D3.2 - Report on database and software design

Version 3

Zhipeng Wu (UM), Lizong Zhang (UM), Alberto González de Zárate (AZTI) ,
Begoña Perez Villarreal(ATZI), Idoia Olabarrieta (AZTI), Ásgeir Ásgeirsson (Marel) and John Gray (UM),
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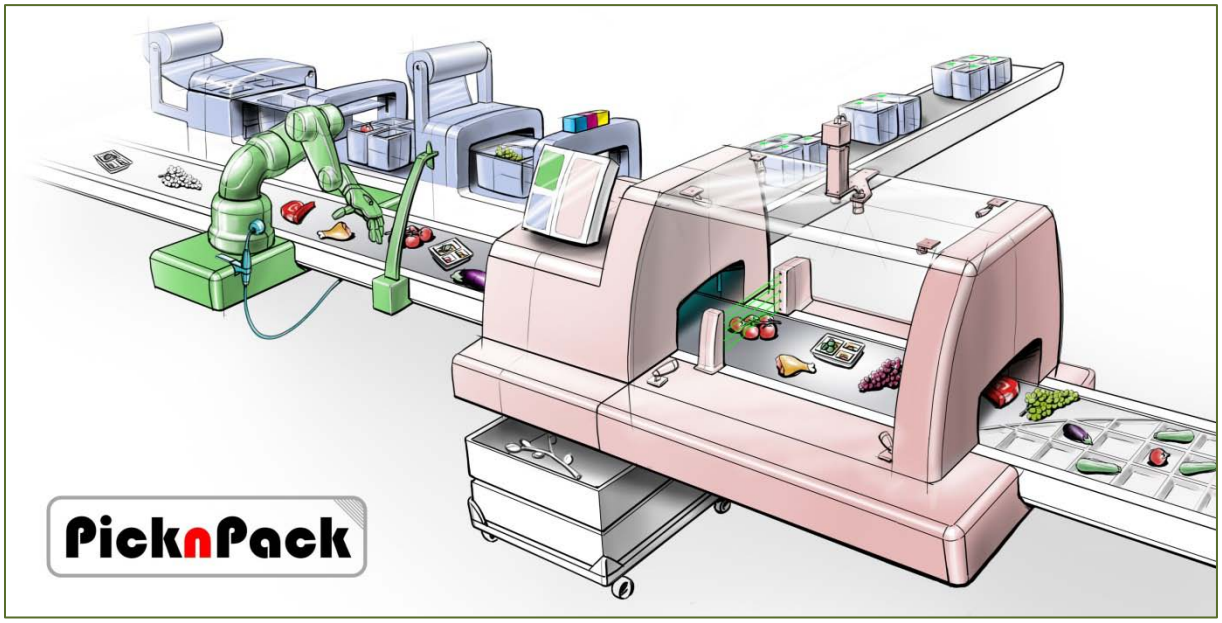

Flexible robotic systems for automated adaptive packaging of fresh and processed food products

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Dissemination level		
PU	Public	X
PR	Restricted to other programme participants (including the EC Services)	
RE	Restricted to a group specified by the consortium (including the EC Services)	
CO	Confidential, only for members of the consortium (including the EC Services)	

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1 Introduction

This document outlines the progress of the traceability system design for WP3 including the system framework design, software application design and database structure and in particular the completion of the tasks defined in the WP 3.1 and WP 3.2:

- Task3.1: Identification of Traceable Information
  - Define the breadth, depth and precision of the traceable parameters.
  - Set up specifications for the traceable information through the packaging process.
  - Assess regulations and commercial practices for the food chains.
  - Assign ID numbers, codes and ranges.
  - Prioritize the traceable parameters.
  - Highlight key parameters for process automation.
- Task3.2: Development of Database and Software for Intelligent Production
  - Design the database with the consideration of traceable parameters in Task 1 and software architecture in WP2.
  - Construct database with extensive traceable information.
  - Develop a user-friendly software program for database management.
  - Interface the software with RFID systems and senor module in WP4.

Two milestones have been achieved to-date and they are discussed in this report:

- M3.1: Database establishment (M6)

A database for PickNPack traceability has been established with SQL Server 2008 having a good number of data tables to store the package and logistical information.

- M3.2: Software development (M12)

A software application for traceability purpose has been developed. This application records data from production lines and stores them to a central traceability database, and it is able to trace information when needed.

Further details are given in the following sections.

2 Initial Design of the proposed traceability system

2.1 The Requirements of the proposed system

The traceability system is designed with the following requirements:

- The system is designed for a packaging factory, and is required to manage certain data generated at various packaging stages from raw materials to food packaging and delivery.
- The system design focuses on the traceability on “one step backward and one step forward” which is required by the EU regulations.

- The traceability function is implemented based on ID numbers assigned to packages or products uniquely. They can then be identified and recognised by the system.
- The system is able to trace back all related information of the products from their ID numbers.
- The system is able to monitor packaging processes in the production line.
- The system provides query/search functions for product traceability.

2.2 Related Traceability, Labelling and Identification Requirements from Law/Requirements.

2.2.1 Traceability Regulation

There is one EU regulation (Regulation 178/2002) that outlines the general principles of food law. Article 18 requires that from the 1st of January 2005 all food businesses must have in place a traceability system. The legal minimum is "a system in which a food business records what ingredients / food products it receives and from who (include contact details) together with what product it dispatches to which customers (include their details) with the only exception being direct supply to final consumers "[1].

To clarify, the legislation only requires the food industry company "to know that a certain product went to a certain customer(s). It is not necessary in law to trace to the batch level." An example given on the explanation documents [2] of 178/2002 illustrates the minimal requirement: "supplier "A" supplied ingredient named "X" and that product named "Y" was sent to customer B." – which is a product level trace. There is no batch/lot or even individual package traceability requirement on the legislation. However, "in the event of a recall all products with that name would have to be recalled."[3]

To sum up, the legislation states that:

0) Only product level traceability is required.
1) Batch/Lot level and individual product Level traceability is not a compulsory requirement.
2) The traceability only needs to cover "one step backward and one step forward", which is called "one-up-one-down system".

An extensive review on legal requirements and voluntary standards for traceability of fruit, vegetables and ready meals can be found in the Appendix of this report. The review serves as a guide to the traceability system design in WP3 of the project.

2.2.2 Labelling requirements

Labelling requirements indicate what information should be included on the package label, and where it should be attached to. The requirements are different for each type of products. Regulation 1182/2007 [4], 1221/2008[5] and 1580/2007[6] describe labelling requirements for fruits and vegetables; Regulation 1169/2011[7](ready meals) and Regulation 931/2011[8] (animal origin food) describe requirements for ready meals.

Some labelling requirements are summarized briefly as follows:

0) GRAPES [4-6]

   Information needs to be displayed in letters grouped on the same side, legibly and indelibly marked, and visible from the outside.

   a) Identification: The name and the address of the packer and/or the dispatcher.
   b) Nature of produce: (1) “Table Grapes”, if the contents are not visible from the outside, or (2) name of the variety or varieties, (3) “Under glass”, where applicable.
   c) Origin of produce: Country (or where applicable, countries) of origin and, optionally, district where grown, or national, regional or local place name.
   d) Commercial specifications (i.e. Class)
   e) Official control mark (optional)

1) Tomatoes [4-6]

   Information needs to be displayed in letters grouped on the same side, legibly and indelibly marked, and visible from the outside.

   a) Identification: The name and the address of the packer and/or the dispatcher.
   b) Nature of produce: (1) “tomatoes” or “trusses of tomatoes” and the commercial type, (2) Name of the variety.
   c) Origin of produce: Country of origin and, optionally, district where grown, or national, regional or local place name.
   d) Commercial specifications: (1) Class, (2) Size, (3) minimum sugar content

- Official control mark (optional)

2) Pizza [7, 8]

   a) The name of the food;
   b) The list of ingredients;
   c) Ingredient or processing aid causing allergies or intolerances
   d) The quantity of certain ingredients or categories of ingredients;
   e) The net quantity of the food;
   f) The date of minimum durability or the "use by" date;
   g) Any special storage conditions and/or conditions of use;
   h) The name or business name and address of the food business operator
   i) The country of origin or place of provenance
   j) Instructions for use where it would be difficult to make appropriate use of the food in the absence of such instructions;
   k) A nutrition declaration (It shall apply from 13 December 2016).

2.2.3 The Issues

Three examples above illustrate that different sets of attributes are needed for different types of products. Consequently, a method for handling multiple sets of product attributes is introduced. The user can dynamically assign any number of attributes to a product type. The details are to be discussed in Section 3.2.2.

2.3 The System Data Process Model

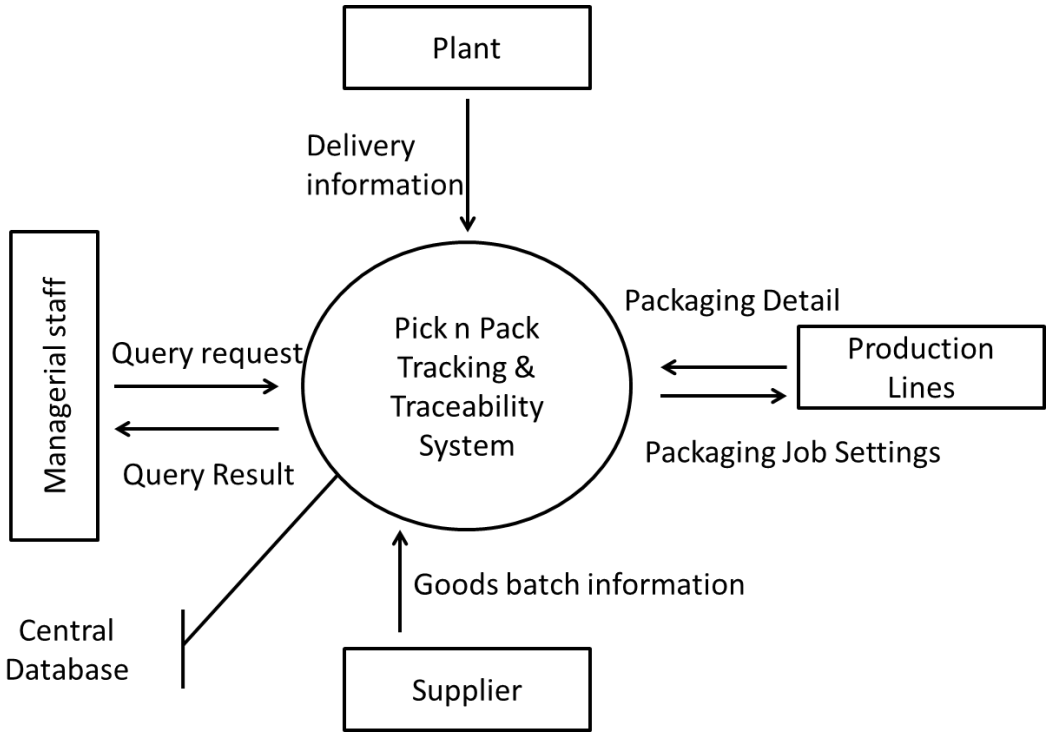


Figure 1 - The data process model

The data process model of the proposed system is illustrated on Figure 1. There are four major data providers: Managerial staff (or the users) issue query commands and receive query results; Customers and Supplier provide source material (ingredients) and delivery information; Production lines are instructed with settings from the system and information from the production lines are registered to provide packaging details for packed products. The proposed system has a central database where the collected information is stored.

