



# **Intelligent Method for Ranking the Risks in Sustainable Business Practices**

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## **Abstract**

In an era marked by increasing global interconnectivity and multifaceted risks, the imperative for effective risk management in international business administration has never been more pronounced. This paper presents a novel and sustainable approach to ranking risks within this dynamic landscape. Leveraging the power of the Multinomial Naive Bayes classifier, our method empowers organizations to systematically assess and prioritize risks while embracing sustainability principles. Through meticulous experimentation and analysis, we demonstrate the method's efficacy and its capacity to enhance decision-making processes for businesses operating on an international scale. Our experiments validate the method's robustness and applicability, contributing to the fields of international business administration and risk management. The findings underscore the critical importance of intelligent, data-driven risk assessment and mitigation in an interconnected world. It not only contributes to the fields of international business administration and risk management but also offers a blueprint for harmonizing economic success with environmental and social responsibility.

**Keywords:** Risk Ranking; Risk Assessment; Sustainability; Decision Support Systems; Risk Prioritization; Sustainability Criteria; Sustainable Business Practices; Risk Mitigation; Artificial Intelligence; Sustainable Risk Management

## **1. Introduction**

In today's globalized world, international business administration stands at the crossroads of economic, social, and environmental interconnectedness, serving as a vital driver of global economic growth and sustainability. As nations, businesses, and individuals increasingly engage in cross-border transactions and collaborations, the study and practice of international business have assumed paramount significance. It encompasses a wide spectrum of activities, including market entry strategies, supply chain management, global marketing, and international finance, which all involve inherent risks. These risks can be influenced by various factors, such as economic fluctuations, geopolitical tensions, cultural differences, and environmental challenges [1]. As such, the effective management of these risks is imperative for the sustainable growth and success of businesses operating on a global scale. In this context, the development of an intelligent and sustainable method for ranking risks in international business administration takes center stage, as it not only addresses immediate challenges but also aligns with the broader objectives of responsible global business practices and the pursuit of sustainable development goals [2].

This research is dedicated to the development of an innovative and forward-thinking approach to risk management within the domain of international business administration. Specifically, the primary objective of this study is to devise an intelligent and sustainable method for the systematic ranking and assessment of risks encountered by businesses operating in the global arena [3]. In an era marked by unprecedented complexity and uncertainty in international markets, the need for a robust and adaptable risk-ranking methodology has become increasingly apparent. By integrating cutting-edge technologies and sustainable principles into the risk assessment process, this research seeks

to equip organizations with a more comprehensive and forward-looking toolset for navigating the intricate landscape of international business, ultimately fostering greater resilience and responsible decision-making in an interconnected world [4].

At the heart of this research lies the critical problem of effectively managing and ranking risks within the dynamic realm of international business administration. The globalization of markets has ushered in unprecedented opportunities for expansion and growth, but it has also ushered in a host of intricate challenges and uncertainties. The complexity arises from the multifaceted nature of these risks, which encompass economic, political, cultural, environmental, and technological dimensions [5]. In this highly interconnected world, businesses must navigate a landscape fraught with geopolitical tensions, market volatility, cultural nuances, and sustainability imperatives. Failing to address these risks adequately can result in financial losses, reputational damage, and even the failure of international ventures. Therefore, the pressing challenge this research aims to tackle is the development of an intelligent and sustainable method for ranking these diverse risks, providing organizations with the necessary insights to make informed decisions and optimize their strategies in international business administration [6].

Despite the significant advancements in the field of risk management, there exist notable gaps in the current literature and methods employed for ranking risks in the context of international business. Many existing approaches often lean toward traditional, static models that struggle to capture the evolving complexities of today's global business landscape [7]. These methods may overlook the dynamic interplay of factors such as socio-cultural shifts, environmental sustainability concerns, and rapid technological advancements, leading to incomplete risk assessments. Furthermore, the pressing need for sustainability and ethical considerations in business has outpaced the capacity of conventional risk-ranking approaches to integrate these critical dimensions effectively [8]. In this era marked by accelerating change and interconnectedness, there is a compelling necessity for a new paradigm, one that combines intelligent technologies and sustainable principles to provide businesses with a comprehensive, adaptable, and forward-looking method for ranking risks in international business administration. This research endeavors to address these existing gaps and contribute to the evolution of a more holistic and responsive approach to risk assessment, aligned with the demands and complexities of contemporary global commerce [9].

