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Digital Twins and their impact on the Supply Chain

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Executive summary

In our previous publication from Deloitte The Netherlands, [‘Did you say Supply Chain Digital Twin? Demystifying Digital Twins and unlocking the value potential in Supply Chains’](#), we explored the capabilities of Digital Twins in the digitization era. We differentiated them from control towers and described the possibilities of leveraging their analytical power from descriptive to predictive insights, thanks to the use of advanced algorithms. Additionally, we discussed their use at operational, tactical and strategic levels, including the potential impact on sustainability.

In this latest report, we built an ad hoc pipeline based on our in-house GenAI assistant **Headstart** to analyze **over 80 academic, professional, and expert sources while retaining the highest level of quality**. This indepth research provided fresh insights into the practical use of Digital Twins across three key Supply Chain domains. We include industryspecific examples to show how this technology can drive measurable results and deliver strong return on the investment.

A Digital Twin is a virtual representation of a physical object, process or system. It enables superior decision-making and value creation through end-to-end optimization.

Digital Twins allow businesses to simulate, predict, and optimize their processes and operations. By using advanced analytics and machine learning technologies, companies can improve efficiency, reduce costs, and enhance service delivery—giving them a competitive edge in a fast-changing world. The power of Digital Twins is maximised through a Decision Intelligence mindset, which integrates analytics insights with effective governance, processes, and automation.



Key Research Findings:

The Digital Twin industry is **poised for exponential growth**, with projections ranging from 30 billion USD to over 250 billion USD. The Asia-Pacific region is expected to lead this growth. This rapid development necessitates that Supply Chain leaders integrate Digital Twins into their strategic, tactical and operational planning. These technologies seamlessly **enhance decision-making** for top and bottom-line growth, ensuring **futureready operations**.



Key Research Focus:

Impact of Digital Twins in three Supply Chain specialization domains:

- **Logistics & Distribution:** Optimizing route planning, warehouse operations, and distribution strategies.
- **Demand & Supply Planning:** Enhancing inventory management, visibility, and demand forecasting.
- **Procurement:** Applying predictive analytics to pricing, supplier management, and risk assessment.

Intro to Digital Twins



In today's rapidly evolving business landscape, understanding Digital Twins is crucial for optimizing Supply Chain operations. This chapter delves into the foundational aspects of Digital Twins, beginning with an exploration of current Supply Chain dynamics. It then introduces the concept of Digital Twins, examines their transformative impact, and highlights key findings from our research. This comprehensive overview sets the stage for understanding how Digital Twins can revolutionize Supply Chain management.



Supply Chains in today's world

Addressing today's Supply Chain challenges with Digital Twin technology to enhance efficiency, resilience, and global adaptability.



The impact of Digital Twins

Unveiling the impact of Digital Twins by driving growth, sustainability, and efficiency across industries.



The Digital Twin

Maximizing ROI with Digital Twins by exploring strategic applications across industries today.



Key findings

Supply Chains in today's world

In today's dynamic global market, Supply Chains are pivotal to business success, yet they face a wide range of challenges. As businesses grapple with disruptive events such as COVID, the urgency of the energy transition, and unpredictable geopolitical landscapes, the task of optimizing Supply Chain operations becomes ever more important. Organizations need sophisticated strategies that balance efficiency with high levels of customer service.

Amidst this complexity, Digital Twin technology emerges as a transformative solution. By creating virtual replicas of physical systems, Digital Twins provide a detailed, real-time view of the Supply Chain. This technology improves decision-making with predictive insights and operational intelligence. It also helps organizations break down silos and create a full overview of live data, enabling more agile and informed responses to disruption.

“By simulating different scenarios and outcomes, Digital Twins enable businesses to adapt swiftly and with more agility to the changing market conditions.”

Digital Twins provide a strategic advantage in optimizing operational processes, reducing costs, and improving service delivery. Each segment of the Supply Chain can benefit distinctly from the integration of Digital Twins, paving the way for a more resilient and responsive Supply Chain ecosystem.

This report explores how Digital Twins are specifically revolutionizing Logistics & Distribution, Demand & Supply Planning, and Procurement, thereby driving the future of global Supply Chains towards unprecedented efficiency and adaptability.

The Digital Twin

In the evolving landscape of digital transformation, the concept of Digital Twins has emerged as a game-changer. A Digital Twin is a virtual representation of a physical object, process, or system. It enables advanced decision-making and value creation through full end-to-end optimization. Digital Twins serve as valuable tool enabling businesses to simulate, predict, and optimize their systems through advanced analytics.

Historically, analytics were confined to siloed parts of an organization. Each business unit or department focused on its own metrics, often missing the bigger picture. Digital Twins are not only a new technology, but they are a new way of looking to optimize an entire system, beyond the parts in which an organization is structured.

Each Digital Twin integrates data and intelligence—combining operational data, environmental insights, and engineering information into a dynamic model that updates and changes as its physical counterpart evolves.

This comprehensive approach allows for opportunities such as real-time monitoring and network optimization, which can substantially reduce costs and increase efficiency.

Digital Twins also play a crucial role in the advancement of the Internet of Things (IoT), Artificial Intelligence (AI), and Machine Learning (ML), with Generative and Agentic AI further amplify the opportunity. They are becoming a cornerstone for decision-making processes. By leveraging the power of Digital Twins, organizations can gain unprecedented insights into their assets, operations, and services. This deep operational insight will foster innovation, boost performance, and increase value creation. Using Digital Twins strategically gives businesses a strong competitive edge. It improves decision-making, optimizes resource allocation, and supports flexible, responsive operations. This ultimately leads to a more sustainable business model accentuated by efficiency and agility.



The impact of Digital Twins

According to our research—comparing more than 80 sources that discuss Digital Twins from different angles and perspectives (see Appendix for detailed information on our methodology and sources)—the global Digital Twin market is experiencing a remarkable growth trajectory. It is expected to soar from 12.91 billion USD in 2022 to a staggering 259.32 billion USD by 2032, demonstrating a Compound Annual Growth Rate (CAGR) of 39.8%. This growth is fueled by increasing adoption across various sectors and significant technological advancements. The Asia-Pacific region, in particular, is anticipated to witness the fastest growth, with notable contributions from South Korea, Japan, India, and China.

