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Construction of Decision Support System for Enterprise Sustainable Management Based on Big Data

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Abstract: In this study, a decision support system for sustainable management of enterprises based on big data is constructed to address the challenges of sustainable development faced by enterprises in the era of big data. The system integrates real-time data flow analysis and prediction models to realize an integrated process from data collection, processing, analysis to decision support. The study improves the efficiency of data flow and value mining by developing a system model with a four-tier architecture, and establishes a comprehensive system of sustainability management indicators by applying advanced technologies such as machine learning. The system also provides a visualization interface with interactive tools to assist management in making quick decisions. Practical results show that the system significantly improves the efficiency and accuracy of corporate decision-making, effectively promotes the balanced development of economic benefits and social responsibility, and provides strong support for corporate sustainable development.

Keywords: Big data, Enterprise sustainable management, Decision support system, Machine learning.

1. Introduction

With the rapid development of the Internet, big data technology has become the core driving force of enterprise management, empowering enterprises to gain precise insights into market dynamics, consumer preferences and operational efficiency, and significantly improving decision-making efficiency and market response speed [1]. However, in the face of the complex challenges in the era of big data, traditional decision support systems can no longer meet the needs of sustainable development of enterprises, especially in the consideration of environmental and social responsibility there are limitations. In this context, it is particularly urgent to build a decision support system for enterprise sustainable management based on big data. Nongfushanquan's rapid growth in market share thanks to its strong data analysis capabilities is a vivid example of big data-enabled enterprise sustainable development (as shown in figure 1). This study is dedicated to exploring the construction and optimization path of this system, aiming to provide scientific and efficient decision support for enterprises, and to promote the balance between economic benefits and social responsibilities, so as to achieve the goal of sustainable development.

