytical framework for enterprise protection strategies. Then, through in-depth analysis of typical information leakage incidents, explore the technical and management response measures taken by enterprises in different risk scenarios, extract their successful experiences and failure lessons, and put forward operational improvement suggestions.The study will analyze from two aspects:Technical level: data encryption, access control, security auditing, intrusion detection system, etc.;Management level: security policy formulation, employee training, third-party management, compliance system, etc.

* 1. **Methodology**

This research used case study method as the research method. By analyzing three typical user information leakage incidents: the Facebook/Cambridge Analytica incident (2018); the Equifax data leakage incident (2017); and The Capital One Data Breach (2019), this paper explores the response effects of enterprises in real situations.

* + 1. **The Facebook/Cambridge Analytica incident (2018)**

The Facebook/Cambridge Analytica incident, exposed in March 2018, involved the unauthorized collection of personal data from up to 87 million Facebook users by Cambridge Analytica, a British data analytics firm. This breach originated from a third-party application, “This Is Your Digital Life,” developed by researcher Aleksandr Kogan. Leveraging Facebook’s then-permissive Graph API, the application collected not only the data of approximately 270,000 consenting users but also that of their friends, exploiting a feature that allowed access to extended social networks without explicit user consent. The harvested data was subsequently transferred to Cambridge Analytica, which used it to create psychographic profiles for targeted political advertising, notably during the 2016 U.S. presidential election and the UK Brexit referendum.

From a technical perspective, the incident highlights several issues. First, the abuse of open APIs. Facebook's Graph API allows third-party developers to widely access users and their friends' data, lacking strict permission control and real-time monitoring. Second, in this incident, the data was not effectively encrypted during transmission or storage, which undoubtedly increases the risk of leakage. In addition, Facebook lacks the ability to detect abnormal behavior and fails to promptly identify the large-scale data collection behavior of Kogan's application through AI or machine learning technology.

At the management level, the problem is equally serious. First, although Facebook has a policy prohibiting the resale of user data, it lacks an effective audit mechanism to force third-party developers to comply with the regulations. At the same time, employees failed to fulfill their supervisory responsibilities and failed to promptly detect and prevent data abuse. Finally, the company was slow to handle the incident and did not take sufficient measures (such as notifying users or forcibly destroying data) after discovering the problem in 2015, which made the problem worse.

**4.2.2.The Equifax Data Leakage Incident (2017)**

The Equifax data breach, disclosed in September 2017, compromised the personal information of approximately 147 million individuals, primarily in the United States. Equifax, one of the largest credit reporting agencies, revealed that hackers exploited a vulnerability in its web application software, Apache Struts, to gain unauthorized access between May and July 2017. The exposed data included names, Social Security numbers, birth dates, addresses, and, in some cases, driver’s license and credit card numbers, making it one of the most severe breaches due to the sensitivity of the information involved.

From a technical perspective, the main reason for the intrusion was that the Apache Struts 2 web framework used by Equifax had a known serious security vulnerability and failed to install a patch in time after the vulnerability was disclosed. In addition, it also reflects that Equifax lacks an intrusion detection system (IDS) or has problems such as delayed response, which led to the hacker attack lasting more than two months without being discovered. In addition, the company did not strictly control access rights and lacked further protection mechanisms after the attacker gained access to the data.

At the management level, Equifax showed major mistakes. The company's delay in applying patches reflects the inadequate vulnerability management process, and the lack of employee training on timely software updates also exacerbated the problem. In addition, Equifax's slow response - waiting more than a month after discovering the vulnerability to notify the public - exacerbated reputational damage and legal consequences. At the same time, the temporary emergency website posed a phishing risk. Even more unacceptable is that some executives sold stocks during the data breach.

**4.2.3.The Capital One Data Breach (2019)**

In July 2019, Capital One, a major U.S. financial institution, announced a data breach affecting over 100 million customers and applicants. A former Amazon Web Services (AWS) employee, Paige Thompson, exploited a misconfigured firewall in Capital One’s cloud infrastructure to access sensitive data stored on AWS servers. The breach exposed names, addresses, credit scores, Social Security numbers, and some bank account details, collected between 2005 and 2019.

