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A SYSTEMATIC REVIEW OF STAGES AND DECISION MAKING APPROACHES IN SUPPLY CHAIN RISK MANAGEMENT

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Abstract

Supply chain risk management (SCRM) is a key element in improving the resilience and sustainability of supply chain performance. Although studies on SCRM have developed, understanding the stages of risk management and decision-making approaches in determining mitigation strategies still requires systematic conceptual structuring. This article presents a systematic literature review aimed to (i) map the stages in supply chain risk management and (ii) identify and examine the decision-making approaches used in determining risk mitigation priorities and strategies. The review followed a structured protocol based on PRISMA diagram, including database selection, keyword formulation, inclusion–exclusion criteria, screening, eligibility assessment, and data extraction. Literature searches were conducted using Scopus and Google Scholar databases, resulting in 230 peer-reviewed articles included for in-depth analysis. The results of the study show that SCRM generally covers five core stages, namely risk identification, risk assessment, risk prioritization, mitigation alternative selection, and performance evaluation. Various decision-making approaches were found in the literature, including Analytical Hierarchy Process (AHP), Analytic Network Process (ANP), Fuzzy Logic, House of Risk (HOR), Supply Chain Operation Reference (SCOR), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), and hybrid approaches. This study confirms that there is no single universal approach for all supply chain contexts; the selection of methods must be tailored to the characteristics of the risks, the objectives of the decision-making, and the operational conditions of the supply chain. This systematic review is expected to strengthen the theoretical foundation and provide a reference for further research and the implementation of more effective and sustainable SCRM practices.

Keywords: *decision making, mitigation strategies, supply chain risk management, systematic review*

1. INTRODUCTION

Supply chains encompass the interconnected relationships among suppliers, manufacturers, distributors, and retailers that facilitate the transformation of raw materials into final products delivered to consumers (Chandrasekaran N, 2014). s dependence and complexity within modern supply chain networks increase, the entire system becomes more vulnerable to various disruptions. Across all sectors, supply chains inevitably face multiple forms of risk and uncertainty. Risk is defined as an aspect associated with the potential to cause adverse impacts or losses. Consequently, disruptions occurring in one entity within the supply chain may affect the entire network, including interruptions in the flow of information and resources at every level. Such conditions can ultimately lead to imbalances between supply capacity and demand (Suharjito et al., 2016). Failure to manage risks

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effectively at any single element of the supply chain may also result in disruptions across partner firms from upstream to downstream (J et al., 2024).

Various factors, both controllable and uncontrollable, have the potential to influence economic activities within a supply chain. Uncontrollable factors include climatic and weather conditions, economic cycles, crop diseases, natural disasters, economic crises, and market-related factors such as oversupply and low demand (Christopher & Lee, 2004; Tang & Nurmaya Musa, 2011; Vilko et al., 2014). Operational and managerial risks are closely related to human judgment and responses, including errors, delays, negligence, and inappropriate actions, which directly affect the performance of each link in the supply chain (Ivanov, 2020). Notably, supply chain risk management differs between agricultural and non-agricultural products. These differences arise because (1) agricultural products are generally perishable, making handling more challenging; (2) planting, growth, and harvesting processes vary and depend heavily on climate and seasonal conditions, resulting in longer lead times; (3) harvested products exhibit variability in form and size; and (4) supply fluctuations frequently occur due to uncertain lead times and dependence on natural conditions. If these issues are not properly managed, delays and substantial losses in product value may occur (Behzadi et al., 2018). Therefore, more specialized supply chain risk control mechanisms are required to address the unique risks inherent in agribusiness supply chains.

In risk management practice, two main approaches are commonly used to assess supply chain risks: expert judgment–based risk evaluation methods and statistical-based risk evaluation methods (Wieland & Durach, 2021). Risk assessments that rely on expert judgment are generally classified as qualitative risk evaluation models (Schoenherr et al., 2008; Wu et al., 2006), whereas risk assessments employing deterministic or statistical approaches are categorized as quantitative risk evaluation models (Nagurney et al., 2006).

