

AI-Based Supply Chain Sentiment and Risk Forecasting Using Real-Time News Analytics

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Abstract

Supply chain disruptions have become increasingly frequent because of geopolitical events, climate change, government regulations, and market volatility. Conventional supply chain risk management systems are mainly dependent on historical information and static variables, making them less capable of recognizing potential risks in real-time. This paper proposes an AI-powered supply chain sentiment analysis and risk prediction system that uses real-time news information to detect possible risks at an early stage. The proposed system uses real-time news articles from various news channels and transformer-based sentiment analysis to determine the underlying sentiment linked to supply chain events. The sentiment values are then converted to dynamic risk scores, making it possible to monitor risks continuously. At the same time, time-series forecasting methods are used to forecast the short-term trend of risk scores based on sentiment-driven values. The experimental outcome shows that the proposed model is capable of accurately detecting negative cues linked to possible risks while performing well on neutral and positive news articles.

Keywords: Supply Chain Risk, Sentiment Analysis, Natural Language Processing, Transformer Models, Risk Forecasting

Introduction

Supply chains have become more complex and interconnected across the globe, making them extremely vulnerable to disruptions caused by geopolitical tensions, natural disasters, government regulations, and market fluctuations. The current scenario across the globe has highlighted the inefficiencies of traditional supply chain risk management practices, which are largely dependent on historical data and static variables. These practices often fail to identify risks in a timely manner, resulting in significant operational losses.

With the growing popularity of digital media, news articles and online news reports have become important sources of information that provide insights into the changing conditions of the supply chain. The text data streams include early warnings of possible disruptions in the supply chain, such as congestion at ports, trade barriers, labor

strikes, and supplier bankruptcies. But the process of analyzing large amounts of unstructured news data manually is not feasible.

Recent breakthroughs in artificial intelligence, especially in natural language processing (NLP), have made it possible to efficiently extract insights from unstructured text. The transformer model has shown great success in sentiment analysis tasks by identifying the context and semantic relationships in text. Using the transformer model for supply chain risk detection helps to monitor news sentiment and detect negative signals.

In this paper, an AI-driven system for supply chain sentiment analysis and risk prediction is proposed. The system combines real-time news ingestion, transformer-based sentiment analysis, and time series forecasting. The system uses sentiment analysis to generate risk scores, which are then forecasted using forecasting methods to predict short-term risk trends. The proposed system combines real-time text intelligence with forecasting to provide an interpretable and proactive decision-support system for supply chain risk management.

Literature Survey

There have been a number of studies on supply chain risk management that have utilized quantitative and analytical methods. Conventional methods are largely dependent on historical operational data, statistical measures, and expert-based risk management models. Although these models provide structured inputs, they tend to be less sensitive to external events and do not pick up warning signals from unstructured sources.

With the increasing availability of digital news sources and online media, researchers have explored the application of text mining and sentiment analysis for economic and supply chain analysis. Early research studies used lexicon-based sentiment analysis techniques to analyze market trends and business risks. Nevertheless, these studies have some drawbacks, such as a lack of understanding of the context and the inability to handle domain-specific language, which is commonly used in supply chain and financial news.

However, recent breakthroughs in machine learning and natural language processing have resulted in the use of supervised learning and deep learning techniques for sentiment classification. Research papers involving the use of word embeddings and recurrent neural networks have shown better results than the conventional approaches. Recently, transformer models have shown state-of-the-art performance in sentiment analysis by efficiently identifying the contextual dependencies in the text. Such models have been used for financial news analysis, market prediction, and risk evaluation.

Some research attempts have tried to combine sentiment analysis with risk modeling by correlating text sentiment with risk indicators. Although promising, most of the current systems are based on static historical data and do not have the capability to ingest data in real-time. Moreover, little work has been done to predict future risk trends using sentiment-based indicators.

In conclusion, the current literature emphasizes the usefulness of sentiment analysis in risk analysis, but it also shows important limitations in relying on historical data, in the lack of real-time processing, and in the integration of forecasting. The proposed system will overcome these limitations by using real-time news ingestion, transformer-based sentiment analysis, dynamic risk calculation, and time series forecasting.

Proposed System

The proposed system is a framework for supply chain sentiment and risk forecasting using AI, which aims to identify possible disruptions in the supply chain by utilizing news data. The system has real-time data ingestion, sentiment analysis using a transformer model, risk scoring,

and time-series forecasting. A description of the system architecture is presented using four main components.

A. Real-Time News Ingestion

The system aggregates news articles related to the supply chain from online news sources using news aggregation APIs. The system uses keywords related to logistics, supply chain disruption, trade policies, production delays, and regulatory issues to fetch relevant news articles. To make the data accurate, the system removes duplicate news articles using content-based deduplication. This helps the system analyze only unique and relevant news articles while providing a continuous stream of information.

