

Blockchain in Logistics



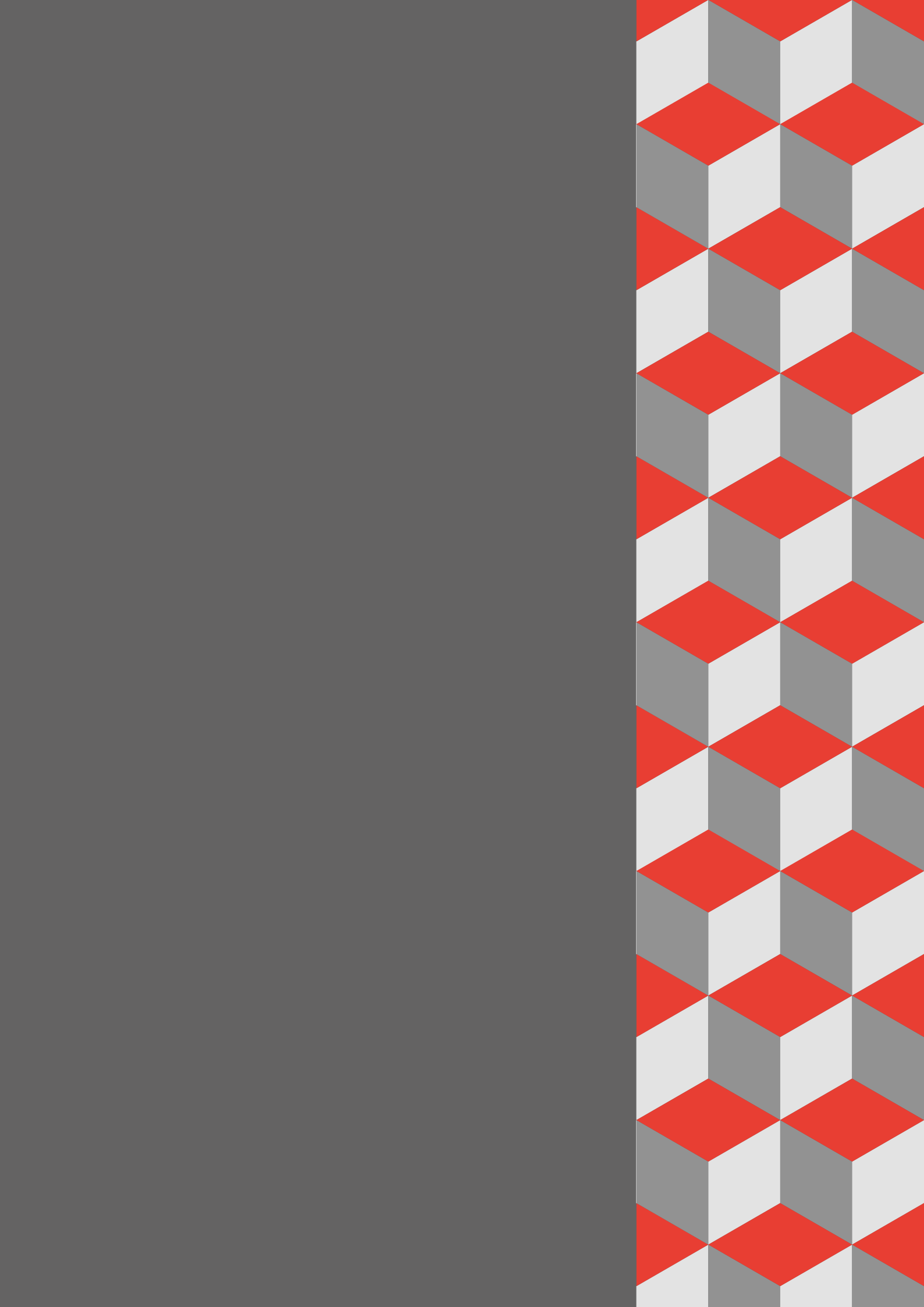


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A Introduction

Logistics is becoming increasingly complex, with more parties directly or indirectly involved in supply chains. This complexity is creating challenges related to communication and end-to-end visibility – making logistics processes inefficient. At the same time expectations of all participants in the supply chain related to transparency, reliability and service are increasing.