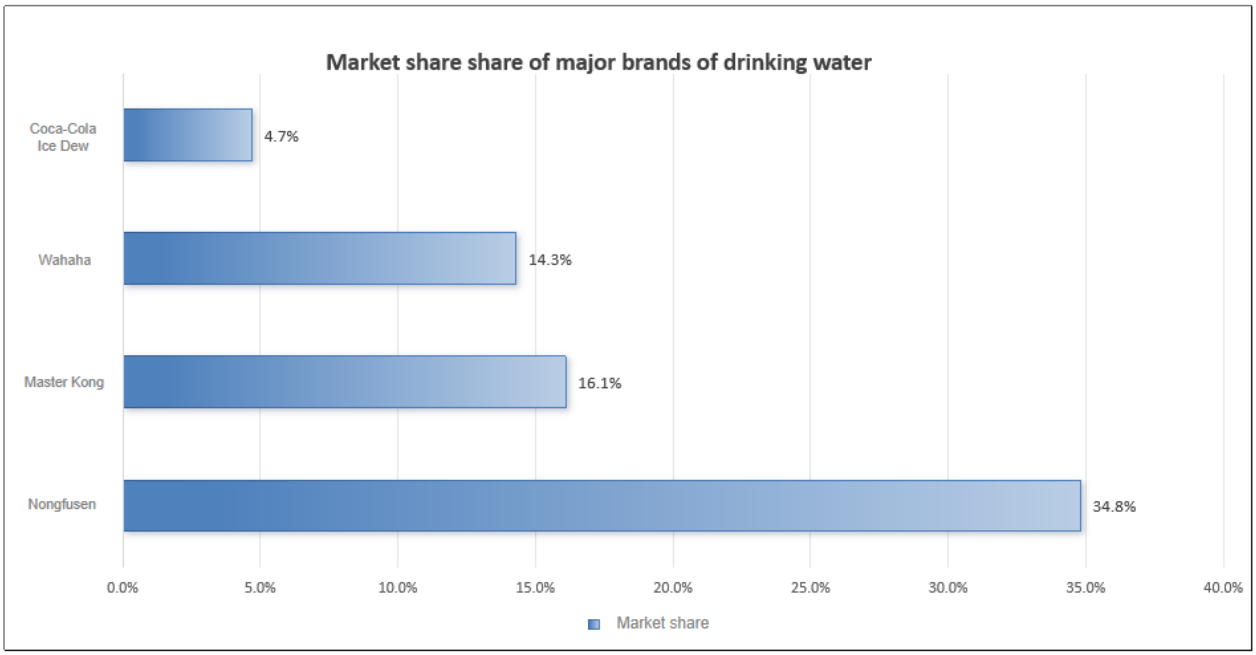

Figure 1. International Attention of Major Brands of Drinking Water in Market Share Share Share
(Data source: https://blog.csdn.net/yangchunlu0101/article/details/78078232)

2. Theoretical Foundation of Enterprise Sustainable Management Based on Big Data

2.1. Big Data Technology

Big data technology, as a key component of modern information technology, refers to the processing of large-scale, diverse, and rapidly generated data collections in order to extract information that is valuable for enterprise decision-making. Its characteristics include large data volume, diverse types, fast processing speed and low value density but high potential value. Core technologies include distributed storage, cloud computing, data mining and machine learning [2]. In enterprise management, big data technology helps enterprises quickly adapt to market changes, optimize resource allocation, and improve operational efficiency through real-time analysis of market trends, consumer behavior, and supply chain status. For example, e-commerce giant Alibaba uses big data analysis to predict consumption trends, achieve personalized recommendations, and enhance user experience and platform loyalty, demonstrating the application of big data in precision marketing and inventory management. In addition, big data technology helps enterprises identify potential risks, such as supply chain disruptions and market volatility, and provides data support for the formulation of strategies to promote sustainable development.

2.2. Enterprise Sustainable Management Theory

The decision support system for sustainable enterprise management based on big data significantly improves the efficiency of enterprise decision-making. The system integrates real-time data streams and advanced forecasting models to accurately capture market dynamics, helping enterprises quickly respond to market changes, shorten decision-making cycles, and reduce the cost of miscalculations. The built-in environmental and social responsibility assessment module of the system utilizes big data analysis to quantitatively assess the environmental impact and social contribution of the enterprise's operations, enhance the transparency and brand image of the enterprise, and provide a scientific basis for the formulation of sustainable development strategies. At the same time, the system uses advanced algorithms to deeply mine enterprise data, dynamically optimize resource allocation, reduce operating costs and improve operational efficiency. In terms of supply chain management, the system recommends optimal procurement solutions to reduce inventory backlogs, and identifies inefficient links through data analysis and adopts flexible labor and other strategies to improve overall operational efficiency. These advantages not only enhance the competitiveness of the enterprise, but also lay a solid foundation for its sustainable development.

2.3. Principle of Decision Support System

As a core tool for modern enterprise management, Decision Support System (DSS) integrates massive data resources and provides data-driven decision support through accurate models and intelligent analysis engines. The system efficiently integrates internal and external data, with powerful data processing capabilities, real-time insight into market dynamics, consumer behavior and operational efficiency, significantly improving decision-making efficiency and accuracy. DSS's unique structure of data warehouse, model library and knowledge base supports complex data mining and predictive analysis, laying a solid data foundation for corporate strategic planning, resource allocation and risk management. Midea Group's self-developed Midea Kepler big data platform, as a model of DSS application, integrates ERP, CRM and social media data to realize accurate analysis of the whole chain of operation. The Stargazer component captures market changes and predicts trends in real time, helping Midea accurately grasp market opportunities, optimize inventory, and improve market response speed. Since its application, the platform has significantly boosted e-commerce sales growth, optimized production processes, improved operational efficiency, and enhanced customer satisfaction, highlighting the key role of DSS in enhancing enterprise competitiveness and promoting sustainable development (as shown in figure 2).