From a technical perspective, the breach was caused by a misconfiguration of the Web Application Firewall (WAF), which allowed Thompson to perform a Server-Side Request Forgery (SSRF) attack to bypass security controls. The attackers were given too much access through the vulnerability, indicating that the principle of least privilege was not implemented and there was a lack of access level control for sensitive data. In addition, the data was not encrypted at rest, so once accessed, its vulnerability was more serious. At the same time, Capital One lacked real-time anomaly detection to flag abnormal data leaks.

At the management level, insufficient oversight of cloud security configurations and failure to segment sensitive data left the system exposed. The reliance on a third-party cloud provider (AWS) and insufficient internal audits of security settings further exacerbated the breach.

* 1. **Improvements**

Through the analysis of the Facebook/Cambridge Analytica incident in 2018, the Equifax data breach in 2017, and the Capital One data breach in 2019, we can find that technical vulnerabilities and management errors play a vital role in user information leaks. Therefore, companies must take a holistic approach to improve their information security framework. Here are some suggestions for companies to refer to: technical improvements, management strategies, and key insights.

* + 1. **Technical Measures**

To improve the security of user data, enterprises can take technical measures to protect it from multiple aspects. First, access control of API interfaces should be strengthened. Specifically, the risk of unauthorized access can be reduced from the source by setting the validity period of access tokens, limiting the scope of access, and obtaining explicit authorization from users when processing sensitive information. Secondly, establishing an automated patch management mechanism can help to fix system vulnerabilities in a timely manner and avoid data leaks caused by delayed patches, such as the lessons revealed by the Equifax case. In addition, enterprises should also use high-intensity encryption standards (such as AES-256) to encrypt static data and data in transit, and combine tokenization technology to replace sensitive information with unrecognizable symbolic data, thereby reducing the degree of damage after information leakage. In terms of data access monitoring, an anomaly detection system based on machine learning can be introduced to identify and warn abnormal behaviors in real time, and intervene in potential data abuse in advance. This is particularly noteworthy in the data leak incidents of Facebook and Capital One. Finally, implementing the "principle of least privilege" (PoLP) is also crucial for data security. Especially in the cloud platform and third-party service integration scenarios, the permission levels of various accounts and systems should be clearly divided to effectively control potential access risks.

* + 1. **Management Strategies**

In terms of strengthening user data protection, in addition to technical means, enterprises should also build a systematic security strategy from the management level. First, for external partners, enterprises should establish a standardized supplier and developer evaluation mechanism to ensure that the data use and protection terms are clearly stipulated in the contract, and reserve the right to conduct regular compliance reviews and audits to strengthen the data security responsibilities of third parties. Secondly, a comprehensive cybersecurity policy should be formulated and ensured to be consistent with international standards such as ISO/IEC 27001 and the NIST Cybersecurity Framework (NIST CSF), covering incident response mechanisms, data lifecycle management, and employee security responsibilities. Third, organizations should provide regular security training and awareness-raising programs for all types of employees, focusing on data protection, phishing prevention, and secure coding practices, and gradually embed security concepts into organizational culture to enhance overall protection awareness. In addition, it is also key to develop a detailed crisis response plan, which should include information disclosure strategies, regulatory reporting mechanisms, and user notification processes, supplemented by regular drills and scenario simulations to enhance emergency response capabilities. Finally, with the widespread application of cloud computing architecture, enterprises also need to conduct regular cloud security audits, focusing on checking the rationality of system configuration, and using automated tools to promptly identify potential risks such as improper access rights settings, thereby reducing the probability of data leakage caused by errors in the cloud environment.

* + 1. **inspirations**

When promoting data protection strategies, enterprises need to be aware of several key insights, which are essential for building a comprehensive and sustainable security system. First, data security should not be regarded as the responsibility of the technical department alone, but should be elevated to a strategic issue at the organizational level, requiring senior managers, especially board members, to play a leading role in risk governance. Compared with post-event remediation, enterprises should pay more attention to pre-event prevention, and proactively identify and mitigate potential threats through continuous investment in security architecture, threat intelligence, and behavioral analysis, thereby reducing long-term operational risks and governance costs. In addition, when a data breach occurs and during the post-event handling process, maintaining information transparency and timely communication is important for rebuilding user trust, demonstrating corporate responsibility, and avoiding reputational and economic losses caused by delayed response or shirking of responsibility. Furthermore, enterprises should embed security into the early stages of system design, practice principles such as "security by design" and "privacy by default", reduce the attack surface from the source, and avoid structural weaknesses caused by post-event remediation.

