Is there a role for blockchain in responsible supply chains?

OECD

This paper will inform discussions at sessions relating to due diligence in global supply chains taking place during the OECD Global Blockchain Policy Forum on 12-13 September 2019 (www.oecd.org/finance/oecd-blockchain-policy-forum.htm). This paper was prepared by Jerwin Tholen, Dennis de Vries, Audrey Daluz, Claudiu-Cristi Antonovici, and Wiets Van Brug from KPMG Advisory N.V., and Rashad Abelson and Dorothy Lovell from the OECD Centre for Responsible Business Conduct in the Directorate for Financial and Enterprise Affairs. It has benefited from multi-stakeholder input, including from government, private sector, and civil society representatives. The authors are solely responsible for any remaining errors.

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Executive summary

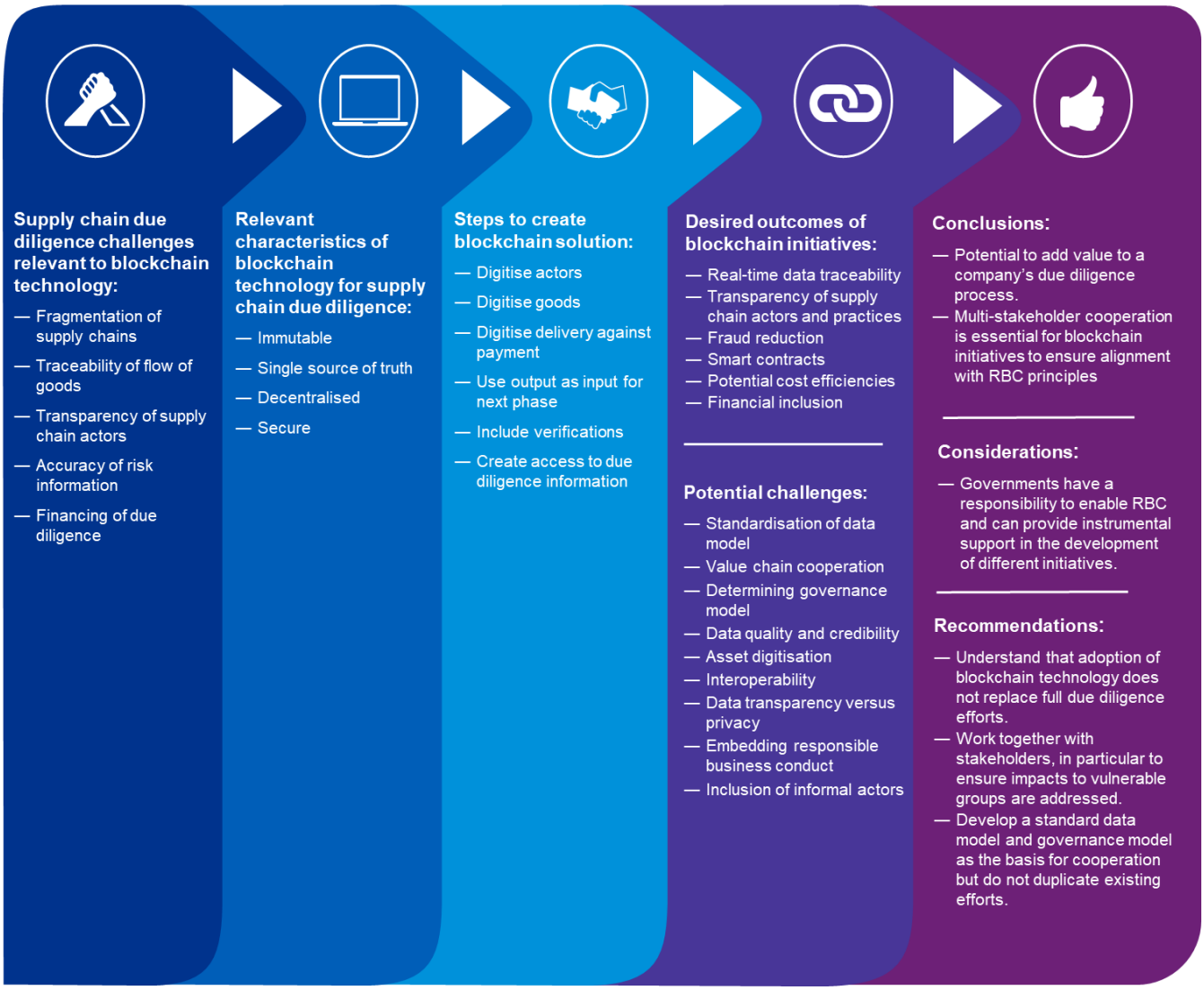
In recent years, blockchain technology has been viewed as a promising tool to help address pressing issues in supply chain due diligence. This technology has already been used in a significant number of supply chain due diligence initiatives across different sectors with varying degrees of success.

The implementation of these initiatives has exposed some challenges when applying blockchain technology. These include: a lack of control over the quality of information initially entered into the system; challenges in access by vulnerable groups, affected communities, and informal supply chain actors; a lack of scalability and incentives for uptake; the emergence of multiple databases for different supply chains; and a lack of interoperability for various systems. However, blockchain-based supply chain initiatives have also shown there are benefits which can be realised for supply chains if these challenges are overcome. Such benefits include the resistance to modification of data; greater efficiency for up-to-the-minute data analysis; as well as providing a structure to enable greater trust between organisations linked across increasingly complex global supply chains.

This paper provides a critical look at how blockchain technology is currently being developed and used to facilitate responsible business conduct, and offers suggestions for how responsible business conduct can be integrated into emerging blockchain initiatives in an effective way, in alignment with the OECD Guidelines for Multinational Enterprises. It was developed by the OECD Secretariat and KPMG Advisory N.V. as a contribution to a broader effort to promote and coordinate best practice and policy coherence in the area of supply chain due diligence.

The paper first introduces the basics of supply chain due diligence and blockchain technology. It then explores how this technology might be implemented in supply chains and the potential impact for supply chain due diligence, and subsequently highlights the main challenges for the implementation of blockchain technology as observed from the first blockchain projects. The final part proposes considerations for governments and businesses and other implementing organisations for the application of blockchain technologies to supply chain due diligence processes. The following diagram provides a detailed overview of the points of discussion in the paper.

Executive summary



Chapter 1 Introduction

1.1. Introduction - The OECD Guidelines for Multinational Enterprises and the sectoral due diligence guidance

The OECD Guidelines for Multinational Enterprises (the Guidelines) are voluntary principles and standards for responsible business conduct (RBC) recommended by governments to business. They acknowledge and encourage the positive contributions that business can make to economic, environmental and social development, and also recognise that business activities can result in adverse impacts related to workers, human rights, the environment, bribery, consumers and corporate governance. The Guidelines specifically recommend that companies carry out supply chain due diligence to identify and address such adverse impacts associated with their operations, their supply chains and other business relationships.

The Guidelines set out the expectation for businesses to act responsibly and a commitment by governments to protect the public interest and a responsibility to provide an enabling framework for RBC. Governments can enable RBC in several ways including: Regulating – establishing and enforcing an adequate legal framework that protects the public interest and underpins RBC, and monitoring business performance and compliance with regulatory frameworks; facilitating – clearly communicating expectations on what constitutes RBC, providing guidance with respect to specific practices and enabling enterprises to meet those expectations; and co-operating – working with stakeholders in the business community, worker organisations, civil society, general public, across internal government structures, as well as other governments to create synergies and establish coherence with regard to RBC.

Based on the recommendation in the Guidelines for companies to conduct supply chain due diligence to identify and address adverse impacts in their supply chains, the OECD has developed sector specific guidance for carrying out supply chain due diligence in minerals, garment & footwear, agriculture, as well as for institutional investors. Most recently, the OECD has developed a general OECD Due Diligence Guidance for Responsible Business Conduct that draws from and builds on sector specific guidance, but can be applied to all sectors of the economy.

The due diligence framework in the OECD Due Diligence Guidance for Responsible Business Conduct consists of the following actions:

— Embed responsible business conduct into policies and management systems.

— Identify and assess adverse impacts in operations, supply chains and business relationships.