Figure 2. Media e-commerce sales (2015-2017)
(Data source: https://www.jnexpert.com/article/detail?id=1105)

3. Construction of Decision Support System for Enterprise Sustainable Management Based on Big Data

3.1. System Architecture Design

In the construction of enterprise sustainable management decision support system based on big data, system architecture design is the key, and its four-layer architecture (data collection layer, data processing layer, data analysis layer, application layer) works closely together to ensure efficient data flow and value mining (as shown in figure 3). The data collection layer integrates heterogeneous data from multiple sources and uses API interfaces and other technical means to realize automated collection; the data processing layer improves data quality through cleaning, conversion and integration; the data analysis layer applies machine learning and other advanced technologies to analyze the data in depth, and builds a system of sustainable management indicators that covers the economy, the environment, and the society; and the application layer provides a visualized interface and interactive tools to support management in making quick decisions. This architecture realizes the closed-loop management from data collection to decision support, providing a solid technical foundation for enterprise sustainable management [3].

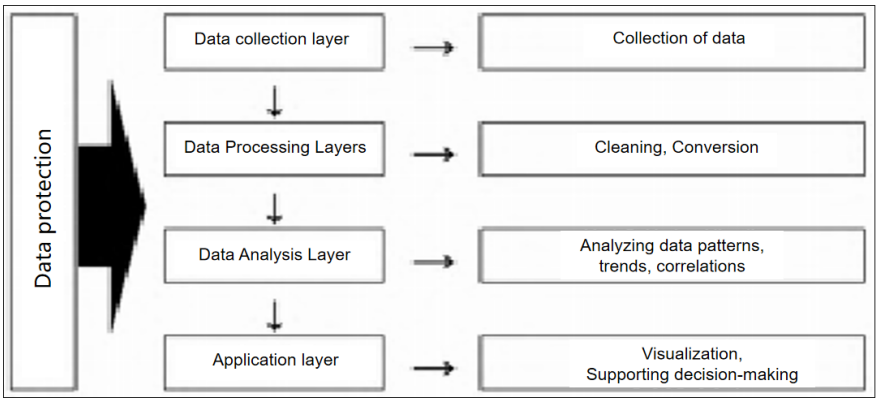

Figure 3. Decision support system architecture design

3.2. Data Collection and Integration

Data collection integrates multiple data sources, including internal financial reports, sales records, external market dynamics, industry reports, etc., to ensure data integrity and consistency across multiple formats. In the pre-processing stage, data undergoes cleansing (eliminating errors and missing values), transformation (unifying data formats) and normalization (standardizing measurement scales) to fit analytical needs. In view of the big data environment, the enterprise sustainable management decision-making system extensively absorbs ERP, CRM, social media, IoT sensors, and government public data, and adopts flexible collection strategies to ensure the comprehensiveness and timeliness of the data [4]. Subsequently, the raw data undergoes rule-based cleaning (missing value filling, outlier identification) and ETL transformation to achieve data format unification. Finally, relying on data warehouse/data lake technology, integrating multi-source data to build a global data view, effectively supporting cross-departmental analysis and decision-making, such as Media, which successfully builds customer profiles by integrating multi-source data to realize accurate insights into market demand.

3.3. Data Analysis and Mining

Data analysis and mining technology plays a central role in the decision support system of enterprise sustainable management. Descriptive statistics accurately reflect sales trends, customer behavior, and operational efficiency by systematically organizing and visually presenting historical data to provide management with immediate data insights [5]. Predictive analytics uses complex statistical models, such as time series and regression analysis, to mine historical data patterns, predict future trends in the market and business operations, and assist companies in forward-looking layout. Data mining, in which clustering analysis, supports customized marketing strategies by unsupervised learning to segment markets and customer groups. Meanwhile, association rule mining reveals the purchase associations between commodities and assists in the promotion of commodity combinations. The anomaly detection mechanism monitors financial data fluctuations and fraudulent behavior in real time to ensure operational security. The construction of data model needs to take into account data diversity and real-time, and adopt hybrid architecture and machine learning algorithm optimization to improve the prediction accuracy and intelligence level of enterprise decision support system, to ensure that the enterprise maintains its competitive advantage in the complex market environment and realizes sustainable development.