Blockchain is emerging as a possible solution for these challenges. In the recently published global digital supply chain study “Connected and autonomous supply chain ecosystem 2025”¹ PwC showed that blockchain is spurring interest in the field, but has not gained much traction yet. Only 5% of all companies and 27% of Digital Champions have already implemented blockchain.²

Some commentators see vast potential for the technology to be applied within logistics functions, however, discussions about blockchain often fall into the trap of excessive hype by suggesting that it could be a solution for everything. The truth is that blockchain can’t solve real-world problems by itself. Instead, it’s an underlying technology that makes it possible to share data across digital networks. There’s currently no blockchain solution available that offers industrial-grade quality – except a handful of pilot projects and consortiums.

This study sheds light on the advantages of blockchain technology in the logistics space. It offers an overview of use cases and estimates their impact on the future of the logistics function to provide objective and pragmatic recommendations about blockchain’s potential in this field. We also would like to share our perspective on the key building blocks you should follow when identifying and defining the potential value of blockchain in logistics for your organisation.

¹ www.pwc.de/en/digitale-transformation/connected-and-autonomous-supply-chain-ecosystems-2025.html.

² Digital Champion = Companies with the highest digital supply chain maturity level.





Global challenges in logistics

Increasingly globalised and complex supply chains are having a major impact on international companies. Stakeholders within supply chains need to handle an increased amount of information while keeping track of more transactions, recording performance and planning future activities.

Logistics processes involving multiple parties require joint execution across every process step. Today, most collaboration is conducted manually and offline, which often leads to redundancies and mistakes. Efficiency will only be possible if parties work together by sharing data to create transparency.

In this changing context, logistics functions face challenges related to sharing information along the supply chain securely. This is relevant in several ways:

- 1. Transparency:** The flow of information to support supply chain planning and controlling (e.g. production or distribution).
- 2. Speed and efficiency:** Getting the right goods to the right place at the right time through digitised and efficient processes (e.g. tariff processes, validating the origin of a consignment).
- 3. Traceability:** Reconstructing the origin and movement of goods, and keeping track of materials at every stage in the value chain (including proof-of-location, audit trails and certifications).
- 4. Payment:** Transferring money to suppliers efficiently and with reliable documentation.

Our clients face the following specific challenges for logistics functions:

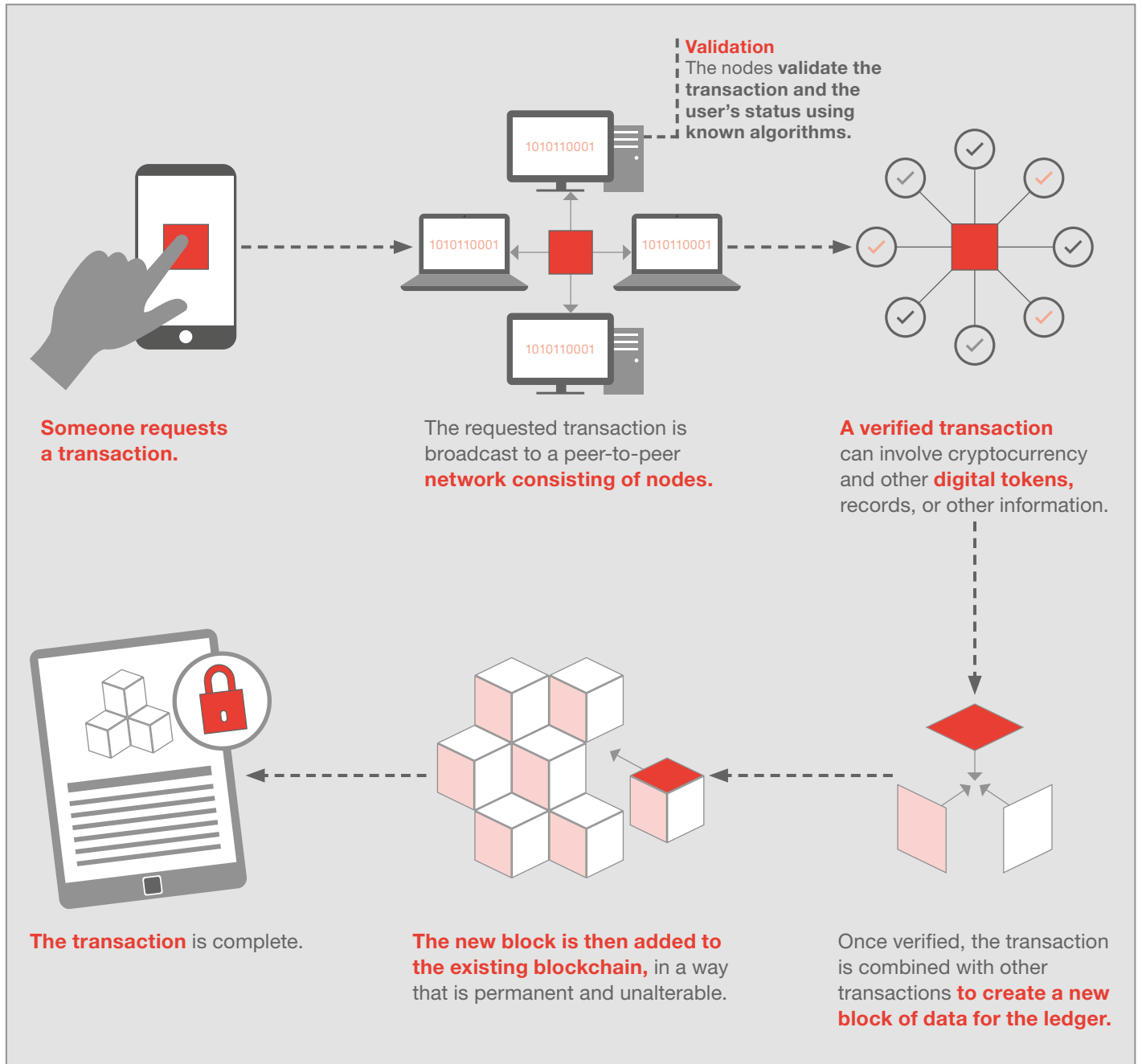
- Long and complex supply chains involving multiple organisations.
- Lack of trust and limited collaboration.
- Manual and paper-based processes, with a significant amount of transport costs related to documentation.
- Lack of end-to-end transparency caused by a restricted flow of information, challenges related to tracing and tracking, as well as underutilisation of assets.