A wide range of conceptual frameworks, both qualitative and quantitative, has been developed to address multiple processes within supply chain management. Moreover, numerous studies in the supply chain literature have sought to identify and analyze the most frequently occurring risks within supply chain systems. Existing studies have extensively examined recurrent supply chain risks; however, literature that simultaneously links risk identification, decision-making approaches, and the impacts of mitigation strategies remains limited. Therefore, this paper addresses the evolution of supply chain risk management processes. More specifically, this study aims to (1) map the main stages of supply chain risk management and (2) identify and examine the decision-making approaches used to determine risk mitigation priorities and strategies.

2. METHOD

This study employs a systematic literature review approach within the scope of supply chain risk in the agribusiness sector. This approach allows for engagement with a broader body of relevant literature. The literature search process was conducted through several systematically structured stages, as illustrated in Figure 1 with PRISMA diagram.

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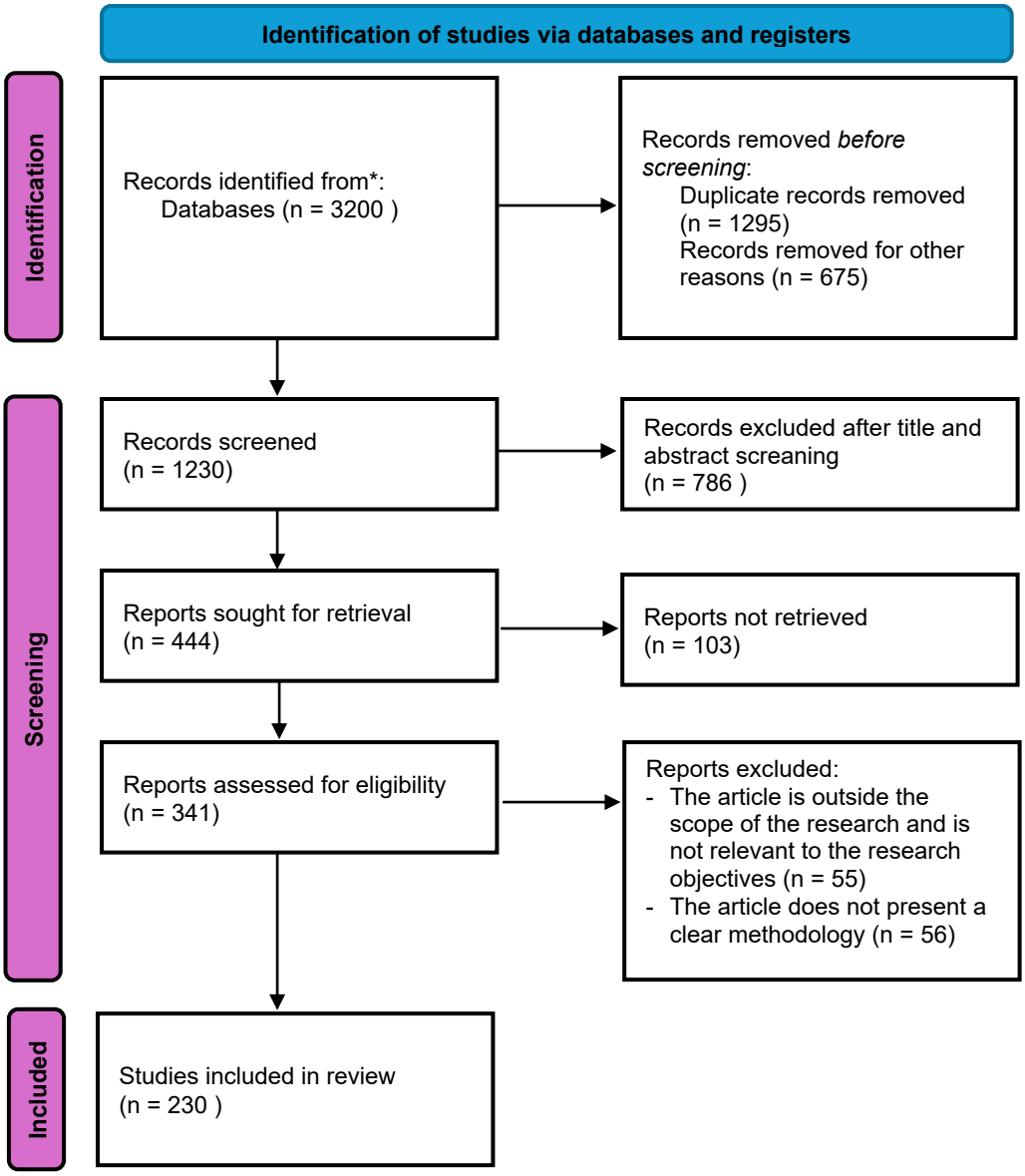

