

Healthcare Cybersecurity and Cybercrime Supply Chain Risk Management

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TO CITE THIS ARTICLE

Jorja Wright (2023). Healthcare Cybersecurity and Cybercrime Supply Chain Risk Management. *Journal of Crime and Criminal Behavior*, 4: 2, pp. 249-264. <https://doi.org/10.47509/JCCB.2024.v04i02.05>

Abstract: Cybercrime risks in healthcare logistics and supply chain management pose a significant threat to patient safety, data security, and overall operational efficiency. Healthcare organizations must take steps to identify and mitigate these risks, as they can have serious implications for an organization's bottom line. As healthcare logistics and supply chain management become increasingly digitized, the importance of cyber security in protecting the data and assets of healthcare organizations is growing. Cyber security is essential to ensuring the integrity, confidentiality, and availability of data, systems, and resources. It plays a key role in protecting the healthcare industry from cyber-attacks, data breaches, and other malicious activities. Cyber security is critical in healthcare logistics and supply chain management to protect patient data, secure medical devices, guard against unauthorized access to healthcare systems, and ensure the accuracy of patient records. It also helps to prevent disruption of services and operations by ensuring the safety and availability of data and systems. Cyber security also helps healthcare organizations maintain their reputation, trust, and credibility.

Keywords: Healthcare cyber security, healthcare management, healthcare logistics management, healthcare supply chain management, health administration, healthcare leadership.

Introduction

Technology has become increasingly important for the healthcare supply chain. The use of technology can help to streamline operations and improve efficiency (Rajagopal & Abraham, 2019). For example, electronic health records (EHRs) can help improve the accuracy and speed of patient data management. Automation can also help reduce costs and improve the accuracy of the supply chain (Rajagopal & Abraham, 2019). However, the use of technology also carries cybercrime risks. Cybercriminals may attempt to

exploit vulnerabilities in computer systems to gain unauthorized access to sensitive data or disrupt the supply chain (Mazza, 2017). The impact of cybercrime on healthcare supply chains is potentially devastating (Cohen *et al.*, 2019). Healthcare supply chains are particularly vulnerable to cybercrime due to their dependence on technology and the copious amounts of sensitive data that they store (Gibson *et al.*, 2018). A successful cyberattack can result in the loss or theft of patient records and medical information, which can cause significant financial and reputational damage to healthcare organizations (Cohen *et al.*, 2019). In addition, a successful attack can disrupt the delivery of healthcare services, resulting in delays and potentially putting patients at risk.

Cybersecurity Risk Management in Hospital Supply Chain and Logistics Hospitals are incredibly complex organizations that bring together a multitude of resources and stakeholders to provide health services. The supply chain and logistics used to store, manage, and transport medical supplies, equipment, medications, and other items are integral to the functioning of these organizations. As such, it is essential that adequate measures are taken to ensure the security and safety of these operations.

The European Union Cybersecurity Agency (ENISA) study (2021) describes how cyber-attacks in the supply chain increased by 400% in 2021. In 62% of the analyzed attacks, cyber criminals exploited supplier trust to reach critical access points (ENISA, 2021). ENISA also notes that the nature of supply chain cyber-attacks includes: 20% of supply chain attacks targeted data; 12% of attackers focused on suppliers' internal processes; 16% of attacks targeted people; 8% of attacks sought out financial assets. In over 60% of attacks, threat actors deployed malicious codes.

Cybercrime can take many forms, from ransomware attacks to data breaches and phishing (Gibson *et al.*, 2018). Information technology (IT) professionals can be targeted by hackers using malware, malicious code, or Trojans to gain access to patient information, medical records, and other sensitive data (Cohen *et al.*, 2019). In addition, cybercriminals may attempt to compromise healthcare systems, such as medical devices, to steal data or disrupt services. Cybercrime can also result in financial losses due to fraud, identity theft, and other malicious activities (Gibson *et al.*, 2018).

