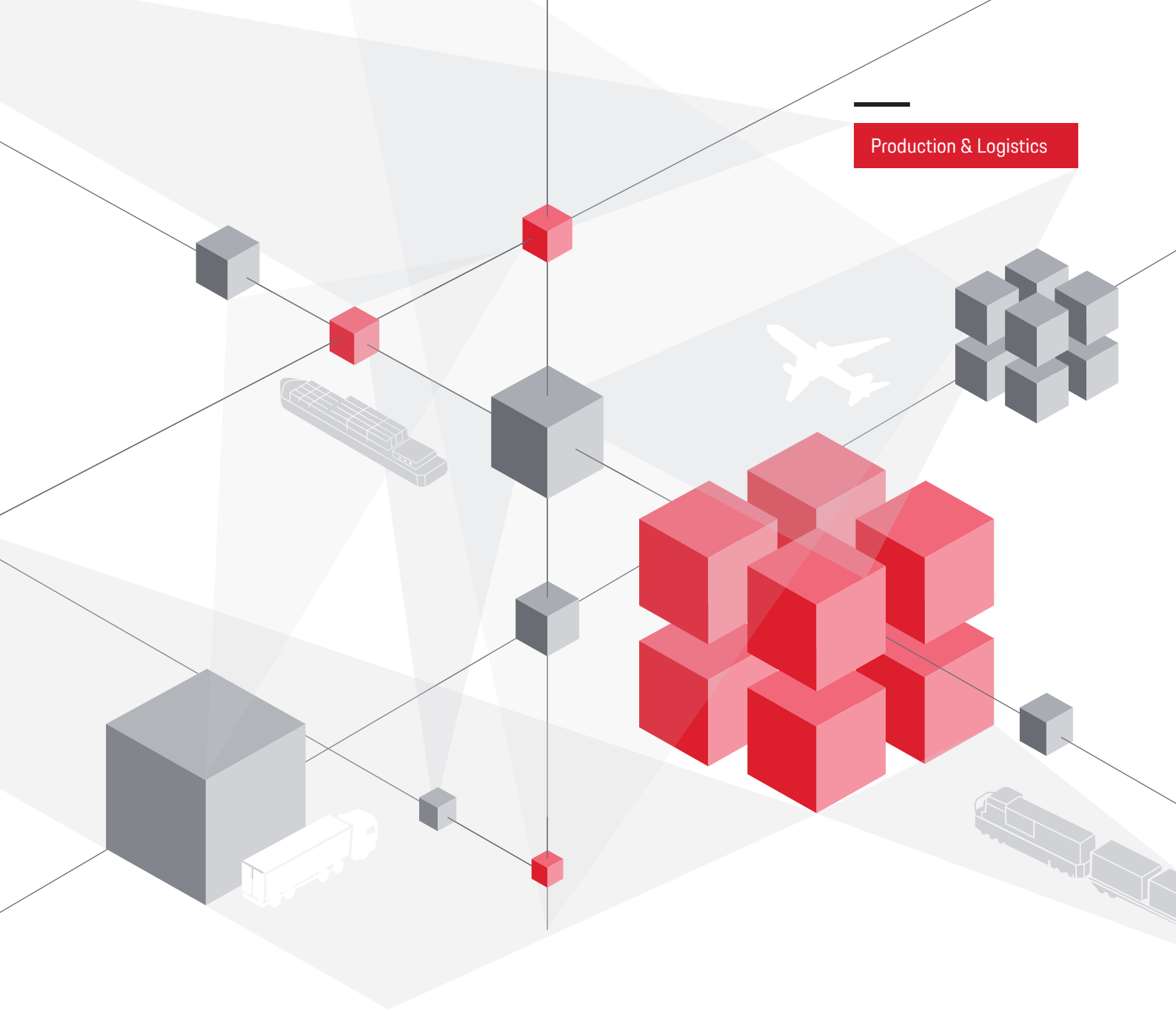


Production & Logistics

Boosting Collaboration across Tomorrow's Supply Chains

How Blockchain will help to improve speed, costs and quality in Supply Chain Management

Porsche Consulting
Strategic Vision. Smart Implementation.

INSIGHTS

//01

Blockchain technology can positively disrupt supply chains.

//02

Use cases can be found within all SCM business functions.

//03

Porsche Consulting has developed an integrated approach for implementing successful Blockchain applications.

