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Exploring risk exposures in the aviation sector by examining risk disclosure information from listed companies

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Abstract

A risky area of the transportation industry is aviation. However, the majority of research have overlooked the risk disclosure of businesses in the air industry and instead concentrated on risk perceptions connected to passenger travel by transport. The rigorous assessment of the risks that these types of businesses, which provide services, is essential to the growth of the aviation-related sub-sectors. Based on the textual risk disclosures in the financial statements, this study makes an effort to pinpoint the risk variables that affect air transport businesses. This paper employs a possible Dirichlet allocation (LDA) method based on the VEM algorithm to find risk disclosures in 15,507 risk headings from 255 public businesses from 2005 to 2022. In addition, this paper discusses the commonalities and differences of risk disclosures between three sub-sectors (airlines, airports, airfreight), and provides some recommendations and responses for future corporate risk decisions. The results of this study can help stakeholders to develop sound and timely risk management strategies.

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1. Introduction

Aviation is a risk-sensitive industry. The intricate relationship between risk and transportation makes it necessary to have a thorough understanding of transportation risk factors. Transportation risk is a critical issue that has significant implications for both individual travelers and the transportation industry as a whole [1].

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Although these risks cannot be completely eliminated, managers can implement risk early warning through risk identification to reduce the uncertainties [2]. Furthermore, transportation risk can also affect the way that transportation services are marketed and managed. For example, modes of transportation with a high level of perceived risk may need to take additional measures to ensure the safety and security of travelers, such as implementing stricter safety regulations or providing more comprehensive emergency response plans. This can increase the costs of operating these modes of transportation, which can in turn impact the profitability of the transportation industry [3].

In this paper, we attempt to systematically identify the risk exposure of aviation companies, using three sub-sectors as examples. To do so, this paper introduces the Latent Dirichlet Allocation (LDA) model, an unsupervised clustering method that effectively identifies hidden knowledge from large amounts of text, to analyse textual risk disclosure data from Form 10-K for all airline listed companies over the period 2005–2022. The main contributions of our work are the following. Firstly, the strength of the data, which is the first systematic identification of risk disclosures in the airline industry using 10-K annual reports from the perspective of the airline industry. Secondly, the ranking of the risk type weights for each of the three areas, airlines, airport and airfreight, gives some management insights for managers in each industry, while the commonalities and characteristics of the risk types in these three sub-sectors are also compared. These findings are important for this type of industry to avoid risks, make scientific decisions and diminish uncertainty in the future.

2. Methods and result

Airline, air freight, and airport are three different industries in the aviation sector with distinct functions and operations. Through LDA-VEM algorithm [4], this study adjusts parameters to determine the number of topics, as well as the high-frequency words of the summarized topics, generates word clouds, and then discusses different topics. Then, we conclude the risks factors in the context of airlines, airports and air freight & logistics. The following are identified topics and related top keywords. As Fig. 1. reveals, we finally determine the topic number for each sub-industry, for airline and airfreight the topic number is 8 (a and c), and for airport the topic number is 12 (b) through perplexity since it is the main indicator of topic numbers that has been used in previous studies for identifying risk types [5].

