

# TRACIFIED

BLOCKCHAIN BASED TRACEABILITY SOLUTION

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Tracified (pvt) Ltd.



# The Problem

## Why isn't traditional traceability good enough for modern supply chains?

Traditional traceability which is typically maintained for regulatory compliance, certifications and recall management has repeatedly proven to be incapable of ensuring trust in supply chains. In a world of complex global supply chains it is increasingly difficult for end-consumers to verify that what they buy is safe for consumption and complies to what the label or the menu claims. Supply chain fraud is taking place in massive scale in the form of organized crime.

In particular, recent food scandals have shown that shameful breach of trust can occur despite of the presence of 'perfect' traceability, whether it is kept as a digital record or on paper. Ultimate goal of delivering verifiable high quality can be achieved only when each actor involved in a supply chain is authentically committed not only to produce quality but also to communicate it effectively. Therefore, modern traceability is an **organizational problem**.

We envision a robust and transparent traceability system for modern day supply chains.

## How blockchain technology could help develop a modern traceability solution?

1. Being a decentralized technology, blockchain can bring in a sense of equality so that even the less powerful organizations and people in a supply chain can contribute traceability information without the fear of those data being manipulated by more powerful players.
2. Credible tracking of quantities in supply chains poses a huge difficulty in the food industry. It has been a link which is vulnerable to fraud. For example, multiple cases have been reported where a company purchased a small amount of a premium ingredient and subsequently sold much more than the purchased amount under the name of the premium ingredient after mixing with low quality substitutes. Making the premium ingredient a blockchain-managed asset at the point of change of custody is a solution to curtail such practices.

When company X sells quantity Q of ingredient K to company Y, X transfers Q amount of assets that represent K to Y. Since the asset is strongly managed within the blockchain, company Y can sell at most quantity Q of ingredient K.

3. Another challenge confronting the premium food industry is the misuse of capacities. For example, an organic farmer who has a certificate for his produce may augment the genuine organic harvest from his farm with produce bought from a non-organic (cheaper than organic) farm to maximize profit. Observing capacity limits by an authorized officer as a prior step and noting it in a blockchain smart contract can solve this problem. The system will disqualify any produce coming from the farmer exceeding the limit for a given period.
4. Upstream visibility into change of custody is a value addition that the blockchain can bring, where a seller can tell with credibility to his buyer that the items were sourced from a particular region / country / organization /

community. This can be achieved by signing each consignment with both seller's and buyer's cryptographic keys and sending the transaction to blockchain.

5. Misusing certificates is a common problem in food supply chains. Displaying an irrelevant certificate for a product and using expired certificates may mislead buyers. Blockchain smart contracts are capable of holding logic pertaining to certificate applicability and applying them at right point of time and for the right product batch. When this capability is linked to a traceability system that tracks every individual batch, and when combined with the commitment from certification issuers to digitally sign the certificate with their cryptographic key while specifying limitations on the applicability of the certificate, buyers can check whether a certification claim is legitimate at item level before purchasing.
6. Since the data ledger in blockchain is immutable it can provide a proof that traceability data added to the system either by human workers or sensors have not been altered afterwards.
7. Badges issued from a decentralized system (blockchain) as accolades for people and organizations involved in a supply chain can boost buyer confidence as suppliers with one or more badges carry higher credibility than those with an accolade issued by a centralized authority. For example, a fisherman who has been in the business for x number of years without major complaints can claim recognition for such achievement from the blockchain as a badge.
8. Blockchain is a highly secure, decentralized technology that offers self-controlled identity with a higher degree of privacy. That enables actors in a supply chain to expose only necessary information without compromising confidential business data.
9. Technologies linked to blockchain such as zero-knowledge-proofs further enhance capability of supply chain actors to prove certain facts about themselves without revealing their identity. For example, a fish supply chain can show a buyer that his fish come from a fisherman who has been in the

business for past 5 years with a clean track record on quality without showing the fisherman's identity. This solves a key problem in supply chain traceability as lot of businesses are reluctant to expose their suppliers to the competition.

10. In addition to the immutable database (ledger), blockchain also makes it possible to implement a crypto-economic model which can be used to reward authentic players while penalizing actors who try to trick the system.

## **Will data integrity proofs from blockchain be sufficient for tackling the organizational problem associated with traceability?**

No.

Blockchain is a digital data structure that doesn't know anything about the physical world. Although blockchain can provide guarantees on data integrity and logical execution levels, trustworthiness of data that were entered into the blockchain in first place remains problematic. Therefore, **direct proofs coming out of blockchain must be complemented with other social and economic information for a traceability system to be able to derive a meaningful measurement of authenticity on what is claimed in traceability.** Social information may include trust relationships between different actors involved in a supply chain while economic aspect may carry information on brand values and economic commitments of roles involved towards generating high quality.

# The Solution

What is Tracified's approach to enabling modern traceability as a way for businesses to communicate the authentic quality of their products?

## WHAT IS TRACIFIED?

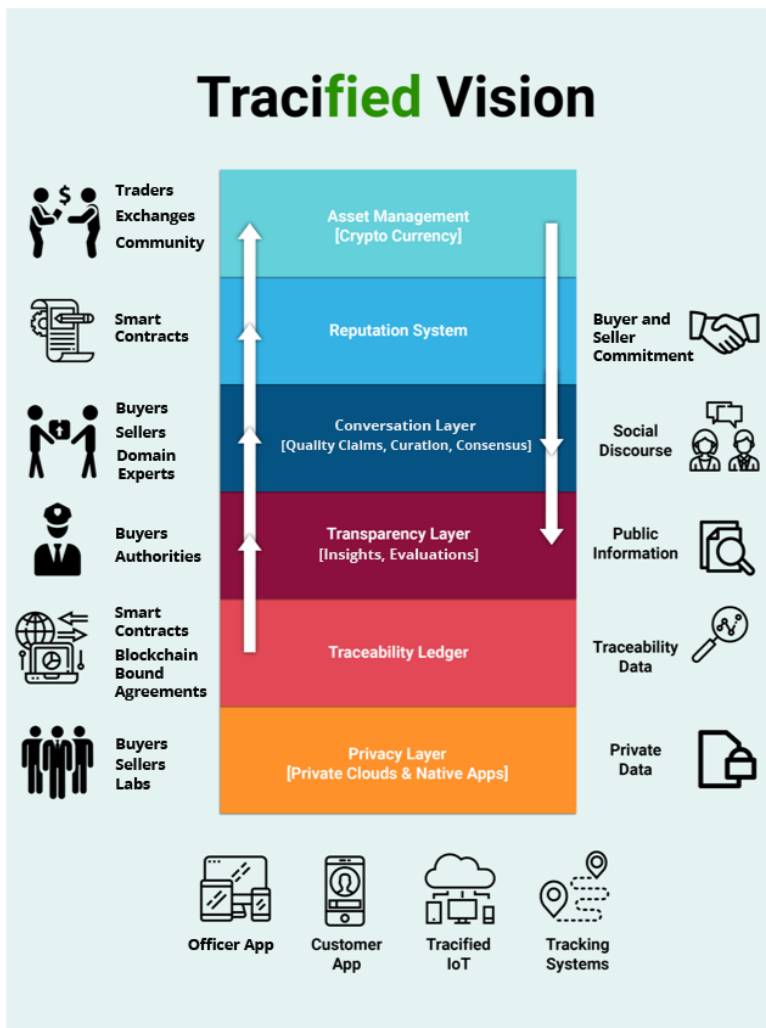
A BLOCKCHAIN BASED PLATFORM THAT ADDS THE CRUCIAL ELEMENT 'TRUST' TO TRACEABILITY INFORMATION. THIS APPLIES TO ANY BUYER – SELLER SCENARIO THAT OCCURS IN A SUPPLY CHAIN (NOT ONLY THE END-CONSUMER). TRUST IS ACHIEVED BY 3 PILLARS IN TRACIFIED.

