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Smart Technology Trends, Smart Supply Chain Management Implementation, and Smart Supply Chain Innovation Performance in China

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Abstract: - Recently, experts and companies anticipated a significant adjustment in the configuration of supply chains as we move into a digitally driven future. The supply chain and management industry identify several risks associated with this transformation, such as increased disruptions to the global trading system caused by various factors like extreme weather events, pandemics, cybersecurity threats, and financial crises. Additionally, the widespread adoption of technology developed during the Fourth Industrial Revolution poses challenges. Businesses that adapt to changes in customer behavior by investing in digitization and embracing diversity are more likely to thrive. The researcher employed a descriptive quantitative approach to investigate the relationship between the implementation of smart supply chain management, smart supply chain innovation performance, and smart technology trends in both developed and developing countries. The findings indicate a correlation between smart supply chain innovation and smart supply chain management performance. Moreover, the ability of smart supply chain management to mediate smart technological advancements needs to be improved.

Keywords: smart supply chain implementation; smart supply chain innovation performance; smart technology trends; Industry 4.0; supply chain management in China.

1. Introduction

In a technologically driven era, various businesses and researchers anticipate that supply chain configuration will undergo a significant revision at this time of transition (Liu et al., 2022). The supply chain and management sector consider these hazards to include the increasing frequency of shocks to the global trading system from both endogenous and exogenous risks, such as extreme weather occurrences, pandemics, cybersecurity, and financial crises, and the widespread adoption of technology developed during the Fourth Industrial Revolution (Cordon, 2020). Companies that survive the coming shifts in consumer behavior will have digitized and invested in differentiating themselves. As technology evolves, businesses must stay ahead of the curve to remain competitive. Smart technology trends are the latest advancements in technology being used to improve the efficiency and effectiveness of supply chain management (Liu et al., 2022).

AI and Machine Learning enhance supply chain management through process automation and optimization of inventory levels, customer demand prediction, and real-time sales data (Gomez, 2020). By 2030, AI's impact could contribute around $15.7 trillion to the global economy (PricewaterhouseCoopers, 2017). The Internet of Things (IoT) enables monitoring and control of supply chain operations through GPS and RFID, providing real-time updates on shipments and inventory (Gomez, 2020). Gartner's poll (2018) reveals that 13% of organizations implementing IoT initiatives already use digital twins, while 62% are adopting them or have plans to do so within a year. Weighing and shipping technologies improve efficiency, reduce costs, and enhance customer service by eliminating manual processes and offering personalized recommendations and automated responses (Gomez, 2020). Mobile weighing technology removes the need for fixed scales during product delivery. Collaborative mobile robots optimize warehouse operations by minimizing walking and increasing accuracy and efficiency (Gomez, 2020). Fully autonomous vehicles have the potential to reduce transportation industry expenses by 45%, resulting in savings of $85 billion to $125 billion (Chottani et al., 2018).

mart technology trends are revolutionizing business operations, offering improved decision-making, enhanced efficiency, and cost reduction. They enable companies to stay ahead in product development and customer experience, increasing competitiveness (Liu et al., 2022). Smart supply chain management implementation is crucial for visibility, cost reduction, efficiency, and customer service improvement. It allows for better control, mitigates risks, and leverages data analytics for demand patterns and supply chain enhancements (Nasiri et al.,

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2020). Leveraging smart technologies like AI and machine learning automates processes, reduces costs, and boosts efficiency throughout the supply chain (Nasiri et al., 2020). Smart supply chain innovation performance drives success in developing countries, helping companies compete globally and find growth opportunities. Organizations must adapt to new technologies and methods to stay competitive in a changing global economy (Liu et al., 2022). Strategic utilization of these advancements maximizes benefits and minimizes compliance issues. Understanding and implementing new technologies effectively is vital in this fast-paced technological landscape.

2. Method and Materials

2.1 Research Design

In this study, the researcher adopts a IMRAD quantitative approach to compare smart technology trends, supply chain management implementation, and innovation performance in China.

2.2 Participants

The study examines businesses in China, a prominent player in global value chains, to analyze the implementation and performance of smart supply chain management. By comparing these businesses, the study aims to uncover differences and provide insights for future strategies in developed and developing economies (Bulman, 2022).