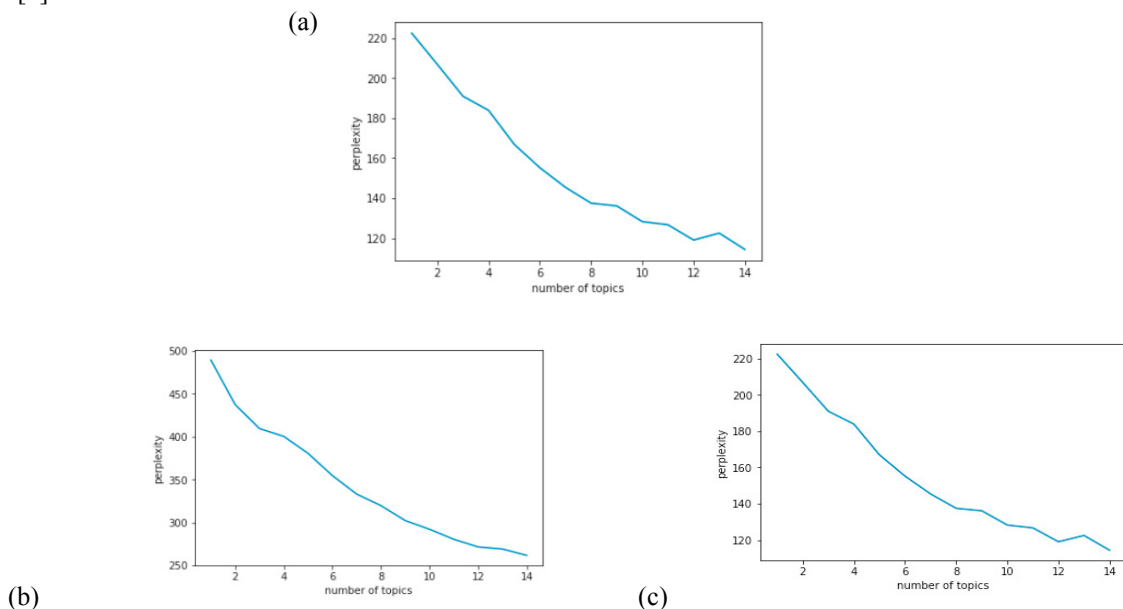


Fig.1. the perplexity of three sub-industries risk topics (a) airline, (b) airport, (c) airfreight and logistics

Firstly, airline refers to companies that provide scheduled and charter passenger air transport services. Airlines operate flights that transport passengers from one destination to another. They typically offer a range of services including seat selection, meals, entertainment, and other amenities to passengers. Airlines generate revenue from ticket

- Topic #0 fuel price fluctuation risk
fuel labor costs disruptions increased supply operating strikes losses prices

- Topic #1 debt liquidity risk
obligations ability conditions liquidity limit operating future economic control covenants
- Topic #2 cost and revenue risk
costs competitive operating regulation agreements substantial maintenance security incur data
- Topic #3 reputation risk
systems harm failure technology operate attacks terrorist heavily automated rely
- Topic #4 information technology risk
costs insurance key personnel operating dependent government regulations coverage suppliers
- Topic #5 volatile stock fluctuation risk
stock price market economic stockholders conditions control fluctuate interruptions volatile
- Topic #6 crash and accident risk
partners reputation share event code limited growth harmed accident major
- Topic #7 partnership risk
third party negatively service services providers delays assets united regional



Fig.2. the word cloud of airline companies risk topics

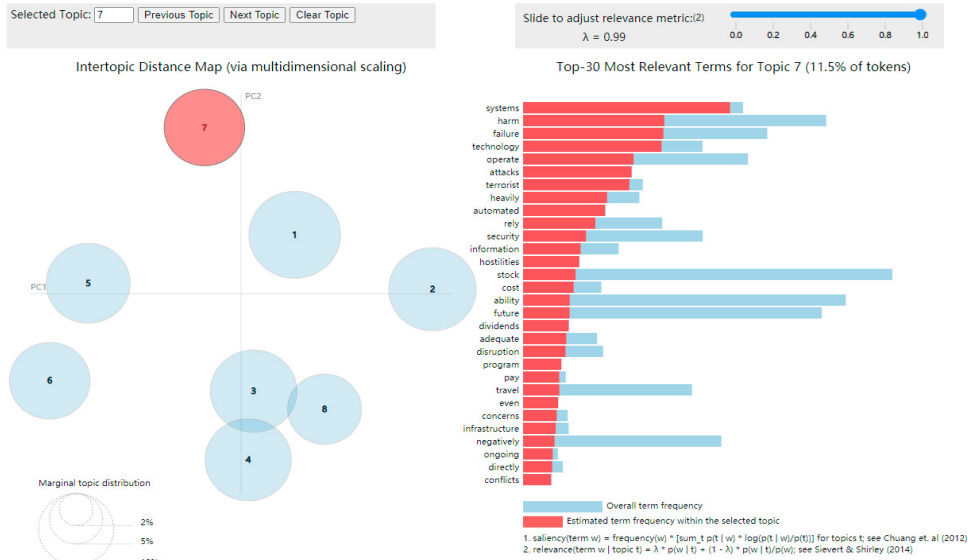


Fig.3. the visualization of airline companies risk topics

Here we define relevance, our method for ranking terms within topics, and we describe the results of a user study to learn an optimal tuning parameter in the computation of relevance. For a given word w , we compute its conditional probability $P(T|w)$: the likelihood that observed word w was generated by latent topic T . We also compute the marginal probability $P(T)$: the likelihood that any randomly-selected word w_0 was generated by topic T . We define the distinctiveness of word w as the Kullback-Leibler divergence between $P(T|w)$ and $P(T)$ [6]:

$$\text{distinctiveness}(w) = \sum_T P(T|w) \log \frac{P(T|w)}{P(T)} \quad (1)$$

We use two open-source packages, LDAvis and Termite, for visual display. As can be seen from Fig.3., when the correlation coefficient $\lambda = 0.99$ describes the risks related to the supplier [7]. By analogy, we can conclude the optimal number of topics and make specific analysis based on the specific situation of the aviation sub-industry.