2.4 The Traceability Information and the Information Chain

In order to meet the compulsory requirements of labelling and traceability, the traceability information needs to be clarified first, which is then followed by the information chain and traceability method development.

2.4.1 Traceability Information

This section identifies the necessary information for the purpose of traceability, which will be collected and managed by the proposed system. The types of information needed are described as follows:

0) Suppliers

The needed Supplier information includes:

(1)Supplier Name, (2) Address or Location, (3) GLN (Global Location Number), (4) Contract Information (optional), (5) Contact Information.

The information of supplier enables the system could trace back the original source provider of a certain product or ingratiates.

1) Incoming goods Batch/Lot

   Incoming goods are managed by 'Batches' or 'Lots' numbers. This allows the system to track the ingredients to the batch level. The information needed includes:

   (1) Good batch GTIN (Global Trade Item Number), (2) Arrival timestamp, (3) Product name, (4) Product attributes, (5) Supplier, (6) SSCC code (Serial Shipping Container Code), (7) Arrival location (factory) and Its GTIN .

2) Production lines and factory

   The information describes the factory and production line location, ID and other information. It is used for indicating the product packaging location and product receiving/dispatching locations. The information includes:
   (1) Factory name, (2) Address, (3) Factory contact information, (4) GLN, (5) ID number or name.

3) Packaging

   During the package process, package records are generated for each individual package, which allows the system tracing back the source information for certain packages or batches. The following information needs to be recorded:
   (1) Package batch/lot number, (2) Production line / Factory, (3) Operator, (4) Ingratiates list, (5) process list, (6) Source material information, (7) IDs assigned to each individual package (8) Timestamp.

4) Product attributes, for both incoming ingredients product and output products

   Product attribute information is needed for both incoming source material and outgoing product. The system design allows the attributes can be assigned by users during the system operation.

5) Containers

   Containers are used to store for source material or packaged products in the factory, and their information needs to be managed by the system. The information includes: (1) Container capacity, (2) Name or ID, (3) Type of container.

6) Individual output(packaged) products

   Individual product information includes: (1) Product type, (2) Timestamp, (3) Package batch/lot number, (4) A unique ID.
   The individual product information is linked to the production line and job batch/lot number. This enables the item level traceability.

7) Customers

   The customer is considered to be the retailer for PickNpack, not the end users. The information includes: (1) Customer name, (2) GLN, (3) Address, (4) Contact information, and (5) First register timestamp.

8) Delivery

Delivery information includes: (1) Source, (2) Customer, (3) Delivery timestamp.
The delivery information in the database is the record of dispatch activities. The database is not designed for order management.

2.4.2 RFID and Barcode

The proposed traceability system is designed to work with RFID system, but it also supports the use of barcode only or both.

Barcode number is designed to be related to the following: container ID, packed product batch number, SSCC number, GTIN number and GLN number.

The RFID tag, because of the pre-defined unique number of each tag, can enable item level traceability by attaching it to each packaged product. It can also be used for tagging containers, incoming materials and outgoing logistical units.

The proposed traceability system allows the user to decide which labelling system they would like to use. RFID and barcode implementations are both optional for internal procedures. But enabling of RFID system could provide additional information and a means for fast tracing and tracking.

2.4.3 Information Chain

A traceability system could cover a complete supply chain. However, not all owners in each traceability step are willing to share their traceable information. Therefore, the traceability system is only focused on the stages from the source material arriving at the factory to the packed products dispatched.

The information chain design is to follow the GS1 Guidance. GS1 is the parent organisation of EPCglobal who developed the most popular RFID standards- EPC G2C1 and ISO 18000-6 [9].

To accomplish the requirements from the GS1 guidance, the following registers need to be made [9]:

0) SSCC - Serial Shipping Container Code: This is used on both received raw materials and dispatched products. It is a world-wide unique code for marking each individual unit.
1) GTIN - Global Trade Item Number: This code can be understood as the product type ID as each type of product has one GTIN code. It is also a world-wide unique code, and it is usually displayed with the lot number on a label.
2) GLN - Global Location Number: This is a unique number for location/ place/ company/ factory/warehouse etc.
3) Lot Number or Batch ID: This code is not a world-wide unique code. It is assigned by the packaging company or product handler/packer, which links to their internal records. This is currently an important ID that enables traceability without RFID.

If RFID technology is applied, each individual packaged product will be assigned a unique ID for traceability in addition to barcode and batch/lot numbers.

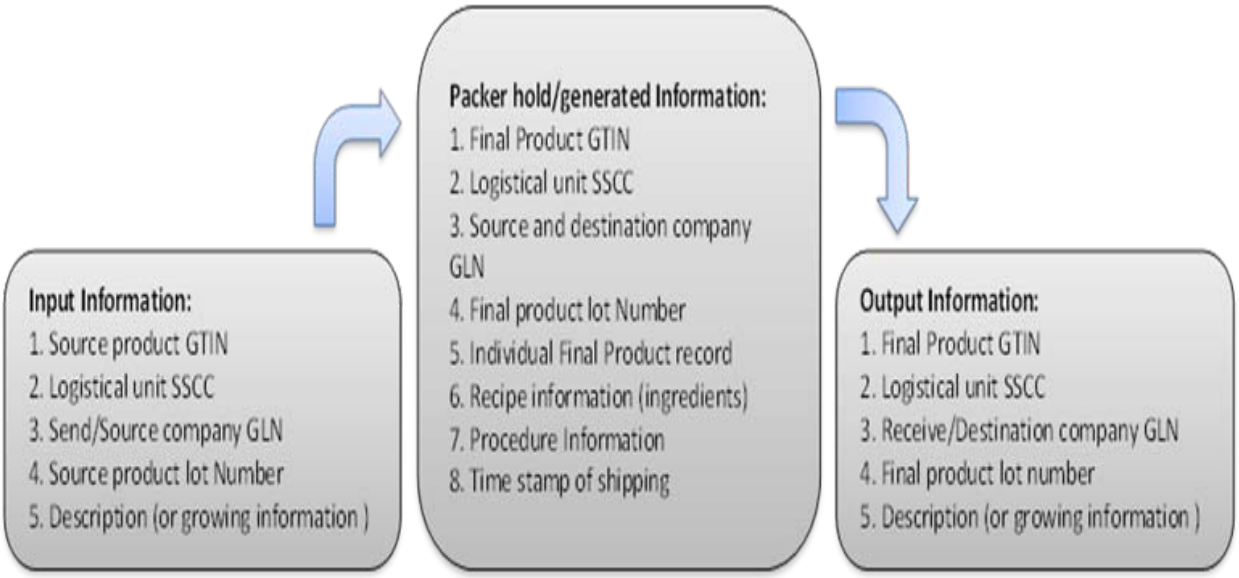


Figure 2 - Information chain of one-step forward and one-step backward

The one-step forward and one-step backward information chain is illustrated in Figure 2 where:

0) Input Information: The source product information is provided by the suppliers. The source material information needs at least to include the GTIN, SSCC, GLN and Lot Number. These four pieces of information help the traceability system to locate the product at the batch level.
1) Packaging Information: The package information can be obtained from RFID equipment/ barcode reader. A new GTIN number is assigned to each type of final product and new SSCC number is given to the logistical unit before despatching. The attributes about the product, such as ingredients and processes are stored into database. Some of them could be printed on to the labels on the package or shared with the customer in the next supply chain.
2) Output Information: The final packed products are grouped as logistical units, and share related information when a shipping task is created. The GTIN, SSCC, GLN code are required to be passed on to with the customer in the next supply chain.

EU regulations require the product content information and logistical information to be shared with the customer in the next supply chain. Thus SSCC, GLN and GTIN numbers are provided. In the GS1 guidance, the batch/lot number is also suggested to be provided to the customer.

2.5 Data Collections and Management

The proposed system is designed to incorporate both RFID technology and barcode with any one or both of them being optional. Not all data in the system can be taken automatically. Some types of data have to be manually inputted, such as the basic information about the suppliers and products. Therefore, the system data collections are from (1) manual inputs or (2) RFID/barcode equipment. The details are given as follows:

0) Manually inputted data/information

- Supplier information
- Customer Information
- Packaging batch information
- Basic information of internal and external containers (e.g. capacity, type, etc.)
- Basic information of factory and production line (e.g. location)
- Attributes for products (e.g. colour, quality, name, etc.)

1) Automatically collected data/information

- Usage of internal and external containers
- Production information from production line (including procedures & their implementation)
- Logistical unit arrival and dispatch information
- Inventory Information

2.6 System Working Environment and Service Process

At present, the system application and database are designed to run in a central server with internet access. Major processes of the system are listed below:

- The supplier provides a batch of food product, i.e. grapes. The supplier and batch information is recorded by the system with a time stamp. Factory staff needs to register the goods into the system with a proper product type.
- The batch of grapes (for example) arrives at the factory. It may be in one or multiple containers which are referred to as 'internal containers'. An RFID tag or barcode may be applied to them. The system is required to identify each individual container in order to trace back to the goods batch and the supplier.
- Grapes are then picked and packed on the production line from the internal containers. It may go through several procedures, such as cutting, weighing, inspecting. The procedure list is pre-assigned by the operator, and the information is registered in the system.
- Packed grapes are then put into crates, which are referred to as 'external containers'. The 'external containers' are also assigned with traceable ID numbers.
- External containers are then packed as 'logistical units', and to be sent to customers.

