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Research on Procurement Risk Management in Polymer Materials Companies

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Abstract: This study focuses on polymer materials companies and identifies three major categories of risks in their procurement processes. The first category comprises data and information security risks, including external cyberattacks and improper internal employee operations, which may lead to the leakage of commercial secrets such as procurement plans, supplier lists, and specialty resin supply channels. The second category involves supplier management risks. Some suppliers lack adequate technical capabilities and standardized data management. Compounding this issue, firms tend to over-rely on digital platforms while neglecting on-site audits, resulting in order matching errors, increased reconciliation costs, and greater difficulty in ensuring self-sufficiency and control over key raw materials. The third category concerns personnel and organizational risks. Digital transformation introduces unclear role definitions, cross-functional communication breakdowns, and a shortage of employees' digital skills, which in turn create misalignment between system development and business needs, extend project timelines, and raise costs. To address these risks, this study proposes the following management strategies: strengthening data security protection, implementing end-to-end supplier management, and optimizing personnel and organizational management. Our findings indicate that polymer materials companies must simultaneously enhance technical safeguards, improve management systems, and invest in employee training to effectively mitigate procurement risks and enhance supply chain stability. Future efforts should also focus on emerging requirements such as green supply chains and industrial chain security, steering procurement risk management toward proactive prevention.

Keywords: Polymer Materials Companies; Procurement Risk Management; Data and Information Security; Supplier Management; Digital Transformation

1. Introduction

A strong chemical industry serves as a critical pillar for a strong manufacturing nation. The decade from 2025 to 2035 represents a pivotal period for China to strategically transition from the world's largest chemical producer to a truly world-class chemical power. Driving this historic leap has become the core agenda and generational mission for the entire industry. Within this process, new chemical materials, particularly polymer materials, have emerged as the frontier for China's pursuit of technological self-reliance and strength. Their technological breakthroughs and stable supply directly bear on national industrial chain security and core competitiveness, as the country gradually breaks free from the long-standing monopoly of overseas technologies.

Polymer materials—key materials centered on macromolecular chains—offer irreplaceable advantages in lightweighting, corrosion resistance, ease of processing, and functional designability. They have been deeply integrated into everything from high-end equipment manufacturing to daily consumer goods, serving as a critical material foundation for modern industrial systems and high-tech industries. Therefore, vigorously developing high-performance, functional, and green polymer materials is not only an inevitable choice for meeting major national strategic needs and transforming China from a large chemical producer into a strong one; it is also a strategic focal point for China to proactively participate in and win future global technological and industrial competition. The flourishing development of this field, in turn, places higher and more complex demands on upstream supply chain stability and risk management.

Against this backdrop, polymer materials

companies play a vital role in connecting upstream and downstream segments of the industrial chain. Their procurement operations determine production costs and product quality, while also profoundly affecting technology transfer efficiency and supply chain stability. However, the polymer materials industry exhibits several distinctive characteristics—diverse raw material sources, significant price volatility, strong technological dependence, and relatively concentrated suppliers—that introduce substantial uncertainties into the procurement process. Existing research on procurement risk management in polymer materials companies remains fragmented and somewhat outdated. Most current literature focuses on procurement process optimization in general manufacturing or the petrochemical industry, lacking a systematic analytical framework tailored to the polymer materials sector, where technological, market, and policy risks often intertwine. Moreover, these studies insufficiently address how risk identification, assessment, and response strategies differ across firms with varying scales and product portfolios.

In response, this study takes procurement risk management in polymer materials companies as its core research question, systematically identifying procurement risks and proposing corresponding management strategies. The research aims to enhance the procurement risk management capabilities of these firms, thereby ensuring their supply chain stability and competitiveness. It also offers useful references for other materials manufacturers facing similar challenges.

2. Literature Review

Procurement risk identification, a critical component of enterprise procurement management systems, refers to the process of systematically identifying, analyzing, and categorizing various potential risks within procurement operations. This process aims to enable early warning and proactive risk control, playing a key role in ensuring supply chain stability, controlling procurement costs, and enhancing overall operational efficiency.