Several factors are accelerating this trend:

- The incorporation of AI and ML into Digital Twins is boosting their analytics and decision-making capabilities through techniques like reinforcement learning and Bayesian Optimization.
- Generative AI makes these analytics more accessible to non-technical users.
- IoT sensors and RFID technology are improving real-time inventory management and Supply Chain transparency.
- Blockchain is enabling secure data exchange across Supply Chains.

Digital Twins also play a pivotal role in promoting sustainability by enabling emissions baselining and reductions. Industry use cases show a 20%-30% decrease in CO₂ emissions. They also contribute to operational efficiency, evidenced by a 20-30% reduction in downtime and a 15-25% improvement in operational efficiency across implemented industries. Moreover, predictive maintenance facilitated by Digital Twins leads to a 5-10% reduction in maintenance costs, enhancing overall energy and resource management.

20-30%
Reduction of near-term
CO₂ emissions when
using Digital Twins for
emissions baselining

Looking ahead, Digital Twins will be central to innovations like 5G-enabled infrastructure and the development of industrial metaverses to transform real-time monitoring and global Supply Chain management. They provide a powerful tool for scenario testing and striking the right balance between profitability and sustainability, acting as a strategic 'crystal ball' for decision-making.



Digital Twin key findings



Industry growth

The Digital Twin market is expected to grow from 12.91 billion USD in 2022 to 259.32 billion USD in 2032.



Sustainability

Digital Twins improve energy and resource management, reducing CO₂ emissions by 20-30% in an industry case study.



Future outlook

The strategic use of Digital Twins is crucial in balancing profitability with sustainability, enabling strategic decision-making.



Emerging tech

The integration of (Gen) AI, Agentic AI, ML, IoT, RFID, and blockchain with Digital Twins enhances analytics, autonomy, security, and real-time visibility.



Geographies

The Asia-Pacific region is anticipated to witness the fastest growth, with contributions from South Korea, Japan, India, and China.

Explore Supply Chain-specific insights from Deloitte's three expertise domains, informed through research and expert opinions. Uncover key trends, opportunities and challenges in the next chapter.



Impact on Supply Chain domains

To provide a comprehensive understanding of how Digital Twins impact the Supply Chain, this deep-dive explores three key areas: Logistics & Distribution, Demand & Supply Planning, and Procurement. Each of these domains leverages Digital Twin technology to enhance efficiency, resilience, and decision-making across the Supply Chain.



Logistics & Distribution

Digital Twins revolutionize Logistics & Distribution with optimized routing, enhanced distribution efficiency, and improved resilience.



Demand & Supply Planning

Digital Twins optimize Demand & Supply Planning with accurate, real-time inventory and demand forecasting.



Procurement

Digital Twins transform Procurement with predictive analytics on spend, enhancing supplier engagement and compliance.



Logistics & Distribution

Digital Twins are revolutionizing the logistics landscape by optimizing routing, enhancing distribution efficiency, and increasing resilience. By constructing virtual replicas of logistics networks, organizations can run real-time simulations, analyze ‘what-if’ scenarios, and make more-informed decisions. This capability significantly decreases delivery times and operational costs. Digital Twins not only support robust route planning, but also optimize warehouse operations and lastmile delivery—critical factors that directly influence service levels and customer satisfaction.

Additionally, the application of Digital Twins in Logistics provides a resilient framework in the face of disruptions, whether caused by market fluctuations, geopolitical tensions, or natural disasters. This resilience is crucial for maintaining uninterrupted operations and high service standards. Casper Sterkman, Manager Supply Chain & Network Operations at Deloitte Netherlands, explains:

“Real-time tracking allows us to better identify opportunities to improve operational efficiency and optimize routes or plans.”

Despite their benefits, challenges remain. Cybersecurity risks, integration complexities, and the need for stakeholder collaboration are common hurdles. Insights from Deloitte’s experts underline the importance of real-time data tracking through both apps and GPS as well as more advanced IoT and developing secure, scalable Digital Twin solutions that integrate seamlessly with existing systems.

Looking forward, the role of Digital Twins in Logistics is set to grow, focusing on operational efficiency and strategic network optimization. The promising future of Logistics with Digital Twins holds potential for substantial improvements in efficiency, cost management, and customer satisfaction.



Logistics

Digital Twins offer great potential for the logistics industry by improving efficiency, resilience and sustainability. They can represent different aspects of the logistics process—like goods in transit or the transport system itself. These Digital Twins give realtime insight into complex Supply Chains and make it possible to model different scenarios, helping businesses make better decisions.

This potential is being realized in a national port authority use case, where a container shipping hub is being represented in a Digital Twin. AI and sensory data integration allowed for advanced scenario modeling and efficiency gains, optimizing trade operations and sustainability outcomes.



Retail

Digital Twins can model entire Supply Chains. Many types of assets, processes and products can be represented in the same Digital Twin. When translating this to the retail industry, this means that stores, warehouses, transport, assets, products, inventory, people and processes, among others, can be included. This Digital Twin is then fed real-time data from sensors as well as ERP and other systems data.

A retail case study showed that Digital Twins help retailers adopt flexible fulfillment models, such as ship-from-store or microfulfillment. The study also demonstrated that Digital Twins can connect internal and external parts of the Supply Chain by sharing the otherwise siloed data. Early retail industry adopters have seen up to 10% lower capital costs, up to 5% less inventory, and EBITDA improvements of 1 to 3 percentage points.

Demand & Supply Planning

The implementation of Digital Twins in Demand & Supply Planning is revolutionizing how organizations manage their entire Supply Chain. By connecting all parts of the Supply Chain—from customers to internal teams to tier-n suppliers—companies can simulate the impact of changes across the whole chain. This helps manage stock more effectively and avoid overstocking or stockouts. It also shortens planning cycles and improves decision-making and responsiveness to market dynamics.

Moreover, the insights from discussions also show that Digital Twins help companies move from static to dynamic planning. They provide ongoing adjustment to forecasts based on current data, enhancing responsiveness to changes in customer behavior or disruptions. This shift is especially critical in environments where Supply Chains are constantly reevaluated on topics such as the delivery model and considerations whether to allocate stock to online versus offline sales channels. This enables companies to navigate with greater agility.

