Supporting Agri food communities and networks in SEE through developing services on digital food quality and traceability using blockchain

FUNCTIONAL SPECIFICATION

ROADMAP

CONTENTS

1. INTRODUCTION

This document Functional specification describes in detail the functional requirements of project "Supporting Agri food communities and networks in SEE through developing services on digital food quality and traceability using blockchain".

This document represents the contractual delivery of:
– Deliverable 3 Technology roadmap
– Deliverable 4 Lab pilot case
– Deliverable 5 Prepared documents for education of DIHs

This document was created by Partner Cuspis d.o.o., as a result of Cuspis d.o.o. domain knowledge, meetings held with Consortium Partners and stakeholders and collected information from producers.

This document describes blockchain solution, elements of blockchain solutions, business processes, user roles, data, validations and web as part of this solution, as well as the necessary data from other systems. Everything described is working on testing environment.

The document does not contain a detailed technical specification that would serve for the development and production of all components of the solution.
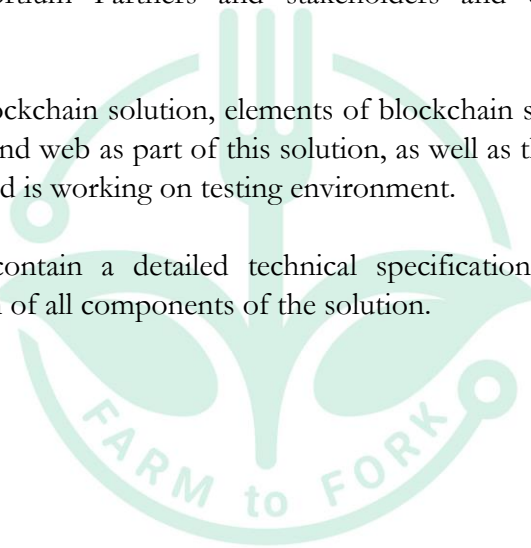
1.1. ABOUT CONSORTIUM

Consortium of four Digital Innovation Hubs in South East Europe partnering with one Competence Centre and one blockchain IT company, is geographically dispersed but reaches wider range of stakeholders throughout the Region.

Consortium Partners are:
Green DIH, Digital Innovation Hub from Romania – Lead Partner
DIH TERA, Digital Innovation Hub from Croatia
DIH Hadas Bar, Digital Innovation Hub from Israel
DIH Smart Village, Digital Innovation Hub from Bosnia and Herzegovina
Centar Kompetencija, Competence Centre from Croatia
Cuspis, Blockchain IT company from Croatia

1.2. ABOUT PROJECT

The Project "Supporting Agri food communities and networks in SEE through developing services on digital food quality and traceability using blockchain – DFTB" increased participation of DIHs in South East Europe Region in digital transformation of Agri-food sector with focus on food traceability using blockchain. Project focuses on supporting services that can significantly improve entrepreneurial business with the help of digitalization using blockchain technology creating transparent supply chain from farm to fork as well as enable customer to know history of the specific package or piece of food they are buying. Project focus is on food processors, customers, regulators, local government officials, and consumer protection association representatives. As a result of the Project, participating DIHs are able to offer range of new digital services: Scouting and ecosystem analysis, Technology Road Map, Proof of concept, Workshops and seminars, Lab facilities, Support for innovative business models.

1.3. ABOUT SMARTAGRIHUBS

SmartAgriHubs is a project funded by the European Union through the Horizon 2020 funding instrument that brings together a consortium of over 164 partners in the European agri-food sector. SmartAgriHub aims to digitize European agriculture by promoting an agricultural innovation ecosystem dedicated to excellence, sustainability, and success. The SmartAgriHubs project serves as a catalyst for innovation in smart farming. By embracing and promoting European innovation in agriculture and IT, SmartAgriHubs is expanding digital solutions in the agri-food sector and helping farmers and their businesses achieve actual and achievable results.

