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Article

Risk management strategies for smart hotel supply chain

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Abstract: In the dynamic and interconnected world of hospitality, smart hotel supply chains play a pivotal role in maintaining operational efficiency and service excellence. However, these supply chains are susceptible to many risks, including transportation disruptions, supplier insolvencies, and cybersecurity threats, which can severely impact business continuity and degrade service quality. This conceptual paper proposes a holistic framework for identifying, assessing, and mitigating supply chain risks within the context of smart hotels. By integrating advanced technologies and strategic management practices, this study aims to reinforce smart hotel supply chains against potential vulnerabilities, ensuring sustainable business operations and superior guest satisfaction. The paper explores various risk management measures and leverages supply chain management, hospitality, and cybersecurity insights to develop a robust risk management strategy tailored for smart hotels.

Keywords: smart hotels; supply chain management; risk management; cybersecurity; business continuity; hospitality management

1. Introduction

The indispensable role of supply chain management in the hospitality industry serves as a cornerstone for operational excellence and the delivery of unparalleled service quality. Effective supply chain management ensures the timely availability of essential goods and services, from food and beverage supplies to linens and technological equipment, directly influencing a hotel's ability to meet and exceed guest expectations [1]. The complexity of these supply chains necessitates meticulous oversight to prevent potential disruptions that could detrimentally affect service delivery and, by extension, customer satisfaction. This underscores the importance of robust supply chain management practices within the hospitality sector, which are critical not just for operational efficiency but also for maintaining the quality of service that guests have come to expect [2,3].

The advent of smart hotels, characterized by incorporating cutting-edge technologies such as the Internet of Things (IoT), artificial intelligence (AI), and automation, signifies a transformative shift in the hospitality industry. These technological advancements enhance guest experiences through personalized services, increase operational efficiency, and introduce complex dynamics into the supply chain [1,4]. Smart hotels rely on a sophisticated network of suppliers and technological systems for their functionality, including automated inventory management and real-time data analytics for predictive maintenance. This evolution in hotel operations highlights the necessity for adept supply chain management that aligns with the intricacies of a technology-driven environment, ensuring that advancements in hotel operations and supply chain management work hand in hand to deliver exceptional service [5].

However, the integration of sophisticated technologies and the reliance on a diverse supplier network introduce several risks, including disruptions in logistics, supplier bankruptcies, and cybersecurity threats. These vulnerabilities present significant challenges to the smooth operation of smart hotels, potentially leading to disruptions in service delivery [2,6]. The problem thus centers on the need for smart hotels to develop and implement effective risk management strategies to identify, assess, and mitigate these risks. Without comprehensive risk management practices, smart hotels may face challenges that could compromise service quality and disrupt business continuity [7].

This paper focuses on two primary objectives in the context of smart hotel supply chains. The first objective is to elucidate the critical role of supply chain management in augmenting operational efficiency and improving service quality within smart hotels. This involves a detailed examination of how streamlined supply chain processes directly contribute to enhanced guest experiences and operational performance. The second objective aims to dissect and understand the complexities introduced by incorporating advanced technologies into smart hotel operations. Specifically, it addresses how these technologies reshape supply chain dynamics, necessitating innovative risk management strategies to maintain business continuity and uphold superior service standards. By fulfilling these objectives, the study contributes to the formulation of strategic frameworks designed to bolster the resilience of smart hotel supply chains amidst evolving technological landscapes and potential operational risks.

2. Literature review

2.1. Theoretical frameworks on supply chain risk management

The discourse on theoretical frameworks for supply chain risk management (SCRM) offers a rich tapestry of concepts and methodologies designed to navigate the complexities of modern supply chains. These frameworks provide a structured approach to identifying, assessing, mitigating, and monitoring risks, thereby ensuring the resilience and continuity of supply chain operations [1–3]. Central to the theoretical exploration of SCRM is the delineation of risk types—from operational to strategic and external threats—that can disrupt the flow of goods and services [8]. The literature introduces various models, such as the Supply Chain Risk Management Process model, which systematically guides organizations through the stages of risk management. This model emphasizes the iterative nature of risk management, advocating for continuous evaluation and adaptation of strategies to mitigate risks effectively. Such frameworks are pivotal for understanding the multifaceted nature of supply chain risks and developing robust strategies to counter these risks [1,4,5].