As the Digital Twin technology matures, its role in strategic Demand & Supply Planning is expected to expand, becoming pivotal in providing a comprehensive view of the Supply Chain dynamics and enabling proactive management adjustments.



Food and beverages

In the food and beverage sector, companies often struggle with Supply Chain disruptions and changing customer demand. To enhance planning, many are turning to Digital Twin technology. These virtual models give insight into production capabilities and inventory levels, making it easier to adapt to market changes.

With real-time analytics embedded in Digital Twins, teams can quickly assess the impact on demand, manufacturing, and logistics. This empowers users at all levels to make better decisions about stock and order fulfillment—leading to faster decision-making, improved agility, and better service levels in meeting customer demands, ultimately reducing waste.



Oil and gas

In the oil and gas industry, it's hard to predict market demand due to fluctuating supply and geopolitical factors. Digital Twin technology helps by creating virtual models that simulate market responses to these changes. With real-time data, companies can analyze trends and forecast demand more accurately. This allows teams to run simulations that guide critical decisions on production levels and distribution strategies. As a result, companies can plan better, handle disruptions more effectively, and meet evolving customer needs in a dynamic market environment.



Procurement

In today's fast-changing digital world, Digital Twins are redefining procurement processes. They provide predictive insights and real-time operational intelligence, helping companies forecast supplier performance, adjust pricing strategies, and deal with market changes. By using big data and AI, they help predict and avoid supplier disruptions.

Digital Twins make it possible to interact virtually with suppliers and market conditions, helping companies spot changes early and adapt strategies swiftly. This capability is essential in maintaining Supply Chain resilience and optimizing cost efficiency. Additionally, discussions show that Digital Twins can significantly improve pricing and risk management by creating insights on tier-n supplier risks and pricing. They also encourage suppliers to deliver high-quality data and become active parts of the ecosystem.

Sumit Kumar, Director Supply Chain & Network Operations at Deloitte India, highlights:

"The ability to accurately model existing Supply Chain structures helps identify bottlenecks and inefficiencies, enabling order schedule optimization, supplier negotiation improvement, and cost reduction."

However, the success of Digital Twins in procurement heavily relies on the data literacy of all stakeholders involved. Smaller suppliers may need support in developing the necessary digital skills required for effective participation.

To tackle these challenges, organizations are focusing on improving how users enter data and offering educational programs to boost digital skills. The goal is to build a collaborative and informed network that unlocks the full potential of Digital Twins. This supports innovation and efficiency in procurement like never before, enabling a transition from traditional practices to a more integrated and proactive procurement model.



Renewable energy

Digital Twins give a clear overview of procurement spending. By adding data such as price indices, competitive supply conditions, and links between suppliers and materials, companies can spot opportunities for automation, track performance, and set priorities. This gives procurement teams room to focus on crucial areas and optimize their procurement portfolios for cost, inventory, risk, or carbon footprint.

In a renewable energy use case, a Digital Twin was used to maximize the value of a capital project. This was done by optimizing the inbound Supply Chain to minimize cost overrun and project delay. Similar projects resulted in cost savings between 3% and 6%.



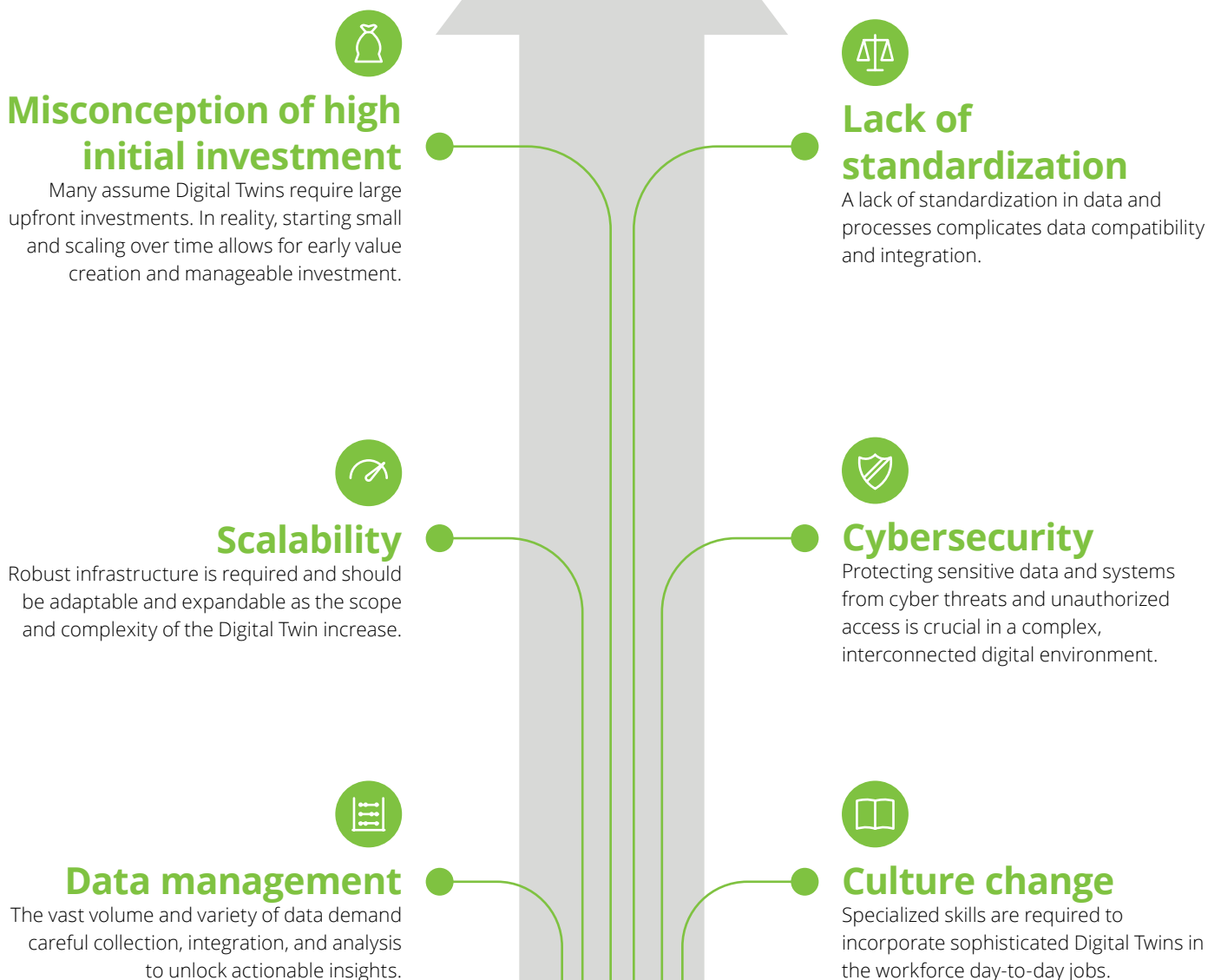
Food and beverages

Digital Twins are increasingly used in procurement to better anticipate and manage risks. By creating virtual versions of real systems, they allow for real-time monitoring and simulation. This helps procurement leaders foresee potential issues early and make smarter decisions to address risks and improve strategies.