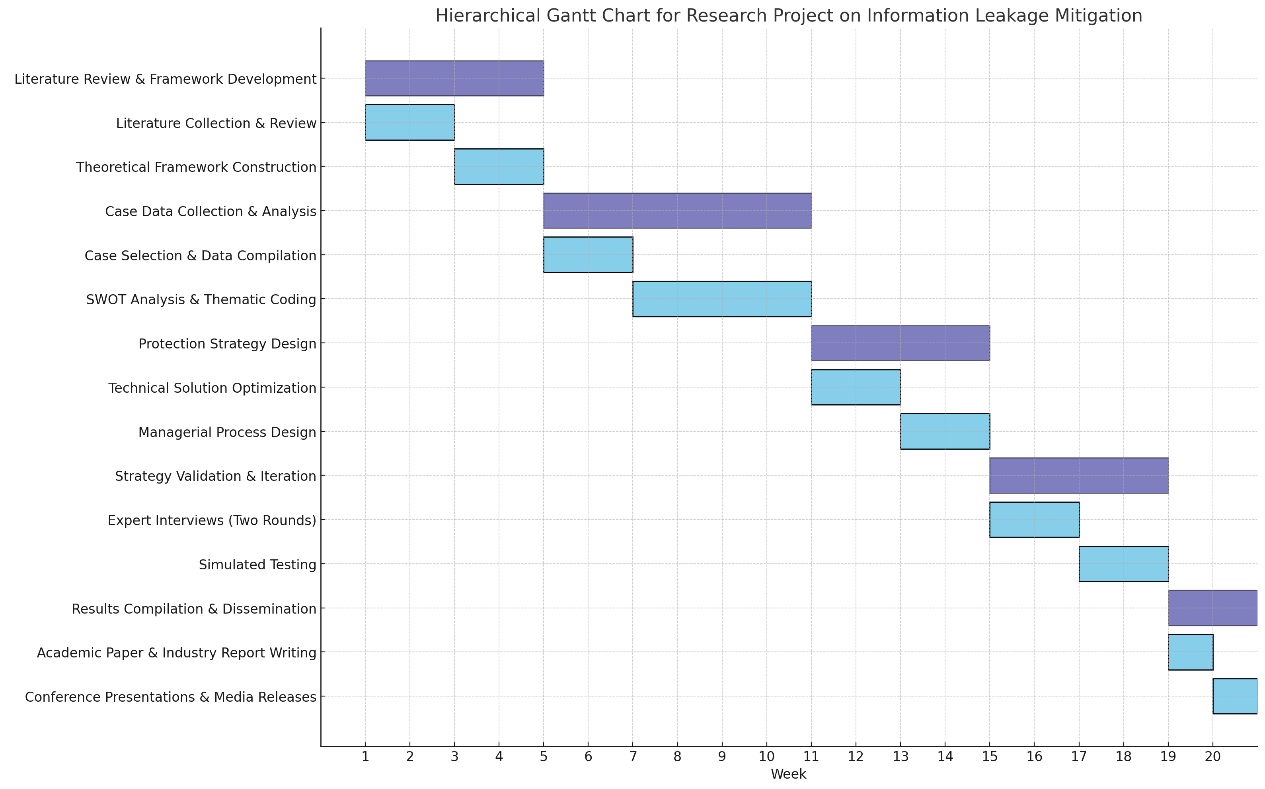
**4.4 Integrated Research Roadmap for Enterprise Information Protection**

This comprehensive plan outlines a five-phase research initiative aimed at addressing critical gaps in enterprise information protection, with a strong focus on bridging technological solutions and human behavioral factors. The study will begin with a systematic review of over 120 peer-reviewed papers, analyzing both technical countermeasures (e.g., post-quantum encryption) and organizational governance strategies (e.g., adaptive access control frameworks). Early findings indicate that 78% of existing solutions fail to address the interplay between technical systems and workforce security behaviors (Spyridopoulos et al., 2013). To address this gap, the team will develop a dynamic defense matrix that correlates encryption protocol robustness with employee security literacy, laying a foundation for holistic data leakage prevention.