Blockchain at-a-glance

Today, data from transactions between parties is usually stored individually with no overview of all of the activities. Blockchain, by comparison, offers an automated network where records are shared.

Sharing data between parties is typically a huge trust issue that makes collaboration difficult. Blockchain addresses this trust issue because data ownership is shared by all of the parties involved.


Blockchain – How it works




At its core, a blockchain is a shared database. Specifically, the term refers to a secure and decentralised record of data that cannot be changed, and that is formed across a peer-to-peer network.

The figure below shows the four characteristics that are fundamental for blockchain.


Key characteristics of a blockchain




Distributed ledger
Every participant in the network has a full copy of all data, updated in real time. This removes the need for verification by creating a single source of truth.



Cryptography
The integrity and security of blockchain data are maintained with cryptographic functions, and all updates and changes are displayed with a timestamp.



Consensus
All updates, changes and transactions must be validated by all participants, This eliminates the need for central controlling and creates trust.



Smart contracts
A computer program which executes itself when certain terms and conditions are met. No human interference is required. It automates the repetitive and 'if else' situation in operational and commercial processes.

Ultimately, blockchain enables different organisations to share data securely and achieve common goals more efficiently. It makes it possible for stakeholders to interact without the need for a central controlling organisation. And it can open up opportunities to develop completely new business models.

Relevance for logistics

How can blockchain add value for logistics functions? Can blockchain make processes faster or manage supply chains involving multiple parties? And can it create trust and strengthen collaboration?

Our checklist provides a quick way to evaluate whether a process could benefit from this technology. The more characteristics are true for your logistics processes the more applicable the blockchain technology is.

Blockchain readiness check

- 
Multiple parties share data
 multiple participants need views of common information
- 
Multiple parties update data
 multiple participants take actions that need to be recorded and change the data
- 
Requirement for verification
 participants need to trust that the actions that are recorded are valid
- 
Intermediaries add complexity
 removal of intermediaries can reduce cost and complexity
- 
Time sensitive interactions
 reducing delay has business benefits
- 
Transactions interact
 transactions created by different participants depend on each other

Several challenges along the supply chain are impacting efficiency for logistics functions. Bottlenecks often occur because of a lack of transparency or cumbersome administration. In many cases, the location of shipments during transport is unclear, which makes scheduling delivery times difficult and causes companies' assets to be underutilised. On top of this, rising expectations related to ethical standards, sustainability and authenticity are making it increasingly important to ensure a trustworthy audit trail – but it's often hard to trace goods along the entire supply chain. And many logistics processes are still manual and paper-based, which can lead to long processing times.