01 | Introduction

Effective supply chain management provides the right part in the right quality at the right time and place. Consumers have become used to a choice of specifications and highly individualized products, so supply chains need to be both flexible and cost efficient. This presents a challenge to supply chain managers, who plan and handle volatile customer demand and short-term disturbances in parts provision. Nowadays, corporate supply chains are grown truly globally, with various suppliers of raw material, distributed processing steps, multiple manufacturers, and logistics service providers. If processes and tools are not intertwined properly, the increased complexity results in higher costs and a lower supply chain performance. To put this into perspective, a single shipment of goods from East Africa to Europe can require over 200 single interactions with more than 30 stakeholders, creating a stack of papers ten centimeters tall. The administrative costs can be as high as those for the shipment and prolong the delivery time significantly.[1]

Supply chain managers choose various tools to maintain a competitive level of service. Possible measures to cope with the challenges include selecting new service providers, using enhanced warehouse systems, or automating material handling steps. However, these tools do not address the root cause of increased complexity. Trust and transparency are required to speed up supply chains and cut costs. This is achieved by sharing relevant data, ideally in real time. Multiple parties currently store the necessary information fragmentally along the value-creation process in individual data silos. In addition, a conflict of interest might result if data needs to be shared with process partners. Nevertheless, trust and accessible information is crucial for everyone involved. This allows further improvement, such as self-adjusting procurement decisions, the automation of material planning and accounting as well as assured traceability along the production processes and in after-sales activities. A new tool may present a solution to unlock the potential: Blockchain.

In recent years, Blockchain, or distributed ledger technology (DLT), has risen with the promise of being a "trust machine." Interest in the technology was aroused with Bitcoin and peaked with the current cryptocurrency boom. The same technological innovations that allow financial transactions to be performed without a bank, however, foster trust and transparency in many other verticals.[2] Trusted and accessible information represents a lever for increasing flexibility and efficiency in production with complex processes and multiple distribution partners. When applied as the informational backbone of a logistics network, Blockchain has the potential to disrupt supply chains in a positive way.

This white paper examines the potential of supply chain management to leverage the capabilities of a Blockchain. Relevant documents on Blockchain and supply chain management have therefore been analyzed, and a comprehensive survey of 50 experts at the Blockchain Expo Europe 2019 has generated further insights into its application.

READING THIS PAPER WILL ...

- **Provide a brief overview of how a Blockchain works**
- **Discuss its current reception among industry experts**
- **Present 18 use cases within the scope of supply-chain business functions**
- **Examine four use cases in each Blockchain lever**
- **Introduce Porsche Consulting's approach to implementation**

02 | Technological Background

The first Blockchain concept hails back to the beginnings of computer science. Its first widespread implementation was Bitcoin, the famously infamous, highly volatile cryptocurrency. Introduced just after the global banking system meltdown in 2008, Bitcoin's technological concept allows online payment without requiring a bank to verify the transaction as an intermediary and avoids double-spending financial assets.[3] Meanwhile, Blockchain has moved far beyond Bitcoin and other cryptocurrencies, despite the technological concept remaining the same.

How does Blockchain work?

Blockchain is a ledger, distributed across a peer-to-peer network of computers and maintained by an algorithm that is based on game theory and secured using cryptography. A more detailed description of the setup is as follows (see Figure 1): A peer-to-peer network is a set of computers connected to each other, for example, via the internet. These computers, or nodes, operate as peers, with no central administrator or server. A copy of the information is stored on every computer instead. As a result, the network can only be manipulated by controlling more than 50 percent of the computers.[3]

Each node can broadcast new information (e.g., a Bitcoin transaction) to the network. The other nodes check whether the new information conflicts with previously stored elements and whether the node's credentials are valid. If there is no conflict in either case, the information is accepted and added to the ledger. This requires two steps: First, the new information is grouped with other new elements into a compilation or "block" of information. Second, the block is sealed or "hashed" by putting it through a cryptographic hash function. These hash functions are designed to create a unique output from a given input. The opposite direction — deriving the input from a given output — is currently next to impossible.[3] To further increase the level of security, the hash function receives not only the new information but also the output from hashing the previous block. This links the current block with the previous block, i.e. chains them together, hence the name Blockchain.

The process of hashing and chaining makes it nearly impossible to alter information once it has been stored. In combination with the information's initial verification, Blockchain provides the basis for distributed trust and transparency.