- 1) BLOCKCHAIN BASED DIRECT PROOFS
- 2) WEB OF TRUST
- 3) SECURITY DEPOSITS

BY IMPROVING TRUST, TRACIFIED ENABLES SMARTER PURCHASING DECISIONS FROM THE BUYERS SIDE WHILE MAKING IT POSSIBLE FOR SELLERS WHO SELL GENUINELY HIGH QUALITY PRODUCTS TO PROVE THEIR VALUE.

Tracified's attempt is to elevate traceability from a traditional compliance tool to an effective mechanism for communicating the quality factor in buyer - seller relationships. This is far from trivial in today's noisy markets where every seller claims high quality (subjective) and tries to compete on cost and price. Inaccurate quality claims combined with attractive prices hinder buyers from acquiring the actual quality they are looking for. *Akerlof's theory of Lemon Markets* show how difficult it is for the seller who produces genuine quality goods to effectively

communicate it to his customers in a way that his products are distinguished from the fake rest.



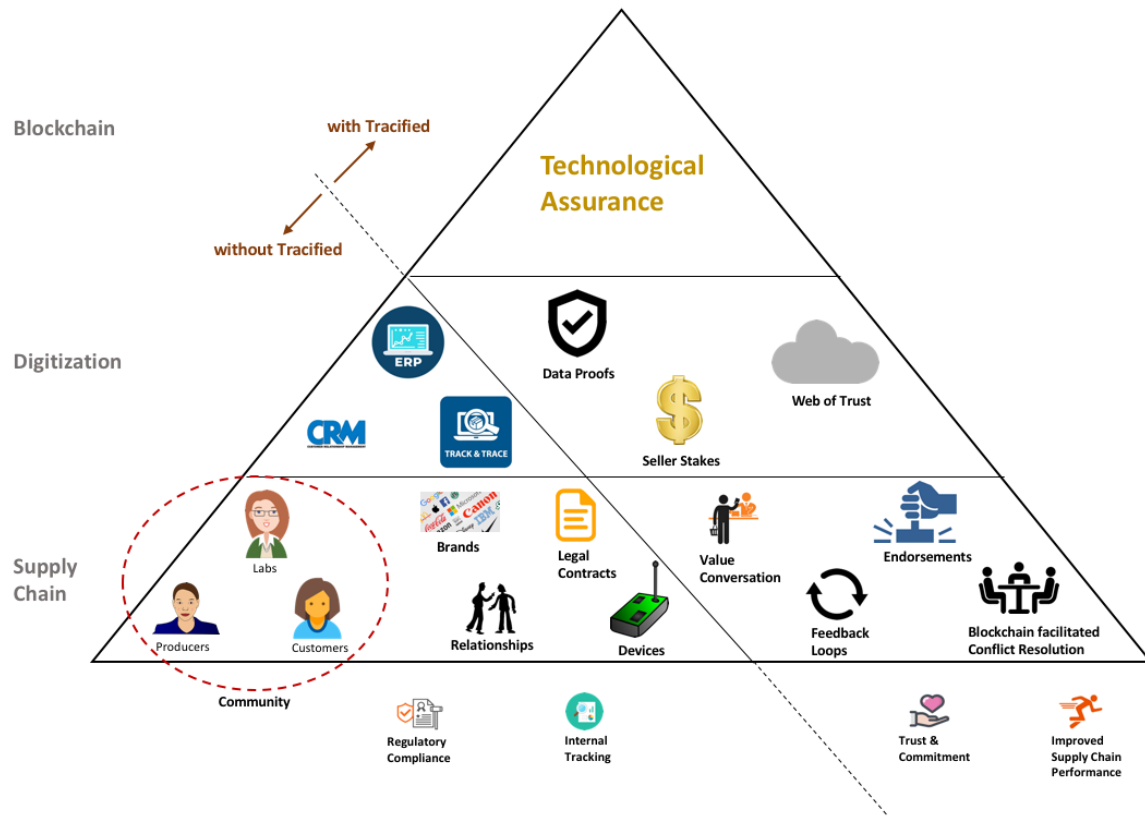
If traceability is to succeed as a credible signal indicating authentic quality, it has to survive harsh economic realities in markets. Tracified takes a multi-dimensional approach in dealing with this challenge. On one side, Tracified's direct blockchain based proofs provide a way for the seller to present certain traceability information in a 'digitally-proven' format. Since these proofs come with a guarantee on integrity from public blockchains, the buyer can trust this information.

Examples for direct blockchain based proofs include Proof of Existence where the blockchain provides a guarantee that traceability information has not been tampered after it is added to the system, Proof of Continuity where the blockchain guarantees that the sequence of stages shown in the traceability history of the product (for a vegetable this sequence may be seeding -> plantation -> harvesting -> post-harvesting -> transport -> warehousing -> distribution -> retail) is correct, Proof of Association where the blockchain guarantees that the product has gone through a certain process (e.g. lab test) or facility (e.g. warehouse), Proof of Certification where the blockchain guarantees that a product actually carries a certain certificate, Proof of Genuine Spending where the blockchain guarantees that ingredient quantities are not manipulated, and so on.

However, not every kind of traceability information can be directly proven in blockchain. For instance, it is not possible to digitally prove that the sensor apparatus used to measure temperature in a cold chain is accurate. These are real world artifacts that can only be verified through human inspection. Therefore, the guarantee on such information can only be as credible as the body that physically conducts the verification. **Tracified takes a Web-of-Trust approach to quantify this credibility of individuals and organizations involved in such verification processes.** Entities (individuals or organizations) have to earn trust from other entities through means such as brand building, long-term good conduct or competency proofs. Once this trust is recorded in the blockchain, every entity is assigned a trust index. Then this number is used to indicate the level of credibility of a certain traceability artifact. A seller who invests heavily on getting his artifacts right (thereby producing high quality products) can pay an entity with high trust index to get those artifacts verified and endorsed.