B Benefits of blockchain in logistics

We believe there is high potential for blockchain applications within logistics functions. The technology can solve key challenges by creating an encrypted digital record that tracks goods at every stage in the supply chain. It makes any irregularities that could disrupt a shipment clearly visible, enabling companies to solve problems quickly. And it can automate processes while also making it easier to verify goods – reducing paperwork and supporting end-to-end traceability. Blockchain enables organisations to share data securely and achieve common goals more efficiently.



Enhance supply chain transparency and traceability

- **Provide end-to-end transparency:** Blockchain provides a single source of truth by integrating data from all the participants in the supply chain.
- **Monitor performance:** Blockchain-based monitoring of performance history of carriers and suppliers provides 'trustworthy' information of past performance.
- **Confirm provenance:** Blockchain provides a proof-of-origin along with assurance of compliance and safety standards throughout the whole supply chain.
- **Increase real-time visibility:** Blockchain-based transparency provides real-time information on events and the status of various transport modes.



Ensure security, immutability and authenticity

- **Authenticate data and documents:** Due to its immutable characteristics achieved via cryptography, blockchain provides a secure and encrypted platform to exchange data and documents.
- **Detect fraud:** Every transaction is visible to all participants and nothing can be removed without it being detected. This eliminates areas where fraud occurs (e.g. double brokering). Shippers can confirm authenticity by tracking when each document or transaction was modified (time stamping).
- **Prevent theft:** Blockchain can contain detailed information and rules, such as photo ID requirements for pick-up or delivery, which improves security.





Reduce process complexity

- **Eliminate intermediaries:** Blockchain replaces the role of intermediaries by bringing trust in the ecosystem and enabling peer-to-peer models.
- **Improve quality assurance:** Every organisation involved in a transaction can assess and validate data. Evaluating freight at pick-up and delivery locations can reduce disputes.
- **Increase level of automation:** Processes such as payments, transfer of ownership, settlement of tariffs or cargo checks can be automated by using “smart contracts”. Smart contracts are rule-based, automatic follow-up activities written in computer code. They can perform the next activity defined in the contract, for example by making an automatic payment once arrival of goods has been verified.



Improve operational efficiencies

- **Improve compliance:** Blockchain can be combined with Electronic Logging Devices (ELDs), which send data about driving behaviour to a blockchain platform in real time.
- **Reduce transaction cost:** Through consensus validation blockchain helps to avoid repetition of transactions as well as process errors by verifying each transaction.
- **Reduce human error:** As smart contracts foster the automation of processes, blockchain additionally reduces the potential for human errors, while being faster than manual processes.



C Blockchain use cases in logistics

We have identified several use cases that support companies as they strive to increase speed, improve traceability and reduce costs.

01 Provenance

In logistics, provenance refers to a timeline of changes in the ownership, custody or location of an object. It could be described as an audit trail and aims to make sure every shipped good has a digital “passport” that proves its authenticity. These passports include data about where and when the product was made, as well as the route it has travelled.

The wine trade offers an example of how blockchain can be applied for provenance. The sale of fake alcohol is a major problem in this industry because it can directly harm people’s health. Provenance makes it possible to trace the location of the winery that produced the wine, while also listing all participants – such as regulators, distributors or retailers. This addresses the flow of counterfeits, while also lowering costs and eliminating duplicated tasks. It also enables customers to obtain information about the origin of the product.



A blockchain-based platform for Hinterland transport

This platform was designed to facilitate transactions between ports and their stakeholders. PwC supported its development by focusing on key challenges facing these organisations: lack of transparency along the supply chain, businesses providing shipment data to ports and transport companies too late, frequent re-work and manual handling at ports and depots, high volume of manual processes such as work orders or e-mails.

The platform was developed on Smart Trace, a modular solution for blockchain in supply chain developed by PwC.

Payments and invoicing 02

Invoicing and payments related to logistics functions often involve manual and paper-based processes because the companies involved each keep separate records. Matching invoices with payments due or credited is a time-consuming task for companies. Blockchain can store and share digitised records, while also creating smart contracts that automatically handle invoices and payments to shorten processing times and ensure accuracy.

For example, a connected pallet can automatically transmit a confirmation of the delivery time or condition of the goods. The blockchain system then automatically verifies the delivery and makes any appropriate payments. This significantly increases efficiency and trust.

Shipchain is another example of blockchain in this context. It is a platform for tracking and tracing shipments, and provides a solution based on smart contracts that can be used for making payments. It offers an open Application Programming Interface that can be integrated with freight management software, as well as features that allow users to store information like geo waypoints.