The global healthcare sector is particularly vulnerable to cyberattacks due to the substantial number of interconnected systems, devices, and networks that are used to store and transfer sensitive information (Stanley, 2019). Hospitals must be aware of the potential threats that are present in any supply chain and logistics operations, as well as the measures necessary to protect against them. Cybersecurity risk management is a critical component of supply chain and logistics security, as it can help identify, assess, and mitigate the risks posed by cyber threats. It is important that hospitals understand the importance of implementing a comprehensive cybersecurity risk management strategy to protect their supply chains and logistics operations.

One of the most important aspects of cybersecurity risk management in hospital supply chains and logistics is the identification of potential threats. This includes understanding the several types of cyberattacks that can occur, such as phishing, malware, ransomware, and denial of service attacks (Wang *et al.*, 2020). It is also important to be aware of the potential sources of these attacks, such as malicious insiders, external actors, and insecure systems. Additionally, hospitals should be aware of any weaknesses in their supply chains and logistics operations that could be exploited by cybercriminals.

Cybersecurity risks in supply-chain software are increasingly becoming a global challenge, especially when different third-party vendors seamlessly cooperate on a global scale (Mayounga, 2017). Even though this mutual interdependence and supply chaining among nations facilitate the transaction of goods and services better, it introduces a new challenge in the global cyber ecosystem (Mayounga, 2017). Abaimov & Martellini (2017) outlined how vulnerabilities are becoming more difficult for attackers to identify and exploit. However, there is an increase in attackers injecting malware implants into the supply chain to infiltrate organizations.

Christopher & Peck (2004) explained that due to the increased complexity of data, uncertainty risk in supply chains is growing, which leads to an increased vulnerability to cyber risks. Cyber risks in the supply chain are dynamic and continuously evolving. The impact of the coronavirus disease (COVID-19) pandemic vividly shows how organizations could be vulnerable to various supply-chain risks. Even though the full impact of COVID-19 on supply chains was dire, organizations that rushed to acquire new infrastructure to satisfy their remote work policies and flexible workforce arrangements may potentially introduce cyber risks. Egan, Hengesbaugh, and Valetk (2020) argued that in addition to ensuring that the networks, virtual private networks (VPNs), and other IT resources can support such a shift. Organizations that have not built such teleworking into their disaster preparedness plans should be aware of and take steps to mitigate the cybersecurity and data privacy risks involved in such a shift (Mayounga, 2017). As companies increase remote work policies and flexible workforce arrangements, IT systems and support must be aligned. The sudden increase in online activity can have enormous implications for system stability, network robustness, and data security (Kilpatrick & Barter, 2020).

Problem Statement and Problem Significance

In recent years, healthcare supply chains have been increasingly vulnerable to cyber threats, risks, and breaches. These attacks disrupt the availability of patient care, jeopardize patient and organizational data security, and cause financial losses (Alazab & Choo, 2019). According to the cybersecurity firm Fireeye, the healthcare industry is the second most targeted industry in the world, with an average of 11.9 attacks per

organization in 2018 (Fireeye, 2018). Furthermore, a recent survey by the Ponemon Institute found that healthcare organizations experienced an average of 6.4 cyberattacks in the past 12 months (Ponemon Institute, 2018). The potential consequences of such attacks are severe, ranging from patient information theft to loss of patient trust and reputation.

Complexity of Healthcare Supply Chains

The complexity of healthcare supply chains makes them particularly susceptible to cyberattacks. Supply chains involve a large number of different stakeholders, including suppliers, manufacturers, logistics providers, and distributors, as well as healthcare providers and patients. Each of these stakeholders has access to various parts of the supply chain and can potentially introduce a vulnerability that can be exploited by attackers. Moreover, these stakeholders often have access to sensitive patient data, which can be used to launch targeted attacks against healthcare providers. As a result, it is essential that healthcare supply chains are adequately protected from cyber threats. (Lai *et al.*, 2018).