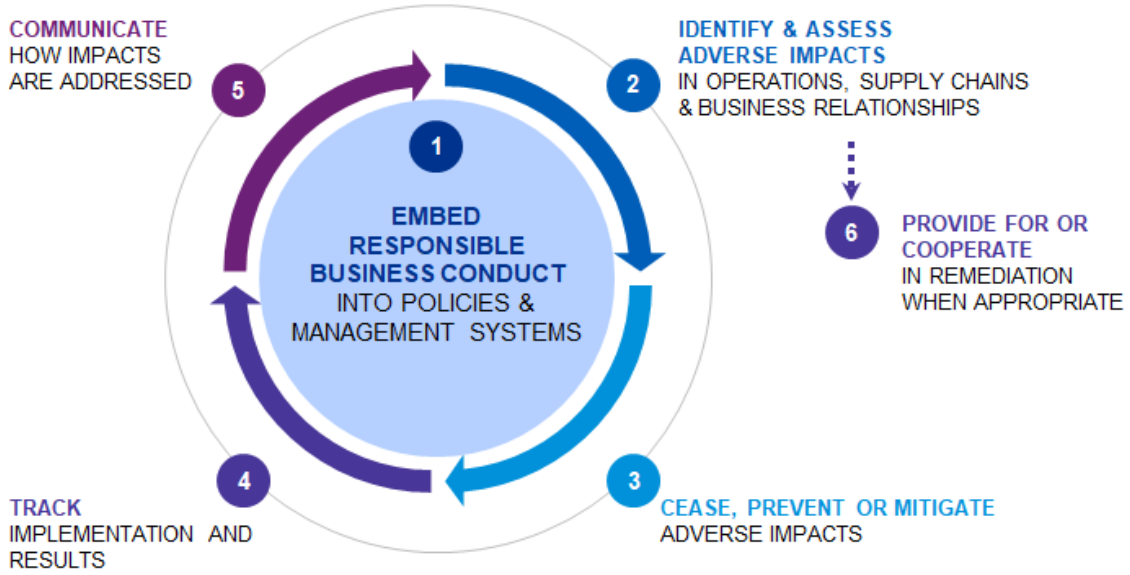
— Cease, prevent or mitigate adverse impacts.

— Track implementation and results.

— Communicate how impacts are addressed.

— Provide for or cooperate in remediation when appropriate.

Figure 1. Due Diligence Process and Supporting Measures



Source: OECD (2018)

In implementing this framework, enterprises may face obstacles that directly affect their ability to conduct meaningful due diligence, explored in more detail in later sections of this paper. It is clear that having full and up-to-date knowledge of the information flow within the supply chain is essential in executing effective due diligence. Normally, information transfer is conducted via exchanges of paper documentation, audits or using traceability software. These transfers can be time consuming, cannot easily be synchronised due to different data formats and architectures, do not provide timely information. Moreover, the information is difficult to verify or measure, or the information is simply non-existent. This results in risks that are difficult to track, prevent and mitigate. As an example of this information transfer inefficiency, a shipping container transporting cargo from China to Europe requires sign-off from at least 30 unique organisations and up to 200 interactions (Hussey, 2018). In this case, a purchaser of those goods further downstream could have significant difficulty understanding and navigating the paper trail and the origin of the goods purchased.

This snowballing trend towards supply chain transparency and stronger due diligence expectations is global in scope and cuts across different sectors. The Guidelines define expectations for supply chain due diligence and are aligned with the UN Guiding Principles on Business and Human Rights and the ILO Tripartite Declaration of Principles Concerning Multinational Enterprises. Acting on commitments made in those international instruments, some governments are introducing legislation requiring due diligence for RBC. In addition, certain RBC expectations outlined in the Guidelines (e.g. on addressing environmental degradation in business activities) are also referenced in global frameworks such as the G20 agenda, the Sustainable Development Goals, and the Paris Climate Accord. Pressure is building on institutional investors to use their leverage on industries to address risks of adverse human rights, labour, integrity and environmental impacts. Likewise, consumers are also growing more conscious of adverse impacts through social media and cheaper travel costs to regions of the world that are negatively impacted by certain business operations.

As consumers, regulators and investors become ever more demanding on RBC issues such as modern slavery, working conditions, foreign bribery, conflict finance, and environmental impacts such as pollution, information on the chain of custody or traceability of goods through the supply chain is necessary for effective company due diligence. Given the complexity of global supply chains, appropriate and efficient technical solutions are in great demand. This paper will examine whether blockchain technology can improve and facilitate supply chain due diligence by more efficiently identifying, prioritising, and tracking RBC risks.

1.2. Introduction to blockchain technology

Organisations tend to have centralised systems for supply chain management services. ERP (Enterprise Resource Planning) systems, for instance, integrate all major business functions such as sales, procurement, accounting, etc. within the same system. Typically companies develop their systems on a standalone basis for their internal purposes, resulting in their own definitions of identities, assets and related properties. When transacting with other parties in the supply chain, this leads to labour-intensive reconciliations between, for example, the purchase transaction of the buyer with the sales transaction of the supplier. Consequently, integrating with other systems and creating synergy with other enterprises to gain visibility of the flow of goods in the supply chain becomes very expensive and challenging. Obstacles to a clear understanding of a supply chain include redundant, missing, outdated information or data, varying data definitions, multiple stakeholders, centralised and siloed information systems, and databases where control is exerted by a single entity. A number of chain of custody and/or traceability service providers exist to provide a solution in which all parties in the supply chain can upload their data to a central service. Many of these existing systems are now experimenting with the use of blockchain technology to manage their information flow.

With the widespread adoption of blockchain technology to share transaction information organisations have increasingly turned to alternative data sharing processes. It should be noted that other IT solutions have similarly tried to address this issue long before blockchain emerged. Blockchain technology was first introduced through the introduction of the cryptocurrency Bitcoin, which demonstrated that it was technically possible to create a ledger in which an asset (the bitcoin tokens) can be transferred between parties on a global scale while the ledger is maintained by thousands of different actors (the “nodes”).

Understanding Blockchain and DLT

Distributed Ledger Technology (DLT) has since emerged as the umbrella term for technologies that store, distribute or exchange, publicly or privately, value between entities / users / peers based on shared transaction ledgers. In a distributed ledger, all copies of transactions are automatically spread and synchronized among entities of a network, facilitating the flow of information between stakeholders and helping to address inefficiency related to information asymmetry (Ellebrecht & Schouten, 2017). While blockchain technology is in fact a specific type of DLT with a very specific technology underpinning (a type in which transactions are grouped in blocks, validated and added to the chain of transactions by consensus) this paper will continue to use the word blockchain to describe the usage of distributed ledgers in general, in line with popular usage of the term.

Key features of blockchain solutions relevant to accuracy of supply chain information include the following:

— Immutability and decentralisation: Transactions in blockchain infrastructures are append only (meaning that transaction cannot be modified after initial creation) and the ledger is maintained by multiple parties, no single party can change transactions recorded in the shared ledger.

— Single source of truth: All participants use the same shared ledger to record transactions, this serves as a single source of truth for all parties in the value chain.

— Security: Transactions in the shared ledger are secured through cryptographic technologies that ensure the integrity and availability of the transactions in the shared ledger.

Within the blockchain ecosystem two main types of shared ledgers have emerged:

— An “open” blockchain is a public blockchain where anyone can read the information on the blockchain. Its first variation is “public permissionless” where anyone can read, and also write information to the blockchain and participate in the verification of data blocks. Examples of this kind of blockchain are Bitcoin and Ethereum. In the second variation, “public permissioned”, authorisation (permission) is required for writing on the blockchain as well as participation in the verification of data blocks. Examples of this kind of blockchain are relatively common in the public sector where only approved entities are allowed to add or change data but everyone can read (for example registries for businesses or land). The open and transparent access to data offered by public blockchains could support due diligence for RBC by providing a clearer picture of the movement of goods and the actors participating in a supply chain as well as transparent communication on RBC policies of the parties in the supply chain. However, the risk would be a refusal or reluctance by participants to share what may be perceived as sensitive commercial information.

— A ‘closed’ blockchain is one which requires participants to have authorisations for all aspects of blockchain participation (reading, writing and data verification) through the granting of different permission levels by the blockchain operator. This first variation is called a ‘consortium’ blockchain, due to it frequently being chosen by industry consortiums (for example, in transport for tracking containers, in insurance, or in banking). Consortium-type implementations headed by a single organisation also exist. The second variation, a “private-permissioned-enterprise” blockchain, follows the same rules as the first; but only the network operator, and no one else, is allowed to write to the blockchain or undertake data verification. This last variation is generally not considered to be a blockchain because the restrictions on writing and data verification create a single point of failure in the network, but this paper is reporting what is being done without making judgements on the classification of applications called “blockchain” by their implementers. Parties in a supply chain may prefer a closed or private blockchain when they want to keep complete control over transaction details and other information they want to share.