The service processes are illustrated in Figure 3 :

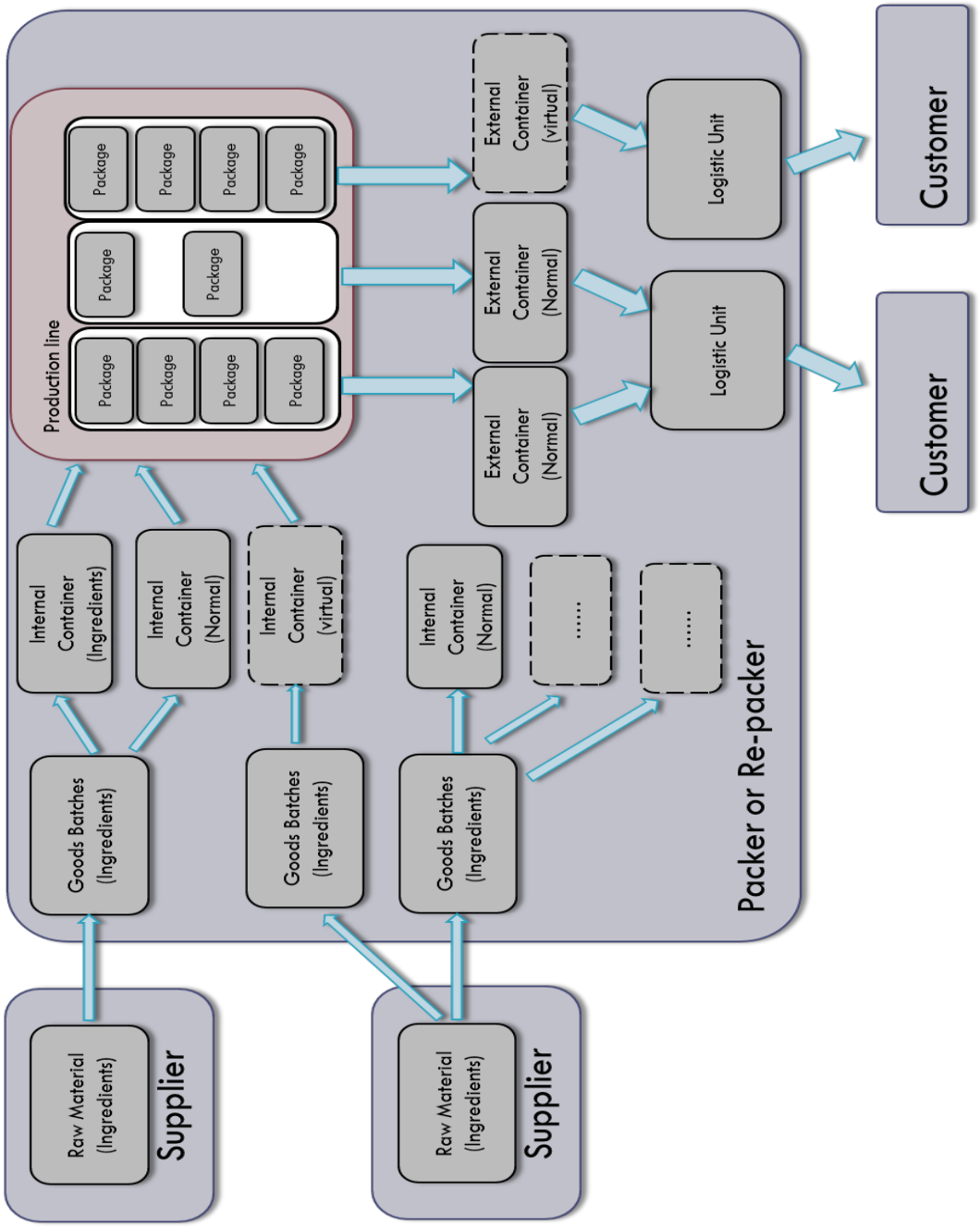


Figure 3 – Illustration of service processes

3 Database Design

This section outlines the design of the traceability database for WP3. The system has a traceability central database which provides support to the entire system. It contains all logistical data, identification number, product, supplier and customer information, etc. The database have a good number of data tables (est. over 30 data tables) to store the information mentioned in the sections above.

3.1 Database Development

The traceability system has a central database used for recording the information of:

(1) Suppliers
(2) Goods supplied & ID codes
(3) Production line processes: methods and procedures
(4) Links to process databases
(5) Product parameters: product type, weight, price, ID codes and others
(6) Labelling details
(7) Customers and delivery
(8) Time stamp at various stages

The traceability central database is to be built using SQL server 2008, as it has an advantage of handling structured data. The selection of SQL for database development was concluded at the May meeting in Iceland.

3.2 Database Structure

The first step to design the database is to address the data entities involved in the information chain and their relationships, in order to identify the necessary data table as well as their 'Foreign key' and 'Primary key'.

This section describes the design of four most important parts of the database: "Product category and type", "Product attributes and values", "Packaging job" and the "Utilization of RFID and barcode".

3.2.1 Product Category and Product Type

The design introduces two concepts to describe the goods: "Product Category" and "Product Type".

"Product Category" describes a group of products that have same attributes but have different attributes values. "Products Type" describes a group of products that have the same parameter set and the same parameter values.

"Product Category" and "Product Type" are both applied to the incoming goods batches and packed l products. Figure 4 illustrates the relationship between the product category and product type, where the relations may be 1 to 1 or 1 to N (multiple).

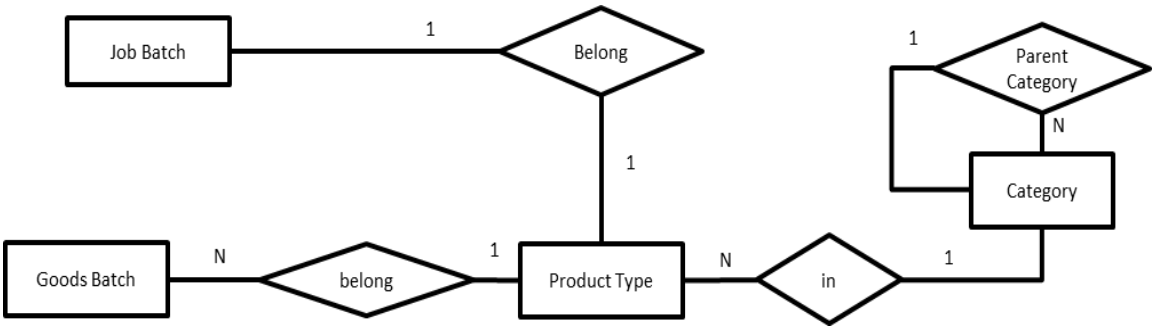


Figure 4 - Relationship of product category and product type

The "Job Batch" is an entity that stores the production line setting details for a packaging batch, and "Product Type" is used to describe the product being packed; The "Goods Batch" entity stores information of incoming materials, which are passed onto the packed product, and a goods batch belongs to a product type. The entity 'Category' is the product category. There may be multiple product types in a category. This entity follows a multi-level structure, with a column named 'Parent Category' indicates its upper level category.

3.2.2 Product Attributes and Values

As discussed previous in Section 2.2.3, the products and ingredients managed by the proposed system may have different attributes. At this initial stage, the system may handle three type of product (grapes, tomato and pizza). A simplest way is to create one data table for one product. However, this solution will not be the best option if there are more than 10 different types of product in the system.

Consequently, the central database adopts a solution to manage the product attributes, which is referred to as 'Entity-Attribute-Value (EAV) model'. This can provide dynamic attributes for each product types and categories, and can handle many types of products.

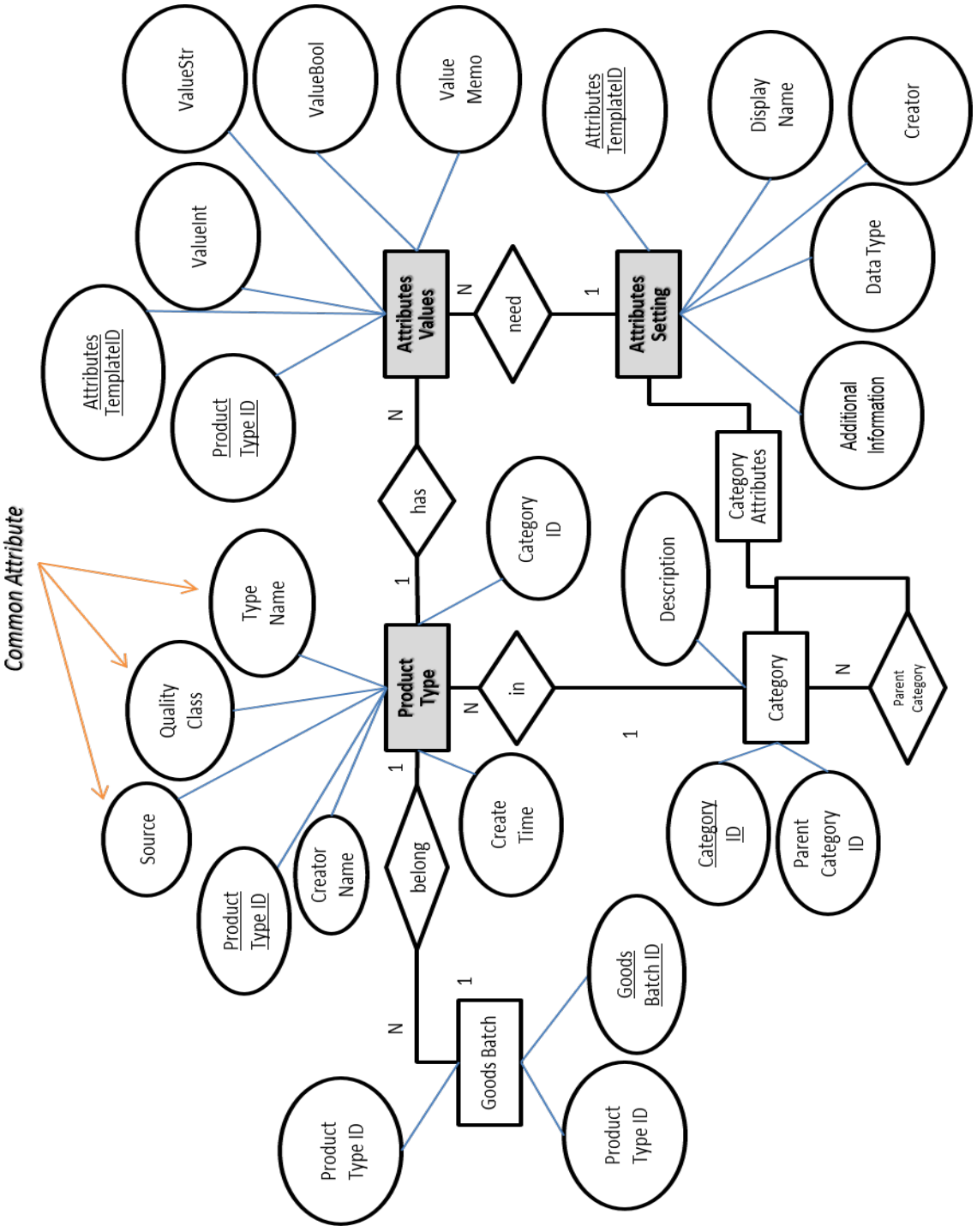


Figure 5 - Entity-Attribute-Value model for managing product attributes

Figure 5 illustrates the EAV model method for the product attribute management. An entity (data table) named “Attributes Setting” used for storing basic information about the attributes, such as the name of the attributes, description, and value range etc. The attribute values are stored in the ‘Product Attribute Values’ data table, where attributes and products are linked with the assigned

values, each product has multiple records rows in this table and stored in a structure of 'Product Type ID – Attributes ID - Value', where the "Product Type ID" and "Attributes ID" are primary keys.

This design enables the user to define a new attribute, create new product type, and assign new attributes/values to a product type.

3.2.3 Packaging Job

The packing job information is for each individual packing, grouped by 'batch/lots'. Figure 6 shows the major part of the database design which is based on the information relating to four questions: "where, when, how and what", i.e. Where – packaging location (Production line information), When – timestamp of packaging, How- processes implemented, and 'What' – the ingredients in the package.