In the food industry, Digital Twins are particularly valuable for managing perishable goods. By tracking the condition and location of these goods across the Supply Chain, businesses can predict shelf life more accurately. This helps with smarter sourcing, better inventory rotation, and efficient distribution. As a result, food distributors are better equipped to maintain product quality and minimize waste.

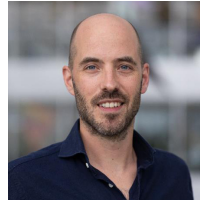
The journey towards a successful transformation

Key challenges



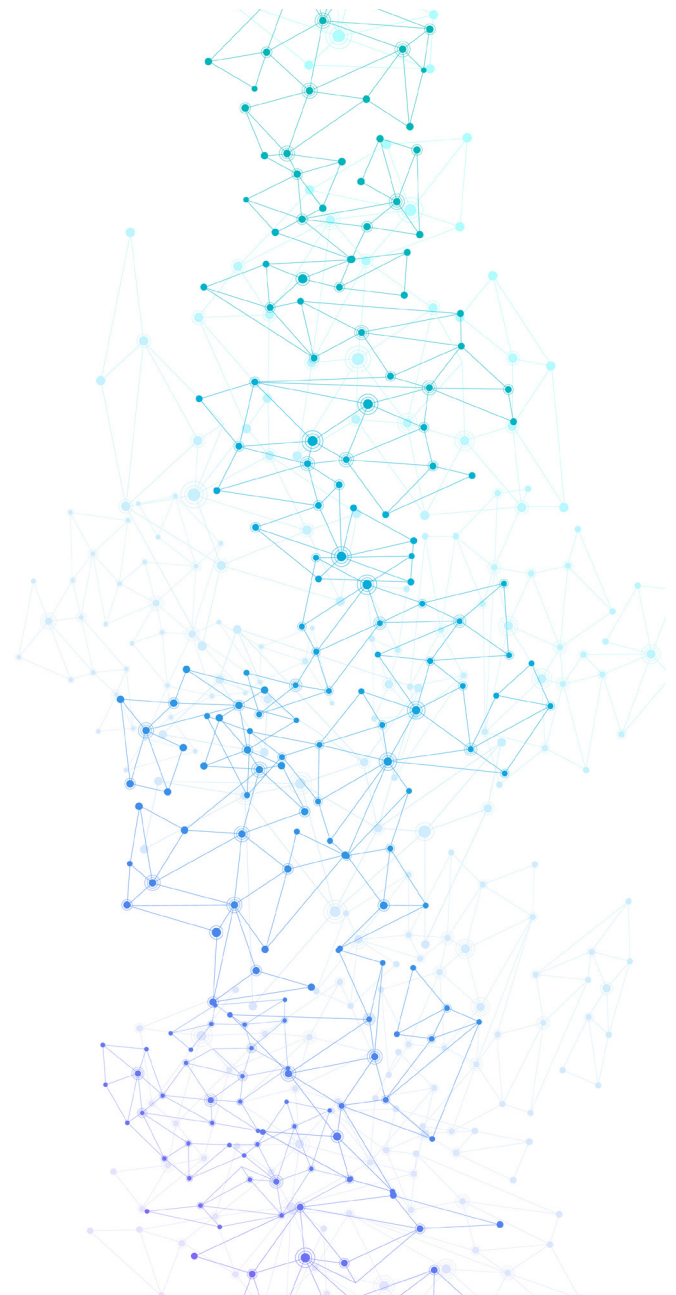
Expert opinion on challenges

“It is important to understand the ‘why’ behind the Digital Twin, and to **understand what value it can create**. With that, a **good business case is crucial as it lays the foundation for our implementations**. It is also important to start with a use case for which the value is obvious. This means that the initial business case can cover the costs to unlock the data. While the first use case may require a larger spend, all **further use cases will require lower investments** as the fundamental investments in unlocking the data and cybersecurity, for example, have already been made and need not be repeated.”



Daan Hoevers

Cloud and IoT Strategy & Architecture Lead
Internet of Things Specialist
Deloitte The Netherlands



Implementation complexities and how Deloitte can help

Implementing Digital Twins can be complex and requires a clear strategy and strong execution. By leveraging our interdisciplinary expertise and orchestration capacities spanning AI, cloud engineering, cybersecurity, and change management, in combination with our expertise on Supply Chains, Deloitte is uniquely positioned to tackle the multifaceted challenges of Digital Twin projects.

Supply Chain & Network Operations

Applies their deep understanding of Supply Chain dynamics to optimize Digital Twin implementations. They tailor each solution to boost performance and help organizations stay competitive.

Cloud Engineering

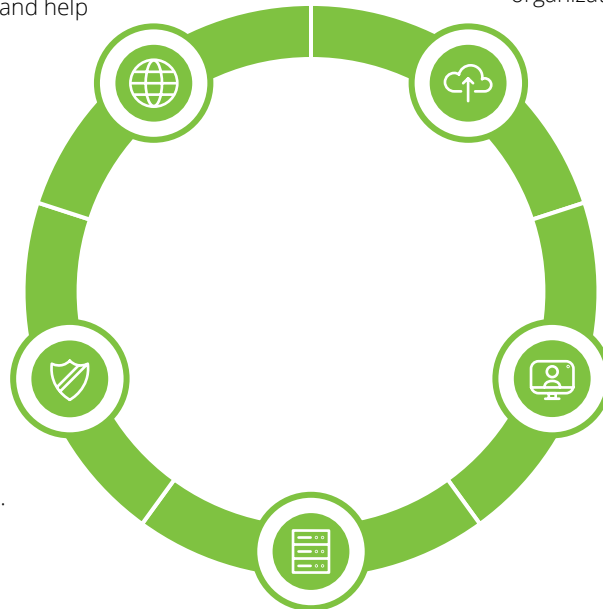
Designs scalable and robust cloud infrastructures that support the growth of Digital Twins. This allows for smooth integration of new features as your organization evolves.

