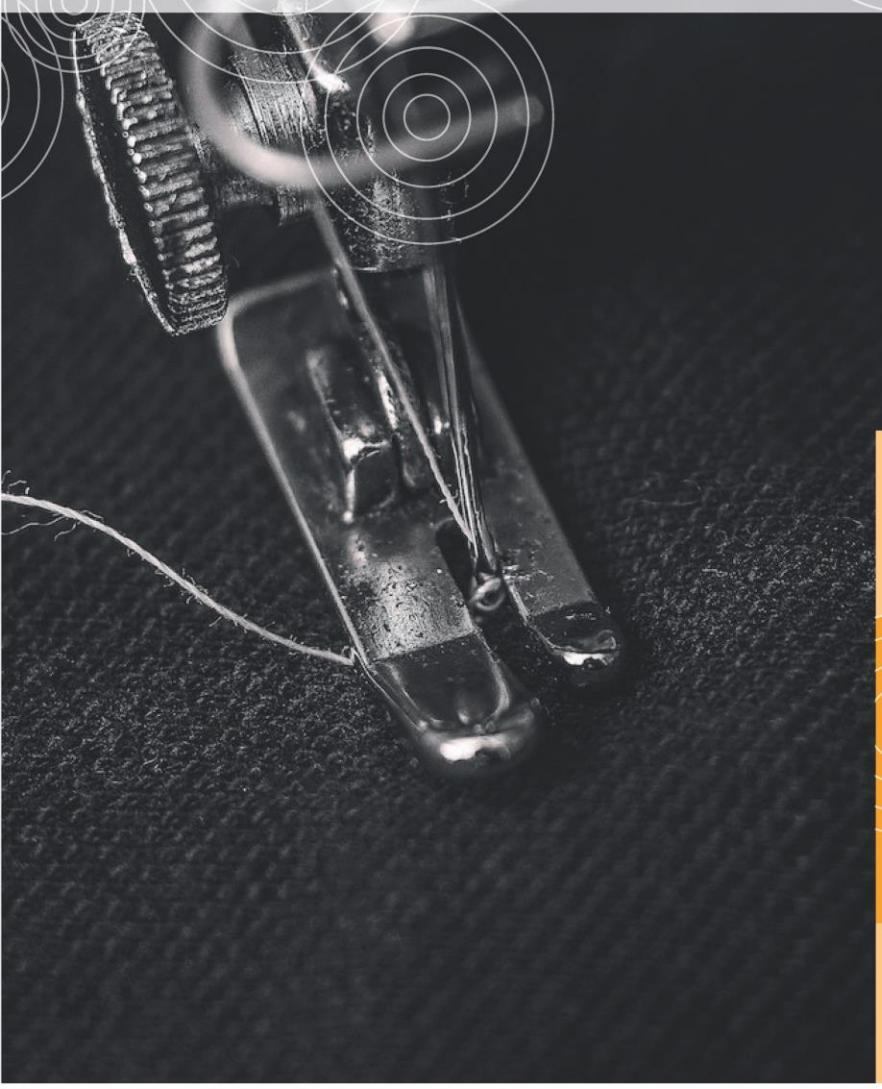
Blockchain for more sustainable value chains



Sector Network
Assets for Asia

Sustainable Economic Development in Asia

Realistic scenario or barking up the wrong tree?
An assessment based on the example of the garment sector.

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This study has been commissioned out of the Assets for Asia Network's Challenge Fund and the sectoral project "Sustainability standards and public-private responsibility".

The sectoral project "Sustainability standards and public-private responsibility" is implemented by GIZ on behalf of the Federal Ministry for Economic Cooperation and Development (BMZ). The goal of the sectoral project is to support sustainable consumption choices of public and private actors and to foster a shift towards more sustainable production processes. The promotion of sustainability along global supply chains for the benefit of society and the environment alike is the basis of collaboration among the project partners. Translating this ambition into action is the goal of the study.

About the Authors:

Andreas Freitag works as Senior Manager and Blockchain expert at Accenture. He works intensively on Blockchain technology and possible applications since 2015. In recent years he has designed and implemented forward-looking Blockchain projects in the public sector and in the energy sector.

"I am Blockchain Realist and look forward to assisting understanding the technology, discovering the possibilities and implementing projects beyond the hype. Personally, I see the greatest potential of Blockchain technology in the public sector. Blockchain is a technology that massively complicates fraud and corruption, creating legal certainty that is a fundamental foundation for a prosperous and well-functioning society, "-Andreas Freitag

Miriam Weber works as Manager and Blockchain expert at Accenture. She is working with Blockchain technology since 2016. She is engaged in Blockchain projects in the financial industry.

"Through my work in micro-finance and participatory agricultural development, I have gained experience in the hardships many face. When applied correctly Blockchain can bring a leap of empowerment to vulnerable actors. I am excited to develop this potential further, defining the future of a balanced and fair garment industry."- Miriam Weber

A special thanks to Harshit Nigam and Chirag Kakkar from Accenture India who conducted the onsite interviews in Bangladesh, India and Pakistan.

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1 EXECUTIVE SUMMARY

Since the invention of Blockchain technology in the year 2008, the main focus was on the impact in the financial industry. In the last years others discovered the unique features of the technology like immutability, transparency and decentralization. Including the supply chain business. The main goal is to make the administration of the supply chain (including transport and trade finance) cheaper and faster.

But Blockchain technology can also bring more transparency to global value- and supply chains and make them more sustainable. With a Blockchain based system all parties in the process can make decisions based on transparent and insured data. Authorities and regulators can automate monitoring compliance with the law and make better use of their resources.

Furthermore the technology has the potential to improve living, environmental and economic conditions in developing countries overall. It can help to fight corruption[1] and foster legal security, both fundamental preconditions for prosperity. Because of the promises, GIZ decided to carry out the study and answer the following question:

"How can blockchain technology help to improve the social, environmental and economic performance situation in garment supply chains?

To answer the question we first identified 34 Blockchain use cases in the garment industry. Out of these, six use cases have been selected with the premise to cover social-, environmental- and economic aspects to ensure diversity. Over 30 interviews were done in Bangladesh, India and Pakistan to assess the use cases with stakeholders. Based on the answers and data collected during the interviews, the selected six use cases have been analysed in detail. The selected use cases are:

- **IoT Tower – Measuring Environmental Parameters**: A device measures environmental parameters like air quality, temperature and humidity in production facilities. The results and the device are secured via Blockchain technology. Regulators, authorities and clients can monitor the parameters in real time.
- **Tagging of Final Products:** Final products e.g. RMG garments will be enhanced with a chip and tagged along the production line storing registries on the Blockchain. The tag increases transparency during the supply chain and is a strong proof of origin.
- **Legal Documentation:** This use case aims at providing a transparent and secure registry of documents (e.g. labour contract, audit results, etc.), with a time-stamp of upload; independent of a central authority. The goal is to create transparency for workers, use it for audit logs and as a certificate of authenticity for documents which has to be exchanged between stakeholders e.g. retailer and producer
- **Management of Funds:** Funds can be tracked via a single source of truth based on a Blockchain platform. The transparency of projects and the use of funds would be higher as it is now. Fraud and corruption would be harder, managing of the funds easier and cheaper.
- **Alternative Financing:** This use case aims at establishing a micro-credit and micro-insurance platform for small entities on a crowdfunding or peer-to-peer lending basis.
- **Training and Certification Platform:** For trainings that are attended the participant receives a training token. This provides a transparent history of all taken/finalized trainings. In addition this token can be exchanged for additional internal services (for example free snacks in the canteen or similar). This also increases employability of the participant when they find opportunities outside their current employer. Employers on the other hand benefit from trained workers whose training level and history can be verified.

[1] https://www.transparency.org/news/feature/corruption_perceptions_index_2016#table; Retrieved September 25th, 2018

The study has identified two main areas for application of Blockchain technology for GIZ:

Internal use of Blockchain technology:

GIZ can use Blockchain platforms[2] (chapter "5.4 Management of Funds") to manage GIZ projects and funds for more transparency and make corruption harder.

GIZ as facilitator and bridge builder:

A Blockchain project needs more than one player to add value. Blockchain projects include various stakeholders. Even competitors form consortiums to run Blockchain projects, e.g. R3 for banks[3], B3i for the insurance industry[4], or VAKT for energy trading[5]. **GIZ** is in a good position to bring stakeholders (retailers, producers, farmers, authorities and regulators) together on a global level into a consortium and **act as a facilitator** for a project. We recommend that GIZ should focus on few use cases and **define a first project with a short duration and scope**. We do not recommend a lighthouse project with a long runtime and a considerable budget: the risks are too high because Blockchain is at its beginning and there is almost no experience within production environments. In the appendix chapter "6.2 Promotion of the Technology by GIZ" we defined a blueprint for running a first project with other stakeholders

The study covers a variety of topics, from stakeholder analysis to technical architecture to provide a deeper understanding. Taking into account the time and resources available, not all topics were covered in detail. The following limitations of the study must be considered. The interviews were voluntary and conducted only in production facilities which have a strong focus to fulfil the expectations from customers. Raw material producers (farmers), small subcontractors and retailers were not interviewed. Considering reports in the media[6,7] and from NGOs, it can be assumed that there are multiple challenges along the supply chain.

[2] https://www.kfw-entwicklungsbank.de/Internationale-Finanzierung/KfW-Entwicklungsbank/News/News-Details_431872.html; Retrieved August 20th
[3] https://www.r3.com/
[4] https://b3i.tech/home.html
[5] https://www.vakt.com/shares-holder
[6] https://www.youtube.com/watch?v=_pIfJoigNF8; Retrieved September 26th, 2018
[7] https://www.pbs.org/newshour/world/bangladesh-leather-factories-child-labor-pollution, Retrieved September 26th, 2018

2 INTRODUCTION: BLOCKCHAIN & THE GARMENT INDUSTRY

2.1 BLOCKCHAIN TECHNOLOGY IN GENERAL

What is the Blockchain? What are the characteristics, what are the possibilities and what are the limitations? Before diving deeper into the use cases and industry specific topics, we will take a look at the technology itself and its main feature – the immutability of data.

We strongly recommend to go through the basics before proceeding with the use cases. If you are already familiar with the basics and potentials of Blockchain technology you can proceed to reading chapter “3 Selection of Use ”.

2.1.1 Glossary

Like every technology, the Blockchain profession has its own language and expressions. The glossary gives a brief overview about the most important phrases.

EXPRESSION	EXPLANATION
Blockchain	A Blockchain is a shared, duplicated and synchronized transaction ledger, with multiple writers & readers; transactions are verified through a technical consensus protocol, and the ledger is immutable. Famous representatives are Bitcoin or Ethereum.
Distributed Ledger Technology (DTL)	Blockchain is a kind of a DLT. It uses similar ideas and design principles. But there are other DLTs, that do not rely on creating blocks. The differences are other consensus mechanisms and in most of the cases a permission of the system is in place. There is no clear distinction between Blockchain and DTL. Representatives of DTL technologies are Corda from R3 or hyperledger.fabric from the hyperledger foundation.
Private / Permissioned Blockchains	Private Blockchains (often called Distributed Ledgers) have permissions in place. Only specific nodes are allowed to process transactions. With these limitations, other consensus mechanisms like proof of authority can be used. Higher throughput can be achieved and most importantly the energy consumption of a proof of work mechanism can be avoided.
Scalability	Scalability is the biggest challenge at the moment. Scalability means how many transactions the technology can process. Public Blockchains can process single-digit to small two-digit transactions per second. In a permissioned setup, three-digit numbers per second are possible.
Node	A node is a server / computer / smart phone / IoT device where Blockchain/DTL software is installed.
Consensus Mechanism	A consensus mechanism ensures that only valid transactions are recorded in the ledger and the transactions are immutable.
Proof of Work (PoW)[8] aka mining	Proof of work aka mining is a method to ensure immutability of data. A mining node tries to find a valid HASH code for the actual Block. The PoW mechanism was the first consensus mechanism which worked. But PoW has also some major shortcomings. The scalability is limited and it has an enormous energy demand.
Proof of Stake (PoS)[9]	Proof of stake is a further development. It was intended to eliminate the shortcomings of PoW and will be used in public Blockchains like Ethereum in the future. To be able to validate transactions, a node must place a “stake” on the Blockchain in a smart contract. After placing the stake, it can validate blocks. If the validator does something wrong unintentionally or intentionally, he loses the stake.
Proof of Authority (PoA)	PoA is used in permissioned/private setups. Only authorized nodes can validate transactions or blocks. It can be implemented in various ways e.g. 80% of authorized nodes have to sign a block before it gets valid.
On-chain / off-chain	Normally, files are not stored on a Blockchain because of cost/performance or/and privacy issues. If data is stored off the chain and is only linked via a digital fingerprint (HASH), it is called off-chain storage. On-chain storage is not common and limited to only few use cases.

Table 1: Blockchain glossary

[8] https://en.wikipedia.org/wiki/Proof-of-work_system; Retrieved September 25th, 2018
[9] https://en.wikipedia.org/wiki/Proof-of-stake; Retrieved September 25th, 2018

2.1.2 Definition of Blockchain

A standardized definition of Blockchain is not available at the moment. Also, a sharp line between Blockchain and Distributed Ledger Technologies (DLT) is missing. For the study we are using the following working definition:

"A Blockchain is a shared, duplicated and synchronized transaction ledger, with multiple writers & readers; transactions are verified through a technical consensus protocol; and the ledger is immutable."

2.1.3 Main feature of a Blockchain/DLT

The main feature of a Blockchain is **immutability.** Once data or a transaction is stored on a Blockchain, it cannot be changed or deleted. This most critical feature serves as basis for every Blockchain service and use case.

In a central or non-Blockchain scenario, a central party has the power and control over data, and the depending parties have to trust that this central authority does not tamper with it. As an example, internal organizations need to trust its software supplier to not build backdoors into the software and that the IT employees are trustworthy. With Blockchain-based systems, these trust challenges are solved by the protocol and its immutability. In short: With Blockchain you don't have to trust anymore.

The second important feature is the **decentralized and distributed** nature of Blockchain and DLT systems. The decentralization ensures a very high level of resilience (no single point of failure) and the distribution ensures transparency.

2.1.4 What is Blockchain Technology

There are still some myths around Blockchain that should be cleared up before the analysis of use cases.

- Blockchain is not only Bitcoin. Bitcoin was the first application of Blockchain, but Blockchain technology has evolved since 2008 and is more than Bitcoin or cryptocurrencies.
- Blockchain technology has some software design principles it must comply with: Blockchain Technology must be **decentralized**, **distributed**, **immutable** and **open source**.
  Permissioned systems have to be open source as well, otherwise the software cannot undergo peer review and backdoors can be implemented. A closed source Blockchain would be a contradiction to the design principles.
- The software has to be "installed" to get an instance of it. A Blockchain can be installed in a public network manner, or as permissioned. The access to permissioned Blockchains is restricted, not everybody is allowed to process transactions or/and to view transactions.

Other technologies are developed around Blockchains. Most of them address data storage or communication.

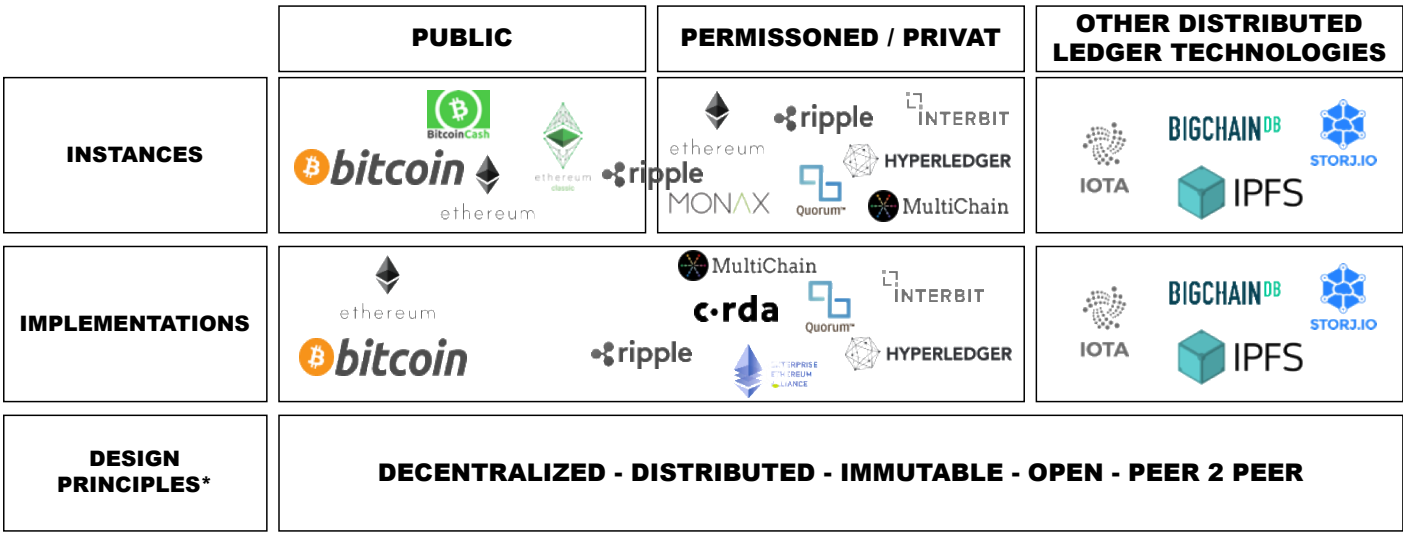

Figure 1: Design diagram

2.1.5 Challenges of Blockchain Technology

Blockchain solutions are continually evolving and it is worth noting that the technology still faces some major challenges. The following table gives an overview of relevant technological attributes that need to be considered. Main differences can be found between public and permissioned Blockchains, where the latter can overcome some limitations of public Blockchains. These limitations are considered in the use case analysis of this study.