The OECD Blockchain Primer further explains the main types of blockchains, segmented by permission model (see Figure 2 and OECD, 2018a).

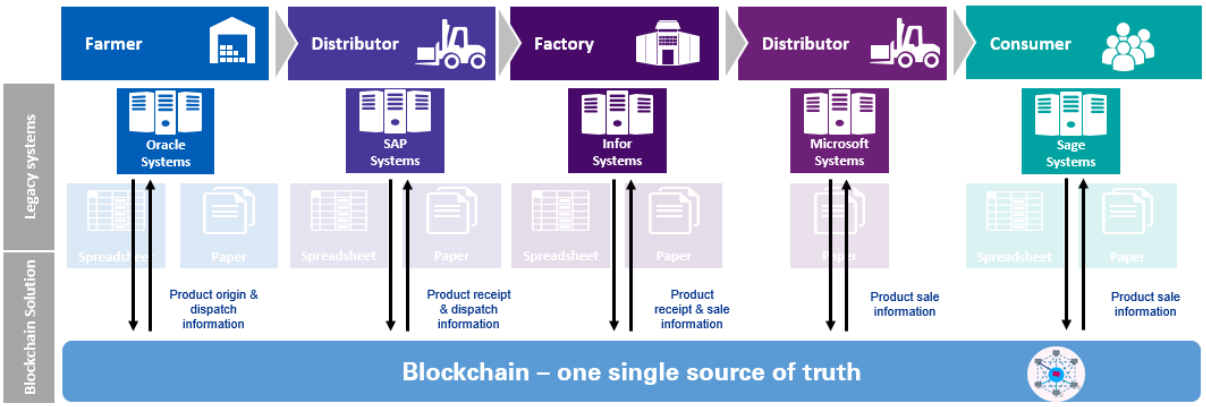
Over the past years, large consumer facing companies in the downstream part of the supply chain, sourcing material from different supply chains, have started to experiment on a large scale with blockchain infrastructures to create a single source of truth for all parties involved. Industry experts have referred to this as a “Shared Ledger Vision”, which describes a shared “global logical ledger” with which all economic actors (companies, individuals, machines) will interact and which will allow any of the parties to record and manage agreements amongst themselves in a secure, consistent, reliable, private, auditable and authoritative manner (Brown, 2018).

Figure 2. The main types of blockchain segmented by permission model

			READ	WRITE	COMMIT	EXAMPLE
BLOCKCHAIN TYPES	Open	Public permission less	Open to anyone	Anyone	Anyone	Bitcoin. Ethereum
		Public permissioned	Open to anyone	Authorized participants	All or subset of authorized participants	Supply chain ledger for retail brand viewable by public
	Closed	Consortium	Restricted to an authorized set of participants	Authorized participants	All or subset of authorized participants	Multiple banks operating a shared ledger
		Private permissioned "enterprise"	Fully private or restricted to a limited set of authorized nodes	Network operator only	Network operator only	External bank ledger shared between parent company and subsidiaries

Source: OECD (2018a)

Figure 3. Example of a shared ledger vision



Information flow in the supply chain (distributed systems perspective)

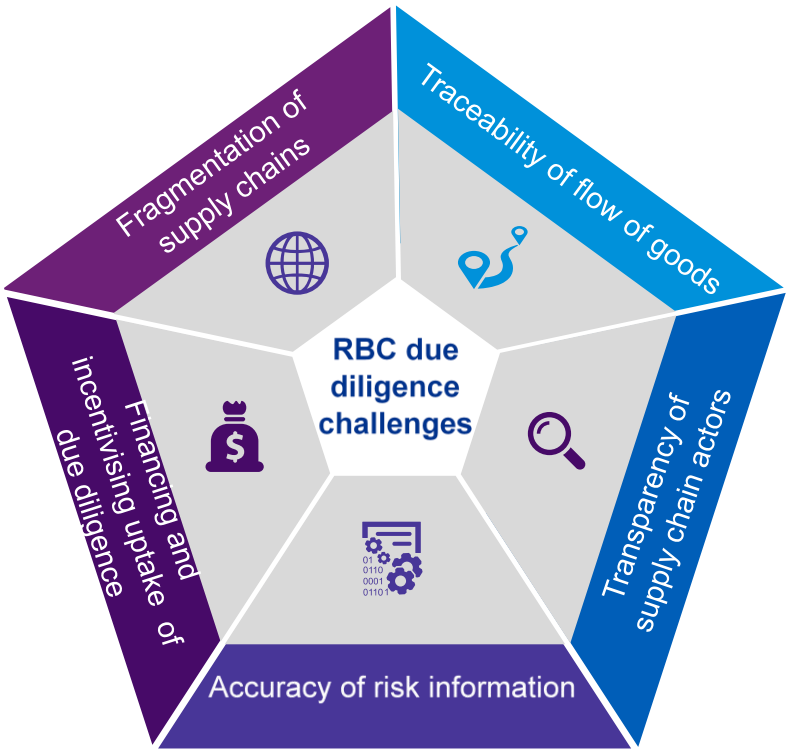
Chapter 2 Application of blockchain for supply chain due diligence

In this chapter the paper will further explore what users of blockchain technology hope to achieve for supply chain due diligence. To understand this, the paper will first describe the complexity of current global supply chains and the due diligence challenges that accompany them (2.1). Understanding this foundation, the paper will then describe what companies are doing to apply blockchain solutions in supply chains (2.2) and how those applications are seeking to address due diligence challenges (2.3).

2.1. Supply chain due diligence challenges

Modern supply chains are complex, fragmented and rely on a large number of suppliers and intermediaries from all parts of the world. Relevant supply chain due diligence challenges include lack of transparency due to inconsistent or missing data, fraudulent data, lack of interoperability of data systems between actors, time consuming paper-based processes, limited information on product traceability, and lack of financing for due diligence activities. At the same time, customers, regulators, investors, and other businesses, are increasingly demanding access to more accurate information on the origin and journey of products they purchase, as well as the conditions under which those products are manufactured/produced (White, 2018). Companies are expected to play a stronger role in due diligence processes, identifying and reporting risks and actual adverse impacts throughout their supply chain, while taking appropriate action to prevent adverse impacts, reduce their harm and if appropriate, contribute to remediation of the harm. Relevant supply chain due diligence challenges are described in more detail below.

