TEMCO

SUPPLY CHAIN MANAGEMENT
REIMAGINED

CONT-

ENTS

Abstract

With multiple outbreaks of health hazards in food products such as the toxic insecticides found in eggs occurring in Europe, South Korea and other countries in 2017, consumers are faced with rising fears.

However, existing supply chain management systems are failing at addressing such concerns. Because they do not provide for monitoring of pre-delivery stages, even if a problem arises, it is difficult to understand at which stage the problem occurred, and to manage the problem. There is a growing tendency for consumers to demand transparency in how a business deals with its supply chain process.

TEMCO is a public supply chain blockchain system that utilizes Smart Contract to overcome the limitations of existing supply chain management systems. In the existing system, the information of each distribution participant within the supply chain process was cut off, but TEMCO has made it possible to connect each participant through a blockchain so that the pre-delivery stages can be grasped in real time. This not only builds consumer trust regarding the supply chain process, but it also has a cost-cutting effect through more efficient supply chain management.

Introduction

The 2017 pesticide-contaminated egg crisis was one which directly revealed the flaws of existing supply chain management systems. The government and corporations contributed to consumers' fears by failing to keep track of records regarding the contaminated eggs.

The only clue that could help trace the origin of the contaminated eggs was the "eggshell code" printed on the eggs for records management. But because every manufacturer has different ways of printing these codes, and several variations of codes are used even within the same farm, the management system was haphazard and lacking standards and regulations, ultimately leading to failure to quickly cope with the crisis. The government repeatedly misreported eggshell codes from substandard farms and had to make corrections daily. According to a representative of the government, it has been a challenge to track unfit farms as well as to identify the farms that manufactured the substandard eggs.

Due to the sloppy nature of existing supply chain management systems revealing the reality of serious limitations in crisis management, the need for transparency and systemization of supply chain processes is becoming increasingly clear. As income levels rise and IT infrastructures expand, consumers also demand a higher level of quality in products. They want to purchase products that have come through a trustworthy supply chain process. Moreover, companies also want to elevate trust in their products and enhance their level of service to allow for more efficient management capabilities.

As a response to the change in consumer needs, large corporations are developing proprietary supply chain management systems. They are also using big data for cost optimization, process improvement, and new business development. On the other hand, medium-to-small businesses are lacking in infrastructure and resources to invest in a similar system.

The TEMCO project aims to create a system that can overcome the limitations of the existing supply chain management system by utilizing Smart Contract within the public blockchain ecosystem. The goal is to enable all participants to have access to real-time information on the entire supply chain process from production through distribution to sale at retail outlets.

Introduction

Through TEMCO, consumers can choose products that have passed through reliable standards. Businesses can increase efficiency by streamlining supply chain process and structure using the TEMCO platform. They can also increase profitability by optimizing product sales strategy using supply chain information within the blockchain.

The cost of introducing infrastructure for SMEs can also be drastically reduced. In the past, it took several million dollars to develop supply chain management infrastructure for SMEs. The TEMCO platform, however, connects every participant under a single platform that offers big data analytics without the need for a large initial investment or additional subscription fees, as the only cost is to execute Smart Contracts.

There is also an advantage in strengthening the product safety mechanism. In the existing system, it was difficult to identify the cause of quality-related claims. With the introduction of the TEMCO platform, it is possible to trace distribution history down to a single order, which can help identify the responsible party if a dispute occurs. Therefore, it is expected that it will help manage food safety at the government level including the Ministry of Agriculture and Forestry and the Food & Drug Administration.

TEMCO also took advantage of the private blockchain. Confidential information that should not be disclosed can be managed without being exposed on the platform.

The TEMCO team will also build a consumer application and platform for big data analytics. The application will increase consumer confidence in products by providing real time supply chain information from beginning to end. The platform for big data analytics based on the data collected in the blockchain will enable SMEs to develop a low-cost supply chain infrastructure and to gain business insights.

Problems Inherent in Existing Supply Chain Management System

Disconnection of Information due to Lack of Supply Chain ICT Infrastructure

Consumer expectation levels for product distribution management are rising due to the increase in the national income level. However, the current supply chain management systems lack infrastructure investment, so there is no unified system that connects the manufacturer to the end consumer. As a result, consumers' confidence in product distribution is very low.

Some large corporations are developing their own systems to manage sourcing, logistics, and distribution of goods. However, the system is tailor-made for individual companies, which means their versatility is low. Small-scale logistics/distribution companies lack the investment capability to develop their own supply chain management systems. According to the data, the investment cost for the informatization of domestic supply chain companies is 1% of the sales amount, which is lower than the industry average (1.6%). The rate of utilization of ICT is 44.6%, which is very low compared to the average of all industries (70.7%).

Retailers who do not have individual warehouses are entrusted to warehouses to store inventories. These local warehouses provide only minimal basic inventory management and delivery systems. Therefore, it is difficult for general retailers to secure consumer credibility of products as compared with large companies.

Without a platform to connect every Participant within complex supply chains processes, there is a limit to the information that consumers receive. A vicious cycle results, where the asymmetrical nature of information intensifies as consumer trust in retail products decreases.

Investment Rate in Informatization Infrastructure & Informatization Rate for Domestic Supply Chain Companies

(Source : Hyundai Research Institute)

■ The Average of Supply Chain Industry
■ The Average of All Industries

Investment Rate in Informatization Infratructure

Informatization Rate

70

45

1.0

1.6

TEMCO's Proposal for an Integrated Supply Blockchain

Data-Centric Smart Supply Chain Solutions

TEMCO started with the idea, "How can products be distributed and delivered to consumers in a reliable way?"

As previously mentioned, existing supply chain management systems do not satisfy consumers who demand reliability, mainly due to the fact that consumers do not have direct access to reliable information, instead receiving information verified by a third party only indirectly.

The TEMCO project aims to ensure that accurate supply chain information is contained within a blockchain when a product is transferred via Smart Contract. This connects manufacturers, warehouses, transport companies, distributors, and end consumers, enabling supply chain information to be shared in real time.

As a data and information-based supply chain solution, the TEMCO project seeks to achieve ① high connectivity between users, ② reliability of supply chain information, ③ transparency and stability of supply chain information, and ④ high efficiency.

High Connectivity Between Users

Reliability of Supply Chain Information

Transparency and Stability of Supply Chain Information

High Efficiency

TEMCO

## TEMCO's Proposal for an Integrated Supply Blockchain
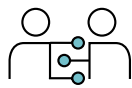
High Connectivity Between Users   TEMCO stores the product's supply chain information from the manufacturer to the end consumer through smart tagging technology such as QR codes through a blockchain protocol. This creates a new type of distribution ecosystem where all participants can access the TEMCO platform anytime, anywhere. Manufacturers, warehouses, transport companies, distributors, and consumers are connected on a single platform, and supply chain information, which was previously disconnected and difficult to identify, is bundled together and shared by all participants.

Reliability of Supply Chain Information   All participants in the supply chain ecosystem except the end consumer go through a vendor verification program implemented by the TEMCO project and follow the correct transport guidelines. By linking the transfer process between participants to a Smart Contract-based authentication system, supply chain information (product location, takeover agent, distribution environment, etc.) can be collected without loss or tampering when the product is transferred from one operator to another. These two processes ensure that the information contained in the blockchain is fully reliable, and the end consumer can confidently utilize this information.

## TEMCO's Proposal for an Integrated Supply Blockchain
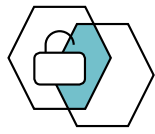
Transparency and Stability of Supply Chain Information Supply Chain information stored in a blockchain based on peer-to-peer (P2P) networks is fully distributed and shared among users and verified through unspecified nodes in the system. Smart Contract based supply chain information is unmodifiable and recreated in the form of transparent information that can be verified by anyone in the decentralized system.

Information generated within the TEMCO platform is stored on a decentralized server. Since a specific key value in a blockchain can be backed up at any time, there is no possibility that an existing transaction can be altered by a malicious third party when a dispute occurs. Based on these features, TEMCO transparently provides complete information to all consumers and vendors using the platform.
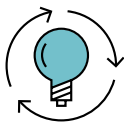
High Efficiency SMEs recognize the necessity of informatization of their supply chain processes, but they are passive about investing due to high cost. The TEMCO project seeks to provide SMEs with an open platform for supply chain management innovations without requiring large-scale infrastructure investments. Through the TEMCO platform, participants in the supply chain network can digitize their entire business processes and increase productivity by utilizing product, distribution, and consumer information.

TEMCO's Supply Chain Management Solution

The use of blockchains and Smart Contracts in supply chain management systems can ensure interoperability between different systems in manufacturing, storage, and transportation.

The vendor authentication system is used to emphasize the reliability of the information generated in the supply chain process. This will provide transparency by minimizing the time it takes to identify problems in case of a dispute and provide a basis for immediately analyzing the necessary data.

As such, the blockchain based supply chain management system will increase efficiency of the entire ecosystem, lower the cost of establishing infrastructure, and increase consumer trust in products.

In order to meet consumers' high demands, various information such as manufacturers, warehousing companies, transport companies, distributors, etc. occurring in supply chain processes should be shared in real time through a single network. The TEMCO project aims not only to provide simple and basic information such as transportation records and product location, but also to provide a platform for sharing and utilizing reliable supply chain information within the blockchain. Through this structure, the TEMCO project intends to implement a customer-oriented advanced supply chain management system.