	PUBLIC		PERMISSONED / PRIVAT
	bitcoin	ethereum	
SCALABILITY	max. 6 Tx/sec real 3 Tx/sec	max. 15 Tx/sec; real 6 Tx/sec Goal is to use different consensus mechanisms and sharding in the future	~200Tx/sec are possible because of different consensus mechanism
ENERGY CONSUMPTION	~300 kWh per Transaction (01/2018)! w/o AC	~25 kWh per Transaction (01/2018)! w/o AC Goal is to use different consensus mechanisms and sharding in the future	Similar to classical server, because of different consensus mechanism
COST	transaction fee >50$ (01/2018)	transaction fee <1$ (01/2018) Executing code (smart contracts) is very expensive	No transaction fee, but cost of operating the infrastructure
PROGRAMMABLE	Limited – only stacked based	Solidity, a language written only for Ethereum. Similarities with javascript	Different frameworks using different languages
GOVERNANCE	ALL major stakeholders have to agree on changes	Uses GPU mining and introduced new concepts like “ice age”	in private/permissioned setups, the governance can be shaped regarding the needs
SPEED	avg. 10 min Block time	10–15 sec Block time	2 sec possible
PRIVACY	every node has all data	every node has all data Goal is to use ZK-snarks	Can be solved with the right architecture e.g. data segregation via multiple chains

* Red: challenge/problem Orange: can be a problem Green: not a problem for majority of use cases

Figure 2: Challenges of Blockchain technology

Main challenges of public Blockchains are **scalability**, **energy consumption** and transaction **costs.** Taking these challenges into account, we do not consider public Blockchains as suited for real world applications to date. This is underpinned by the learnings of the last months, where start-ups had to suspend their services as public Blockchains did not cover their needs (e.g. share and charge[10], etherisc[11]).

The issue of scalability and cost have become evident with the cryptocurrency hype in 2017/2018, and a decentralized game on the Ethereum Blockchain called cryptokitties[12]. The resulting transaction volume exceeded the capacity of the public Ethereum Blockchain. To get their transactions processed, users needed to pay more fees than the others. Thereby the operation cost of the services skyrocketed. In general, if the maximum transaction capacity in public Blockchains is reached, the transactions with the highest transaction fees gets processed, beating the others.

On the other hand, public Blockchains can have an advantage compared to permissioned Blockchains for use case implementation, as they can be used immediately and have a higher level of decentralization and therefore more security and resilience.

The selected architecture depends on the use case (transactions volume, speed and privacy requirements,…) and has to be designed individually to fit the use case. There is no one architecture that suits all.

[10] https://medium.com/share-charge/the-next-share-charge-bc5f6807ddd6; Retrieved September 25th, 2018
[11] https://etherisc.com/; Retrieved September 25th, 2018
[12] https://www.cryptokitties.co/; Retrieved September 25th, 2018

2.2 BLOCKCHAIN IMPACT ON THE GARMENT INDUSTRY

In this chapter we will investigate the potential impact of Blockchain technology on the garment industry, considering the main aspects **tamper proof** (integrity of data, audit trail, single source of truth), an **open and transparent platform** (more than one acting party) and **decentralization** (security/resilience). Three aspects will serve as corner stones for the following analysis (sub-chapter break-down structure):

- **social** aspects (improvement of working and living conditions),
- **environmental** aspects (reduction of the environmental impact) and
- **economic** aspects (productivity and performance).

In general, the main characteristics of the technology can ensure **traceability** and **transparency**. Based on this, the framework for a **sustainable** garment industry can be created.

2.2.1 SOCIAL: improvement of working and living conditions

The fashion industry is one of the global economy's most important sectors; creating goods and employment for people all over the world. At the same time, environmental sustainability and fair means of production, especially for individual manufacturers, are highly questionable.

Working conditions in the garment industry have received severe critical media coverage. One of the major concerns are the working hours and forced overtime in factories. With tight order deadlines, overtime may be enforced with penalties, verbal abuse or dismissals. Pressure to meet production workloads may result in exhaustion and fatigue injuries. If the workers seek medical help, they may face a cut in wages or even get fired. Even though local regulators perform audits, health and safety standards for the workforce show room for improvement. This lack of safety standards can result in health damages due to the exposure to chemicals, heat, noise, overwork and exhaustion[13].

When these working conditions and safety breaches came to light, they triggered boycotts and cancelled trade agreements. However, following the boycotts, factories had to close down or cut the workforce, pushing the then unemployed workers to less monitored production sites with potentially even worse working conditions. This shows that a radical shift towards a more socially responsible approach cannot be enforced in this way.

We firmly believe that an intrinsic shift must happen within the supply chain and its actors to lead to sustainable change. Instead of working under pressure and facing penalties, employees should be motivated to work by an incentive structure, reflecting their achievements. Supported by digital technology, and especially Blockchain, this vision can become more realistic.

[13] Chipman, I. (2016). How to Improve Working Conditions in the Developing World. Retrieved July 6th, 2018 from https://www.gsb.stanford.edu/insights/how-improve-working-conditions-developing-world

2.2.1.1 Technology examples addressing social aspects

Blockchain can allow for transparency of the employees' contributions, fair remuneration, and funding within the production chain and beyond. Being able to track down the profit margins from each stage of the value and supply chain enables each worker to be visible – even to the end consumer. Taking this idea a step further, a consumer could send assets or payments directly to the worker and hence create a better awareness and higher standard for their production. Overall, enabling a secure, shared database to which all parties have access allows for creating a fair share for each stakeholder of the supply chain[14].

With the up-rise of Blockchain technology, established companies like Coca-Cola have started to revise their potential to support labour rights and improve social aspects along supply chains.[15, 16]

On the other hand, Blockchain start-ups addressing labour problems like working conditions, working hours or training can hardly be found. One of the few examples is handshake, a start-up aiming to increase contractual transparency for migrant workers[17].

2.2.2 ENVIRONMENTAL: reduction of the environmental impact

Each step of the production process in the garment industry carries the potential for an environmental impact, with substantial consumption of water, fertilizers and chemicals. For example, conventionally grown cotton, one of the most popular clothing fibres, is also one of the most water- and pesticide-dependent crops.[18] The environmental impact is further amplified by a short-term clothing consumption (fast-fashion), with up to 50–100 fashion micro-seasons, increasing the amount of outdated garment items that end up in landfills. Only a small percentage is re- or downcycled.[19]

In a nutshell, the environmental challenges in the garment sector can be grouped into three topics: **environmentally responsible production**, **extension of usage** of clothes and **recycling**. The concept of the circular economy combines these topics and rethinks the current industrial model of take-make-dispose. It does not only focus on reducing the negative environmental impact, but represents a systemic shift which aims to build long-term resilience. An essential part of circular economies is the recycling and re-usage of goods to enable a full circle. Next to environmental and social benefits, these shifts also bring business and economic opportunities through extended product lifecycles as "eco-fashion"[20] [21].

The International Standards Organization (ISO) has identifies eco-fashion through

"the general environmental performance of a product within a product group based on its whole life-cycle in order to contribute to improvements in key environmental measures and to support sustainable consumption patterns." [22]

Blockchain technology provides a technological advancement, enabling full transparency for fashion and eco-fashion, regarding the product lifecycle. By making use of data along the supply chain, techniques such as predictive maintenance or advanced lifecycle analytics are enabled. Not only final products can be traced, but also raw materials and organic goods. As this study will also focus on the track & trace Blockchain solutions, the applicability throughout this case will be highlighted in the use case analyse in chapter "5.2 Tagging of Final Products (NFC cryptotags)"

A prominent and current example for sustainability activities in the garment industry is the Adidas Parley project. Focusing on the problem of ocean plastic, Adidas worked on a concept to clean up the ocean and

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[14] Reinhard, K., Schmidt, D., Rützel, F., & Zentgraf, M. (2013). Working conditions in the global fashion industry. Retrieved July 6th, 2018 from https://laboureconomics.wordpress.com/2013/04/30/working-conditions-in-the-global-fashion-industry/

[15] https://www.forbes.com/sites/alexcapri/2018/02/14/how-blockchain-could-help-end-modern-day-slavery-in-asias-exploitative-seafood-industry/#2205f1ab4b65 Retrieved Aug. 8th, 2018

[16] https://behaviour.exchange/coca-cola-will-use-blockchain-prevent-labor-rights-abuse-supply-chain Retrieved August 8th, 2018

[17] http://handshake.tech/index.html Retrieved Aug. 8th, 2018

[18] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1964887 Retrieved Aug 27th, 2018

[19] http://www.wri.org/blog/2017/07/apparel-industrys-environmental-impact-6-graphics Retrieved Aug 27th, 2018

[20] Gregson, N., Crang, M., Fuller, S. & Holmes, H. (2015). Interrogating the circular economy: the moral economy of resource recovery in the EU. Journal Economy and Society. Volume 44, 2015 – Issue 2

[21] Ellen Macarthur Foundation (2017). Circular Economy Overview. Retrieved July 6th, 2018 from https://www.ellenmacarthurfoundation.org/circular-economy/overview/concept

[22] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1964887 Retrieved Aug 27th, 2018

redesign the plastic circulation. By following the Parley **A**void – **I**ntercept – **R**edesign strategy, Adidas reuses marine plastic waste and works it into their running shoes. Even beyond its own effort, Adidas has created an educational campaign for individuals, other industry players as well as governmental entities to take over responsibility for the marine plastic pollution[23] [24].

However, even beyond this initiative from private companies such as Adidas, concepts for sustainability and environmental friendliness are emerging. This study will elaborate on a few of these concepts which could have a significant influence on current economies when combined with Blockchain technology.

2.2.2.1 Technology examples addressing environmental aspects

The Internet of Things (IoT) interconnects physical information resources (e.g. devices, systems, etc.) with sensors, electronics, etc. to process information, exchange and react[25]. Sensors can measure environmentally relevant data like air pollution, temperature, humidity. In general, sensor item costs have been decreasing over the past years making use cases economically more feasible, but trading off sensor performance at times[26]. Environmental data that is retrieved via sensors can also be secured with Blockchain technology. This on-chain environmental data can allow to automatically trigger actions via integration of smart contracts.

In the context of the garment industry, a factory can e.g. measure air pollution and energy consumption with sensors. The CO_2 production of the factory could be directly linked to CO_2 certificates, retailers and consumers can check the environmental impact, and if the factory exceeds defined limits, authorities get informed immediately and it would be possible that public authorisations are voided or penalties are automatically levied. This example may sound futuristic, but the technology necessary is available already. Examples of start-ups combining IoT and Blockchain are Filament[27], Riddle & Code[28] and Chronicled[29].

2.2.3 ECONOMIC: productivity, performance and traceability

Logistics is often considered the lifeblood of the modern world, with an estimated 90% of world trade carried out by the international shipping industry every year[30]. Thus, reaching excellence in logistics requires collaboration of the global stakeholders along a supply chain to optimize the flow of physical goods as well as to simplify information and financial transactions. Nonetheless, in today's industry offers are often fragmented and competitive, with a lack of transparency. Data entry at times is manual and documentation paper-based, causing frictions. Especially when there is cross-border trading involved – like in the Garment industry – companies aim to unlock greater efficiencies and new business models.[31]

2.2.3.1 Technology examples addressing economic aspects

Blockchain technology can increase the visibility and predictability of logistics operations while enabling a faster handling of the physical flow of goods. It creates a single source of truth, enabling data transparency and trust across different actors within the supply chain. Furthermore, who the involved parties are can become visible to the end consumer; allowing for conscious consumption decisions. Depending on the data registered on the Blockchain, processes can be automated via smart contracts.

In the context of the Garment industry, e.g. the delivery of a resource input can be registered on-chain. If it meets certain parameters (e.g. just-in-time requirements), a financial exchange can be triggered

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[23] Adidas Group (2017a). PARLEY AIR – BUSINESS. Retrieved July 6th, 2018 from https://static1.squarespace.com/static/52e1b262e4b06ef060506756/t/5ac7ed1caa4a9953a2886346/1523051804305/Air_business.pdf

[24] Adidas Group (2017b). PARLEY A.I.R. STRATEGY. Retrieved July 6th, 2018 from http://www.parley.tv/updates/2015/9/12/air-strategy-swrwk

[25] https://www.iso.org/files/live/sites/isoorg/files/developing_standards/docs/en/internet_of_things_report-jtc1.pdf Retrieved Aug 28th, 2018

[26] http://ec.europa.eu/environment/air/pdf/Brochure%20lower-cost%20sensors.pdf Retrieved Aug 28th, 2018

[27] https://filament.com/; Retrieved September 25th, 2018

[28] https://www.riddleandcode.com/; Retrieved September 25th, 2018

[29] https://chronicled.com/; Retrieved September 25th, 2018

[30] http://www.ics-shipping.org/shipping-facts/shipping-and-world-trade Retrieved Aug 28th, 2018

[31] Heutger, M., Kückelhaus, M., Chung, G., Gockel, B., Acar, T., & Forster, M. (2018). Blockchain in Logistics: Perspectives of the upcoming impact of Blockchain technology and use cases for the logistics industry. DHL Customer Solutions & Innovation. Retrieved July 6th, 2018 from https://www.logistics.dhl/content/dam/dhl/global/core/documents/pdf/glo-core-blockchain-trend-report.pdf

automatically via a smart contract. At the same time, the exact location of a good in a process step and the involved party can be visible for all participants of the supply chain – from the producer to the end-consumer.

One recent example of implementing Blockchain in established industries is Walmart[32]. The retailer uses Blockchain technology to make value and supply chains more transparent and prove that goods are created with ethical and sustainable methods.

Next to Walmart, Everledger[33], an UK start-up, is using Blockchain technology to prove the origin of precious goods such as diamonds, wine and fashion. Everledger creates a digital record of each good and stores the information regarding the ownership and product lifecycle on a Blockchain. Taking the example of diamonds, Everledger creates a certificate number which is engraved on the corresponding physical diamond. Next to this physical solution, Everledger is integrated in a fully constructed ecosystem, directed by the United Nations, which was used before the arrival of Blockchain technology. Blockchain technology replaces a faulty paper-based process with an immutable digital record which cannot be forged nor replaced. Other start-ups which are addressing the Garment industry directly are Provenance[34] and Loomia[35].

2.3 OPPORTUNITIES & CHALLENGES OF BLOCKCHAIN IN THE GARMENT INDUSTRY

Before proceeding to the subsequent sections, we would like to highlight some of the opportunities and challenges that might be attached to blockchain-based solutions when it comes to fostering sustainability in garment supply chains:

OPPORTUNITIES	CHALLENGES
• Tamper-proof certificates – Replacement of bulk certificates – Real-time audit – Volume management • Tamper-proof physical tagging (crypto TAGs) • Pursuit of the goods through the supply chain • Fair payment through a transparent supply chain (e.g. organic farmers get rewarded, can sell their certificates for cotton with the raw material) • Increase legal security for individuals and small companies • Replacement of paper processes • Common platform for all stakeholders • New ownership models and financing models	• Garbage in – garbage out, the technology cannot decide whether data entries are correct or wrong • Technological infrastructure, know-how, perception and willingness of the actors involved • Getting all stakeholders on board (role of GIZ as connector and platform) • Maturity level of different Blockchain frameworks (e.g. scalability) • Building a permissioned public Blockchain for the garment supply chain (effort) • Regulations (e.g. GDPR) • Governance • Cost • Interoperability with extablished IT-systems

Table 2: Opportunities and challenges of Blockchain technology in the Garment industry

[32] https://www.bloomberg.com/news/articles/2018-04-23/walmart-is-getting-suppliers-to-put-food-on-blockchain-to-track Retrieved August 20th, 2018
[33] https://www.everledger.io/; Retrieved September 25th, 2018
[34] https://www.provenance.org/; Retrieved September 25th, 2018
[35] https://www.loomia.com/token; Retrieved September 25th, 2018

3 SELECTION OF USE CASES

In total, 34 use cases were identified on the basis of provided documents from GIZ, by research and with input from subject matter experts from Accenture. The use cases were divided into 6 groups.