In addition, healthcare supply chains are often subject to a variety of regulatory and compliance requirements, which can make them vulnerable to cyberattacks. For example, many healthcare providers are required to comply with data privacy regulations, such as the Health Insurance Portability and Accountability Act (HIPAA), which can introduce additional complexity into the supply chain. This complexity can create additional points of vulnerability that can be exploited by attackers. Furthermore, healthcare supply chains often involve a number of different vendors and contractors, each of whom may have distinct levels of security in place. As a result, it can be difficult to ensure that all elements of the supply chain are adequately protected from cyber threats. (Jiang *et al.*, 2019).

According to Story (2016), the technologies that organizations adopt to improve their supply chains encompass a variety of constructive uses in ways that can make organizations more resilient and smarter in their ability to respond rapidly to change. The use of smart, resilient strategies is about the ability to find ways to leverage technologies to improve the supply chain management process (Story, 2016). These technologies also have cybersecurity risks that must be managed. To be effective, supply chain organizations must be efficient and cost-effective. However, they must also improve the ability of management to collect, use, and interpret information about an organization's supply chain network and its members so that overall performance is improved (Nowicki, 2015).

Finally, healthcare supply chains are often subject to several diverse types of cyber threats, including malware, ransomware, phishing, and other forms of attack. These

threats can have a significant impact on the security of healthcare systems, as they can result in the theft or corruption of patient data and the disruption of healthcare services. In addition, attackers may use supply chains to gain access to other parts of the healthcare system, such as medical devices or hospital networks, which can lead to further disruption and damage. As a result, it is essential that healthcare providers are aware of the potential cyber threats that can affect their supply chains and act appropriately to mitigate these threats. (Yuan *et al.*, 2019).

To protect healthcare supply chains from cyber threats, it is essential that healthcare providers implement a comprehensive cybersecurity strategy. This strategy should include the implementation of strong authentication and access control measures as well as the use of encryption to protect sensitive data. Additionally, healthcare providers should ensure that all vendors and contractors are compliant with data privacy regulations and that their systems are regularly monitored for potential vulnerabilities. Finally, healthcare providers should ensure that their supply chains are adequately protected from external threats, such as malware and ransomware, by utilizing a robust security solution. (Rezaei *et al.*, 2018).

Risk Management

Risk management is the process of identifying, assessing, and responding to cyber threats. It is a critical component of any successful cyber security program, as it helps organizations mitigate the impact of a successful attack (Chitale *et al.*, 2018). Recent research has shown that effective risk management can reduce the likelihood of a successful attack (Kushida *et al.*, 2018). In addition, organizations that take an initiative-taking approach to risk management tend to have more robust cyber security systems than those that do not (Tschofenig *et al.*, 2018).

In addition to risk management, cyber security awareness culture also plays a significant role in reducing the risk of cyber-attacks. Cybersecurity awareness culture is the process of teaching employees about cybersecurity risks and how to protect themselves from them (Krebs, 2016). Research has shown that organizations with a strong culture of cyber security awareness have a lower risk of successful cyber-attacks (Choudhary & Nair, 2017). In addition, organizations with a strong culture of cyber security awareness are more likely to have employees who are familiar with cyber security best practices (Jones & Weerakkody, 2018).

Supply chain management is another crucial factor in mitigating cyber security risk. Supply chain management is the process of managing the flow of goods and services from vendors to customers (Liu & Zhang, 2016). Recent research has found that organizations that have robust supply chain management practices are better able to protect their networks from cyber threats (Bakshi *et al.*, 2017). Additionally,

organizations that have strong supply chain management practices are more likely to be able to detect and respond to cyber threats quickly (Tseten *et al.*, 2019).

Logistics and supply chain cybersecurity are critical issues for healthcare organizations operating in today's ever-evolving technological landscape. The increasing use of technology, in combination with the complex and interconnected nature of supply chains, has created an environment where organizations are vulnerable to a wide range of cyberthreats. As such, it is important for organizations to develop effective risk mitigation and management strategies to ensure the security of their supply chain operations. However, there are a number of current weaknesses in this area that need to be addressed.