Tracified also provides a way for the seller to stake money on certain quality aspects of his product. These stakes appear in the blockchain as smart contracts. Seller locks some amount of money as a warranty on his product's quality. This gives the buyer more confidence in buying the product. If the buyer is happy about the quality after using the product the seller gets his money back. In case the buyer is not happy and manages to prove that the quality is not acceptable (these proofs happen in the form of long running transactions in blockchain) seller's staked money is transferred to the buyer as compensation.





There is one more step in trustworthy communication of quality; summarization of traceability information so that the buyer can comprehend it. Since the tracking data can be much wider and deeper than the buyer can digest, it is necessary to create a synopsis that only addresses his concerns. Maintaining credibility in this summarization step is as important as ensuring authenticity in data recording process. It is essential to make sure that the buyer is not cheated by misinterpreting tracking data. However, since the summarization heavily involves intuition of domain experts it is not possible to provide direct blockchain proofs on this step. Instead Tracified leverages on the Web-of-Trust model here as well. The buyer can choose a synopsis coming from an expert of his choice. In making this decision the buyer will likely choose an expert with high trust index.

# What is Tracified's unique value proposition compared to traditional traceability software?

Traditional traceability software tracks information for internal reference and regulatory compliance. They are not made with a vision for making traceability aimed at buyers. However, with the advancements in blockchain, artificial intelligence & IoT technologies traceability could be introduced as a vital tool to assist buyers make informed purchasing decisions.

Tracified harnesses modern technology to elevate traditional traceability to an advanced new level. With Tracified, **sellers can use traceability to communicate**



## WHAT IS TRACIFIED'S UNIQUE VALUE PROPOSITION?

ENABLES A BUSINESS TO CREDIBLY COMMUNICATE THE QUALITY OF ITS PRODUCTS TO CUSTOMERS. THE TERM 'QUALITY' ALSO INCLUDES SUPPLEMENTARY FACTORS SUCH AS SUSTAINABILITY PRACTICES FOLLOWED WHEN MAKING THE PRODUCT AND THE COMMUNITY /SOCIAL IMPACT OF MAKING SUCH A PURCHASE. TRACIFIED'S TARGET CUSTOMER IS A BUSINESS THAT HAS THE POTENTIAL TO SIGNIFICANTLY IMPROVE ITS SALES IF THE MARKET CLEARLY RECOGNIZES THE QUALITY OF PRODUCTS SOLD.

TRACIFIED ALSO ENABLES SUPPLIERS TO CONSTANTLY IMPROVE THEIR OPERATIONS AND PRODUCTS BY SENDING FEEDBACK (UPSTREAM TRACEABILITY).

authentic quality of their products while being able to tap into a new generation of tech-savvy, quality-conscious customers who are ready to pay a premium for proven value. This results in a disruption of the traditional marketplace where authentic sellers, premium buyers, food experts, laboratories, certification bodies, product verifiers and the global economy as a whole are all well-positioned to reap enhanced benefits.

## How is Tracified different from other blockchain based traceability products?

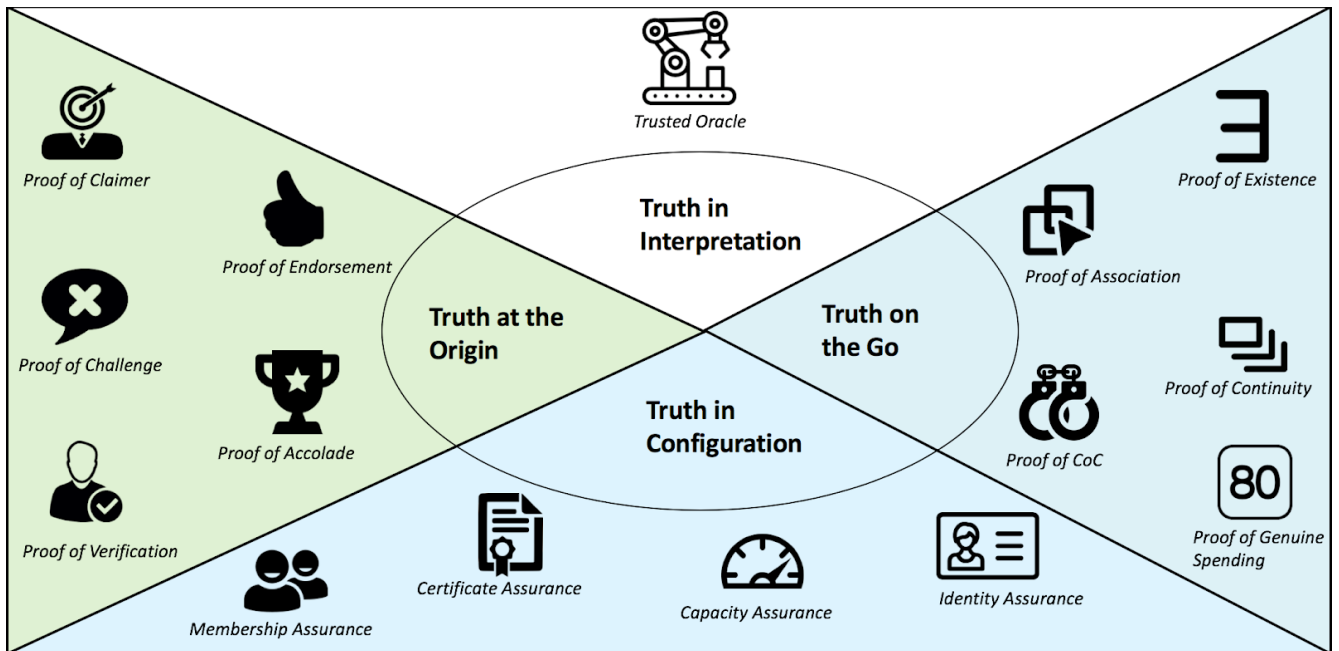
There are few products and solutions that claim to deliver supply chain traceability with blockchain. Most of these solutions use the blockchain only for its immutable ledger. On top of that they provide guarantees that the traceability data have not been tampered after they have reached the blockchain. However, this is not sufficient to build credibility into it as the data can be manipulated in numerous ways before they even reach the blockchain. For instance, **a business can send temperature data into blockchain that would show as if proper cold chain conditions have been maintained while it's not really the case in practice.**

There are some blockchain based traceability products such as Provenance and Origin Trail that provide more advanced blockchain proofs and smart contract platforms. However, they also fail to capture the real world complexities involved in supply chains such as the trustworthiness of verification bodies, appropriateness of sensor apparatus used to generate tracking data, authenticity of workers involved, etc.