Education

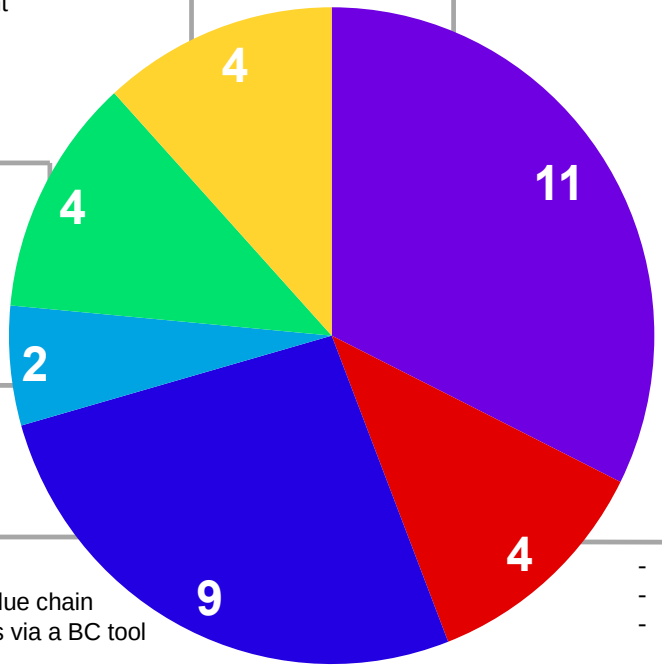
- Workforce Recognition Token for Achievements
- Social Training / Empowerment Token
- Transparency on grants and development funds
- Cross-Producers Registry on Prices and Market Conditions for SMEs

Environmental

- Track Carbon Footprint of each good
- Vendor categorization (fertilizer, etc.)
- Measurement of pollution via IoT devices direct at the plant
- Recycling life-cycle meets financial benefit

Track & Trace

- “Seal of premium raw material” for consumer
- Green Button/Grüner Knopf tracing



Certificates

- General purpose certification and notarization platform for the garment industry
- SA8000 proof across actors
- Fraud protection on certificates
- Vendor onboarding process (KYC)
- Documentation & notarization of labor law compliance (work time, child labor, payment,..)
- Training certificate for sale
- Personal certification creation from the farmer
- Digital, trusted SMETA reports
- Collaboration with Leather Working Group (LWG)
- Partnership with Sustainable Apparel Coalition (SAC)
- Material certification like ‘Oeko-Tex’

Organizational

- Crowd sourcing of certified trainers
- Replacement of paper processes along the value chain
- Management of grants and development funds via a BC tool
- Compliance standardization
- Common platform for all retailers to exchange data
- Voting of Labour Representatives
- AI Analytics (VR/AR) to reduce workplace accidents
- Crowd sourcing of certified auditors for compliance
- Preserving niche skilled artisans and suitably awarding them

Finance

- Recycling life-cycle meets financial benefit
- Introduce „Digital FIAT“ for the garment industry
- Employee crowd financing of SME in the garment industry
- Ownership “Genußrecht” and different financing models

Figure 3: Overview of identified use cases

A qualitative impact analysis was performed to narrow down the use cases for the detailed analysis. The study analyses 6 use cases in more detail and performs interviews with a focus on these six use cases.

The selection process was carried out in stages:

1. Grouping and impact analysis (social, environmental, economic and mapping in accordance with the service offering from GIZ for the textile and garment industry
2. Expert feasibility estimation (organisational and technical)
3. Selection of 3 use case favourites
4. Selection of use-cases 3–6 within project team

he following list shows the six selected cases including a description:

USE CASE	DESCRIPTION	GROUP
IoT-Tower – measuring environmental parameters	Production sites are subject to / produce a variety of environmental parameters (inflowing and outflowing), which they are exposed to or the initiator of. The use case aims at establishing an IoT device for measurement and storing key results on the Blockchain. Depending on the environmental parameters measured, different benefits can be obtained. Temperature, humidity, dust load, and volume can be measured to guarantee decentcorrect working conditions. The production site can check the working conditions in “real” time and log the data chronologically for later revision. In a next step, also exhaust air and waste water can be measured. This would allow calculation of the carbon footprint and control the usage of chemicals or/and the effectiveness of cleaning systems. The Blockchain technology can be used to manage the identity of the devices and ensure the integrity of the transmitted data. Selectively and depending on the detailed use case implementation, retrieved environmental data can be put on-chain, also allowing for automatically triggering actions via integration of smart contracts.	**Environmental**
Tagging final products (NFC Cryptotags	Final products (e.g. RMG garments) will be tagged along the production line with an NFC tag. An NFC (Near-Field Communication) tag is a small memory chip – not bigger than a coin – specifically designed for short distances and secure data transfer. The tag has to be provisioned, this can happen with a mobile phone or a dedicated device for NFC tags. After the provision, the tag is immutable and will be connected to the Blockchain. From now on, information can be added to the tag/Blockchain (e.g. source of the raw materials, date of production, who produced it plant, way of transport, guidelines on how to recycle the garment, etc.). Everybody, i.e. also consumers, can revise the data via a NFC enabled mobile phone.	**Track & Trace**
Legal documentation	This use case aims at providing a transparent and secure registry of documents (e.g. labor contract, audit results, etc.), with a time-stamp of upload; independent of a central authority. A cryptographic hash function is a mathematical algorithm that maps any input (e.g. a word, or even whole contracts or pictures) to a deterministic string of a fixed size. Same inputs always result in the same hash strings. If the hashes of two supposedly equal contents are different, it proves that a modification of the document has taken place. Registering a document’s hash, or in selected cases even agreed conditions or audit results on the Blockchain, generates a trustworthy and accessible prove of the current, agreed state. This can for example be relevant for migrant workers, who after their departure from their home countries, often receive a different salary than previously agreed or who have to do a different job altogether. A decentralized and accessible storage will increase security that their future employment is along the agreed lines. Also the same idea could be used for creating audit log. To avoid collusion or a later change of results, an audit log of findings can assure that the documents are not tampered with. This is especially relevant for cases where the auditor works for the organization they are auditing.	**Certificates**
Management of funds	Blockchain enables storing a validation proof for processes in procurement, contracting, managing tenders and fund disbursement without a central authority. The required proof – or in this case, a contract or purchase document – is saved on the Blockchain allowing for a tampering-proof time stamp and a clear audit trail. As an example, KfW, a German development bank, made use of the technology and developed TruBudget (Trusted Budget Expenditure Regime). The goal is to increase transparency by collaborating and keeping track of all changes on the platform. Another potential example: after the Rana Plaza accident, a variety of public and private actors made funding commitments to improve Bangladesh’s RMG sector. However, managing the grants to improve factory conditions was challenging; a Blockchain-based platform could support this management of grants.	**Finance**

USE CASE	DESCRIPTION	GROUP
Alternative financing	This use case aims on establishing a micro-credit and micro-insurance platform for small entities on a crowdfunding or peer-to-peer lending basis. Micro-credit: In general, peer-to-peer may be socially motivated by the money provider (usually located in industrialized countries), requiring lower or no risk premiums to cover the risk of loss. A Blockchain platform allows a user to directly contribute money for a project of choice and a lower or in some cases no effective interest rate at all. Alternatively, the platform can serve to unite the offer of different – already existing – micro-finance providers in the market to provide a consistent overview to the client. Peer-to-peer concepts allow bringing the small producer and consumer closer together, despite geographic distances. Consumers can directly invest in local small businesses. In case of micro-credits, the potential risk of low financial savviness as well as overindebtedness of the loan recipient need to be considered in the surrounding processes. Micro-insurance: Providing an insurance through a Blockchain-based solution allows for micro-insurances that have more flexible characteristics than traditional insurances (e.g. daily, small crop quantities,..). The insurance platform can be partially automated with Smart Contracts whenever the insurance content occurs (e.g. crop insurance).	**Finance**
Training and certification platform	For attended trainings, participants receive a training token. This provides a transparent ledger of all completed trainings. In addition to this token being exchanged for additional internal services (e.g. free snacks at the "World Woman Café"), this also increases employability of the participants when they find opportunities outside their current employer. Employers on the other hand get trained workers whose training level and history can be verified.	**Education**

Table 3: Selected use cases

A detailed analysis of the use cases can be found in chapter 5 "Use Case Analysis".

A complete list of all identified use cases can be found in the appendix "7.2 Identified Use Cases".

4 STAKEHOLDER INTERVIEWS

Based on the selected use cases, a questionnaire was created. The questionnaire includes two sections: 25 general questions and 148 specific questions addressing the selected 6 use cases.

With the interviews, we checked if the selected use cases are of relevance for the stakeholders, which framework conditions prevail regarding education and infrastructure, and we tried to find out how high the awareness of technological, environmental and social topics is.

In total, more than 30 interviews with 10 stakeholders in 3 different countries (Pakistan, Bangladesh and India) were conducted. The majority of the interviews took place with stakeholders in the middle of the supply chain. No interviews with producers from raw materials (e.g. farmers) or retailers took place. A list of the interviewed companies can be found in the appendix "7.1 Stakeholders: Interviewed Companies"

5 USE CASE ANALYSIS

In a Blockchain use case assessment, the first question which has to be answered is: **“Why Blockchain?”**

Many rating and flow chart models for answering this question are available. We recommend in addition focussing on the core characteristics of the Blockchain technology and check if they add any benefit. **Tamper-proof** (integrity of data, audit trail, single source of truth), **open and transparent platform** (more than one acting party, fast and easy on- and off-boarding) and **decentralized** (security/resilience) are the core characteristics.

We performed a Blockchain assessment for the selected six focus use cases to check the viability of organization specific use cases in terms of technical feasibility, value added by the technology as well as regulatory implications. This presents a first indicator and reference point for further considerations.

The Blockchain use case assessment is based on a questionnaire with 21 fundamental questions with predefined answers grouped into 5 areas (Parties involved, Processed data, Systems & Processes, Business Value, and Regulatory and Compliance). Each answer to a questions has a weighting. The weighting of the answers sums up in the group result (spider diagram) and each group has again a weighting to the overall result, the **Blockchain Applicability index**.

The use case analysis follows a standardized format. On the one hand, we focus on the possible impacts for transparency, sustainability, diversity and workforce of Blockchain and distributed ledger technology, on the other hand on the technical feasibility (which technology is available and can be used) as well as on the economic feasibility (does it make economic sense with the benefits in mind).

The assessment if a stakeholder rather benefits, loses or is neutral against the use case was made on a qualitative assessment outlined in the description section. This is a highly generalized statement and perceptions may vary once the use case is implemented, depending on the stakeholders and other influencing factors.

Stakeholder	Working Definition
Farmer	Supplier of raw-materials e.g. cotton to enable the production facility
Carrier	Transports the goods
Production facilities – employer	An individual or group of individuals producing textiles for the production facility (weaving, dyeing, printing, CMT, sewing)
Employee	An individual being a contractual partner of the textile company
Environment	All that concerns the environment (air, water, soil)
Government / Authorities / Auditor	Taking care of regulations and laws such as labour law and sustainability
NGOs	Proactive actor running programs to improve social, environmental or economic aspects
Retailer	Client of the production facilities and last stop of the B2B supply chain
Consumer	User of the produced goods

Table 4: Overview of stakeholders

5.1 IOT-TOWER – MEASURING ENVIRONMENTAL PARAMETERS

5.1.1 Use Case Introduction

Production sites have a variety of environmental parameters (inflowing and outflowing), which are exposed to or the initiator of. The use case aims at establishing an IoT device for measurement and storing key results on the Blockchain. Depending on the environmental parameters measured, different benefits can be obtained.

- Temperature, humidity, dust load, and volume can be measured to guarantee correct working conditions. The production site can check the working conditions in “real” time and log the data chronologically for later revision.
- In a next step, also exhaust air and waste water can be measured. This would allow calculation of the carbon footprint and control the usage of chemicals or/and the effectiveness of cleaning systems.

The Blockchain technology can be used to manage the identity of the devices and ensure the integrity of the transmitted data. Selectively and depending on the detailed use case implementation, retrieved environmental data can be put on-chain, also allowing for automatically triggering actions via integration of smart contracts.

5.1.2 Results and Expressions from Stakeholder Interviews

Environmental conditions

The interviews showed that a high level of awareness for environmental protection is in place. All factories visited have plans to improve environmental aspects. As an example, all are aware of the high water usage in the garment industry and want to raise the percentage of reused water. Nevertheless, at the moment the level of reuse for water is only between 0% and 15% in the visited factories.

One issue is sewage sludge. The sludge gets dried onsite and is handed over to authorities for disposal. The factories don’t control the proper disposal. As the sludge contains harmful ingredients such as heavy metals and a number of toxic chemicals, a transparent disposal chain should be considered.

All 4 factories treated water and air and performed measurements via lab testing. An automated measurement via IoT devices is not in place (partly in only 1 factory). The use of IoT devices would increase the coverage and ensure real time monitoring.

Workplace conditions

Only 1 factory out of 4 measures workplace conditions on a constant basis. A constant measuring via IoT devices would raise the level of awareness.

Conclusion:

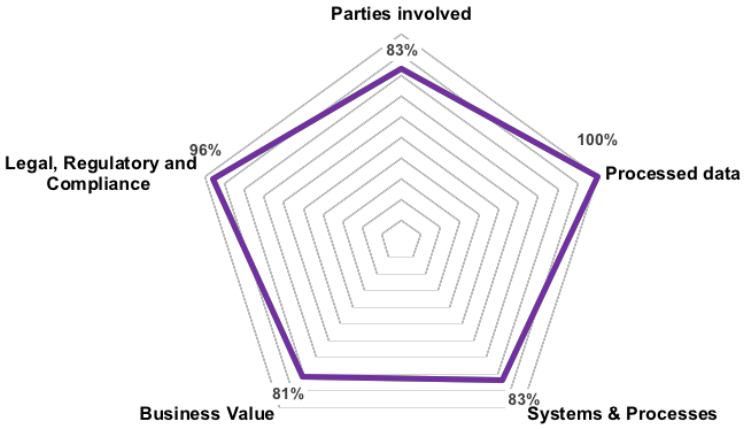
As a conclusion from the interviews, metering via IoT devices can improve environmental and workplace conditions. With constant monitoring, the operators can react immediately to malfunctions of the facility. For authorities, regulators, retailers and customers, monitoring the conditions would introduce a new level of transparency.

5.1.3 Blockchain Assessment

BLOCKCHAIN APPLICABILITY INDEX

89%

DETAILED RESULT



5.1.4 Technical Architecture

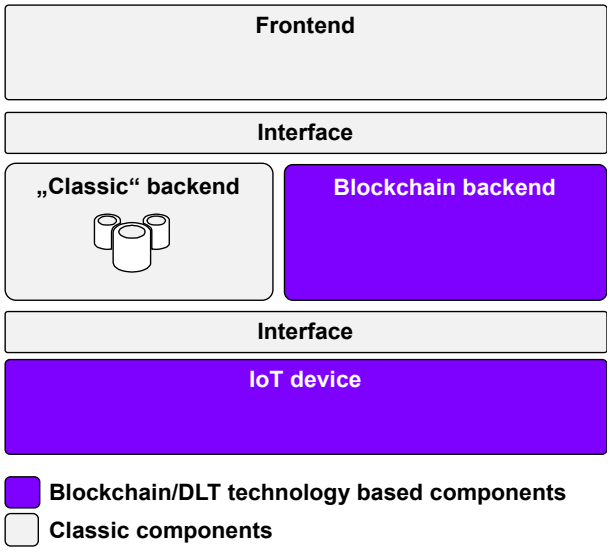


Figure 4: Technical architecture IoT tower

Frontend

The frontend will be for managing the IoT devices and for accessing the submitted data. Depending on the user group, different frontends with different access levels have to be implemented.

“Classic” backend

A classic backend (Web server, database, scripts) is necessary because the submitted data from the IoT devices cannot be stored within a Blockchain.

Blockchain backend

The Blockchain backend will store the Identity of the IoT devices (Metadata) and the fingerprints of the submitted data.

IoT device

The IoT device is the main building block of the use case. The IoT device has to fulfill several requirements. It must be low-cost, durable and robust. It has to measure environment variables in a reliable way and must be protected against manipulation.The Blockchain technology can help to protect and manage the IoT device. The IoT device can be provisioned with an unique and tamper-proof decentralized identity. With the decentralized identity, the IoT device can sign data before submission.

5.1.5 Stakeholders and Prerequisites

Prerequisites:

The following prerequisites must be fulfilled before implementation:

- The IoT device must be low-cost, durable and robust.
- Internet connection or mobile coverage must be available to connect the IoT device with the internet.
- The amount of data provided from the IoT devices would exceed the possibilities from public Blockchains. Therefore a permissioned/public Blockchain or a middleware layer must be installed. The Blockchain/middleware layer must be hosted by more than one party. Parties can be governmental actors, NGOs, retailers or others which have a high interest in the data.