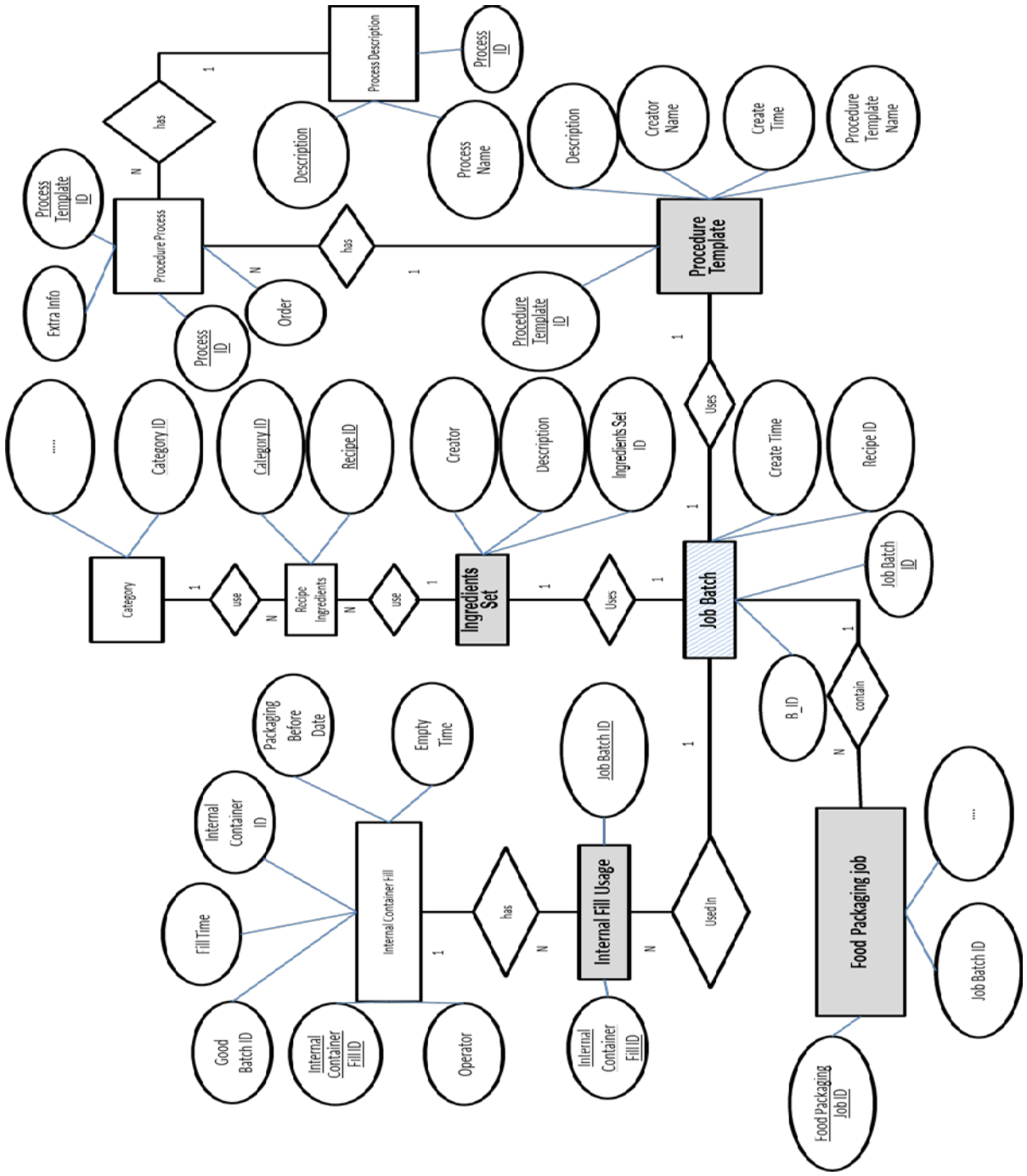


Figure 6 - Entities for packaging Job

Consequently, as Figure 6 illustrated, the major entity is the 'Job Batch' that records the settings and details for a group of products in the same batch; 'Procedure Template' stores a list of process of packaging job; 'Ingredients Set' indicates the ingredients (based on category) of a batch; 'Internal Fill Usage' records the actually used ingredients (the source material); 'Food Packaging Job' is the record for each individual job, which enables the item level identification.

3.2.4 RFID Technology and Barcode

The proposed system is designed for using RFID Technology but it also can use with or only Barcode. Barcode can be converted directly from the IDs that already used in the system, such as SSCC number, GTIN number and/or GLN number, etc. The RFID tag, as the pre-defined unique number in it, they could enable item level traceability by attaching them to each product package. It can also be used for tagging containers for output or input products.

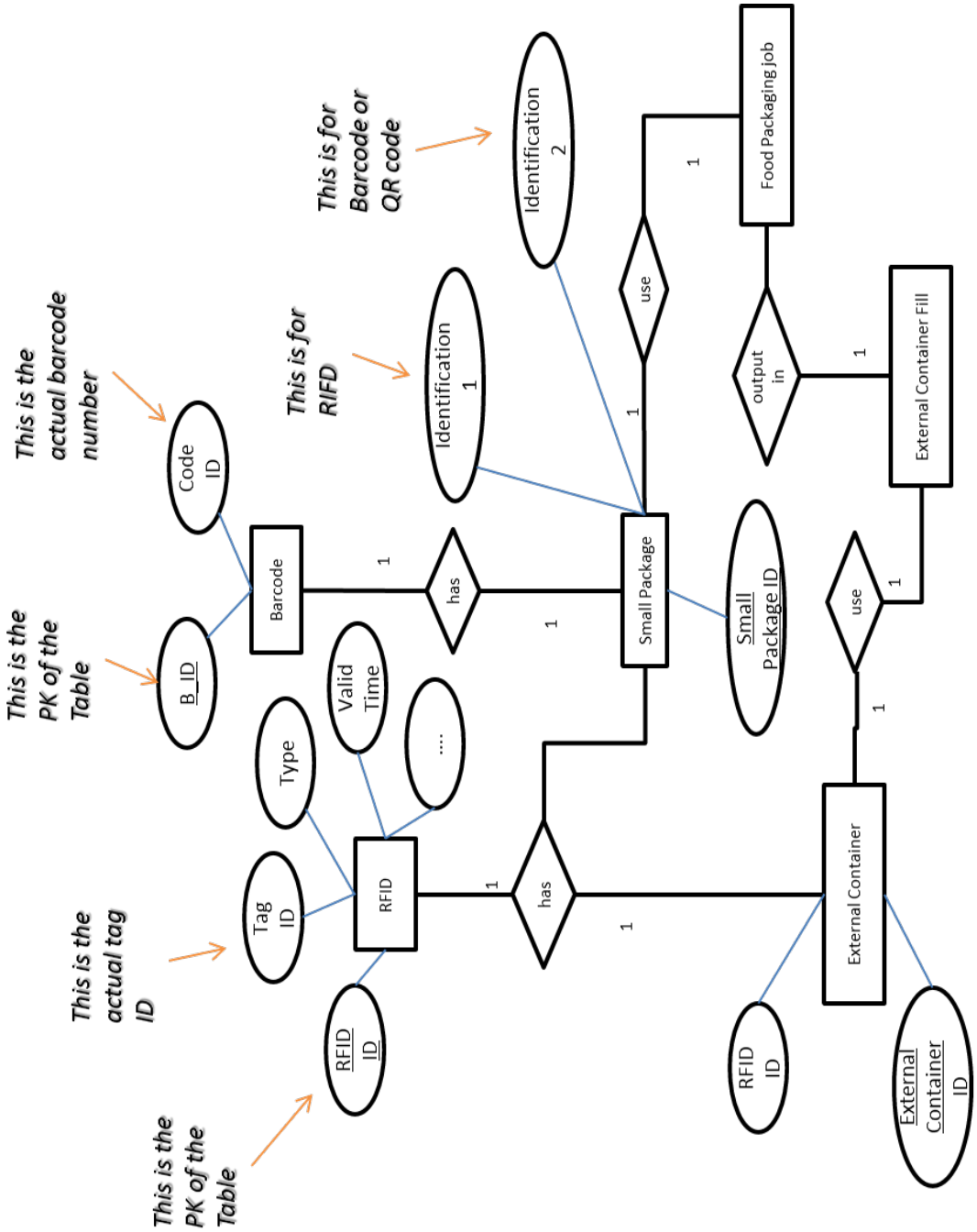


Figure 7 - The usage of barcode and RFID technology

Figure 7 shows the usage of barcode and RFID for individual packages of final products. The 'Small Package' data table reserves two column named 'Identification1' and 'Identification 2' for RFID and barcode. The 'External Container' and 'External Container' data table also reserve two columns for RFID and barcode.

This structure allows users to choose between RFID and barcode.

3.3 Entity–Relationship Model

The Entity-Relationship Model (ER Model) of the traceability central database is shown on Figure 8. The database contains 28 data tables. It covers all necessary data for traceability purpose, and it enables the item level traceability (if RFID technology has applied). The information that the database records includes: (1) Suppliers, (2) Incoming goods supplied, (3) Production line processes: ingredients and procedures, (4) Product attributes, applied both to incoming goods and outgoing packaged products, (5) Labelling details, (6) Customers and delivery, (7) Time stamp at various stages.