In studies on the objects of procurement risk identification, scholars have conducted systematic explorations across different levels, ranging from macro-level cross-border operations and internal firm processes to specific public sectors and industries. At the macro level, Ganbat et al. used international engineering projects as examples to reveal the theoretical mechanisms and response strategies for various risks, including procurement, thereby broadening systematic understanding of cross-border procurement risks [1]. In recent years, with advances in data technologies, risk identification methods have increasingly emphasized quantitative precision and intelligent prediction. For instance, Fleuren et al. stressed improving the accuracy of identifying risks and demand fluctuations through rigorous quantitative analysis [2]. Jian et al. further applied machine learning to complex procurement environments, constructing a hybrid learning model to support data-driven risk identification and prediction [3]. Thus, procurement risk identification methods have evolved from theoretical classification to systematic analysis, gradually integrating data intelligence technologies to form a multi-method, dynamic-static identification system.

Procurement risk response refers to the process of taking targeted measures for high-probability, high-impact procurement activities based on risk assessment results. Bart et al. examined the dual risks of procurement and innovation faced by governments in promoting green innovation, emphasizing that public sectors need to build effective risk response mechanisms by actively embracing risk and deepening organizational collaboration. Their findings offer important references for green procurement risk management in the public sphere [4]. Building on this, SpendEdge highlighted the critical role of early warning mechanisms and supply chain collaboration for stability and sustainability in biomass energy procurement [5]. Gallego developed a flexible material planning mechanism based on supplier behavioral differences using scenario simulation methods, providing adaptive strategies for organizations to cope with external fluctuations [6].

Further studies have underscored the importance of information sharing and decision-making mechanisms in risk prevention and control. Dekel focused on cognitive biases in government procurement, advocating for enhanced process transparency and improved decision procedures to mitigate human-induced risks [7]. Endo and Kamei similarly emphasized the need to strengthen risk information sharing within supply chains, pointing out that management's risk perception and leadership are

key factors affecting the effectiveness of corporate risk management [8]. Wang found, through a study of dynamic guarantee financing models, that information delays reduce guarantee fees, lower procurement efficiency, and affect supplier delivery performance [9]. Lingg et al. used the example of orthopedic medical device procurement in Mexico to argue that knowledge sharing—integrating clinical knowledge and making it openly accessible—can improve procurement mechanisms [10].

Moreover, with digital development, technology-driven risk monitoring has become a research focus. Banerjee proposed digitally monitoring procurement expenditures and setting abnormal indicators using internal and external data, enabling real-time identification and early warning of procurement cost risks [11]. Harju et al. based on a survey of procurement departments in Finnish companies, indicated that procurement digitalization enhances information processing capabilities and reduces supply chain uncertainty, deepening the understanding of the link between procurement digitalization and supply chain resilience [12]. Gurgun et al. took the construction industry as an example to study the transition from traditional procurement to e-procurement, proposing pathways to overcome implementation difficulties and thereby improve supply chain operational efficiency [13].

3. Procurement Risk Identification in Polymer Materials Companies

3.1 Data and Information Security Risks

During the procurement process in polymer materials companies that employ digital systems, a vast amount of sensitive data is generated and transmitted, including procurement plans, supplier lists, contract terms, and technical parameters of certain raw materials. The growing reliance on digital procurement platforms, while improving efficiency, also exposes firms to heightened risks of data breaches. Unauthorized disclosure or leakage of such confidential information could facilitate commercial fraud, enable unfair competitive practices, and directly undermine the company's market position and long-term profitability.

Polymer materials companies face data security risks from both external and internal sources. Externally, malicious actors such as hackers may exploit system vulnerabilities, deploy phishing emails, or launch ransomware attacks against procurement systems, potentially paralyzing operations and extracting sensitive data. Internally, improper employee operations, insufficient cybersecurity awareness, or inadequate access permission settings can lead to inadvertent data leakage or intentional unauthorized alterations. Moreover, procurement data in polymer materials companies often involve critical trade secrets—for instance, specialty resin supply channels, sourcing relationships for rare additives, or proprietary formulation recipes. The loss or exposure of such information not only harms immediate competitive advantage but may also compromise compliance with industry regulations and damage stakeholder trust. Consequently, robust and multi-layered data security management is particularly essential for this type of enterprise, demanding continuous investment in technology, processes, and human capital.

3.2 Supplier Management Risks

Polymer materials companies typically work with a large and diverse supplier base, whose capabilities vary considerably in terms of technical expertise, production capacity, data management standards, and operational reliability. When screening potential suppliers, excessive reliance on digital platforms may lead these companies to overlook non-digital yet critically important factors, such as supplier corporate culture, social responsibility performance, and long-term strategic alignment. While digital technologies significantly expand the pool of available suppliers and improve sourcing efficiency, a substantial number of suppliers lack the requisite technical capability to effectively interface with the purchasing firm's digital procurement systems. This technological gap impairs order processing, real-time information transmission, and automated workflow coordination, ultimately reducing supply chain responsiveness.