Stakeholder consideration:

Stakeholder	Description	Role	Benefit / Lose / Neutral*
Farmer	Not affected		
Carrier	Not affected		
Production facilities – employer	The owner of the factory must install the IoT device in a proper place. IoT results can trigger automated actions; e.g. penalty payments, stopping machines (in the most extreme case) or an alert message to the internal audit if a certain threshold is surpassed. The Blockchain Solution needs to be installed by the production facility, with nodes distributed across several users (e.g. production facility units, but also beyond the facility, towards e.g. the carrier) to increase the buy-in and trust of the technology. The producer can provide a higher level of transparency towards the regulator, companies upstream, and the final consumer.	Implementation	
Employee	Environmental working conditions in the factories are monitored in real time for selected parameters (e.g. if a certain level of critical humidity has been breached). Peaks can be stored on the Blockchain and then be accessed by third parties (e.g. regulators working against sweatshops) for timely action against unfavourable conditions. The employer will have a high interest in keeping the conditions within the boundaries to avoid negative impact on his reputation, as breaches are being logged on the Blockchain.	Beneficiary	
Environment	Continuous monitoring of exhaust air and sewage makes control of regulations much easier and more reliable than sampling.	Beneficiary	
Government / Authorities / Auditor	Government or/and regulators can accelerate the implementation with accompanying measures (e.g. easier audit requirements, tax benefits, make it mandatory, …). The government should be part of the permissioned/public Blockchain. The authorities can monitor the compliance with the regulations in real time and will get an alert when there is a violation. Effort for reviews and audits would decrease and resources can be used optimally. Auditors should check that the IoT devices have been installed correctly and have not been tampered with as part of their audit procedure.	Influencer	
NGOs	GIZ as honest broker, or NGOs and other actors from civil society can be part of the permissioned/public Blockchain infrastructure to ensure a high level of transparency and trust.	Facilitator	

Stakeholder	Description	Role	Benefit / Lose / Neutral*
	They can lobby with the government and/or production facilities to introduce this transparent measurement.		
Retailer	Retailers can ensure that the contractor keeps the agreed key performance indicators for working and environmental conditions. The retailer can demand transparency on compliance with environmental standards, etc. by the production facility. The retailer can run a node (aka server), signalling the importance of the solution and the collaborative will behind it. As a benefit to them, retailers can prove to their consumers that their products were produced under conditions in compliance with health and safety agreements and regulations.	Influencer	
Consumer	If consumers know in which factory their product was produced, they themselves can check the working conditions and environmental conditions during the production time of their product.	Influencer	

*Green= Benefit; Yellow=Neutral; Red=Lose – the classification depends on assumptions made based on the interviews and the impact the use case may have.

Table 5: Stakeholder considerations IoT-tower

5.1.6 SWOT Analysis

	STRENGTHS	WEAKNESSES
INTERNAL	• Measurement of environmental values like pH value, temperature, humidity, dust, etc. is easy and cheap • Decentralized identity management of the IoT devices • Securing of data from IoT devices (integrity of data, increased level of security)	• Measurement of environmental values like carbonate hardness, total hardness, ammonium, nitrite, nitrate, phosphate, etc.) is complex and requires photometric equipment. • Technical feasibility • Choosing the wrong architecture/technology
	OPPORTUNITIES	**THREATS**
EXTERNAL	• Small and medium actors can gain market advantage because of transparency • Industry-wide IoT platform to improve transparency • Possible real-time auditing • Real-time business processes based on IoT data and smart contracts	• Fraud by technical manipulation • Non-acceptance of the stakeholders, low adoption rate

Table 6: SWOT analysis IoT tower

5.1.7 Impact Analysis

The impact analysis was done based on the service catalogue from GIZ for the textile, garment and footwear industry. The areas marked in green are most impacted by the use case.

5.1.8 Use Case Conclusions

The use case is promising. It combines social and environmental aspects and would have a high impact on transparency and sustainability. With an IoT device measuring environmental conditions, retailers do not depend on "promises" from contractors. They can check the past history before awarding a contract and can monitor conditions during production. For authorities it would be a help to ensure legal compliance.

Nevertheless it has to be pointed out that the implementation is not easy. There are a lot of technological and organizational challenges. To proceed with the use case we would suggest to form a project group consisting of authorities, pilot factory, NGOs, retailers and an implementer and start a small scale feasibility project.

5.2 TAGGING OF FINAL PRODUCTS (NFC CRYPTOTAGS)

5.2.1 Use Case Introduction

Final products e.g. RMG garments will be enhanced with an NFC chip and tagged along the production line storing registries on the Blockchain.

An NFC (Near-Field Communication) tag is a small memory chip – not bigger than a coin – specifically designed for short distances and secure data transfer. NFC tags are eligible for a variety of use cases as they can be easily added to e.g. packaging, labels or to clothing, allowing to transmit information.

To mention a famous example: this has been used for the official match football of the 2018 FIFA World Cup, where an NFC chip was located at the top of the ball, allowing to retrieve information via a smart-phone (Figure 5: NFC tags).

To make an NFC tag usable for a Blockchain use case – NFC Cryptotag –, it has to be provisioned. This can happen with a mobile phone or a dedicated device for NFC tags. After the provision, the tag is immutable and will be connected to the Blockchain. From now on, information can be added to the tag/Blockchain (e.g. source of the raw materials, date of production, which worker produced it, plant, way of transport, guidelines on how to recycle the garment, etc.). Which information is added in which granularity, depends on the detailed use case. Added content can be then retrieved by e.g. consumers via an NFC enabled mobile phone.

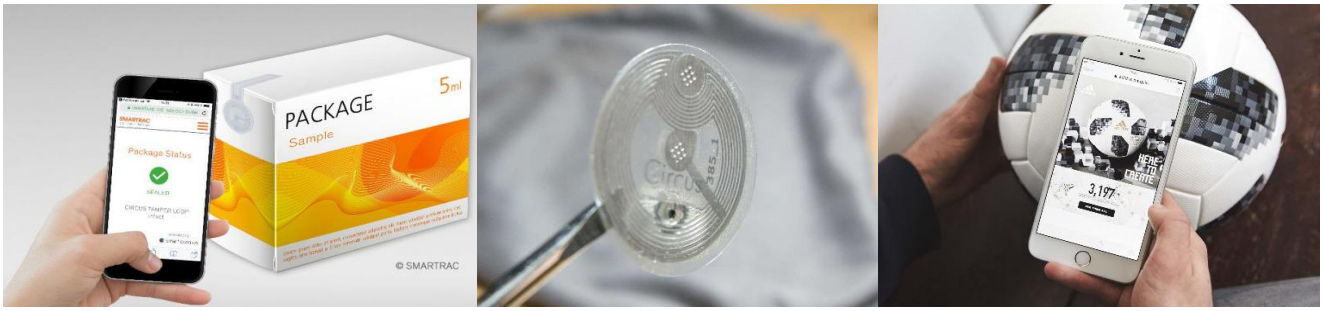


Figure 5: NFC tags[36] [37] [38]

5.2.2 Results and Expressions from Stakeholder Interviews

Track and trace:

The factories know little to nothing about the conditions (environmental and social) from the raw material producers. No sophisticated track and trace solution is in place at the factories we visited, most solutions in place address internal track and trace and only on bulk level. All interview partners are interested in more sophisticated solutions. A crucial point is cost. A solution has to be cheap to be accepted. One company tested RFID tags but did not proceed because of the cost involved.

Customer benefit:

The benefit for the customer is seen from all interview partners.

Recycling:

Processes addressing recycling and life span of the clothes (fast fashion) are not implemented yet, but the producers are interested in solutions. Only for one interview partner this was no topic at all.

[36] https://packaging-journal.de/etiketten-mit-nfc-tags-bieten-zusatzfunktionen/ Retrieved September 7th, 2018
[37] Circus Flex Clothing NFC Tag Image. https://nfc.today/news/adidas-fifa-world-cup-football-includes-nfc-tag Retrieved September 7th, 2018
[38] https://www.soccerbible.com/performance/football-equipment/2017/how-does-the-2018-adidas-telstar-nfc-ball-work/ Retrieved September 7th, 2018

Conclusion:

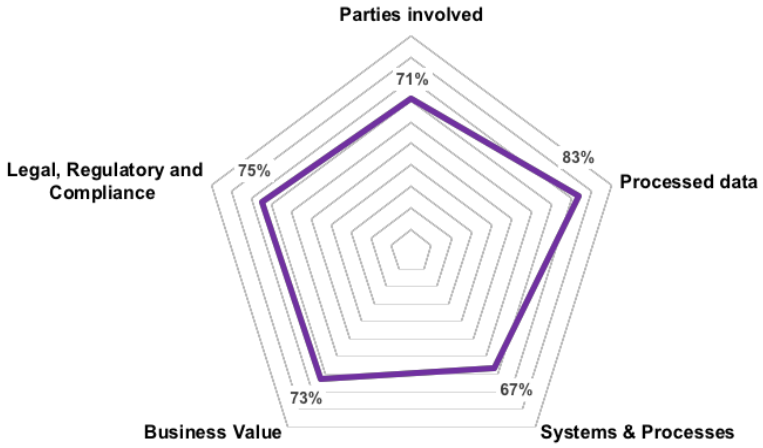
The conclusion from the interviews with producers is that they are very interested in the use case. The use case has to be discussed with other stakeholders. Authorities, consumers and retailers may have a higher interest in tracking products than the producer itself.

5.2.3 Blockchain Assessment

BLOCKCHAIN APPLICABILITY INDEX

73%

DETAILED RESULT



5.2.4 Technical Architecture

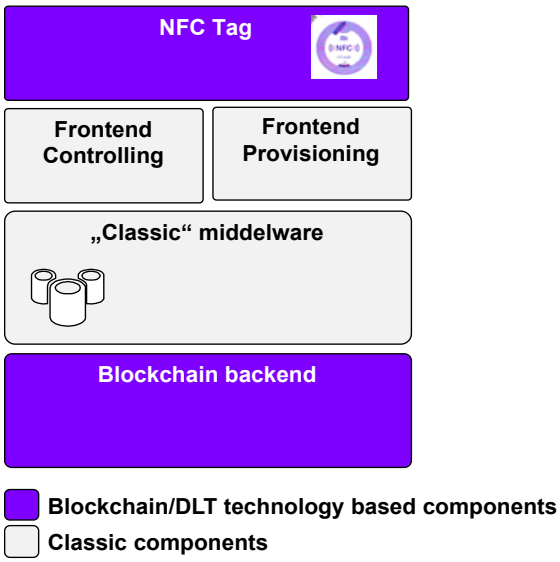


Figure 6: Technical architecture tagging final products

NFC tag and frontend provisioning

The main building block of the technical architecture is the NFC tag. The tag is the connection between the physical world and the Blockchain. It has to be provisioned as well, in such a way as to make it really tamper-proof. Off-the-shelf NFC tags have a unique identifier, but that alone is not safe enough. The NFC tag has to be incorporated in the final product in a way that it cannot be removed without destroying the chip.

Frontend controlling

The frontend for controlling the tag will be a mobile app. With an NFC-enabled mobile phone and the app, everybody can check/read the NFC tag and see the stored metadata like production time, factory, involved employees, picture of the product, raw materials, care instructions and many more.
If desired, additional metadata information can be stored by the owner.

"Classic" Middleware layer

The amount of data exceeds the capacity of a public or permissioned Blockchain, therefore a middleware layer is necessary. In the middleware layer, all the metadata is stored and only a cryptographic fingerprint of the data (HASH function) is handed over to the Blockchain. This ensures that the data cannot be manipulated. If a query took place, the app will check if the identity of the NFC tag is stored in the Blockchain and will retrieve the associated metadata set from the middleware layer.

Blockchain backend

The Blockchain backend is used to manage the identity of the NFC tag. The NFC tag address gets connected to a Blockchain address and the cryptographic fingerprint of the connected metadata will be stored on the Blockchain. At this stage of the analysis, a final decision for a public or permissioned Blockchain cannot be made. Considering the amount of products (millions) and the transaction fee in public Blockchains, it is most likely that a permissioned Blockchain has to be used.

5.2.5 Stakeholders and Prerequisites

Prerequisites:

The following prerequisites must be fulfilled before implementation:

- NFC tags have to be sourced and tested (durable and cheap)
- A permissioned Blockchain system has to be set up because of the number of items. In a first test system, a public chain may be used.
- Factories have to be fitted with NFC equipment

Stakeholder consideration:

Stakeholder	Description	Role	Benefit / Lose / Neutral
Farmer	Within this use case, tagging was considered only for inputs after a transformation stage (e.g. transforming cotton to strings). Individual farmers will not tag the produced raw inputs due to the cost aspect that outweighs the benefit for them. At the stage of farming associations or medium to big-scale farmers, including the NFC tag can serve to track the inputs' arrival at the production site.	Implementation	
Carrier	NFC tags allow for transparency of the good's position (e.g. input received from farmer), which is relevant especially for just-in-time deliveries. Handover by the carrier to the production facility is logged and time-stamped on the Blockchain.	Beneficiary	
Production facilities – employer	The owner of the factory can log production stages. The NFC tag can help to automate quality gates in the production (e.g. raw material A was revised at check-point B). It can help to structure production process optimization. The producer can provide a higher level of transparency on origin of inputs, which may be reflected in higher returns. The owner of the factory must train employees in incorporate NFC tags in garments. Even though we believe this to be a clear beneficiary case, producers during the interviews did not see the benefit for them. The use case must thus be discussed with auditors or stakeholders upstream.	Facilitator	
Employee	The employees can log the product they are working on; making their contribution visible also to the end consumer. Transparency of this value creation may lead to fairer wages or a sustainable work-load for the employees.	Beneficiary	

Stakeholder	Description	Role	Benefit / Lose / Neutral
Environment	Making the international stages of the value chain transparent to end consumers may encourage them to purchase more local products or support environmentally friendly producers.	Beneficiary	
Government / Authorities / Auditor	Government or/and regulators can base audits (e.g. labour law on working efforts) on logged data, generated by the NFC chip. Effort for reviews and audits would decrease. Governmental seals can be improved and enhanced. Introducing this as a washable button NFC Tag (available already on the market) instead of a simple button, e.g. via new clothing seals, hinders illegal copying of goods and allows for transparent tracking.	Influencer	
NGOs	NGOs can be part of the permissioned/public Blockchain infrastructure to ensure a high level of transparency and trust. NGOs can support the platform and ensure the open character. Additional parties need to be on- or off-boarded fast and cheap. Furthermore, they can steer the public sentiment to underline the importance of a fair and transparent supply chain.	Facilitator	
Retailer	Retailers must demand NFC tags and provide the technical infrastructure (application, backend, etc.). Nodes can be distributed across several users (e.g. Production facility) to increase the buy-in and trust of the technology. It must be a platform which is used by more than one retailer. Final products with an included NFC tag can be checked automatically (origin, quantity,…) along with other processes in the supply chain. Retailers can provide consumers with a strong proof of origin. Plausibility tests can be made to ensure that producers comply with the contract (e.g. use of non-authorized subcontractors). On an upside for retailers, consumers may be willing to pay higher prices if local positive impact is displayed. *"Made in"* becomes more than a label, but a statement that can be traced back to the very origin, e.g. *"strands from Tummalapalle village located in Kadapa, India*". Retailers can add additional benefits or/and services connected to the NFC tag. Like discount for the next purchase or entrance to a concert where the NFC tag can act as ticket. Care manuals and recycling instructions can be added. The possibilities to improve customer relationship are huge.	Implementation	
Consumer	If consumers know who the involved actors along the supply chain for their product are, they can take a conscious consumption decision. Consumers can check the metadata of the product themselves and can add additional data if desired. NFC chips can include a small message from the initial producers to the end consumer or other benefits (e.g. loyalty program). Clothing transforms in the customers' perspective from a piece of fabric to smart fashion.	Influence	

*Green= Benefit; Yellow=Neutral; Red=Lose – the classification depends on assumptions made based on the interviews and the impact the use case may have.

Table 7: Stakeholder considerations tagging final products

5.2.6 SWOT Analysis

	STRENGTHS	WEAKNESSES
INTERNAL	• Traceability of final products • Plausibility checks are possible (e.g. is the amount of T-shirts in the time period plausible?) • Tamper-proof NFC tag	• Additional effort in the production • NFC tags resilience. Have to be tested in terms of resilience against water, heat and mechanical load. • Technical feasibility • Choosing wrong architecture/technology
	OPPORTUNITIES	**THREATS**
EXTERNAL	• Small and medium actors can gain market advantage • Improvement of transparency • Real time business processes based on IoT data and smart contracts • Retailers can have a marketing advantage against competitors with fewer or less transparent tracking solutions	• Acceptance from the end consumer • Additional price is too high for market adoption • Garbage in, garbage out: Wrong data can be entered.

Table 8: SWOT analysis tagging final products

5.2.7 Impact Analysis

The impact analysis was done based on the service catalogue from GIZ for the textile, garment and footwear industry. The areas marked in green are most impacted by the use case.

5.2.8 Use Case Conclusion

The main driver for this specific use case must be the retailers. Retailers can realize the greatest benefits by attaching NFC tags to final products. Using Blockchain technology only makes sense if more than one retailer uses the platform. We would recommend to form a consortium of retailers who start creating the platform. The consortium should also include one or more NGOs to ensure the trustworthiness of the implemented platform.
To include as many retailers as possible, the platform should be run with a pay-per-use model.