2.3 Instrumentation

The instrumentation of this study is adapted from the study of Capt. Veera Pandiyan K.S. entitled "Supply Chain Management Practices, Supply Chain Integration, and Supply Chain Performance. A Study of Electronics Firms in Malaysia". The researcher modified some parts of the question to fit the research objectives.

2.4 Statistical Treatment

The mean is used to identify the smart supply chain implementation level, smart supply chain innovation performance, and smart technology trends usage. Pearson's correlation determines the relationship between smart supply chain implementations on supply chain innovation performance in developing developed economies. Multiple Regression tests smart technological trends to mediate smart supply chain implementations and supply chain innovation performance in developing and developed economies.

3. Results

Smart Supply Chain Management Implementation

Table 1: Smart Supply Chain Management Implementation in China

Statements	Mean
Firms in our supply chain establish more frequent contact with each other	1.86
Firms in our supply chain create a consistent communication and information system	1.67
Our firm extends its supply chain beyond its customers/suppliers	1.93
Our firm participates in the marketing efforts of its customers	1.49
Our firm participates in the sourcing decisions of its suppliers	1.54
OVERALL MEAN	**1.70**
VERBAL INTERPRETATION	**Agree**

Note: 1=Extremely Agree 2=Agree 3=Neither Agree nor Disagree 4=Disagree 5=Extremely Disagree

The supply chain management companies in China **agree** that *firms in the supply chain establish more frequent contact with each other* (1.86), *firms in the supply chain create a consistent communication and*

information system (1.67), their company *extends its supply chain beyond its customers/suppliers* (1.93), the supply chain management companies **extremely agree** that their company *participates in the marketing efforts of its customers* (1.54). Further, the *firm engages in the sourcing decisions of its suppliers* (1.49). Overall, the supply chain management companies in China **agree** that the smart supply chain implementation companies in China significantly improved and helped the company work efficiently (1.70).

In developing economies like China, they are also investing in developing artificial intelligence (AI) and machine learning (ML) technologies to improve the efficiency of their supply chains. AI and ML can automate processes, such as inventory management and order fulfillment, and provide predictive analytics to help companies make better decisions. The implementation of smart supply chains in China is helping to improve the efficiency and cost-effectiveness of their supply chains. This is helping to drive economic growth and create new business opportunities in both countries. Smart supply chains are becoming increasingly important in these countries as they strive to remain competitive in the global market. As a result, these countries are well-positioned to remain competitive in the worldwide market.

Smart Technology Trends

Table 2: Smart Technology Trends in China

Statements	Mean
Smart technology trends such as artificial intelligence, blockchain, and the Internet of Things are revolutionizing supply chain management by providing real-time visibility, improved accuracy, and increased efficiency.	1.27
Smart technology trends enable supply chain managers to make better decisions faster, reduce costs, and improve customer service.	1.37
Smart technology trends are helping supply chain managers to identify and address potential risks and disruptions before they occur, allowing for more proactive management.	1.14
Smart technology trends enable supply chain managers to optimize their operations by leveraging predictive analytics and machine learning to anticipate customer needs and demand.	1.50
Smart technology trends allow supply chain managers to automate processes, reduce manual labor, and increase productivity.	1.40
OVERALL MEAN	**1.34**
VERBAL INTERPRETATION	**Extremely Agree**

Note: 1=Extremely Agree 2=Agree 3=Neither Agree nor Disagree 4=Disagree 5=Extremely Disagree

In China, smart supply chain management companies **extremely agree** that *smart technology trends such as artificial intelligence, blockchain, and the Internet of Things are revolutionizing supply chain management by providing real-time visibility, improved accuracy, and increased efficiency* (1.27). Further, *smart technology trends enable supply chain managers to make better decisions faster, reduce costs, and improve customer service* (1.37). In addition, *smart technology trends are helping supply chain managers to identify and address potential risks and disruptions before they occur, allowing for more proactive management* (1.14). Moreover, *smart technology trends enable supply chain managers to optimize their operations by leveraging predictive analytics and machine learning to anticipate customer needs and demand* (1.50). Lastly, *smart technology trends allow supply chain managers to automate processes, reduce manual labor, and increase productivity* (1.40). Overall, the supply chain management companies in China **extremely agree** that smart technology trends hugely change the way the supply chain operates (1.34). Companies have increased visibility and can follow activities better because supply chain technologies and automation employ real or near real-time data. This improves collaboration and communication with major vendors while also lowering costs through improved vendor contract management.