Moreover, certain suppliers fail to maintain disciplined data management practices. Their internal material coding schemes often deviate from the company's established standards, frequently causing order matching errors, delayed deliveries, and increased reconciliation costs. Because some polymer materials companies do not conduct sufficiently rigorous on-site audits or comprehensive vetting of suppliers' actual operating conditions, selected suppliers may fail to meet agreed-upon quality

standards and delivery timelines. In extreme cases, suppliers may even engage in fraudulent behavior—such as falsifying test reports or substituting inferior raw materials—imposing direct financial losses and reputational damage on the purchasing firm. Furthermore, when selecting suppliers for critical raw materials or strategically important components, polymer materials companies must also consider broader factors such as supply self-sufficiency, industrial chain security, and geopolitical risks. These additional dimensions further complicate supplier management, requiring firms to balance cost efficiency with resilience and long-term strategic autonomy.

3.3 Personnel and Organizational Risks

Digital transformation may also entail significant organizational restructuring and business process reengineering within the procurement department of polymer materials companies. Unclear role delineation during such transitions can lead to blame-shifting among positions, interdepartmental friction, and internal conflicts that undermine operational efficiency. For instance, companies may create new roles such as data analyst or digital supplier manager, or reintegrate traditional functions like procurement execution and contract management into hybrid positions. During the digital transformation of polymer materials companies, the organizational change risk faced by the procurement department is a complex, multi-dimensional issue that encompasses structural realignment, workflow redesign, and cultural adaptation. This risk can significantly affect both the effective functioning of the procurement function and the overall success of the firm's digital transformation journey.

Polymer materials companies typically emphasize cross-functional collaboration as a cornerstone of operational excellence. However, during the transition period, poor communication and incomplete coordination mechanisms between the procurement department and other key functions—such as information technology (IT) and finance—may cause the digital procurement system to diverge from actual business needs, thereby undermining transformation outcomes. Organizational change often disrupts existing collaboration patterns, making it difficult to establish new coordination mechanisms in a timely manner. For example, when implementing a digital procurement system, the procurement department relies heavily on the IT department for technical support, system integration, and ongoing maintenance. If the two departments lack effective communication channels and structured coordination protocols, the procurement department may fail to convey its system requirements clearly and comprehensively. Consequently, the IT department may develop a system that does not align with actual procurement operations—featuring mismatched functionalities, inefficient workflows, or missing critical features—thus seriously hindering the transformation's effectiveness and return on investment.

The digital transformation of procurement also places substantially higher demands on employee competencies. Staff members need to master new skills spanning information technology, data analytics, and digital platform management. However, some employees in polymer materials companies remain unfamiliar with digital procurement tools and lack the necessary data analysis capabilities, making it difficult for them to adapt to the transformation's requirements. This competency gap can undermine project implementation in multiple ways: delayed system adoption, increased error rates, reliance on external consultants, and resistance to change. Ultimately, this situation leads to extended project timelines, escalated costs, and suboptimal realization of the anticipated benefits of digital transformation. Therefore, proactive investment in training, change management, and skill development is essential to mitigate these personnel-related risks.

4. Procurement Risk Management Pathways for Polymer Materials Companies

4.1 Strengthening Data and Information Security Protection

Polymer materials companies can manage data and information security risks from both external and internal directions, adopting a multi-layered defense strategy that integrates technical safeguards, organizational policies, and human factors. For external protection, firms should conduct regular vulnerability scans of procurement systems to identify potential security gaps and promptly patch identified weaknesses. They also need to deploy robust antivirus software and advanced email filtering systems to prevent hackers from launching

phishing or deceptive email attacks, which remain a primary vector for initial system infiltration. In addition, implementing firewalls, intrusion detection systems, and periodic penetration testing can further strengthen the external security perimeter.

On the internal side, companies must establish and enforce strict data usage policies that govern how sensitive information is accessed, processed, and shared. Access rights to view, modify, or transmit data should be assigned based on the principle of least privilege, aligning with each employee's specific job responsibilities and functional needs. Sensitive data—including procurement plans, supplier lists, contract terms, and technical parameters of raw materials—should be subject to tiered confidentiality management, with different levels of protection applied according to data criticality and exposure risk. Companies should also provide regular, role-based data security training to employees, ensuring they understand what information must not be disclosed without proper authorization, how to recognize potential social engineering attempts, and the correct procedures for reporting security incidents.