Blockchain

Generating
Smart Code

Smart
Tagging

Request
Data

Provide
Data

Manufacturer

Fulfillment
Center

Wholesale
& Retail

Consumer

TEMCO APP

Inputted Data =

Temperature

Quality Certification

GPS

Vendor Information

Provide BI·Analytics
Tools for Data
Visualization and
Analysis

IPFS

TEMCO
SDK

RSK
(RVM)

Swagger Rest API
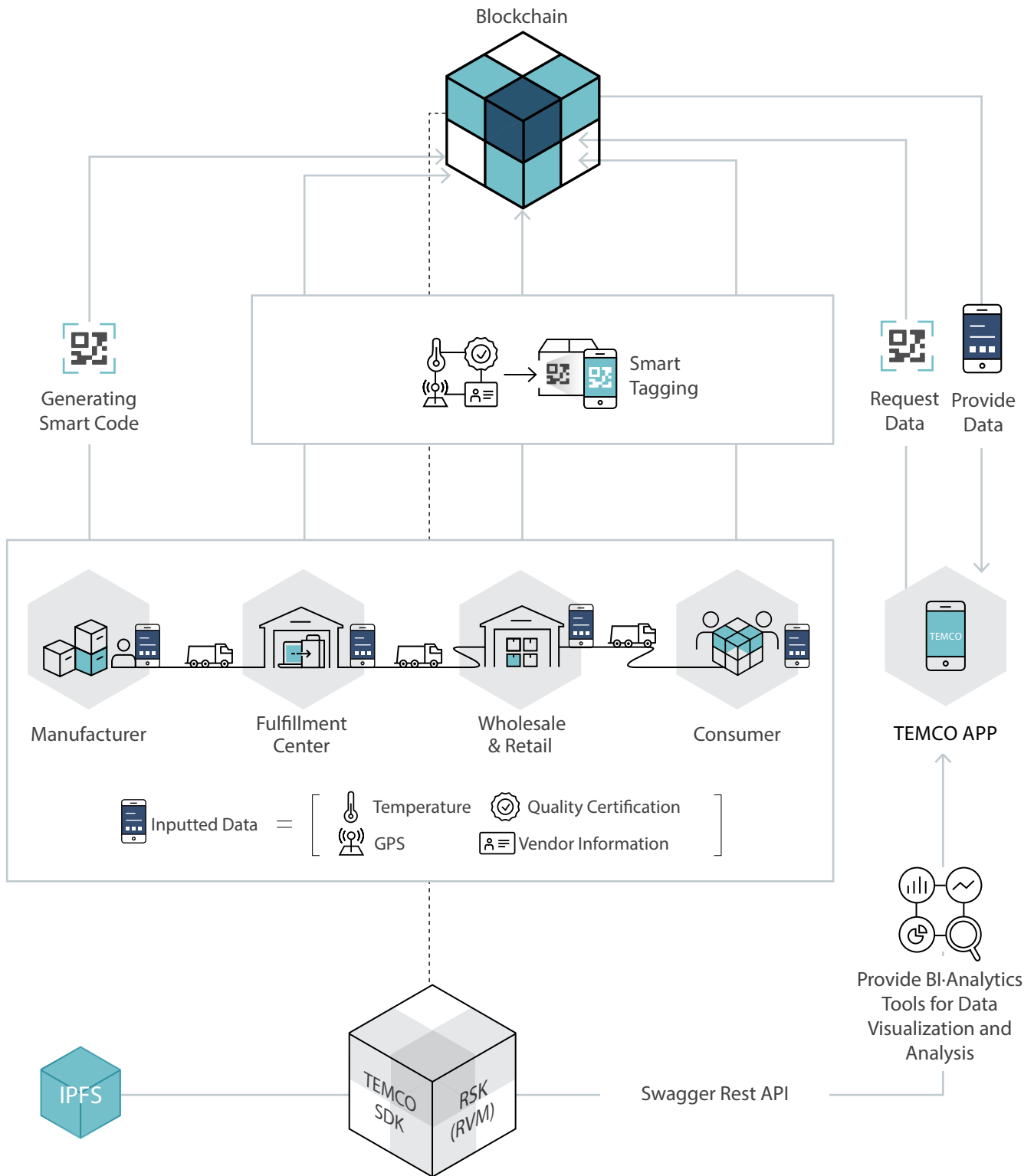
TEMCO's Supply Chain Management Solution

TEMCO's Technical Structure

TEMCO's technology consists of 3 levels:

1. Uploading data on blockchain from the back-end layer is referred to as the "core" level.
2. Retrieving data on blockchain through the core level and accessing it in the form of API from the middle layer is referred to as the "service" level.
3. Displaying data at the UI level is referred to as the "application" level.

The back-end consist of blockchain, big data, and analytics engine. The front-end consists of web, mobile application, and BI Tool. The back-end is developed with JAVA and Spring Framework, and the service level implements Swagger API Framework. The REST API provided by Swagger returns data in the JSON format and can be used in both web and mobile application. The front-end GUI is built with Typed Script, which supports object-oriented programming, and AngularJS 4. Web3.js is used to interact with the RSK node and is used to store or retrieve data by calling Solidity code, which is a programming language for Smart Contract deployed on RSK Virtual Machine (RVM).

CONNECT NETWORK
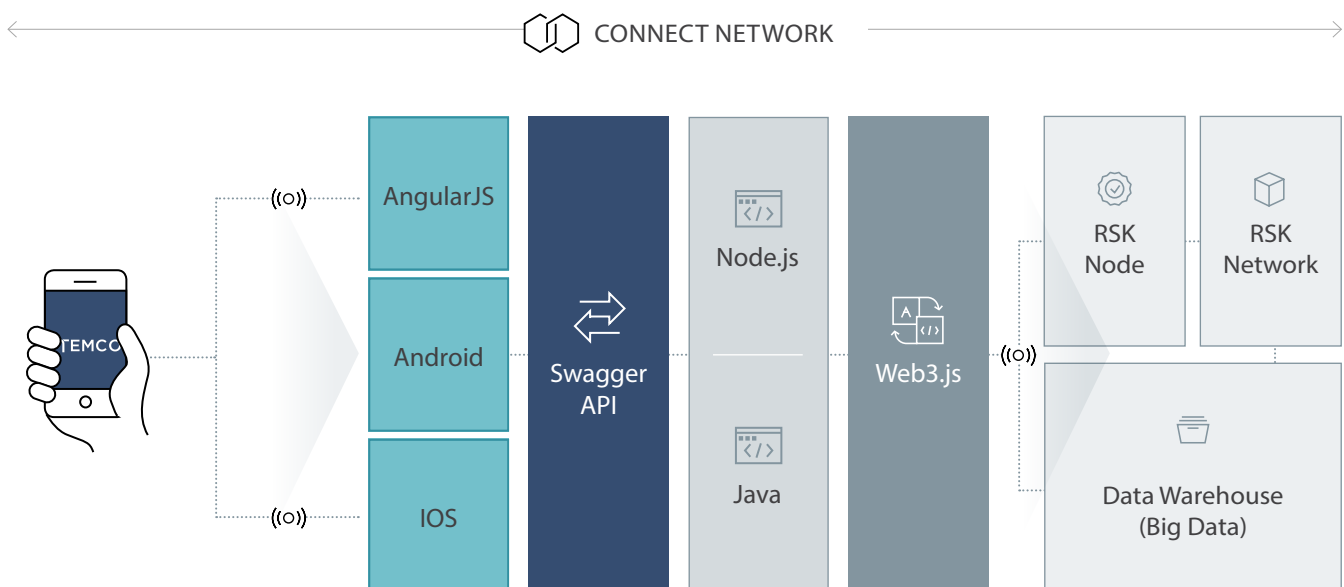
TEMCO's Supply Chain Management Solution

TEMCO's Operating System Layer Diagram

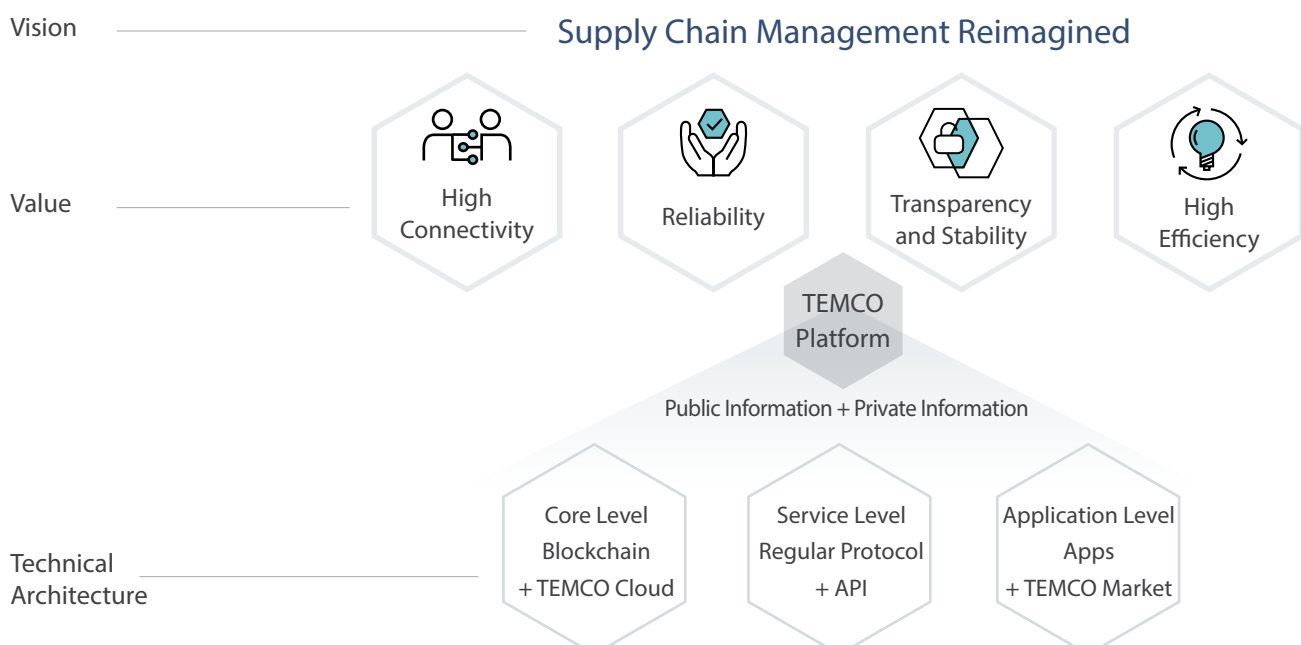**Core Level** Blockchain is a data storage technology for cryptocurrency system that is almost impossible to hack or manipulate. Due to its' characteristics (P2P, Hashing, PoW), blockchain is implemented in many industries and systems such as authentication, finance, asset trading, and IoT.