5.3 LEGAL DOCUMENTATION

5.3.1 Use Case Introduction

This use case aims at providing a transparent and secure registry of documents (e.g. labour contract, audit results, etc.), with a time-stamp of upload; independent of a central authority.

A cryptographic hash function is a mathematical algorithm that maps any input (e.g. a word, or even whole contracts or pictures) to a deterministic string of a fixed size. Same inputs always result in the same hash strings. If the hashes of two supposedly equal contents are different, it proves that a modification of the document has taken place. Registering a document's hash, or in selected cases even agreed conditions or audit results on the Blockchain, generates a trustworthy and accessible prove of the current, agreed state.

This can for example be relevant for migrant workers, who after their departure from their home countries, often receive a different salary than previously agreed or who have to do a different job altogether. A decentralized and accessible storage will increase security that their future employment is working out along the agreed lines[39].

Also the same idea could be used for creating audit logs. To avoid collusion or later change of results, an audit log of findings can assure that the documents are not tampered with. This is especially relevant for cases where the auditor works for the organization they are auditing.

5.3.2 Results and Expressions from Stakeholder Interviews

Economically relevant

Only one interview partner sees audits as a burden. All others see it as an asset for client communication and a tool for establishing trust and transparency.

Retroactive counterfeiting of audits

About 50% of the interview partners think that it is possible to retroactively change the audits.

Platforms

There is no standardized platform for storing documents or/and audits. Retailers, authorities and others are running separate platforms. Access without a login is not possible.

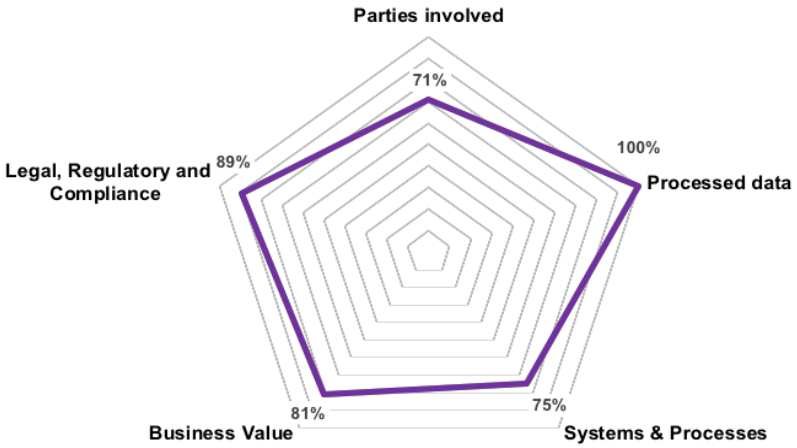
[39] http://handshake.tech/index.html

5.3.3 Blockchain Assessment

BLOCKCHAIN APPLICABILITY INDEX

84%

DETAILED RESULT



5.3.4 Technical Architecture

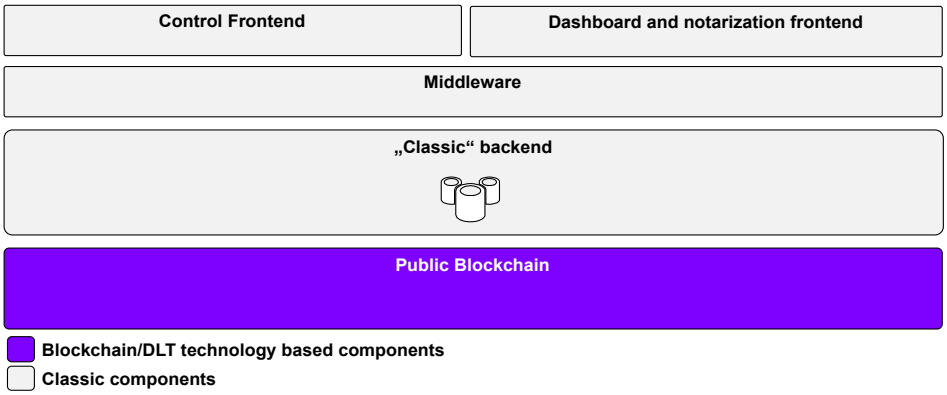


Figure 7: Technical architecture legal documentation

Dashboard and notarization frontend

The frontend has to fulfil two tasks: to provide an interface where authorized parties can notarize the documents, and to have a dashboard which gives an overview about already notarized documentation.

Control frontend

Involved parties need to control the entered documentation, therefore a control frontend is necessary.

Middleware and “Classic” backend

The amount of data exceeds the capacity of a public Blockchain, therefore a middleware layer is necessary. In the middleware layer, all the metadata is stored and only a cryptographic fingerprint of the data (HASH function) is handed over to the Blockchain. This ensures that the data cannot be manipulated. If a query takes place, the app will check if the identity is stored on the Blockchain and will retrieve the associated metadata set from the middleware layer.

Blockchain backend

The Blockchain backend is used to store the fingerprints of the documents. At this stage, a final decision for a public or permissioned Blockchain cannot be made. It highly depends on the amount of documents, the detailed architecture and on the decision, which services are to be on-chain. If business logic is to be executed with smart contracts, a permissioned Blockchain may be necessary.

5.3.5 Stakeholders and Prerequisites

Prerequisites:

The following prerequisites must be fulfilled before implementation:

- All stakeholders have to agree on one platform
- No technical obstacles for implementation

Stakeholder consideration:

Stakeholder	Description	Role	Benefit / Lose / Neutral
Farmer	Not affected – unless the platform is extended for a repository for trade contracts.		
Carrier	Not affected		
Production facilities – employer	Through a transparent repository it becomes harder to overstep agreed contract conditions or audit findings. Upload to a Blockchain based solution is an additional step introduced in the process and employees (e.g. HR or internal audit) need to be trained accordingly.	Influence	
Employee	Bargaining power and standing of employees would be increased by a transparent repository. However, as only few of them can count on trade unions (especially not migrant workers etc.), the push for this platform needs to come from a higher authority (e.g. government). From a legal perspective, enforcing standards on contracts is difficult as of now for employees, as these agreements may take place across borders and are centralized into small agencies.	Beneficiary	
Environment	Not affected		
Government / Authorities / Auditor	The set-up of a Blockchain based registry should be pushed by the government as a mandatory repository of e.g. audit findings or contracts. Nodes can be distributed across several users (e.g. production facility) to increase the buy-in and trust of the technology. This platform should include a variety of producers. Government or/and regulators can base audits (e.g. labour law vs. contracts) on logged data. Effort for reviews and audits would decrease.	Implementation	
NGOs	GIZ or NGOs can be part of the permissioned / public Blockchain infrastructure to ensure a high level of transparency and trust. Securing the platform set-up could also be driven by them.	Implementation	
Retailer	The retailers should push for transparency on contracts/audit reports etc. by their producing counterparts. Internal audit findings made by a retailer along the supply chain can be secured as well.	Influence	
Consumer	Not affected		

*Green= Benefit; Yellow=Neutral; Red=Lose – the classification depends on assumptions made based on the interviews and the impact the use case may have.

Table 9: Stakeholder considerations legal documentation

5.3.6 SWOT Analysis

	STRENGTHS	WEAKNESSES
INTERNAL	• Single source of truth • One document store • Documents can be checked from anywhere • Plausibility check possible • Technical requirements are low	• A documentation of audits is in place already, a new solution and the benefit of transparency could be questioned
	OPPORTUNITIES	**THREATS**
EXTERNAL	• Retailer can check factories fast and reliably • Authorities have an overview about all sites • Workforce gets independent, documents are connected with the person, not with the factory	• No adoption/acceptance from the stakeholder • Garbage in, garbage out. Wrong data can be entered

Table 10: SWOT analysis legal documentation

5.3.7 Impact Analysis

The impact analysis was done based on the service catalogue from GIZ for the textile, garment and footwear industry. The areas marked in green are most impacted by the use case.

5.3.8 Use Case Conclusion

The use case is easy regarding technical implementation. All necessary technical parts are available and tested. It would be a great use case for testing the technology and exploring the limitations and possibilities.

The challenge is in the organization of the platform and getting all stakeholders to use the platform. GIZ would be in a good position to bring together a group of stakeholders and facilitate a project.

5.4 MANAGEMENT OF FUNDS

5.4.1 Use Case Introduction

Blockchain enables storing a validation proof for processes in procurement, contracting, managing tenders and fund disbursement without a central authority. The required proof – or in this case a contract or purchase document – is saved on the Blockchain allowing for a tampering-proof time stamp and a clear audit trail.

As an example, KfW, a German development bank, made use of the technology and developed TruBudget (Trusted Budget Expenditure Regime)[40]. The goal is to increase transparency by collaborating and keeping track of all changes on the platform.

After the Rana Plaza accident, such a platform would have been useful. A variety of public and private actors made funding commitments to improve Bangladesh's RMG sector. However, managing grants to improve factory conditions was challenging[41]. A Blockchain-based platform could support this management of grants and make it faster, more transparent, and more resistant against corruption.

5.4.2 Results and Expressions from Stakeholder Interviews

From the interviews we have no clear picture how grants are utilized by the producers. Some companies use grants rarely and some use many sources for grants. Once we got the answer that they do not apply for grants because the process is too tedious. Furthermore, the grant situation changes from country to country.

A platform which gives an overview about all available grants and makes the process simple would be a big improvement especially for small companies which don't have the administrative resources for managing grants.

[40] https://www.kfw-entwicklungsbank.de/Internationale-Finanzierung/KfW-Entwicklungsbank/News/News-Details_431872.html Retrieved August 20th

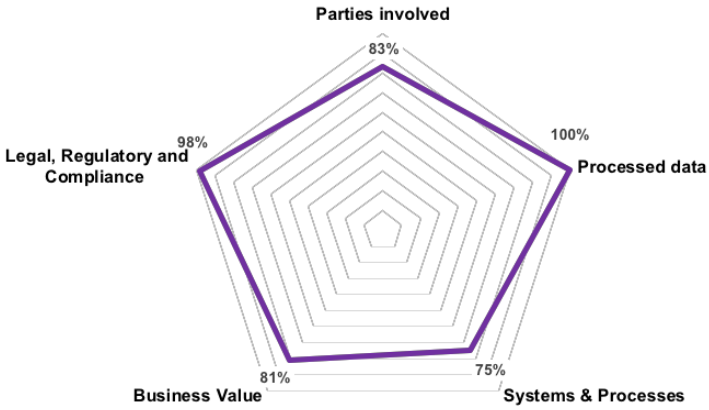
[41] https://static1.squarespace.com/static/547df270e4b0ba184dfc490e/t/58f6460e579fb3776b2c18f2/1492534798499/Funding+Timeline+FinalVersion+Feb.+10.pdf Retrieved August 20th

5.4.3 Blockchain assessment

BLOCKCHAIN APPLICABILITY INDEX

87%

DETAILED RESULT



5.4.4 Technical Architecture

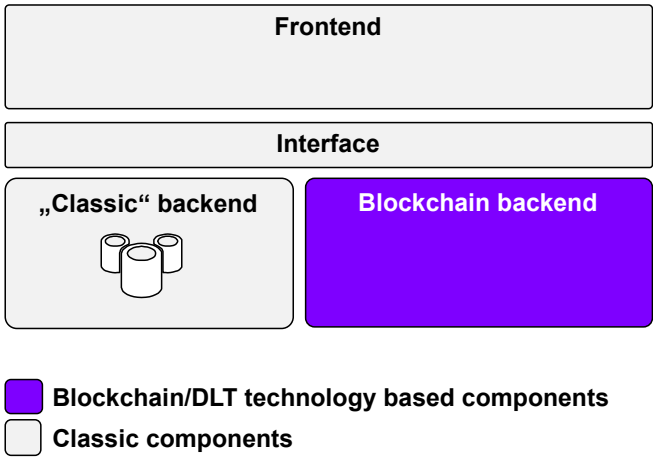


Figure 8: Technical architecture management of funds

Frontend

The frontend is the access to the application.

“Classic” backend

A classic backend is necessary to run the frontend and store data if necessary.

Blockchain backend

During the design phase, it has to be decided if a heavy-chain approach is feasible. On a heavy-chain architecture, all data gets stored on a Blockchain. This is only possible if the expected amount of data and the growth can be managed from the used Blockchain technology. In general, the use cases for a heavy-chain architecture are limited, but in this use case it may be considered.

5.4.5 Stakeholders and Prerequisites

Prerequisites:

The following prerequisites must be fulfilled before implementation:

- Major stakeholders have to agree to use the platform
- Stakeholders must have access to basic infrastructure (Internet connection, desktop PC, mobile phone)
- Technical prerequisites are minimal. Tools are already developed or under development

Stakeholder consideration:

Stakeholder	Description	Role	Benefit / Lose / Neutral
Farmer	Farmers have to provide receipts to prove the usage of government subsidies or received loans. With the increasing smartphone coverage, this proof can be digitized. Secondly, with the registry on a Blockchain, this process can be provided independent of a central authority. Users need to have smartphones and have basic digital skills (e.g. upload). They should be trained on the new interface to trust it as a valid document entry point.	Beneficiary	
Carrier	Not affected		
Production facilities – employer	External funding used by the production facility can range from traditional banking to development funding. These usually require a range of formal proofs. A Blockchain validation allows managing and providing these proofs without a central authority verifying their entry. Staff needs to be trained on the new process (e.g. Finance or internal audit).	Beneficiary	
Employee	Not affected		
Environment	Not affected		
Government / Authorities / Auditor	The government or the auditing authority should push for setting up the basic framework. Nodes can be distributed across several users (e.g. production facility) to increase the buy-in and trust of the technology. The Blockchain-based solution is defined as the key entry point for progress reports and receipts for disbursed loans. Trainings / user manuals are provided to users. With this formal proof, the audit effort can be reduced and streamlined. In case of fraud, it becomes visible which party has uploaded the wrong receipt and when.	Implementation	
NGOs	The same applies as for “Government / Authorities / Auditor” in case the NGO provides funding. If certain social implications are bound to the loan (e.g. provide training) this proof (e.g. training certificate) can be stored as well. NGOs can provide trainings to farmers/employees that have only basic technical knowledge but should use the platform in order to decrease the fear of “the new technology” and push for adaptation.	Implementation	
Retailer	Not affected		
Consumer	Not affected		

*Green= Benefit; Yellow=Neutral; Red=Lose – the classification depends on assumptions made based on the interviews and the impact the use case may have.

Table 11: Stakeholder considerations management of funds

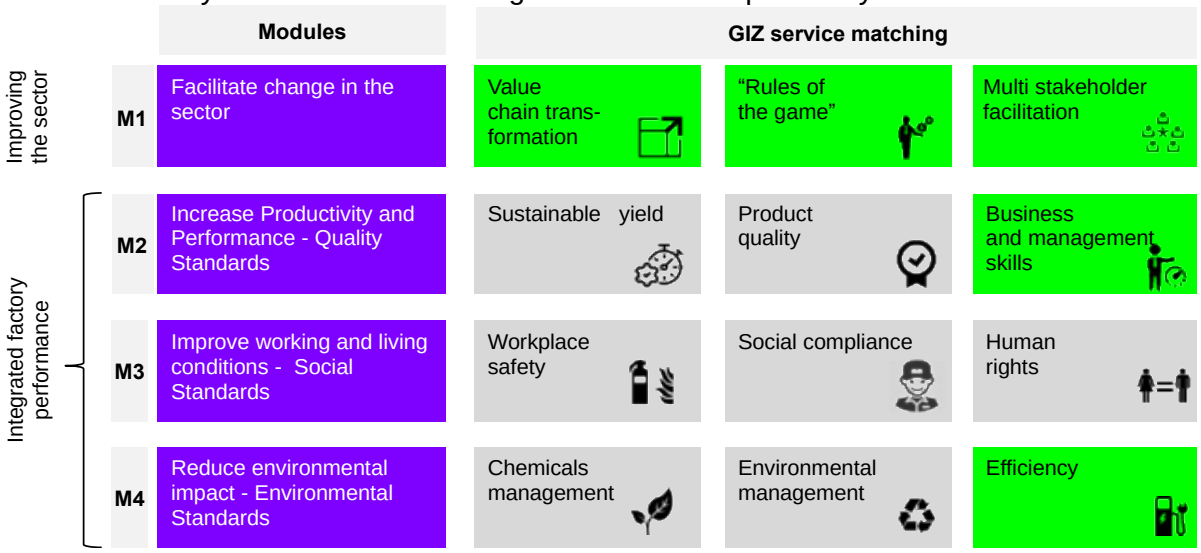
5.4.6 SWOT Analysis

	STRENGTHS	WEAKNESSES
INTERNAL	• Technical requirements are low • Single source of truth	• Has to replace established processes • The audit process cannot be completely eliminated, but is supported by a clear trail
	OPPORTUNITIES	**THREATS**
EXTERNAL	• Fraud and corruption is made more difficult • Liability is high, everybody signs every entry with their private key = signature • Contributor can check the usage of funds • Release of funds can be bound to rules and KPIs • Can be used as project management and monitoring tool	• No adoption/acceptance from the stakeholders • Garbage in, garbage out. Wrong data can be entered

Table 12: SWOT analysis management of funds

5.4.7 Impact Analysis

The impact analysis was done based on the service catalogue from GIZ for the textile, garment and footwear industry. The areas marked in green are most impacted by the use case.