One of the main weaknesses in logistics and supply chain cybersecurity risk mitigation and management is the lack of visibility into the network (Rothman *et al.*, 2019). This lack of visibility makes it difficult for organizations to detect and respond to potential threats (Rothman *et al.*, 2019). Additionally, many organizations are not taking the necessary steps to secure their networks, such as conducting regular security audits and implementing security protocols (Rothman *et al.*, 2019). This lack of security can leave organizations vulnerable to cyberattacks, data breaches, and other malicious activities (Rothman *et al.*, 2019).

Another current weakness in logistics and supply chain cybersecurity risk mitigation and management is the lack of adequate training and awareness programs. Many organizations are not adequately training their employees on how to identify and respond to potential threats. Additionally, they are not providing adequate support and guidance on how to develop and implement security protocols (Kumar *et al.*, 2018). Furthermore, many organizations are not taking the necessary steps to ensure that their suppliers and third-party partners are meeting their security requirements. This lack of oversight can leave organizations vulnerable to potential supply chain risks (Raman *et al.*, 2017).

Finally, when there is a lack of effective communication and collaboration between organizations and their partners. This lack of communication can hinder the effectiveness of risk mitigation and risk management efforts as organizations are not able to share information and resources with their partners (Kumar *et al.*, 2018). Additionally, organizations are not taking the necessary steps to ensure that their partners are complying with their security requirements, which can leave them vulnerable to potential risks (Raman *et al.*, 2017).

To address these weaknesses, organizations need to take a proactive approach to supply chain security. They should start by conducting a comprehensive risk assessment to identify potential threats and vulnerabilities (Rothman *et al.*, 2019). This assessment should include identifying and assessing the security risks posed by their suppliers

and third-party partners. Organizations should also develop and implement security protocols to address potential threats and vulnerabilities (Rothman *et al.*, 2019). Additionally, organizations should provide adequate training and awareness programs to their employees to ensure that they are able to effectively identify and respond to potential threats (Kumar *et al.*, 2018).

Organizations should also take steps to ensure that their partners are meeting their security requirements. This can be done through the establishment of secure communication channels, such as the use of secure messaging and document sharing platforms, and the implementation of monitoring and auditing procedures. Finally, organizations should establish effective communication and collaboration processes with their partners to ensure that they are able to share information and resources to effectively respond to potential threats (Kumar *et al.*, 2018).

Data Discussions

Fifteen logistics subject matter experts were interviewed in three separate focus groups of 5 participants each. All worked in logistics and had been through training in the U.S. Army Logistics University that worked in disaster and humanitarian relief, public health, and healthcare. The requirement was an undergraduate degree and over three years of experience in logistics and supply chain management in disaster and humanitarian relief. The data collection questions were:

What are the most significant cyber security vulnerabilities and risk areas in healthcare supply chain management?

- Suppliers and vendors who have workers working in the supply chain who are not appropriately trained in cyber and information security
- Suppliers and vendors who have poor security procedures
- Third-party service providers or vendors, whose offerings can range from janitorial services to software engineering and who have either physical or virtual access to information systems and facilities
- Vulnerabilities in information systems or software utilized by vendors and suppliers
- Vulnerabilities in software or hardware that was obtained from vendors and suppliers that were vulnerable or had been compromised
- Vulnerabilities in the systems used for logistics and supply chain management at every level of the chain, specifically those that include third-party data storage or data aggregators.
- The presence of phony hardware or hardware containing malware in the systems of the logistics and supply chain at every level of the chain.

What are the challenges to quantifying cyber risks' nature and potential severity in healthcare supply chains?