Data on blockchain is distributed, meaning it is stored on every node in the world rather than on a centralized server. Data immutability is verified by checking against each node. If some of the nodes are compromised, rest of the nodes are responsible for the task.

TEMCO uses proof of work (POW), a mechanism introduced by Satoshi Nakamoto of Bitcoin to create distributed trustless consensus and solve the double-spend problem. POW is not a new idea, but the way Satoshi combined this and other existing concepts—cryptographic signatures, Merkle chains, and P2P networks—into a viable distributed consensus system, of which cryptocurrency is the first and basic application, ensured the reliability and credibility of Bitcoin. Proof of work is a requirement that expensive computations, also called mining, be performed in order to facilitate transactions on the blockchain.

Vision — **Supply Chain Management Reimagined**

Value

| High Connectivity | Reliability | Transparency and Stability | High Efficiency |

TEMCO Platform

Public Information + Private Information

Technical Architecture

| Core Level Blockchain + TEMCO Cloud | Service Level Regular Protocol + API | Application Level Apps + TEMCO Market |

TEMCO's Supply Chain Management Solution

Uploading and retrieving data on blockchain is through executing Smart Contracts. In existing system, contracts were not codified so actual person had to execute the terms of the contract by physically sending cryptocurrency. Instead, contract terms are now codified and executed automatically through Smart Contracts. Removing human dependency not only simplifies the process but also increases reliability. To execute Smart Contracts, Solidity, a scripting language, is used. It is easily compiled through an online compiler called Remix. Uploading Smart Contracts is also easy with tools like MEW and Truffle, and cURL is used to test Smart Contracts.

TEMCO is developing its platform on RSK blockchain. The benefits of RSK blockchain is fast transaction speed, low transaction cost, and high scalability. It is ideal for supply chain processes. Data is collected by scanning through the dApp provided by TEMCO at each point in the supply chain. The scanned data is stored in the blockchain via the TEMCO protocol and PoW. The information collected by TEMCO is classified as public and private information, and the public information that can be shared is stored in the blockchain through the TEMCO protocol. Sensitive and confidential information is cryptographically hashed and stored. Only specific users with permission are allowed to view the stored data. This ensures that all information, from publicly available information that everyone can share to confidential information that should be disclosed only within the company, can be securely stored and accessed in the connected supply chain.

TEMCO is also implementing data warehousing for efficiency. If tens of thousands of supply chain transaction data are stored everyday only through Smart Contracts, it is difficult to effectively process exponentially growing data. The TEMCO data warehouse is a separate storage solution for efficient storage and sharing of supply chain data. Using BI tool, data can be extracted by executing dynamic SQL and MDX statements against the data warehouse. In addition, analytics data can be extracted by running the analytic engine.

TEMCO's Supply Chain Management Solution

IoT is another crucial component of TEMCO platform. Information such as temperature and humidity are tracked by IoT developed by a company called LIoT in Korea. IoT used by TEMCO platform is active and passive temperature loggers. The active temperature logger has a data transmission feature, which is used to send temperature and humidity data. It requires a battery but lasts for 6 months. It is used to monitor environment sensitive medicine and fresh food products. Active temperature loggers measure temperature and humidity real time, and measured data is sent to the temperature service through the Bluetooth technology. The temperature service stores that data, which is accessible from the webpage. The measured data can be retrieved from the temperature service through the REST API. The output is a JSON format, which is a standard for web and mobile.

The passive temperature tag combines the technology of RFID and temperature sensor. Using SoC, it operates without a battery. Normally, these sensors are asleep, and they wake up when a scanner sends a signal. At that moment, temperature is measured and uploaded using the Bluetooth technology. Similar to the active temperature logger, data is uploaded to the temperature service and accessed through the web. It can also be retrieved through the REST API.

For inventory management, passive tag can be used to signal the position of products. It is a RFID tag that works similar to the passive temperature tag and does not require a battery. It is asleep until signaled. When signaled, it beams a light, revealing the position of the target product. Passive tags are cheap, but they can vastly improve inventory management.

Data collected through various devices and channels are stored in blockchain and TEMCO's big data tool, Hadoop. Hadoop is a collection of open-source software utilities that facilitate using a network of many computers to solve problems involving massive amounts of data and computation. It is written in Java and stores data in many server clusters. By storing data in multiple locations, Hadoop provides data protection. Hadoop consists of Hadoop file system, MapReduce engine, Java archive files, and starting scripts. When the data is uploaded to blockchain, private information is stored in Hadoop through TEMCO's core level using a batch process.

TEMCO's Supply Chain Management Solution

Service Level   The service level serves as an intermediary for connecting the user dApp and the supply chain vendor dApp, and for providing integrated supply chain information. To operate a stable TEMCO ecosystem, the service level uses a blockchain platform without a central intermediary. This structure enables real-time information such as various contract information, satellite positioning system (GPS) information, temperature, humidity, and time generated in the distribution process to be browsed through the web or dApp.

To store such data in the blockchain, TEMCO will use IoT based RFID that takes advantage of ultra-low power semiconductors. Measuring humidity and temperature for certain products sensitive to external environments is not a new idea. However, the current process is neither complete from beginning to end nor trustworthy because it is not verifiable. TEMCO plans to solve these limitations by adopting IoT to digitize and upload real-time data in the blockchain. This will provide a basis for the stable processing of supply chain transactions that grow exponentially after the Genesis block (the first block created in the system) while maintaining decentralization, verifiability, and transparency of the data which the blockchain pursues.

In the future, we plan to establish a basis for developing various applications by offering standard protocols and APIs. In addition, both structured and unstructured data within the big data cluster will be analyzed and provided to businesses in different formats for ease of use.

TEMCO's Supply Chain Management Solution

Application Level Consumers will be able to obtain more transparent and reliable information and to provide feedback on the products they use through user applications. This will also enable consumers to serve as major contributors to the quality of the supply chain information. Using the vendor application, businesses will be able to access real-time information needed for innovation and management of supply chain processes. This will increase the quality of the service provided by the company and will ultimately lead to consumer confidence in the brand and products. As a result, TEMCO will enable businesses to expand consumer segments and increase the possibility of lowering costs while empowering consumers to buy products that they trust.

A massive amount of data stored in Hadoop can be accessed by Tableau, a BI tool. Using Hive that supports SQL interface, data in each cluster can be retrieved. Such technology is called live connection. Tableau is directly connected to the data engine so that big data processing is fluid. This mechanism is useful when data queries are slow, and the data result set is small to medium in size. It is also used for offline analysis. If fast data queries are required, Tableau supports in-memory data, which is stored in between Hadoop and Tableau layers. It is called an indexing engine, which supports data queries against 1,000,000,000 records in milliseconds.

**TEMCO's
Supply Chain
Management
Solution**

TEMCO's Information Security

TEMCO platform has 4 categories of information security concerns:

TEMCO platform

a. HTTPS Protocol: Browsers request or upload data to web servers through either HTTP or HTTPS protocol. For HTTPS protocol, data is encrypted between the browser and web server. It stands for HTTP over SSL (Secure socket layer) and implements Public Key Infrastructure. Using the public key to encrypt, corresponding private key is used to decrypt and vice versa. TEMCO uses HTTPS for all browser to web server communications.

b. Session cookie & HttpOnly flag: The communication between browser and server ends when data is requested and responded. After the communication is over, stateful data is deleted including the login state. To solve this issue, a small data file called a cookie file is generated and stored on the browser. Permanent cookies have certain duration that can be specified. However, using permanent cookie for login state can leave a user logged in when the user should be in the logged-out state. Instead, TEMCO uses a session cookie to make sure user's logged-in session is only valid for the duration of browser to web server connection. When the connection is closed, session cookies are deleted including any information in it. Since cookies are stored on the browser, they can be manipulated. By using the HttpOnly flag, only the web server can change the content and settings of the session cookies.

c. Log-in password hashing: Username and password are sent to the web server when a user logs in. If the password is stored as-is in the TEMCO's database, it can be reused when hacked. By hashing the login password, we can protect our users when our database is compromised. During the login, we hash the input password and match it with our database record.

TEMCO's
Supply Chain
Management
Solution

d. Server security: TEMCO can structure our internal servers in two ways: hosting physical servers at one or more physical locations or using a cloud service. The first method is susceptible to more attacks because we need to think about the security of the physical locations and the machines. Since TEMCO owns the servers, we must build additional layer of security services to protect us and our users. The problem is hacking technology is improving at a fast rate, meaning we need one or more security experts to actively manage the threats. It is not only costly but also ineffective. Instead, we use infrastructure-as-a-service (IaaS) by using a cloud service like Amazon's AWS, Google's Google Cloud, or Microsoft's Azure.