Secondly, airport industry plays a vital role in global transportation, serving as hubs for connecting flights and facilitating the movement of people and goods around the world. They provide essential services including passenger handling, aircraft maintenance, cargo operations, and security. The result of airport industry is as follows, Fig.4. also delineates the word cloud for those eight risk types in airport industry:

- Topic #0: personnel management risks
personnel management key maintain add must traded stock systems
- Topic #1: price and shares risks
stock price stockholders market future current available shares foreign securities
- Topic #2: imposing laws risks
laws failure poses prospects foreign costs comply impose fines expenses
- Topic #3: government regulation risks
stock extensive regulation less makes liquid active governmental rules penny
- Topic #4: revenue and demand risks
revenue future continued demand threat foreseeable actions successful private terrorist
- Topic #5: economic risks
control economic profitability laws stock sufficient systems agreements failure foreign
- Topic #6: shareholders and directors risks
stock board shares rights preferred right holders directors issue generate
- Topic #7: customers management agreement risks
customers key management loss team agreement influential voting power agreements
- Topic #8: price warrants risk
fuel warrants potential provisions financing options existing dilution granting dilute

- Topic #9: services risks
competitive services operate fiercely segment stock operating costs customer securities
- Topic #10: insurance securities and risks
securities capital risks operating future stockholders foreseeable market demand stock
- Topic #11: company expanding risks
fractional expand interests need sales new profitability available competitive customer



Fig.4. the word cloud of airport companies risk topics

Thirdly, air freight refers to the transport of goods or cargo by air. Air freight companies typically offer cargo transportation services for businesses and individuals. This includes transporting goods such as perishable items, electronics, and industrial equipment, often using specialized containers or pallets designed for air transport. Air freight companies generate revenue from charging fees for transporting goods by air [8]. The result is as follows, Fig.5. also delineates the word cloud for those eight risk types in airfreight industry:

- Topic #0: cost risk
costs lessees engines lease equipment sales weather conditions dependent ability
- Topic #1: personnel management risks
key services service employees competitors personnel terms competitive logistics performance
- Topic #2: provider and carriers risk
service risks carriers providers operating fedex based ocean capacity profitability
- Topic #3: operating risks
tax customer negatively materially united including operating states meet jurisdictions
- Topic #4: technology and systems risks
systems disruptions customers conditions also reporting technology global costs failures
- Topic #5: rules and regulations risks
regulations trade laws international restrictions governmental costs comply penalties failure
- Topic #6: disasters and engine disruption risks
event cash systems disruption meet obligations engine catastrophic major harm
- Topic #7: revenue risks
revenues maintenance customers ability based dependent systems must competitive segment



Fig.5. the word cloud of air freight and logistics companies risk topics

In a word, airlines transport passengers, air freight companies transport cargo, and airports provide facilities and services for aircraft. While they are all part of the aviation industry, they serve different purposes and operate in distinct segments of the market. And different industries take different responsibilities, so the risk types vary from industry to industry.

3. Risk exposures of three sub-industries

In this section, we delve into more details and make comparisons between these three sub-industries, we calculate the risk exposures in each sub-industry and further compare them to distinguish the main threats of different sub-industries.

Table 1 Risk importance in three sub-industries

	Airline		Airport		Airfreight	
1	Fuel price fluctuation	15.19%	Personnel management	16.04%	Cost risk	19.52%
2	Cost and revenue risk	14.41%	Government regulation	11.28%	Provider and carrier risk	15.43%
3	Debt liquidity	14.32%	Customer risks	10.53%	Operating risk	15.24%
4	Partnership risk	13.28%	Law risks	10.53%	Rules and Regulations	12.64%
5	Volatile stock fluctuation	11.97%	Price warrants risk	9.52%	Revenue risk	11.34%
6	Reputation risk	11.62%	Revenue and demand	8.27%	Disasters and engine disruptions	9.29%
7	Crash and accident risk	10.96%	Company expanding risks	8.27%	Personnel management	8.55%
8	Information technology	8.26%	Service risks	8.02%	Information technology	7.99%
9			Shareholder risks	6.27%		
10			Insurance securities	5.76%		
11			Shares risks	3.01%		
12			Economic risks	2.51%		

As shown in Table 1, there are also some visible differences between them. In the airline industry, fuel price fluctuation (15.19%) is a significant risk because fuel is one of the most significant operating costs for airlines. Any sudden increase in fuel prices can lead to increased expenses, which can reduce profitability. Cost and revenue risk (14.41%) are also important because airlines are exposed to the risk of sudden changes in demand for air travel and are often faced with intense competition. Additionally, debt liquidity risk (14.32%) is relevant as airlines often rely on financing to purchase new aircraft, maintain operations, and fund expansion plans. Any difficulties in obtaining

financing can impact the airline's ability to operate and grow. Finally, cost risk is important as airlines must manage their costs effectively to maintain profitability and competitiveness.

