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Research on the Management of Green Supply Chain by the Digital Transformation of Tsingtao Beer

Junke Chen

School of Business, Xinjiang University, Xinjiang 830000, China

Abstract

With the increasingly serious global climate change and environmental problems, green supply chain management has become one of the key paths for enterprises to achieve sustainable development. In this context, Tsingtao Brewery, as a leading enterprise in China 's beer industry, actively responds to the wave of digital transformation and integrates the green concept into all aspects of supply chain management. This study aims to explore the impact of Tsingtao Brewery 's digital transformation on green supply chain management and its effectiveness. This paper analyzes the degree and characteristics of the digital transformation of the beer industry, discusses the specific impact of digital transformation on the green supply chain management of Tsingtao Brewery, and proposes corresponding improvement strategies for the problems existing in the digital green supply chain management of Tsingtao Brewery. It aims to provide useful reference and reference for other enterprises in digital transformation and green supply chain management.

Keywords

Digital Transformation; Green Supply Chain; Enterprise Performance; Tsingtao Beer.

1. Introduction

With the increasingly serious global climate change and environmental problems, green supply chain management has become an important way for enterprises to achieve sustainable development and fulfill their social responsibilities. In recent years, the Chinese government has attached great importance to environmental protection and green development, and has issued a series of relevant policy documents, such as ' Made in China 2025 ', ' Green Manufacturing Engineering Implementation Guide ', etc., emphasizing the promotion of green manufacturing and green supply chain management to achieve industrial green transformation and sustainable development.

In this context, Tsingtao Brewery, as a leading enterprise in China 's beer industry, actively responds to the national call to continuously promote digital transformation and optimize supply chain management. Digital transformation has brought many benefits to enterprises, including improving production efficiency, reducing costs, and improving customer service. At the same time, digital transformation also provides more possibilities for green supply chain management. Through the application of information technology and big data, enterprises can better track and optimize the whole life cycle of products, achieve efficient use of resources and reduce waste emissions.

However, the impact of digital transformation on green supply chain management is not achieved overnight, which requires enterprises to continuously explore and improve in practice. As a pioneer in digital transformation and green supply chain management, Tsingtao Brewery 's experience and practices have important reference significance. Therefore, this study takes Tsingtao Brewery as the research object, and deeply discusses the impact and practice of its digital transformation on green supply chain management, aiming to provide

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reference and inspiration for other enterprises and provide strong support for enterprises to achieve sustainable development.

2. The Status Quo of Digital Green Supply Chain Management of Tsingtao Beer

2.1. Tsingtao Brewery and Upstream and Downstream Relationship Management Status Quo

Under the dual background of globalization and sustainable development, Tsingtao Brewery has shown a positive attitude in promoting green supply chain management. Tsingtao Brewery 's ESG (Environment, Society and Governance) report clearly sets out strict requirements for value chain partners, which not only reflects the company 's social responsibility, but also highlights its strong commitment to green and sustainable development.

The upstream of Tsingtao Brewery covers many fields such as planting, equipment manufacturing, food additives and packaging manufacturing. In order to ensure the green and sustainability of the supply chain, Tsingtao Brewery has put forward clear responsibility requirements for upstream partners. In the planting industry, Qingdao Beer cooperates with suppliers to promote sustainable planting technology, reduce the use of chemical fertilizers and pesticides, and ensure the green and safe raw materials. In the equipment manufacturing industry and packaging manufacturing industry, Tsingtao Brewery encourages partners to adopt environmentally friendly materials and energy-saving technologies to reduce environmental pollution and waste of resources in the production process. Tsingtao Brewery also conducts ESG sustainability risk assessment and communication training for newly established partners to ensure that partners can understand and comply with the company 's green supply chain management policies.

The downstream of Tsingtao beer mainly includes sales channels such as distributors and online e-commerce. In order to ensure the green and sustainable sales channels, Tsingtao Brewery has established close cooperation with downstream partners. By providing green packaging and reducing carbon emissions in the logistics process, Tsingtao Brewery encourages downstream partners to jointly promote green sales. At the same time, Tsingtao Brewery also pays attention to communication and training with downstream partners, shares the importance and practical experience of green supply chain management, and jointly improves the green level of the entire supply chain.