IoT Security

Active and passive temperature loggers are used in the TEMCO's platform. Using ultra-low power RFID to send data using the Bluetooth technology.

a. RFID software hacking: When the software installed on RFID is hacked, different data value can be uploaded. To protect it, firmware is encrypted and only decrypted when activated. The firmware cannot be analyzed by accessing physical flash or memory. In addition, each RFID has different encryption key, which prevents duplication.

b. RFID software update: Problems found post distribution is updated through a firmware update. In doing so, the firmware update can be hijacked and manipulated. To prevent such act, we enforce secure update. During the secure update, RFID device and IoT provider must authenticate each other. The authentication message is encrypted so it cannot be manipulated.

c. RFID storage encryption: RFID employed by us is ultra-low powered, so it cannot store a lot of data. Since it also contains RFID device id, we are not worried about storage encryption.

d. RFID authentication: When data is uploaded from RFID to the database through the consumer application, each device must be authenticated by each other. Through the mutual authentication, no other 3rd party device can pretend to be one of the authenticated devices and send false data. During the mutual authentication, encrypted keys are exchanged.

TEMCO's Supply Chain Management Solution

RSK Smart Contract security

a.   Data encryption: Data is hashed and uploaded to RSK blockchain. By hashing, data is useless unless decrypted. Using Public Key Infrastructure, public and private key of each user's wallet are used for encryption and decryption. Since every user has different combination of public and private keys, hacking one user does not impact other users' data.

b.   System security: RSK has conducted two very deep audits of their system. They will continue to do more audits in the future, and the results will be shared on their homepage. Through our MOU with RSK, we receive technical support from RSK. In case of any problem, we will be able to react fast.

Blockchain security

a. Hash encryption: Each block consists of header and body. In the header, previous block's hash, current block's hash, and Nonce are included. Each block's hash is generated from the previous block's hash, and therefore, it is very difficult to manipulate. To generate the hash, SHA-2 encryption is used.

b. Public key encryption: During an exchange between individuals, digital signatures are authenticated to prove that the transaction has not been tempered. ECDSA (The Eliptic Curve Digital Signature Algorithm) is used to prove this, and it is one of the three standards for digital signing in the United States along with DSA and RSA. In addition, the user's public key is an account number that is not connected to personal information, so it provides anonymity.

c. Double-spending prevention: Uploading data to two or more addresses is called double-spending. To prevent this problem, total number of currency and The Longest Chain Wins methodology is used. When there is a double-spending, the total number of currency exceeds the cap (21million). It also causes two or more blocks to be created. If one block is created before the other blocks and new blocks are added to the first one, it is considered the longest chain and deemed valid.

TEMCO's Supply Chain Management Solution

TEMCO's Operating Cycle

TEMCO operates through a vendor verification system, information storage, verification, evaluation, and the TEMCO Market. Through each process, manufacturers, warehouses, transporters, distributors, and consumers are connected to each other and the creation, verification, storage, evaluation, and utilization of supply chain information takes place in real time.

Product

| Manufacturer | Transport Company | Fulfillment Center | Transport Company | Wholesale & Retail | Consumer |

All Participants

Information

Input·Verify

Blockchain

Public Information
1. Origin Information
2. Temperature
3. Departure and Arrival Time
4. Quality Certification
5. Product Information

Public Blockchain

The public information that can be shared is stored in the blockchain through smart tagging.

Private information
1. Shipping contract
2. Purchase agreement
3. Details of transfer process
4. Product cost
5. Wholesale & Retail cost
6. Personal information

Private Blockchain

Relatively sensitive confidential information is cryptographically stored in the TEMCO cloud and allows only specific users to view the stored data.

TEMCO's Supply Chain Management Solution

Vendor Verification System   TEMCO operates vendor verification systems for manufacturers, warehouses, and distributors. Through the vendor application, vendors are verified according to business registration, factory registration, quality certification, etc. depending on the company.

Only certified vendors can communicate with consumers using the supply chain management solution services provided by TEMCO. Consumers can see the exact information of the vendors through the consumer application and know what vendor the product was purchased through.

Manufacturer | Fulfillment Center | Transport Company | Wholesale & Retail

Vendor App

Approval

Approved Vendor

· Business Registration
· Factory Registration
· Quality Certification
  (Organic, Eco Friendly, Etc.)
· Driver License
· Employment Contract

Vendor Authentication System

TEMCO

TEMCO Market

Private Blockchain

Public Blockchain

Consumer App

Consumer
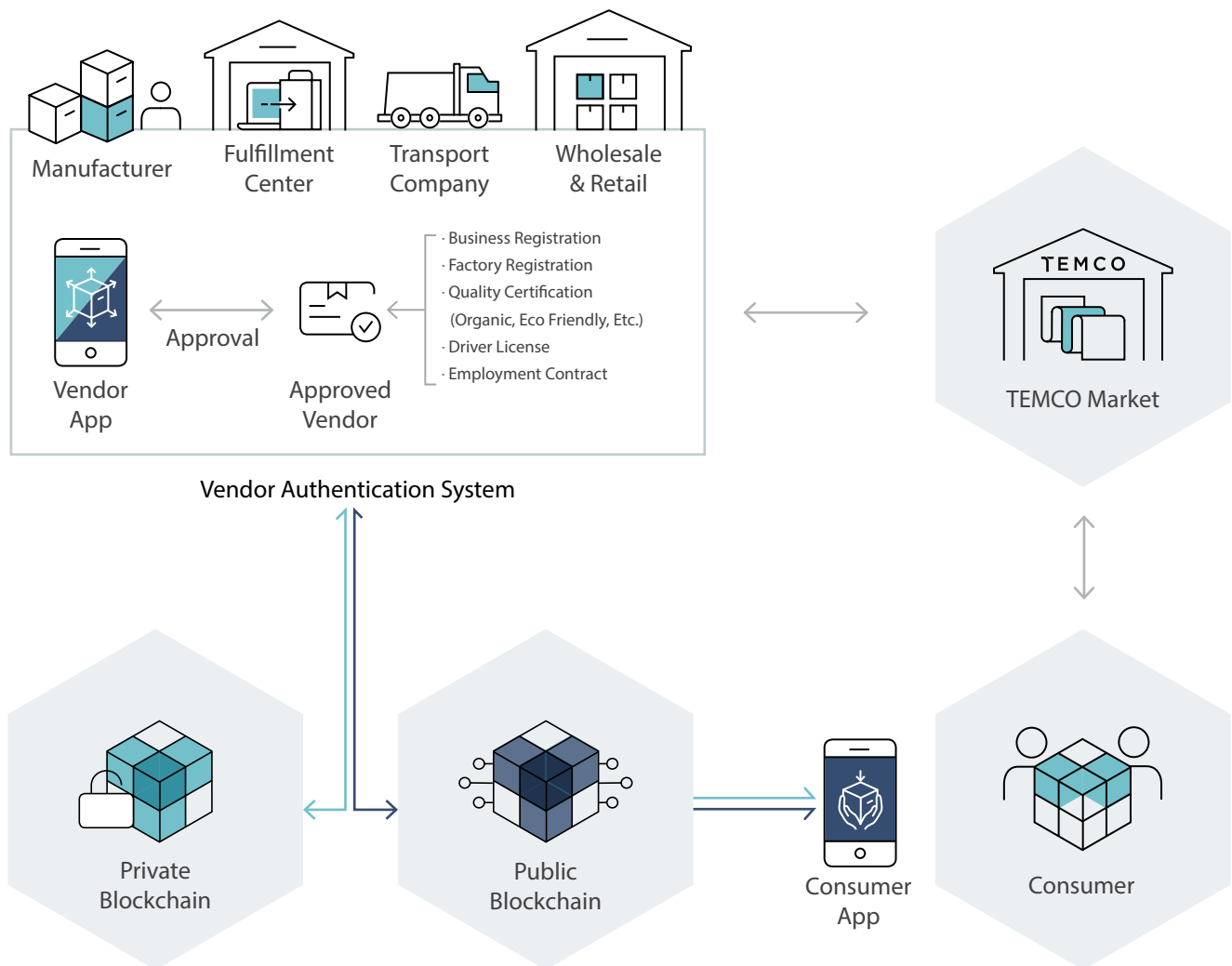
TEMCO's Supply Chain Management Solution

Supply Chain Information Storage Proces   Companies registered through the vendor verification system store supply chain information in a blockchain through smart tagging and data verification.

Once the manufacturer has handed over the product to the warehouse vendor and the process is complete, it will request verification through the vendor application.

As the warehouse company acquires the product from the manufacturer, it tags the QR code and RFID of the product into TEMCO's smartphone application. If the product is delivered correctly, the application verifies and approves the data. This process is based on Smart Contracts.

The warehouse manages the product in accordance with the product retention guidelines as required by the manufacturer, and when it ships, it requests approval from the carrier.

Carriers use smart tagging to verify the storage information of the products such as temperature and environment, and to approve after verification. This process is also based on Smart Contracts, and all of the information gathered are stored in the blockchain.

The acquired product is shipped to the wholesaler and distributor in accordance with the shipping guidelines as required by the manufacturer. Carriers also request approval upon delivering the product, and wholesalers and retailers approve after verifying smart tagging and data upon receiving the correct product.

Smart tagging and data validation are done through Smart Contract each time the management company changes during the supply chain process, and the information is stored in the blockchain in real time.

TEMCO's Supply Chain Management Solution

Customer's Confirmation of Supply Chain Information   With smart tagging provided by the consumer application, consumers can access product supply chain information anytime, anywhere. Consumers can learn more about how their products are managed as they flow from manufacturer to end-user, including temperature, distribution channels, as well as location information.