Human Capital

Develops the right skills within your workforce through focused training. By combining this with insights from other teams, they help build confidence in using Digital Twin technologies and promote a culture of digital innovation.

Cybersecurity

Fortifies the security of Digital Twins, protecting sensitive data and systems from cyber threats. They implement strong security measures to maintain the integrity and confidentiality of your digital assets.



Artificial Intelligence & Data

Powers Digital Twins with the latest algorithms and intelligence. Addresses data management and standardization issues. They streamline data processes and integrate governance frameworks to ensure data is usable and consistent across systems.

Key success factors

We see a future where Digital Twins help shape the ‘Industrial Metaverse’—a new way of working that transforms how we design, run, and improve physical operations. Virtualization is the next big step, offering unmatched ease of use, clarity, and efficiency at scale.

The Industrial Metaverse refers to a virtual world where physical and digital systems come together to create a smooth, connected experience. It allows businesses to simulate, collaborate, and improve their operations in real-time, leading to better performance, higher productivity, and more innovation. On the path to this future, we’ve defined five stages of maturity that a Digital Twin goes through:

Status Quo	Enabled by Metaverse technology within this decade		Outlook for the upcoming years	
1	2	3	4	5
Virtual Twin A realistic visualization of the environment based on AI supported scanning and slicing. 3D models of machines and factories.	Simulation Twin The Digital Twin can be used to simulate new processes and identify efficiency gains. Therefore, processes are virtualized.	Connected Twin Connection between data stream of real assets and virtualization. Overarching machine management system based on kinematic and movement data.	Smart Twin Leveraging twins to create synthetic data for predictive purposes. Proactive decision-making based on simulation and generated data.	Autonomous Twin Immersive environment which is driven by autonomous micro-decisions and self-optimization. Human oversees and intervenes when necessary.

In relation to the Industrial Metaverse, Inge Crauwels, Director Artificial Intelligence & Data at Deloitte The Netherlands, explains:

“Start with high value initiatives. Design a thin IT architecture concept. Implement a data-driven culture. Work with open technologies that are common to allow for lower cost resourcing.”

In the industrial metaverse, the true power of Digital Twin emerges when it is implemented with Decision Intelligence thinking, a methodology that stimulates and streamlines insight-driven decisions. It models the decision-making process by identifying events and trade-offs, assessing impact of each scenario, recommending best mitigation option and streamlining stakeholder alignment. We will provide our point of view on Decision Intelligence in our next article.

Actionable steps for organizations to kickstart their Digital Twin transformation

To handle the significant upfront investment in Digital Twins, organizations should take a phased approach. By breaking the transformation into smaller, actionable steps, the financial load can be spread over time. This makes the implementation more flexible and the investment easier to manage. It also allows for early wins, helping to ensure the overall success of the transformation.



Activate your Digital Twin strategy with Deloitte

Contact info



Naser Bakhshi

nbakhshi@deloitte.nl
Partner Artificial Intelligence & Data
Deloitte, The Netherlands



Marc den Boogert

mdenboogert@deloitte.nl
Director Supply Chain & Network Operations
Deloitte, The Netherlands



Dario Raffaele

draffaele@deloitte.nl
Director Artificial Intelligence & Data
Deloitte, The Netherlands



Stan Fransen

stfransen@deloitte.nl
Manager Supply Chain & Network Operations
Deloitte, The Netherlands



Tom de Valk

tdevalk@deloitte.nl
Consultant Artificial Intelligence & Data
Deloitte, The Netherlands



Floris Ganzeboom

fganzeboom@deloitte.nl
Consultant Supply Chain & Network Operations
Deloitte, The Netherlands