Figure 4: RBC due diligence challenges relevant to blockchain technology

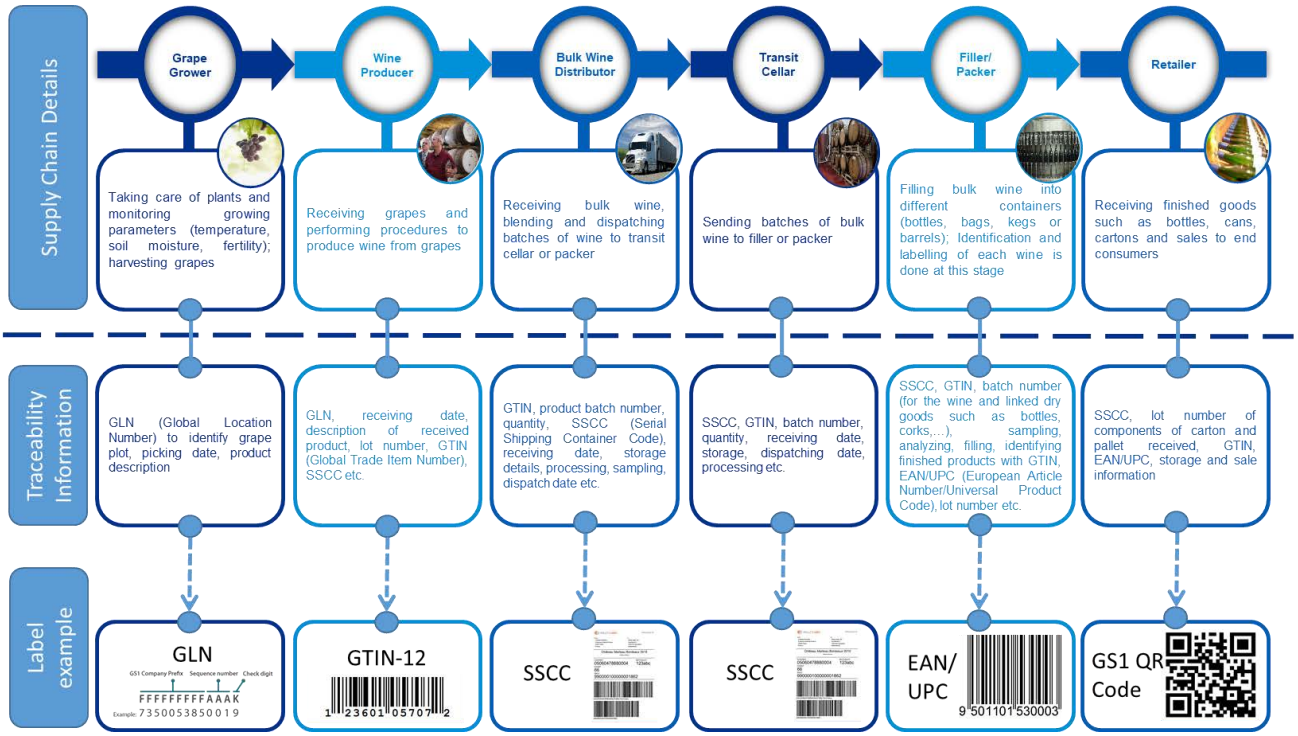


Lack of information on flow of goods: Traceability is the process by which companies track the origin and other factual information associated with the production and movement of materials and products through the supply chain. Establishing traceability is one way to gather basic information in order for companies to identify risks of adverse impacts further upstream in a company's supply chain, and on that basis, prioritise further efforts to prevent or mitigate such risks. The types of information normally recorded for traceability purposes include the countries of origin of products, including raw materials (e.g. farm or mine) and intermediate products (e.g. components), quality of the material, the method of production (e.g. artisanal mining or large scale mining, small scale farming), and the means and routes of transportation. It is critical to note that traceability is only part of the overall due diligence exercise and without more information (e.g. the presence of armed groups at a mine site or sexual violence taking place at a factory), many of those adverse impacts will go unaddressed.

The ideal situation would then be to have a level of detail in traceability, transparency over supply chain actors, and other important due diligence information, such that product information (including the conditions of production and trade) and its journey can be accessed, verified, and made available throughout the supply chain as required to help companies carry out due diligence (e.g. identifying risk, prioritising activities, tracking and reporting) more efficiently.

To facilitate the exchange of information and the flow of goods between different actors, standardised systems have been used to help companies share information in a similar digital language. For instance the GS1 system numbering and bar coding is used in different sectors of industry. The following figure shows an example of how this standard is applied in the wine industry to implement traceability from grape grower to retailer by breaking down the wine supply chain into stages.

Figure 5: Wine supply chain and potential RBC risks



Source: KPMG analysis based on the GS1 standard.

Fragmentation of supply chains: Most supply chains share similar characteristics or are even more complex than the one exemplified in the figure above for wine, with many processing steps throughout the production chain, requiring information from each actor. The more complex and fragmented the supply chain is, the more complicated it will be for companies to carry out due diligence, understand and categorise the severity and likelihood of the risks in their supply chain, and apply leverage at the appropriate points.

Lack of transparency of supply chain actors: Mapping the basic circumstances of the company's supply chain(s), is a necessary step for supply chain due diligence for RBC. It is described in detail as Step 2 of the six step due diligence process from the OECD Due Diligence Guidance for RBC. This broadly involves first creating an initial, high-level picture of the company's areas of operation and types of business relationships to understand what information will be relevant to gather in more detail. Based on that initial scoping, companies can then prioritise collecting information on the company's high-risk activities, geographies, products and key supply chain issues to address.

Aside from product level traceability, companies can also seek to gather basic aggregate information on key suppliers in their supply chains. Gathering information on suppliers and sub-suppliers at key points in the chain can help obtain basic information in order to understand their possible exposure to risk, while avoiding costs of product level traceability and respecting confidentiality concerns of suppliers that may be reluctant to disclose supplier relationships and other information that they may consider to be commercially sensitive.

Inaccuracy of risk information: Areas of the supply chain where the information flow is distorted or lacking altogether could be an indicator of heightened associated risks of adverse impacts. In order to identify and address the areas of the business and value chain where risks are most likely to be present and most significant, businesses need reliable, credible, comparable and accessible information on risks from midstream and upstream supply chain actors. This includes, for example, reports of human rights abuses, the presence of armed groups near production sites, bribery, tax evasion, labour conditions, environmental management, etc.

On-the-ground risk or incident reporting/sharing is common practice among many industry initiatives. However, companies face challenges with gathering, verifying and sharing this type of qualitative information. A major issue is that assessments of this information are subjective, context-specific, and subject to frequently changing circumstances. The purpose of due diligence is to anticipate and prevent or mitigate adverse impacts. An important characteristic of due diligence to note here that the due diligence process is not static, but ongoing, responsive and changing. It includes feedback loops so that the enterprise can learn from what worked and what did not work. Enterprises should aim to progressively improve their systems and processes to avoid and address adverse impacts. Through the due diligence process, an enterprise should be able to adequately respond to potential changes in its risk profile as circumstances evolve (e.g. changes in a country's regulatory framework, emerging risks in the sector, the development of new products or new business relationships).

Incentivising uptake of due diligence: An important factor to help prevent/mitigate risk is playing a part in helping to formalise key actors in the supply chain. Vulnerable supply chain actors operating in areas of weak governance (artisanal miners, farmers, home workers) often face challenges to securing financing due to their inability to provide important financial information to banks or difficulty in even accessing financial institutions. This can lead to those individuals turning to illicit sources of finance and logistical support for their operations, which in turn can perpetuate their problems.

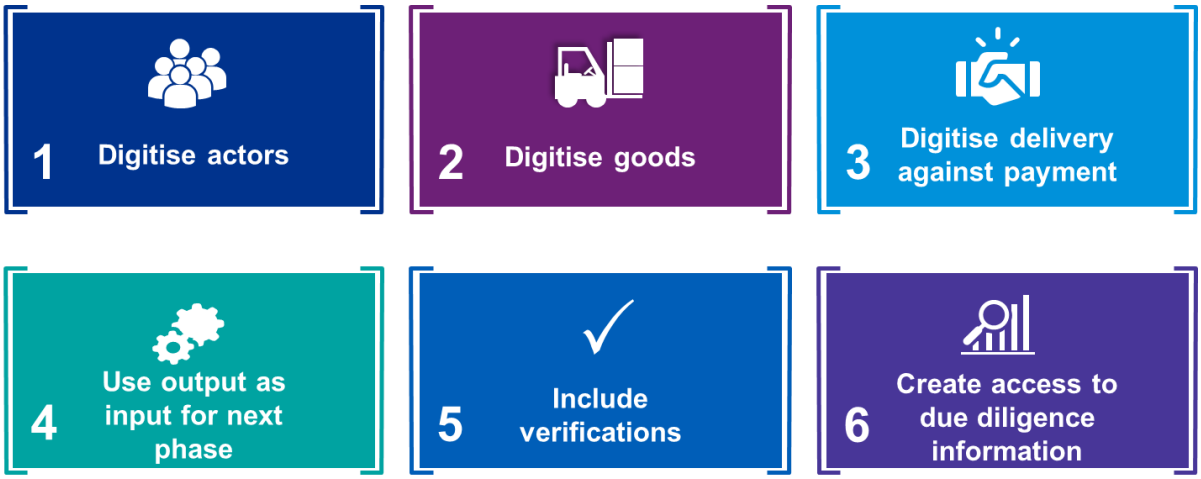
Financing of due diligence: Price pressures can also make it difficult for companies to invest in due diligence or participate in programmes (e.g. prices are negotiated down, as expectations for

compliance go up). Also, these risk assessments can be quite costly to implement and have access to. Another challenge is how to share the cost equitably, so that the information gathered and transmitted downstream has value, and those that use/benefit from on-the-ground due diligence information pay for it.

2.2. Existing blockchain initiatives: Practical application

As explained in chapter 1, the vision for blockchain infrastructures is to create a shared ledger for all parties in a supply chain in which information is available on how assets are exchanged between the different players in the ecosystem. The key idea is to create a "digital twin" of physical assets so that the digital twin can be traced through the shared ledger. This digital twin is recorded in the immutable shared ledger and used by subsequent actors in the value chain as input for their decision making and risk management processes. If all supply chain actors participate in this shared ledger, this creates end-to-end traceability and chain of custody during all stages in the supply chain.