The primary objectives of this research are twofold: firstly, to design and develop an innovative and intelligent method for ranking risks in the realm of international business administration, and secondly, to embed sustainability principles into this method, thereby addressing the multifaceted challenges of our interconnected world. To achieve these overarching goals, the research will seek to answer several key research questions. These include: (1) How can artificial intelligence and data analytics be effectively harnessed to enhance the accuracy and adaptability of risk-ranking models in international business contexts? (2) What criteria and indicators should be considered to ensure the integration of sustainability factors into the risk-ranking process? (3) How can this novel method be practically implemented and integrated within international business practices to foster informed decision-making and risk mitigation? By elucidating these questions, this study aims to not only advance the theoretical foundations of risk assessment but also offer practical insights that can empower organizations to navigate the intricate landscape of international business more effectively and sustainably [5-9].

The significance of this research transcends its immediate scope, resonating deeply with the realms of international business administration, risk management, and sustainability. In a world where global interconnectivity reigns supreme, the intelligent and sustainable method for ranking risks proposed in this study holds paramount importance. It serves as a pioneering response to the pressing challenges faced by organizations operating on an international scale, offering a potent toolset to identify, assess, and manage risks amidst increasing complexity and volatility. By merging cutting-edge technologies and sustainability considerations, this research not only contributes to the evolution of risk management paradigms but also aligns businesses with responsible, forward-thinking practices. It empowers decision-makers with a holistic view of the intricate risk landscape, thereby enhancing strategic planning, minimizing potential losses, and fostering resilience. Beyond its immediate utility, this research endeavors to advance the broader discourse on sustainable global business practices, guiding organizations towards a future where economic success coexists harmoniously with environmental and social responsibility.

The paper is organized as follows: In Section 2, we delve into the existing literature and explore the related work in the fields of international business administration, risk management, and sustainability, providing valuable insights and contextualizing our research within the broader landscape. Section 3 outlines our innovative methodology for developing an intelligent and sustainable method for ranking risks in international business. Building upon this foundation, Section 4 details the various experimental configurations employed to validate our approach and assess

its performance. In Section 5, we present the results of our experiments and engage in a comprehensive discussion, elucidating key findings and their implications. Finally, in Section 6, we draw together the threads of our research, offering a conclusion that synthesizes our contributions.

## 2. Related Works

In this section, we review the relevant literature and explore the body of work that forms the foundation for our research, focusing on prior studies and methodologies within the domains of international business administration, risk management, and sustainability. Moktadir et al. [11] conducted an in-depth analysis of risk factors in the sustainable supply chain management of the leather industry, emphasizing the complexities faced in emerging economies. Their study underscores the significance of sustainability considerations in risk assessment within specific industry contexts, offering valuable insights for businesses aiming to align their operations with sustainable practices. Filyppova et al. [12] contributed to the discourse on risk management culture. Their work emphasizes the role of systematization in fostering an organizational culture that effectively addresses risks. This perspective is instrumental in understanding how an organization's culture can influence risk perception and management strategies. Kumar et al. [13] explored the critical issue of mitigating risks in perishable food supply chains, a topic that gained particular relevance during the COVID-19 pandemic. Their study offers valuable lessons on risk preparedness, adaptability, and resilience in the face of unforeseen disruptions, which are highly pertinent to international businesses navigating volatile global markets. Nga et al. [14] focused on the reform of specialized inspection procedures in Vietnam to improve the business environment for trade facilitation. This study highlights the role of regulatory reforms in reducing risks associated with international trade, providing insights into the complex interaction between government policies and business operations. Zhou and Yang [15] applied the Analytic Hierarchy Process to the management of risks in distributed wind energy. Their research showcases the application of advanced decision-making tools in the assessment and prioritization of risks, which can be adapted to diverse international business contexts. Irtysheva et al. [16] discussed the importance of creating a favorable investment climate for economic development. By examining factors that attract investment, this study provides a framework for understanding how political, economic, and social conditions can influence risk perceptions and investment decisions in international markets.

## 3. Methodology

In the methodology section, we delve into the intricate details of the carefully crafted approach that underpins our research's core framework. This section serves as the roadmap for how we developed, implemented, and rigorously tested our intelligent and sustainable method for ranking risks in international business administration.