Appendix

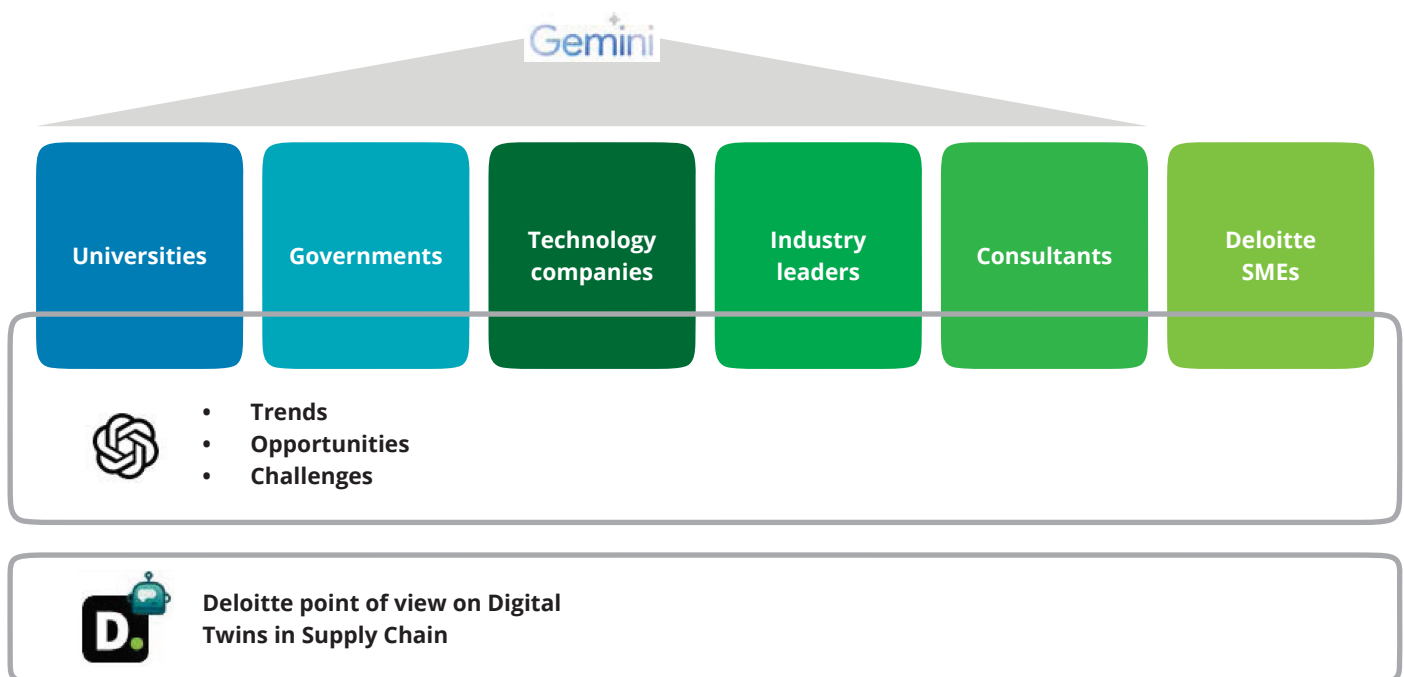
Methodology

In the rapidly evolving digital technology landscape, Digital Twins are key innovations. A comprehensive literature review helps us understand current trends, opportunities, and challenges. We combine insights from academia, industry reports, and expert analyses to maintain an updated knowledge base.

Our data collection followed two main methods. We used Google Gemini to gather relevant sources across sectors, supplemented by a manual search that included Deloitte's own resources. We also interviewed Deloitte's global experts to gain practical insights into the applications and future of Digital Twins. To extract data—and to showcase the potential of technological like generative AI—we used OpenAI's ChatGPT along with an automated Python script to summarize the literature efficiently. We focused on key

topics such as trends and challenges. We applied strict validation checks to ensure accuracy. These summaries helped shape the targeted questions for our expert interviews. When drafting the report, we carefully analyzed both the AI-generated summaries and expert insights. Each piece of information was reviewed for clarity and relevance. With support from Deloitte Headstart*, we refined experts' responses to uncover deeper insights, creating a solid base for our strategic report on Digital Twins in the Supply Chain.

This structured approach ensures our report is both current and forward-looking, offering a well-rounded view that includes expert predictions about the future of Digital Twins in the Supply Chain.



* Deloitte Headstart is an advanced generative AI tool designed for internal use at Deloitte, aimed at generating content, answering questions, and providing insightful information to support business operations and decision-making.

Sources

Our data collection led to a strong set of over 80 diverse sources from consulting firms, government bodies, universities, industry leaders, and technology companies—all published within the past five years. These sources offer an up-to-date view of the Digital Twin market, specific use cases from various industries, and insights into the future adoption and implementation. This wide range of sources provides a broad perspective on the present state and potential advancements of Digital Twins, helping us understand their impact across different sectors.

“The data collection led to over 80 online sources, enhanced with insights from Global Deloitte experts”

Alongside these written sources, our research was significantly enhanced by insights from numerous Deloitte experts from our global Deloitte network. These interviews provided practical insights into the application of Digital Twins across various client projects, illustrating real-world trends, opportunities, and challenges.

Our experts’ deep knowledge, coupled with their direct engagement in implementing Digital Twin technologies, brought valuable perspectives grounded in real-world situations and a nuanced understanding of client needs and industry dynamics. This first-hand knowledge from our professionals not only validated findings from secondary sources but also added a layer of strategic depth to our analysis, based on actual project experiences and client interactions.

Together, these two research approaches provide a well-rounded and informed perspective on Digital Twins, highlighting both theoretical frameworks and practical applications.