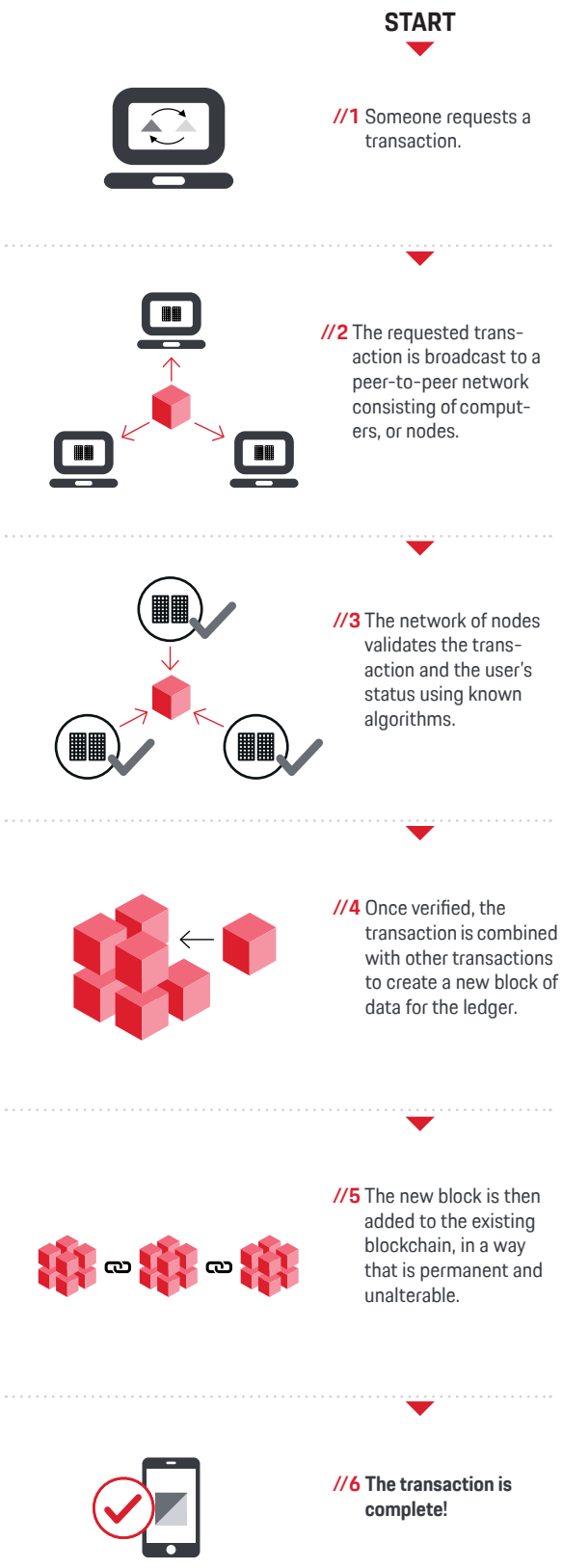


Fig.1 The fundamental Blockchain process

Blockchain 2.0 and 4.0

The technology as described refers to its development status as of the year 2008. In the meantime, Blockchain applications have become more advanced with additional features. These developments enable various use cases in other verticals and shift Blockchain's application from a solely financial context to an increasingly universal one, such as production ecosystems. Two main developments are of great interest for use cases in supply chain management:

- **Blockchain 2.0,**
  which introduces transaction automation, and
- **Blockchain 4.0,**
  which enables virtual representation of physical objects.

Blending different elements of Blockchain 2.0 and 4.0 presents levers for flexibility and efficiency potential in supply chain use cases.

BLOCKCHAIN 2.0

In 2015 the Blockchain protocol Ethereum introduced smart contracts — code snippets allowed to perform logical operations and used to automate the process. The term smart contract may be misleading, because it does not represent a legal contract. However, it could be used to automate legal obligations, such as changing the owner of property once payment has arrived.

BLOCKCHAIN 4.0

This setup makes Blockchains predestined to applications related to ownership, thereby bridging the digital and the physical. This field is often referred to as the Internet of Things (IOT) or Industry 4.0. Physical information must be broadcasted automatically to enable a seamless transition between both worlds.[4] The coming years will see the development of many Blockchain features related to end-to-end, itemized and automated data exchange.

Public, private, and consortium Blockchains

Most cryptocurrency Blockchains are entirely public by design. Anyone can see the stored information and register to write and validate transactions. This is feasible for a virtual currency, where value and acceptance depend on the size of its trusted network. For a company, however, disclosing information publicly may not be desirable. Two other options, private and consortium, are thus available to set up a trusted network in supply chain applications.

PRIVATE BLOCKCHAIN

Companies can set up their own private Blockchains as well as determine who is allowed to participate and which rights each participant has, for example, only allowing users to write new information. Validation and visibility are restricted to the company itself.

CONSORTIUM BLOCKCHAIN

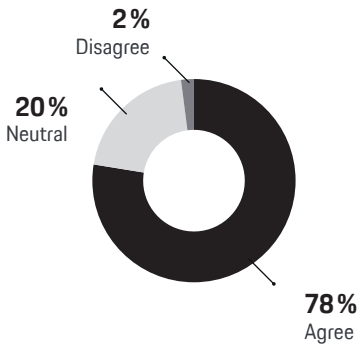
For many use cases, a consortium would be set up for centralization and control by a single company. A consortium Blockchain represents a compromise. Participation is only allowed by invitation. Once invited, however, the interaction is on a peer-to-peer basis and information is fully transparent.

Selecting a suitable Blockchain type is a process of negotiation and cooperation among all participants. Regarding the gathered, processed, and stored data, additional databases and applications are a solution to current challenges (e.g., federal privacy laws, data volumes, and reaction times). The Blockchain thereby acts as an information backbone, storing transactional fingerprints and private access keys as tokens for use in additional ecosystem functions.

03 | Value Proposition

Awakening the potential of Blockchain means putting theoretical concepts into practice. A survey among 50 industry experts was conducted at the Blockchain Expo 2019 in Amsterdam to gain insight into the current perception and appraisal of Blockchain use cases in supply chain management. They can be categorized into Blockchain solution providers (n: 29) and industry representatives (n: 21) who develop corporate use cases and pilots. The key results show that Blockchain is of high relevance to the industry. Among respondents, 78 percent believe that "Blockchain can positively disrupt today's supply chains."