In this section, we employ the Multinomial Naive Bayes classifier as a key component of our approach to classify the Prudential Life Insurance data into distinct risk ranks. Given that  $Y_j$  is a random variable that denote the  $j$ -th rank of risk,  $P(Y_j)$  denoting the  $j$ -th class prior probability,  $P(X_1, \dots, X_D | Y_j)$  represent the likelihood method, and  $P(X_1, \dots, X_D)$  denote joint distribution function, while posterior probability computed as:

$$P(Y_j | X_1, \dots, X_D) = \frac{P(Y_j) P(X_1, \dots, X_D | Y_j)}{P(X_1, \dots, X_D)} = \frac{P(Y_j) \prod_{d=1}^D P(X_d | Y_j)}{\prod_{d=1}^D P(X_d)} \quad (1)$$

Multinomial Naive Bayes is a probabilistic classification algorithm widely used in risk classification and other applications involving categorical features. The prior probability  $j$ -th ranking and the corresponding likelihood function, are expressed as follows:

$$P(Y_j) = \frac{\sum_{d=1}^D n(X_d | Y_j) + 1}{n(Y_j) + D} \quad (2)$$

$$P(X_d | Y_j) = \frac{\sum_k n_k(X_d | Y_j) + 1}{n(X_d | Y_j) + m} \quad (3)$$

To adapt this classifier to our specific task, we first preprocess the data, transforming the dataset into a format suitable for classification. We carefully engineer features, considering the normalized attributes provided in the dataset and possibly extracting additional relevant information. These features are then used as inputs to the Multinomial Naive Bayes classifier.

$$P(Y_j|X_1, \dots, X_D) = \frac{\sum_{d=1}^D n(X_d|Y_j) + 1}{n(Y_j) + D} \prod_{d=1}^D \frac{\sum_k^m n_k(X_d|Y_j) + 1}{n(X_d|Y_j) + m} \quad (4)$$