Within SCRM theoretical frameworks, resilience emerges as a critical attribute, highlighting the ability of supply chains to withstand and recover from disruptions. Resilience-oriented frameworks focus on building adaptive capacity within supply chains to enable rapid response to unforeseen events. This involves not only the identification and management of known risks but also the preparation for low-probability, high-impact events that can cause significant disruptions [6,7]. The literature on resilience emphasizes the importance of flexibility, redundancy, and

collaboration among supply chain partners as critical factors in enhancing the resilience of supply chains. By adopting resilience as a strategic objective, organizations can develop supply chains that are resistant to disruptions and capable of recovering swiftly, thereby minimizing operational and financial impacts [4,8,9].

The concept of agility in supply chain risk management further complements the notion of resilience, focusing on the capacity of supply chains to quickly adapt to changes and uncertainties in the environment. Agile supply chain frameworks advocate for using real-time data, advanced analytics, and flexible operational processes to enhance the responsiveness of supply chains to market dynamics and supply disruptions [9–11]. Agility enables organizations to rapidly adjust their operations and supply chain configurations in response to emerging risks and opportunities, thereby maintaining a competitive edge. Technology integration plays a pivotal role in achieving supply chain agility, with advancements in IoT, AI, and blockchain offering new avenues for enhancing the speed and efficiency of supply chain responses [12,13].

Collaboration and integration across supply chain partners are highlighted within theoretical frameworks as essential for effective risk management. Collaborative risk management models stress the importance of shared information, joint risk assessment, and coordinated risk mitigation efforts among all stakeholders in the supply chain [6,9]. This collaborative approach enhances transparency, improves risk visibility, and facilitates the development of collective strategies to address shared vulnerabilities [4,14]. Such models advocate for establishing partnerships and alliances that extend beyond transactional relationships, fostering a cooperative environment where knowledge and resources are pooled to tackle supply chain risks more effectively.

Lastly, the literature on SCRM theoretical frameworks underscores the significance of continuous monitoring and learning as part of an effective risk management strategy. Dynamic risk management models advocate for ongoing surveillance of the risk landscape and adopting a proactive stance toward risk identification and mitigation [15–17]. This involves not just the tracking of existing risks but also the anticipation of future threats through scenario planning and predictive analytics. The emphasis on learning and adaptation reflects the evolving nature of supply chains and the need for risk management practices to be agile and forward-looking [16]. By embedding continuous monitoring and learning mechanisms within their risk management frameworks, organizations can ensure that their supply chains remain robust and responsive to the ever-changing risk environment.

2.2. Smart hotel technologies and their supply chains

Studies [1,2] focusing on smart hotel technologies and their supply chain implications shed light on the transformative impact of digital innovations on the hospitality industry. Integrating technologies like the Internet of Things (IoT), artificial intelligence (AI), and blockchain into hotel operations has revolutionized the guest experience, offering personalized services, enhanced operational efficiency, and improved security measures. These technologies, however, also introduce new dynamics and challenges within the supply chain, necessitating a reevaluation of traditional supply chain management practices [17]. For instance, implementing IoT devices for smart room controls and AI-driven customer service platforms requires

hotels to establish robust supply chains that support these technologies' procurement, maintenance, and upgrading. Moreover, the reliance on digital systems increases the need for cybersecurity measures, adding another layer of complexity to supply chain management [5,18]. Studies in this domain explore the intricate balance between leveraging technological advancements to improve service delivery and managing the associated risks and dependencies within the supply chain. The adoption of blockchain technology, for example, offers potential solutions for enhancing transparency and security in supply chain transactions, yet it also demands new competencies and partnerships with technology providers [1,19].