Blockchain technology can positively disrupt supply chains

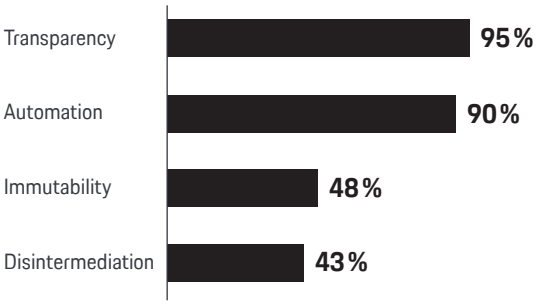


With an eye to specific fields of improvement, experts expect significant effects in processes and data: respondents agree that Blockchain applications are set to decrease labor costs (79 percent), decrease processing time (73 percent), and improve data quality (56 percent). Process automation through smart contracts and data gathering with IOT devices are considered main levers for success.

Benefits from deploying blockchain technology

The disruptive power of Blockchain is found in the decentralized storage and validation of information. This core innovation translates into four levers (see Figure 2) — transparency, automation, immutability, and disintermediation — which were ranked by industry representatives.

Blockchain levers about to positively disrupt supply chains



Transparency | The survey revealed that 95 percent of respondents see transparency as the most prominent Blockchain lever. Information is visible to every participant at any time, making Blockchain-backed supply chains highly responsive.

Automation | Among experts surveyed, 90 percent viewed smart contracts as important due to their automation of manual processes along the supply chain. The demand for dispatching and other indirect functions decreases significantly.

Immutability | The information saved on a Blockchain cannot be altered or corrupted retrospectively. Backward traceability reduces time spent and costs. Among respondents, 48 percent believe this will transform future supply chains.

Disintermediation | By decentralizing the validation of information, no third party needs to be involved in Blockchain-backed transactions. Fees for authorities and other institutions, such as banks, are reduced significantly.

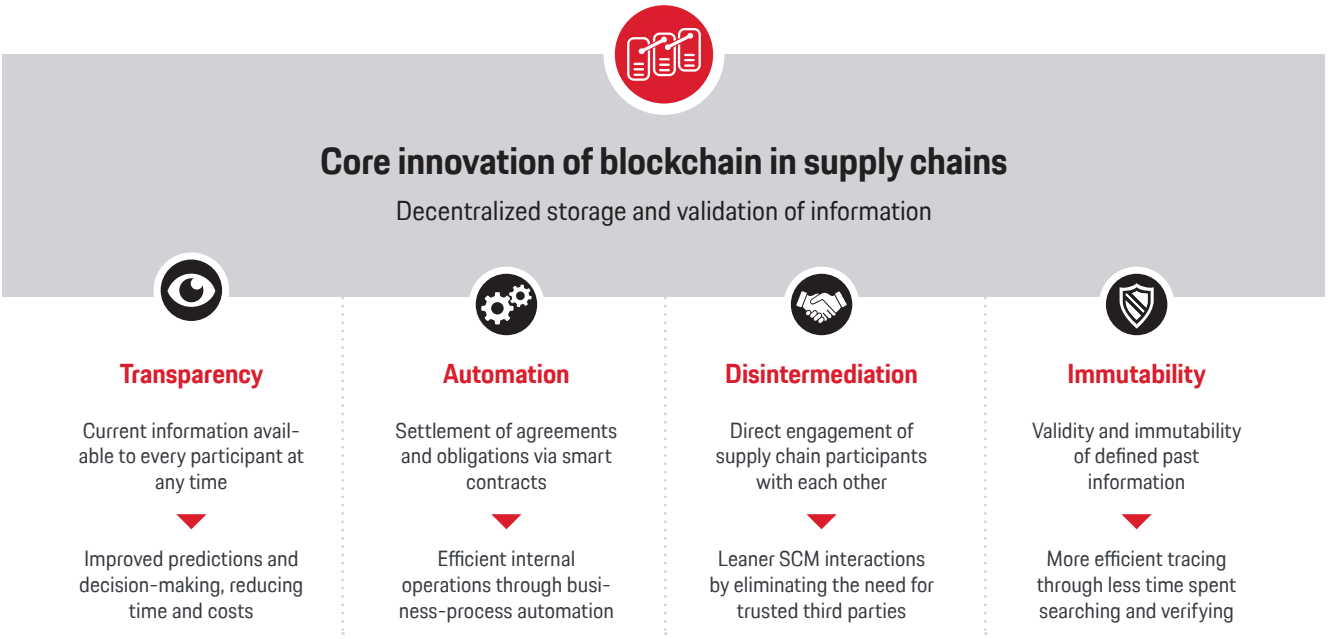
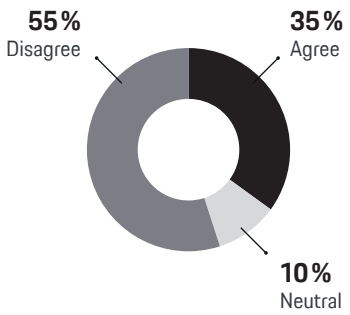


Fig 2. he four Blockchain levers for Supply Chain Management

Putting theory into practice

Notwithstanding its appeal, supply chain applications that successfully harness Blockchain are hard to find. Many industry representatives surveyed felt that current Blockchain technology was not ready for implementation in their logistics networks.