B. Sentiment Classification Using Transformer Models

The compiled news articles are then processed using a transformer-based sentiment classification model. A pre-trained DistilBERT model is fine-tuned on a labeled financial news corpus to classify each news article into three categories based on its sentiment: positive, neutral, and negative. The choice of transformer models is based on their ability to capture contextual and semantic relationships in text, which is crucial for making sense of the complex language used in relation to supply chains. The model performs well on all categories of sentiment.

C. Dynamic Risk Scoring Mechanism

To convert the outputs of sentiment analysis into meaningful intelligence, the system assigns numerical risk scores to the predicted sentiment labels. Negative sentiment is associated with a high risk of disruption, neutral sentiment with a moderate risk, and positive sentiment with a low risk. The mapping of sentiment to risk makes it easy to continuously monitor risk and helps decision-makers understand the meaning of sentiment indicators in terms of operational risk. The risk scores provide an interpretable measure of supply chain risk that is directly obtained from the text data.

D. Risk Forecasting Using Time-Series Analysis

The risk scores based on sentiment are then combined over time to generate a risk time series. A time series forecasting model is then used to predict the future risk trends in the short term. In this research, an ARIMA-based forecasting method is used due to its simplicity and efficiency when working with a small time series dataset. The forecasting part of the system will allow it to predict higher levels of risk and make proactive decisions instead of reactive ones.

E. System Workflow

The proposed system begins with real-time consumption of news articles, followed by sentiment analysis and risk evaluation. This is followed by continuous update of risk values whenever new information is introduced into the system and its input into the forecasting module for the prediction of future trends that are yet to manifest in the market. The final product will entail real-time risk values, risk values in numbers, and short-term risk forecasts provided through risk evaluation.

Experimental Results and Discussion

This section describes testing the system for supply chain sentiment and risk predictions. It examines the strength of the sentiment classifier, the process for calculating risk scores, and the results for the predictive system using actual data and real-time news feeds.

A. Dataset Description

A sentiment classification model has been developed using a labeled dataset of financial news with 5,842 samples. The samples have been grouped into three types based on the sentiment associated with them, namely, positive, neutral, or negative. The dataset represents generic news articles related to finance, business, and other business-related topics that could be useful for sentiment analysis associated with supply chains. The dataset was split into a testing and a training set using stratified sampling.

B. Sentiment Classification Performance

A DistilBERT transformer-based model was then trained on the training data and evaluated on the holdout data. This resulted in achieving an overall accuracy of about 80%, where the results were excellent in the case of the neutral class as well as the positive class. The negative class had lower recall due to class imbalance along with the complex representations of negativity in the case of financial news. The criteria used to evaluate the models in our comparison were precision, recall, as well as F1.

C. Real-Time Risk Scoring Results

The trained sentiment model was used for processing real-life news articles that were extracted from online news channels. All articles were tagged with a category of sentiment and associated with a risk score. Articles that contained negative reporting about policy adjustments, trade restrictions, and supply chain disruptions were identified as high-risk indicators, and other articles that were neutral and positive corresponded with medium and low risks, respectively. The algorithm is able to extract unstructured text and interpret it as a clear risk indicator.

D. Risk Forecasting Analysis

The sentiment-driven risk scores were aggregated over time to construct a risk time series. An ARIMA-based forecasting model was applied to predict short-term future risk trends. Due to limited real-time data during initial testing, the forecasting results demonstrated stable trends, highlighting the dependence of forecasting accuracy on continuous data collection. As additional real-time data become available, the forecasting component is expected to provide more reliable predictions of rising or declining supply chain risk.

E. Discussion

These results really highlight how our system effectively merges real-time news sentiment analysis with risk assessment and forecasting. Using transformer-based sentiment classification, it will be able to understand the nuanced language that is often used in discussing supply chains. The sections of risk scoring and forecasting then turn those insights into concrete, actionable guidance. Built to scale and adaptable by design, the system fits ongoing use in real-world supply chain monitoring.

Conclusion and Future Work

The proposed article discusses an AI system for sentiment detection and risk prediction in supply chains, utilizing news sources for early warning signals of disruptions. It combines sentiment analysis based on transformers with dynamic risk assessment and time series forecasts to offer continuous monitoring of risks in supply chains through unstructured texts. Experiments performed reveal that this system is capable of identifying sentiment information in finance as well as supply chain news and utilizing this data for risk signals.

The transformer models allow for the accurate sentiment classification of specialized industry-specific terms, whereas the risk scoring and forecasting models provide the actionable insights required for proactive decision-making. Unlike conventional risk management strategies that rely solely on the static history of data provided, this strategy focuses intensely on the importance of real-time intelligence and predictive models.

For future consideration, the system could extend its input characteristics to include social media and industry news, as well as logistics data obtained from sensors. Investigation into more sophisticated methods of forecasting, such as deep learning methods for time-series data, could also prove useful as more real-time data becomes available. Integrating the system into existing enterprise-level decision support systems could increase its usefulness for enterprise-level supply chain risk management.

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