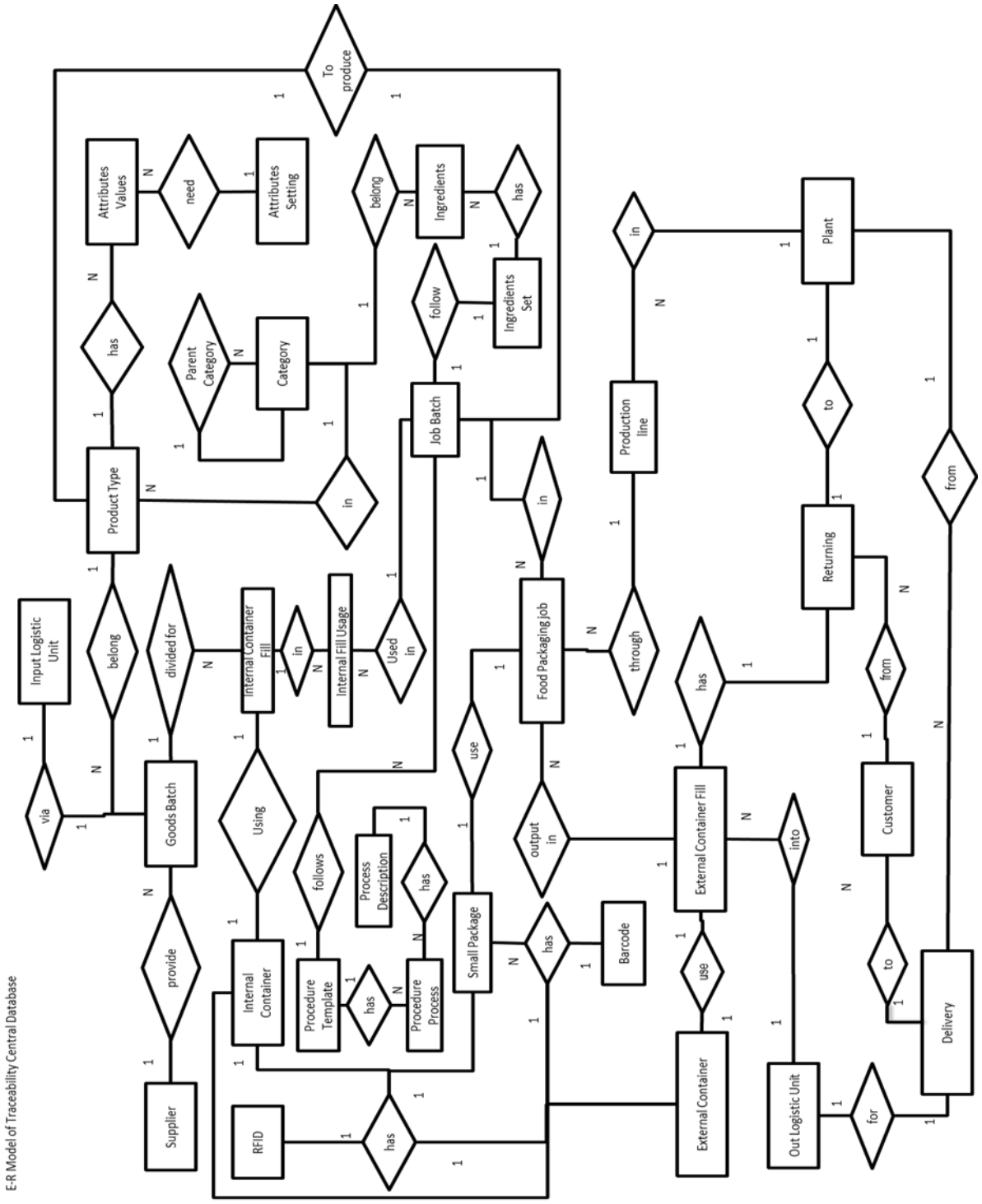


Figure 8 - Entity-Relationship model

3.4 Database Implementation

The implementation of the database uses SQL Server 2008, There are 28 data tables in the database with more than 50 stored procedures and triggers. The overall structure is shown on Figure 9. Some key data tables are listed in this section as examples.

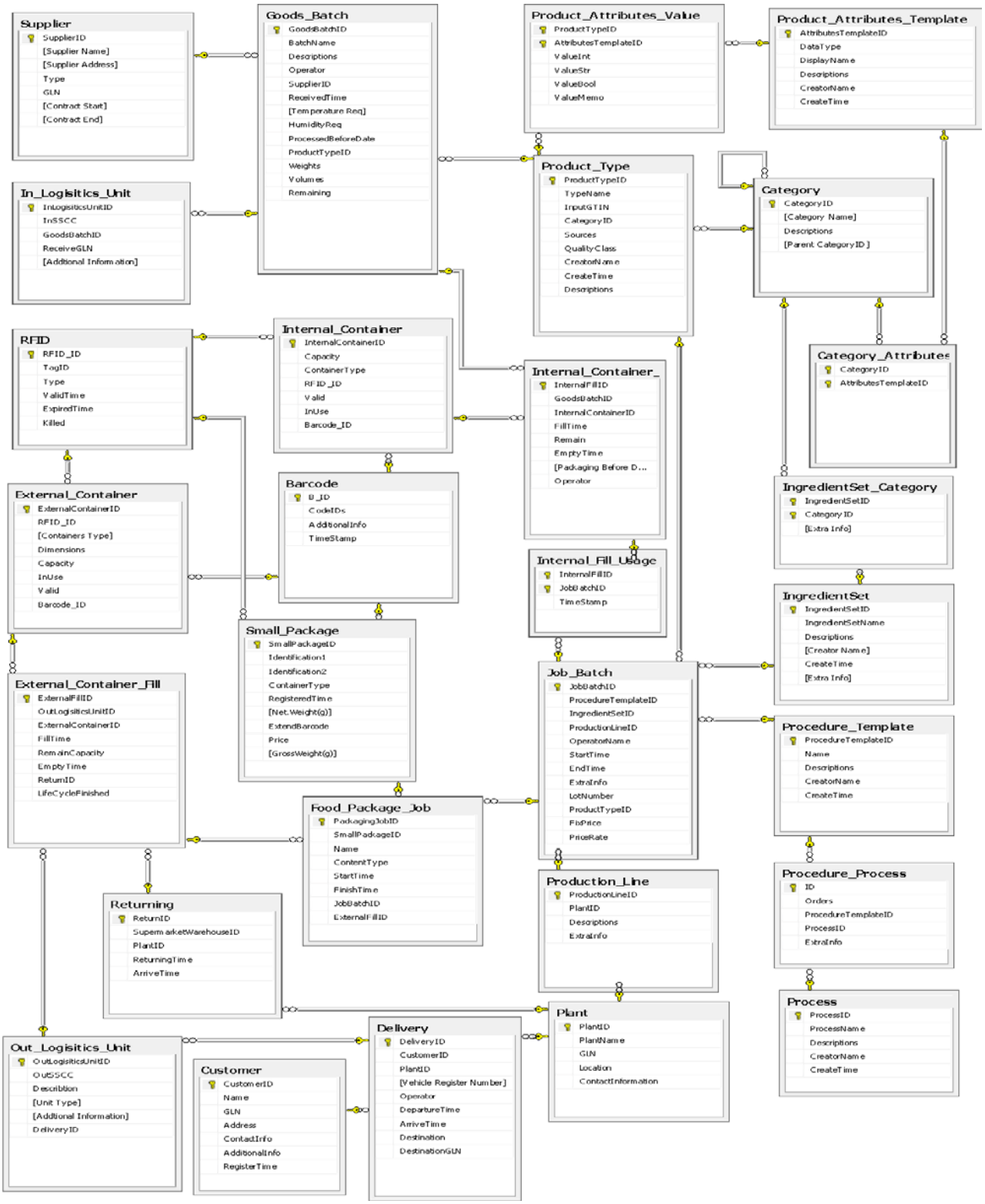


Figure 9 - The implementation of database

4 Software Application Design

4.1 Aim of the Proposed Design

The proposed design aims at integrating system's hardware and software components together to enable the traceability functions. Consequently, the following objectives of the software application are to be conducted:

- To develop a module for monitoring the production line operation;
- To develop a module for recording and managing the packaged product information
- To develop a module for tracking and tracing the product and ingredient information by Batch/Lot number barcode and/or RFID tag;
- To develop a module for managing labelling information.
- To provide HUI (Human User Interface) for the proposed system.

4.2 System Function Design

In order to accomplish the aim and objectives above, system's functions need to be designed. These functions are described as follows

- Database management
  - The software application is required to connect the central database to query data and to update records.
  - A module for handling SQL server connection is developed.
- Controlling RFID and/or barcode hardware
  - RIFD system and barcode hardware need to be controlled by the system.
  - The hardware module is able to receive data from RFID readers and barcode readers.
- Monitoring the production lines
  - The system monitors the production line through RFID and/or barcode readers.
  - The source material and product package on the production line can be scanned by the readers as required.
  - The data can then be processed by the application module and they are inputted to database for record.
- Retrieving product details and related information
  - This is a major representation of traceability of the system.
  - Product details include source material information, production information and packaging information.
  - The retrieving function is based on provided IDs, which could be (1) RFID tag number or barcode number of final package product, (2) Packaging batch/lot number, and/or (3) The IDs of containers in the factory.
  - The IDs can be provided by RFID/Barcode reader or manually inputted by the user.
- Recording the incoming material
  - Incoming goods (source material) information is registered into the system.

- The records are manually inputted by operational staff if the suppliers do not provide them electronically.

- Recording the utilization of containers
  - There are two types of containers used in the factory, one for incoming goods, and another for packaged products.
  - The usages of the containers are recorded by RFID/barcode.
- Recording the products dispatches from factory
  - Dispatching information is required by the EU regulation.
  - Dispatching information is recorded manually, but could be automatically recorded if RFID tags are applied.
  - The information recorded at the stage of the packaged products is passed on to the customer.
- Managing other necessary information/data
  - The information includes RFID numbers, factory information, supplier information, container information and customer information.
  - They are registered into the system manually.
  - The information can be updated at any time.

4.3 System Structure and Work Environment

The software is currently designed for a single production line, but it can be extended to multiple lines. The system structure is shown in Figure 10.

The traceability central database stores all records of the system. When a query is made, the information is retrieved from the central database.

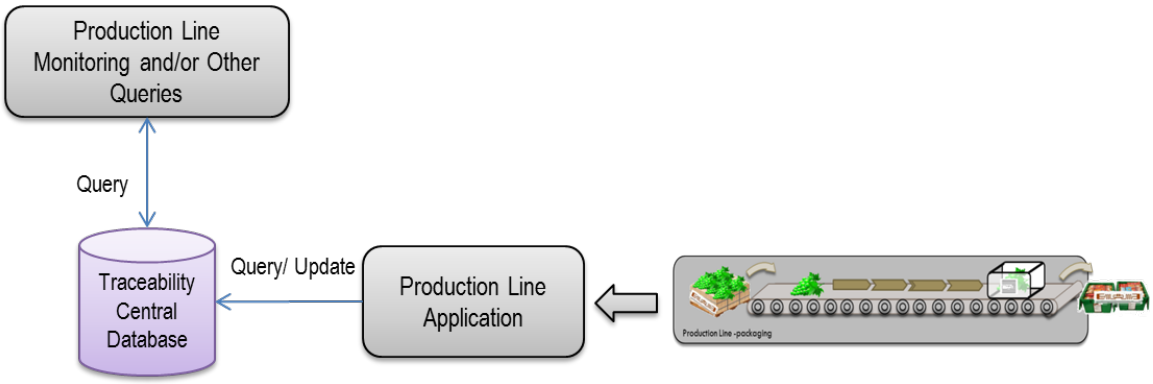


Figure 10 - System software application working environment

4.4 Application Implementation and HCI Design

The Human-Computer Interface (HCI) takes up a simple one-screen design as shown in Figure 11. All functions can be called to display on the screen, which is shown in Figure 12. Essential information for the packed products on the production line is also shown in this interface.