All existing blockchain based traceability products and solutions fail to appreciate the fact that it is impossible to capture the peculiarities associated with supply chain processes and relationships completely into program logic. This severely limits the practical value of these technologies.

Tracified, in contrast takes a holistic approach towards capturing, recording and reporting supply chain data. This includes combining tracking data with information on various kinds of trust relationships that exist between people and organizations in a supply chain. As a result, Tracified provides a platform that possesses capabilities to provide blockchain-based proofs and execute smart contracts while also being able to absorb meaning in people's subjective

judgements and harnessing them to strengthen the credibility of the traceability claim. Following diagram shows direct and indirect proofs provided by the Tracified blockchain.



Proofs given in Tracified blockchain are grouped into four categories

# Does the Tracified model promote supply chains to achieve United Nations Sustainable Development Goals (SDG)?

Yes. Several goals.

Tracified provides a platform for supply chain participants to **provide trustworthy evidence** on their commitment towards sustainable practices, nurturing communities and reducing inequalities. The catch here is the ability to support these claims with trustworthy digital evidence so that they can be distinguished from the mere claims coming from the competition. These claims can be directly linked to many SDGs.

- Goal 12: Responsible consumption and production
- Goal 1: No poverty
- Goal 5: Gender equality
- Goal 10: Reduced Inequalities
- Goal 8: Decent work and economic growth
- Goal 6: Clean water and sanitation

A 2018 report by Food and Agriculture Organization of United Nations titled “Transforming Food and Agriculture to Achieve the SDGs” recognizes 20 actions for food and agricultural supply chains that integrate the 3 dimensions of sustainable development; economic growth, social inclusion and environmental protection. Many of these actions can be credibly communicated and coordinated via proofs and web of trust in Tracified.

- Action 2: Connect smallholders to markets
- Action 4: Build producers’ knowledge and develop their capacities
- Action 5: Enhance soil health and restore land
- Action 6: Protect water and manage scarcity
- Action 7: Mainstream biodiversity conservation and protect ecosystem functions
- Action 8: Reduce losses, encourage reuse and recycle and promote sustainable consumption
- Action 9: Empower people and fight inequalities
- Action 11: Use social protection tools to enhance productivity and income

## How does Tracified ascertain the authenticity of data entered into the blockchain?

Tracified assigns a cryptographic key to each individual person / organization / device / technology involved in the supply chain. Data coming from each entity is signed with the respective key. As a result, Tracified knows who provided each piece of information when showing traceability. Additionally, every piece of data that enters the supply chain together with its relationship to other data is hashed (hash is the cryptographic footprint of data) and every quantity involved is tracked in blockchain in terms of cryptographic assets. When these mechanisms are combined numerous direct proofs on various facets of authenticity can be derived. The facets that cannot be directly proven are linked to an objective measure of the level of authenticity calculated from the reputation of organizations, people and technologies involved using web of trust. Tracified also makes it possible for sellers to (optionally) keep deposits in blockchain as security for their quality claims. This gives extra confidence to a buyer when making the purchasing decision.

Tracified utilizes smart contracts extensively to ascertain authenticity of quality claims, but the uniqueness compared to other blockchain based solutions is that Tracified's smart contracts are designed to co-exist with already prevailing relationships in supply chains, which we believe is an essential trait for a traceability platform to survive in practical supply chains.

## Images and videos can play an instrumental role when telling the story of a product to a potential buyer. How does Tracified utilize this?

Tracified enables people working in a supply chain to capture different stages of product items or batches as images and video using mobile devices. For example, images and videos can be recorded within an agri supply chain in all stages such as propagation, plantation, harvesting, transportation, cleaning, warehousing and distribution. Multimedia content can capture not only the product items but also the people, equipment and facilities involved. All images and videos are automatically time-stamped and geo-coded to enhance credibility. They are also hashed into blockchain to ensure no tampering.

This kind of tracking enables the buyer to see the story of a product in multimedia form before making a purchasing decision. The fact that **these images and videos cover the exact product item or its batch (in contrast to pre-shoot content)** makes this story more compelling.



Images taken at various stages in the supply chain from the exact batch that the item belongs to, are shown in the image-slider

## Does Tracified work with e-commerce as well as with brick & mortar?

Yes.

Tracified works with both. Especially its ability to provide Point-of-Sale traceability in e-commerce sets Tracified apart from the competition. **Point-of-Sale traceability is different in e-commerce than in retail.** In a retail shop the buyer can see the exact item he is buying. Therefore, he receives traceability information for that exact item. In web shops, more often than not, the exact item to deliver is decided only after the buyer places the order; which means 'exact traceability' cannot be provided at the Point-of-Sale. Tracified offers a generic mechanism to handle this additional complexity in e-commerce. It provides flexibility for the web shop admins to configure which batches to be used at a given time to derive Point-of-Sale traceability for a product. In an organic vegetable web shop for instance, Point-of-Sale traceability may be derived by aggregating over all batches that are currently in the inventory because, if the product is ordered, the item being delivered will most likely be from the current inventory. If the product is not in the current inventory, the business may show traceability from the next inventory. Everything depends on the exact business process unique to each business operation. Tracified provides a great level of flexibility in configuring that using *Tracified Grammar*. When the buyer gets the item delivered, he can see traceability for the exact item just like when purchasing at a brick & mortar store.

Tracified provides plugins to popular web shops such as Shopify and WooCommerce. Plugins are equipped with a feature-rich admin backend that enables business admins configure settings according to the process employed by the business. What the customer sees before purchasing a product can be configured using a common or tailor-made synopsis.



## How easy is it now to integrate Tracified with enterprise systems and how scalable is the operation?

As of now Tracified platform experts are required to configure the system for a new business. In the near future (6 - 8 months from now) it will be possible for an in-house IT admin to configure the system without assistance from Tracified support personnel. A designer-like interface is being developed to achieve this task. In 1 - 1.5 years Tracified will make it possible for a business person without IT knowledge to connect Tracified to his business seamlessly. At this point Tracified will be ready for a full scale SaaS launch.

Extra effort required from the customer to run Tracified depends on the maturity of the digital systems used to run business operations and the level of depth the business intends to capture its supply chain. Tracified can easily pull data out of ERP/SCM software, if the business is satisfied with the data that is already being captured. In that case the business does not have to put any extra effort to adopt Tracified. However, if deeper levels of information should be captured than what is handled by existing systems, the business can choose to utilize Tracified's IoT interface or Officer mobile app. Then the physical mechanisms for data capturing (sensor apparatus and / or manual processes for recording data) have to be implemented.

The business can ensure complete privacy of its data by sending only the cryptographic footprints of its data to Tracified. Being a system which is developed with compliance to ISO 27001, Tracified ensures high level of security for data and functionality.