Figure 1. Flowchart from PRISMA diagram

2.1 Research Design

This study adopts a systematic literature review (SLR) approach to synthesize existing knowledge on supply chain risk management stages and decision-making approaches in agribusiness and related supply chain contexts. The SLR was conducted to ensure transparency, replicability, and methodological rigor, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram. The research model is structured to capture the sequential stages of risk management, beginning with the identification of research questions that focus on types of risks and risk control strategies in agribusiness supply chains. The framework guides the review process by linking risk identification, risk assessment, risk prioritization, mitigation strategies, and evaluation approaches. Through this structured model, the study aims to synthesize existing knowledge and

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provide an integrated understanding of how risk management stages and decision-making approaches are applied across agribusiness supply chains.

2.2 Data Collection

Data collection was conducted through a systematic and reproducible search of major scientific journal databases, namely Scopus and Google Scholar, which were selected due to their broad coverage of high-quality, peer-reviewed literature in supply chain and agribusiness research. The search strategy was designed to capture studies explicitly addressing supply chain risk management processes and mitigation decision-making. Keyword combinations included terms such as "supply chain risk management", "agribusiness supply chain", "agri-food supply chain", "risk mitigation", and "risk prioritization", combined using Boolean operators (AND, OR) to refine and expand the search scope. The initial search results were subjected to a screening process based on predefined inclusion and exclusion criteria, focusing on topical relevance, methodological clarity, and alignment with agribusiness or closely related supply chain contexts. Only journal articles written in English and published in peer-reviewed outlets were retained for further assessment. Through this structured process, a final set of 230 international journal articles was selected and used as the empirical basis for the literature synthesis.

2.3 Data Analysis

The selected articles were analyzed using a qualitative thematic analysis approach to move beyond descriptive aggregation toward analytical integration. A structured data extraction protocol was applied to systematically capture key information from each study, including research objectives, supply chain context, identified risk types, stages of supply chain risk management, and decision-making or analytical methods employed. The extracted data were coded and grouped into higher-order themes corresponding to the five core stages of supply chain risk management: risk identification, risk assessment, risk prioritization, selection of mitigation alternatives, and performance evaluation. This analytical process enabled the identification of recurring methodological patterns, complementarities among decision-making approaches, and gaps in the existing literature. By synthesizing findings across studies and stages, the analysis provides a critical understanding of how different methods are applied, rather than merely cataloguing their usage.

3. RESULT AND DISCUSSION

Specifically, research on supply chain risk management aims to develop appropriate approaches for identifying, assessing, mitigating, and responding to vulnerabilities and risks within supply chains (Emrouznejad et al., 2023; Fan & Stevenson, 2018). This study re-examines supply chain risk management through five key aspects, beginning with risk identification, followed by the measurement and assessment of identified risks. Subsequently, risk prioritization is conducted to determine which risks require immediate attention due to their greater potential impact. The analysis then considers supply chain performance in relation to risk, as well as the selection of alternative mitigation solutions, supported by the application of relevant analytical and decision-making models.