The software application is developed by using C#, with the support of .Net framework 3.5. The design of the application is discussed further below:

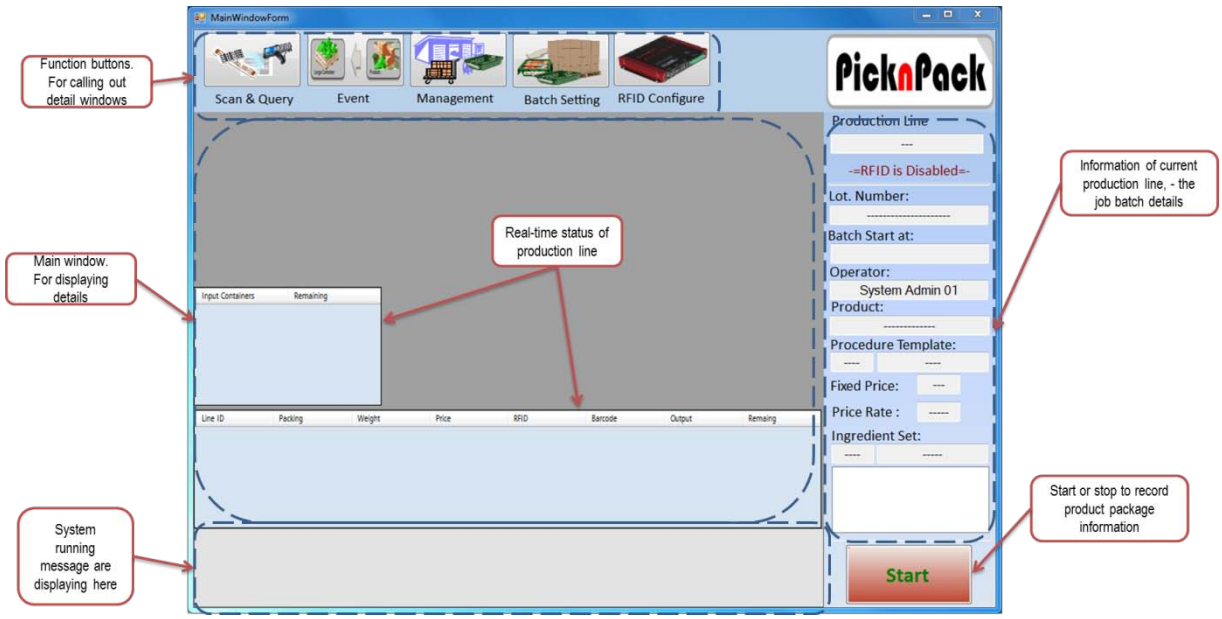


Figure 11- Software entry screen

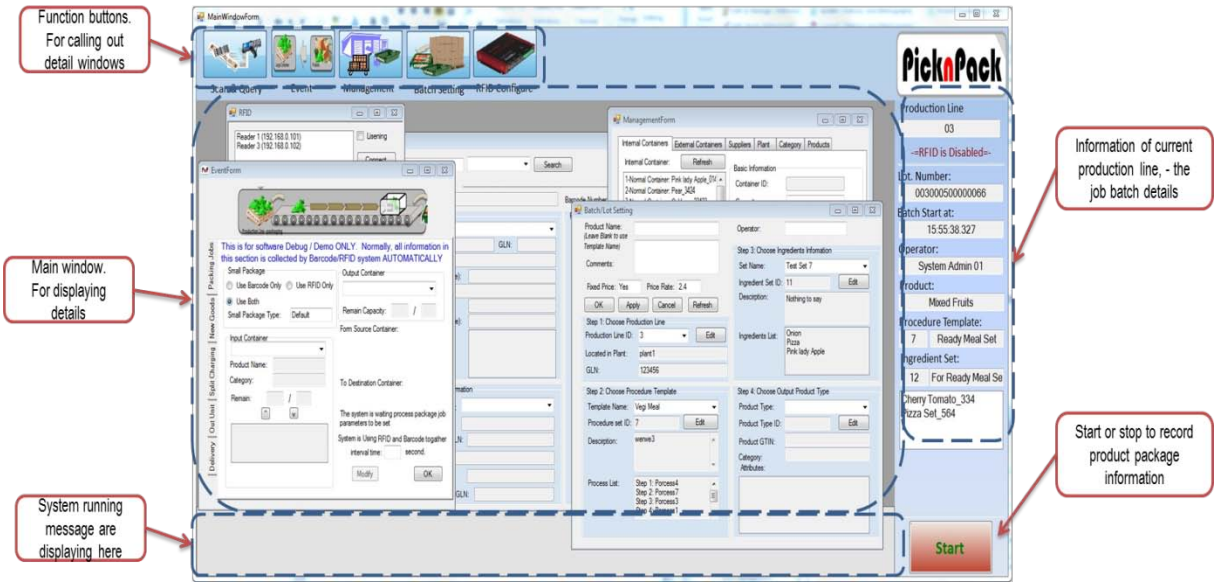


Figure 12 - The software application Human-Computer Interface (HCI)

4.4.1 Scan and Query Function

This function is a major feature of traceability system. It allows the user to retrieve related information by provided ID number, which can be a batch/lot number, RFID/barcode of the packaged product, or container number.

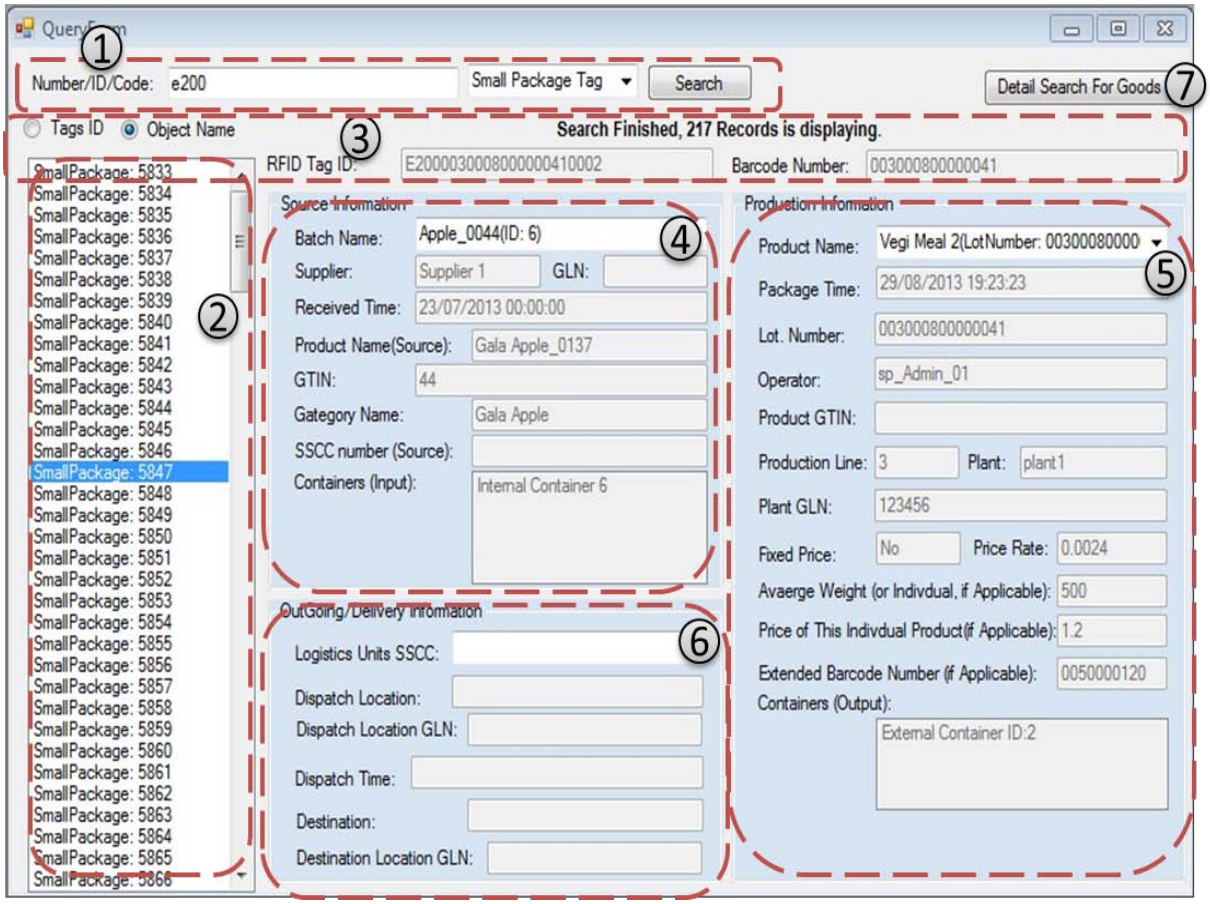


Figure 13 - Scan and query function interface

The interface of 'Scan and Query' function is shown in Figure 13. The interface has six areas, which are marked with numbers in the figure. They are described as follows:

Area 1: This is where the user can key in an ID number for searching the information. Once clicking on the button 'Search', all found information is displayed in Area 2.

Area 2: All found records are displayed in this area. The user can click on any one of them. Related information is then displayed in areas 3, 4, 5 and 6.

Area 3: The display in Area 2 can be switched between product name and ID. This area also shows the RFID tag ID and barcode of the product.

Area 4: The area is to display source material information.

Area 5: This area displays the packaging job batch information. It also shows the price and weight of the package.

Area 6: Delivery Information is displayed in this area.

Area 7: This is a button that calls out a window to display the incoming goods information.

4.4.2 Functions Grouped into an Event Button

In the current design for demonstration without RFID/barcode hardware connected, the functions grouped into the Event button include: (1) Packaging Job Setting, (2) New Goods Arrival, (3) Subdivisions, (4) Register Outgoing Logistical Unit and (5) Delivery.

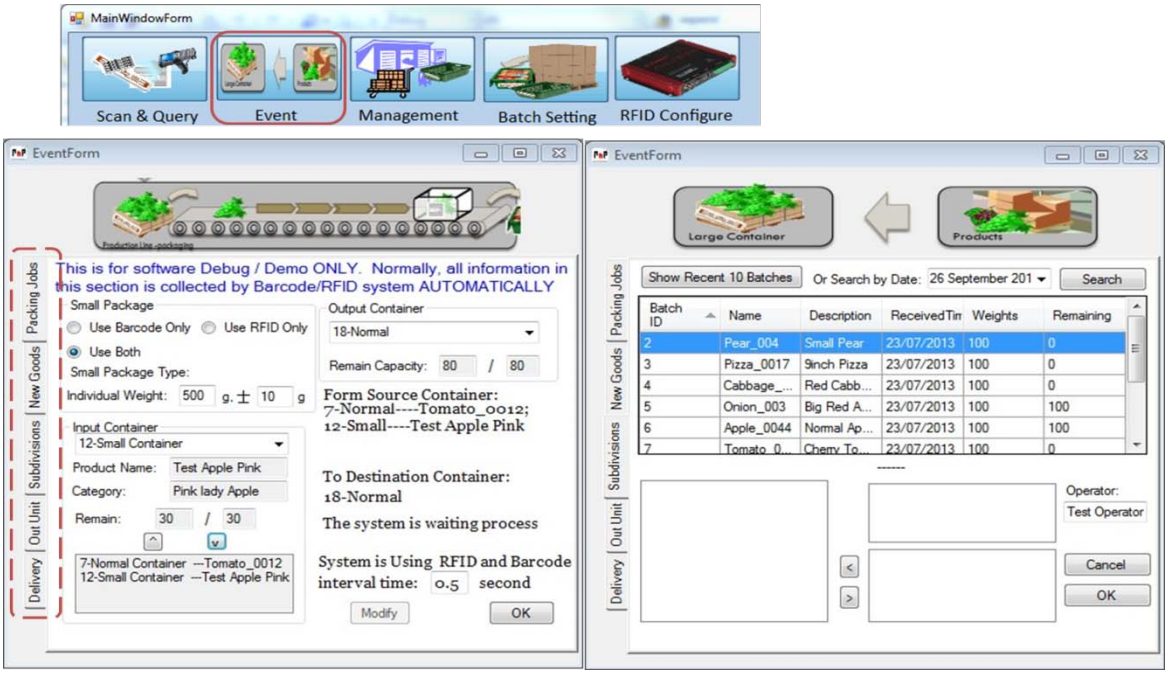


Figure 14- Interface of 'Event'

As Figure 14 shows, the interface of 'Event' contains five tabs, each for one event. Two of them are illustrated in the figure.