Tsingtao Brewery has achieved remarkable results in digital green supply chain management. Through close cooperation and joint efforts with upstream and downstream partners, it not only helps to enhance the competitiveness and brand image of enterprises, but also has a positive impact on society and the environment. Promote the green transformation of the entire industrial chain and promote the sustainable development of society.

2.2. Tsingtao Beer Digital Green Procurement Management Status Quo

(1)Supplier classification

According to the list of qualified suppliers, Tsingtao Brewery classifies suppliers horizontally according to equipment and materials, technical services, construction companies, etc., and vertically according to qualification information, product conditions, historical cooperation, etc., and implements targeted management strategies according to the category characteristics of suppliers to achieve all-round management of suppliers.

(2)Supplier access

Tsingtao Brewery implements a strict green audit and evaluation system for cooperative suppliers. The audit covers multiple dimensions such as food safety, quality, service, and supply

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completion rate, and pays special attention to the performance of suppliers in environmental protection, energy conservation, and emission reduction. Through the combination of ' dynamic tracking ' and ' periodic evaluation ', Tsingtao Brewery continuously collects supplier 's work data information and regularly evaluates supplier 's performance. For suppliers that do not meet the green standards, Tsingtao Brewery will take corresponding punitive measures, such as limiting cooperation and reducing procurement volume ; for outstanding suppliers, Tsingtao Brewery will give more cooperation opportunities and rewards to motivate suppliers to continuously improve green performance.

(3)Supplier audit and evaluation

Tsingtao Brewery implements annual and on-site audit comprehensive evaluation of cooperative suppliers every year. The audit scope mainly covers food safety, quality, service, actual supply completion rate and other dimensions, focusing on food safety, quality control and environmental performance improvement. In 2023, the cooperative suppliers have all reached the qualified standard, which effectively guarantees the production of Tsingtao beer. In daily work, Tsingtao Brewery focuses on strengthening the analysis and evaluation of the value objectives of both suppliers and demanders, carrying out supplier evaluation work in a combination of ' dynamic tracking ' and ' regular evaluation ', dynamically collecting supplier work data information, regularly carrying out supplier evaluation work, urging suppliers to apply energy-efficient environmental protection equipment, enhancing the enthusiasm of suppliers to cooperate, and improving the overall performance of suppliers.

2.3. Current Situation of Digital Green Manufacturing Management of Tsingtao Beer

Tsingtao Brewery has always adhered to the 3R principle of circular economy, continuously strengthened the proper management of waste and packaging materials, comprehensively deepened emission reduction measures, actively explored recycling methods, and effectively promoted the green and sustainable development of enterprises.

(1)Green, circular packaging

Tsingtao Beer is committed to creating sustainable packaging, comprehensively promoting packaging recycling, and continuously optimizing packaging combinations through innovation and improvement to reduce the impact of packaging materials on the environment. It strictly regulates the production process involving plastic packaging, studies and explores materials and products used to replace plastics, reduces plastic components in packaging in an all-round way, and promotes green packaging. By 2023, Tsingtao Brewery 's suppliers had collected 34920 tons of broken glass for reuse, reducing carbon emissions from packaging materials by 1136 tons and saving 283 tons of plastic film.

(2)Waste management

In the process of manufacturing green beer, Tsingtao Brewery attaches great importance to waste management. The company actively promotes the principles of waste reduction, recycling and harmlessness, and realizes the effective management and resource utilization of waste by introducing advanced waste classification and treatment technology. Tsingtao Brewery not only optimizes the production process and reduces the generation of waste, but also establishes a perfect waste recycling system to recycle recyclable waste, reduce environmental pollution and enhance the sustainable development ability of enterprises.

2.4. Tsingtao Beer Digital Green Logistics Management Status Quo

Tsingtao Brewery has made remarkable progress in digital green logistics management, and its intelligent logistics is shown in Table 1. Intelligent logistics-supply chain management builds an efficient warehousing and distribution system by improving the level of modernization, accurately predicting demand, and realizing data integration and order visualization by

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establishing an information middle platform and a mobile order platform. The use of mobile platforms and applications to monitor the transportation process has improved logistics efficiency, reduced environmental impact, and alleviated urban traffic problems.