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3.1 Risk Identification

Several studies identify different types of risks across supply chain segments depending on the sector under analysis (Tummala & Schoenherr, 2011). Impacted areas must be clearly identified and well understood to ensure that appropriate risk mitigation strategies can be effectively implemented (Chopra & Sodhi, 2004). Supply chain risks can be reduced and managed more effectively when risks are identified from their root causes. In this regard, risk identification provides substantial contributions to supply chain risk management. At least two key contributions arise from conducting risk identification at an early stage: first, it helps reveal various risks that affect each flow within the supply chain; second, it enables managers and policymakers to make informed decisions by understanding risk exposure and managing it more effectively (Yeboah et al., 2014).

Based on several literature reviews, studies on risk identification consistently emphasize three main flows within supply chains: material flow, financial flow, and information flow. Risk identification serves as the initial stage in the evaluation process, enabling potential impacts to be understood and addressed through more appropriate decision-making. Accurate decisions can only be achieved when identified and classified risks are subsequently measured and assessed using suitable approaches or models. Each supply chain and research context possesses distinct characteristics; therefore, the types of risks that emerge may vary across cases. Consequently, a context-specific risk identification process is required to determine the relevant risks present in each supply chain and object of analysis.

3.2 Risk Measurement and Assessment

Risk measurement and assessment constitute the second step following risk identification. Supply chain risk measurement can be viewed as an assessment of supply chain performance (Pham et al., 2023). This stage involves quantifying and analyzing the impacts of various identified risk factors and may require the use of decision-support tools to facilitate informed decision-making (Choudhary et al., 2022). Risk assessment can be conducted using objective information and probability distributions to evaluate relevant and significant risks or changes. However, in supply chain risk management, risks are often difficult to assess objectively; therefore, risk analysis frequently relies on subjective judgments (Vilko et al., 2014). A wide range of methods and tools is available to measure and assess risks, and their selection should be aligned with the research objectives and the specific types of risks identified.

Based on several reviews, risk measurement is commonly conducted by applying various models or methods that enable the evaluation of the magnitude and severity of risks. The results of risk measurement subsequently inform risk prioritization in the decision-making process. Several measurement approaches are used to assess the extent to which risks threaten supply chain continuity, including the House of Risk (HOR), Supply Chain Operations Reference (SCOR), Fuzzy-based methods, Data Envelopment Analysis (DEA), and the Analytical Hierarchy Process (AHP). These measurement models also support the selection of appropriate analytical approaches for identifying the most effective solutions to mitigate supply chain risks.

Jurnal Bisnis Tani
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3.3 Risk Prioritization

Risk prioritization in decision-making is based on the objectives of the supply chain. Priorities are established to enable the selection of appropriate management actions. Various models and approaches can be applied to support risk prioritization in mitigation decision-making, including the Analytical Hierarchy Process (AHP), House of Risk (HOR), MICMAC analysis, and DEMATEL. Therefore, prioritizing risks within the supply chain is essential to enhance focus and minimize costs. Effective risk prioritization allows organizations to address the most critical risks accurately. Without a clear prioritization of risks, organizations may expend excessive time, cost, and effort in attempting to manage all risks simultaneously, which can ultimately undermine supply chain performance and success.

3.4 Solution Alternative Selection

Risk management in supply chains involves the consideration of multiple solution alternatives. A single risk may have one or more possible mitigation options, and one alternative may address multiple risks simultaneously. The literature on supply chain risk indicates the availability of various mitigation alternatives that can be applied across different supply chain contexts.

The formulation of risk mitigation alternatives is typically based on managerial experience, expert recommendations, or insights from prior studies. The selection of alternatives can be conducted qualitatively through managerial judgment or quantitatively using decision-making models. Some studies classify mitigation alternatives into four broad categories: avoidance, prevention, sharing, and retention (Giannakis & Papadopoulos, 2016). Other studies propose more specific alternatives, such as the selection of particular suppliers. These actions avoidance, prevention, sharing, and retention—are chosen according to the nature of the risks faced. Except for certain risks, such as weather-related, biological, and environmental risks, most other risk factors can be optimized to enhance agribusiness supply chain (ASC) performance (Tchonkouang et al., 2024), although doing so may require substantial resources. Therefore, solution alternatives should not be selected solely based on their effectiveness in addressing specific risks but also on the supply chain's capacity and capability to implement such actions.