Smart technology trends are being increasingly utilized in the supply chains of China. In a developing economy such as China, smart technology trends are being used to improve the efficiency of the supply chain by

providing real-time visibility into inventory levels, tracking shipments, and automating processes. It helps to reduce costs and improve customer service. Further, smart technology trends are being used to improve the accuracy of forecasting and demand planning, which helps reduce inventory costs and improve customer satisfaction.

Smart Supply Chain Management Performance

Table 3: Smart Technology Trends in China

Statements	Mean
The smart technology trends help the smart supply chain to respond to and accommodate demand variations, such as seasonality.	1.32
Smart technology trends help the smart supply chain to respond to and accommodate periods of poor manufacturing performance such as machine breakdown.	1.03
The smart technology trends help the smart supply chain to respond to and accommodate periods of poor supplier performance	1.49
The smart technology trends help the smart supply chain to respond to and accommodate periods of poor delivery performance	1.54
The smart technology trends help the smart supply chain to respond to and accommodate new products, new markets or new competitors	1.27
Total cost of resources used are reduced.	1.37
The total cost of distribution, including transportation and handling cost, is reduced.	1.49
The total cost of manufacturing, including labor, maintenance, and rework costs is reduced.	1.54
The cost associated with held inventory is reduced	1.27
Return on investments is quickly seen.	1.37
Sales significantly increased due to efficient work.	1.00
Order fill rate is quick.	1.00
On-time deliveries are consistent.	1.49
Quick customer response time	1.54
Minimal shipping errors	1.27
High-speed manufacturing lead time	1.37
Easily and efficiently catered to customer complaints	1.00
OVERALL MEAN	**1.31**
VERBAL INTERPRETATION	**Extremely Agree**

Note: 1=Extremely Agree 2=Agree 3=Neither Agree nor Disagree 4=Disagree 5=Extremely Disagree

With the mean of **1.31** the smart supply chain management companies in China **extremely agree** that the smart supply chain implementation greatly improves efficiency and enables businesses to increase product flow by accurately estimating demand and sales, as well as by improving inventory management to stop the bullwhip effect and prevent underproduction.

The supply chain management companies in China **extremely agree** that *smart technology trends help the smart supply chain respond to and accommodate demand variations, such as seasonality* (1.32). Further, *they* **extremely agree** *that smart technology trends help the smart supply chain to respond to and accommodate periods of poor manufacturing performance such as machine breakdown* (1.03), *help the smart supply chain to respond to and accommodate periods of poor supplier performance* (1.49), *help the smart supply chain to respond to and accommodate periods of poor delivery performance* (1.54), and *help the smart supply chain to respond to and accommodate new products, new* markets or new competitors (1.27). Through smart technology trends, the *total cost of resources used is reduced* (1.37), and *the total cost of distribution, including transportation and handling, is reduced* (1.49). In addition, *smart technology trends helped reduce the total cost of manufacturing, including*

labor, maintenance, and rework costs (1.54) and *inventory* (1.27). The companies also saw a *quick return on investment* (1.37), a *significantly increased in sales due to efficient work* (1.00), *quick order fill rate* (1.00), *on-time deliveries are consistent (1.49), quick customer response time (1.54), minimal shipping errors (1.27), high-speed manufacturing lead time (1.37), and easily and efficiently catered to customer complaints (1.00).*

Relationship between Smart Supply Chain Implementation and Performance

Table 4: Relationship between smart supply chain innovation performance in China

	Mean	Pearson Correlation	Sig. (2-tailed)	Decision	Verbal Interpretation
SSCMI	1.6965	.479	.001	Reject Null Hypothesis	Low Positive Correlation
SSCMP	1.3138				

H0: There is no relationship between smart supply chain implementations on supply chain innovation performance in China.