The implications of smart hotel technologies on supply chains extend beyond operational adjustments to influence strategic decision-making and collaboration among stakeholders. As smart hotels rely on a diverse network of suppliers and service providers, the need for integrated supply chain strategies becomes paramount [2, 20]. This integration encompasses the physical flow of goods, information, and financial flows, requiring seamless coordination of data exchange and financial transactions among partners. Studies [2,20] emphasize the role of advanced analytics and data management capabilities in forecasting demand, optimizing inventory levels, and ensuring timely delivery of services, which are crucial for maintaining service quality in smart hotels [3,21]. Furthermore, the sustainability of supply chain practices in the context of smart technologies is a growing concern, prompting research into environmentally responsible sourcing and waste reduction through technology-enabled efficiencies. Ultimately, these studies highlight a shift towards more collaborative, technology-driven supply chain models that prioritize agility, sustainability, and resilience, enabling smart hotels to navigate the challenges and opportunities presented by digital transformation [15,22].

2.3. Common risks in hotel supply chains

With their reliance on cutting-edge technologies and complex supply networks, the advent of smart hotels introduces a new landscape of risks to hotel supply chains, necessitating a nuanced analysis of common vulnerabilities. Traditional risks such as logistical disruptions, supplier reliability, and fluctuating demand are now compounded by technology-specific challenges, including cybersecurity threats, technological obsolescence, and the integration complexities of digital systems. These risks threaten the operational continuity of hotels and potentially impact guest satisfaction and hotel reputation [2,23]. Cybersecurity is a paramount concern, with smart hotels employing many digital solutions for personalized guest experiences, operational efficiency, and property management. The interconnectedness of these systems exposes hotels to the risk of data breaches, unauthorized access, and system failures, underscoring the critical need for robust cybersecurity measures and protocols [24]. Moreover, the pace of technological advancement places hotels at risk of rapid obsolescence, challenging them to continuously update and upgrade their technological infrastructure to stay current and competitive [15,25].

The integration of diverse technologies and the reliance on a wide range of suppliers introduce complexities into the supply chain that can exacerbate existing vulnerabilities. Managing technology vendors, in particular, becomes a critical aspect of supply chain risk management in smart hotels. Ensuring the reliability and stability

of these vendors is paramount, as any disruption, whether due to financial instability [1,26], legal issues, or failure to meet service level agreements, can have direct implications on hotel operations and guest experiences. This dependency on external entities for critical technological functions and services necessitates a strategic approach to supplier selection, contract management, and ongoing performance monitoring. Furthermore, the intricacies of integrating various technological systems and ensuring their interoperability without compromising security or functionality add another layer of risk, highlighting the importance of technical expertise and rigorous system testing in deploying smart hotel technologies [16,20].

Environmental sustainability and ethical sourcing have also emerged as significant concerns in the context of smart hotel supply chains. As guests become increasingly conscious of environmental and social issues, hotels must ensure their supply chains reflect sustainable and responsible practices. This includes considerations around the sourcing of materials [27], the energy consumption of technological solutions, and the disposal and recycling of electronic waste. Failure to adhere to sustainability and ethical standards can lead to regulatory penalties and damage the hotel's reputation among environmentally and socially conscious consumers. The challenge for smart hotels lies in balancing the technological advancements that drive operational efficiency and enhanced guest experiences with the imperative to minimize environmental impact and ensure ethical supply chain practices [16,19].

Therefore, risk management strategies for smart hotels must encompass a broad spectrum of considerations, from technological and operational to environmental and ethical. Developing a comprehensive risk management framework involves identifying and assessing potential risks and formulating mitigation strategies that are adaptable and responsive to the evolving landscape of smart hospitality [2,28]. This includes investment in cybersecurity defenses, robust vendor management processes, continuous technology assessment and upgrades, and a commitment to sustainability and ethical practices. Collaboration and communication across all stakeholders, including suppliers, technology partners, and regulatory bodies, play a crucial role in enhancing the resilience of smart hotel supply chains against these multifaceted risks [5].