Smart Contract is also prepared for the possibility of information forgery at the book entry stage. The TEMCO project has the ability to track product distribution through the blockchain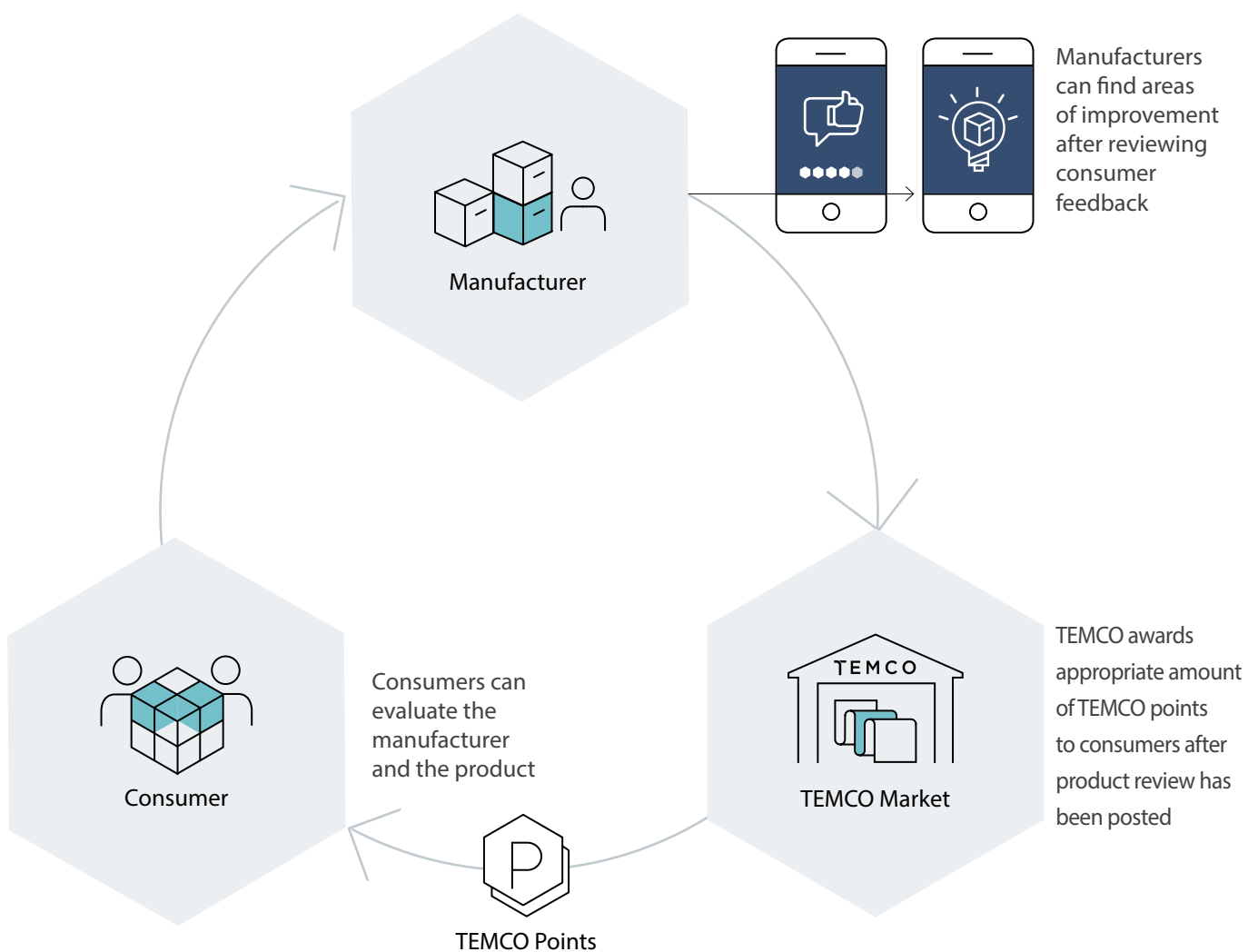 down to a single order thus reducing the possibility of moral hazards such as suppliers recording inaccurate information regarding the actual condition of the products at the Smart Contract stage.

Manufacturer

Vendor App

Transfer The Product

Smart Tagging Request Approval & Verification

Transport Company

Vendor App

Transfer The Product

Smart Tagging Request Approval & Verification

Fulfillment Center

Vendor App

Public Information 1
1. Origin Information
2. Temperature
3. Departure and Arrival Time
4. Quality Certification
5. Product Information

Private information 1
1. Shipping contract
2. Purchase agreement
3. Details of transfer process
4. Product cost
5. Wholesale & Retail cost
6. Personal information

Public Information 2
1. Origin Information
2. Temperature
3. Departure and Arrival Time
4. Quality Certification
5. Product Information

Private information 2
1. Shipping contract
2. Purchase agreement
3. Details of transfer process
4. Product cost
5. Wholesale & Retail cost
6. Personal information

Public Blockchain 1   Private Blockchain 1   Public Blockchain 2   Private Blockchain 2

TEMCO's Supply Chain Management Solution

Consumer Reviews and Product Ranking System   Consumers can evaluate the product through the consumer application after purchasing a product. Evaluation is comprised of satisfaction evaluation, reviews, etc., and TEMCO discloses the product's ranking by period according to consumer evaluations.

The ranking given here cannot be the absolute evaluation standard for the manufacturer. However, the review system allows consumers to receive more information, and manufacturers can accurately and quickly identify and improve upon consumer demands.

Manufacturer

Manufacturers can find areas of improvement after reviewing consumer feedback

Consumer

Consumers can evaluate the manufacturer and the product

TEMCO Points

TEMCO Market

TEMCO awards appropriate amount of TEMCO points to consumers after product review has been posted

TEMCO's Supply Chain Management Solution

TEMCO Market　TEMCO rewards TEMCO Points to promote active participation in the platform. (eg. QR scan, product reviews, customer data sharing, etc.) Consumers can convert TEMCO Points into TEMCO Tokens, and TEMCO Tokens can be used in the TEMCO Market.

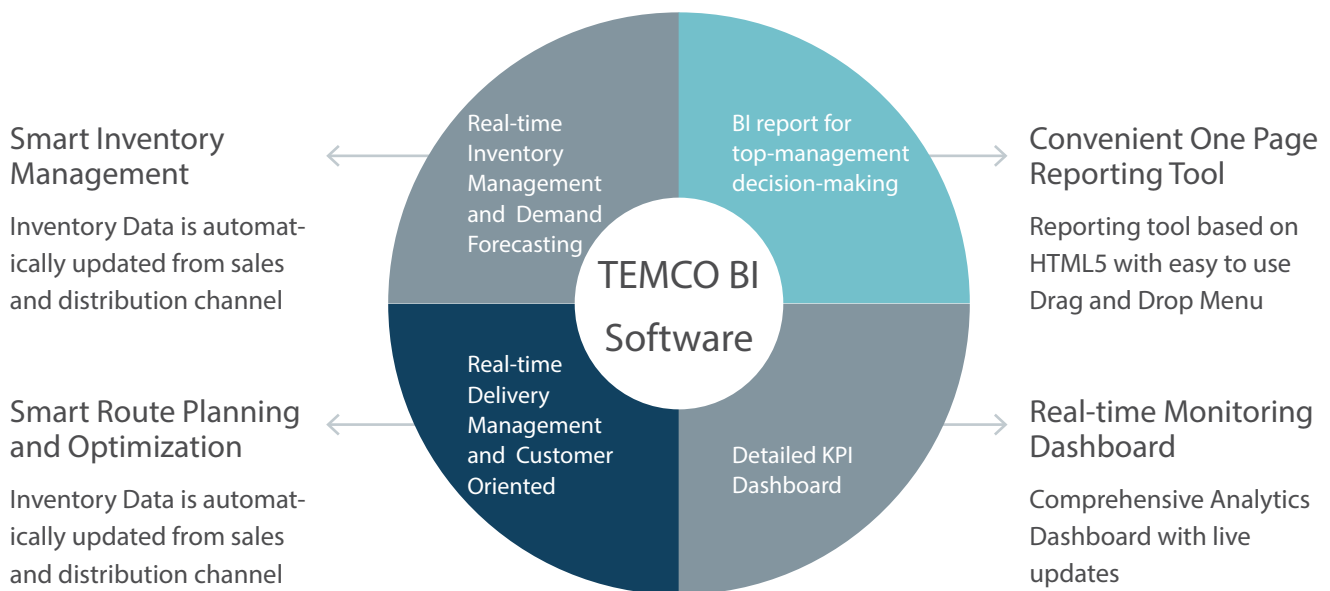From TEMCO Market, consumers can buy reliable products and are rewarded for their participation. As a result, the TEMCO Market serves as a hub to connect the entire supply chain process.
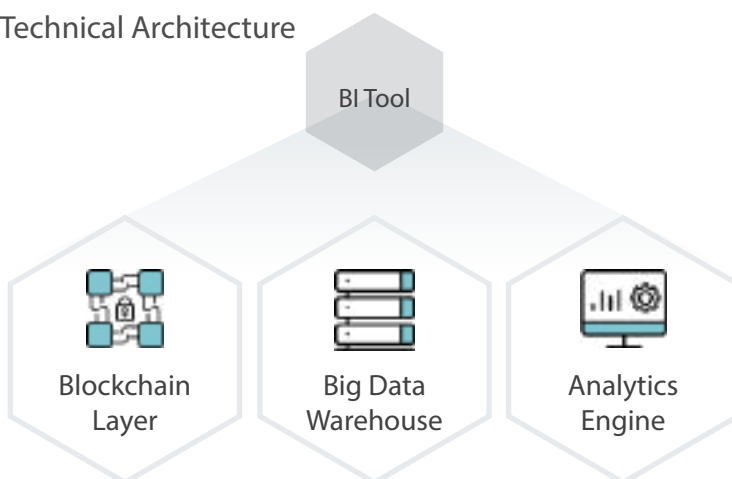