Table 4 represents Pearson's correlation to determine if there is a significant relationship between the means of China's Smart Supply Chain Implementation. If significant (p-value) is less than the alpha level ($p<.05$), then the hypothesis is statistically significant. The table shows that the sig p-value is less than the alpha level ($.001<.05$). Thus, the researcher **rejects** the null hypothesis (H_0) and *concludes that the implementation of the smart supply chain in China improves its performance.*

The implementation of smart supply chain practices in China has the potential to improve business process performance significantly. As a global manufacturing and trade hub, China has recognized the importance of leveraging smart technologies to enhance the efficiency, agility, and competitiveness of its supply chain operations. There are several key reasons why implementing a smart supply chain in China can improve business process performance.

First, smart supply chain implementation enables greater visibility and transparency across the entire network. By leveraging technologies such as IoT sensors, RFID tags, and real-time tracking systems, companies can obtain accurate and real-time data on the movement of goods, inventory levels, and production status. This visibility helps optimize inventory management, reduce stockouts, and improve demand forecasting accuracy. With enhanced visibility, companies can make data-driven decisions, identify bottlenecks, and proactively address issues, improving operational efficiency and reducing lead times.

Secondly, smart supply chain practices enable automation and digitization of processes. Manual and repetitive tasks can be automated by deploying technologies like robotic process automation, machine learning, and AI-powered analytics, freeing up resources and reducing human errors. For instance, automated order processing, warehouse operations, and transportation management systems streamline operations, improve accuracy, and accelerate order fulfillment. Digitization of processes also enables seamless integration and information sharing among supply chain partners, fostering collaboration and reducing communication delays.

Furthermore, implementing a smart supply chain in China facilitates data-driven decision-making. The vast amounts of data generated through various smart technologies can be analyzed using advanced analytics tools, enabling companies to gain valuable insights into customer behavior, market trends, and operational performance. These insights help identify improvement opportunities, optimize resource allocation, and enhance supply chain responsiveness. By making informed decisions based on data, companies can mitigate risks, reduce costs, and improve overall business process performance.

Moreover, smart supply chain practices support sustainability and environmental responsibility. China has been increasingly emphasizing green initiatives and sustainable practices in recent years. Smart technologies can assist in monitoring and reducing energy consumption, optimizing transportation routes, and minimizing waste. By implementing eco-friendly procedures, companies can improve their environmental footprint, comply with regulations, and enhance their reputation as socially responsible organizations.

Lastly, implementing a smart supply chain in China can improve customer satisfaction and enhance competitiveness. The ability to track and trace products in real-time, provide accurate delivery estimates, and offer personalized services based on customer preferences can significantly improve the customer experience. Smart technologies also enable efficient reverse logistics and after-sales support, further boosting customer satisfaction and loyalty. By meeting customer expectations and delivering products and services promptly and efficiently, companies can gain a competitive edge in the market.

In conclusion, implementing a smart supply chain in China can improve business process performance through enhanced visibility, automation, data-driven decision-making, sustainability, and improved customer satisfaction. By embracing smart technologies and leveraging their capabilities, companies in China can streamline their supply chain operations, optimize resource allocation, reduce costs, and ultimately achieve higher levels of operational efficiency and competitiveness in the global marketplace.

Smart Technology Trends, Smart Supply Chain Management Implementation, and Smart Supply Chain Innovation Performance

Table 5: Mediation of Smart Technology Trends in China's Smart Supply Chain Management

Model	R	R Square	Adjusted R Square	Std. Error of Estimate
	.484[a]	.235	.228	.18632

In China, smart technology trends have a weak mediation in the smart supply chain implementation and performance, with the R Score of **.484**. In addition, smart technology trends have a **23.5 %** effect on the smart supply chain innovation performance based on the R Square of .235. Hence, smart technology trends have a **moderately significant effect** between smart supply chain implementation and performance.

While smart technology trends have the potential to bring about significant improvements in smart supply chain implementation, their actual impact on performance can sometimes be weak or limited. Several factors contribute to this moderately significant effect.

Firstly, the complexity and cost of implementing smart technologies can pose challenges. Adopting advanced technologies such as AI, IoT, and blockchain requires substantial infrastructure, software, and skilled personnel investments. Small and medium-sized enterprises (SMEs) may need help to afford these investments, limiting their ability to leverage smart technologies and achieve the desired performance improvements fully.