Table 1. Intelligent Logistics-Supply Chain Management Construction

Intelligent Logistics-Supply Chain Management	
Warehousing and distribution system	Improve the modernization level of the entire industrial chain and supply chain from upstream procurement to downstream terminal distribution, realize the mastery and prediction of consumer demand, and create a warehousing and distribution system that can quickly cover all consumers.
Supply chain information business platform	Establish a supply chain information business middle platform to achieve data integration management.
Mobile order platform	Establish a mobile order platform to realize the visualization and information sharing of business chain orders.
Mobile device	Operation of mobile platform applications, to achieve the whole process of business transportation visual intensive control.
Control tower	Through the control tower, the end-to-end order and market information are integrated, the whole chain resources are coordinated, the production, supply and sales of the intensive area are intensive, the digital platform of the regional supply chain is constructed, and the overall operation efficiency of the supply chain is improved.
Distribution network	With the help of distribution network, integrate resources, scale operation, improve the utilization efficiency of logistics resources, improve the quality of urban distribution services, improve the efficiency and efficiency of urban distribution, reduce truck exhaust emissions, and reduce urban traffic congestion.

Data source:Tsingtao Beer 2023 ESG report.

3. Research on the Performance of Digital Green Supply Chain of Tsingtao Beer

3.1. Research on the Non-financial Performance of Digital Green Supply Chain of Tsingtao Beer

3.1.1. Green Manufacturing Water Resources Management

Water is a necessary element of beer production. Tsingtao Brewery makes rational use of freshwater resources and regards water resources management as the top priority of business operations.

It can be seen from Table 2 that Tsingtao Brewery has achieved remarkable results in water resources management in recent years. From 2020 to 2023, the company 's total water consumption decreased year by year, from 28309 thousand cubic meters to 23053 thousand cubic meters, a year-on-year decline of 12%. More prominently, the water consumption per unit product is also decreasing year by year, from 3.69 cubic meters per liter of production to 2.99 cubic meters, a decrease of 8%. This significant reduction shows that Tsingtao Brewery has made positive progress in green manufacturing water resources management. This achievement is inseparable from the effective application of digital technology. Through the introduction of advanced digital management system, Tsingtao Brewery can monitor and analyze the water consumption in the production process in real time, and find and solve the potential waste of water resources in time. In addition, digital technology can also optimize the

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production process and reduce the water consumption per unit product based on big data analysis, so as to realize the efficient utilization of water resources.

Table 2. Use of water resources

Name of indicator	Unit	2020Y	2021Y	2022Y	2023Y	Year-on-year variation in 2023
Water consumption	Kilostere	28309.00	27185.00	26339.00	23053.00	-12%
Water consumption per unit of beer production	Cubic meters / kiloliters production	3.69	3.44	3.24	2.99	-8%

Data source:Tsingtao Beer 2023 ESG report.

3.1.2. Green Manufacturing Energy Management

With its forward-looking vision, Tsingtao Brewery actively explores the application of digital technology in green supply chain management. Especially in the aspect of green manufacturing energy management, Tsingtao Brewery continues to promote process innovation, energy-saving transformation and application of new energy-saving technologies by introducing digital technology. According to the characteristics of beer production process, process and equipment, the improvement measures and key control points for reducing energy consumption in each link are tailored.

As shown in Table 3, Tsingtao Brewery has significantly adjusted and optimized the consumption of various energy sources in recent years. In particular, the consumption of coal has been greatly reduced from 275000 tons of standard coal in 2020 to zero consumption in 2023. This change marks the transformation of Tsingtao beer from high pollution to clean energy in energy use. In 2023, the comprehensive energy consumption of the company 's 1000-litre liquor will be reduced by 6.44 % year-on-year, which will reduce the energy consumption cost of the product, thereby reducing the cost of beer production, improving the company 's market competitiveness, and significantly reducing environmental pollution, laying the foundation for the green manufacturing and sustainable development of Tsingtao Beer.