## Different roles involved in a traceability ecosystem and trust relationships among them is an important dimension of supply chain traceability. What are the key roles that Tracified recognizes?

Tracified's 'Traceability Community' model recognizes many roles that are indispensable in generating authentic traceability.

1. **Traceability Advocate:** The organization in the supply chain that leads the traceability initiative
2. **Quality Custodian:** Any person / organization that handles a product / item at any stage in the supply chain
3. **Oracle:** A person / organization that inputs data pertaining to a certain characteristic of the product / item e.g. A lab that conducts a test and uploads a report
4. **Registrar:** A trusted person / organization (e.g. NGO, government) who has both authority and competency to perform some admin level functions such as visiting a farm and specifying its maximum monthly output of organic produce or specifying acceptable ranges of ratios for mixing ingredients (for example mixing milk and salt to produce cheese)
5. **Regulatory body:** e.g. customs
6. **Certification Authority:** An accredited organization for issuing a certificate
7. **Buyers**

# The Technology

## What are the types of data handled within Tracified?

Tracified handles four types of data within its system. All four types are instrumental in bringing the intended character to the traceability output that Tracified promises to deliver.

### 1. Master Data

These are the type of data that define entities in the business that do not change often; for example, farmers, farms, warehouses, communities, delivery services, etc. in an agri supply chain

### 2. Tracking Data

This refers to the data collected from items and batches while they move through the supply chain. Therefore, tracking data has a very dynamic nature. Examples are temperature readings taken in warehouses, soil quality reports, information on weeding, photos of items.

### 3. Social Data

Social data defines trust structures formed among people and organizations involved in a supply chain. These data are vital for information filtration and summarization. For instance, a buyer may see only the traceability information endorsed by his trusted network.

### 4. Economic Data

These are the economic assurances provided by the seller on his traceability claims.

## How can tracking data be fed into Tracified system?

Data is injected to the system in three ways.

1. Manual entry via mobile apps by people working in the supply chain
2. Automatic feed from sensors
3. Imports from other digital systems such as ERPs

Data is signed at the origin and are hashed (they are also time-stamped and geo-coded when applicable). Only the hashes along with metadata go to the blockchain. Plain data resides in a user-provided, off-chain data store.

It is also possible for business admins to specify how tracking data should be absorbed into the system. For example, while temperature sensors set up to track a cold chain would send streams of readings throughout different stages of a product item, Tracified can be configured to store only maximum, minimum and average values per each stage.

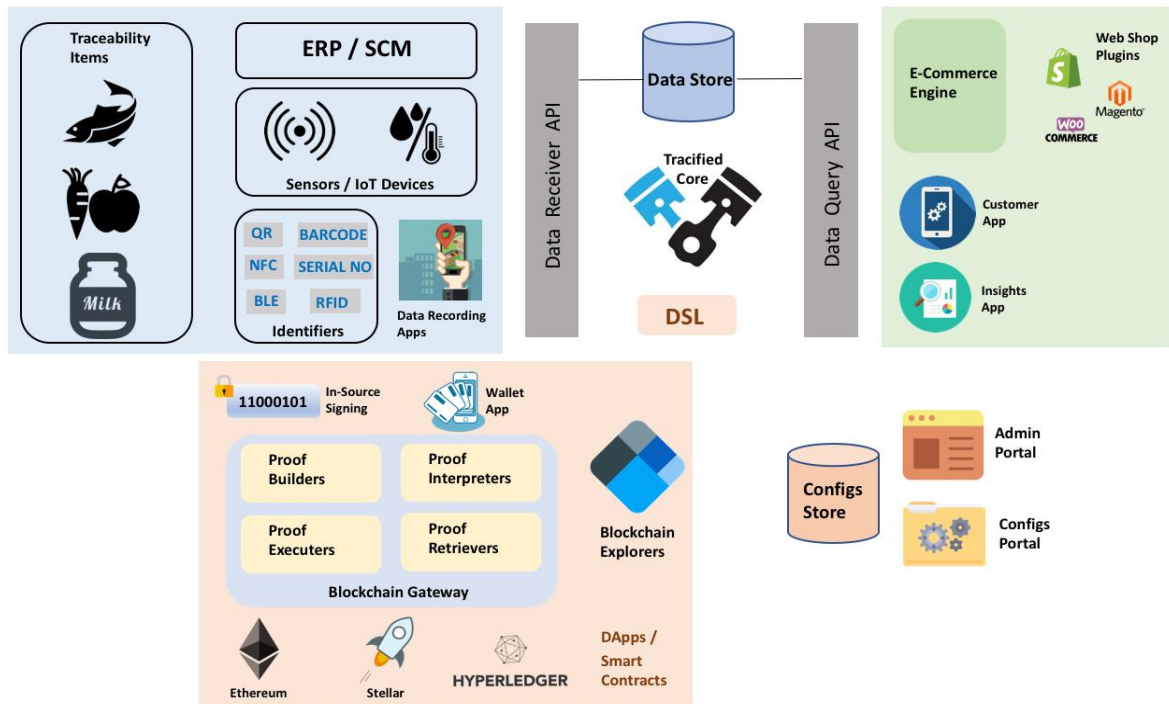
## How does Tracified allow a business to express the configuration of its supply chain?

Supply chains are complex. They comprise many items, stages, activities and processes. Many people and organizations get involved in delivering a final product. Tracified provides high degree of flexibility in modeling a supply chain down to fine grained detail.

A designer-like interface in Configs Portal enables business admins to define stages involved in the supply chain and the data involved in each stage. This designer interface targets survey-type screens that would appear in the officer mobile app for capturing the supply chains. Master data involved in each stage can also be specified. Complexities such as cascaded scenarios are also supported. A WYSIWYG view is provided on-the-go while defining the supply chain to help the business admin to validate his model. After defining the model, the officer mobile app is automatically generated.

Based on the supply chain model, business admin can then configure how the traceability information should appear in customer facing front-ends such as point of sale view in e-commerce and customer mobile app. After they are defined the front-ends are also generated automatically.

# What are the technical components of Tracified system?



The illustration above shows main modules and components of the Tracified platform. They are further explained below.

**Tracified Core:** This is the main Tracified server. It acts like the brain of the system. It handles Tracified data model and item workflows. Entire traceability life cycle of a batch is handled by this component. It also handles batch splits, merges and physical transforms (e.g. vegetables being chopped).

**Officer mobile app:** Mobile app that runs on both android and iOS for people working in a supply chain to enter traceability data at different stages. This app is directly connected to the blockchain (without going through an intermediate server) to ensure credible data recording. These apps are automatically generated by Tracified once the business admin has configured all screens using configs portal.