3.4. Decision Support Interface and Visualization

In the enterprise decision support system, visualization analysis, as an efficient data interpretation strategy, profoundly promotes the depth and efficiency of data analysis through customized, intelligent and humanized interface design. For multi-dimensional data types such as time series, complex structures and geography, it flexibly applies visualization tools such as line charts, heat maps, scatter plots, map integration and 3D graphics to intuitively present data features, simplify the interpretation of complex data relationships, and enhance the intuition of data analysis and immediacy of decision-making. TIBCO Software and other systems utilize big data and AI technologies to comprehensively cover the information analysis of all aspects of business operations, and promote the analysis of information in every aspect of enterprise decision-making. Systems such as TIBCO Software utilize big data and AI technology to comprehensively cover all aspects of enterprise information analysis in all aspects of operation and promote accurate decision-making (as shown in figure 4). Examples

show that by integrating interactive dashboards and 3D maps in the retail and logistics sectors, the accuracy of market insights and the efficiency of resource allocation have been improved, respectively, and operational costs have been reduced. Therefore, visual analytics, with its precise customization, intelligent adjustment and humanized expression, has become an important support to promote accurate decision-making and sustainable development of enterprises.

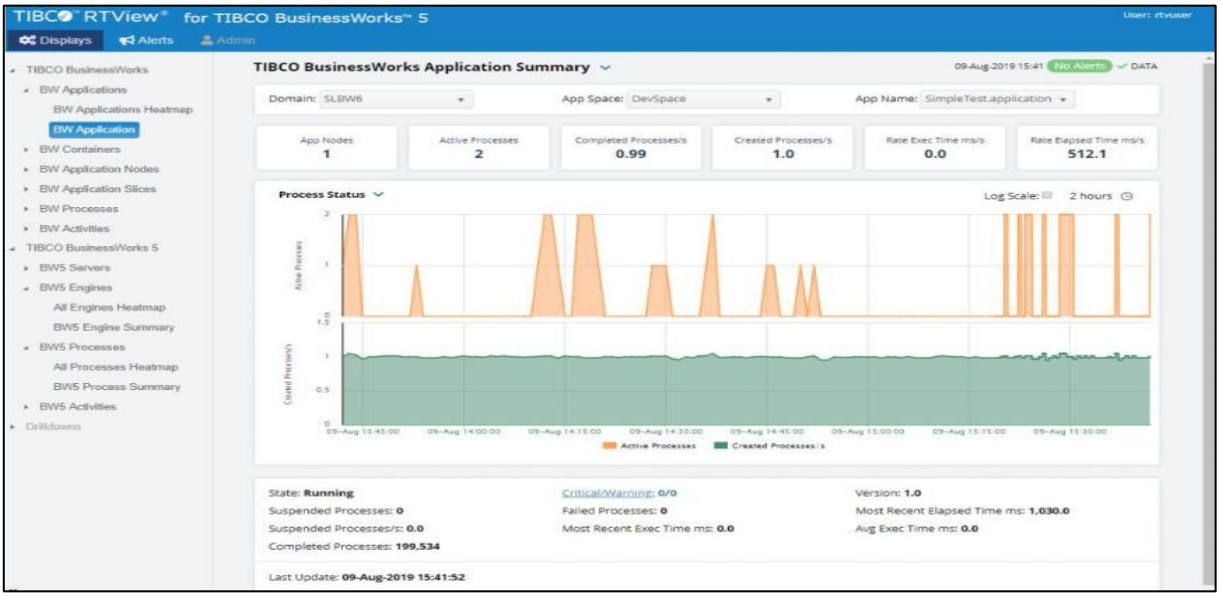

Figure 4. Data visualization interface

(Data source: https://blog.csdn.net/u014514254/article/details/139069010)