According to Chopra and Sodhi, the greatest challenge faced by firms is reducing supply chain risk without eroding profitability (Chopra & Sodhi, 2004). In this context, the role of managers is analogous to that of portfolio managers, who aim to achieve the highest possible returns for a given level of risk while operating efficiently. In practice, this requires either (A) moving to a higher level of efficiency by reducing risk while increasing returns, or (B) remaining at the current efficiency level while accepting lower risk accompanied by reduced returns.

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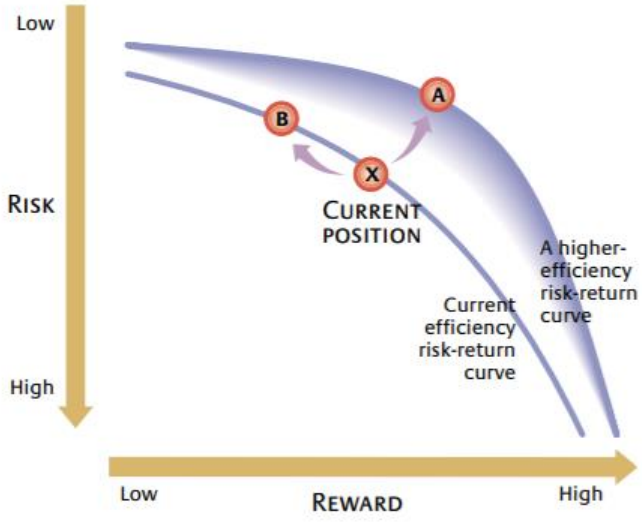

Figure 2. Risk reduction alternatives
Source: Chopra and Sodhi (2004)

3.5 Assessing the Impact of Mitigation Strategies

Unfortunately, no single strategy is fully effective in protecting an organization's supply chain. Instead, managers need to understand which mitigation strategies perform best in addressing specific types of risks.

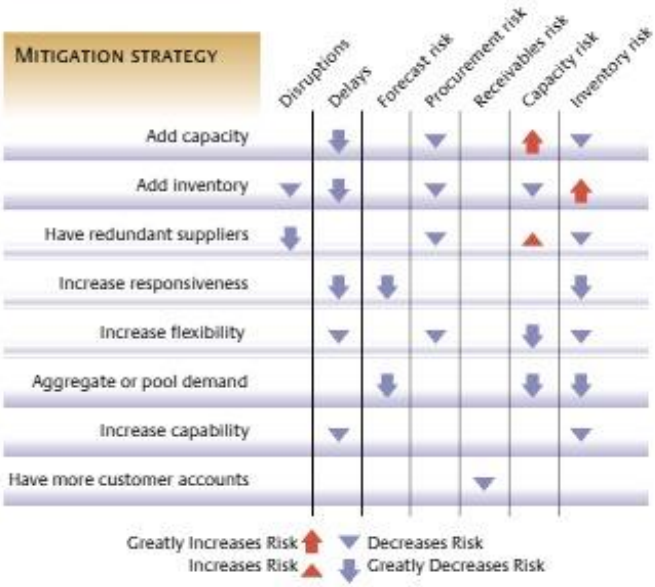

Figure 3. Evaluation of risk mitigation strategies
Source: Chopra and Sodhi (2004)

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Firms can address disruptions in material flows by building inventory buffers or by maintaining redundant suppliers, as it is unlikely that all suppliers will be disrupted simultaneously. However, holding inventory under such conditions can be highly costly. The reason is straightforward: while inventory holding costs are incurred continuously, the stockpiled inventory is only utilized when disruptions occur, which are relatively infrequent. In essence, firms pay and continue to pay for reserves that may never be used.

Therefore, risk management actions should not stop at the implementation of mitigation measures alone; managers must also evaluate mitigation strategies in terms of their impact on firm performance. In practice, risk management can both enhance and reduce performance. Managers are thus required to make informed decisions when addressing risks, particularly with respect to the resources required for mitigation and the returns generated. If the returns gained are lower than the resources invested, it indicates that the chosen risk management actions may be suboptimal.