- There are inadequate vetting mechanisms to understand the security risks associated with modern technologies that are being acquired and implemented, which increases the chance of an attack affecting both this new technology and existing legacy technologies that are running on the same networks.
- A culture within the organization that does not acknowledge the existence of insider dangers or comprehend how to respond to them.
- The difficulty of immediately recognizing terrorists, industrial spies, cybercriminals, and foreign intelligence services that may be targeting a business, its vendors, or its suppliers as potential victims
- There is a lack of historical data on cyber incidents involving vendors and suppliers, as well as how those incidents have been dealt with.
- The nature of cyber risk is always shifting as a direct result of developments in technology, new methods, and new actors.

What is the best approach to identifying and managing potential healthcare supply chain risks?

- Employ unbiased specialists to perform a comprehensive security review of the newly generated software and products.
- Keep an up-to-date and accurate inventory of all Internet of Things devices as well as their pertinent features throughout the lifecycles of the devices so that you may use that information for the purposes of cybersecurity risk management.
- Identify and mitigate known vulnerabilities in IoT device software throughout the lifecycles of the devices to limit the possibility and simplicity of exploitation and compromise. This should be done at all stages of the devices' lifecycles. The elimination of vulnerabilities is possible through the installation of updates (such as patches) and the modification of configuration settings. Introduce various solutions for maintaining a constant security watch over the apps.
- Prevent illegal and improper access to, usage of, and management of Internet of Things devices throughout their lifecycles by people, processes, and other computing devices. This includes both physical and logical access. The attack surface of the device can be decreased by restricting access to its interfaces; as a result, there will be fewer opportunities for malicious actors to penetrate the device.

- Prevent unauthorized access to and tampering with data while it is either at rest or in transit, as this could lead to the disclosure of confidential information or allow for manipulation or interruption.
- Throughout the lifecycles of the devices, it is necessary to monitor and evaluate the activities of IoT devices for issues concerning device and data security.

What are the best practices to strengthen the overall cybersecurity posture against healthcare supply-chain cyber risks?

- Take a “zero-trust approach” to the situation. A zero-trust strategy demands verification of every asset, user account, and application; this replaces the traditional practice of presuming that a vendor or supplier is secure. It is necessary for them to have their authentication for access to organizational systems approved. Even users working within an organization’s IT infrastructure are required to verify their information anytime they make a request to access any resource, whether that resource is part of the supply chain network or not.
- Maintain a record of information on vendors and service providers. Because a supply chain is a structure made up of multiple layers, it is possible for a company’s vendor to collaborate with other third parties and rely on their reliability without doing independent verification.
- Establish a risk criterion that will apply to the various providers and vendors.
- It is important to manage suppliers over the entirety of the supply chain lifecycle.
- Create a list of controls and rules with which firms in the supply chain need to demonstrate compliance to become certified as vendors. This certification should be based on the controls.
- The organization is tasked with determining whether the security checks of your vendors and suppliers are carried out on an annual or semi-annual basis.
- Prior to applying for a vendor’s services or signing a contract for software development, it is imperative to ascertain whether the vendor complies with the applicable cybersecurity standards. Be sure to include a liability clause in the contract if there are any security breaches.
- Define a remediation and arbitration mechanism for dealing with organizations in the supply chain that are not currently reaching the required level of security.

Conclusions

To mitigate the risks posed by cybercrime in healthcare supply chains, organizations must take an initiative-taking approach to security (Gibson *et al.*, 2018). This includes implementing measures such as data encryption, access control, antivirus software, and firewalls to protect against malicious attacks (Cohen *et al.*, 2019). In addition, organizations should conduct regular security audits to ensure that their systems are up-to-date and secure (Gibson *et al.*, 2018). Finally, organizations should develop policies and procedures for responding to cybercrime incidents and ensure that all employees are trained in cybersecurity best practices (Cohen *et al.*, 2019).