3. Methodology for a risk management framework

The methodology for developing a comprehensive risk management framework for smart hotel supply chains begins with creating a conceptual framework. This foundational step is predicated on an exhaustive review of existing literature spanning several critical disciplines, including supply chain management, hospitality, and information technology security [1,11]. The essence of this phase lies in bridging the gap between theoretical insights and the practical challenges that smart hotels face in today's digital era. By synthesizing information from varied sources, the aim is to distill key risk factors that are both prevalent and potentially debilitating to smart hotel operations. Furthermore, this process involves the identification of effective mitigation strategies that are tailored to address the unique vulnerabilities of smart hotels. The outcome is a robust framework that highlights the multifaceted nature of risks within

the smart hotel supply chain and offers a structured approach to managing these risks, ensuring the continuity and efficiency of hotel operations [10,16].

The second phase, risk identification and assessment, employs a systematic approach to uncover and categorize the risks associated with smart hotel supply chains. Utilizing both qualitative and quantitative techniques, this stage is crucial for comprehensively understanding the probability and impact of each identified risk [1,4,11]. Qualitative methods may include expert interviews and focus groups that provide insights into the experiential and subjective aspects of risk. In contrast, quantitative techniques can involve statistical analysis to measure risk probabilities and impacts. This dual approach ensures a holistic view of the risk landscape, enabling hoteliers to prioritize risks based on their potential to disrupt operations [29]. The assessment process thus lays the groundwork for informed decision-making in the subsequent stages of the risk management framework, guiding the development of targeted strategies to mitigate high-priority risks.

In developing risk mitigation strategies, the framework introduces a multi-layered approach encompassing technological, operational, and strategic measures tailored to the identified risks. This phase emphasizes the integration of cybersecurity measures to protect against digital threats, implementing supplier relationship management practices to ensure the reliability of the supply chain, and developing contingency plans to prepare for unexpected disruptions [15,30]. The multi-layered approach recognizes the complexity of risks in smart hotel supply chains and the need for diverse strategies that address different aspects of risk. By combining technological solutions with operational best practices and strategic planning, smart hotels can create a resilient supply chain that minimizes vulnerabilities and safeguards against potential disruptions [31].

Stakeholder engagement and implementation represent critical components of the risk management framework. This aspect underscores the importance of involving all relevant stakeholders in risk management, including hotel management, suppliers, technology providers, and guests. Engaging stakeholders fosters a culture of risk awareness and collaboration and ensures that risk management strategies are comprehensive and aligned with the needs and expectations of all parties involved [1]. The framework advocates for a phased approach to implementing risk management strategies, beginning with pilot projects and scaling up based on success and feedback. This phased implementation allows for adjustments and refinements, ensuring the methods are effective and practical in real-world settings [2,3].

Furthermore, continuous monitoring and feedback mechanisms are integrated into the framework to ensure that the risk management strategies remain relevant and effective over time. This dynamic component of the methodology acknowledges that the risk landscape is ever-changing, particularly in the context of smart hotels, where technological advancements and market dynamics can rapidly alter risk profiles [15,16,30]. Continuous monitoring allows for the early detection of new risks and the assessment of the effectiveness of existing mitigation strategies. Feedback from stakeholders plays a vital role in this process, providing valuable insights that can inform the ongoing refinement of the risk management framework [3,4,32].

