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Artificial Intelligence for Decision Making in the Supply Chain

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Abstract

Artificial intelligence (AI) is a technology that has the potential to significantly impact organizational decision-making. In supply chain management (SCM), data analysis and organizational decision-making play a crucial role in providing insights into various aspects of the supply chain, such as relevant goods, inventory levels, order processing times, delivery times, and transportation costs. By analyzing data, companies can identify inefficiencies in their supply chain and take corrective actions to improve performance. The SC system is a customer-oriented and integrated system that determines planning, administration, and management processes for internal and external material and related flows, formulating the optimal factor of added value. In this study, we aim to identify hazardous products by analyzing product identification information at customs checkpoints and locations where vendible items are delivered to customers. We have identified several commodity groups and substances that are potentially harmful and dangerous to human health.

Keywords: AI, SC, algorithm, Weka.

Introduction

The supply chain is a complex and diverse system that dynamically changes with respect to various factors such as investment policy, scientific and technical development, supplier and customer concentration, geographical location of system users, demand and dynamics for products and services, competitive environment, and warehousing and transportation service costs. Due to the complexity of obtaining and processing information, managers cannot always achieve high levels of supply chain optimization and rationalization. The SC system is a completely integrated and customer-oriented system that determines planning, administration, and management processes for internal and external material and related flows, formulating the optimal factor of added value.

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Main Part. Technological progress has brought new challenges to people regarding the healthiness of the products we consume daily because the number of hazardous products has already reached its peak.

The economic potential of many little countries depends almost entirely on exports, and the movement of material resources and reservations are related to significant resource and labor inputs, which increase the cost of goods [1]. In some countries, local entrepreneurs and exporters add hazardous substances to the content of products, reducing operating expenses tied to the production of goods, making them cheaper, but significantly damaging human health and causing various diseases. Such products mainly include foodstuffs, building materials, clothing, toys, etc. In this study, we analyzed product identification information at customs checkpoints and locations where vendible items are delivered to customers to identify hazardous products. We highlighted several commodity groups and substances that are potentially harmful and dangerous to human health, and the table below shows three groups with subgroups of toxic elements and their admissible indicators.

Commodity group	**Toxic elements**		**Admissible indicator**	**An indicator higher than allowed %**	**Customer age**
Meat and meat products	Lead	A	0,1	28%	Adolescent and adult
	Arsenic	B	0,05	10%	
	Cadmium	C	0,3	28%	
	Grisin	D	Inadmissible	3-5%	
Milk and dairy products	Lead	A	0,05	26%	Adolescent and adult
	Arsenic	B	0,05	8%	
	Cadmium	C	0,02	11%	
	Pesticides	D	0,01	15%	
Toys	Antimony	A	0.75	29%	Adults
	Arsenic	B	0.4	14%	
	Cadmium	C	0.1	17%	
	Mercury	D	0.18	36%	

The accumulation of vast amounts of data on various household products enables us to leverage machine learning techniques to identify relevant data and take appropriate actions. After identifying and recording a product that is prepared for sale, a pre-designed algorithm is used to analyze the information. An operator at the Information Management Center analyzes the contents of the received message, identifies the main issue—the type of incident—and selects the category of toxic elements for which the permissible limit is pre-determined by the algorithm.

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The recorded information is then transmitted to all active operators for a thorough analysis of the relevant data for each product. The operators' primary task is to identify the product that contains the most harmful concentrations. To achieve this, the data is preprocessed and analyzed, and appropriate machine learning algorithms are developed. However, during the primary data collection stage, we often have minimal control over the process, leading to the occurrence of anomalous data such as external spectrum values, unidentifiable data, incomplete data, and data inappropriate for learning.

Failure to filter out these anomalous cases while analyzing the data can result in erroneous conclusions. To process and analyze the data, we use the Python programming language, which has a vast ecosystem of third-party libraries, including NumPy, Pandas, and Scikit-learn, that provide advanced data processing and analysis features. Scikit-learn is a library for machine learning that provides tools for data modeling and predictive analysis.

We have broken down the data parameters into the following classifications. The following are examples of anomalous data that may occur during the primary data collection stage [3]:

- External spectrum values include adverse effects that may arise during product transportation or a violation of packaging requirements.
- Unidentifiable data.
- Incomplete data.
- Data that is not suitable for learning, such as information that is not related to product suitability,.

If anomalous cases are not filtered out during data analysis, it can lead to inaccurate conclusions. To carry out data processing and analysis, we utilize the Python programming language due to its vast ecosystem of third-party libraries such as NumPy, Pandas, and Scikit-learn that offer advanced data processing and analysis features. Scikit-learn is a machine learning library that provides tools for data modeling and predictive analysis. In order to streamline the analysis process, we begin by eliminating "triage" actions, which involve multiple operators processing information simultaneously.

We have categorized the expiration date of the product under the One Hot Encoding method, while we have selected the following transitional periods as categories: 1-5-14-30 days old;

We utilized the Python programming language in conjunction with a collection of machine learning algorithms known as Weka for data analysis and visualization. Weka contains a diverse range of machine learning algorithms and tools that can be utilized for tasks such as data preprocessing, classification, clustering, association rules, and visualization. We utilized Weka's visualization tools to generate a graphical representation of the correlation coefficient for the data. The following visualization fragments provide an approximate model for the interdependence of the data.