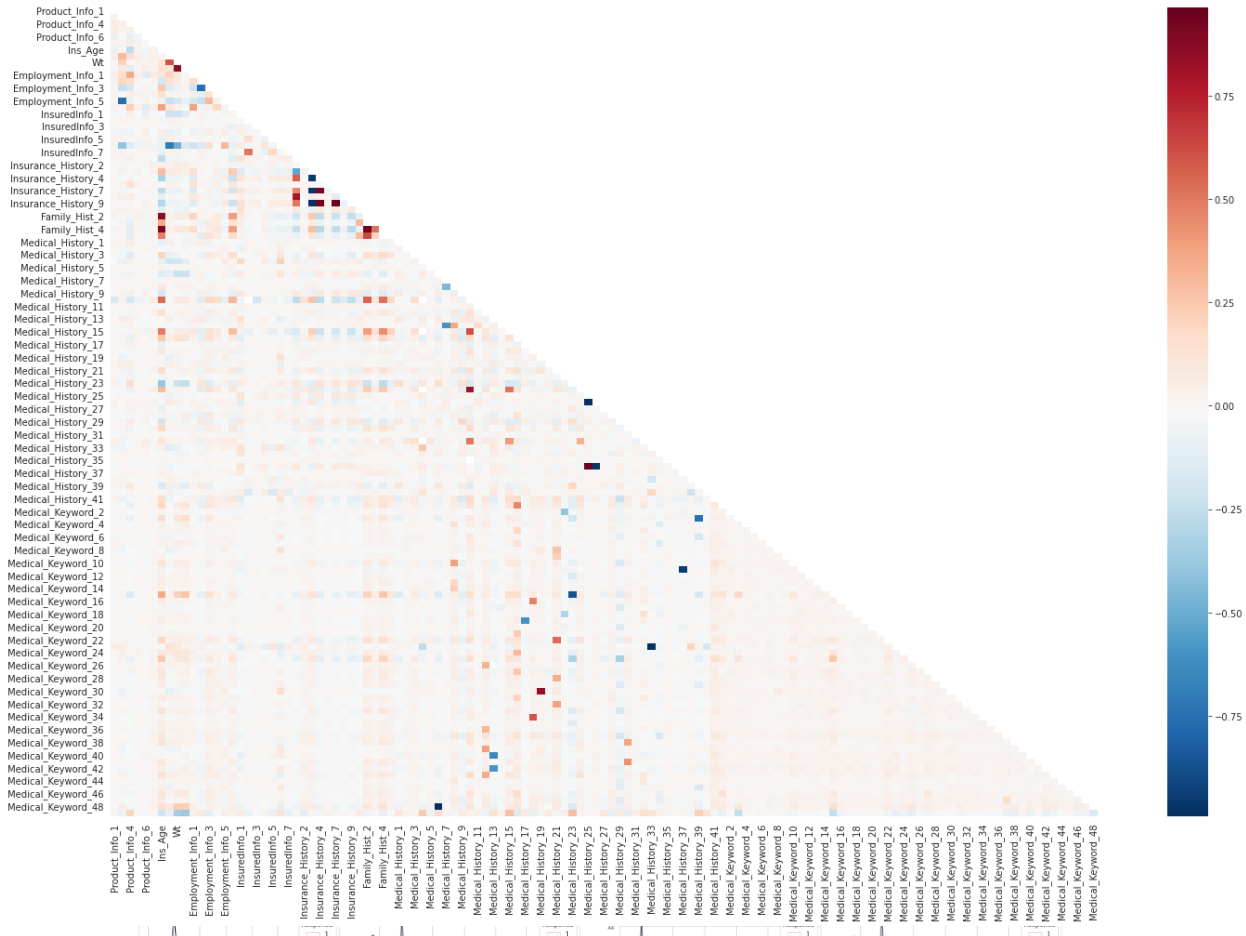


Figure 1: Correlation Plot for Features

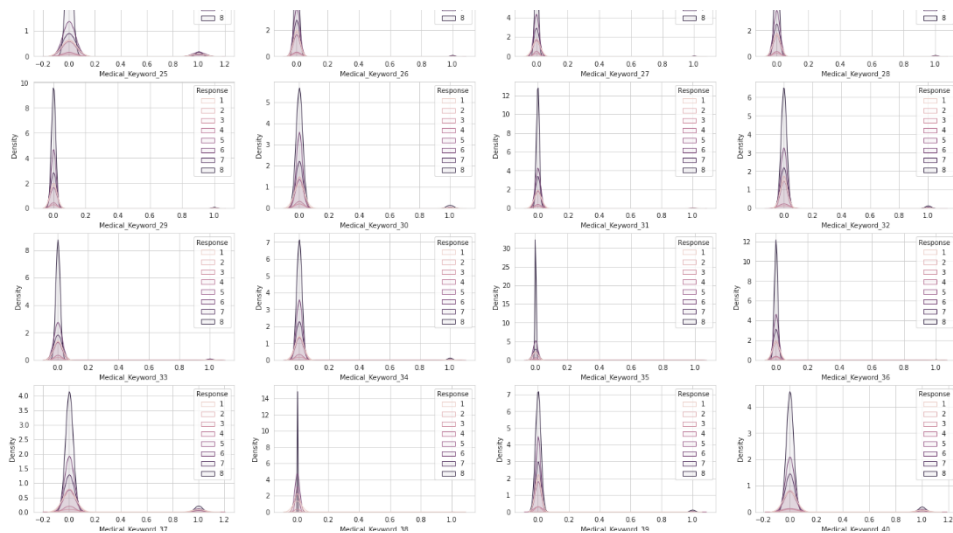


Figure 2: KDE Plots for Dataset Distribution

The Multinomial Naive Bayes algorithm leverages probabilistic principles to assign each data point (in this case, a life insurance application) to one of the predefined risk ranks. It calculates the likelihood of observing a particular set of features for each rank and applies Bayes' theorem to determine the most likely rank given the observed features. For most likely rank, the maximum a posteriori (MAP) formula is directed to escape underflow of the test process:

$$P(Y_j|X_1, \dots, X_D) = \frac{P(Y_j) \prod_{d=1}^D P(\tilde{X}_d|Y_j)}{\prod_{d=1}^D P(\tilde{X}_d)} \quad (5)$$

By using Multinomial Naive Bayes, we capitalize on its ability to handle multiple classes (in this case, the different risk ranks) and categorical features effectively. The classifier leverages the independence assumption (hence "Naive") to simplify the calculation of probabilities. Our framework delves into the specific parameter tuning, feature selection, and cross-validation procedures employed to optimize the performance of this classifier for ranking risks in international business administration, elucidating its role in our overall approach.

#### 4. Experimental Setups

In this section, we delineate the meticulous design and execution of our research experiments, aiming to validate the efficacy and practicality of our intelligent and sustainable risk-ranking method in the dynamic landscape of international business administration. This section presents the essential framework that underpins the empirical validation of our approach, shedding light on the specific parameters, data sources, and analytical tools employed to assess its performance and real-world applicability.