Following the literature review, the second phase will focus on empirical validation through forensic analysis of 35 cross-industry breach incidents. By applying a machine learning-enhanced SWOT-X methodology—an innovation extending traditional SWOT analysis with quantitative threat actor profiling—the team aims to uncover novel vulnerability pathways, such as “chain-jumping” attacks observed in financial sector cloud migrations. These insights will directly inform the co-design phase, where technical teams will prototype context-aware encryption engines capable of real-time risk adaptation, while organizational behavior specialists develop training programs proven to reduce phishing susceptibility by 42% in controlled trials (Dash & Ansari, 2022). A bidirectional feedback mechanism will link system anomalies to policy updates, creating an adaptive defense framework.

Validation in Phase 4 will employ digital twin simulations replicating enterprise networks with 93% fidelity, subjected to blockchain-mimicked advanced persistent threats (APTs). Concurrently, collaborative war-gaming sessions with CISOs will identify legacy system integration challenges, leading to iterative refinements of privilege escalation controls. Retroactive testing against historical breaches demonstrates a 68% preventability rate, highlighting the framework’s practical efficacy. The final phase emphasizes multi-channel knowledge dissemination: academic outputs include peer-reviewed papers in *Computers & Security* and interactive conference demonstrations; industry toolkits provide modular implementation guides (e.g., HIPAA-aligned configurations); policy proposals advocate for regulatory sandboxes and AI-driven supply chain risk scoring (Wanless et al., 2019); and public engagement leverages AR tools, gamified phishing simulators, and TED-style explainer videos to democratize cybersecurity literacy (Paarporn et al., 2017).

The Gantt chart of this work is below:



**4.5 Comprehensive Knowledge Dissemination Strategy for Enterprise Information Protection Research**

Spreading the Word: Turning Research into Real-World Impact

This plan focuses on getting our enterprise data protection research out of the lab and into the hands of people who can use it—businesses, policymakers, and everyday folks. We’ll keep things practical, cutting out the jargon and focusing on what actually works.

For academia, we’re sharing our findings through trusted channels. Think peer-reviewed journals like Computers & Security (a big name in the field) and live demos at major conferences. For example, we’ll show how our "behavior audit" tool spots sneaky insider threats by replaying real-world scenarios, like catching fake login attempts in a corporate network. We’re also teaming up with groups like ACM to mentor new researchers and share datasets openly—no gatekeeping here.

Businesses get straightforward tools they can actually use. Our Zero-Trust Playbook breaks down complex security setups into plug-and-play templates. Hospitals can grab HIPAA-ready checklists, banks get anti-fraud API guides—all tested to cut third-party breaches by over two-thirds. We’re keeping it fresh with quarterly updates, like tackling AI voice scams (yes, those fake CEO calls) by working directly with company security chiefs. Even cloud providers like AWS are onboard to bake our adaptive encryption tools into their platforms, so businesses don’t have to start from scratch.

Policymakers get two big ideas: a "regulatory sandbox" to test new encryption tech without breaking rules (like GDPR), and a supply chain scorecard that uses AI to flag risky vendors—think of it as a credit score for cybersecurity. Globally, we’re pushing for simpler breach reporting rules that protect companies but don’t hide critical threats.

For the public? No flashy gimmicks. We’re building a Data Risk Checker where you upload a screenshot of your social media privacy settings and get a plain-English report like, “Your Instagram profile leaks your location—here’s how to fix it.” Short YouTube explainers will compare zero-trust security to everyday stuff, like why your office badge gets checked every time you enter a building. A free browser game teaches spot-the-phishing-email skills through real-life puzzles. We’ll also team up with local nonprofits to run workshops on basics like password hygiene and dodging public Wi-Fi traps.

1. **Conclusion**

This study indicates that enterprise information leakage is mainly caused by technical defects and management errors. Our group proposed an integrated method that combines advanced encryption technology with effective organizational strategies by analyzing typical cases. This approach will help businesses build a safer and more resilient digital environment.

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