03 Digital documentation

Combining blockchain with the Internet of Things (IoT) can enable intelligent logistics contracts. This is possible when digitised documents (e.g. bill of lading, certificates, invoices, pre-advice) and real-time shipment data are embedded into blockchain-based systems.

Digital documentation and smart contracts using blockchain are already in place at the ports in Antwerp, Rotterdam and Singapore. For example, physical, administrative and financial streams are now integrated through paperless processes in Rotterdam. This ensures security and addresses double spending issues, while also reducing paperwork, connecting data silos and automating processes.



eTradeConnect

eTradeConnect is a platform that aims to digitise open account transactions by leveraging blockchain to foster trust. By digitising trade documents and automating processes, it improves efficiency, reduces risks and facilitates finance. The benefits include: lower costs and fewer paper-based processes, faster processes for obtaining working capital from banks, facilitated applications for trade financing for open account trades.

eTradeConnect completed two new proofs-of-concept to boost its efficiency in facilitating trade financing. As project manager, PwC, verified the feasibility of data exchange from the financing and shipping cycles.

05 Logistics marketplace

Blockchain enables smooth and integrated communication across complex supply chains. In this way, it improves trust, security and speed. It can even be used to create platforms where logistics service providers offer free capacity in trucks or ships in real time.

Cargo Chain, for example, is an interactive marketplace that enables logistics companies to share availability in real time. It offers full traceability, as well as a payment solution, transport management system and a hub for managing consignments via web and mobile applications. With CargoChain, the efficiency between partners can be improved and transactional costs can be reduced.

Identity management 04

Blockchain Identity Management is a secure solution that protects people's identities against injury or theft. It uses a distributed trust model to ensure privacy where identity documents are secured, verified and validated by authorised participants.

Blockchain-based identity management offer, for example, the possibility to manage access rights for companies to input information about pick-up and delivery of goods.

In addition, third party providers in Know Your Customer/Anti Money Laundering processes, last mile deliveries or driving licensees of truck drivers can be verified by using Blockchain Identity Management.



Trade Community System

The Trade Community System (TCS) is an open and secure data exchange platform that links participants worldwide. Smart contract functions enable TCS to connect multiple supply chain systems that are operated by different organisations. In this way, it creates a transparent flow of information across the supply chain, improves efficiency and increases customer confidence.

Participants pay little or no costs and there are no additional fees for accessing data. Instead, the TCS generates revenue from service innovations such as benchmarking prices for specific routes, export/import analytics, customs analytics or provenance.

D How to make it happen

So blockchain in theory seems to be a potential solution for some logistics challenges and there are interesting use cases out there. So why is not everybody using it?

We have identified five key hurdles (shown in the figure below) that have prevented a breakthrough for blockchain technology in logistics applications.

Overall, there is no single answer to the question of the potential value of blockchain for logistic functions. Companies should keep these hurdles in mind – but should also acknowledge the value this technology can create in specific use cases and setups.

“Without a doubt, blockchain is a very interesting technology. However, there are several aspects to keep in mind. Current use cases mostly focus on bringing together data from different parties, but this could also be achieved with other technologies. More importantly, conversations about blockchain today are creating momentum for collaboration between different stakeholders throughout the value chain and openness to consider emerging technologies to solve shared challenges.”

Erik Lamoral
CIO, H.Essers.

Hurdles of blockchain



Knowledge and awareness

- Lack of understanding and awareness about blockchain and its potential
- Limited availability of skilled workforce to design, implement and operate blockchain solutions
- Lack of trust among companies who are nervous about sharing data on open platforms although blockchain in fact is building trust (“trust paradox”)



Interoperability

- Integration issues due to variety of individual solutions used from each party involved
- Non-existence of a standard “one blockchain” solution



Performance

- Very specific use cases and requirements of existing blockchain solutions (e.g. online payments)
- Limited direct visibility of benefits for the flow of goods due to more focus on process automation and optimisation



Regulation and governance

- Lack of clear legal frameworks to govern blockchain transactions in various domains
- Limited accepted business practices to act as a reference for operating and governing blockchain solutions



Risk on disintermediation

- Redundancy of intermediates in the logistic chain. Today several intermediates make their living of the inefficiency in logistics processes, so if blockchain takes away this inefficiency or lack of transparency, intermediates may become redundant or at least less involved

Four steps to blockchain success

Creating and implementing a blockchain solution is not a traditional IT task. There's no point re-creating the old world with a blockchain at its core. Organisations that do not recognise this risk reassert existing roles, processes

and business models. Instead, you need a strategy that transforms your approach. As blockchain has the potential to change the way of working in the logistics sector, PwC suggests to follow a well structured approach.