Table 3. Types of energy use and consumption

Energy use	Unit	2020Y	2021Y	2022Y	2023Y	Year-on-year variation in 2023
Coal	Ten thousand tons of standard coal	2.75	1.59	0.00	0.00	0%
Electricity	Ten million kilowatt hours	49.41	48.37	47.34	43.33	-8%
Natural gas	Ten million standard cubic	8.92	9.22	7.83	7.83	-10%
Heating power	One billion kilojoules	3082.00	2311.00	2050.00	2020.00	-18%
The comprehensive energy consumption per unit product of beer production	Tonnes of standard coal per thousand liter of production	0.039	0.033	0.028	0.028	-6%

Data source:Tsingtao Beer 2023 ESG report.

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3.1.3. Green Manufacturing Packaging and Waste Management

(1)Packaging management

As shown in Table 4, from the data table of Tsingtao Brewery 's product packaging material consumption, we can observe that digital technology has achieved remarkable results in the management of green manufacturing packaging in the green supply chain. These effects are not only reflected in the effective control of the total amount of packaging materials, but also in the optimization of the amount of packaging materials required for unit output.

Table 4. Product packaging material consumption data

Supplies	Unit	2020Y	2021Y	2022Y	2023Y	Year-on-year variation in 2023
New beer bottle	Kiloton	1140.00	1212.00	1171.00	1380.00	18%
Old beer bottles	Kiloton	3109.00	3183.00	3139.00	2769.00	-12%
Pop-	Kiloton	70.00	75.00	83.00	73.00	-13%
Box board container	Kiloton	215.00	235.00	254.00	245.00	-3%
Die	Kiloton	12.60	12.70	10.20	10.70	5%
Bottle cap	Kiloton	22.44	22.77	23.00	25.35	10%
Trade mark	Kiloton	9.99	9.89	9.89	9.92	0%
Total amount of packaging materials	Kiloton	4579.00	4750.00	4690.00	4513.00	-4%
Beer production unit packaging material quantity	Thousand tons / Thousand liters of production	0.00062	0.00063	0.00060	0.00061	2%

Data source:Tsingtao Beer 2023 ESG report.

From the perspective of the change in the total amount of packaging materials, Tsingtao beer achieved a reduction in the total amount of packaging materials in 2023, a year-on-year decline of 4%. This shows that the company has successfully implemented a series of effective green packaging management measures to reduce unnecessary packaging material consumption. Although the beer production unit packaging material quantity increased, but that is affected by the company 's beer production and variety structure, part of the material consumption caused by the total weight growth. According to the annual reports of 2023 and 2022, it can be found that the cost of packaging in 2023 is lower than that in 2022, which indicates that the company 's implementation of green circular packaging not only reduces carbon emissions but also reduces product costs.

(2)Waste management

Digital technology enables Tsingtao Brewery to monitor the generation and processing of waste in real time. Through accurate data analysis and prediction, the company can more accurately predict and control the amount of waste generated. In addition, digital technology also promotes the precision of waste classification and recycling, improves the recycling rate of waste, and reduces the impact of waste on the environment.

As shown in Table 5, according to the waste weight and density data of Tsingtao Brewery in recent years, we can clearly see the remarkable results of digital technology in waste management of green supply chain. Tsingtao beer adopts emission reduction management measures for hazardous waste and harmless waste. The total amount of harmless waste in 2023 decreased by 10 % compared with that in 2022, and the total amount of hazardous waste

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decreased by 0.3 % compared with that in 2022. It is worth mentioning that the reduction of waste glass bottles and cans is particularly significant, reaching a decrease of 31 %. This achievement not only reflects the efforts of Tsingtao Brewery in green packaging management, but also reflects the great potential of digital technology in promoting waste recycling. By introducing an advanced waste management system, Tsingtao Brewery can handle these recyclable wastes more efficiently, reduce waste of resources, and achieve green production.

Table 5. Waste weight and density

Harmless waste		Unit	2021Y	2022Y	2023Y	Year-on-year variation in 2023
Waste wine cellar	Quantification	Ton	132139.00	137689.00	127484.00	-7%
Waste yeast	Quantification	Ton	11380.00	11726.00	11113.00	-5%
Waste glass bottles,cans	Quantification	Ton	71472.00	53529.00	36982.00	-31%
Total amount of harmless waste	Quantification	Ton	336563.00	300173.00	269025.00	-10%
Harmless waste density	Quantification	Tons / Thousand liters of production	0.04	0.04	0.04	-6%
Hazardous solid waste		Unit	2021Y	2022Y	2023Y	Year-on-year variation in 2023
Total hazardous waste	Quantification	Kilogram	105609.00	111064.00	110724.00	-0.3%

Data source:Tsingtao Beer 2023 ESG report.