Sources

- 5 ways Digital Twinning will revolutionize logistics, DHL, 2019, <https://lot.dhl.com/5-ways-digital-twinning-will-revolutionize-logistics/>
- Abouzid, I., Saidi, R., Digital Twin Implementation Approach in Supply Chain Processes, Scientific African, 2023
- Adami, M., Nowak, M., Toelen, M., Valle, C., Van der hasselt, A., Weinmann, A., The strategic promise of Digital Twins to enhance Supply Chain resilience, PwC, 2023
- Anderson, A., Digital Twins In Decision-Making: Reaping The Benefits And Overcoming The Challenges, Forbes, 2024, <https://www.forbes.com/sites/forbestechcouncil/2024/03/12/digital-twins-in-decision-making-reaping-the-benefits-and-overcoming-the-challenges/>
- Argolini, R., Bonalumi, F., Deichmann, J., Pellegrinelli, S., Digital Twins: The key to smart product development, McKinsey & Company, 2023, <https://www.mckinsey.com/industries/industrials-and-electronics/our-insights/digital-twins-the-key-to-smart-product-development>
- Ashoosh, C., Kalyanaram, H., Digital Twin technology and its benefits for the retail industry, PwC, 2022
- Ashraf, M., Etlawil, A., Ali, I., Disruption Detection for a Cognitive Digital Supply Chain Twin Using Hybrid Deep Learning, Egypt-Japan University of Science and Technology, University of Alexandria, 2023
- Borden, K., Herlt, A., Digital Twins: What could they do for your business?, McKinsey & Company, 2022, <https://www.mckinsey.com/capabilities/operations/our-insights/digital-twins-what-could-they-do-for-your-business>
- Borden, K., Herlt, A., Lajous, T., Rowshankish, K., Zimmel, R.W., What is digital-twin technology?, McKinsey & Company, 2023, <https://www.mckinsey.com/featured-insights/mckinsey-explainers/what-is-digital-twin-technology>
- Buck, S., The Complete Guide To Supply Chain Digital Twins, Coupa, 2022, <https://www.coupa.com/blog/supply-chain/complete-guide-supply-chain-digital-twins>
- Byrnes, K., LOWE's Unveils Industry-First Digital Twin, Giving Associates 'Superpowers' to Better Serve Customers, Lowe's, 2022, <https://corporate.lowes.com/newsroom/press-releases/lowes-unveils-industry-first-digital-twin-giving-associates-superpowers-better-serve-customers-09-20-22>
- Camarella, S., Conway, M. P., Goering, K., Huntington, M., Digital Twins: The next frontier of factory optimization, McKinsey & Company, 2024, <https://www.mckinsey.com/capabilities/operations/our-insights/digital-twins-the-next-frontier-of-factory-optimization>
- DeLallo, D., Digital Twins:How to build the first twin, McKinsey & Company, 2022, <https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/digital-twins-how-to-build-the-first-twin>
- Deshpande, R., Tech Trend 04: Digital Twins: Creating intelligent industries, EY, 2024, https://www.ey.com/en_in/technology/digital-twins-creating-intelligent-industries
- Dharmani, S., Lulla, S., How Digital Twins give manufacturers a real-world advantage, EY, 2020, https://www.ey.com/en_nl/advanced-manufacturing/how-digital-twins-give-automotive-companies-a-real-world-advantage
- Dialani, M., Digital Twins—Transforming Supply Chains and Operations, IDC, 2022
- Digital Twins in Logistics, DHL
- Dohrmann, K., Digital Twins Have Come Alive in Logistics, DHL
- Feenstra, S., Bakhski, N., den Boogert, M., Sterkman, C., Raffaele, D., Bom, S., Did you say Supply Chain Digital Twin?, Deloitte, 2023
- Fonarov, O., Digital Twins And Their Role In Shaping The Future Of Manufacturing, Forbes, 2024, <https://www.forbes.com/sites/forbestechcouncil/2024/03/01/digital-twins-and-their-role-in-shaping-the-future-of-manufacturing/>
- Fortune Business Insights, Digital Twin Market Size, Share & Industry Analysis, By Type (Parts Twin, Product Twin, Process Twin, and System Twin), By Application (Predictive Maintenance, Business Optimization, Product Design & Development, and Others), By Enterprise Type (Large Enterprises and SMEs), By End-user (Aerospace & Defense, Automotive & Transportation, Manufacturing, Healthcare, Retail, Energy & Utilities, Real Estate, IT and Telecom, and Others), and Regional Forecast, 2024-2032, 2025, <https://www.fortunebusinessinsights.com/digital-twin-market-106246>
- Galea-Pace, S., The evolution of Digital Twins in Supply Chain, SupplyChainDigital, 2020, <https://supplychaindigital.com/technology/evolution-digital-twins-supply-chain>
- Gazula, N., Digital Twins: Catalyst for transformative infrastructure, KPMG, 2023, <https://kpmg.com/xx/en/blogs/home/posts/2023/10/digital-twins-catalyst-for-transformative-infrastructure.html>
- Geissbauer, R., Schrauf, S., Schneider, J., Hermans, M., Connected and autonomous Supply Chain ecosystems 2025, PwC, 20
- Gibbons Paul, L., Howells, R., How Digital Twins Are Driving the Future of Business, SAP, 2022
- Gollings, M., Brown, L., Lee, S., Ott, P., Yurchisin, M., Levo, T., Military readiness through Supply Chain resilience, Accenture, 2023
- Gollings, M., Creating the Environment for Digital Twins to Super Charge Defense Supply Chains, Government Technology Insider, 2023
- Hayhurst, C., Digital Twins Gain Steam with Federal Agencies, FedTech, 2023, <https://fedtechmagazine.com/article/2023/05/digital-twins-gain-steam-federal-agencies>
- Henrich, J., Li, J.D., Mazuera, C., Perez F., Future-proofing the Supply Chain, McKinsey & Company, 2022
- Hofman, H., Four ways Digital Twins will shake up logistics, Maersk, 2023, <https://www.maersk.com/insights/digitalisation/2023/01/31/digital-twin>
- Jonas, I., The Take: Enriched by Real-Time Data, Digital Twins Thrive in Resilient Supply Chains, SAP, 2023, <https://news.sap.com/2023/01/the-take-resilient-supply-chains-digital-twins/>
- Junghanns, J., Digital Twin within Supply Chain—The Benefits, Capgemini, 2021, <https://www.capgemini.com/insights/expert-perspectives/digital-twin-within-the-supply-chain-the-benefits-2/>
- Klar, R., Fredriksson, A., Angelakis, V., Digital Twins for Ports: Derived from Smart City and Supply Chain Twinning Experience, Linköping University, Swedish National Road and Transport Research Institute
- Koshulko, A., How Digital Twins Can Help Supply Chains Survive Disruption, Forbes, 2022, <https://www.forbes.com/sites/forbestechcouncil/2022/06/21/how-digital-twins-can-help-supply-chains-survive-disruption/>
- Kumpf, R., Yankovitz, D., Hussaln, A., Reducing carbon, fueling growth: Lowering emissions in the chemical industry, Deloitte, 2022, <https://www2.deloitte.com/us/en/insights/industry/oil-and-gas/chemical-industry-emissions-reduction.html>