4. System Realization and Case Study

4.1. System Realization Steps

In the process of building a decision support system for enterprise sustainable management based on big data, the following steps are taken:

First, the development environment and technology selection, the system relies on the cloud computing platform, and AWS or AliCloud is selected as the infrastructure to ensure the high efficiency of data processing and analysis. In the technical architecture, Hadoop HDFS is used for distributed data storage, Spark framework is responsible for data processing tasks, and Kafka optimizes data stream transmission. The front-end interface is built with Vue.js and integrates machine learning libraries such as MLlib to support the development of intelligent analytics and predictive models.

Secondly, module development and integration, the system is designed according to modularization, including data collection, storage, analysis, decision support and visualization display. The data acquisition module interfaces with ERP and CRM systems through APIs to realize real-time capture of business data. The data analysis module uses Spark technology stack to complete data preprocessing and analysis. Decision support module embeds machine learning algorithms and outputs optimization strategies. Visualization module uses ECharts and other tools to transform data into intuitive charts to assist in decision making.

Third, testing and optimization, the system implements a strict testing process, including unit testing, integration testing and stress testing, to ensure system stability and performance. Test results guide the optimization of code and algorithms to improve system performance. At the same time, a continuous monitoring and log analysis system is built to ensure stable system operation and timely response to potential problems.

Through these steps, the system is able to provide accurate decision support for the enterprise and promote the implementation of sustainable management.

4.2. Case Study

Target implemented a decision support system based on big data to effectively improve its sustainable management capabilities in market trend forecasting, consumer behavior analysis and operational decision-making. The system is built on a solid technical foundation and realizes the integration of data collection, storage, analysis, decision support and visualization display through a modular development strategy. Integration with ERP and CRM systems using APIs ensures real-time capture and processing of business data. The data analysis module incorporates advanced data processing techniques, while the decision support module incorporates machine learning algorithms to provide management with data-driven strategy recommendations. The system went through a rigorous testing process, including unit testing, integration testing and stress testing, to ensure stability and performance, and was safeguarded by a continuous monitoring and log analysis system. After implementation, Target realized significant improvements in sales forecast accuracy, inventory management, and customer loyalty, with e-commerce sales increasing twofold, the number of online customer communications decreasing by 30%, spending by active users increasing by nearly 30%, and ROI on marketing activities and customer satisfaction increasing (as shown in figure 5). Regular evaluation of system performance and user feedback ensures continuous optimization of models and strategies to support the long-term sustainability of the business.