4. Risk management framework for smart hotel supply chains

The proposed framework (**Figure 1**) for managing supply chain risks in the smart hotel industry adopts a comprehensive approach, integrating advanced GPS tracking, software solutions, and the establishment of diverse logistics partnerships to mitigate transportation risks. The literature underscores the significance of such strategies; for instance, scholars [2,5] illuminate how geopolitical tensions and fuel price fluctuations render logistics and supply chain operations unpredictable. This unpredictability necessitates a robust mechanism for real-time adjustments and contingency planning, highlighting the critical role of diversified logistics strategies in preempting and mitigating transportation-related disruptions, ensuring the seamless delivery of services and goods essential for hotel operations.

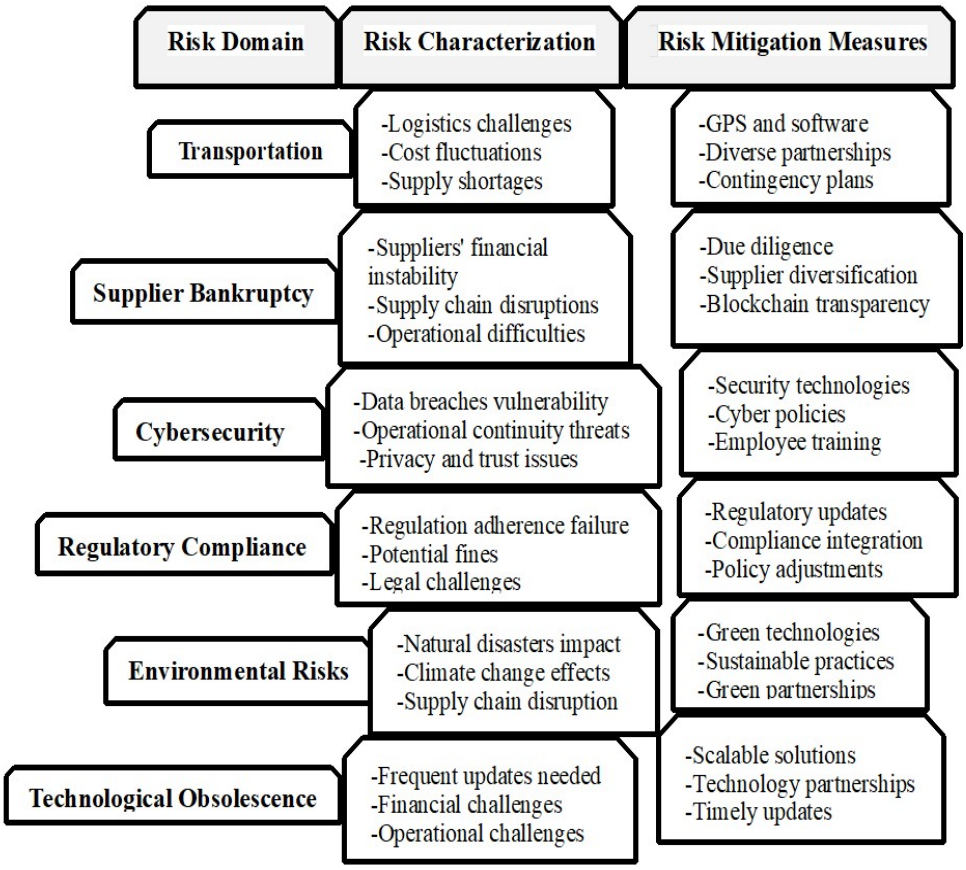

Figure 1. Risk management strategies for smart hotel supply chains.

In addressing the risk of supplier bankruptcy, the framework emphasizes the importance of conducting thorough due diligence, diversifying supplier bases, and leveraging blockchain technology for enhanced transparency [1]. The extant literature shows the pivotal impact of supplier financial stability on the continuity of supply chains, advocating for proactive monitoring and diversification strategies to preclude disruptions. Such an approach is aligned with the framework's recommendations, where blockchain's transparency is particularly noted for its ability to offer real-time insights into suppliers' financial health, thus enabling smart hotels to mitigate risks associated with supplier insolvency effectively [6,7].