- Kyle, S., Rosales, A., Why Digital Twins are not the future of Supply Chains, they are the present, Deloitte, 2023, <https://www.deloitte.com/au/en/services/consulting/blogs/why-digital-twins-not-future-supply-chains-they-are-present.html>
- Lagunas, J., Making a Digital Twin work for your Supply Chain, Accenture, 2021, <https://www.accenture.com/us-en/blogs/business-functions-blog/making-a-digital-twin-work-for-your-supply-chain>
- Laybourne, G., Transforming decision making in Supply Chain logistics with Digital Twins, Maersk, 2023, <https://www.maersk.com/news/articles/2023/01/20/transforming-decision-making-in-supply-chain-logistics-with-digital-twins>
- Le, T.V., Fan, R., Digital Twins for Logistics and Supply Chain Systems: Literature Review, Conceptual Framework, Research Potential and Practical Challenges, Purdue University, 2023
- Lind, M., Lehmacher, W., Watson, R.T., Van Gogh, M., How Digital Twins can help navigate Supply Chain disruption, The World Economic Forum, 2024
- Liu, J., Yeoh, W., Qu, Y., Gao, L., Blockchain-based Digital Twin for Supply Chain Management: State-of-the-Art Review and Future Research Directions, Deakin University
- Logistics Digital Twin, Siemens, 2024, <https://plm.sw.siemens.com/en-US/digital-logistics/consulting/logistics-digital-twin/>
- Lugaresi, G., Jemai, Z., Sahin, E., Digital Twins for Supply Chains: Current Outlook and Future Challenges, Laboratoire Genie Industriel, CentraleSupélec, 3 Rue Joliot Curie, 91190 Gif-sur-Yvette, France, 2023
- Lulla, S., Anand, D., CanaSupply ChainDigital Twinmakeoutweasagile?, EY, 2021, https://www.ey.com/en_gl/insights/advanced-manufacturing/can-a-supply-chain-digital-twin-make-you-twice-as-agile
- Manickam, S., Yarlalagadda, L., Padinjappurathu Gopalan, S., Lal Chowdhary, C., Unlocking the Potential of Digital Twins: A Comprehensive Review of Concepts, Frameworks and Industrial Applications, Vellore Institute of Technology, 2023
- McLaren Racing and Deloitte to prioritize sustainability in latest multi-year collaboration, Deloitte
- McLaren racing continues collaboration with Deloitte, Deloitte
- Modabber, H., Digital Building Twins, Bosch, https://www.boschbuildingsolutions.com/x/en/news-and-stories/digital-building-twins/?gad_source=1&gclid=Cj0KCQjwwYswBhDcARsAOyL0fgg8DS5TcA4asmgHl9A8iHfro2HbhhE50pIX7-Rg9-l-u8p42chUxAAASHIEALw_wcB
- Noble, P.J., Digital Twins: Technology For The Supply Chain, Forbes, 2022, <https://www.forbes.com/sites/paulnoble/2022/10/31/digital-twins-technology-for-the-supply-chain/>
- Nolan, M., Accenture and MIT Team to Create a Supply Chain Resilience Stress Test, Accenture, 2020, <https://newsroom.accenture.com/news/2020/accenture-and-mit-team-to-create-a-supply-chain-resilience-stress-test>
- Parrott, A., Umbenhauer, B., Warshaw, L., Digital Twins: Bridging the physical and digital, Deloitte, 2020, <https://www2.deloitte.com/uk/en/insights/focus/tech-trends/2020/digital-twin-applications-bridging-the-physical-and-digital.html>
- Parrott, A., Warshaw, L., Industry 4.0 and the Digital Twin, Deloitte, 2017
- Peladarinos, N., Piromalis, D., Cheimaras, V., Tserapas, E., Munteanu, R.A., Papageorgas, P., Enhancing Smart Agriculture by Implementing Digital Twins: A Comprehensive Review, University of West Attica, 2023
- Pettey, C., Prepare for the Impact of Digital Twins, Gartner, 2017
- Phipps, S., Digital Twin: How Can It Facilitate Large-Scale Innovation?, Slimstock, 2023, <https://www.slimstock.com/blog/digital-twin/>
- Porter, S., Thomson, J., Wellener, P., Sanborn, S., Smart energy management for industrials, Deloitte, 2021, <https://www2.deloitte.com/us/en/insights/industry/power-and-utilities/smart-energy-management.html>
- Pratt, A., Reich, A., Hyltegard, R., Revolutionizing the retail Supply Chain with Digital Twins, Microsoft, 2021, <https://www.microsoft.com/en-us/industry/blog/retail/2021/01/26/revolutionizing-the-retail-supply-chain-with-digital-twins/>
- Quintanilla, G., What is a Digital Supply Chain Twin and How can it Support Your Strategic Decisions?, AIMMS, 2022, <https://www.aimms.com/story/what-is-a-digital-supply-chain-twin-and-how-can-it-support-your-strategic-decisions/>
- Sathyannarayanan, B., Digital Twin-driven adaptive Supply Chain, TCS, <https://www.tcs.com/insights/blogs/supply-chain-transformation-digital-twin>
- Schuster, R., Nath, G., Mitjavila, L., Conquering Complexity in Supply Chains with Digital Twins, BCG, 2020, <https://www.bcg.com/capabilities/operations/conquering-complexity-supply-chains-digital-twins>
- Smith, J., Unilever Uses Virtual Factories to Tune Up Its Supply Chain, Unilever, 2019
- Sonnenburg, H., Building Resilience: How Digital Twins Deliver the Holy Grail of Connected Supply Chains, Siemens, 2022, <https://www.siemens-advanta.com/blog/digital-twin-supply-chain>
- Srinivasan, G., Gupta, R., Mittal, N., Nanda, R., Perricos, C., Nuttall, K., A new frontier in artificial intelligence, Deloitte, 2023
- Stuijt, L., Towards Digital Twins for Real-time Control in Reversed Supply Chain Operations, TU Delft, 2021, <https://repository.tudelft.nl/islandora/object/uuid%3A14ee57ca-0a20-475a-b936-436d0913a574>
- Sustaining Value from an Advanced Digital Supply Chain, BCG, 2024, <https://www.bcg.com/capabilities/operations/digital-supply-chain>
- The Digital Twin, Siemens, 2021
- The Digital Twin, Siemens, <https://resources.sw.siemens.com/en-US/white-paper-the-digital-twin>
- Toaznli, O., Saney, M. J., Unlocking the Potential of Digital Twins in Supply Chains, MIT Sloan Management Review, 2022
- Tzachor, A., Richers, C.E., Jeon, S., Transforming Agrifood Production Systems and Supply Chains with Digital Twins, University of Cambridge, Reichman University, Alan Turing Institute
- Unilever sites join network of world's most digitally advanced factories, Unilever, 2023, <https://www.unilever.com/news/news-search/2023/unilever-sites-join-network-of-worlds-most-digitally-advanced-factories/>
- Van der Valk, H., Strobel, G., Winkelmann, S., Hunker, J., Tomczyk, M., Supply Chains in the Era of Digital Twins—A Review, International Conference on Industry Sciences and Computer Sciences Innovation, 2022
- Vieweger, T., RFID: a Digital Twin to create better Supply Chain visibility?, NEDAP, 2022, <https://www.nedap-retail.com/rfid-a-digital-twin-to-create-better-supply-chain-visibility/>
- What a Digital Twin is and how you can contribute, Department for Business & Trade
- Xu, L., Schoepf, S., Mak, S., Digital Twins for Supply Chains, University of Cambridge, 2016, <https://www.ifm.eng.cam.ac.uk/research/supply-chain-ai-lab/current-themes/supply-chain-digital-twins/>



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