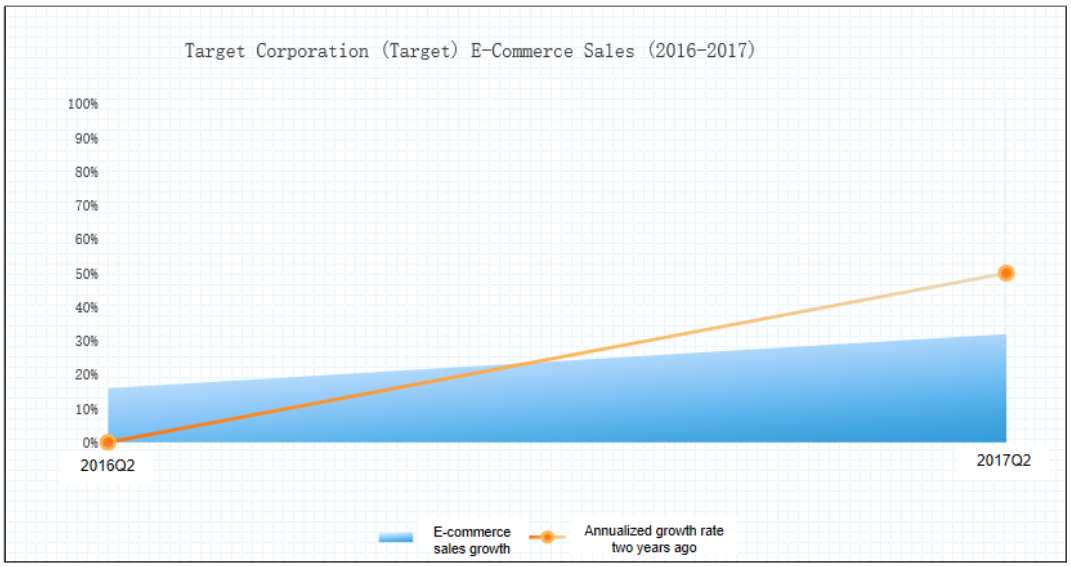

Figure 5. Comparative yearly analysis of e-commerce sales at Target Corporation

(Source: https://www.digitaling.com/articles/51547.html)

5. System Advantages and Challenges

5.1. System Advantages

The big data-based enterprise sustainable management decision support system significantly improves decision-making efficiency and accuracy by integrating real-time data flow analysis and prediction models, instantly capturing market dynamics and key indicators of internal operations, providing leaders with accurate data insights, shortening decision-making cycles, and reducing the cost of miscalculations. The system has a built-in environmental and social responsibility assessment module, which, combined with big data analysis, accurately identifies key areas and risks of sustainable development, quantitatively evaluates the effectiveness of energy saving, emission reduction and social responsibility, enhances corporate transparency, and promotes the efficient use of resources and the circular economy. At the same time, the system uses advanced algorithms to optimize resource allocation, dynamically adjust production plans, manpower allocation and financial budgets to achieve optimal allocation of resources and precise cost control, such as reducing operating costs through flexible labor and telecommuting solutions, while improving employee satisfaction and work efficiency, and comprehensively enhancing the company's ability to achieve sustainable development and market competitiveness.

5.2. Challenges

With the increasing amount of data, enterprises need to cope with the normalized growth of PB-level and even EB-level data, which poses a serious challenge to data processing capabilities. In projects such as smart cities, real-time data analysis is in urgent demand, and the traditional batch processing model has been difficult to meet. Although the distributed computing framework and stream processing technology have eased the pressure to a certain extent, optimizing algorithm efficiency and reducing resource consumption to achieve instant data mining are still the hotspots and difficulties of current research. At the same time, the surge in data volume makes the issue of data security and privacy protection increasingly prominent, especially in sensitive areas, data leakage will bring huge losses. New network threats require enterprises to build a multi-level security protection system, while blockchain technology provides a new solution for data encryption and access control, but how to promote data sharing and value release while ensuring data security still needs to be further explored. In addition, in the face of the transformation of data-intensive business models, traditional enterprises are facing profound adjustments in their organizational structure and personnel skills structure, and cross-departmental data sharing, data science team building and training have become key. However, in reality, there is often a shortage of talent and lagging skills, and enterprises need to accelerate the construction of talent teams through various ways to meet the challenges of the data era.

6. Conclusion

This study builds a decision support system for enterprise sustainable management based on big data, integrating data collection, processing, analysis and decision support to significantly improve decision-making efficiency and accuracy. The system integrates real-time data streaming and predictive modeling, with built-in environmental and social responsibility assessment to provide accurate insights and strategies. The results include a four-tier architecture model, efficient data processing and cleansing, an economic, environmental and social indicator system, and a visual decision-making interface. The system helps companies balance economic efficiency and social responsibility to promote sustainable development. In the future, with the development of big data and AI technology, the system will optimize algorithm efficiency, resource consumption, and strengthen data security and privacy protection. At the same time, the system develops towards intelligence and personalization, and improves self-adaptation and decision-making accuracy. It also has prospects for application expansion in intelligent manufacturing, smart cities and other fields, helping to realize the goal of sustainable development in various industries.

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