'Packaging Job Setting' interface is only for demonstration purpose, the necessary information listed in this window will be automatically collected by the barcode/RFID equipment. For demonstration purpose, the following information needs to be provided: (1) Identification technology: RFID, barcode or both; (2) Package description (bag, box or else); (3) Input container (filled with source material /Ingredients); (3) Output container used; (4) The interval time of packaging at the production line; and (5) the weight information of the product pack. Once the 'OK' button is clicked, an event will occur periodically to simulate the operation of a production line.

'New Goods Batch' interface is for registering new incoming source material. Necessary information may be required to be inputted manually. The product type of the incoming goods needs also to be

assigned here. The user can choose one from the list or create a new product type from the 'Management Function Interface'.

'Subdivisions' is for splitting the incoming goods batch into containers (input container).

'Outgoing Unit' is for creating the logistical units. The user could assign one or multiple containers (i.e. 'External Container') to create a logistical unit for delivery.

'Delivery' interface records the dispatch activities.

4.4.3 Management Function

The 'Management Function' is designed for creating new records or updating existing records, including the following information: container, supplier, factory and production line, product category and product type. Screenshots of the management window are shown in Figure 15.

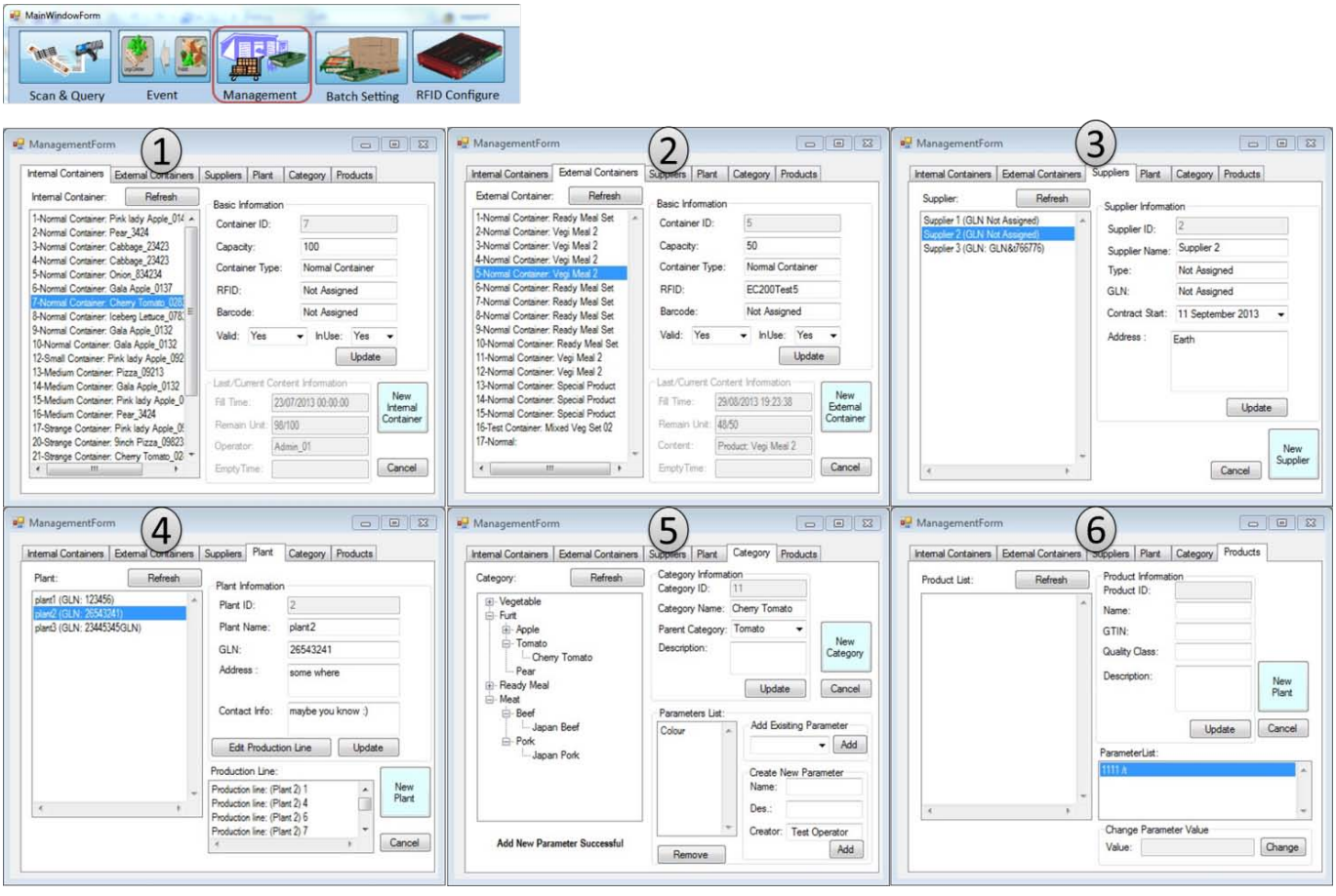


Figure 15 - Interface of management function

The first two windows are for creating or modifying container records used in the factory. The third window allows the user to create new or modify existing supplier information. The fourth window handles factory and production line information. The fifth and sixth windows are to create or modify attributes of the product category and product type.

4.4.4 Batch/Lot Setting Function

This function is to set the packaging job configurations and to update it in the database. Any change in the production line and packaging job settings would result in a new batch/lot number to be generated.

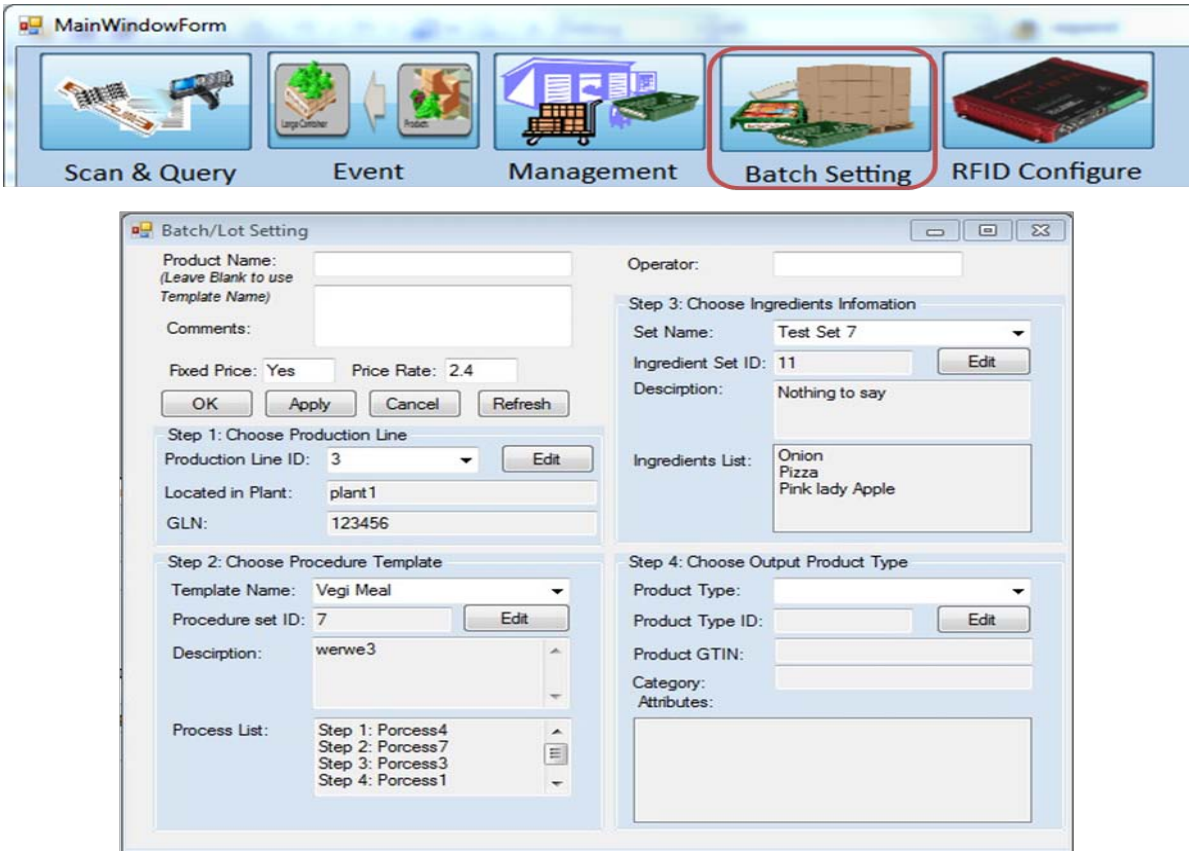


Figure 16 - Package job batch setting interface

Figure 16 shows the interface of Batch/Lot Settings. The following information needs to be provided: (1) Name of the product, descriptions, and product pricing method – fixed or by weight. (2) Production line (Step 1), (3) Procedure list (Step 2), (3) Source material used (Step 3), and (4) Product type and GTIN number.

Once necessary information is properly inputted, it is then displayed on the right part of the main window, as illustrated in Figure 17. The production line recording can then be started by the user clicking on the 'Start' button. This will also trigger a database update action: a new job batch record is created in the database, and the readers (RFID or barcode) start to monitor the packaging in the production line.