5.4.8 Use Case Conclusion

Using Grants to control or steer an industry is not wide spread in development countries compared e.g. with the European grant system for agriculture. Therefore the stakeholders are not using grants to a great extent.

A platform which provides easy access to grants/funds and makes the processing easy also for small companies, could help provide the right stakeholders with grants and manage funds in an effective way.

5.5 ALTERNATIVE FINANCING

5.5.1 Use Case Introduction

This use case aims at establishing a micro-credit and micro-insurance platform for small entities on a crowdfunding or peer-to-peer lending basis.

Micro-credit:

- In general, peer-to-peer may be socially motivated by the money provider, requiring lower or no risk premiums to cover the risk of loss. A Blockchain platform allows a user to directly contribute money with a project of choice and a lower interest rate, or in some cases at no effective interest rate at all.
- Alternatively, the platform can serve to unite the offer of different – already existing – micro-finance providers in the market to provide a consistent overview to the client.
- Peer-to-peer concepts allow bringing the small producer and consumer closer together, despite geographic distances. Consumers can directly invest in local small businesses.
- In case of micro-credits, the risk of low financial savviness as well as over indebtedness need to be considered in the surrounding processes.

Micro-insurance:

- Providing an insurance through a Blockchain based solution allows for micro-insurance with more flexible characteristics than traditional insurance (e.g. daily, small crop quantities, etc.).
- The insurance platform can be partially automated with Smart Contracts whenever the insurance content occurs (e.g. crop insurance).

There are two options to realize the use case.

Option 1:

The first and faster one is to use the same approach as for Initial Coin Offerings (ICOs). With a smart contract on a public Blockchain, the investor and the beneficiary agree on the terms. The beneficiary gets a cryptocurrency or a digital FIAT (digital FIAT = central bank money like $ or €). In return the investor gets a token in his wallet which securitizes his rights. The advantage of this option is a very fast and cheap implementation. The disadvantages are the potential high transaction costs, depending on the development of the transaction fee on public chains, and an intervention in retrospect not being possible (e.g. if the smart contract code contains a bug)

Option 2:

Development of an own platform where assets (bonds, shares) can be tokenized and traded. The implementation of such a platform takes longer and more effort than option 1 but provides a lot more possibilities regarding function and services. Also, financial services like micro-loans and micro-insurances can be implemented.

5.5.2 Results and Expressions from Stakeholder Interviews

Financing

All interview partners finance their business through classic models. The most common type of financing is the bank loan. Factories owned by Muslims did not take out classic loans because of religious rules. These group finances investments out of profits from the running business.

There is a difference in terms of access to credits. Large companies have no challenges in financing via credits, for smaller companies it is sometimes a big hurdle. A loan of several thousand dollars can take months until it gets approved or declined.

Alternative financing instruments like crowd-investing, crowd-financing, micro-loans or peer-to-peer lending are not known in the areas where we did the interviews.

Insurance

Additional insurance products like micro-insurances are interesting, especially for labour. The biggest problem with insurances are the long processing times when it comes to claims.

Conclusion

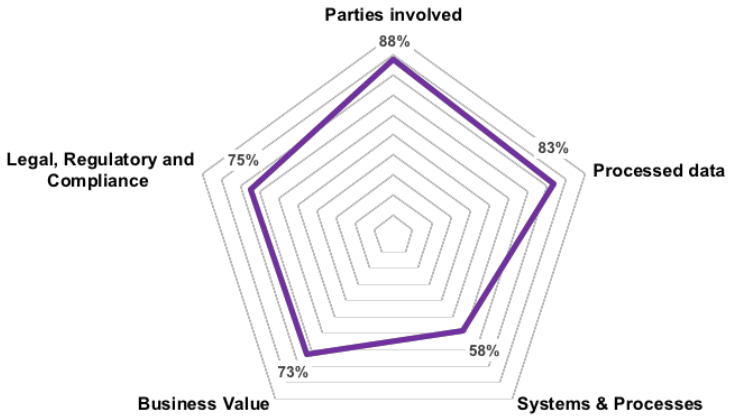
Derived from our interviews, there is potential for alternative financing channels in the sector. Introducing crowd investment or financing can be a huge opportunity for smaller companies or start-up entrepreneurs in the textile sector with unique offerings. To establish a prosperous economy, a financial tool accessible for everybody and legal security are key. Blockchain technology combined with new financial tools from Europe and the US can be a huge benefit for the stakeholders.

5.5.3 Blockchain Assessment

BLOCKCHAIN APPLICABILITY INDEX

73%

DETAILED RESULT



5.5.4 Technical Architecture

5.5.4.1 Option 1

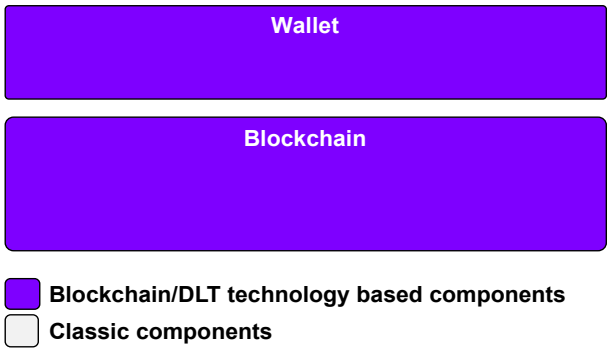


Figure 9: Technical architecture option 1 alternative financing

In Option 1, the available infrastructure is used. A smart contract has to be developed which executes the crowd investing. Beside the core infrastructure, an accompanying website will be necessary to explain the projects which are available for funding in more detail.

5.5.4.2 Option 2

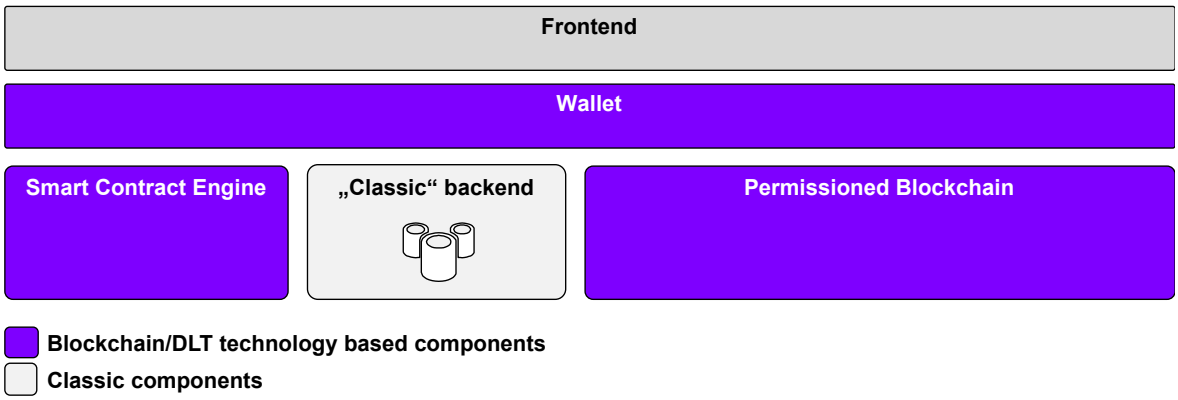


Figure 10: Technical architecture option 2 alternative financing

Frontend:

The frontend would be the connection between the user and the technology. In the design phase it has to be decided if the wallet is integrated into the frontend or separated. The wallet is the place where all assets get stored and is therefore a crucial part of the infrastructure.

Smart Contract Engine:

In Option 2, additional features are possible, like micro-loans, crowd-lending and also micro-insurance. The services are realized via smart contracts. To ensure the security of such contracts, a smart contract engine has to be developed. In the engine, the “user” can create smart contracts which are tested before deployment on the production system.

Classic backend:

A classic backend host, the frontend and all necessary interfaces.

Permissioned Blockchain:

In this scenario, a permissioned Blockchain is necessary to fulfill scalability and privacy requirements.

5.5.5 Stakeholders and Prerequisites

Prerequisites:

The following prerequisites must be fulfilled before implementation:

- Legal aspects have to be clarified
- Technical implementation for option 1 is simple.
- Technical implementation for option 2 is a big challenge here. The market should be monitored until a huge player (bank or trading house) provides a platform.

Stakeholder consideration:

Stakeholder	Description	Role	Benefit / Lose / Neutral
Farmer	Farmers can get access to direct funding via a peer-to-peer network, with potentially lower effective interest rates than are available in the market. It is, however, important to note that the risks of overindebtedness and financial illiteracy exist in the visited countries. When implementing a Blockchain micro-insurance or micro-finance solution, the surrounding processes need to take this into account. Smartphones and/or internet connectivity is required by the farmer/small producer. Further trainings surrounding this new platform should be provided, with mandatory attendance, to assure that the new environment can be technically used by the farmer/small producer.	Beneficiary	

Stakeholder	Description	Role	Benefit / Lose / Neutral
Carrier	Not affected		
Production facilities – employer	The visited production facilities (medium- to large-scale) stated not to require funding/insurance support by a peer-to-peer solution. For small producers, insurance and funding solutions are expected to remain crucial. The same aspects as under “Farmer” apply. Consumers may invest in small production businesses; e.g. funding of the first 100 T-shirt batch with 1 T-shirt as interest in return. In a peer-to-peer platform, users can rate each other based on timely repayment or delivery of service.	Beneficiary	
Employee	Not affected		
Environment	Not affected		
Government / Authorities / Auditor	Governments may serve as micro-finance loan or micro-insurance providers. A case in point: in India, a governmental crop insurance was established in 2016 to resolve the problem of the unpredictable nature of farming and prevent farmer suicides in the country (PMFBY42). Crop insurance – e.g. for cotton – could be partially automated through smart contracts on a Blockchain solution, allowing for lower premiums for poor farmers. The government or the auditing authority should push for setting up the basic framework. Nodes can be distributed across several users (e.g. production facility) to increase the buy-in and trust of the technology. Alternatively, implementing this Use Case as a private company would require close alignment with the local regulator (e.g. the Indian Insurance Regulatory and Development Authority).	Implementation	
NGOs	NGOs often serve as micro-finance loan or micro-insurance provider with the aim of connecting them with social or environmental development goals. Keeping costs of execution and disbursement low is crucial. A Blockchain solution can support this by automating certain tasks through smart contracts. The Blockchain solution allows to keep transparent records, even on disbursements or insurances in remote areas, as long as Internet connectivity is given. This might reduce the need for local staff.	Implementation	
Retailer	Not affected		
Consumer	Consumers can participate through micro-finance loans or as part of the micro-insurance pool actively in the day-to-day business of participants of the supply chain (Utilizing on prosumer tendencies for a triple-win: ↑ availability of funding for (small-scale) farmers / producers; ↑ Consumer value attachment to produced goods; ↑ retailers can use positive outcomes for marketing purposes).	Facilitator	

*Green= Benefit; Yellow=Neutral; Red=Lose – the classification depends on assumptions made based on the interviews and the impact the use case may have.

Table 13: Stakeholder considerations alternative financing

[42] http://www.agri-insurance.gov.in/PMFBY.aspx Retrieved August 27th

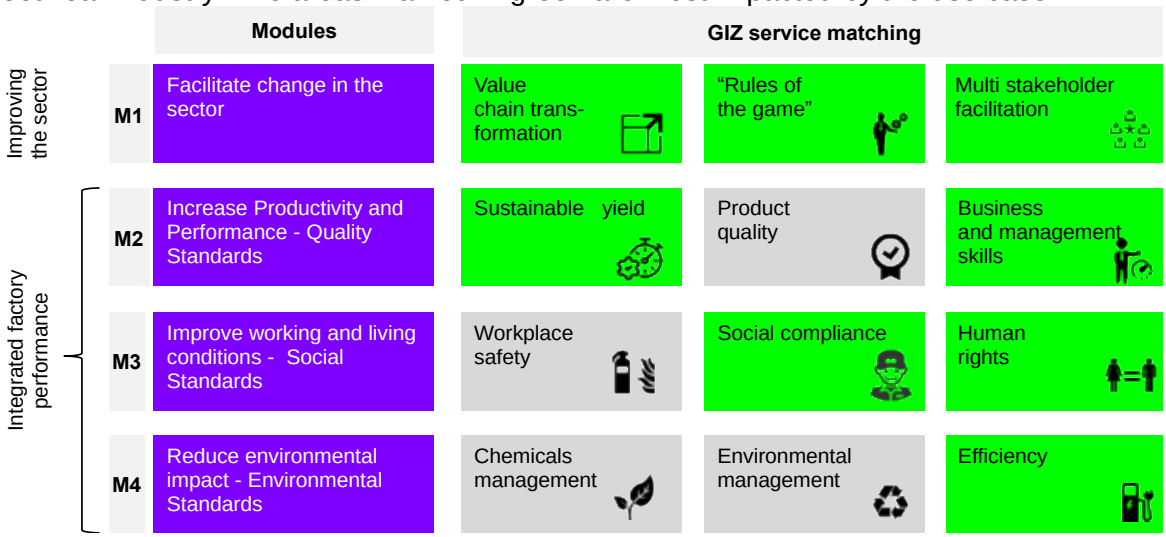
5.5.6 SWOT Analysis

	STRENGTHS	WEAKNESSES
INTERNAL	• GIZ can position oneself as frontrunner	• Implementation of such a platform is a high effort • Technical feasibility has to be ensured
	OPPORTUNITIES	**THREATS**
EXTERNAL	• Parties which have no access to conventional financing can finance the project through other channels • Consumers can directly invest in projects • Projects with a positive impact on social and environmental aspects can be directly supported without an intermediary • Financial inclusion could be improved	• Misbehaviour of beneficiary • Fraud • Financing of project with little chance of success • People do not accept/adopt the platform and the ideas • Increase of over indebtedness if processes do not foresee this risk

Table 14: SWOT analysis alternative financing

5.5.7 Impact Analysis

The impact analysis was done based on the service catalogue from GIZ for the textile, garment and footwear industry. The areas marked in green are most impacted by the use case.



5.5.8 Use Case Conclusion

Alternative financing would be an additional channel for the industry. At the moment, crowd financing or funding are not well known. The legal aspects have to be considered and clarified before an implementation project can be started to avoid stranded cost.

We recommend contacting established players (banks, trading houses, exchanges). Most of them are working on platforms to provide alternative investments with the power of Blockchain technology. A platform just for one industry would not pay off.

5.6 TRAINING AND CERTIFICATION PLATFORM

5.6.1 Use Case Introduction

For trainings that are attended the participant receives a training token. This provides a transparent history of all taken/finalized trainings. In addition to this token being exchanged for additional internal services (for example free snacks in the canteen or similar), this also increases employability of the participant when they find opportunities outside their current employer. Employers on the other hand benefit from trained workers whose training level and history can be verified.

5.6.2 Results and Expressions from Stakeholder Interviews

Use of mobile devices:

The use of mobile phones is between 50% and 90% according to the answers of the interview partners. The spread of the use is key if digital tools for the employees are implemented.

Education:

The value and advantage of education is seen by everyone interviewed. The higher the level, the more important the training. Thus, education drives salary. In the interviews we did not find a structured program to develop employees internally and enable their rise in the company.

Mandatory vs. voluntary trainings:

Recurring trainings are mandatory and address areas of safety and productivity. Voluntary trainings provided for the employees are carried out if there is a positive economic impact. Very few interviewed companies run trainings because of social or environmental aspects.

Record of trainings:

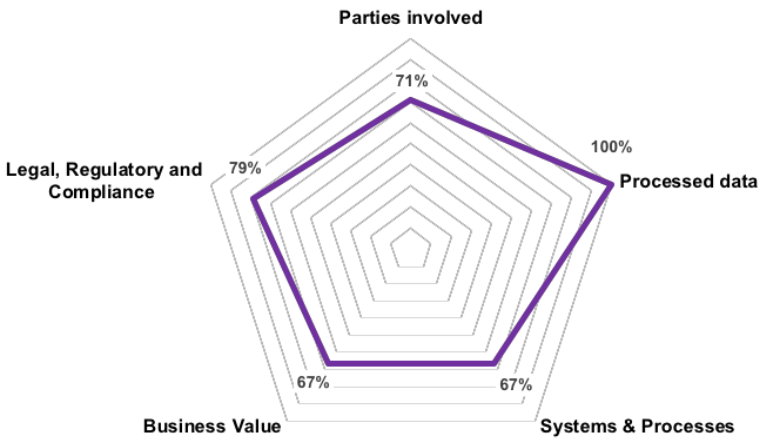
The trainings are recorded from the employees mostly on spreadsheets for statistical reasons. Only about 50% of the companies provide training certificates to the employees.