Figure 6: Blockchain practical application



Setting up a blockchain solution in supply chains generally requires the following steps:

1. **Identify actors**: As a first step, all actors in the supply chain need to be identified and assigned roles based on their position in the supply chain. In the case of wine, for example, the key actors are the grape grower, the wine producer, the bulk wine distributor, the filler/packer and retailers.
2. **Digitise assets and related properties**: Each actor digitises its own assets to create a digital twin on the blockchain as a starting point for creating a digital trail of the physical goods. This can be done in a coordinated way to ensure that the same types of assets are digitised uniformly. In the wine supply chain, the grape harvest would need to be digitised by the grape grower logging the growing conditions as objectively as possible (e.g. through smart sensors and recording certain information of pickers) and adding this to the blockchain. Existing approaches include physical tagging of the material or logging chain of custody information. Some examples that tag material, also record supplementary information along the supply chain. In line with OECD due diligence guidance, such information can include a company's RBC policies and information on management systems, as well as audit reports or certificates.

3. **Digital settlement of asset delivery against payment**: When goods are delivered to the next actor in the supply chain, settlement of the transaction can occur instantaneously using a digital currency once the next actor confirms receipt of the physical goods and digital twin.
4. **Digitise manufacturing and production workflows:** Each actor digitises its own workflow and declares it to the network for validation and approval. Validated workflow data elements are used as smart contract parameters, and as a basis for anomaly detection.
5. **Link outputs to inputs**: Each subsequent actor in the value chain would link the inputs it uses to the (digital) output created in the previous phase and then add on any new output information following their production process. For example, in minerals supply chains, when a raw material changes form (e.g. gold ore to bullion bars), the traceability system should link outputs to inputs by logging certain characteristics of the transformed material (e.g. the weight and quality), generating a mutually agreed upon identification number for the new output, and adding this information to the blockchain.
6. **Include verifications and risk profiles**: Crucially, a blockchain-based due diligence process does not replace the responsibility of business actors to carry out verification of information inputted into the blockchain. Blockchain is a means to gather, store, and analyse due diligence information, but does not replace the human element. Assessments of business relationships, such as on-site inspections and audits, are still an important part of a risk-based approach. The type of assessment that an enterprise employs will be tailored to the nature of the risk. The outcomes of these controls/audits can be uploaded by authorised parties on the blockchain, allowing supply chain actors to have a view on the risk landscape throughout the supply chain, depending on the type of blockchain permission structure being implemented. For example, a certification agency could file its inspection report on a site visit of a grape producer on the blockchain, or a merino wool farmer could upload a certificate of non-mulesing (an animal cruelty prevention measure) to its raw material digital twin when it is first written to the blockchain.
7. **Create access to due diligence information**: Supply chain actors should be able to view the due diligence information on products and materials in their supply chains. In line with the OECD due diligence approach, the blockchain should enable meaningful disclosure to the public and other relevant stakeholders.

The blockchain vision means building up a shared ledger in which all actors in the value chain log their activities, thus creating a single source of truth for the entire supply chain. As only outputs registered on the blockchain from actors in an earlier phase of the supply chain are used as input to a next stage, and the digital information registered at each stage is linked to the digital information from the previous state, this prevents any reconciliation issues.

Importantly, that supply chain actors operating in areas of low governance and in informal working conditions – often the most vulnerable to adverse impacts – may struggle to access this technology. Companies using blockchain to implement supply chain due diligence would have to pay particular attention to these groups in a way that is consistent with the Guidelines. Affected groups include, for example, artisanal and small scale miners, migrant agricultural workers, and homeworkers in the garment sector.

Despite investments in blockchain being at an early stage, several initiatives have already started to emerge to meet increasing expectations for organisations in terms of due diligence. Table 1 provides some examples of new initiatives and the due diligence challenges they were created to address.

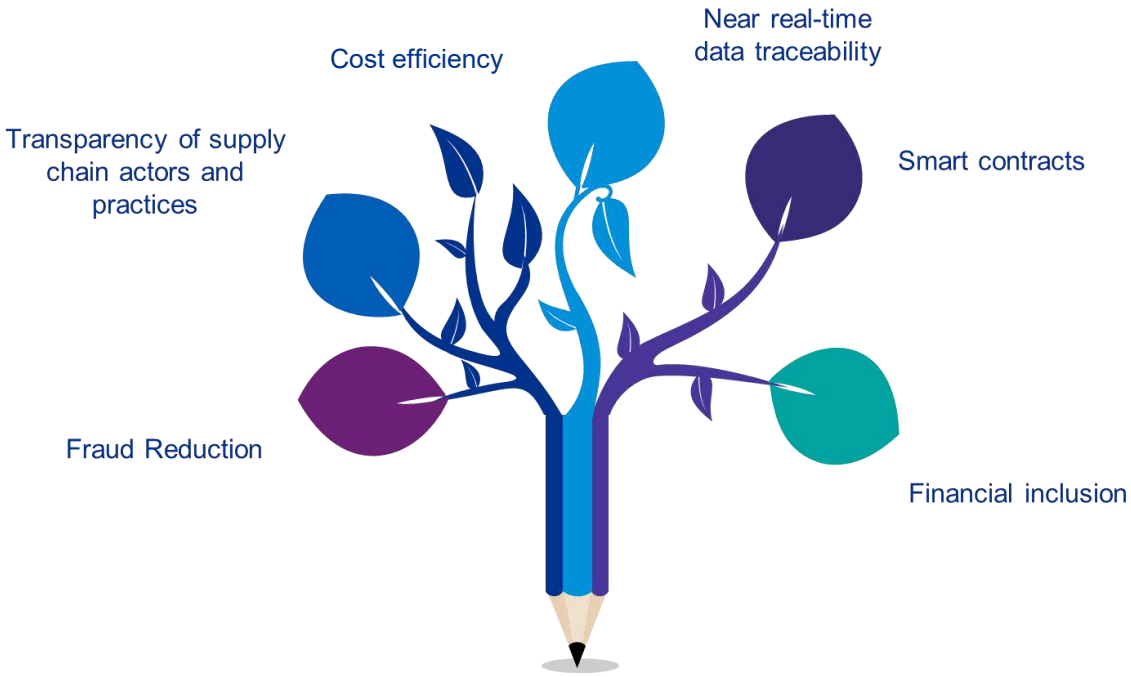
Table 1. Examples of due diligence initiatives using blockchain and their intended purpose

Sector	Initiative	Due diligence challenge to address
Garment	Hugo Boss	Increase transparency and traceability in garment supply chains and integrate RBC requirements into smart contracts.
Garment	United Nations Economic Commission for Europe (UNECE) (Feitelberg, 2019)	Increase interoperability between emerging blockchain initiatives in the garment and footwear sector through a standardised tool to collect and exchange data and information on compliance with due diligence/sustainability requirements along the entire value chain.
Agriculture	AB InBev (Knapp, 2019)	Promote financial inclusion, fair payment, and supply chain efficiency by connecting directly with small-scale farmers through smart contracts and mobile banking services.
Agriculture	Pooley Wines (KPMG, 2019b; FutureIoT, 2018)	Increase supply chain transparency by providing wine consumers with detailed traceability and audit information of supply chain actors.
Minerals	Barksanem (Barksanem, 2019)	Promote financial inclusion and fraud reduction by incentivising formalisation of artisanal and small-scale miners through the use of virtual currency.
Minerals	Responsible Minerals Initiative (Responsible Minerals Initiative, 2019)	Development of guidance to increase interoperability between emerging blockchain initiatives in the minerals and metals sector by creating data ontology of key traceability information of data collected from the mine to the refiner.
Minerals	Volvo Cars + Circulor + Kumi Consulting	Tracking origin of cobalt used in electric vehicle batteries. Chain of custody underpinned by third party supplier audits on RBC practices.
Information and Communications Technology (ICT) and Other Sectors	Trust Your Supplier (TYS) Network (Computerworld, 2019)	Blockchain network to verify the credentials and certificates of suppliers. Network includes IBM, Anheuser-Busch InBev, GlaxoSmithKline, Lenovo, Nokia, Schneider Electric and Vodafone.

2.3. Desired outcomes of initiatives

With a basic understanding of what a blockchain solution for supply chains would look like, this paper can explore the potential benefits of such a solution and the implications for responsible business conduct.

Figure 7: Blockchain: Desired outcomes of initiatives



— **Real-time data traceability**: If all actors in a supply chain log their interactions in a shared ledger this could potentially create traceability and a complete chain of custody for the entire supply chain. Reliable data tracing the flow of goods and services across a supply chain is considered a critical aspect of the OECD due diligence process and a shared ledger providing real-time data traceability could enhance a company's due diligence process. For example, a local distributor in a consuming country would be able to trace the bottle of wine sold back to the original grape producer. If reasonable evidence exists that a farm linked with irremediable human rights abuses is located in the supply chain, the time and costs will be significantly reduced by knowing exactly which batches are to be targeted and how to target corrective action with the relevant supplier.