3.1.4. Carbon Footprint Management of Green Logistics

From the perspective of total greenhouse gas emissions, Tsingtao Brewery has achieved remarkable results in range 1 and range 2 emissions, as shown in Table 6.

Scope 1 emissions refer to direct emissions, such as emissions from the combustion process. From 2021 to 2023, emissions will decrease from 235455 tons of carbon dioxide equivalent to 211748 tons. Scope 2 emissions refer to indirect emissions, such as emissions from electricity and thermal procurement, from 555148 tons in 2022 to 241848 tons in 2023, a decrease of up to 56%. In the range of 3 emissions, such as transportation and distribution, although emissions are still large, but Tsingtao beer also achieved a 6% decline. Based on the total emissions of scopes 1, 2 and 3, Tsingtao Brewery reduced from 6033376 tons in 2022 to 5427063 tons in 2023, achieving a 10% reduction. This shows that Tsingtao Brewery has achieved positive results in green logistics carbon footprint management.

In addition, from the perspective of greenhouse gas emission density, that is, the greenhouse gas emissions generated per liter of production, from 771.7 tons of carbon dioxide equivalent / liter production in 2022 to 732.6 tons in 2023, a decrease of 5 %. This shows that Tsingtao beer not only improves production efficiency, but also effectively reduces greenhouse gas emissions per unit output.

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Table 6. Total greenhouse gas emissions and density of beer

Greenhouse gas		Unit	2021Y	2022Y	2023Y	Year-on-year variation in 2023
Total greenhouse gas emissions (range 1)	Quantification	Ton of carbon dioxide equivalent	235455.00	188948.00	211748.00	12%
Total greenhouse gas emissions (range 2)	Quantification	Ton of carbon dioxide equivalent	543191.00	555148.00	241848.00	-56%
Total greenhouse gas emissions (range 3)	Quantification	Ton of carbon dioxide equivalent	-	5289280.00	4973467.00	-6%
Total greenhouse Gas emissions (range 1 + 2 + 3)	Quantification	Ton of carbon dioxide equivalent	-	6033376.00	5427063.00	-10%
Greenhouse gas emission density (range 1 + 2 + 3)	Quantification	Ton of carbon dioxide equivalent	-	771.70	732.60	-5%

Data source:Tsingtao Beer 2023 ESG report

3.2. Research on EVA Financial Performance of Digital Green Supply Chain of Tsingtao Beer

Compared with financial indicators, EVA (Economic Value Added) takes into account the cost of capital investment and can measure the wealth of shareholders and the ability to create corporate value. Therefore, it is more comprehensive than financial indicators and is suitable for evaluating long-term performance. Its calculation formula is :

$$\begin{aligned}\text{Economic Value Added(EVA)} &= \text{Net operating profit after tax} - \text{Total capital} \\ &* \text{Weighted average cost of capital}\end{aligned}$$

(1)Calculate net operating profit after tax (NOPAT), Net operating profit after tax measures the free cash flow of the enterprise. The calculation formula is as follows.

$$\begin{aligned}\text{Net operating profit after tax} &= \text{Operating profit} - \text{Income tax expense} + (\text{Interest expense} \\ &+ \text{Asset impairment loss} + \text{Development Expenditure}) * (1 \\ &- \text{Corporate income tax rate}) + \text{Deferred income tax liability increase} \\ &+ \text{Deferred income tax asset reduction}\end{aligned}$$

This article obtains the above data through choice, and calculates the net after-tax operating profit of Tsingtao Brewery from 2019 to 2023 as shown in Table 7.