For trade secrets involving specialty resin supply channels and the sources of novel additive formulations, firms should set up higher-level access permissions restricted to a limited number of authorized personnel. Moreover, every access attempt—including the time, user identity, and specific data accessed—should be systematically logged and periodically audited to detect any anomalous or unauthorized activities. Such stringent controls not only deter internal misconduct but also enable rapid forensic analysis in the event of a suspected breach. Collectively, these external and internal measures form a comprehensive data security framework that is essential for protecting the competitive advantage and operational integrity of polymer materials companies.

4.2 Ensuring End-to-End Supplier Management

Polymer materials companies can manage supplier risks from two complementary perspectives: technical compatibility and credit assessment. Each perspective addresses distinct dimensions of supplier-related vulnerabilities and requires tailored evaluation procedures.

On the technical compatibility front, before selecting a supplier, firms should conduct a thorough assessment of the supplier's information technology capability, including their hardware infrastructure, software systems, data interoperability standards, and cybersecurity protocols. Companies may require potential suppliers to provide a detailed connection plan for their digital systems, specifying how data exchange, order processing, and real-time inventory updates will be seamlessly integrated with the buyer's procurement platform. For suppliers that operate with non-standard material coding schemes—a common issue in the polymer materials industry—the purchasing firm can negotiate the adoption of unified coding rules or provide automated conversion tools. Such measures help significantly reduce order matching errors, minimize manual interventions, and lower reconciliation costs over the long term. Additionally, firms should establish regular technical audits to ensure that suppliers maintain compatible system upgrades over the duration of the partnership.

On the credit assessment side, companies should not rely solely on digital platform data or self-reported supplier profiles, which may be incomplete or overly optimistic. Instead, they should conduct on-site audits of suppliers' production facilities, quality management systems, delivery capability, and contingency planning. These audits provide firsthand evidence of operational reliability and reveal potential red flags that digital records might obscure. It is also necessary to understand the supplier's corporate culture, environmental compliance record, and social responsibility performance—factors that influence long-term collaboration stability and reputational risk. By doing so, firms can avoid selecting substandard suppliers due to information asymmetry and reduce the likelihood of supply disruptions, quality defects, or ethical violations.

When selecting suppliers for critical raw materials—such as specialty polymers or rare additives—companies must further assess the supplier's self-sufficiency capability, including their access to raw material sources, production redundancy, and ability to maintain supply during external shocks. Industrial chain security level, geopolitical exposure, and regulatory compliance in the supplier's home region should also be evaluated. Rather than focusing solely on price and efficiency, procurement decisions for strategically important inputs must balance cost considerations with resilience, continuity, and

long-term strategic autonomy. Integrating both technical compatibility and credit assessment into a unified supplier risk management framework enables polymer materials companies to build a more robust and trustworthy supply base.

4.3 Optimizing Personnel and Organizational Management

Polymer materials companies can manage personnel and organizational risks from three interconnected perspectives: organizational structure, cross-functional coordination, and employee skills. Each perspective addresses a distinct layer of risk arising from digital transformation and requires targeted management strategies.

In terms of organizational structure, when advancing procurement digital transformation, companies should first conduct a systematic review of existing roles and workflows to identify gaps and overlaps. They must then clearly define the responsibilities, reporting lines, and performance metrics for each newly created or modified role. A well-documented role and responsibility matrix can effectively prevent blame-shifting, reduce internal conflicts, and enhance accountability. For newly created positions—such as data analyst, digital supplier manager, and procurement system coordinator—firms need to explicitly define the handover processes and communication protocols between these roles and traditional procurement positions (e.g., buyer, sourcing specialist, contract administrator). Without such clarity, task duplication or omission may occur, leading to operational inefficiencies and employee frustration.

Regarding cross-functional coordination, companies should establish regular, structured communication mechanisms between the procurement department and other key functions, particularly IT and finance. These mechanisms may include weekly status meetings, shared digital dashboards, and joint problem-solving workshops. For example, monthly coordination meetings allow the procurement department to articulate system functional requirements clearly and prioritize them based on business impact, while enabling the IT department to provide timely updates on development progress, technical constraints, and resource availability. This structured approach prevents the digital procurement system from diverging from actual business needs—a common failure mode in digital transformation where technical teams build features that users do not require, while critical user needs remain unaddressed. Additionally, establishing a cross-functional steering committee with representatives from procurement, IT, finance, and operations can help resolve escalated issues and guide strategic alignment.