**Admin portal:** This is the main Tracified web portal for business admins. It is used to create and manage users and their access rights within the system (e.g. which officers have the right to enter tracking data for a particular stage), defining and maintaining master data for the business (they are called artifacts in Tracified), generating access token for e-commerce admin, generating QR codes, etc.

Action	Name	E-mail	Contact Number	Type	State	Overview	Devices	User Manage
	Kamal Perera	admeastwood4@gmail.com	+9465658498495	Traceability Advocate	Enable			<a href="#">Disable user</a>
	Samantha Pradeep	admeastwood5@gmail.com	+9462523252625	Traceability Advocate	Enable			<a href="#">Disable user</a>
	Malinda Samaraweera	foeastwood3@gmail.com	+942121212121	Field Officer	Enable			<a href="#">Disable user</a>
	Suranga Lakmal	foeastwood2@gmail.com	+9465651665656	Field Officer	Enable			<a href="#">Disable user</a>
	Weerasekara Fernando	manamperishashika@gmail.com	+9471548623	Field Officer	Enable			<a href="#">Disable user</a>

**Insights portal:** Insights app is a web portal dedicated for business admins to have system-wide insights on traceability data. Currently the users can see all traceability information for all ongoing batches plus all customer reviews. In future this portal will also offer traceability business intelligence e.g. see a report correlating processes applied correlated to sales data.

#	Batch ID	Current Stage ID	Current Stage Name	Date and Time
31	abc01	00201	Propagation	2019-07-18 10:51 AM
32	6677	00208	Dispatching	2019-07-18 11:44 AM
33	6556	00208	Dispatching	2019-07-18 11:44 AM
34	4554	00208	Dispatching	2019-07-18 11:44 AM
35	9878	00208	Dispatching	2019-07-18 11:44 AM
36	3432	00208	Dispatching	2019-07-18 11:44 AM
37	5245	00208	Dispatching	2019-07-18 11:44 AM
38	3849	00202	Harvesting	2019-07-18 12:00 PM
39	2040	00202	Harvesting	2019-07-18 12:00 PM
40	899	00202	Harvesting	2019-07-18 12:01 PM

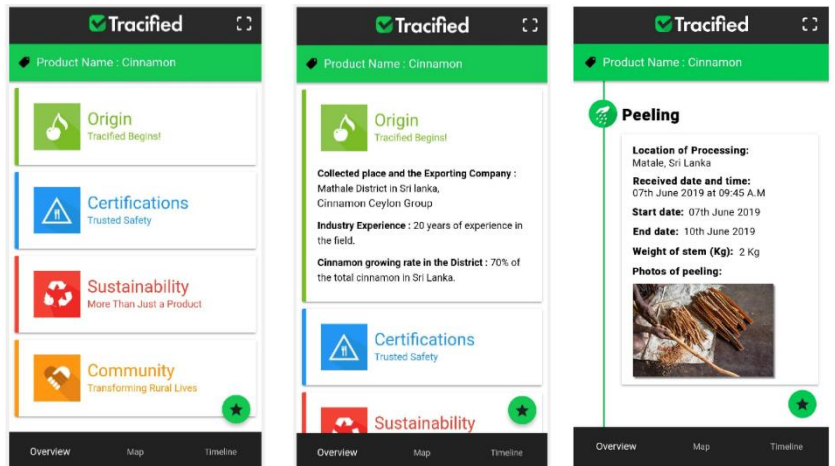
**Configs portal:** This portal provides a designer-like interface to define the entire supply chain including stages involved, possible stage transitions, master data, tracking data to expect in each stage along with their data types and limits and summarizer functions to be applied to tracking data. Configs portal also makes it possible for the business admin to configure screens to appear in officer mobile app, e-commerce PoS and consumer mobile app.



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        "mergerFunction": "getOneUniqueArray",
    