1.4. GLOSSARY

TERM	DESCRIPTION
API	Acronym for Application Programming Interface, a software intermediary that allows two applications to "talk" to each other
Blockchain	Blockchain is a digital ledger of transactions that is duplicated and distributed across the entire network of computer systems on the blockchain
Business process	An activity or set of activities that accomplish a specific goal
Digital identity	Information used by computer systems to represent an external agent – a person, organization, application, or device
IT	Acronym for Information Technology
MetaMask	Software cryptocurrency wallet used to interact with the Ethereum blockchain
Method	A particular procedure for accomplishing something
Premium brands	Brands which produce premium food
Premium food	Food of higher quality and higher price range
Product ID	Product identifier which represents series of numerical or alphanumerical digits that are used to identify a specific product.
POS	Acronym for Point of Sale, place where products are sold
Smart Contract	Self-executing contract with the terms of the agreement between buyer and seller being directly written into lines of code
Smoke tests	Subset of test cases that cover the most important functionality of a component or system, used to aid assessment of whether main functions of the software appear to work correctly
Wallet address	Unique string of letters and numbers that allow users to store, send, and receive cryptocurrencies

2. EXPECTED BENEFITS OF THE PROJECT

Blockchain is recognized as an emerging technology in the agri-foods industry which may provide an efficient and robust mechanism for enhancing food traceability and a transparent and reliable way to validate quality, safety, and sustainability of agri-foods.

Blockchain technology, also referred to as distributed ledger technology, is a type of public bookkeeping protocol executed by a network of computing systems. The networked computing systems execute a pre-determined protocol to maintain a record of transactions, which are stored in "blocks." Each block of the blockchain includes data (e.g., one or more records/transactions), a hash value of the immediately preceding block, and a hash value of the contents of the current block. Blockchain is different from a normal database in that there are specific rules about how data is added to the blockchain:

1. The data added to the blockchain cannot conflict with other data that is already on the blockchain, thus data stored on a blockchain must be consistent.
2. Data may only be appended to a blockchain (e.g., new data cannot be inserted into a previously recorded block), and thus data stored on a blockchain is immutable.
3. Every computing system executing the blockchain protocol must agree on what the state of the data stored on the blockchain is (e.g., the blockchains stored in each computing system operating the blockchain protocol must be the same).
4. A public blockchain is not owned by a central party, and thus no single entity can unilaterally modify the state of the blockchain.

Blockchain is capable of providing immutable data records and traceable transaction history, which provides great potential to enhance efficiency, transparency, and traceability.

Using blockchain technology, data about food quality is, for the first time, available to consumers by scanning code on the product that contains all the necessary data such as: production data, date of harvest, date of delivery from the farmer, date of packaging, date of supply stores as well as other data depending on the targeted product.

Project focuses on supporting services that can significantly improve entrepreneurial business with the help of digitalization using blockchain technology creating transparent supply chain from farm to fork as well as enable customer to know history of the specific package or piece of food they are buying. By increasing the transparency and traceability, trust level between stakeholders in the value chain increases and "premium brands" justify the trust and receive the boost in their marketing strategies. This is a win-win situation – people eat healthier and businesses thrive.

Consortium DIH partners have identified specific "Premium" food products to be focused on as follows: eggs, black Slavonian pig, apples, wine and avocado.

3. BLOCKCHAIN SOLUTION

Blockchain solution consist of following elements in testing environment:

– Self-assessment tool for use by stakeholders to determine their current stage of digitalization. Output that will give directions how to use digital food quality and digitalization tools

– Communication hub for collecting data with automatic integration to web site and blockchain

– Web site tool for stakeholders to directly input data about their production lifecycle or supply chain that will be automatically written and sent to communication hub and written to blockchain and published on web

– API interface for stakeholders that have their own IT system in place where they'll send their production lifecycle or supply chain data through API to communication hub which will be automatically published on web and written in blockchain

– Web site for consumers where they'll be able to search by the lot number and find all relevant information about production of this specific food they are buying, search by products and by producers
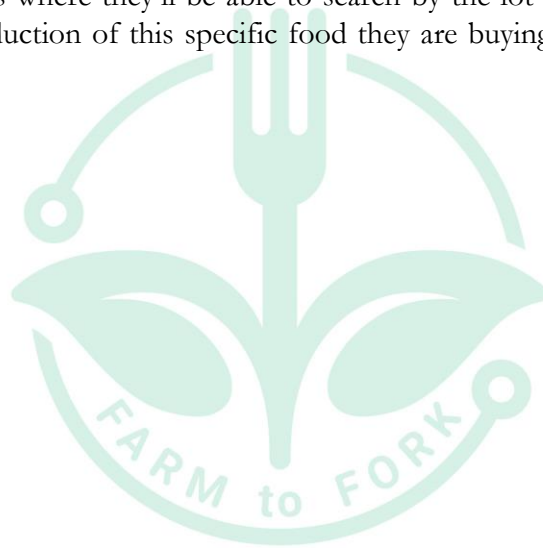
4. SELF-ASSESSMENT TOOL

Self-assessment tool is used by stakeholders to determine their current stage of digitalization. Output will give directions how to use digital food quality and digitalization tools.