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Table 7. Tsingtao Brewery 's net operating profit after tax from 2019 to 2023 (Unit:ten thousand yuan)

	2019Y	2020Y	2021Y	2022Y	2023Y
Operating profit	269788.98	325008.45	445495.47	500092.51	573682.59
Income tax expense	79779.44	91258.05	122273.16	120141.98	139820.84
Interest exchange	1362.13	1366.27	2268.50	923.78	1643.05
Asset impairment loss	-12105.14	-13055.37	-18906.04	-2612.37	-8285.37
Corporate income tax rate	25%	25%	25%	25%	25%
Deferred income tax liability increase	-2100.00	-1600.00	400.00	3100.00	3600.00
Deferred income tax asset reduction	-24800.00	-26300.00	-38100.00	-7500.00	19500.00
Net operating profit after tax	160423.79	202928.13	281362.93	375128.38	455301.17

Data source:Tsingtao Beer 2019-2023 annual report, choice database.

(2) Calculate the total capital (TC)

The total amount of capital includes equity and debt capital. The calculation formula is as follows. The calculation results are shown in Table 8.

$$\begin{aligned}\text{Total capital} = {} & \text{Total owner}'\text{sequity} + \text{Asset impairment provision} \\ & - \text{Impairment provision for construction in progress} \\ & - \text{Net construction in progress} + \text{Deferred income tax liabilities} \\ & - \text{Deferred income tax assets} + \text{Short} - \text{term loans} \\ & + \text{Trading financial liabilities} + \text{Non} - \text{current liabilities due within 1 year} \\ & + \text{Long} - \text{term loans} + \text{Bonds payable} + \text{Long} - \text{term payables}\end{aligned}$$

Table 8. Tsingtao Brewery 2019-2023 Total Capital (Unit : 10,000 Yuan)

	2019Y	2020Y	2021Y	2022Y	2023Y
Operating profit	269788.98	325008.45	445495.47	500092.51	573682.59
Income tax expense	79779.44	91258.05	122273.16	120141.98	139820.84
Interest exchange	1362.13	1366.27	2268.5	923.78	1643.05
Impairment losses	-12105.14	-13055.37	-18906.04	-2612.37	-8285.37
Enterprise income tax rate	25%	25%	25%	25%	25%
Deferred income tax liability increase	-2100.00	-1600.00	400.00	3100.00	3600.00
Deferred income tax asset reduction	-24800.00	-26300.00	-38100.00	-7500.00	19500.00
Net operating profit after tax	160423.79	202928.10	281362.93	375128.38	455301.17

Data source:Tsingtao Beer 2019-2023 annual report, choice database.

(3)Calculate the weighted average cost of capital (WACC)

Based on the annual report of Tsingtao Brewery, this paper uses the capital asset pricing model to calculate the cost of equity, in which the risk-free interest rate is the 1-year fixed deposit interest rate, the market return rate is the 1-year market return rate of the Shanghai and Shenzhen 300 index, the β coefficient is the weighted β value of the circulation market value of the Shanghai and Shenzhen 250 trading days, and the debt capital cost rate is the 1-year short-term loan interest rate. The weighted average capital cost of Tsingtao Brewery is calculated as Table 9.

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Table 9. Tsingtao Brewery 2019-2023 Weighted Cost of Capital

	2019Y	2020Y	2021Y	2022Y	2023Y
Cost of debt capital Kd (%)	4.35	4.35	4.35	4.35	4.35
Corporate Income Tax Rate (%)	25.00	25.00	25.00	25.00	25.00
Debt capital / total capital (%)	6.40	4.80	4.70	4.90	5.20
Cost of equity capital Ke (%)	6.70	5.10	10.80	14.10	13.50
Equity capital / total capital (%)	93.60	95.20	95.30	95.10	94.80
Weighted average cost of capital (%)	6.70	5.10	10.50	13.89	13.10

Data source:Tonghuashun iFinD database.

(4)Calculation of Economic Value Added (EVA) Based on the above data, the economic value added of Tsingtao Brewery can be obtained as shown in Table 10.

Table 10. Economic value added of Qingdao beer from 2019 to 2023

	2019Y	2020Y	2021Y	2022Y	2023Y
Net operating profit after tax (ten thousand yuan)	160423.78	202928.13	281362.93	375128.38	455301.17
Total capital (ten thousand yuan)	1924990.97	2081586.00	2157948.09	2408446.79	2611819.74
Weighted average cost of capital	6.70%	5.10%	10.50%	13.89%	13.10%
Economic value added EVA (ten thousand yuan)	31449.39	96767.24	54778.38	40595.12	113152.78

Data source:Tonghuashun iFinD database.