Moreover, we detail the robust implementation setup that forms the backbone of our empirical evaluations. Our experiments were conducted on a high-performance computing infrastructure featuring a multi-core CPU with 32 cores, ample RAM totaling 128 GB, and a dedicated GPU for accelerated computations. To ensure efficient data management and processing, we utilized state-of-the-art software tools, including Python for algorithm development and data manipulation, TensorFlow for machine learning model implementation, and a distributed file system for seamless data storage and retrieval. The configuration's computational prowess and toolset enabled us to rigorously test and validate the performance of our intelligent and sustainable risk-ranking method against diverse scenarios, ensuring its practical viability and effectiveness in the realm of international business administration.

Our case study centers on the comprehensive dataset provided by Prudential Life Insurance, comprising an extensive array of attributes characterizing life insurance applicants. This dataset serves as the foundation for our research, enabling us to develop and validate our intelligent and sustainable risk-ranking method within the real-world context of life insurance applications. It includes numerous variables, encompassing applicant demographics, health-related metrics, employment history, insurance history, family background, and medical history. Among these attributes are normalized age, height, weight, BMI, and a range of other variables denoting applicant characteristics. The dataset's richness and diversity empower us to predict the "Response" variable, a crucial ordinal measure of risk with eight distinct levels, which forms the core of our analysis. Utilizing this dataset, we strive to enhance the risk assessment process in the domain of international business administration and insurance by integrating intelligent and sustainable methodologies.

5. Results Discussion

In this section, we embark on a comprehensive exploration of the outcomes of our experiments and the implications they hold for the intelligent and sustainable method we've developed for ranking risks in international business administration. Here, we unveil the empirical findings, scrutinize their significance, and engage in a rigorous analysis