```

**Customer mobile app:** A mobile app for buyers to see traceability in individual product item level before and after purchasing. These apps are automatically generated by Tracified once the business admin has configured all screens using configs portal.



**E-Commerce:** Tracified has plugins for popular web shops such as Shopify, WooCommerce & Magento. A business that runs a web shop can use these to show traceability data.



**Cold chain maintained**  
to ensure optimum freshness throughout the product life cycle

**5 out of 5** batch(es)

**Graded for size, ripeness and maturity**  
for enhanced consumer experience

**5 out of 5** batch(es)

**Individual care given in product handling**  
to ensure optimum freshness throughout the product life cycle



**Freshness** Fresh Everyday!

Effort to deliver it to you fresh from an average of 5 batches

- Latest Harvested Date**  
Tue Nov 19 2019
- Latest Packhouse Received Date**  
Wed Nov 20 2019
- Cold Chain Maintained**  
Yes

**Food Safety** Trusted Safety

Your product has the below standards of compliance

- Product Integrity**
- Process Integrity**
- Product Handling Method**  
Visually Inspected

**Sustainability** More than just a product

Sustainable product methods used

- Composting**
- Crop rotation to ensure soil health**
- Integrated Pest Management**

**Community** Transforming Rural Lives

Your purchase helps

- She Trades**  
12 out of 26 farmers are women
- Foster Knowledge**  
Your purchase helps to improve education of 3 children
- Economic Development**  
26 out of 26 farmers have bank accounts

**API:** Tracified provides a complete RESTful API on its functionality. Businesses can use this to various things such as integrating Tracified with their existing digital systems, extending capabilities of Tracified, etc.

**Blockchain:** Tracified offers a blockchain gateway that connects to several blockchains such as Ethereum, Stellar and Hyperledger.

Proof Builders, Proof Executors, Proof Retrievers and Proof Interpreters together implement the functionality required for Tracified blockchain based direct proofs such as PoE (Proof of Existence), PoG (Proof of Genesis), PoCoC (Proof of Change of Custody), PoC (Proof of Continuity), Certificate Assurance, PoA (Proof of Association).

**Proof Builders:** These module makes sure that all data required to build a certain proof is collected and prepared.

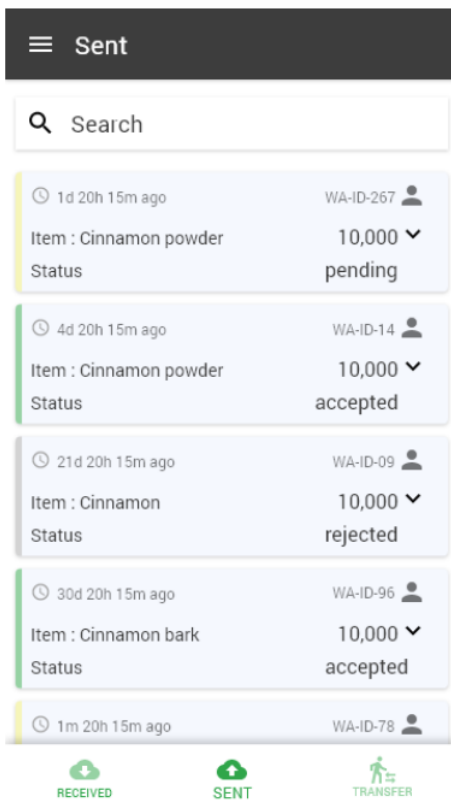
**Proof Executors:** These modules take the data gathered by proof builders and execute them in the blockchain.

**Proof Receivers:** These modules query data entered into blockchain by proof executors.

**Proof Interpreters:** These modules use the data queries by proof receivers to arrange them in a human understandable form.

**Blockchain explorer:** This is a web application that acts as the main front end for the blockchain. This can be used to visualize blockchain based proofs on traceability, auditing purposes, etc. In addition, all blockchain transactions can be viewed in fine-grained detail.

**Wallet app:** This is another mobile app which acts as a frontend to the blockchain. It is currently used for managing cryptographic keys of all involved users and performing change of custody.



As an example for change of custody, a farmer initiates a consignment of 100 kg carrots and marks the warehouse guy as its receiver using the wallet app. Now the warehouse guy notices this transaction in his wallet app. When the consignment arrives at the warehouse he checks quantity, quality, etc. and if everything is ok, he confirms the transaction in the wallet app. This causes a multi-signature CoC (change of custody) transaction to happen in the blockchain. It helps players later in the chain to verify through blockchain that the item at their hand has gone through the correct custody chain and the correct

quantities are respected in transactions (no alternatives were mixed). In future wallet app will also carry functionality for registrars (trusted parties in supply chains such as governments and NGOs) to record capacity limits of production facilities and certification bodies to manage their certificates.

**In-source signing:** This is the process of cryptographically signing data right at its source. This minimizes the possibility of tampering data at the source. For example, when a field officer enters tracking information using the officer mobile app, the data is timestamped and geotagged by the app and is signed using the officer's private key. This removes the possibility for a more powerful business admin to later manipulate this data.

Data Receiver API is a part of Tracified. It is a public API. Therefore, it's possible to send tracking data or any other kind of data into Tracified by calling this API. When we integrate with a business that already runs an ERP / CRM, we need to do an implementation (this is a part of the initial system implementation) to pull data from ERP / CRM at appropriate triggers (these triggers can be either periodic or spawned by events in the ERP / CRM) and call the appropriate Tracified API calls

with them. Data Store is the mongodb database used by Tracified. This is where the master data, tracking data, user data etc. is stored.

## Intellectual Property

Being an innovative technology built based on a novel concept, Tracified carries a number of patentable components.

### Traceability Data Model

This is a novel abstract model that captures a great deal of complexities involved in modern traceability. This model was built after studying several supply chain architectures, artefacts governing them, material flows, roles involved, relationship paradigms and associated problems. Tracified Core, which is the brain of Tracified platform is based on this model.

While being generic enough to be used to model a supply chain for any domain, this data model offers great flexibility in accommodating nitty-gritty of a practical value chain. Tracified leverages on this model to provide a generic direct proof mechanism in the blockchain. *Proof Builders* and *Proof Interpreters* in blockchain gateway are tightly coupled to the data model.

This data model has the following features that make it suitable to capture all kinds of complexities in a supply chain.

1. Ability to model generic stage transitions (typically representing change of custody)
2. Ability to define tracking data involved in each stage
3. Ability to specify data to be tracked in each tracking scenario
4. Accommodates master data with arbitrary structure
5. Provides master data versioning to help disambiguating the version of a particular piece of master data applicable in a given tracking scenario
6. Captures relationships between different kinds of master data

7. Accommodates splits where a batch of items is divided into multiple smaller batches, and merges where multiple batches of same or different kinds of items are aggregated to form a larger batch.
8. Accommodates physical transformations of items
9. Supports upstream traceability (feedback)
10. Ability to integrate different kinds of tracking systems used by organizations involved in a supply chain

## Traceability Domain Specific Language (DSL)

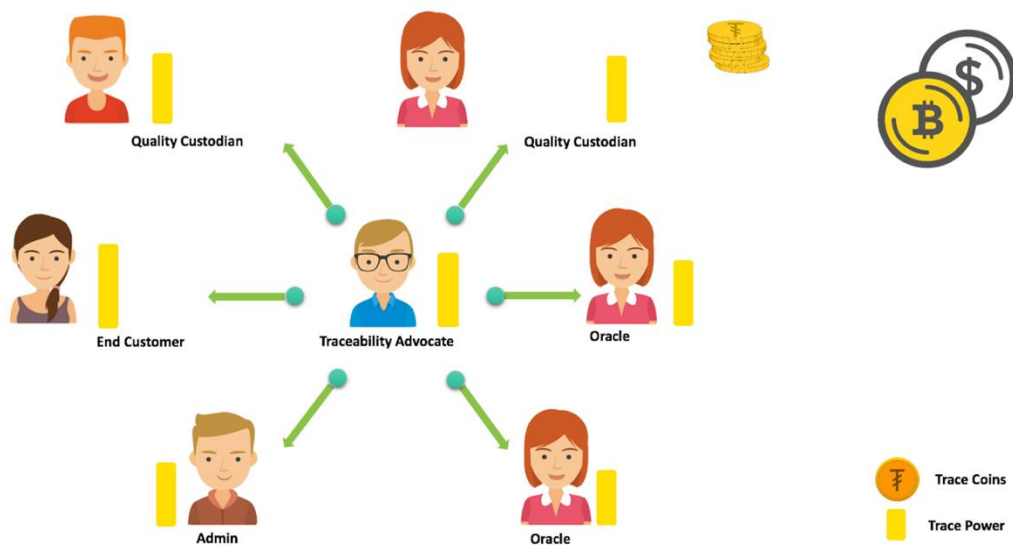
Need for running custom queries on traceability data model is a common requirement within Tracified platform. Some examples are:

1. Binding data to user interface widgets
2. Inventory calculations for e-commerce
3. Generating traceability reports
4. Generating alerts

A study on these requirements indicated that the querying mechanism needs to be as powerful as a general purpose programming language while being tailor-made for traceability in order to make the task of writing queries a simple and fluid operation for business admins. Taking this into account, *Tracified Grammar* was developed as a DSL with expressivity similar to any other imperative, context-free language. Its syntax is customizable and is close to sentences in natural language. These two features combined makes Tracified Grammar flexible enough to be configured to look like statements made in any human language. Business admins express complex logic in a way similar to writing a business specification, just with a little bit of formality.

Tracified Grammar adds a great deal of expressivity on top of Traceability Data Model to slice and dice information so that they make sense to different audiences that interact with Tracified. In future the possibility of connecting it to blockchain will be explored with the vision of making it possible to write smart contracts in Tracified blockchain directly with Tracified Grammar.