The cyber supply chain risk is becoming more complex and difficult to mitigate (Mayounga, 2017). Multiple researchers (Christopher & Peck, 2004) have explained that due to the increased complexity of data, uncertainty risk in supply chains is growing, leading to increased vulnerability to electronic risks. The technological acceleration of the cyber-physical world is matched by the acceleration and sophistication of attacks (Denardis, 2020). Nation-state adversaries have a history of intercepting computer shipments from hardware vendors and inserting unauthorized wireless and other transmitters in the equipment. Supply chain technology using connected devices enables remote operation of the compromised equipment once the computers are deployed at a destination site. Such equipment may show no apparent signs of tampering when the attackers have repackaged, re-shrink-wrapped, and otherwise made their tampered-with equipment seem in “brand new” condition (Ginter, 2016).

While organizations are still grappling with supply-chain-related cyber risks, consumers’ and organizations’ proliferation and adoption of Internet of Things (IoT) devices are creating another cybersecurity challenge within the supply chain (Mayounga, 2017). Unfortunately, many industries, consumer and commercial technology device owners, and infrastructure operators are fast discovering themselves at the precipice of a security nightmare. The drive to make all devices “smart” creates a frenzy of opportunities for cybercriminals, nation-state actors, and security researchers alike. These threats will only grow in their potential impact on the economy, corporations, business transactions, individual privacy, and safety (Russell & Duren, 2016). Therefore, organizations should devise a way to evaluate the security posture of IoT implementation and deployment systematically. This applies to the acquisition of hardware items as well.

Rosencrance (2019) argued that most risks are caused by not having the proper controls in place for third-party vendors. Supply-chain transparency must now go beyond the traditional visibility of the movement of goods (Mayounga, 2017). The data that supply-chain transparency can provide is a meaningful insight that enables organizations to manage cyber threats more effectively with their supply-chain partners (Mayounga, 2017). Organizations should vet suppliers to ensure their organization and

their systems meet their security standards (Mayounga, 2017). Understand and screen suppliers' data management practices to ensure there are no holes in their system (Weir & Yates, 2016). However, having a comprehensive internal supply-chain unit must be the first step that organizations need to consider. Supply chain risks are associated with a vendor's decreased visibility into and understanding of how they acquire, develop, integrate, deploy, and secure technology and software (Mayounga, 2017). They are also associated with the processes, procedures, and practices used to assure the integrity, security, resilience, and quality of the products and services (NIST, 2015; NIST, 2020).

Organizations in the logistics and supply chain management sectors must understand the importance of having a comprehensive risk management strategy. This strategy should include the identification of critical assets, the assessment of threats, the development of security policies and procedures, and the implementation of security measures (Metzger & von Solms, 2015). It is also important to ensure that all personnel are professionally trained in cybersecurity risk management, as this can help reduce the risk of attack and provide assurance that the organization is taking steps to protect itself from cyber threats. Additionally, organizations should consider partnering with a trusted third-party vendor to provide additional security measures and monitoring services.

Given the risks posed by cybercrime, it is essential that healthcare organizations take steps to ensure the security of their systems. Organizations must take initiative-taking steps to reduce the risk of cyber threats and breaches in their healthcare supply chains. The first step is to identify and mitigate the risks associated with their supply chains. Supply chain risk management (SCRM) is the process of identifying, assessing, and responding to risks in a supply chain (Wang, Wang, & Tham, 2019). SCRM should include an assessment of the current cyber security environment, identification of potential threats, and implementation of mitigation measures (Alazab & Choo, 2019). Another key component of SCRM is the development of a comprehensive cyber security plan. This plan should include the establishment of policies, procedures, and controls for the protection of patient data, the maintenance of secure systems, and the prevention of unauthorized access (Alazab & Choo, 2019).

Recommendations for Future Research

There is a need for further research on cybercrime risks in healthcare logistics and supply chain management. Research should focus on the distinct types of cybercrime risks and their implications for healthcare organizations, as well as strategies for mitigating these risks. Additionally, research should explore the role of technology in the healthcare supply chain and the implications for security. Furthermore, research should examine the potential for future technological advances to reduce cybercrime risks in the healthcare supply chain.

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