5.6.3 Blockchain Assessment

BLOCKCHAIN APPLICABILITY INDEX

77%

DETAILED RESULT



5.6.4 Technical Architecture

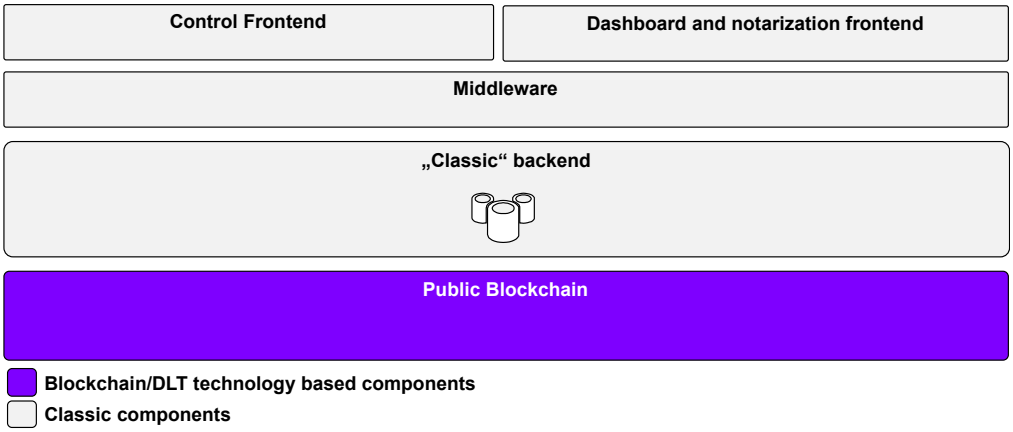


Figure 11: Technical architecture training and certification platform

Dashboard and notarization frontend

The frontend has to fulfil two tasks. One is to provide an interface where authorized parties can notarize the documents. Second is to have a dashboard which gives an overview about already notarized documentation.

Control frontend

Involved parties need to control the entered documentation, therefore a control frontend is necessary, also to redeem tokens against incentives.

Middleware and “Classic” backend

The amount of data exceed the capacity of a public Blockchain, therefore a middleware layer is necessary. In the middleware layer all the metadata is stored and only a cryptographic fingerprint of the data (HASH function) is handed over to the Blockchain. That ensures that the data cannot be manipulated. If a query took place the app will check if the identity is stored on the Blockchain and will retrieve the associated metadata set from the middleware layer.

Blockchain backend

The Blockchain backend is used to store the fingerprints of the documents. At this stage a final decision for a public or permissioned Blockchain cannot be made. It highly depends on the amount of documents, the detailed architecture, and the decision, which services should be on-chain. If business logic should be executed with smart contracts, a permissioned Blockchain may be necessary.

5.6.5 Stakeholders and Prerequisites

Prerequisites:

The following prerequisites must be fulfilled before implementation:

- A high level of mobile phone usage
- No technical obstacles for implementation

Stakeholder consideration:

Stakeholder	Description	Role	Benefit / Lose / Neutral
Farmer	If farmers participate in trainings, comparable benefits as for “Employees” apply.	Beneficiary	
Carrier	Not affected		
Production facilities – employer	Production facilities may cover the set-up of training recognition via the Blockchain. When hiring new staff, employers get workers whose training level and history can be verified.	Implementation	

Stakeholder	Description	Role	Benefit / Lose / Neutral
	Production facilities are not expected to be the driving force to set up this training log. As this does not provide the employer with any additional benefit apart from training traceability. This needs to be encouraged by the government, NGOs, or retailers upstream.		
Employee	Employees that participate in trainings receive a formal recognition that remains as proof on the Blockchain. Regardless of short labour contracts or a job change, the employees can retrieve the results stored on the chain. This also increases employability of the participants when they find opportunities outside their current employer. Training evaluations or final tests could be saved as well, connecting certain benefits to a score. This introduces the gamification aspect to training and allows participants to compare with their peers. In addition a "training token" could be exchanged for internal services (for example free snacks or a drink). The employee should have access to a smartphone or the Internet in order to access the current trainings log. Furthermore, they need to be trained on the new user interface.	Beneficiary	
Environment	Not affected		
Government / Authorities / Auditor	There are certain mandatory trainings required by the regulator for production sites in the garment industry – for example on labour safety. With the training recognition, the actual participation of the workforce could be traced and audited. The government can be the driving force for the set-up of this Blockchain solution and/or run a node to support the network.	Implementation	
NGOs	NGOs can encourage the usage of a Blockchain-based platform on the market place to raise awareness. They can run a node to support the network or even be the driving force that is required to push for this set-up. Multiple NGOs aim to empower vulnerable groups – like women in the garment industry – through trainings. Comparability across trainings as well as impact assessment remain main pain points. Registering trainings on the Blockchain does not directly solve the quality & impact issue. However, it allows training facilitators to see which trainings the participants joined previously, independent of their current employment; further results of final assessments can be logged. They can provide trainings to employees / farmers to understand the new user interface.	Implementation	
Retailer	Retailers can encourage the usage of a Blockchain-based platform in the market place to raise awareness also downstream. They can run a node to support the network.	Facilitator	
Consumer	Not affected		

*Green= Benefit; Yellow=Neutral; Red=Lose – the classification depends on assumptions made based on the interviews and the impact the use case may have.

Table 15: Stakeholder considerations training and certification platform

5.6.6 SWOT Analysis

	STRENGTHS	WEAKNESSES
INTERNAL	• Single source of truth • One document store • Documents can be checked from anywhere • Plausibility check possible • Technical requirements are low	• Replacement of current system
	OPPORTUNITIES	**THREATS**
EXTERNAL	• Employers can check new employees' qualification • Incentives for training can be introduced and administration is transparent • Motivation for further education • Workforce gets independent, documents are connected with the person, not with the factory • Acquirement of an identification "document" if no official ID has been issues by the governmental bodies yet	• No adoption/acceptance from the stakeholders • Garbage in, garbage out. Wrong data can be entered • Fraud from the parties entering the data

Table 16: SWOT analysis training and certification platform

5.6.7 Impact Analysis

The impact analysis was done based on the service catalogue from GIZ for the textile, garment and footwear industry. The areas marked in green are most impacted by the use case.

5.6.8 Use Case Conclusion

Education is key to improve the social situation of the workforce. Training also improves productivity. This use case can improve the transparency of the education level and empower the workforce to get control over their education/trainings. The employees would immediately get an overview of already completed trainings and can optimize the training program.

The token system would motivate employees to attend non-mandatory trainings and improve their qualification.

6 CONCLUSION AND RECOMMENDATIONS

Blockchain technology has the potential to improve social and environmental situations in developing countries. The study shows how many possibilities are imaginable. Blockchain can improve the integrity of data and enable a financial inclusion through all social levels.

Nonetheless the technology cannot solve all problems. People have to be educated to use the new technology. The data which is entering a Blockchain must be validated beforehand to ensure their correctness. The use of Blockchain technology can only be one part of a solution.

The results of the study are not limited to the garment industries, the findings and use cases can also be applied to other areas like agriculture or high-tech production. Social fairness and environmental protection are a pressing topic in all areas with a global production and supply chain.

We recommend that GIZ should focus on few use cases and **define a first project with a short duration and scope**. We do not recommend a lighthouse project with a long runtime and a considerable budget: the risks are too high because Blockchain is at its beginning and there is almost no experience within production environments.

A Blockchain project needs more than one player to make sense. Blockchain projects include various stakeholders. Even competitors form consortiums to run Blockchain projects, e.g. R3 for banks[43], B3i for the insurance industry[44], or VAKT for energy trading[45].

GIZ is in a good position to bring stakeholders (retailers, producers, farmers, authorities and regulators) together on a global level into a consortium and **act as a facilitator** for a project.

Before an implementation project is started all, participants should follow a multi-level process.

The first step is **education:** all stakeholders have to understand the possibilities and – even more important – the limitations of the technology. This first step is crucial for a successful project and the right expectations on the results.

The second step is **exploring:** here, the stakeholders explore the possibilities and shape the use case in more detail. The participants need to think out of the box. It should be avoided to rebuild old processes with new technology. It takes some time for this thinking to happen.

The third step is an **experimenting** project with a limited small budget and timeline. This step is crucial for a successful implementation project. The assumption and the business case are checked and can be adopted without high risk (money and time).

If the experimenting project was a success, an **implementation** project can be started with the goal of implementing a scalable production platform.

6.1 CURRENT GIZ PROJECT & USE CASES

It is a challenge to pick the right use case to start with. To structure the decision process, GIZ projects have been listed in the following table together with the six focus use cases. The use cases have been mapped to the projects. If one use case has potential to support the goal of a project, it is marked with an “x”. The overview shows which use cases have an impact on existing GIZ projects.

The matrix shows that the use cases “IoT-tower”(supports 9 from 11 projects), “Notarization”(supports 8 from 11) and “Training & Certification platform” (supports 8 from 11) have the highest potential application rate in the current GIZ projects.

[43] https://www.r3.com/
[44] https://b3i.tech/home.html
[45] https://www.vakt.com/shares-holder

GIZ PROJECT	IOT-TOWER	TAGGING FINAL PRODUCTS	NOTARI-ZATION	MANAGE-MENT OF FUNDS	ALTER-NATIVE FINANCING	TRAINING & CERTIFI-CATION PLATFORM
Bilateral project: Promotion of Social and Environmental Standards in the Industry (PSES III) (2017 - 2020) Country: Bangladesh	x		x			x
Bilateral project: Support to Safety Retrofits and Environmental Upgrades in the Bangladeshi Ready-Made Garment Sector (SSREU) (2017 - 2020) Country: Bangladesh	x		x			
Bilateral project: Employment Injury Protection Scheme for Workers in the Textile and Leather Industries (EIPS) (2017 - 2019) Country: Bangladesh	x					
Bilateral project: German-Bangladesh Higher Education Network for Sustainable Textiles (HEST) (2017 - 2019) Country: Bangladesh			x			x
Bilateral project: Improvement of labour and social standards in the Pakistani textile industry (2017 - 2020) Country: Pakistan	x		x			x
Bilateral project: Environmental and social standards in the textile and clothing industry (2016 - 2019) Country: Ethiopia			x			x
Regional project: Social and Labour Standards in the Textile and Garment Sector in Asia (SLSG) (2015 - 2019) Countries: Bangladesh, Myanmar, Cambodia, China, Pakistan	x		x			x
Sectoral project: Sustainability in textile supply chains (2015 - 2019) Country: Germany	x	x	x			x
Global project: Promotion of multi-stakeholder projects for sustainable textile supply chains (2017 - 2020) Country: Worldwide	x	x	x			x
Sectoral project: Sustainability Standards and Public-Private Responsibility (2017 - 2019) Country: Germany	x	x	x			x
Planned sectoral project: Sustainable textile consumption (2019 - 2021) Country: Germany	x	x				

Table 17: Project / use case matrix

6.2 PROMOTION OF THE TECHNOLOGY BY GIZ

How can GIZ promote the use of Blockchain technology for sustainability in supply chains?

Blockchain projects depend on the collaboration of multiple parties. Key to a successful implementation is forming to form a consortium out of multiple parties and managing it throughout the project. These parties can be competitors in the market, therefore managing such a consortium can be challenging. GIZ is in a neutral market position and would be suitable to drive / lead / coordinate such consortia.

The creation of a consortium could be supported by a series of events. The events should help to focus GIZ and the industry on the most promising use cases. Such events can be organized in various forms (conferences, hackathons or challenges). The shortest setup would be a hackathon. The disadvantage of hackathons is lacking sustainability. In the given timeframe, it is not possible to develop a common picture of the challenge, get to know each other, and develop a useful prototype.

Better concepts are challenges which extend over a longer period of time and are supported by mentors from the industry. A challenge should have a clear focus on an industry and should include predefined problem statements for the participants. With the challenge format, the chance for sustainable results is much higher than with a weekend hackathon.

A possible design of such an challenge is shown here:

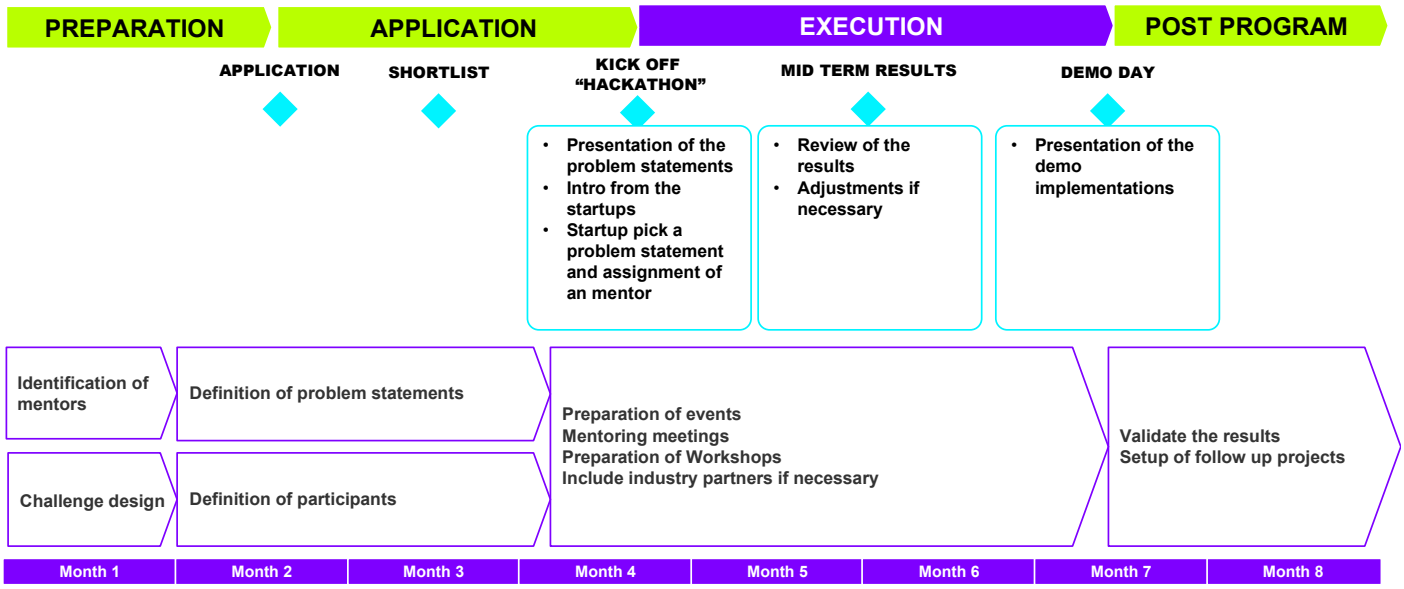


Figure 12: Blockchain challenge design

The challenge timeframe is divided into 4 phases. A **preparation phase** where the final and detailed planning and onboarding of participants (mentor, supporters) is done. In the next phase, the **application phase**, interested startups/implementers are identified and picked. At the end of the phase, 4–8 participants should be picked. A higher number of participants means more effort for the organizer and mentors but ensures success at the end. The risk of drop-outs is high during the **execution phase** because the creation of a pilot demands a lot of resources from the startups. If possible, startups should get a compensation for their effort during the execution phase. The last phase, the **post program phase**, is the most important one regarding sustainability. In this phase, the organizer together with mentors from the industry and the participants should form follow-up projects based on the results from the execution phase.

6.2.1 Participants and Roles

For the successful execution of such a challenge, various roles are necessary. We will highlight in short the most important ones.

Project support & -management:

A crucial role of the challenge is the project support and management. The team will start and drive the challenge. The main challenge is to design the setup, onboard mentors and startups, prepare the events and be first contact point for all inquiries during the challenge.

Mentors:

Mentors ensure that the topics for the challenge are relevant and the projects are feasible. Mentors should be across all affected parties (producers, factory, retailer, NGOs, authorities, technology companies). The main task is to define problem statements before the start of the execution phase and to be available on a regular basis for the startups during the execution in order to provide support. A mentor should at least spend 1 day per week on the role.

Startup / Tech companies / Implementers:

The most important role are the implementers, who develop solutions according to the problem statements. Finding the right implementers during the application phase is a challenging task. Good companies are usually running at full capacity and get a lot of requests to participate in similar programs. Therefore the application phase will have to be an active phase for the organization team. A compensation for the picked participants after the execution phase should be considered and other advantages have to be well defined.

GIZ can play the role of the organizer and/or the role of a mentor.

7 APPENDIX

7.1 STAKEHOLDERS: INTERVIEWED COMPANIES

The following table lists the interviewed companies in order to retrieve stakeholder insights.