Stakeholder can answer questions to determine on which stage of digitalization its organization is. Final result will give direction for possible improvements and examples of next steps.

Questions are based on users roles in supply chain – Producer, Processor, Distributor and POS (Point of Sale). Depending on the role, categories of questions are:
   – measuring parameters
   – devices for measuring parameters
   – products health checks
   – measurement frequencies
   – organization of production land

For each answer, user receives points. At the end, final score will be calculated and user will get percentage of their current stage of digitalization. Depending on final score, there are 4 stages of digitalization:

0-25   Beginner
26-50   Intermediate
51-75   Advanced
76-100 Expert

At the end, user will also receive some recommendations for next steps:

–   Think about measuring conditions
–   Think about using devices for measuring parameters
–   Think about collecting information from devices for measuring parameters
–   Think about processes you can automate
–   Think about testing your products (for presence of virus, bacteria, disease, parasite, etc…)
–   Think about organizing your land by dividing it on smaller multiple lots for more accurate measurement of conditions

4.1. BUSINESS PROCESS
   – Filling Self-assessment tool by answering questions
   – Cross checking answers with self-assessment tool
   – Defining current stage of digitalization
   – Reading directions for possible improvements and next steps

5. COMMUNICATION HUB

Communication hub is used for collecting data and has automatic integration to web site and blockchain. In this case communication hub is represented by Smart Contract. Smart Contract is program stored on a blockchain that run when predetermined conditions are met. It is used to automate the execution of an agreement (in this case transaction) so that all participants are immediately certain of the outcome, without any intermediary's involvement or time loss. That means that code controls the execution without the need for a central authority, legal system, or external enforcement mechanism. This agreement (transaction) is written to blockchain, which means that all agreements (transactions) are trackable and irreversible.

Communication hub has 2 Smart Contracts – one is Admin Smart Contract and one is Users Smart Contract.

In general, Admin Smart Contract has methods for:
  – adding/changing status of admin addresses that can use this Contract
  – adding new products to blockchain with defined parameters and values for that product
  – reading data stored on blockchain

In general, Users Smart Contract has methods for:
  – adding new lot numbers and registering address to specific lot number
  – adding new parameters for existing products to blockchain
  – reading data stored on blockchain

Each Smart contract has its own roles – Admin Smart Contract has Admin role, and Users Smart Contract has Producer, Processor, Distributor and POS.

5.1. ROLES

During the lifecycle, specific product goes through several stages – production, processing, distribution, sale. Each stage has its own inputs and outputs, and each stage has its own conditions that needs to be met in order to accomplish optimal environment for specific product. For each product, partners defined which parameters need to be measured and what are the optimal values for those parameters.

Since product goes through different stages, different parameters are measured, so users need to have different roles in order to record parameter specific for product stage.

5.1.1. Admin Smart Contract / Admin role

Admin role is implemented for purpose of adding (writing) new products on blockchain and adding/changing status of admin addresses on blockchain. That means that other users cannot add

new products to blockchain if they have one of the Users roles. Admin role is implemented in order to prevent "dirty" data (inaccurate/incorrect/incomplete data).

5.1.2. Users Smart Contract / Users roles

Users will have roles according to their role in product lifecycle and product stages – production, processing, distribution, sale.

1 – Producer
Producer is organization which produces specific product and measures product parameters during growing/production stage.

2 – Processor
Processor is organization which buys product from producer, combine it with some other products from the same or other producers and make a new product. Processor measures all parameters for different products (that are combined) during processing stage.

3 – Distributor
Distributor is organization which transports specific product and measures product parameters during distribution stage. One specific product can have several distributors before going to the point of sale. Each distributor will measure product parameter during their distribution.

4 – POS
POS (Point of Sale) is organization which sales specific product and measures product parameters while the product is on POS. One specific product can have several POS before customer buys it. Each POS will measure product parameters while the product is on POS.

5.2. BUSINESS PROCESS

As mentioned above, Communication hub has 2 Smart Contracts – one is Admin Smart Contract and other is Users Smart Contract.

Both Smart Contracts use Set Methods (adding (writing) data to blockchain) and Get Methods (reading data from blockchain).

When used, Set Methods are paid each time – small transaction fee needs to be paid in order to write certain data on blockchain.

When used, Get Methods are free – no transaction fee needs to be paid in order to read certain data from blockchain.