1 Make the business case: where and how to start

Commit to new ways of working

Creating a blockchain doesn't have to mean complete reinvention, but you need to make sure you don't slip into familiar ways of doing things. New ways of thinking and operating will be required.

Frame the problem and solution

Your blockchain project needs to be supported by a strategy. What is the issue you are addressing, and how will blockchain help? How might this same issue be affecting others in your industry?

Start small, then scale up

Make sure you know where blockchain will fit in your business environment, and fine-tune issues along the way. But stay focused on the long-term value: an external shared resource that makes new scale economies possible.

2 Build an industry ecosystem: new rules for the new relationships

Focus on a cooperative few

Start with smaller ecosystems with a tradition of cooperating on matters of industry-wide importance. It's also possible to build a blockchain that starts with just a few stakeholders but is ready to expand.

Broaden your network

Blockchain consortia are valuable resources for staying close to technology developments, but you can look to established industry groups or trade organisations to find a community for exploring industry applications.

Work across the value chain

Conduct a competitive analysis: Are competitors or new entrants already planning on using blockchain? Is there a potential for partnership? Will you have to participate in their blockchain solution in order to continue doing business?

3 Design deliberately: determine rules of engagement

Confront risks early

Plan to add cybersecurity, compliance, and legal and audit specialists to blockchain development teams. Involving risk professionals from the start will enable you to build a framework that regulators and all your stakeholders will trust.

Consider privacy implications

Blockchain needs to fit into enterprise privacy strategies. GDPR, for example, requires that personally identifiable information be erasable. This has to be reconciled with the fact that data immutability is an important characteristic of blockchain.

Invest in data and processes

Traditional organisational processes, such as sales, manufacturing and shipping, are often suboptimal and siloed. Focusing efforts to streamline processes and data flows lays the groundwork for blockchain efforts.

4 Navigate regulatory uncertainty: watch, but don't wait

Shape the trusted tech discussion

The risks of blockchain, and how to trust it, are part of a growing public discussion of responsible innovation and trust in technology. Engage with regulators and industry groups to help shape emerging policies and best practices.

Monitor evolving regulation

Besides directly regulating the technology itself, laws around data use and protection can fundamentally change how blockchain operates. It is vital to engage with regulators to help shape how the environment evolves.

Use existing regulation as a guide

Current regulations still apply – but they may apply in different ways. By and large, we expect existing regulation to extend to new business models and applications. If you remain agile, you'll be able to adapt and remain compliant.

E Conclusion

Blockchain has many potential advantages in the logistic industry. It enables companies to increase efficiency (e.g. process automation, reduced paperwork, etc.), transparency and traceability, while also making supply chains more secure as the origin and authenticity of products is known, proven and shared.

However, companies are waiting for the real breakthrough solution for logistics functions. There is a lack of trust and understanding regarding the technology and its applications. Many executives are still unclear about what blockchain is and how it is changing business. Blockchain's capacity to offer a new form of infrastructure and a new way to digitise assets through tokens is not easy to explain because it is an underlying technology, and all happens behind the scenes.

Currently, there is no industry standard for blockchain available. Instead the market offers very fragmented solutions. Thus, waiting for a solution to emerge for logistic functions may not be the right strategy. Similar to

EDI in the past, there has to be a big push from e.g. the retail, chemical or automotive industry, where industry-wide standardisation has already been proven, in order to develop a viable scale beyond pilots.

What does this mean for your individual organisation? Should you just "wait and see"? Blockchain offers the potential to create value in logistics, however its implementation and use is not that straight forward, as we have highlighted. Given this situation and based on our experience from many technology-enabled transformations in operations, PwC strongly suggests to lay the groundwork for blockchain technology. Organisations have to identify and understand the relevant applications and requirements for their logistics processes in the first place. Secondly, it is also critical to look at the potential use of blockchain in logistics in the overall context of supply chain development. In this way organisations ensure to be prepared for blockchain or any other emerging technology, as they all require the same foundation.



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About us

Our clients face diverse challenges, strive to put new ideas into practice and seek expert advice. They turn to us for comprehensive support and practical solutions that deliver maximum value. Whether for a global player, a family business or a public institution, we leverage all of our assets: experience, industry knowledge, high standards of quality, commitment to innovation and the resources of our expert network in 157 countries. Building a trusting and cooperative relationship with our clients is particularly important to us – the better we know and understand our clients' needs, the more effectively we can support them.