From Table 10, it can be seen that Tsingtao Brewery 's EVA has increased year by year from 2019 to 2023, and the profits on behalf of investors have continued to increase. This is due to Tsingtao Brewery 's active promotion of high-end transformation in 2018, accelerating the transformation of intelligent manufacturing, promoting the conversion of old and new kinetic energy, focusing on giving full play to the advantages of the main brand, using the industrial Internet to realize the digital transformation and coordination of the whole value chain, and constantly improving its core competitiveness, thus continuously creating shareholder wealth. Therefore, the digital transformation layout of Tsingtao Brewery has brought value enhancement to the enterprise and has a positive effect on the creation of enterprise value.

4. Tsingtao Beer Digital Green Supply Chain Management Problems and Improvement Strategies

4.1. Problems in Digital Green Supply Chain Management of Tsingtao Beer

4.1.1. The Change of Market Demand Requires Continuous Adjustment of Supply Chain Strategy.

With the trend of diversification, personalization and sceneization of beer consumption demand in the domestic consumer market, consumers ' demand for high-quality products is increasing. Enterprises continue to increase investment in high-end products, develop and launch new products and new packaging, pay attention to the improvement of product quality and service quality, and shape and enhance brand image. At present, the concentration of the

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domestic beer market is increasing, and the competition in the domestic middle and high-end product market is further intensified, which leads to the continuous growth of market costs such as advertising and promotion. Cost changes will also have an impact on the company 's future sales, income and profit growth. At the same time, Tsingtao Brewery 's supply chain is also facing challenges, such as supplier risk, product quality management and logistics costs. Tsingtao Brewery needs to constantly adjust its supply chain strategy to respond quickly to market changes.

The order quantity of Tsingtao Brewery does not match the demand. Although the sales volume of medium and high-end products of Tsingtao Brewery increased by 10 % year-on-year in 2023, the overall sales volume decreased slightly from 8.07 million to 8.01 million litres, indicating that there may be oversupply or insufficient demand in some markets or product categories, which may lead to inventory backlog or overproduction.

4.1.2. Network Attack and Data Leakage Risk

With the deepening of digital transformation, Tsingtao Brewery relies on cutting-edge technologies such as the Internet of Things, big data analysis, and artificial intelligence (AI). The application of these technologies has improved production efficiency and product quality. However, the rapid evolution of these technologies requires Tsingtao Brewery to continuously update and maintain technology to ensure the stability and security of the system. IoT devices and technologies may need to be upgraded to support new communication protocols or improve data processing capabilities, while big data analysis tools and AI algorithms may need to be updated regularly to adapt to new market data and business needs. In addition, Tsingtao Brewery needs to ensure that its supply chain system keeps pace with the latest industry standards and technology trends in order to maintain a competitive advantage. Technology updates and maintenance involve not only hardware and software upgrades, but also training and education for employees, as well as investing in cybersecurity measures to protect the digital supply chain from potential cyberattacks and data breaches.

4.1.3. Complexity of Supply Chain

Due to the diversification of market demand and the increasing demand of consumers for personalized and customized products and services, Tsingtao Beer has become complicated in supply chain management. In order to adapt to these changes, Tsingtao Brewery 's supply chain must become more flexible and agile, able to handle more product variants, shorter delivery times and higher service levels, which requires the company to adopt more sophisticated supply chain management methods, including more accurate demand forecasting and inventory management, as well as production plans that can quickly adapt to changes in orders while maintaining cost efficiency. In addition, optimizing logistics and distribution networks is also key to achieving faster and more reliable delivery. Tsingtao Brewery also needs to strengthen cooperation with suppliers to ensure they can provide the materials and products they need, while maintaining quality and cost control. This requires companies to coordinate and share information more closely in all aspects of the supply chain, including procurement, production, inventory, logistics and customer service.

4.1.4. Inventory Management Issues

Tsingtao Brewery inventory management is good, but beer is a perishable commodity, so the efficiency of logistics and distribution is essential to maintain product freshness, inefficient logistics may lead to increased costs and product quality decline. Tsingtao Brewery faces some problems in channel compression. The annual report for 2022 shows that Tsingtao Brewery 's contract liability is about 8.91 billion yuan, an increase of 9.7 % year-on-year. In particular, in the fourth quarter, the single-season contract liability increased significantly by 3 billion yuan, which indicates that the company may face greater pressure in the channel and circulation distributor market.