Blockchain is ready for supply chain applications



Those who had not experimented with Blockchain technology yet were skeptical of use cases and concepts and called a lack of overall understanding the most prominent hurdle. When asked about the reasons for this, the industry representatives referred to a lack of overall understanding among prospective corporate Blockchain participants. In addition, the negotiation process was also considered a major hurdle to rapid implementation.

On the other hand, one-third of respondents agreed that Blockchain was mature enough for use in supply chain applications. These participants had already experimented with Blockchain technology in small pilots. Open collaboration among participants and shared value creation were named as key success factors in the implementation of promising use cases.

Overall, experts and solution providers agreed that Blockchain-based logistics networks and specific use cases represented a future breakthrough.

04 | Use Cases

An analysis of relevant literature and in-depth interviews with supply chain experts have identified a set of 18 Blockchain use cases for supply chain management. Figure 3 presents a use case landscape, organized by Blockchain levers and supply chain management business functions. This provides initial guidance for supply chain managers to ideate individual corporate Blockchain applications. The relevance for each business function is described in the following.

Procurement should ensure high-quality supply at a competitive price. Automation and disintermediation are levers to keep costs low, while the immutable information on the Blockchain certifies safety and origin of the products purchased.

Logistics operations must function on schedule. Transparent information and automated decision-making make Blockchain-powered logistics operations faster and more accurate. Automated accounts clearing and payment processes are replacing manual efforts in **accounting**.

Once the final product is shipped, an immutable record of information ensures that after-sales can accompany the customer during services and warranty issues.

DO I NEED A BLOCKCHAIN?

- Despite its positive reception, blockchain may not always be the tool of choice.
- At this time, there is only a small number of large-scale implementations. In addition, there are various ledger systems, not all of them guaranteed to last. Implementing a blockchain is not a straight-forward software update but requires some instruction.
- Whether a use case is suitable for blockchain greatly depends on its characteristics. Various factors need to be considered, such as supply chain participants, IT systems, and third-party participants. Current technologies, such as a cloud solutions may be better suited to certain use cases. For others, however, blockchain promises a big leap.