— **Transparency of supply chain actors and practices:** A shared ledger would create visibility of actors in the supply chain. Indeed, a blockchain solution could be used by actors to publish their RBC policies. A shared ledger can also enable transparency of payment data, particularly where there is high risk of exploitation of vulnerable production networks such as homeworkers. To further strengthen the company's due diligence processes, third party assessors could be given permission to publish assessment results in a way that is easily accessible by other relevant supply chain actors.

— **Fraud reduction**: If all actions of supply chain actors are logged on a shared ledger and outputs from earlier actors are used as inputs for next actors, this creates transparency of the flow of goods and reduces the potential for fraud – provided that robust digital twins have been established for the goods and there is quality control on the actions registered. In the case of wine, a wine producer cannot produce more wine than grape harvest received from the grape grower. In addition, counterfeit products will be easier to identify given their lack of a digital audit trail. In the context of the minerals sector, a common red flag for illicit conduct that would

require deeper due diligence is a sudden surge of raw materials from a supplier or country that does not normally produce those volumes. Easy access to information on the blockchain adds to the efficiency of focussing due diligence activities, as information relating to risks would be easier to triangulate and verify.

— **Smart contracts**: If actors and their assets are digitised on a single platform, this provides the opportunity for cross-organisation automatisation. Automatisation is defined as the use of technology to allow processes to take place without human input or work. In the blockchain context, the use of automatisation to facilitate the execution of a business transaction is commonly referred to as a "smart contract". Smart contracts result in cost reduction and efficiency gains for all parties involved. Smart contracts further reduces the risk of non-compliant behaviour in the supply chain and lead to greater formalisation of relationships and information exchange.

— **Cost efficiency:** The efficiency and automatisation potentially yielded by a blockchain solution could free up capital that was previously used to support individual operations. However, there is a still a challenge to make sure that the costs and efficiency dividends are fairly shared. Some of these efficiencies may be the result of greater uptake and value chain cooperation.

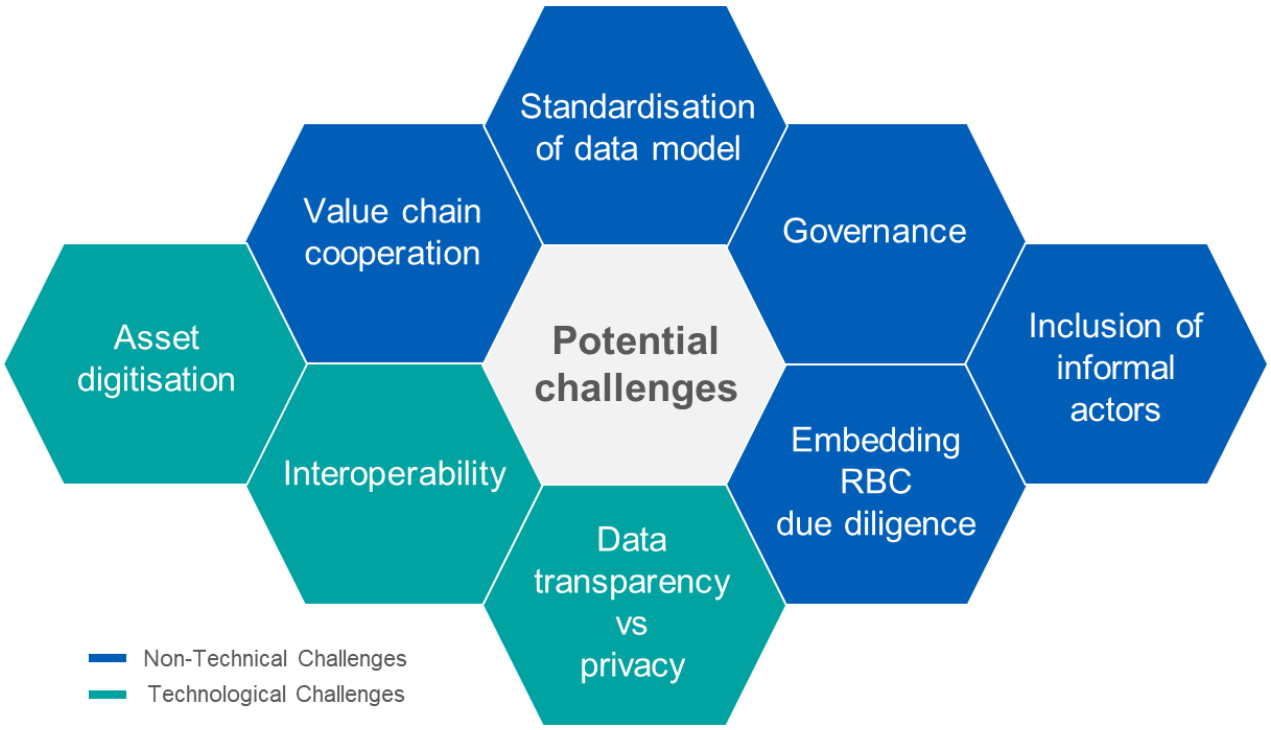
— **Financial Inclusion:** Vulnerable supply chain actors operating in areas of weak governance (e.g. artisanal miners, farmers, home workers) often face challenges to securing financing due to their inability to provide important financial information to banks or difficulty in even accessing financial institutions. This can lead to those individuals turning to illicit sources of finance and logistical support for their operations, which in turn can perpetuate their problems. Being part of a blockchain system could create financial inclusion either through secured and efficient transaction with an exchangeable virtual currency or through creating more detailed records of business transactions in order to apply for banking services.

It is important to note that while the use of blockchain technology can address a number of these challenges, increased supply chain traceability and transparency from the use of this technology does not replace the entire supply chain due diligence process. Thus, questions remain regarding the use of blockchain to help reduce adverse impacts or mitigate risks (e.g. child labour or conflict finance in supply chains), as well as the potential impact on remediation obligations for companies.

Chapter 3 Challenges in blockchain adoption

Since 2014, a significant number blockchain Proof-of-Concepts, Minimal Viable Products and some production blockchain platforms have been launched. This chapter will take a critical look at whether blockchain is an appropriate solution to due diligence challenges and explore relevant obstacles encountered during the development of blockchain projects. Section 3.1 focuses on non-technical challenges from blockchain projects before exploring the technical challenges in 3.2.

Figure 8: Challenges in blockchain adoption



3.1 Non-technical challenges

Embedding responsible business conduct

As explained in chapter 2, blockchain solutions for supply chains will typically focus on the flow of goods in a supply chain. While various supply chain blockchain solutions might facilitate the due diligence process, incorporating RBC considerations in a blockchain solution will depend on the type of organisation at the origin of the initiative. For traditional businesses, the due diligence process is likely to not be the first driver for setting up the blockchain solution. However, early involvement in multi-stakeholder groups (e.g. with civil society groups, government representatives, and local community leaders, etc.) may have the potential to mitigate risks and facilitate the due diligence process in an effective way.

Inclusion of informal actors and other vulnerable groups

A blockchain solution is only as good as the parties it links and the extent to which they are willing to collaborate. Thus, for a comprehensive due diligence process, the blockchain needs to include all parties that contribute to the journey of a product. The challenge then lies within the so-called 'first mile problem' of supply chains, i.e. the road from the farmers (first mile) to the customers (last mile). Several issues can arise regarding the first mile problem. Indeed, often times, the first producers are low-income smallholders who operate without a working contract and are practically anonymous to players further in the chain. In addition to informal actors, other vulnerable groups may lack access to participation in the blockchain as well e.g. individuals in rural areas without technical infrastructure, homeworkers who are denied access to telecommunications services (smart phones), etc. This is the stage where a high risk of human rights violations and corrupt practices arises. A blockchain solution that aims to facilitate the due diligence process would need to find a way to incorporate these actors, e.g. by using mobile infrastructure capabilities that tend to be better developed than traditional infrastructure in developing countries. The infrastructure and technology for blockchain-based applications need to be carefully selected, especially for the upstream parts of the supply chain, in order to avoid creating de-facto barriers to entry especially for informal actors. Just as well, blockchain initiatives would have to identify the right partners on the ground, who understand the context and are trusted by informal actors, to further facilitate uptake in a way that effectively addresses risks.