3.6 Decision-Making Approach Methods

Risk management models differ across studies, reflecting variations in the industries examined, research settings, and methodological approaches. Nevertheless, most risk management models consistently begin with risk identification, followed by risk assessment, risk prioritization, and risk control. Some studies, however, conclude at the risk prioritization stage and provide qualitative recommendations without proceeding to implementation (Certa et al., 2016). Various decision-making approaches have been employed in the literature, including Failure Mode and Effects Analysis (FMEA), Analytic Network Process (ANP), Analytical Hierarchy Process (AHP), Fuzzy-based methods, and the House of Risk (HOR) (Ganguly & Kumar, 2019; Kurniawan et al., 2021; Magableh et al., 2024). These approaches are predominantly applied in two key stages, namely risk prioritization and the selection of alternative mitigation solutions.

Modeling approaches in risk control have their respective strengths and limitations. Therefore, recent developments have increasingly combined multiple methods to enhance analytical robustness. For example, fuzzy-based methods are often integrated with the Analytical Hierarchy Process (AHP) and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to improve decision-making accuracy (Rostamzadeh et al., 2018; Sequeira et al., 2022). Essentially, the selection of risk control actions is an integral part of the decision-making process. Therefore, a risk control framework can be viewed as a decision-making framework. The Analytical Hierarchy Process (AHP) and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) are multi-criteria decision-making techniques that can be applied to address both qualitative and quantitative problems and to identify superior alternatives based on the defined criteria and sub-criteria (Mahmoudi et al., 2025).

Another commonly used method is Failure Mode and Effects Analysis (FMEA), in which risk assessment is conducted by calculating the Risk Priority Number (RPN), defined as the product of three main components: the probability of failure occurrence, the severity of its impact, and the system's ability to detect the failure. The RPN is calculated without considering expert weighting or the relative importance of the occurrence (O), severity (S), and detection (D) elements. One notable development of FMEA is the House of Risk (HOR) model. The HOR model assigns probability values to each risk agent and severity levels to each risk event. Since a single risk agent can trigger multiple types of risk events, the model measures the aggregate risk potential generated by each risk agent. In contrast, the Analytic Network Process (ANP) is used to capture high levels of interdependence

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among different types of risks and their contributing factors, enabling more accurate prioritization of risks and selection of mitigation alternatives to support improved decision-making (Magableh et al., 2024). Although numerous risk control models have been developed, such as the Analytical Hierarchy Process (AHP), fuzzy AHP, and the House of Risk (HOR), there is still no definitive consensus on which method is most suitable for a particular supply chain. Each modeling approach has its own strengths and limitations. Consequently, the selection of an appropriate approach ultimately rests with managers, who must consider the specific context, risk characteristics, and organizational capabilities of the supply chain.

4. CONCLUSION

The results of the literature review indicate that agribusiness supply chain risk management generally proceeds through five main stages: risk identification, risk measurement and assessment, risk prioritization, selection of mitigation alternatives, and performance evaluation. The literature further emphasizes that the primary differences among studies lie in the methods used to identify risks and the analytical approaches applied in decision-making. Across various contexts, risk identification consistently refers to three main supply chain flows: material flow, information flow, and financial flow. Nearly all studies assess potential risks based on one or more of these flows, making initial risk identification a fundamental determinant of the relevance of selected mitigation solutions.

Moreover, the findings show that the selection of analytical models or methods for risk mitigation must be aligned with the types of risks identified. Approaches that are not suited to the characteristics of the risks may lead to less effective recommendations. Widely used decision-making methods, such as Fuzzy-based approaches, AHP, ANP, and HOR, each have their own strengths and limitations, and no single method has been universally recognized as the most appropriate for all supply chain conditions. Therefore, method selection remains the responsibility of managers, who must base their choices on organizational needs, risk context, and operational capabilities.

This study concludes that the success of risk mitigation is highly dependent on accurate risk identification and the suitability of the analytical methods employed. For future research, empirical evaluations of the effectiveness of different modeling approaches across diverse supply chain contexts are required to develop a stronger understanding of which methods are most relevant for specific situations.

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