In the airport industry, personnel management (16.04%) is an important risk factor because airports need to ensure that they have a skilled and motivated workforce to provide high-quality services to passengers and airlines. Government regulation (11.28%) is another significant risk as airports are often subject to strict regulations related to safety, security, and environmental standards, which can increase operating costs and impact their ability to expand. Finally, customer risks (10.53%) are relevant because airports need to maintain positive relationships with airlines and passengers to ensure ongoing business and revenue growth [12].

In the airfreight industry, government regulation is also an important risk factor because airfreight carriers are subject to various regulations related to customs, security, and safety. Provider and carrier risk (15.46%) are also significant as airfreight carriers often rely on a network of providers and carriers to transport goods, and any disruptions in this network can impact their ability to fulfill customer orders. Operating risk (15.24%) is also important as airfreight carriers must manage various risks associated with the transportation of goods, including damage or loss, which can result in financial losses and damage to their reputation [14].

4. Related responses for managers in these three sub-industry companies

Fuel is a significant expense for airlines and airports, these two sub-industries consume a large amount of fuel due to the nature of their operations, which involves operating and maintaining aircraft and ground support equipment. As a result, fuel represents a significant expense for both airlines and airports, and any fluctuations in fuel prices can have a significant impact on their profitability. Airlines and airports have a more complex and extensive operational network, which requires more fuel usage compared to air freight. Air freight companies may use fuel surcharges to offset the impact of fuel price fluctuations. This means that air freight companies can pass on some of the additional fuel costs to their customers, making them less vulnerable to fuel price fluctuations [9,13].

Cost and partnership risks are significant challenges faced by the airline, airfreight, and airport industries. Here are some responses and suggestions that these industries can consider in the future to mitigate these risks:

Cost Risks:

- Cost optimization: All three industries can explore various cost optimization measures, such as fuel-efficient aircraft, streamlining operations, reducing wastage, and embracing technology to reduce operational costs.
- Hedging strategies: Airline and airport industries can implement hedging strategies to protect themselves from volatile fuel prices, currency fluctuations, and interest rate risks [10].
- Diversification: Diversification can help in reducing cost risks. Airfreight companies can consider diversifying their customer base, focusing on new markets and offering additional services, such as logistics and warehousing, to offset the impact of any adverse cost factors.

Partnership Risks:

- Strategic alliances: All three industries can form strategic alliances with other companies in the same or related industries to share risks, reduce costs and enhance their competitive position.
- Contract management: Effective contract management is crucial for managing partnership risks. The industries need to develop and implement robust contract management procedures to monitor partner performance, ensure compliance, and resolve disputes [11,15].

To mitigate cost and partnership risks, the airline, airfreight, and airport industries need to focus on cost optimization, hedging strategies, diversification, strategic alliances and effective contract management. By implementing these measures, these industries can reduce their exposure to risks and improve their financial performance and sustainability.

5. Conclusions

This article applies the LDA-VEM methodology to the identification of risk for aviation companies, using textual data on listed companies provided by the SEC. Through text mining method, we identified 8, 12, 8 risks for In the airline sector, managers should pay more attention to fuel price fluctuations, cost and revenue risks, debt liquidity, and

in the airport sector, managers should pay more attention to human resource management, government regulation, customer risk, in the air freight sector managers should also be aware of cost risk, supplier and carrier risk, operational risk. We also concluded that airline industry is more vulnerable to debt liquidity risk than the other sub-industries, that is because airlines have high operating costs due to the complex and capital-intensive nature of their operations. In contrast, airfreight industry is more vulnerable to credit risks than the other two. Airfreight transactions can be complex, which can increase the risk of errors or disputes.

The findings of our research have some practical implications. First, our findings can help investors have a better understanding of the risk status of traffic industry, especially aviation industry. Also, when making more sound and wise decisions, managers need to focus on the differences between different sub-industries, which will provide a kind of guidance for generating more reasonable strategy to avoid risks. For managers working in aviation companies, no matter what sub-industry, they should pay attention to the risk types that have higher importance, and constantly optimize the business structure. They should also combine the characteristics of the aviation industry with its specific times, through the changes of risk types, they will then have awareness of the uncertainty in the environment and the situation. For example, the customer risk, partnership risk has increased significantly, in the future, this predicts a kind of tendency, they should strengthen the human resource management.

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