## Crypto-economic Model



Tracified's vision is to facilitate participants in supply chains to authentically share data so that other participants are better informed to play their role. This reciprocity-inducing behavior of authentic sharing has to be driven by a mechanism in the platform. Answering this need Tracified will come up with a crypto currency based economic mechanism which will enact rewards and penalties. Good behaviors (the behaviors that help other participants in the supply chain to make right decisions) are rewarded with crypto currencies with an amount proportional to their impact while bad behaviors result in the participants involved losing their crypto (*Trace Coin*).

Technically this will be implemented by assigning each participant a reputation score called *Trace Power*. Trace power is convertible to trace coin and vice versa subjected to time and quantity based restrictions. After each consensus cycle each participant's trace power will be adjusted according to a set of predefined rules. Few of the preliminary conceptual elements that form the base for the crypto-economic model are as follows.

1. Trace power must be an in-chain asset governed by a carefully designed consensus mechanism
2. Trace power's (and hence trace coin's) intrinsic value comes from the new value generated in supply chains due to reciprocal activity of sharing authentic traceability data. The new value will ultimately reflect as the premium price the customers will be willing to pay. Mechanism design in the blockchain must ensure that the value of trace power is pegged to this price difference in order to prevent trace coin becoming yet another medium-of-exchange token.
3. Tracking data and expert vetting should be considered claims instead of information in the sense that their truthfulness and validity have to be verified later in the chain using evidence, feedback and consensus.
4. Verification of claims can span across several blocks in the blockchain due to the practicalities in supply chains. Therefore, verification boundaries must be clearly defined.
5. Proven claims deserve rewards while disproven claims will carry a penalty. To make this happen claimers (participants who submit claims) have to keep some part of their money (trace power or trace coins) at stake.
6. Sellers can put trace power stakes on chosen quality aspects of their products to boost buyer confidence.
7. High trace power holders will have their traceability data getting more visibility. They will also enjoy a higher level of influence in evaluations (feedback) and consensus.

Tracified's crypto-economic model is still in conceptual stage.



# Case Study: Saaraketha Organics - *Transforming Rural Life*

Saaraketha Organics is an organic exporter and retailer from Sri Lanka. While not owning any farm directly, they work very closely with a growing community of 3000+ farmers from rural areas in Sri Lanka. Saaraketha nurtures this community by constant education and supervision, helping to obtain certifications, supporting farmer organizations, offering guaranteed prices, etc. They operate a network of field officers who pay frequent visits to farms for monitoring and providing assistance. The organization maintains a quasi-integrated supply chain set up where they control each stage starting from collection up to export or local distribution. Saaraketha also runs a very active web shop selling almost their entire product range.

Saaraketha uses Tracified to communicate various facets of value associated with their products. This value is presented in 4 dimensions.

**Freshness:** *factors that determine how fresh the item is*

when the batch was harvested, when the batch was received into the packhouse, whether cold chain is maintained properly

**Safety:** *factors governing how safe the item is for consumption*

whether good agricultural practices were followed, product handling method

**Sustainability:** *how environment-friendly the production was*

composting, crop rotation, integrated pest management

**Community:** *what is the community that the buyer is supporting by purchasing the product*

Percentage of women farmers involved, improvement in the education of children in poor families involved, what fraction of farmers are banked

In addition, the geographic locations of farms and packing houses involved with the batch in interest is shown in a map. An image slider shows images taken of the batch at various stages. Storyline view presents a stage by stage narration of the products journey. The buyer can see blockchain based proofs available in a separate screen. This screen also shows people and technologies involved along with their trace power. This screen will also show seller's stakes when that functionality is implemented.

### DATA, WHO AND HOW ?

**MASTER DATA:** FARM, FARMER FAMILY, FARMER COMMUNITY, SEED, WEED CONTROL, FERTILIZER, IRRIGATION, SOIL QUALITY

**TRACKING DATA:** DATES (SEEDING DATE, HARVESTING DATE, COLLECTION DATE, WAREHOUSING DATE, ETC.), LOCATIONS (FARM, PACK HOUSE), PROCESS INFO (WASHING TYPE, WIPING TYPE, PACKAGING TYPE, FERTILIZER, TRANSPORT TRUCK CONDITION, COLD CHAIN CONDITIONS), CERTIFICATES

**WHO:** FIELD OFFICERS, SAARAKETHA BUSINESS ADMINS

**How:** USING TRACIFIED FIELD OFFICER MOBILE APP AND ADMIN WEB PORTAL

Traceability information is shown at various points in the customer journey.

1. Point-of-Sale in Saaraketha web shop  
(<https://www.saaraketha.com/collections/traceability-enabled>)
2. Point-of-Sale in Saaraketha retail shop and supermarkets
  - a. Customer uses Tracified consumer mobile app to scan the QR code in item's packaging to see traceability information for the exact item's batch
  - b. If the customer does not have Tracified consumer mobile app installed he can use any QR code scanning app on his phone to see the traceability information in a web view
3. After-Sale traceability for e-commerce purchases via Tracified consumer mobile app or web

Master data such as farm, farmer family, farmer community, seed, weed control and fertilizer are collected from Saaraketha field officers. Infrastructure meta data such as irrigation facilities and soil characteristics are taken from government sources. Saaraketha provides meta data pertaining to its facilities and business

processes such as packing houses, warehousing, washing facilities, collection & distribution trucks and field officers.

Tracking data are entered by field officers and handlers in packing houses and warehouses using Tracified officer mobile app. Data for each batch is entered starting from seeding stage down to last mile delivery. Photographs are taken of each batch in every stage. When items move from one stage to another sometimes batch splits (one batch is divided into several new batches) and merges (several batches are aggregated into one bigger batch) occur. These are captured in officer app by mapping identifiers of the batches involved in the respective operation. Unique barcodes generated by Tracified web portal are used to recognize batches. Plastic tags containing these barcodes are attached to the containers that carry batches at each stage. Mobile devices with barcode scanners connected are stationed in appropriate places in the facilities for efficient scanning. Tracified officer app communicates with the barcode scanner to know the batch for which the tracking data is added.

When packing items to be sent to retail shops or e-commerce delivery truck, a unique QR code is pasted on the pack. Before pasting the officers link the QR code to the barcode of the item's batch using Tracified admin portal. It is this QR code that the buyer scans upon receipt of the item to see its traceability. The buyer can provide his feedback as a rating plus a comment after using the item. This feedback is treated by Tracified as upstream traceability. They are correlated to the original batch information and are shown in Tracified Insights portal so that the admins can derive business intelligence by linking customer feedback to farmers, workers, processes and facilities involved. These insights are vital in triggering corrective and proactive actions to remove customer pains and improve satisfaction.

Saaraketha Organics went live with a production beta with Tracified in June 2019. This beta version included a selected number of products. Blockchain frontends were added.