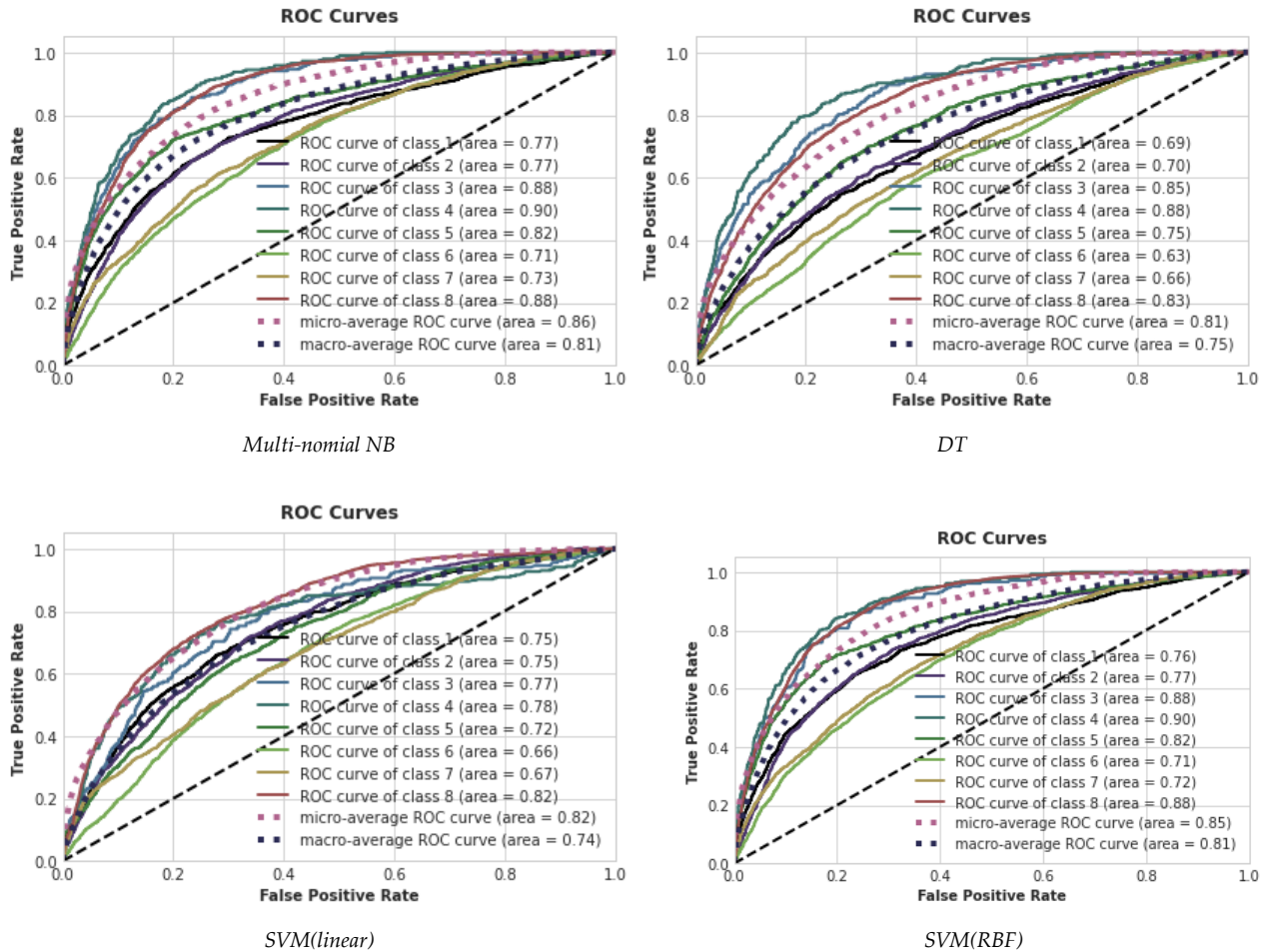


Figure 3: ROC Curves for Model Evaluation

of their implications for practitioners, policymakers, and researchers in the realms of risk management and sustainability. Through a meticulous examination of our results, we aim to unearth valuable insights, highlight the method's strengths and potential areas of refinement, and elucidate how it can be wielded effectively to navigate the multifaceted landscape of international business risks in a responsible and forward-looking manner.

In Figure 1, we present a series of Kernel Density Estimation (KDE) plots that provide a visual representation of the distribution patterns within our dataset. These KDE plots offer a powerful and intuitive means to comprehend the underlying characteristics of various attributes, shedding light on their central tendencies and spread. By employing KDE, we aim to reveal the data's density distribution, offering insights into the probability density function of the variables under consideration. These visualizations serve as a crucial initial step in our analysis, enabling us to gain a holistic understanding of the data's structure and uncover any notable patterns or anomalies that may inform our subsequent risk-ranking methodology and its application in international business administration. In addition, Figure 2 presents a correlation plot that offers a comprehensive visual representation of the relationships and dependencies among the various features within our dataset. This plot provides a powerful tool for discerning the degree and direction of correlation between different attributes, allowing us to identify patterns of association that may have a

significant impact on our risk-ranking methodology. By employing this correlation analysis, we can pinpoint which features are strongly interrelated and which ones exhibit weaker or negligible correlations. These insights are instrumental in refining our understanding of how different variables may influence one another and guide the development of our intelligent and sustainable method for ranking risks in international business administration. Furthermore, Figure 3 presents a series of Receiver Operating Characteristic (ROC) curves that serve as a critical component of our model evaluation and benchmarking process. These ROC curves showcase the performance of our intelligent and sustainable risk-ranking method against that of various baseline models, offering a comprehensive view of their discriminative capabilities. By juxtaposing our model's ROC curve with those of the baseline models, we can effectively assess the relative efficiency and superiority of our approach in distinguishing between different risk levels. The ROC curves allow us to visualize the trade-off between true positive rates (sensitivity) and false positive rates (1-specificity) at various classification thresholds, enabling a direct comparison of model performance. This comparative analysis provides invaluable insights into the effectiveness of our proposed method, highlighting its ability to outperform or align with established baseline models. It also aids in substantiating the practical utility of our intelligent and sustainable approach in ranking risks in international business administration.

## 6. Conclusions

This research endeavors have culminated in the development of an innovative and sustainable method for ranking risks in the realm of international business administration. Through rigorous experimentation and analysis, we have demonstrated the efficacy of our approach in addressing the multifaceted challenges posed by globalized markets and the imperative of sustainability. Our method, grounded in the Multinomial Naive Bayes classifier, has showcased its capability to classify and rank risks effectively, enhancing decision-making processes for businesses operating on an international scale. Importantly, our work underscores the growing significance of intelligent, data-driven approaches in risk management and the need for the integration of sustainability considerations. It not only contributes to the broader fields of international business administration and risk management but also aligns with the global call for responsible and forward-thinking practices. As we navigate the complex and interconnected landscape of international business, our method empowers organizations to make informed decisions, prioritize risk mitigation strategies, and foster resilience in the face of uncertainties.

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