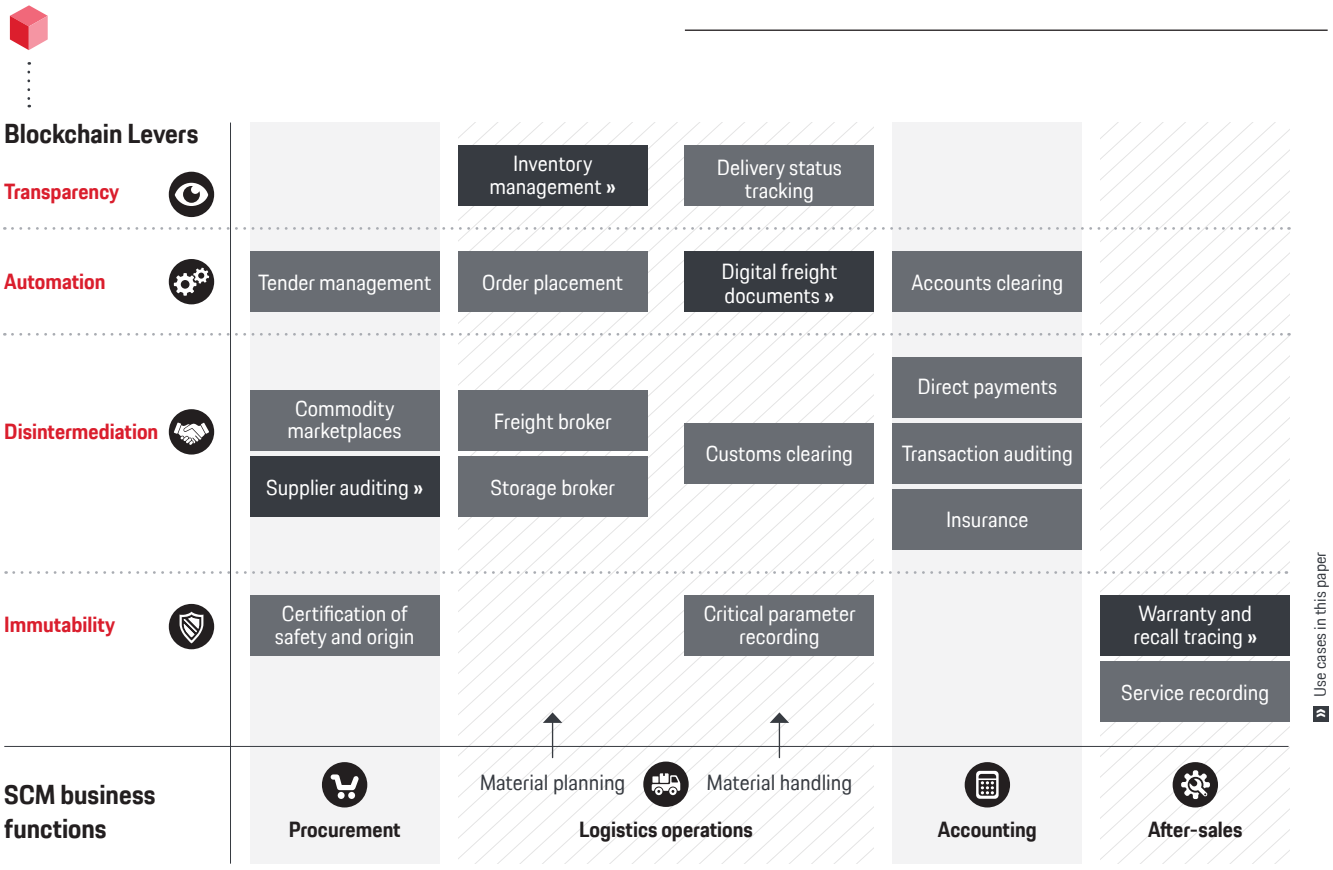


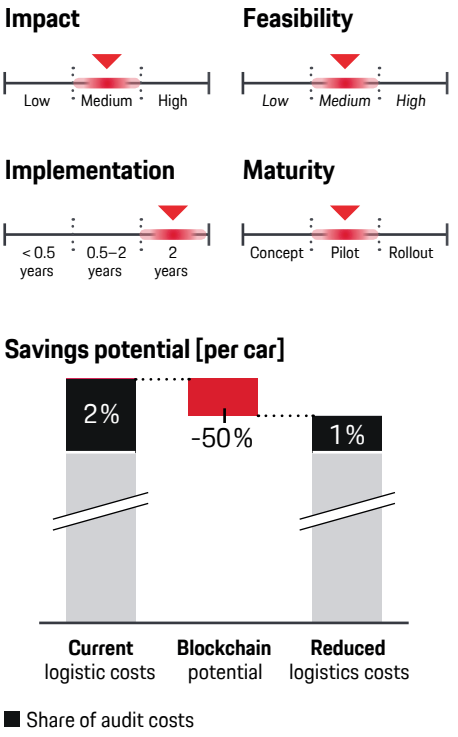
Fig 3. Landscape of use cases for Blockchain in Supply Chain Management

SUPPLIER AUDITING

IATF 16949 certification is an industry standard along automotive supply chains. Many original equipment manufacturers (OEM) also require individual certificates. Each certificate means suppliers must undergo costly and extensive audits. Blockchain-based auditing offers the possibility of sharing certificates among companies and across industries, thus reducing the need for audits and their associated costs.[5|6]

Audit costs are a part of the procurement budget and represent 2 percent of total logistics costs. By sharing audit results across supply chains, a potential savings of 50 percent on all audit-related costs was identified. The effect on total logistics costs is limited, but the total number of audited suppliers within the network is increased.

The maturity of this use case is still conceptual. Numerous OEMs would need to combine efforts to set up a Blockchain-based platform.

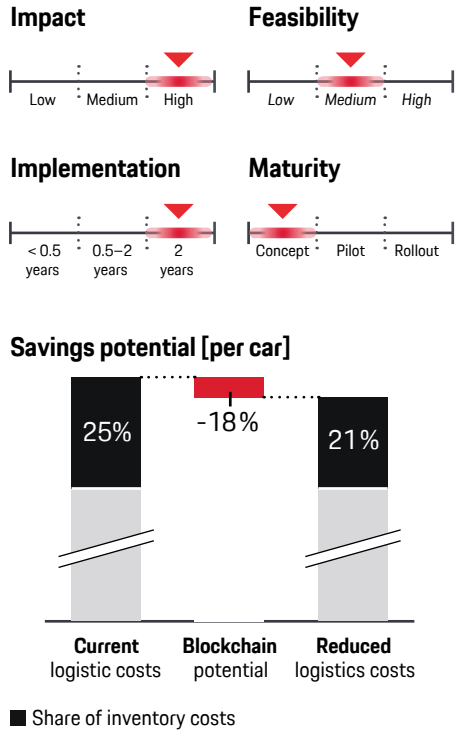


INVENTORY MANAGEMENT

Efficient inventory management reduces holding costs and minimizes stockouts. Suppliers and OEMs already share some information on inventory levels and future demand planning. This is known as collaborative planning and forecasting.

Using Blockchain technology helps to increase the information shared and the pace of further adaption. As a specification within the Blockchain application, zero-knowledge proof integration allows information sharing without disclosing actual inventory levels to partners and competitors.

Inventory holding costs represent a significant share (one-quarter) of total logistics costs. Improved inventory management based on transparent information and collaborative planning and forecasting reduces these costs by 10 percent to 18 percent, noticeably lowering total logistics costs.