COUNTRY	NAME	TYPE OF COMPANY	COMPANY SIZE*	No. of INTER-VIEWEES	DATE	TYPE
Bangladesh	Genesis Group	Dyeing, Washing, CMT	large	5	31.07.18	onsite
Bangladesh	DBL group	Spinning, Knitting, Dyeing, Printing, CMT	large	8	30.07.18	onsite
Bangladesh	BGMEA	BGMEA (Bangladesh Garment Manufacturers and Exporters Association)	n.a.	1	31.07.18	onsite
Pakistan	Softwood	CMT	medium	1	24.07.18	phone
Pakistan	Samad Apparels	CMT	medium	5	18.07.18	phone
India	Raj Overseas	Spinning, Weaving, Dyeing, Printing, CMT	large	3	18.07.18	onsite
India	Swift corporation	CMT	small	3	17.07.18	onsite
India	IR Accessories	CMT	small	1	17.07.18	onsite
India	Raymonds	CMT	medium	3	20.08.18	onsite
India	Shahi Export	CMT	medium	4	20.08.18	onsite

* large >3000 emp., medium 100-3000 emp., small <100 emp.

Table 18: List of interviews

7.2 IDENTIFIED USE CASES

TITLE	GROUP	DESCRIPTION	BENEFIT & SOLVED PROBLEM	AFFECTED ECOYSTEM (ENVIRONMENTAL, SOCIAL & ECONOMIC)
Control tower (IoT devices, sensors, analytics) e.g. gases and effluents discharge by a factory.	Environmental	Measurement of pollution via IoT devices directly at the plant. More in detail, even the carbon footprint of each product could be measured. Additionally enforcement of safety standards to lower the rate of incidents are possible. Collaboration and implementation of Zero Discharge of Harmful Chemicals initiatives	Environmental & labour standards will be achieved through the measurement of pollution and the tamper-proof data.	Environmental
Alternative form of finance Micro-loan/ -insurance & crowd funding	Finance	Establishing a micro-credit and loan platform for small entities on a crowdfunding or peer-to-peer lending basis. Additionally, a micro-insurance to cover potential losses such as e.g. crop loss. The insurance platform could be automated with Smart Contracts. Last but not least, crowdfunding would allow additional sources of credit for small producer.	Alternative forms of financing enable a flexible loan distribution for small producers and enable the coverage of potential crop loss.	Social
Tagging (Cryptoseal-NFC) for final products	Track & Trace	Final products (e.g. RMG garments) will be tagged along the production line for traceability of source of origin as well as destination. As the product is discarded by the consumer, recyclability and sustainability can also be tracked.		Environmental, Economic

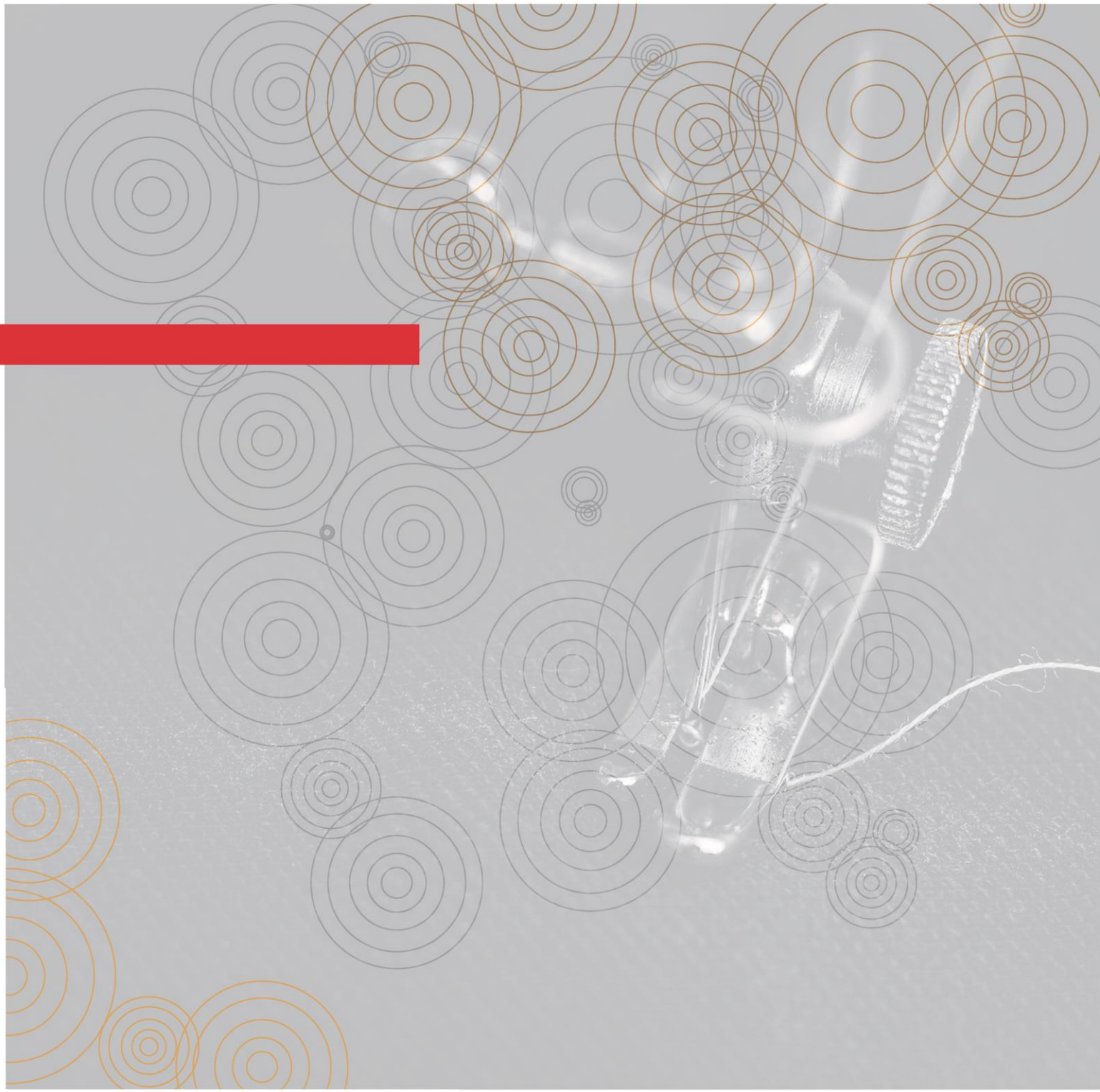
TITLE	GROUP	DESCRIPTION	BENEFIT & SOLVED PROBLEM	AFFECTED ECOYSTEM (ENVIRONMENTAL, SOCIAL & ECONOMIC)
Social Training / Empowerment Token	Education	For social trainings that are taken for empowerment (e.g. by women) the participant receives a training token. This provides a transparent ledger of all completed trainings. In addition to this token being exchanged for additional internal services (for example free snacks at the “World Woman Café”), this also increases employability of the participant when they find opportunities outside their current employer. Employers on the other hand get trained workers whose training level and history can be verified	Around 80% of garment workers are women, often uneducated or semi-educated. Empowerment for labour fairness is key. The token can increase transparency & buy-in of participants thanks to transparency/recognition.	Social
Documentation and notarization of compliance of the legal framework (e.g. head count, work time, child labour, payment in CMT,...)	Certificates	All relevant data from the workforce (worktime, age, education,…) will be stored in the Blockchain to enable a transparent platform to control social standards. The data can be used for audits. Contract registry for workers – fighting forced labor (e.g. for migrant workers: http://handshake.tech/index.html) - (a) Actual one – this notebook has actual number of workers receiving payroll and healthcare benefits. (b) Client facing one – this notebook shows more of resources in an attempt to fabricate their capability to win business	Blockchain enables full-transparency and hence keeps track of the compliance with labour laws. Through keeping track of labour contracts, misconduct by employers is reduced. Making it transparent via Blockchain allows it to be tamper-proof.	Social
Management of grants and development funds via a BC tool	Organisational	Similar to Accenture's trusted budget case, transparency among the distributed funds would result in increased fairness	Full transparency regarding the fund distribution and capital flows along the supply and value chain.	Economic
"Tagging with NFC of premium raw material"	Track & Trace	Before the raw material leaves the source of origin (farmer), the bulk will be tagged with an NFC chip and recorded in the Blockchain. Keeping track of WIP products avoids fraud in terms of the reengineering or tampering with the raw materials. Visibility to premium raw material used like “Egyptian cotton”, “cashmere wool”, “Grade A cowhide” can fetch premium positioning	The track and trace of raw material allows full-transparency along the supply chain and enables a proof of origin.	Environmental, Economic
Tagging (Cryptoseal-NFC) for work in progress products (e.g. from the mill)	Track & Trace	WIP products will be tagged.		Environmental, Economic
Help small co-operatives & farmers to maximize crop volume and value	Education	Crop yield varies significantly year on year. Create trainings and price transparency to enable consistent/growing yield, fairness and equal fund distribution ; e.g. http://www.agriledger.com/	The transparency regarding the funds enables economic and social inclusion. Trainings to improve crop yield increases farmers' motivation.	All
Common platform for all retailers to exchange/reconcile data from producers	Organisational	At the moment, every retailer tracks the producers separately. A Blockchain registry used by all could lead to a better overview about producers.	Improve transparency over the producers but ensure data security for the brands.	Social
Recycling life-cycle meets financial benefit	Finance	Provide financial incentives or a recognition reward for the recycling of production waste.	Managing and caring about the production waste in terms of recycling does not only benefit the environment, but also lowers the costs.	Environment

TITLE	GROUP	DESCRIPTION	BENEFIT & SOLVED PROBLEM	AFFECTED ECOYSTEM (ENVIRONMENTAL, SOCIAL & ECONOMIC)
Apparel or footwear product test reports documented on Blockchain and made available to consumers	Environmental	Currently, the wash care (apparel) or stamps (footwear) are the only reference points for consumers to know if their product was made from 100% cotton or 100% leather or even a grade of wool like 100% merino. Recording test reports on Blockchain and making them available to consumers immensely improves transparency, customers' trust in a brand and value for money.	Blockchain allows secure & full transparency regarding the origin and used mixture of the textiles.	Environmental
General purpose certification and notarization platform for the garment industry	Certificates	The certification platform would be a base layer for other use cases and enhances transparency amongst the stakeholders. E.g. a farmer could create certificates for a certain amount of raw material and sell it separately to consumers.	The non-transparency of current certifications will be resolved and always accessible via the Blockchain.	All
Green Button /Grüner Knopf tracing-make the Green Button smart and tamper proof	Track & Trace	The German government is introducing a new sustainability seal 'Grüner Knopf/Green Button' added to clothing. With an aditional NFC tag, every green button would be unique and could be traced.	Increased transparency; with the new seal, the German government performs an independent review.	Environmental
Vendor evaluation & onboarding process	Certificates	Once a vendor is shortlisted by a brand, multiple onboarding formalities are needed to empanel a vendor. These formalities are similar for most brands/retailers. Efficiencies can be created by putting certificates on the Blockchain and leveraging them for future evaluation and onboarding.	Cost reduction by erasing repetitive compliance procedures.	Economic
Crowd sourcing of certified trainers for improving social, economic, environmental conditions	Organisational	Suppliers resist investing time and money in having dedicated trainers in their workforce. Certified, crowd sourced trainers can be leveraged by multiple factories and units while trainer performance and credentials are recorded on Blockchain. This will also help government bodies which require more resources to enforce legal provisions to ensure that affected individuals have a fair chance of asserting their claims.	Availability of professional trainers while reducing the need to have dedicated workforce on a company's payroll.	All
Replacement of paper processes along the value chain (communication, orders, etc.)	Organisational	Digitize most paper based processes to create efficiencies and be more environmentally friendly.	Resulting in faster and cheaper processes, the digitization of paper trails also contains benefits for the environment.	Economic, environmental
Farming documentation of used resources	Environmental	Documentation of fertilizer and resources used. To avoid fraud, farmers also have to record invoices of inputs.	The track and trace of raw materials allows full transparency along the supply chain and enables a proof of origin.	Environmental
AI Analytics (VR/AR) to reduce the risk of workplace accidents	Organisational	Companies within the GIZ network provide relevant anonymized data. AI uses this information collected from companies to assess possible risks in real time. Companies are encouraged to provide data by receiving a token as exchange for the internal marketplace.	Reduces the risk of workplace accidents by using enhanced analytics. Furthermore, manages emergency situations more efficiently.	Social
Categorization for audit firms	Certificates	Audit firms are competing against each other and hence are lowering the standards to pass the standard for companies. Blockchain would allow a two-step certification and vendor categorization.	Weaker standards for the SA8000.	All

TITLE	GROUP	DESCRIPTION	BENEFIT & SOLVED PROBLEM	AFFECTED ECOYSTEM (ENVIRONMENTAL, SOCIAL & ECONOMIC)
Compliance standardization and lot inspection reports on Blockchain across all modes of product sourcing	Organisational	Products are sourced via 3 key methods – (a) sourcing via own sourcing/buying offices in manufacturing countries (b) direct sourcing from suppliers (c) indirect sourcing via local importers who buy from suppliers in manufacturing countries. There is huge variance between these three methods in terms of standards followed for manufacturing. Trust in supply chain is people-dependent and not process-dependent.	Streamlining all three sourcing methods and enabling standardization via Blockchain.	Environmental
Digital, trusted SMETA reports	Certificates	Sedex Members Ethical Trade Audit (SMETA) is one of the most widely used ethical audit formats in the world.	Achieving environmental standards by being compliant with SMETA reports.	Environmental
Collaboration with Leather Working Group (LWG)	Certificates	LWG assesses the environmental compliance and performance capabilities of leather manufacturers and promotes sustainable and appropriate environmental business practices within the leather industry.	Improving environmental standards and achieving sustainability goals by collaborating with business leaders in the leather industry.	Environmental
Voting of Labour Representatives / Basic democratic decision-making in co-operatives	Organisational	Assures a democratic/transparent vote for local labor representatives or decisions in co-ops.	Labour rights / voting	Social
Crowd sourcing of certified auditors for conducting social, technical and environmental compliance	Organisational	High cost (for e.g. professional companies like BV, SGS, etc.), lack of SOPs (by smaller third party compliance) and lack of enforcement (by own buying office resources) leads to suppliers not following required norms.	Achieving a higher proportion of certified auditors and compliance on the supplier side.	Environmental
Ownership and financing models	Finance	The consumer buys a *"Genußrecht"* [jouissance right] on a field/cow and the producer creates a better customer experience and relationship.	The producer can gain additional profits selling a *"Genußrecht"* [jouissance right] on the field/cow. Also enhances customer relationship.	Economic
Introduce "Digital FIAT" for the garment industry	Finance	With digital fiat, money can be earmarked for e.g. training, food, childcare and many more. Direct value transfer would be possible.	To be rewarded with the seal, frequent audits will happen.	Economic
Vendor categorization (fertilizer, etc.)	Environmental	A Blockchain-based vendor categorization would increase transparency, avoid corruption and achieve sustainability through the immutable, shared access to the same data.	Lacking transparency regarding the used suppliers is reduced and potential resulting accidents as well.	Environmental
Workforce Recognition	Education	Empowering and recognizing the workforce for their achievements and performance.	Creation of a sustainable and intrinsically motivated workforce.	Social
Sustainable Denim	Education	Denim processing has been one of the most polluting and hazardous to human health processes. Recording various wet processing techniques used in achieving specific finishes and color on denim jeans not only creates benchmarks for sustainable products but also makes consumers aware of their environmental and social responsibility.	Achieving environmental and social standards.	Environmental, social

TITLE	GROUP	DESCRIPTION	BENEFIT & SOLVED PROBLEM	AFFECTED ECOYSTEM (ENVIRONMENTAL, SOCIAL & ECONOMIC)
Partnership with Sustainable Apparel Coalition (SAC)	Certificates	SAC's tool of Higg Index for measuring and scoring a company's or product's sustainability performance needs a robust platform to create visibility for consumers on sustainability rating of the product they are buying.	Achieving environmental and product sustainability standards.	Environmental
Documentation and notarization of the training of the workforce -> Certificate	Certificates	Create a certificate which can be sold to generate an additional incentive for training and better skilled people.	Variety of different seals decreases, resulting in increased consumer transparency.	Social
Fraud protection on certificates	Certificates	Standards like the SA8000, ISO, etc. can be tampered with and used even if the certification has not been achieved or has expired. Blockchain enables a tamper-proof track record of the certification.	Fraud protection and enabling compliance standards.	Social
SA8000 – Proof of Attributes	Certificates	In order not to alter the data about working hours or other certification attributes, Blockchain could enable a tamper-proof database for these.	To avoid non-transparency and the resulting fraud, a certification platform between the different stakeholders should be put onto a Blockchain.	All
Preserving niche skilled artisans and suitably awarding them	Organisational	Skills like hand embroidery, block printing, tie & dye, hand painting, goodyear welting, etc. are becoming rare. Incentivizing these artisans will provide much-needed encouragement and development.	Preventing a labour shortage from artisans.	Economic
Visibility to material certification like "Oeko-Tex", "Organic cotton" at each batch level	Certificates	Currently, a factory when claims as "Oeko-Tex"-certified doesn't mean that all products (all SKUs – styles, colorways, sizes, fit) are "Oeko-Tex"-certified by default.	The certificate resolves fraud and non-transparency regarding the "Oeko-Tex" label.	Environmental

Table 19: List of all identified use cases



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