5.2.1. Admin Smart Contract

Admin Smart Contract has following methods:

SET METHODS:

setAdmin

This method adds new wallet address as admin address. Only admin address can add new admin address or change existing admin address into active or inactive. Parameters that need to be added:

  – Wallet address that will be added or changed
  – True/False if wallet address is active/inactive

setProductInfo

This method adds new product with all parameters that will be measured. Only admin address can add new products. Parameters that need to be added:

  – Product ID (following Product Code list)
  – Name of the product
  – Category of the product
  – Attributes of the product (attributes should define which parameters will be measured and for which role, data type and data length for each parameter, and optimal values for each parameter)
  – True/False if product is active/inactive

GET METHODS:

getAdmins

This method reads all admin addresses. Only admin address can read other admin addresses. No parameter needs to be added to read this method.

getProductAttributeById

This method reads information about products specific attribute. Parameters that need to be added:

  – Product ID (following Product Code list)
  – Index for parameter of specific product (following Product Code list)

getProductAttributeLengthById

This method reads information about how many parameters specific product has and type of data. Parameters that need to be added:

  – Product ID (following Product Code list)

getProductById

This method reads all information about attributes for specific product (parameters, roles, data type, optimal values). Parameters that need to be added:

  – Product ID (following Product Code list)

getProductsInfo

This method reads all information about all attributes for all products (all parameters for each product, roles, data type, optimal values). No parameter needs to be added to read this method.

getProductInfoById

This method reads all information about added parameters for specific product. Parameters that need to be added:

    –   Product ID (following Product Code list)

getProductNameById

This method reads information about name of specific product. Parameters that need to be added:

    –   Product ID (following Product Code list)

5.2.2. Users Smart Contract

Users Smart Contract has following methods:

SET METHODS:

setLotEndDate

This method adds end date to specific lot number. Parameters that need to be added:

    –   Existing Lot number
    –   End Date
    –   Wallet address

End date is automatically added when Lot number is transferred to other address. But user (any role) can also add end date to lot number for different reasons. Some examples:

    –   product is sold
    –   product is damaged
    –   product expired

setLotNumberInfo

This method adds new Lot numbers for specific product. Parameters that need to be added:

    –   New Lot number (personalized or predefined in format YYYY-ProductID-LocationCode- yyyyMMddHHmmssfff)
    –   Product ID (following Product Code list)
    –   Station on which product is produced (can be personalized and added manually)
    –   Location on which product is produced (following Location Code list)
    –   Year in which product was produced

setLotNumberAddresses

This method adds specific Lot number to specific wallet address. Parameters that need to be added:

    –   Existing Lot number

- Wallet address to which lot number will be registered
- Start Date
- End Date
- Role of user of wallet address

setProductParameters

This method adds parameters to specific lot number on specific date of measurement. Parameters that need to be added:
- Existing Lot number
- Measured values of parameters for specific attributes of the product
- Date of measurement

GET METHODS:

getLotNumbersByAddress

This method reads all lot numbers registered to specific address and information about those lot numbers (name, location, station, starts and end date). Parameters that need to be added:
- Wallet address

getProductAddressesById

This method reads information about all addresses and locations connected to specific product. Parameters that need to be added:
- Product ID (following Product Code list)

getLotNumberInfoByLotNumber

This method reads information about specific lot number. Parameters that need to be added:
- Existing Lot number

getLotNumberAddressesByLotNumber

This method reads all addresses to which this lot number was register, and current address to which is registered. Parameters that need to be added:
- Existing Lot number

getProductsInfo

This method reads all information about all attributes for all products (all parameters for each product, roles, data type, optimal values). No parameter needs to be added to read this method.

getProductInfoById

This method reads all information about added parameters for specific product. Parameters that need to be added:
- Product ID (following Product Code list)

getDataByAddress

This method reads all lot numbers registered to specific addresses and parameters added for this lot numbers by this specific address. Parameters that need to be added:

– Wallet address

### getDataByAddressAndLotNumber

This method reads all parameters added for specific lot number by specific address. Parameters that need to be added:

– Wallet address
– Existing Lot number

getTestsByAddressAndLotNumber

This method reads all measurement date and time added for specific lot number by specific address. Parameters that need to be added:

– Wallet address
– Existing Lot number
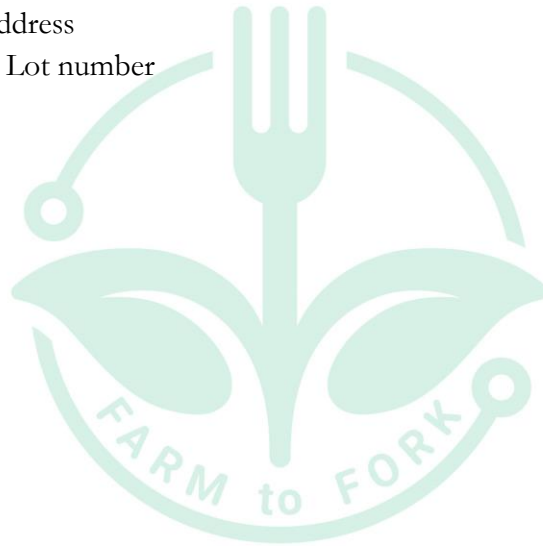
6. WEB SITE TOOL FOR STAKEHOLDERS

Web site tool for stakeholders gives producers, processors, distributors and POS (points of sale) tool to directly input data about parameters for product they produce/process/hold during its production lifecycle or supply chain. Inputted data is automatically written and sent to communication hub, written to blockchain and published on web. Stakeholders can use their digital identity to register and login to web site tool.

6.1. DIGITAL IDENTITY

Before filling data into web site tool for the first time, users (stakeholders) need to register to web. Registration is done using digital identity. Digital identity is represented by cryptocurrency wallet. Stakeholder needs to have registered cryptocurrency wallet which will be used for paying transactions.

After user select Login menu on web site tool for the first time, message will appear and ask user to connect cryptocurrency wallet. It is suggested to use MetaMask extension for browser. MetaMask is a software cryptocurrency wallet used to interact with the Ethereum blockchain.

After installing MetaMask extension and logging in on MetaMask extension, user will be redirected to connect wallet to web site and then to fill in Profile info (name and info about organization). After that, user can add lot numbers for products and add parameters for specific lot numbers.

After user has registered profile, next time won't be necessary to register it again because user will only need to log in and everything will be ready to fill in data into web site tool.

6.2. WEB SITE INTERFACE

After user is logged in to web site, features are shown in dropdown menu. User can update profile info for organization, add new lot numbers for products, add parameters for added lot numbers, transfer lot number to another address or end lot number.

6.2.1. Profile info

In Profile info, user can add/update/delete information about organization. Field names that can be filled and descriptions are as follows:
  - **Wallet Address (required)**
    User can see own Address which is automatically added from wallet extension
  - **Your organization name (required)**
    User can add organization name which will appear when searching lot number that is connected to organization, when searching products and when searching organizations
  - **Your email address (optional)**
    User can add email address which will be used to send important updates to user

– **About your organization (required)**

User can add short description of organization which will be shown when searching organizations. Maximum allowed characters are 1.000.

When data is added or changed, user needs to select button "Save" to save changes.

6.2.2. Products data

In Products data, user can add parameters to lot numbers that are connected to this user address, under certain conditions. That means that user can add parameters if:

– Lot number is registered by this user and visible in menu Lot data
– Lot number is register by another user, transferred from another user address to this user address and visible in menu Lot data
– Lot number is active, meaning that there is no End Date on lot number and visible in menu Lot data

Following these criteria, user can't add parameters if:

– User don't have lot number(s)
– Lot number is transferred to another user
– Lot number is ended (has End Date)

Field names that can be filled and descriptions are as follows:

1. **PRODUCT DATA**
   – **Lot number**

   User selects Lot number from dropdown menu (all available lot numbers will be shown). Parameters for selected Lot number will be shown on right side under PRODUCT PARAMETER. Parameters will be added for selected Lot number.

   – **Measurement Date**

   User can add measurement date and time, or select it from dropdown menu which will show calendar with dates and clock with time. By default, filed will show current date and time, but user can select its own date and time. Selected date and time can't be before lot number started and can't be date and time in future.

2. **PRODUCT PARAMETER**

   After selecting Lot number, parameters connected to Lot number (and product register in Lot number) will be shown.

   Each parameter will have name and unit in which is measured. User can add values for each parameter. To be able to save data, at least one parameter must be added (meaning that user can save data if at least one parameter is added, but user can add few or all parameters too).

After adding values to parameters, user can save data selecting button "Save" or disregarding data selecting button "Cancel":

– If user selects button Save, wallet extension will show pop up window with details about transaction and buttons to reject transaction (button "Reject") or confirm transaction (button "Confirm").