Secondly, the integration of smart technologies into existing supply chain processes may need to be improved. Legacy systems, outdated infrastructure, and organizational inertia can hinder the seamless integration of new technologies. Companies may encounter compatibility issues, data integration challenges, and resistance from employees who resist change or need more skills to utilize the new technologies effectively. These implementation barriers can impede the realization of the full potential of smart technologies and weaken their impact on supply chain performance.

Furthermore, the effectiveness of smart technology trends in improving performance relies on data availability and quality. Smart technologies heavily rely on accurate and timely data for their functionality. If data sources are reliable, complete, and properly integrated, the insights and outcomes generated by smart technologies may be protected. Data privacy and security concerns can also limit data sharing and utilization, hindering smart technologies' effectiveness in optimizing supply chain processes.

Additionally, the dynamic nature of smart technology trends can pose challenges in terms of sustainability and scalability. Technology advancements occur rapidly, and companies may need help to keep up with the latest trends and upgrades. This can result in implementing technologies that quickly become outdated or incompatible with future innovations, limiting their long-term impact on performance.

In conclusion, while smart technology trends promise to improve supply chain performance, their impact can be weakened by challenges related to implementation complexity, integration hurdles, data quality, and the dynamic nature of technological advancements. Overcoming these challenges requires careful planning, investment, and a strategic approach to ensure the successful integration and utilization of smart technologies in supply chain operations.

Table 6: ANOVA

	Sum of Squares	Df	Mean Square	F	Sig.
Regression	2.417	2	.1.208	34.806	<.001[b]
Residual	.7.881	227	.035		
Total	10.297	229			

The ANOVA of these variables, Smart Technology Trends, Smart Supply Chain Management Implementation, and Smart Supply Chain Innovation Performance, shows that smart technology trends are ***expected*** in this field based on F=34.806. A p-value less than 0.05 (typically ≤ 0.05) is statistically significant. It indicates strong evidence against the null hypothesis, as there is less than a 5% probability that the null is correct. Based on the results, p-value is greater than the alpha value (p= .001<0.05), resulting in **accepting the mediation of smart technology trends** between smart supply chain implementation and smart supply chain innovation performance.

Mediating smart technology trends between smart supply chain implementation and innovation performance is crucial for driving and optimizing supply chain outcomes. Smart technology trends act as the bridge that connects the implementation of intelligent technologies and the performance of innovative supply chain practices. These trends encompass a range of cutting-edge technologies, including artificial intelligence, machine learning, robotics, IoT, and blockchain, which bring about transformative changes in supply chain management.

Through smart supply chain implementation, companies adopt and integrate these technologies into their operations, enabling automation, real-time data analytics, and intelligent decision-making. Smart technologies empower organizations to optimize processes, streamline workflows, enhance visibility, and achieve operational efficiencies across the supply chain. For instance, AI and machine learning algorithms can automate demand forecasting, inventory management, and route optimization, leading to cost savings and improved responsiveness. IoT devices provide granular data on product location, condition, and performance, facilitating proactive issue resolution and predictive maintenance. Blockchain technology ensures transparency, trust, and security in supply chain transactions, mitigating risks and reducing fraud.

There needs to be more than the implementation of smart technologies to achieve optimal supply chain performance. The mediation of smart technology trends extends beyond implementation to encompass the innovation performance of the supply chain. This involves continuously exploring and adopting novel practices, strategies, and business models enabled by smart technologies. Companies leverage these technologies to innovate and improve their supply chain processes, products, and services.

Smart technology trends facilitate supply chain innovation performance by enabling companies to explore new avenues for improvement and differentiation. For example, data-driven analytics allow organizations to identify patterns, trends, and insights that lead to improved forecasting accuracy, demand planning, and inventory optimization. Robotic process automation and autonomous vehicles enable efficient warehousing, picking, and delivery operations. Smart technologies also enable enhanced collaboration and visibility among supply chain partners, enabling seamless information sharing, improved coordination, and faster response times.

In summary, smart technology trends mediate the relationship between smart supply chain implementation and innovation performance. Companies can drive innovation, optimize processes, and improve supply chain outcomes by implementing intelligent technologies and leveraging their capabilities. Mediating these trends

ensures that companies adopt smart technologies and actively use them to explore new opportunities, enhance performance, and remain competitive in a rapidly evolving business landscape.