Standardised data model

A common lesson learned from blockchain projects is that creating a shared ledger inevitably means that participants to the shared ledger need to agree on the definitions used in the shared ledger. Creating a standard data model for a value chain is likely to result on numerous and lengthy detailed discussions between the participants, since this is the moment that the differences between the current historically grown silo administrations of the participants become apparent.

Blockchain projects typically move faster when a standard data model already exists.[1]. Other blockchain projects such as the Blockchain in Transport Alliance (Bita, 2017) are leading the effort to develop and embrace a common framework and standards for their industry (in case of BITA transportation, logistics, supply chain and freight). The key challenge is to collaborate with value chain participants in a non-competitive initiative which will create a common language for the entire industry in the future.

Value chain cooperation

To achieve traceability, it is important that all actors in the value chain cooperate in a single initiative that could potentially serve as an industry utility. Blockchain projects typically involve competitors from the same industry cooperating in a joint initiative, which may be quite a cultural barrier to overcome and in which anti-trust regulations need to be carefully considered. Clearly, an initiative is more likely to succeed if the number of value chain participants is relatively small. As an example of a blockchain network based on a short-value chain, blockchain start-up VAKT was a created by a small group of key stakeholders in the North Sea crude oil trade: 3 major oil companies, 3 large banks and 3 trading houses, with the objective to reduce time spent on operations and make trading more efficient.

In a broader sector wide effort, the Responsible Mineral Initiative (RMI) introduced voluntary guidelines to drive the common adoption of definitions and concepts in the application of blockchain-enabled solutions for minerals supply chains. The RMI Blockchain Guidelines seek to

[1] For example, the B3i project https://b3i.tech/ using the ACORD data model https://en.wikipedia.org/wiki/Association_for_Cooperative_Operations_Research_and_Development.

standardise data and promote interoperability for blockchain applications in mineral supply chains, which could reduce the fragmentation of blockchain projects by recommending a set of fundamental attributes for projects to include.

Another key step in creating a supply chain verifiable by blockchain technology is convincing all actors to provide sufficient detail about their internal due diligence processes. An accurate digital representation of manufacturing or production workflows is required to reliably connect a physical input – and its digital twin – with a new physical output. Workflows can be audited and approved by network participants, and, where appropriate, used as parameters in smart contracts, e.g. audited production capacity is used to validate mass balance calculations.

For implementation in supply chains, getting stakeholders involved and aligned is likely to be challenging given the global nature and enormous number of participants in most supply chains. In addition the alignment of incentives of the stakeholders, fair allocation of benefits from the platform as well as the allocation of costs for developing a shared ledger seems to be a larger issue for supply chains that typically involve huge imbalances in (economic) power between participants (e.g. small farmers at the beginning of the value chain and much more powerful multinationals upwards in the value chain). Without strong multi-stakeholder participation, many of the benefits of the technology are likely to not be realised.

Governance of the blockchain

Creating a shared ledger requires the development of a governance structure to define roles and responsibilities for the participants in the network. The governance structure needs to address basic questions on entry and exit participants, validation of transactions, role and responsibility of nodes, change management of business logic, legal structure, appointment and dismissal of management, jurisdiction, dispute resolution etc. Best practices could include the following, but remains to be developed as initiatives are still relatively young:

- Aligning incentives with the participants' goals, keeping the incentives relevant with the needs of participants over time.
- Establishing a defined process through which participants can decide on future changes to the governance model.

While the objective of decentralisation is at the origin of blockchain technology, it has been observed that the majority of projects appear to result in new legal entities created and owned by the traditional existing participants in the value chain. Companies should look to existing multi-stakeholder initiatives before creating new projects. International organisations such as the OECD can play a role to facilitate cooperation, and governments are called upon to ensure policy coherence and develop standards.

3.2 Technological challenges

Asset digitisation

Blockchain is a secure way to record the factual control of digital assets and transfers of these assets between digital identities, for example the purchase of a digital music recording by an individual, or a music company. However, for a blockchain to record a non-digital asset (e.g. sugar, coffee, and grapes) a digital twin needs to be created, a process that is commonly referred to as tokenisation. A commonly overlooked fact is that an entry in the blockchain for a digital twin will only as reliable as the party that first created the digital twin on the blockchain. What would stop a fraudulent actor from creating digital twins for goods that do not actually exist? In addition, further entries in a blockchain about a digital twin are also only as reliable as the source of the data. For

example, what is to stop incorrect data being registered (by mistake or for fraudulent motives) about the truck that is scheduled to pick up goods at a seaport?

The core mitigating strategy is to try and make the physical product unique by tagging technologies such as RFID or QR codes or Internet of Things sensors to minimize human input into the shared ledger. The less unique a physical product, the more important is a technology to artificially create uniqueness. Even with a solution for creating unique digital twins for physical products, periodic validation of the link between digital asset and physical assets by an independent assessor will be essential to establish trust and to guarantee data quality in the shared ledger.

Interoperability

Blockchain entails creating a shared ledger in which enough value chain actors participate based on a standardised data model. However, the current reality is that many companies are already using software solutions like Enterprise Resource Planning (ERP) systems to manage their business processes based on their own data definitions, which typically link to internal accounting and risk management systems. This presents a significant implementation challenge for newly developed blockchain solutions. While it is observed the emergence of ERP providers who are developing a service offering to link existing ERP solutions to shared blockchain ledgers, the sheer volume of existing IT applications will complicate blockchain solution adoption. For example, the average cellular phone has approximately 45 different raw material inputs, with multiple fragmented blockchain traceability initiatives already existing for some of these such as tin, cobalt, and gold. The recording and collection of data from different blockchains on these raw materials thus risks becoming an additional burden, rather than a source of cost savings and efficiency. In addition, some actors in the value chain might also participate in other value chains (e.g. banks, insurance companies, transporters) which may have their own blockchain technology solution in place.

One potential way to create interlinkages between legacy systems and blockchains, as well as between blockchains, is the use of Application Program Interfaces (APIs), however when working with multiple value chains this can begin to create significant computing and cost overheads. As a result, interoperability between different blockchain technologies is a key area of exploration for companies interested in adopting blockchain.

Data transparency vs privacy

As discussed in figure 2 of chapter 1, viewing rights to blockchain transactions can be set up as open or closed and adding transactions to the blockchain can be open or restricted to specific stakeholders. For supply chain transparency purposes open blockchain solutions is an option based on a principle of maximum transparency to all users. However, there may be commercial, regulatory and other reasons that may prevent actors from choosing an open platform. From a commercial point of view, companies may not want to disclose all parties in their supply chain to the full detail to their competitors, let alone the financial details of buyer / supplier transactions. From a regulatory point of view strict data privacy regulations (e.g. GDPR) may prevent certain data, particularly personal data (e.g. individual farmer data), from being accessible through a blockchain solution. Other reasons not to opt for an open platform may include that producers may not want customers or competitors to understand every detailed transition in the production process. Techniques are being developed, such as zero knowledge proofs, which can improve confidentiality in a public ledger (ING, 2018). These techniques might drive adoption of open platforms in the future. Especially for supply chains the type of blockchain platform and related data transparency or privacy option to choose presents a very fundamental design choice as well as the ownership and related commercialisation of the data.