    – If user selects "Confirm" on pop up window, transaction will be processed if user have enough cryptocurrency in wallet. If user don't have enough cryptocurrency in wallet, message will appear with information that transaction is rejected and to check users wallet. If user have enough cryptocurrency in wallet, transaction will be processed, and message will appear confirming that transaction was successful and data is saved on blockchain. Parameters for selected Lot number will be saved.

    – If user selects "Reject" on pop up window, message will appear with information that transaction is rejected and to check users wallet. Parameters for selected Lot number won't be saved.

– If user selects button "Cancel", all entered values will be deleted, Lot number field will show last selected lot number and Measurement Date will show current date and time. Parameters for selected Lot number won't be saved.

6.2.3. Lot data

In Lot data, user can see all lot numbers connected to user account and relevant information about those lot numbers.

Column names and descriptions are as follows:

– **Checkbox column**

    User can see which lot numbers are selected. Lot numbers can be selected/ deselected individually by clicking on row with lot number, or can be selected/deselected all by clicking checkbox in top of the column. Lot numbers that are selected will have tick in the checkbox on the beginning of the row, and those that are not selected, will have empty checkbox on the beginning of the row.

– **Name**

    User can see name of the product to which specific lot number belongs

– **Lot Number**

    User can see Lot number

– **Star Date**

    User can see starting date and time of specific Lot number

– **End Date**

    User can see ending date and time of specific Lot number

– **Station**

    User can see station where Lot number is located. Station is used for better organizing and defining exact location of the Lot number on specific location. Name of the station is individual for user, so user can create own Station names.

– **Location**

    User can see location code where specific Lot number is located. Location code can be found in Location code list, in attachments.

– **Year**

    User can see year in which Lot number is created.

– **History**

    User can see history of handling specific Lot number – it shows wallet address of user, start date (date and time when this lot first come to this user address), end date (date and time when this lot was last time handled by this user address), role of this user (see 5.1.2 Users Smart Contract).

– **Lot No.**

    User can see Lot number and URL address for searching data about this lot number parameters. It also allows user to generate QR code for this specific Lot number. QR code can be downloaded.

– **Transfer**

    User can transfer individual Lot number to another address. User will see own address from which Lot number is transferred (Transfer from), and need to enter new address to which Lot number is being transferred (Transfer to). User also needs to choose from dropdown menu role of new address to which this Lot number is transferred. After selecting Save, user needs to pay transaction for writing data to blockchain. After Lot number is transferred to another address, user can't add new data to this Lot number (add new parameters, transfer it), but can read existing data (History, Lot No., search data about parameters).

Note:

There are two buttons for transferring Lot numbers:
1. Button "Transfer" on the end of the Lot number row is used for transferring this specific Lot number to another address.
2. Button "TRANSFER" on the top of the page is used for transferring one or more Lot numbers to another (same) address.

User can also use buttons "NEW LOT", "TRANSFER" and "END LOT".

Button "**NEW LOT**" allows user to add new Lot number for specific product. Selecting button "NEW LOT", new pop-up window will appear. Field names and descriptions in this window are as follows:

– **Product**

    User can choose from dropdown menu product for specific Lot number.

– **Location**

    User can choose location from dropdown menu on which specific Lot number is located.

– **Station**

    User can add station (which is part of the location) on which specific Lot number is located. One location can have multiple stations, and one station can have multiple lot numbers. Brief explanation is presented on picture:

Location

Station 1   Station 2

Lot 1.1.   Lot 2.1.

Lot 1.2.   Lot 2.2.
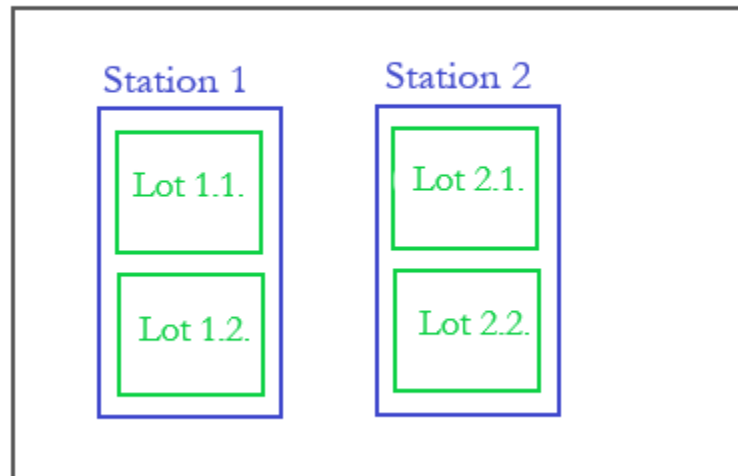
Picture 1. Differences between Location, station and Lot number

- **Year**

    Current year in which Lot number is created. This field is read only, can't be changed.