Consumer App

Consumer

Order

TEMCO Market

Order

Manufacturer

Deliver Product

Smart Contract

Transport Company

Prodcut Information

Temperature

Quality Certification

GPS

Vendor Information
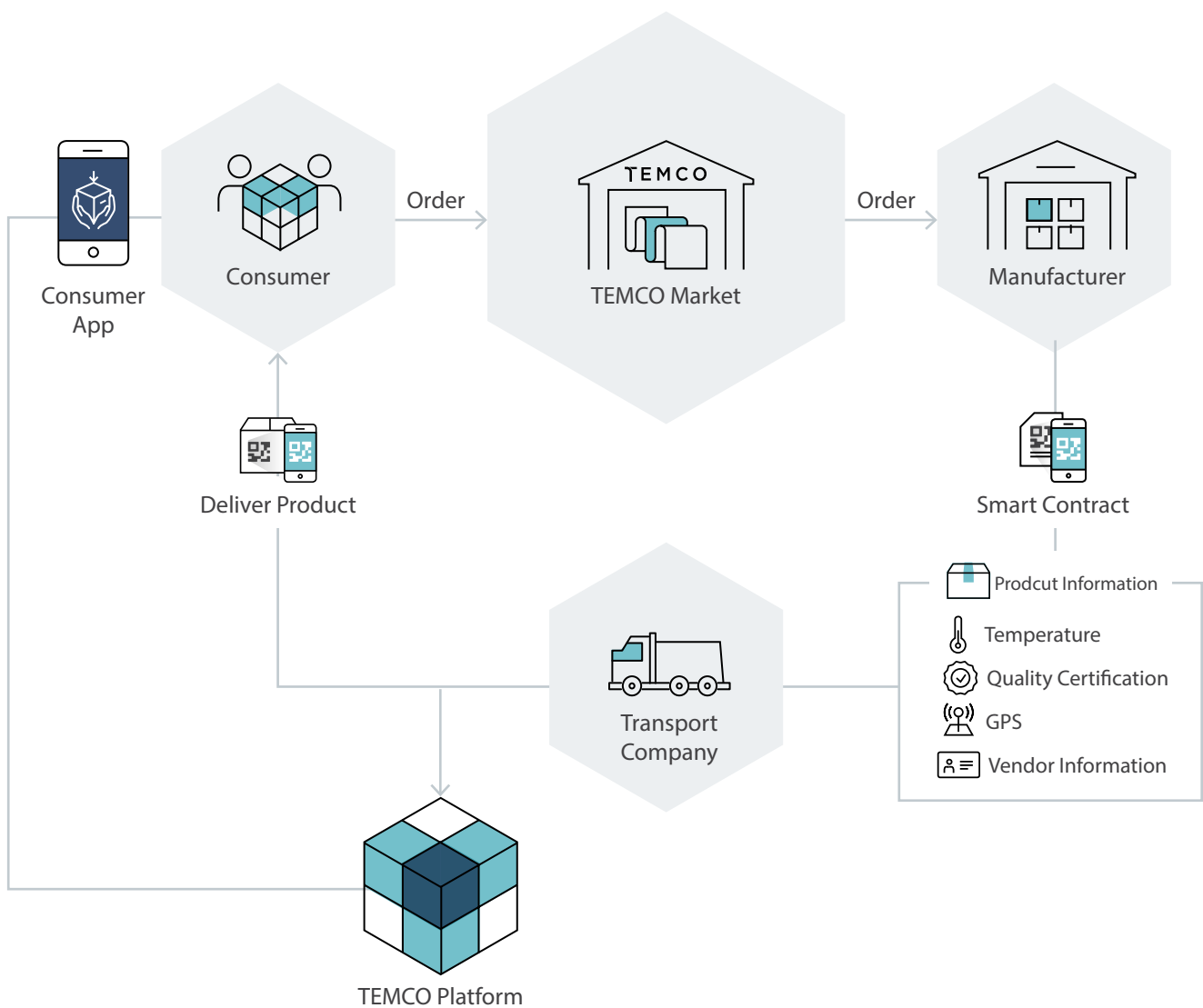
TEMCO Platform

TEMCO's Supply Chain Management Solution

Big Data Analytics Platform TEMCO will operate a big data analytics platform using the data captured in the blockchain. TEMCO's big data analytics platform will combine and structure product, distribution, and consumer information stored in the data warehouse. It also uses external data such as weather and traffic information.

TEMCO will help businesses to gain insights through fast data extraction, sales strategy development from consumer behavior, data visualization, and etc.

Smart Inventory Management

Inventory Data is automatically updated from sales and distribution channel

Smart Route Planning and Optimization

Inventory Data is automatically updated from sales and distribution channel

Real-time Inventory Management and Demand Forecasting

BI report for top-management decision-making

TEMCO BI Software

Real-time Delivery Management and Customer Oriented

Detailed KPI Dashboard

Convenient One Page Reporting Tool

Reporting tool based on HTML5 with easy to use Drag and Drop Menu

Real-time Monitoring Dashboard

Comprehensive Analytics Dashboard with live updates

Technical Architecture

BI Tool

Blockchain Layer

Big Data Warehouse

Analytics Engine

Big data generated from blockchain
↓
Save in big data cluster
↓
Big data preprocessing
↓
Operation of blockchain platform and dApp

TEMCO's Supply Chain Management Solution

TEMCO's Business Model

TEMCO's business model consists of 3 steps:

1) Develop blockchain based supply chain network

2) Develop big data analytics tool and launch TEMCO Market

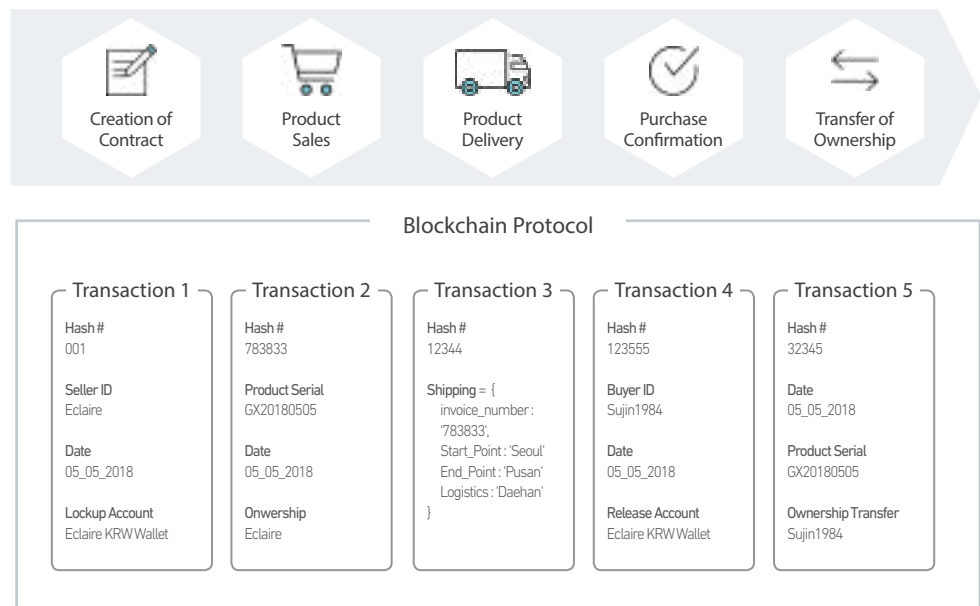3) Provide big data analytics service and data

TEMCO offers a data analytics tool for businesses to utilize valuable data within the blockchain. For consumers, we offer easily accessible real-time supply chain data about their purchases. Market platform will allow consumers to use cryptocurrencies to make purchases. Businesses outside the platform can also take advantage of our big data analytics.

Develop blockchain based supply chain network   TEMCO will connect existing siloed systems into a single platform to prevent data isolation and to allow all participants to access real-time data. Supply chain participants are connected through the application provided by TEMCO. Product information registration, transfer activity, and ownership changes are processed through Smart Contracts. TEMCO Tokens are used to fulfill Smart Contracts. By offering standard protocols and APIs, businesses can easily integrate their system with TEMCO's system.

Using Smart Scan, consumers can obtain detailed information about their purchases. To facilitate active consumer participation, TEMCO rewards consumers with TEMCO Points in the event of Smart Scan. Consumer information connected to the Smart Scan is stored in the blockchain anonymously.

Through blockchain based supply chain infrastructure, businesses gain visibility and control over their supply chain management processes, and consumers receive accurate and trustworthy information. For TEMCO, we can obtain initial users and seed data for BI tool.

TEMCO's Supply Chain Management Solution

Creation of Contract · Product Sales · Product Delivery · Purchase Confirmation · Transfer of Ownership

Blockchain Protocol

Transaction 1	Transaction 2	Transaction 3	Transaction 4	Transaction 5
Hash # 001	Hash # 783833	Hash # 12344	Hash # 123555	Hash # 32345
Seller ID Eclaire	Product Serial GX20180505	Shipping = { invoice_number : '783833', Start_Point : 'Seoul' End_Point : 'Pusan' Logistics : 'Daehan' }	Buyer ID Sujin1984	Date 05_05_2018
Date 05_05_2018	Date 05_05_2018		Date 05_05_2018	Product Serial GX20180505
Lockup Account Eclaire KRW Wallet	Onwership Eclaire		Release Account Eclaire KRW Wallet	Ownership Transfer Sujin1984