The framework also proposes the deployment of security technologies, the establishment of comprehensive cybersecurity policies, and the implementation of extensive employee training programs to counter cybersecurity threats. We amplify the urgency of such measures, revealing that the increasing digitalization of hotel operations escalates their vulnerability to cyberattacks [5,6]. This insight bolsters the framework's call for a layered cybersecurity defense strategy, including the use of advanced encryption and intrusion detection systems alongside ongoing cybersecurity awareness and training for staff to protect against data breaches and ensure the privacy and trust of guests [33].

The framework also addresses regulatory compliance, recommending regular updates to compliance measures and their integration into operational strategies. The literature sheds light on non-compliance's potential legal and financial ramifications, emphasizing the need for smart hotels to incorporate compliance into their strategic planning [34] proactively. This approach aligns with the framework's advocacy for continuous monitoring and adaptation to regulatory changes, underscoring the importance of staying abreast of and conforming to industry regulations to avoid fines and legal challenges [35].

The framework further advocates for the adoption of green technologies, sustainable practices, and partnerships with environmentally conscious suppliers to mitigate environmental risks. Literature supports this stance, suggesting that sustainable technologies and practices can significantly reduce the impacts of natural disasters and climate change on supply chains [36]. This recommendation resonates with the growing demand for environmental sustainability in the hospitality sector, highlighting how adopting green initiatives can not only mitigate environmental risks but also align hotel operations with broader sustainability goals.

The framework suggests investing in scalable and upgradable technology solutions and fostering strong partnerships with technology providers to combat technological obsolescence. We highlight the rapid pace of technological advancements as a critical challenge, necessitating agile and adaptable technology infrastructures to maintain operational efficiency and competitiveness. This perspective validates the framework's emphasis on continuous innovation and strategic partnerships as essential measures for ensuring that smart hotels remain at the forefront of technological advancements and avoid the pitfalls of obsolescence [37].

The integration of these strategic measures, grounded in scholarly insights and practical applications, provides a solid foundation for smart hotels to navigate the complexities of supply chain risk management. By tailoring risk mitigation strategies to address specific vulnerabilities identified through a comprehensive analysis of the supply chain landscape, the framework offers a path toward enhancing resilience, ensuring operational continuity, and maintaining high service standards in the face of evolving challenges [5]. Ultimately, this enriched approach to managing supply chain risks in the smart hotel industry underscores the importance of a proactive, informed, and adaptable strategy. By leveraging the latest research findings and practical insights, smart hotels can develop and implement comprehensive risk management plans that address current vulnerabilities and future uncertainties, thereby securing a competitive edge in the rapidly evolving hospitality sector.

5. Discussion

The proposed risk management framework emphasizes identifying key risk areas, employing risk assessment models, and implementing detailed mitigation strategies, presenting a comprehensive approach tailored for innovative hotel supply chains. Its applicability and effectiveness, however, can vary across different hotel operational contexts [1,6]. The framework can be particularly effective in luxury and high-end hotel segments, where the reliance on advanced technologies and international supply chains is more pronounced [15,33]. These hotels often have the resources and infrastructure to implement sophisticated risk management strategies, including the latest cybersecurity and supply chain monitoring technological solutions [3,34].

Furthermore, their clientele's high expectations for impeccable service and seamless experiences justify investing in advanced risk management practices, making the proposed framework applicable and essential for maintaining their market position and guest satisfaction levels [5,16].

Conversely, more minor, independent hotels or those in emerging markets might face challenges in fully implementing the proposed framework. The financial and technical resources required for some of the technological solutions and strategic partnerships outlined in the framework could be beyond the reach of these operators [35,36]. Moreover, the complexity and scale of operations in smaller hotels might not warrant such an extensive risk management approach. This leads to adapting and scaling the framework to fit their specific operational and contextual realities. This discrepancy underscores the necessity for flexibility and customization in applying the framework across different hotel operational contexts, ensuring that it remains practical and effective for hotels with varying capabilities and resources [2,3].