- **Start Date**

    User can add start date and time when Lot number is created. It can be current date and time, and date and time in past, but it cannot be date in future.

- **Lot number**

    User can choose to use default predefined Lot number (format YYYY-ProductID-LocationCode- yyyyMMddHHmmssfff) or can create own and enter it in the field.

User can save data selecting button "Save" or disregarding data selecting button "Cancel":

- If user selects button "Save", wallet extension will show pop up window with details about transaction and buttons to reject transaction (button "Reject") or confirm transaction (button "Confirm").

    - If user selects "Confirm" on pop up window, transaction will be processed if user have enough cryptocurrency in wallet. If user don't have enough cryptocurrency in wallet, message will appear with information that transaction is rejected and to check users wallet. If user have enough cryptocurrency in wallet, transaction will be processed, and message will appear confirming that transaction was successful and data is saved on blockchain. Lot number will be created.

    - If user selects "Reject" on pop up window, message will appear with information that transaction is rejected and to check users wallet. Lot number won't be created.

- If user selects button "Cancel", pop up window will close and all entered data will be deleted. Lot number won't be created.

Button "**TRANSFER"** allows user to transfer multiple Lot number to another address (the address must be the same). User selects Lot numbers which want to transfer by clicking on checkbox in front of the row of Lot number and then selects button "TRANSFER". Selecting button

"TRANSFER", new pop-up window will appear. Field names and descriptions in this window are as follows:

–   **Lot Numbers**
    User will see all selected Lot numbers that will be transferred.
–   **Transfer from**
    User will see own address from which Lot number will be transferred
–   **Transfer to**
    User will need to enter new address to which Lot numbers will be transferred
–   **Choose the role**
    User needs to choose from dropdown menu role of new address to which Lot numbers will be transferred.

User can save data selecting button "Save" or disregarding data selecting button "Cancel":

–   If user selects button "Save", wallet extension will show pop up window with details about transaction and buttons to reject transaction (button Reject) or confirm transaction (button Confirm).
    –   If user selects "Confirm" on pop up window, transaction will be processed if user have enough cryptocurrency in wallet. If user don't have enough cryptocurrency in wallet, message will appear with information that transaction is rejected and to check users wallet. If user have enough cryptocurrency in wallet, transaction will be processed, and message will appear confirming that transaction was successful and data is saved on blockchain. Lot numbers will be transferred.
    –   If user selects "Reject" on pop up window, message will appear with information that transaction is rejected and to check users wallet. Lot numbers won't be transferred.
–   If user selects button "Cancel", pop up window will close and all entered data will be deleted. Lot numbers won't be transferred.

Button "**END LOT**" allows user to put end date to selected Lot number(s). Even though End date is automatically added to Lot numbers during transfer to another address, sometimes it will be necessary to manually add End date (e.g., product is sold; something happened to product during production, transport; product expired...).

User selects Lot numbers which wants to end by clicking on checkbox in front of the row of Lot number and then selects button "END LOT". Selecting button "END LOT", wallet extension will show pop up window with details about transaction and buttons to reject transaction (button "Reject") or confirm transaction (button "Confirm").

   –   If user selects "Confirm" on pop up window, transaction will be processed if user have enough cryptocurrency in wallet. If user don't have enough cryptocurrency in wallet, message will appear with information that transaction is rejected and to check users wallet. If user have enough cryptocurrency in wallet, transaction will be processed, and message will appear confirming that transaction was successful and data is saved on blockchain. Lot numbers will be ended.
   –   If user selects "Reject" on pop up window, message will appear with information that transaction is rejected and to check users wallet. Lot numbers won't be ended.

6.3. BUSINESS PROCESS

– Filling Self-assessment tool. Based on output start to use web tool for stakeholders
– Register/login to web with digital identity
– Start filling data into web site tool for stakeholders – add lot number for specific product
– Start filling data into web site tool for stakeholders – add parameters for specific lot number
– Check if communication hub will automatically receive input data and write them to blockchain and publish them on web
– After current phase is finished, send lot number to next organization in supply chain
– Repeat this for all stages of product lifecycle

7. API INTERFACE

API interface is developed for stakeholders that have their own IT system in place where they'll send their production lifecycle or supply chain data through API to communication hub which is automatically published on web and written in blockchain.