Develop big data analytics tool and launch TEMCO Market   TEMCO plans to offer a data analytics tool and launch TEMCO Market after initial users and seed data are secured. The data analytics tool will provide many features including real-time inventory using supply chain data within our data warehouse, KPI dashboard, delivery analysis, one-page reporting, etc. Through the tool, businesses can extract necessary data fast and easy. Using that data, businesses can obtain insights, improve operational efficiencies, and benefit in many other ways.
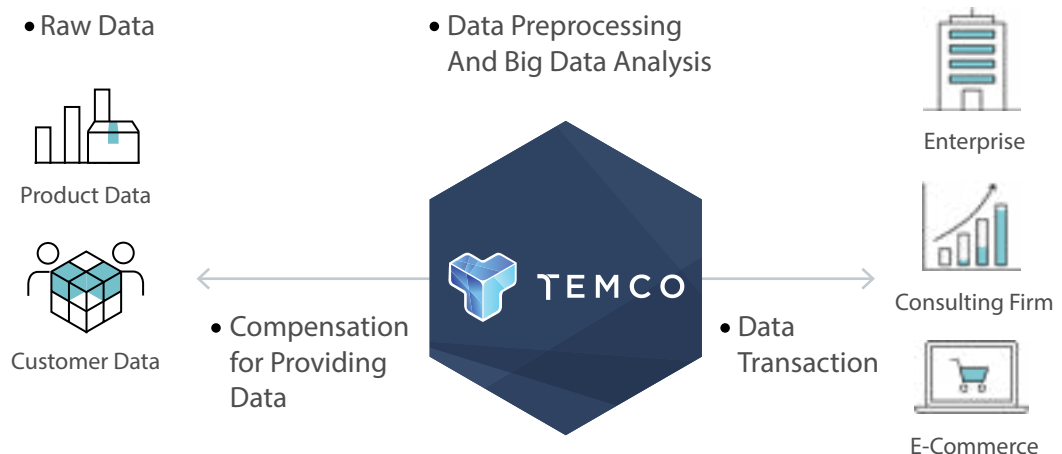
TEMCO will introduce an online marketplace where consumers can use TEMCO Points awarded from their participation in the platform. (e.g. Smart Scan, Reviews, "Likes", etc.) The online market consists of partner mall and point mall. Vendors who passed TEMCO's verification system will be able to offer their products for sale using cryptocurrencies. In the point mall, consumers can use TEMCO Tokens in the form of rewards to purchase highly popular products.

TEMCO's Supply Chain Management Solution

Provide big data analytics service and data The big data industry, which is about collecting and generating large amount of data, is growing at a rapid rate. According to a market research company, Statista, worldwide big data industry will grow from about 38 billion dollars to 104 billion dollars by 2026. The data generated from TEMCO's platform is not only massive in size, but it also contains relevant information about products, distribution, and consumers. Since they are connected, they are highly valuable.

High quality data is processed through TEMCO's big data analytics service and provided to businesses in the form of API and other means. Businesses can learn about patterns, relationships, consumer behaviors, and other valuable information to optimize their products and processes.
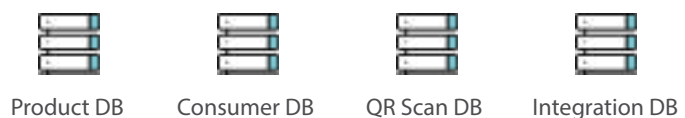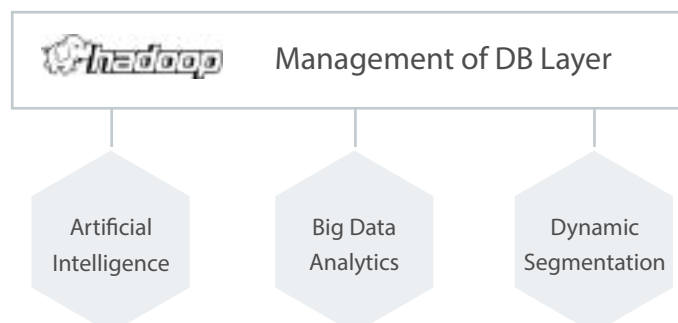
TEMCO Big Data Business Flow

- Raw Data

Product Data

- Data Preprocessing And Big Data Analysis

Enterprise

Customer Data

- Compensation for Providing Data

TEMCO

- Data Transaction

Consulting Firm

E-Commerce

Technical Architecture

Data Management

- Accumulation of Diverse Data

Product DB   Consumer DB   QR Scan DB   Integration DB

hadoop   Management of DB Layer

Data Analytics

- A Tool for Unifying And Analyzing Diverse Data

Artificial Intelligence   Big Data Analytics   Dynamic Segmentation

TEMCO's Supply Chain Management Solution

TEMCO's Token Model

The TEMCO system is based on 'Tokens' and 'Points'. TEMCO Tokens are used as transaction intermediaries within the platform. Specifically, it is a key means of payment for the execution of Smart Contracts and the purchase of products and is a major vehicle for economic activities with versatility to be able to link to external exchanges.
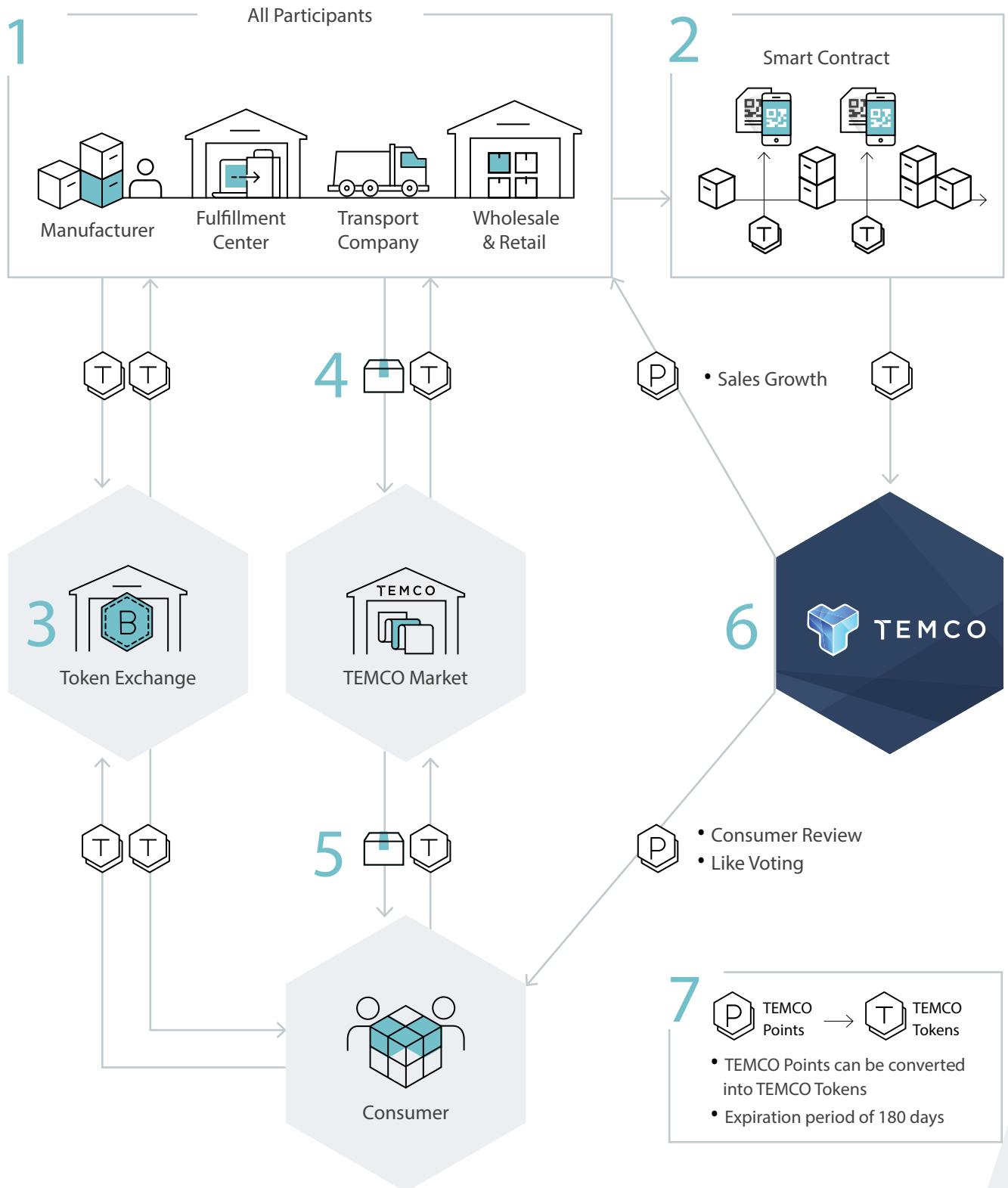
TEMCO Points will be used to build sustainable compensation schemes for Market and TEMCO platform participants. TEMCO Points serve as token of appreciation to encourage users to voluntarily participate in community activities. If the consumer buys a product using a token, or if he or she participates in the community (such as by scanning QR code, writing a review, reacting to customer reviews, or sharing other customer information) the system calculates the value of the contribution and compensates with TEMCO Points.

Vendors can also receive points based on monthly product rankings and quarterly market sales growth. It may also be possible to pay for Smart Contract fulfillment and/or platform subscription fee by leveraging revenue from product sales.
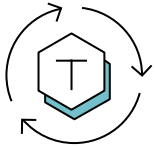
TEMCO Points have a validity period of 6 months. This will encourage users to keep their tokens and engage them with continued interest in the long-term success of the platform.