With respect to employee skills, companies should offer comprehensive, ongoing training programs in digital tools and data analysis tailored specifically for procurement staff. Recognizing that employees have different baseline competencies, firms can design a tiered curriculum comprising introductory courses for beginners (covering basic system navigation, data entry standards, and common troubleshooting) and advanced courses for experienced users (focusing on data visualization, predictive analytics, and system customization). Beyond formal training, companies may encourage experienced employees to mentor junior colleagues through a structured buddy system or peer-learning sessions. Such knowledge transfer accelerates the learning curve and fosters a collaborative culture. Furthermore, firms should periodically assess skill gaps through surveys or performance reviews and adjust training content accordingly. Only when employee skills keep pace with transformation demands can project timelines be controlled, costs contained, and the anticipated benefits of digital procurement—such as improved efficiency, reduced errors, and better supplier collaboration—be fully realized.

5. Conclusions

Currently, polymer materials companies still exhibit significant deficiencies in procurement risk management across multiple dimensions, which collectively undermine their supply chain resilience and competitive positioning. These deficiencies are not isolated but rather interconnected, reflecting systemic challenges in adapting to digital transformation while safeguarding sensitive information, managing diverse supplier relationships, and reorganizing internal processes.

In data security, these firms face dual pressures from external cyberattacks and internal operational errors. External threats include increasingly sophisticated phishing campaigns, ransomware attacks, and exploitation of

unpatched system vulnerabilities, all of which target procurement platforms as high-value entry points. Internally, improper data handling, lack of cybersecurity awareness among employees, and inadequate access governance contribute to a high risk of leaking trade secrets—such as procurement plans, supplier lists, contract terms, and technical specifications for specialty resins. The convergence of external and internal vulnerabilities amplifies the potential for data breaches, which can lead to commercial espionage, unfair competition, and erosion of hard-won market advantages.

In supplier management, over-reliance on digital platforms leads firms to neglect non-digital factors that are equally critical for long-term collaboration, including supplier corporate culture, environmental and social responsibility records, and strategic alignment. Combined with weak technical capabilities and non-standardized data practices among some suppliers, this narrow focus results in frequent order matching errors, increased reconciliation costs, and heightened difficulty in ensuring self-sufficiency and control over critical raw materials. Moreover, the lack of on-site audits and comprehensive due diligence further exacerbates information asymmetry, occasionally leading to the selection of suppliers that fail to meet quality, delivery, or ethical standards. In strategically sensitive areas, such as specialty polymers or proprietary additives, the need to balance cost efficiency with supply chain security and geopolitical resilience adds another layer of complexity.

In personnel and organization, digital transformation introduces unclear role definitions, cross-functional communication breakdowns, and a lack of employee digital skills. As procurement departments adopt new technologies—such as e-procurement platforms, spend analytics tools, and supplier relationship management systems—traditional job boundaries blur, leading to role ambiguity and turf conflicts. Poor coordination between procurement, IT, and finance functions often causes digital procurement system development to diverge from actual business needs, resulting in feature-bloated but operationally misaligned solutions. Furthermore, insufficient investment in upskilling leaves many employees unable to effectively use digital tools or interpret data-driven insights, which in turn extends project timelines, inflates implementation costs, and reduces return on digital investment.

Looking ahead, polymer materials companies need to establish a more systematic, integrated procurement risk management framework that addresses these three dimensions in a coordinated manner. In data security, firms should strengthen tiered access controls based on the principle of least privilege, implement continuous employee training on cybersecurity hygiene, and deploy real-time monitoring systems to detect anomalous data activities. In supplier management, they should integrate online assessments with mandatory on-site audits, develop unified data standards for coding and documentation, and incorporate non-digital criteria—such as ethical sourcing, environmental compliance, and supply chain transparency—into supplier scorecards. In personnel and organization, they should clarify role responsibilities through updated job descriptions and RACI matrices, improve cross-functional coordination mechanisms via regular steering committee meetings and shared KPIs, and enhance employee digital skills through tiered training programs and peer-mentoring initiatives. Moreover, companies must pay attention to emerging requirements such as green supply chains, circular economy principles, and industrial chain security—factors that are increasingly shaping regulatory landscapes and customer expectations. Shifting procurement risk management from a reactive, incident-driven approach to a proactive, prevention-oriented strategy will require continuous investment in risk intelligence, scenario planning, and cross-industry collaboration. Ultimately, these efforts will provide a solid foundation for the high-quality development of the polymer materials industry, enabling it to navigate uncertainty while seizing opportunities for sustainable growth.

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