API interface is available via Users Smart Contract (described in <u>5. Communication Hub</u>) deployed address.

There are two ways of accessing Users Smart Contract:
1. By web implementation
2. By backend implementation

Technical details about how to connect existing system to this system are described in DFTB - Implementation documentation.

7.1. BUSINESS PROCESS
- Filling Self-assessment tool. Based on output start to integrate API interface for stakeholders
- Check status for communication hub for collecting data with automatic integration to web site and blockchain
- Start filling data into own digital system
- Send them automatically using API interface for stakeholders to communication hub
- Check if communication hub will automatically receive data form API interface and write them to blockchain and publish them on web
- Repeat this for all stages of product lifecycle

8. WEB SITE FOR CONSUMERS

Web site for consumers gives consumer tool to search by the lot number and find all relevant information about production and supply chain of specific food they are buying. They can also search the web by products and by producers and check which products or producers are on web.

8.1. WEB SITE INTERFACE

Consumer can check parameters for specific Lot number, check which products are traced and check which producers are tracing their products.

To be able to do any of that, user needs to visit https://www.foodqualitrace.com first. On Home page, user needs to select button "Read more" under Lab section. Lab section is developed to show how system works in test environment

8.1.1. Check Lot number

User can check specific Lot number in two ways:
- By visiting https://www.foodqualitrace.com/ (Lab section), entering Lot number from product and selecting Search.
- By scanning QR code from product.

In both ways, user will be redirected on page with representation of product parameters for this specific Lot number during different stages of production and supply chain. User will see information about organizations that handled product, what parameters were measured and when, values of those parameters, testing results (if there are health check tests), start date/end date for each phase. User will also see information about optimal values for each measured parameter.

8.1.2. Check Products

User can check which products are traced. By visiting https://www.foodqualitrace.com/ (Lab section), user needs to select button "Search" bellow Products. All products that are traced (meaning that at least one Lot number is registered for that product) will be shown. Selecting one of the products, user will see information where this product is produced and who is producing it.

8.1.3. Check Organizations

User can check which organization are tracing their products. By visiting https://www.foodqualitrace.com/ (Lab section), user needs to select button "Search" bellow Producers. All organizations that are tracing products (meaning that they have at least one Lot number registered), no matter the role, will be shown. Selecting one of the organizations, user will see information about this organization – organization role in supply chain and which products they are handling, organization name, email address (if available), short description of organization.

8.2. BUSINESS PROCESS:

– Check products by scanning code. Check if all input data in the previous steps is displayed
– Check products by going to web site and search by lot number. Check if all input data in the previous steps is displayed
– Check products by going to web site for consumers and search by product and by the lot number. Check if all input data in the previous steps is displayed
– Check products by going to web site for consumers and search by producer and by the lot number. Check if all input data in the previous steps is displayed

9. LAB FACILITIES

Lab facilities are built to enable DIHs to independently offer Proof of concept digital service based on Technology Road Map. Lab facilities enable DIHs to perform all Proof of Concept for its stakeholders using easy to use web interfaces and API simulation interfaces in test environment.
Lab facilities consist of following elements in testing environment:
  – Self-assessment tool
  – Communication hub
  – Web site tool for stakeholders
  – API interface and simulator for testing API interface
  – Web site for consumers
  – Administrative console
  – Smoke tests for testing availability of all modules

Self-assessment tool is described in 4. Self-assessment tool
Communication hub is described in 5. Communication hub
Web site tool for stakeholders is described in 6. Web site tool for stakeholders
API interface and simulator for testing API interface is described in 7. API interface
Web site for consumers is described in 8. Web site for consumers
Administrative console is described in 6.2.3. Lot data

9.1. SMOKE TESTS

Smoke tests are subset of test cases that cover the most important functionality of a component or system, used to aid assessment of whether main functions of the software appear to work correctly. In other words, smoke tests are used for testing availability of modules.

In this case, smoke test is done by sending method getProductsInfo (described in 5.2.1. Admin Smart Contract). If response is received, system is up and running, but if response is empty, then something isn't working in the system.

10. CODE LISTS

List of Code lists used in this project

10.1. PRODUCT CODE LIST

This list includes list of products with product IDs, products parameters, optimal values, etc. in accordance with users' roles.

10.2. LOCATION CODE LIST

This list includes list of location code list.