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Figure 1 illustrates the relationship between the concentration indicator and unacceptable quantities of permissible substances. Each point on the graph represents a separate case. The content of the substances not allowed in the product is filled with orange, while those that are identified and marked with an admissible quantitative indicator are depicted in blue.

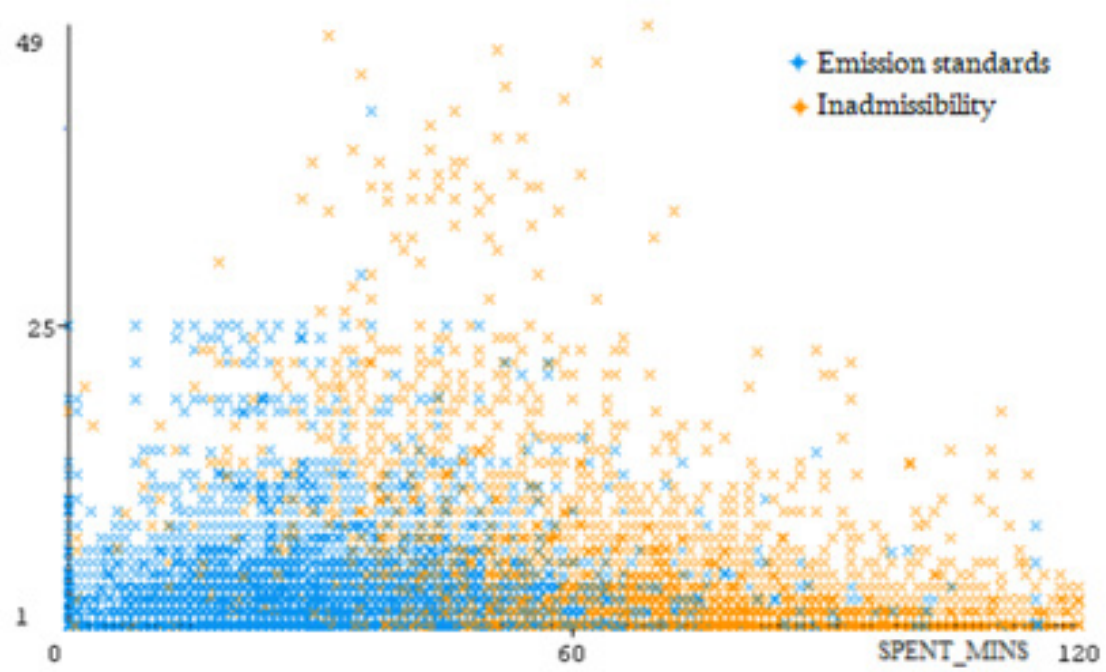

Figure 1

The graph below (Figure 2) gives the result of the analysis carried out by different operators to identify one harmful substance.

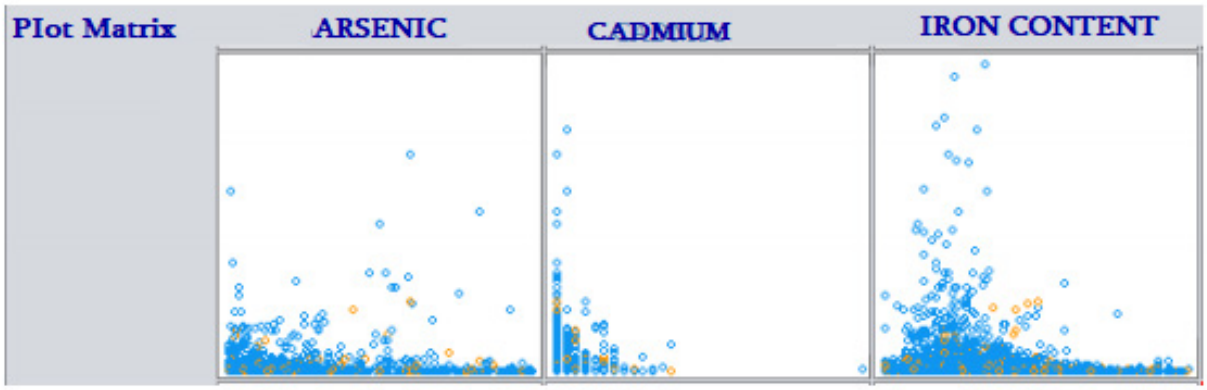

Figure 2

The Weka tools enable us to analyze the product based on various parameters and visualize the results. However, one potential solution to address this issue is by using a smart contract in the transportation process. The contract can specify the requirement for a product that is safe for human consumption, and this condition can be verified using an artificial intelligence algorithm. The authenticity of the suppliers and carriers can

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be stored in a blockchain, and the terms of the mutual agreement can be determined using the smart contract. Before the final confirmation of the contract and the transfer of the service amount, the fulfillment of the conditions specified in the contract between the parties can be verified using a logically designed mathematical algorithm and program code [2].

Conclusion

Artificial intelligence (AI) is highly recommended as one of the most important technologies for managing supply chains, as it is a powerful tool for monitoring and controlling the delivery of safe products. In this study, we employed the Python programming language to carry out extract, transform, and load (ETL) operations and preprocess the data to obtain a structured dataset suitable for machine learning. By utilizing the Python programming language and Weka tools, we conducted an analysis of the dataset of a product exported. During the analysis, we identified, removed, and corrected anomalous cases that could potentially impact the accuracy of the machine learning results. Consequently, we obtained results that enhance the protection of consumers from hazardous products.

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