Chapter 4 Conclusions, considerations and recommendations

4.1. Conclusions

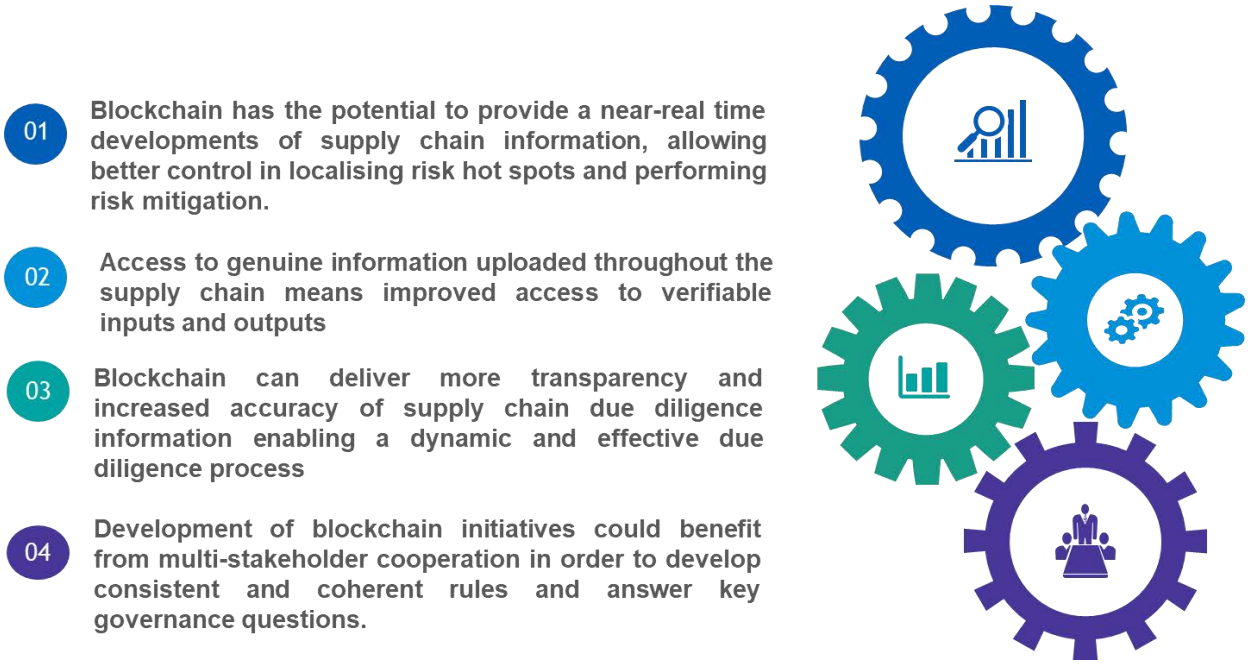
This paper considers the role blockchain technology may have in facilitating responsible supply chains. As highlighted in Chapter 2, organisations face a number of challenges when conducting effective due diligence for responsible business conduct. Having explored a number of use-cases as well as the obstacles that arise when implementing a blockchain solution, this paper concludes the following (see also figure 9):

1. Under the caveat that companies have already mapped out their entire supply chain, a blockchain layer connecting all the parties could provide a near-real time overview on all transactions occurring throughout the supply chain, thus allowing for better control in localising risk hot spots and performing risk mitigation. However, this will only apply for those parties who can actually be connected to the blockchain. Informal actors along a supply chain will be difficult to integrate in such a system, meaning that tracking RBC risk information associated with upstream activities in the supply chain will remain a challenge.
2. The immutable nature of a blockchain will enable an organisation to have improved access to verifiable data. Nevertheless, as long as there is a human component to uploading information, there is always the risk of inaccuracy. As such, two aspects will be imperative to be integrated in the due diligence process:
    - Assurance – Regular checks throughout the supply chain are still required to ensure that the human input to the blockchain matches the situation on the ground.
    - Automatisation – Minimise needs for certain human input through allowing Internet of Things sensors to upload data to the blockchain. Smart contracts will enable automatic transactions to take place, but attention needs to be given to their implementation.
3. Blockchain can deliver more transparency and increased accuracy of supply chain due diligence information. This will enable companies to have a dynamic and effective due diligence process, including being able to disclose accurate information and take actions to prevent and mitigate risk.
4. The development of blockchain initiatives could benefit from multi-stakeholder cooperation to create consistent and coherent rules, answer key governance questions, and ensure integration of RBC principles.

A common recurring question for any blockchain project is whether the objectives of the project could have been achieved without blockchain technology. One could argue that if the non-technical challenges (standard data model, value chain cooperation, governance) and technical challenges (asset digitisation, interoperability and data transparency) are solved many of the same value chain transparency benefits could be achieved with traditional database technology.

It is too early to say whether blockchain can add value to companies' existing supply chain due diligence efforts, but there is certainly potential. However, for companies considering adopting blockchain technology, this paper offers considerations and recommendations to make sure its use is aligned with internationally accepted responsible business conduct standards.

Figure 9: How blockchain seeks to address due diligence challenges



4.2. Considerations for governments

Governments have a responsibility to enable RBC and promote policy coherence. With respect to the adoption of blockchain technology for supply chain due diligence, governments can provide instrumental support in the development of different initiatives. Key to this will be the following measures:

a. Facilitating governance model development for blockchain initiatives, specifically encouraging alignment with internationally accepted standards on RBC, including the Guidelines, the UN Guiding Principles on Business and Human Rights, and the ILO Tripartite Declaration.

b. Developing clear guidance on the use of blockchain technology to facilitate recording and exchange of government data (e.g. land registries, financial data, citizen identification information, etc.).

c. Promoting the development of standard data models through participation in multi-stakeholder initiatives.

d. Working with other governments and international organisations to align policy development and guidance for use of blockchain for responsible supply chains.

e. Providing guidance on how to apply existing regulations on data transparency and data privacy, e.g. by issuing guidelines and creating an enabling regulatory environment to encourage experimenting with innovative projects.

4.3. Recommendations for businesses and other implementing organisations

Businesses are expected to implement supply chain due diligence to identify and address actual and potential adverse impacts in their supply chain. In an effort to make the due diligence process more efficient, some businesses are adopting blockchain technology. This non-exhaustive list contains recommendations for business to ensure that use of this technology aligns with international standards on supply chain due diligence. These recommendations are relevant to business organisations across the supply chain, as well as multi-stakeholder initiatives, blockchain service providers, and public sector organisations with supply chains, such as government procurement agencies:

a. Understand that adopting blockchain technology does not dispense a business from conducting full due diligence as expected under the Guidelines and explained in the OECD Due Diligence Guidance for RBC. A blockchain solution should not supplant or replace other due diligence efforts and in fact forms part of a more complete process. For example, on-the-ground verification of information will likely still be necessary.

b. Do not duplicate efforts. Build on existing multi-stakeholder initiatives before developing your own.

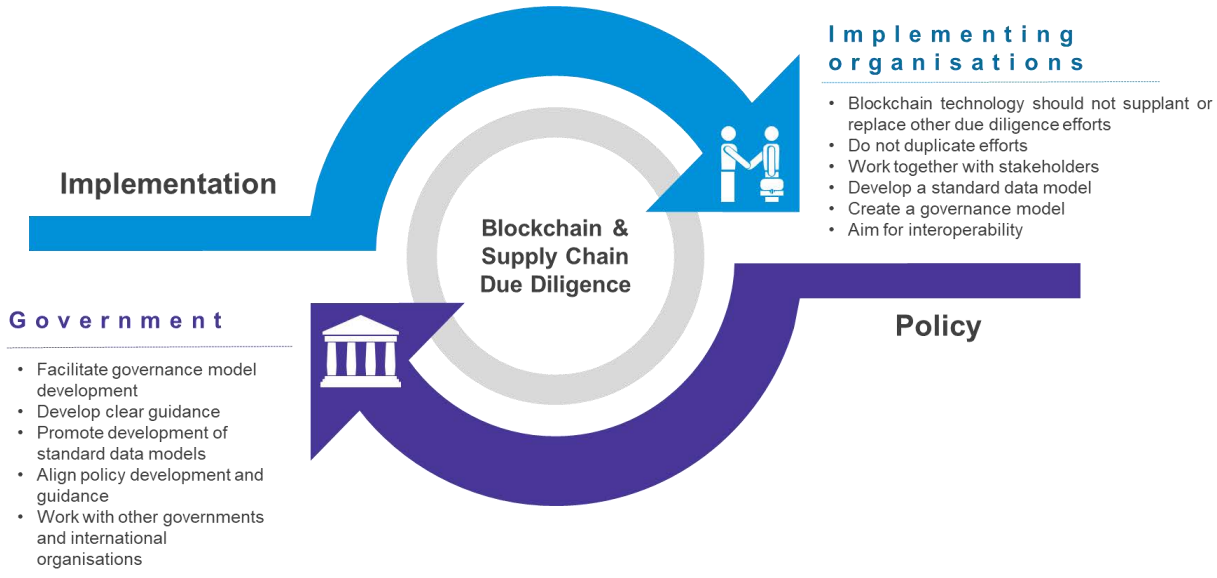
c. Work together with stakeholders, in particular, considering the impacts on vulnerable groups in the supply chain and in communities where business operations take place. Ensure the adoption of blockchain technology does not impede the access of vulnerable and informal actors to global supply chains by implementing technology solutions with low barrier to entry as a conduit to blockchain.

d. Develop a standard data model as basis for cooperation within your value chain, in alignment with existing initiatives seeking to address this issue.

e. Create a governance model that defines the basis for cooperation, in alignment with existing policy and guidance.

f. Aim for interoperability between existing IT systems and the newly developed blockchain platform as well as with other (blockchain) platforms in your value chain.

Figure 10: Summary of considerations and recommendations



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