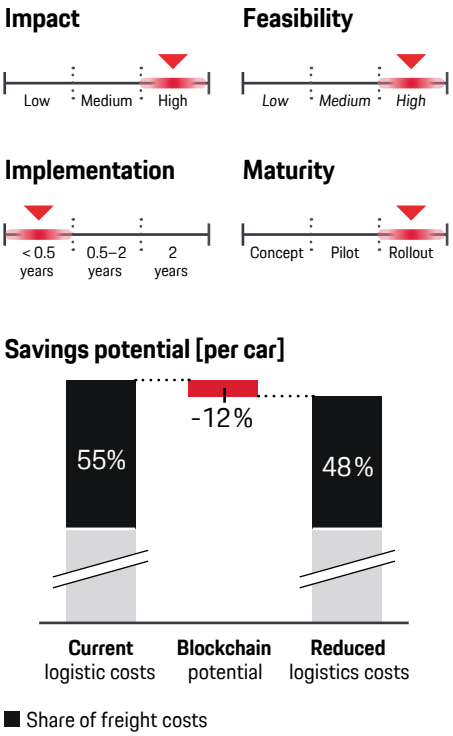


DIGITAL FREIGHT DOCUMENTS

Transportation accounts for the largest cost block in today's supply chains, representing over half of total logistics costs. Manually performed tasks, such as generating and handling paperwork, play a major role.[7]

In a Blockchain application, information currently found on paper-based freight documents is captured on the ledger instead. Access to the information is granted based on current ownership of the goods transferred and secured by item-linked token possession. Smart contracts enable automatic document updates and seamless exchange with governmental institutions and other third parties.

Eliminating the need for printing, handling, and manually checking documents reduces transportation costs by up to 12 percent and significantly lowers overall logistics costs.

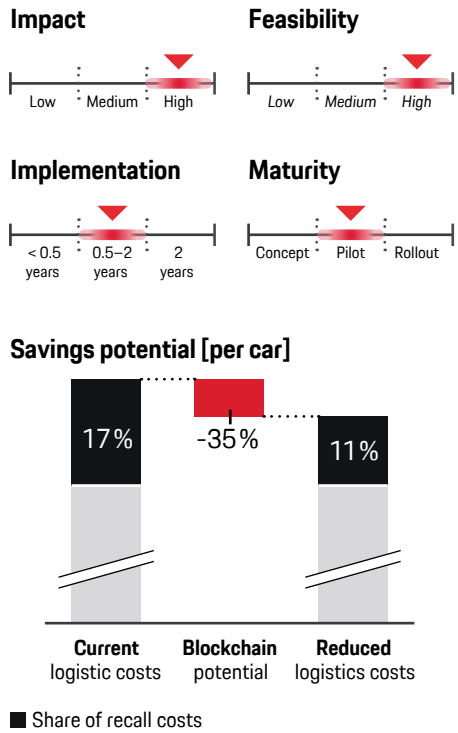


WARRANTY AND RECALL TRACING

This use case maps the entire value chain via Blockchain — starting with supplier integration and continuing with information on the manufacturing process, such as production conditions and materials or machines used.[8]

If products are recalled due to faulty components, the information stored on the Blockchain is used to trace the cause. This makes it possible to identify suppliers who may not have met quality standards. Above all, the manufacturer has the opportunity to precisely identify the vehicles affected by defective components.

Recalls currently account for as much as one-fifth of logistics costs. Faster and more effective recall tracing lowers these costs by 25 percent to 35 percent, reducing total logistics costs and process times.



05 | Implementation

The first successful pilots and commercial applications have proven Blockchain's capabilities in supply chain management. Transparency and automation are two areas with specific potential for double-digit savings, while maintaining speed and flexibility. A holistic and mutual-value proposition must be formulated to ignite all supply chain partners. Structured and open communication is therefore essential to aligning all partners and sharing the technology's benefits.

With Blockchain's disruptive power and value proposition at hand, the next step is initiating it. Porsche Consulting has developed an implementation guideline consisting of five phases and four supporting success factors (see Figure 4).

01 | Prepare
Blockchain will be new to most of those involved. During its implementation, it will be necessary to evaluate the technology's feasibility and communicate with technology providers and other partners. It is therefore crucial **to ensure sufficient Blockchain know-how** before the journey starts. The project can be initiated by reaching an agreement with important stakeholders on Blockchain use cases.

02 | Analyze
The analysis of supply chain use cases starts by mapping the value stream and associated material, information, and financial flows. Full transparency regarding available data and their sources is necessary. Contractual obligations relating to the data are also mapped. Participants along the value stream are identified and categorized; possible roles include users, network operators, regulators, and authorities.

The different use cases are evaluated according to this information, and their actual value proposition is determined. This is a crucial moment to **focus on creating value**, not only for one company, but for all Blockchain participants.

It is also essential to question whether Blockchain is the right tool for the job; some use cases may call for a centralized cloud. Once a use case has been selected and Blockchain is considered the appropriate technology, the project should move forward to the concept phase.

03 | Conceptualize
There are many decisions to make when setting up a Blockchain. As with the analysis phase, the concept follows the value stream and answers the following questions:

HOW TO DERIVE A CONCEPT?

- Who should participate?
- How are permissions and access rights designed?
- What data should be shared?
- How is the data uploaded?
- How should the user interface be designed?
- How should interfaces to other systems be designed?
- What processes can be automated with smart contracts?
- Is an automated data upload through IOT cost-efficient?