Implementing comprehensive risk management strategies in smart hotel supply chains has challenges and limitations. One of the primary challenges lies in the rapidly evolving nature of technology and the digital landscape [37]. As smart hotels continuously integrate new technologies to enhance guest experiences and operational efficiency, they must also contend with the emerging risks associated with these technologies [4,5]. Staying ahead of cybersecurity threats, managing the lifecycle of technological assets, and ensuring seamless integration of new systems presents a constant challenge for hotel operators. Additionally, the reliance on external suppliers and partners for technology solutions introduces vulnerabilities that are often beyond the direct control of the hotel, complicating risk management efforts [1].

Another significant challenge is the cultural and organizational change required to effectively implement a comprehensive risk management strategy. Risk management must be embedded in the hotel's organizational culture and operational processes to be genuinely effective [33]. This requires a shift in mindset from reactive problem-solving to proactive risk identification and mitigation, involving training, awareness, and regular engagement with all levels of staff and management. However, achieving this cultural shift and ensuring the alignment of all stakeholders with the risk management objectives can be daunting, particularly in larger organizations or those with entrenched operational practices [1,6].

Furthermore, the complexity and interconnectivity of global supply chains challenge the implementation of the proposed framework. Disruptions in one part of

the world can cascade effects on hotels thousands of miles away, as seen in natural disasters, geopolitical tensions, or global pandemics [15,33]. Navigating these complexities and developing flexible and robust contingency plans requires a deep understanding of worldwide supply chain dynamics and the ability to anticipate and respond to events often outside the hotel's direct influence [35,36].

However, while the proposed risk management framework offers a structured approach to safeguarding smart hotel supply chains against a myriad of risks, the operational context of the hotel influences its application and effectiveness [2,3]. Challenges in implementation, ranging from technological evolution and resource constraints to organizational culture and global supply chain complexities, highlight the need for adaptability, continuous learning, and engagement with the broader risk management community. Addressing these challenges and limitations is crucial for hotels to effectively implement comprehensive risk management strategies, ensuring their resilience and ability to deliver exceptional guest experiences in an ever-changing risk landscape [37].

6. Conclusion and future directions

As risk management strategies for smart hotel supply chains are discussed above, developing and implementing a comprehensive risk management framework (**Figure 1**) for intelligent hotel supply chains underscores the complex and multifaceted nature of managing risks in an increasingly digitalized hospitality environment. The key findings from this exploration reveal that effective risk management within innovative hotel supply chains requires a systematic approach to identify, assess, and mitigate risks [37]. This involves leveraging technological solutions, engaging stakeholders, and adapting policies to address the challenges posed by technological advancements, supplier dependencies, and external threats. The significance of these findings lies in their implications for innovative hotel supply chain management, emphasizing the need for resilience, adaptability, and proactive risk management strategies to safeguard operational continuity and maintain high standards of guest satisfaction [3,34].

Moving forward, recommendations for future research include a deeper investigation into the specific impacts of emerging technologies on supply chain risks, including the role of artificial intelligence, blockchain, and the Internet of Things (IoT) in enhancing supply chain resilience and efficiency. Additionally, there is a need for empirical studies that examine the real-world application and effectiveness of the proposed risk management strategies across different hotel operational contexts [33], from luxury chains to independent boutique hotels. Such research can provide valuable insights into the practical challenges and success factors of implementing risk management frameworks in the hospitality industry.

Fostering a culture of innovation and learning within the hospitality industry is crucial for continuously improving risk management practices. This involves staying abreast of technological advancements and evolving risk landscapes and embracing a collaborative approach to risk management [35,36]. Hotels should seek to build strong partnerships with suppliers, technology providers, and industry associations to share risk management knowledge, best practices, and resources. Moreover, training and development programs for hotel staff and management in risk awareness and

mitigation strategies are essential to building internal capabilities and resilience.

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