Table 7: Coefficients

	Unstandardized B	Coefficients Std. Error	Standardized Coefficients Beta	T	Sig.	95.0% Confidence Lower Bound	Interval for B Upper Bound
Constant	.903	.122		7.430	<.001	.663	1.142
SSCMI	-.089	.069	-.079	-1.291	.198	-.226	.047
STT	.695	.084	.502	8.246	<.001	.529	.861

Based on the data presented in the table above, smart technological trends significantly affect smart supply chain implementation and smart supply chain innovation performance. If significant (p-value) is less than the alpha level ($p<.05$), then the hypothesis is statistically significant. The table shows that the sig p-value is more than the alpha level ($.001<.05$). Thus, the researcher accepts the null hypothesis (H_0) and concludes that the implementation of the smart supply chain in China does not necessarily affect its performance.

Smart technological trends shape the relationship between smart supply chain implementation and innovation performance. Integrating advanced technologies such as artificial intelligence, Internet of Things, big data analytics, and blockchain has revolutionized supply chain management. Smart supply chain implementation refers to adopting and utilizing these technologies to enhance supply chain operations' efficiency, visibility, and agility. By leveraging smart technologies, companies can automate processes, monitor real-time data, improve inventory management, and streamline logistics, thereby reducing costs and enhancing overall supply chain performance.

Moreover, smart technological trends also drive smart supply chain innovation performance. The continuous evolution and technological advancements create opportunities for innovative solutions and practices in supply chain management. For instance, AI-powered predictive analytics can enable proactive demand forecasting and inventory optimization, improving customer satisfaction and reducing stockouts. IoT devices can provide real-time visibility into product location and condition, enabling proactive issue resolution and efficient supply chain planning. Blockchain technology ensures transparency, traceability, and security in supply chain transactions, mitigating risks and enhancing stakeholder trust. These innovations, facilitated by smart technologies, empower companies to optimize their supply chain processes, respond quickly to market changes, and gain a competitive edge in the dynamic business landscape.

Overall, smart technological trends act as a catalyst for smart supply chain implementation and innovation performance. They enable companies to transform traditional supply chains into intelligent and agile systems, improving operational efficiency, enhancing customer satisfaction, and increasing profitability. Embracing these trends is essential for businesses to stay relevant, adapt to changing market dynamics, and achieve sustainable growth in today's increasingly digital and interconnected world.

4. Discussion

In a developing economy like China, smart supply chain management implementation can help reduce costs and increase efficiency. Supply chain management companies can do it by using technology to automate processes, reduce manual labor, and improve communication between suppliers and customers. Additionally, smart supply chain management can help reduce the risk of supply chain disruptions, which can significantly impact a business’s bottom line. However, a weak relationship exists between smart supply chain implementation and smart supply chain innovation implementation. Also, the mediation of smart technology trends has a weak significant effect. The contradiction showed that Industry 4.0 in supply chain management needs further learning. As a rising trend in the supply chain, it is expected to be utilized in the upcoming years. Gartner (2022) predicts that by 2026, 75% of large organizations will have implemented some intralogistics smart robots in their warehouse operations. In addition, over 75% of commercial supply chain management application suppliers will provide embedded advanced analytics (AA), artificial intelligence (AI), and data science. Therefore, supply chain management

companies in developing countries should focus on research and development and then shift to the proper implementation.

Despite their relative obscurity, these two initiatives are closely related and should be integrated (Gartner, 2022). If these activities are maintained separately, expect significant value loss due to underperformance and missed opportunities. When held separately, neither project performs optimally. Because the digital supply chain twin is too far away, end-to-end supply chain optimization could be better quality (Gartner, 2022).

5. Conclusion

Smart supply chain management implementation is crucial for businesses as it involves managing the flow of goods and services throughout the supply chain, from origin to consumption. It encompasses procurement, production, inventory management, transportation, and customer service. To remain competitive globally, businesses must prioritize smart supply chain management implementation. In China, a weak significant relationship exists between smart supply chain management implementation and smart supply chain innovation performance. While smart technology can enhance the efficiency and effectiveness of the supply chain, there are other substitutes for effective management. It can automate certain processes and reduce costs but does not replace the need for thorough research and careful implementation. Ultimately, smart supply chain management implementation is vital in maintaining competitiveness in today's global market.

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