During the concept, a third success factor is crucial: Collaboration Is Key while designing a Blockchain application. It is the idea of working together as peers with transparent information that lets Blockchain surpass other technologies.

04 + 05 | Pilot and scale
Once the concept has been fixed, it is time to set up the Blockchain and roll out its use in specific applications. As with other software development projects, lean and agile is the most suitable approach: **Start small, Scale fast.**

An initial proof-of-concept includes a selected number of participants. Initial lessons and improvement ideas are fed back to the development, which could lead to review parts of the concept. Once the setup is stable, the number of participants can be rapidly increased, leveraging the full benefits and associated value proposition.

Blockchain is a technology that can take supply chain management to the next level in terms of

- **Transparency**
- **Automation**
- **Disintermediation**
- **Immutability**

in order to increase operational speed, reliability, and flexibility. Besides the aforementioned potentials in automotive supply chain applications, other verticals show similar use cases and potentials.

With our structured project approach and in collaboration with our partner network, Porsche Consulting helps to identify, evaluate and implement the right solution for every function and in every vertical.

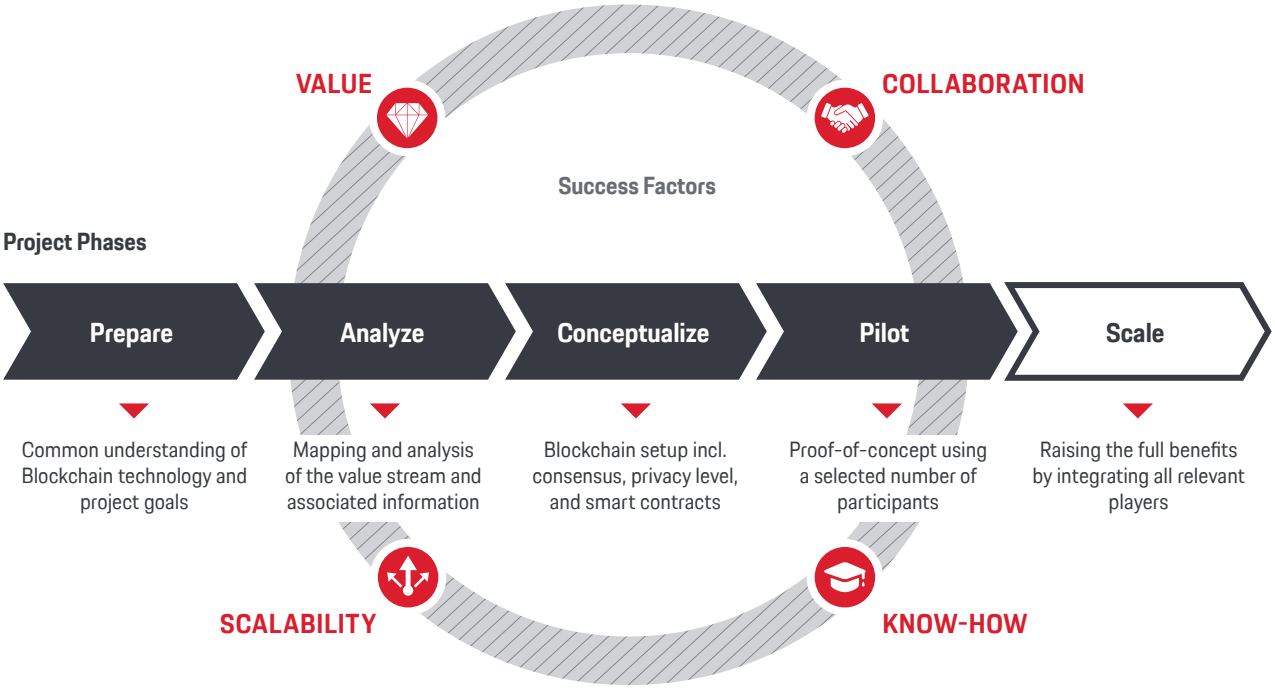


Fig 4. Project phases and sucess factors for implementing Blockchain use cases

IN BRIEF

01 Through its decentralized storage and validation of information, Blockchain offers an opportunity to improve speed, costs and quality in supply chains.

02 Blockchain is predestined to IoT related features with many applications to be developed in the coming years.

03 78 % of our interviewed experts state Blockchain technology can positively disrupt supply chains.

04 The four Blockchain levers are transparency, automation, disintermediation and immutability.

05 Savings potentials in logistics costs of selected use cases range from 12 % up to 50 %.

06 When implementing Blockchain applications, collaboration is key. Within your own supply chain, but also across other connected ones.

Appendix

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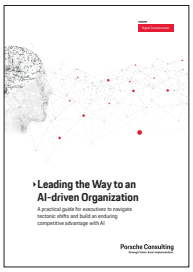
Further reading



Study
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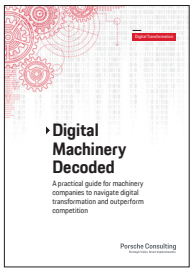
Connected Procurement

White Paper
Predictive Asset Management



Study
Digital Machinery Decoded

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