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4.2. Tsingtao Beer Supply Chain Management Improvement Strategy Overall Train of Thought

4.2.1. Streamlining Costs

Tsingtao Brewery is adopting a series of strategies to better adapt to market demand, reduce inventory backlog and improve production efficiency. The company can use big data and artificial intelligence technology to analyze consumer behavior and market trends, accurately predict changes in demand, and avoid overproduction and inventory backlogs. At the same time, Tsingtao Brewery uses digital technologies such as blockchain to improve supply chain transparency, ensure traceability of product sources and production processes, enhance consumer trust and enhance brand image, while complying with environmental and sustainability standards. In addition, the company improves production efficiency through automation and intelligent technology, adopts lean management to reduce waste, reduce costs, enhance competitiveness, and effectively cope with the impact of cost changes on sales, income and profitability. These measures have jointly improved the management level of Qingdao Beer 's digital green supply chain and promoted the sustainable development of the company.

4.2.2. Technical Update and Maintenance

In response to the challenges of digital transformation, Tsingtao Brewery should take a series of measures to ensure the stability and security of its supply chain system. First, the company should regularly upgrade IoT devices and technologies to support new communication protocols and improve data processing capabilities. Secondly, big data analysis tools and AI algorithms should be updated regularly to adapt to new market data and business needs. In addition, Tsingtao Brewery also needs to ensure that its supply chain system is synchronized with the latest industry standards and technology trends to maintain a competitive advantage. Companies should also invest in cybersecurity measures to protect digital supply chains from potential cyberattacks and data breaches.

4.2.3. Layout of Raw Material Producing Areas

Tsingtao Brewery has adopted the strategy of multi-producing areas of raw materials and supported the development of domestic raw materials to reduce the dependence of raw materials on imports. In order to avoid exchange rate changes and raw material supply risks, Tsingtao Brewery should continue to pay close attention to the changes in production conditions in major barley producing areas, judge the timely purchase of the market, and expand the purchase of barley in new producing areas. And continue to implement the list management of barley varieties in the main producing areas. Every year, according to the changes of barley varieties in the main producing areas, new varieties with a certain planting area will be tested, tracked, used and evaluated.

In addition, Tsingtao Brewery should increase its efforts to support the development of domestic raw materials, continue to actively cooperate with domestic suppliers, build a large flower and fragrant flower planting base in Qingdao, and cooperate to study the purification and optimization of varieties. The signing of long-term contracts to encourage planting, the implementation of high quality and high price to improve quality, improve the income of partners and growers ; always support the cultivation of domestic barley and maintain a certain amount of domestic malt procurement to ensure the production of domestic malt suppliers.

4.2.4. Optimize Inventory Management

Tsingtao Brewery can enhance its ability to predict changes in market demand through in-depth market analysis, which will help more accurately plan production and inventory levels to reduce unnecessary inventory backlogs. Through accurate market forecasting, companies can ensure that their production and inventory strategies are consistent with market demand and avoid excess or shortage.

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In addition, Tsingtao Brewery should optimize its logistics network to reduce logistics costs and improve product freshness by improving logistics planning and transportation efficiency. Tsingtao Brewery also needs to strengthen cooperation with distributors to ensure that channel pressure is controlled within a reasonable range, and reduce contract liabilities and dealer market pressure through more transparent communication and effective inventory management.

5. Conclusion

This study deeply explores the impact of Tsingtao Brewery on green supply chain management and its implementation status under the background of digital transformation, and evaluates the impact of digitalization on the non-financial performance and EVA financial performance of Tsingtao Brewery 's green supply chain. The results show that digital transformation not only improves the green manufacturing capacity of Tsingtao Brewery and reduces environmental costs, but also improves the operation efficiency and market competitiveness of enterprises by optimizing supply chain management.

However, Tsingtao Brewery still faces some challenges in digital green supply chain management, such as changes in market demand, network attacks and data leakage, supply chain complexity, and inventory management issues. In response to these problems, this study proposes a series of improvement strategies, including streamlined costs, technology updates and maintenance, raw material multi-production area layout, and optimization of inventory management.

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