The TEMCO community is most meaningful when all participants are engaged in active and ongoing activities under token and point-based economic incentive schemes. Under this structure, consumers can purchase safe products that have gone through a proper supply chain process, and manufacturers and distributors can create a virtuous cycle structure that is rewarded with fair value.
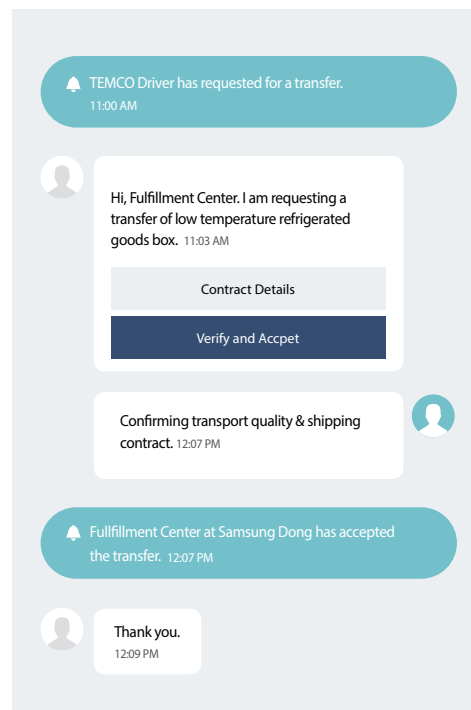
Token Appreciation

1 — All Participants

Manufacturer · Fulfillment Center · Transport Company · Wholesale & Retail

2 — Smart Contract

3 — Token Exchange

4 — TEMCO Market

5

6 — TEMCO

7

- Sales Growth
- Consumer Review
- Like Voting

TEMCO Points → TEMCO Tokens

- TEMCO Points can be converted into TEMCO Tokens
- Expiration period of 180 days

TEMCO's Supply Chain Management Solution

1 Requesting and accepting a transfer between supply chain participants (eg. Manufacturers, transport companies, warehousing companies, distributors, etc.) will occur through a chat system.

🔔 TEMCO Driver has requested for a transfer.
11:00 AM

Hi, Fulfillment Center. I am requesting a transfer of low temperature refrigerated goods box. 11:03 AM

Contract Details

Verify and Accpet

Confirming transport quality & shipping contract. 12:07 PM

🔔 Fullfillment Center at Samsung Dong has accepted the transfer. 12:07 PM

Thank you.
12:09 PM

4 TEMCO points are given as a reward for selling on the TEMCO Market or experiencing sales growth from the TEMCO Market. TEMCO points can be converted into TEMCO tokens.

5 Consumers must use TEMCO tokens to make purchases. TEMCO points are given as a reward for participating in the TEMCO platform through reviews and "Like"s. TEMCO points can be converted into TEMCO tokens.

2 Processing Smart Contracts based on blockchain will require TEMCO tokens to cover a transaction fee. TEMCO tokens paid for that purpose will return to TEMCO.

6 TEMCO tokens received by TEMCO for processing Smart Contracts and selling products on the TEMCO Market will be used to reward consumers and supply chain participants.

3 Consumers and all supply chain participants can use token exchanges to convert TEMCO tokens into other forms of token.

7 TEMCO points can be converted into TEMCO tokens but not vice versa. TEMCO points have an expiration date of 180 days to foster consistent participation in the TEMCO Market.

TEMCO's Supply Chain Management Solution

## Contribution Level Evaluation Algorithm

Consumers can review and "Like" their purchased products, and they can select the best reviews by commenting on and "Liking" other consumer reviews.

The best reviews represent information that has been selected as useful by many consumers, so there is confidence in trusting this information. Voting for other consumer reviews is also considered a community contribution, so voters can get the corresponding rewards.

However, since comments and ratings may be manipulated, the following constraints will be designed with the algorithm to minimize the risk of information distortion.

Reviews can be modified after creation but cannot be modified by other consumers. Creation of duplicate postings for the same product within 24 hours is limited. In addition, the number of "Like"s that users can leave on products and reviews in a day is limited in order to improve credibility of reviews.

The contribution evaluation algorithm for distribution participants is divided into a quarterly sales growth model and a monthly product feedback compensation model. The quarterly sales growth rate compensation model is an algorithm that compares the sales growth rate of products sold in the TEMCO market by quarter. The formula is as follows:
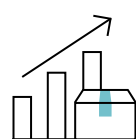
$$\text{x Incentive Rate x } \frac{\dfrac{\text{Product Price x (Current Sales Volume - Past Sales Volume)}}{\text{Past Sales Volume}}}{\dfrac{1}{\text{Temco Point Price}}}$$

TEMCO's Supply Chain Management Solution

The Product Feedback Compensation System is intended to quantify consumer feedback on the product and to announce the rankings to the community on a monthly basis so that the distribution participants have a certain weight on the incentives for community contribution by product rank. Through this system, consumers' reviewing power, in the form of reviews and Likes, can encourage the production and distribution of honest products. TEMCO points are provided in the Point Pool and the related formulas are as follows:

$$TPP - (R \times D \times S) \times T + [MV_0 \times \{(1 + GR_1)(1 + GR_2) \ldots (1 + GR_T)\} \times I \times [\quad] \times \frac{1}{P}] \frac{1}{T}$$

$$- \{(\sum_{n=1}^{T} MV_{n-1} GR_n) \times D \times \frac{1}{P} \times T \leq 0$$

* TPP = TEMCO Points Pool, R = Contract Usage Fee,

  D = Distribution Rate S = Number of Smart Contracts,

  MV_n = Market Turnover at point in time "N",

  GR_n= Market Growth Rate at point in time "N", I = Market Transaction Fees,
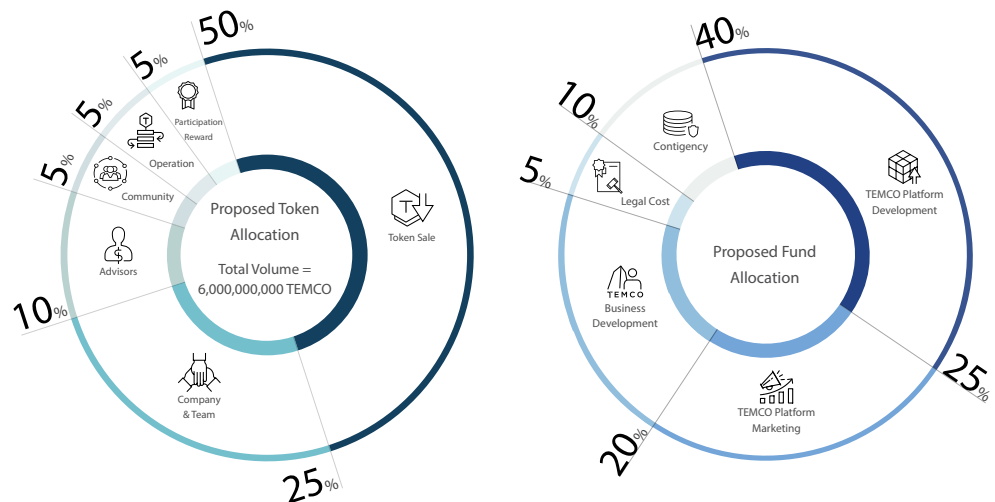
  P = TEMCO Point Price, T = Full Dissolution Period

Points earned by the consumer can be converted into TEMCO tokens assigned to the point pool at any time within the validity period. The TEMCO token conversion ratio of TEMCO points will be further optimized through future simulations.

When the points that should be paid to the community contributor are not delivered, 50% of the points are given to all participants and the rest are returned to the point pool. This is designed to prevent changes in the value of TEMCO tokens due to the rapid depletion of point pools.

Token Distribution

Token sales are intended for the development of the TEMCO platform and the construction of the ecosystem, and participation is through Bitcoin (BTC) and Ethereum (ETH). The exact exchange rate will be announced through the official channel (homepage, etc.) prior to token issuance. Tokens paid through token sales account for about 50% of the issue volume. 25% of the total token issuance goes to the TEMCO team, 10% goes to the advisors, 5% is used for community building, and 10% is for participation reward.

The Bitcoin (BTC) and Ethereum (ETH) proceeds from the token sale is used for following: 40% on product development, 24% on marketing, 20% on business development, 5% on legal, and 10% for emergency.

Proposed Token Allocation — Total Volume = 6,000,000,000 TEMCO

Token Sale 50% · Participation Reward 5% · Operation 5% · Community 5% · Advisors 10% · Company & Team 25%

Proposed Fund Allocation

TEMCO Platform Development 40% · Contigency 10% · Legal Cost 5% · TEMCO Business Development 20% · TEMCO Platform Marketing 25%

Roadmap

May, 2018	Launch website Release whitepaper
June, 2018	Release prototype Develop advisory board
Aug, 2018	Start private sale
Oct, 2018	Start whitelisting
Nov, 2018	Start public sale (TBD)
Dec, 2018	Develop decentralized RSK based supply chain network
1Q 2019	Develop BI tool, ERP, and consumer application Develop a business model for luxury goods industry
2Q, 2019	Develop IoT on TEMCO supply chain platform
3Q, 2019	Launch beta BI tool
4Q, 2019	Launch beta consumer application Launch TEMCO verified API service
1Q, 2020	Launch beta luxury goods market on TEMCO platform
2Q, 2020	Launch luxury goods market on TEMCO platform Launch BI tool Launch beta ERP
3Q, 2020	Launch ERP and consumer application
4Q, 2020	Launch partner's mall and point mall Launch TEMCO data service

Issues
& Risks

The TEMCO team (including TEMCO LABS PTE. LTD. and its shareholders, employees, and affiliates) has written this white paper for reference only to those interested in specific information on the new supply chain management platform planned by the TEMCO Project. In other words, this white paper is not intended to invite you to invest in the platform and team that the TEMCO project is planning. In addition, this white paper is prepared and provided according to information that is correct at the time of writing, so we do not guarantee that everything in the white paper, including the conclusions, will remain accurate in the future.

The TEMCO team does not guarantee the legitimacy of any of the information in the white paper and therefore is not legally responsible for any of its content. The TEMCO team does not assume any legal responsibility for ① the white paper being legitimately written, ② the white paper having commercial value, ③ the white paper coinciding with your specific purpose, and ④ the information contained in the white paper being perfect and free of errors.

All the results (profit, damages, etc.) arising out of the matters determined by using the white paper and other information are entirely at your discretion, and the TEMCO team does not bear any legal responsibility (compensation, reward, etc.) for it.

* To Note) The possession of TEMCO tokens has nothing to do with the decision-making of all matters related to the TEMCO project, and the TEMCO team does not provide any compensation (profit or share allocation, dividends, etc.) for token ownership.

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