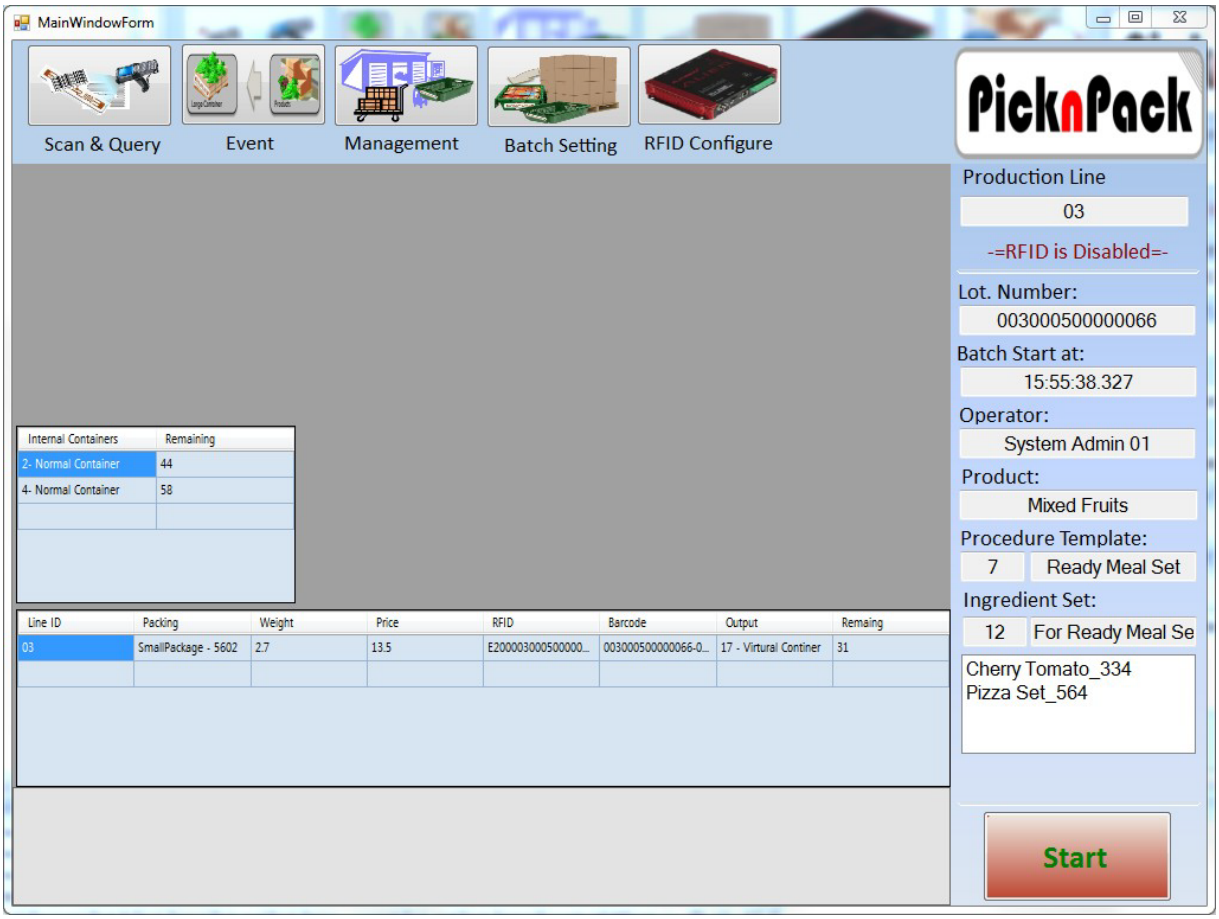


Figure 17 - Main window of the proposed software application with job setting

4.4.5 RFID Hardware Management

The 'RFID Configure' button calls out an RFID control window, as shown in Figure 18. This part will be further developed when the RFID hardware is implemented and integrated with the system.

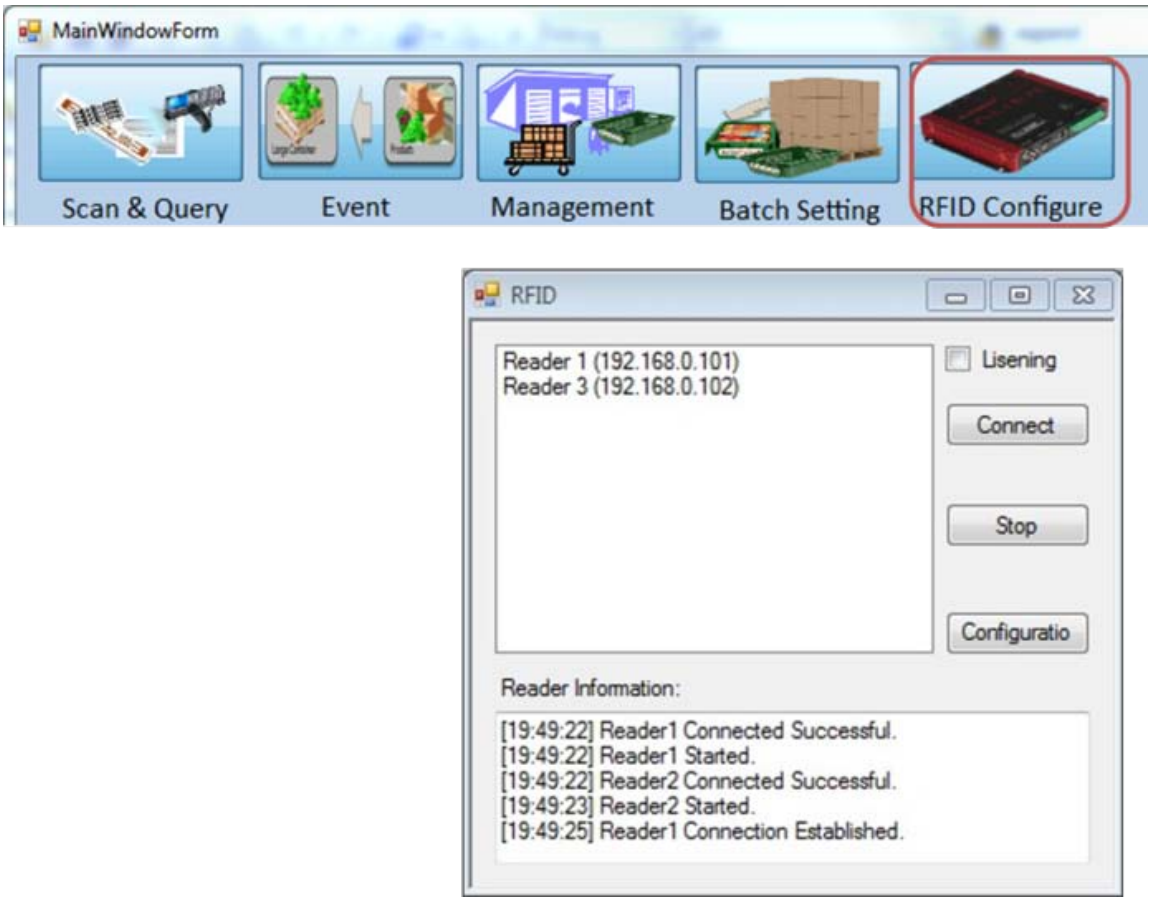


Figure 18 - RFID reader hardware control interface

5 Next Step

The next step of the database and software development for traceability would be to improve the current design, particularly with the integration of RFID and barcode hardware. The traceability system would also need to be expanded to interface with other distributed databases associated with the PickNpack system.

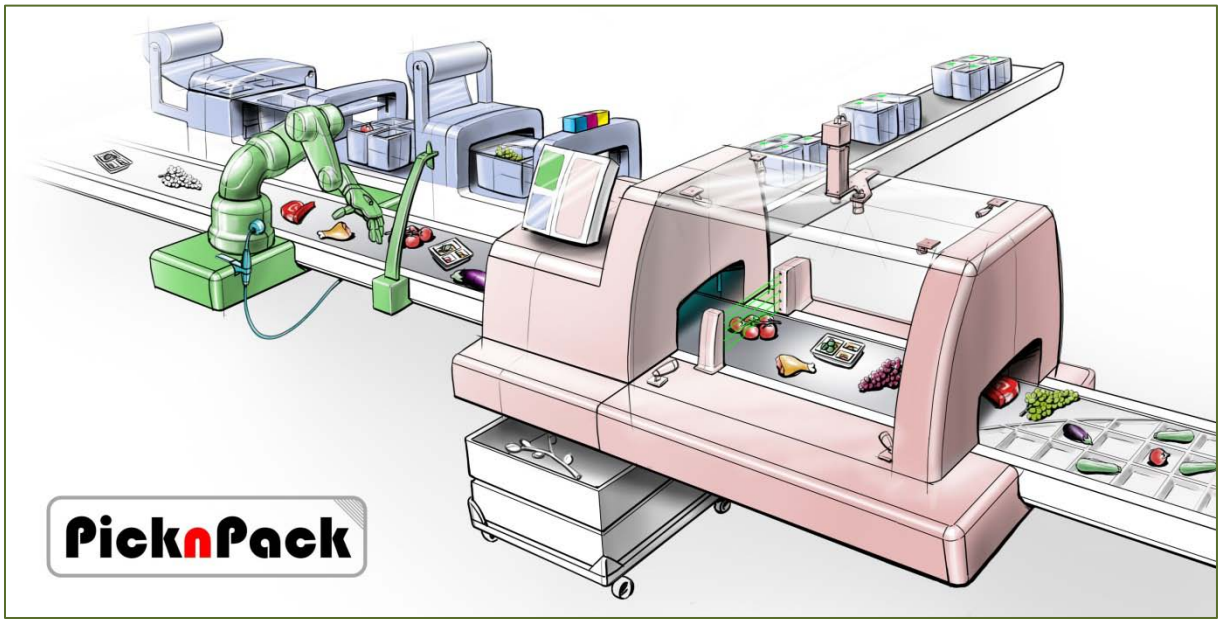
6 Reference

1. THE EUROPEAN PARLIAMENT AND OF THE COUNCIL, *REGULATION (EC) No 178/2002 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 28 January2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety*, in *Official Journal of the European Communities*. 2002.
2. Food Safety Authority of Ireland, *Guidance Note No. 10: Product Recall and Traceability (Revision 2)*. 2010.
3. Food Safety Authority of Ireland. *FAQ - Traceability*. 2011; Available from: ://www.fsai.ie/faq/traceability..

4. THE EUROPEAN PARLIAMENT AND OF THE COUNCIL, *COUNCIL REGULATION (EC) 1182/2007 of 26 September 2007 laying down specific rules as regards the fruit and vegetable sector, amending Directives 2001/112/EC and 2001/113/EC and Regulations (EEC) 827/68, (EC) 2200/96, (EC) 2201/96, (EC) 2826/2000, (EC) 1782/2003 and (EC) 318/2006 and repealing Regulation (EC) 2202/96.* Official Journal of the European Communities, 2007.
5. THE EUROPEAN PARLIAMENT AND OF THE COUNCIL, *COMMISSION REGULATION (EC) 1221/2008 of 5 December 2008 amending Regulation (EC) No 1580/2007 laying down implementing rules of Council Regulations (EC) 2200/96, (EC) 2201/96 and (EC) 1182/2007 in the fruit and vegetable sector as regards marketing standards.* Official Journal of the European Communities, 2008.
6. THE EUROPEAN PARLIAMENT AND OF THE COUNCIL, *COMMISSION REGULATION (EC) 1580/2007 of 21 December 2007 laying down implementing rules of Council Regulations (EC) 2200/96, (EC) 2201/96 and (EC) 1182/2007 in the fruit and vegetable sector.* Official Journal of the European Communities, 2007.
7. THE EUROPEAN PARLIAMENT AND OF THE COUNCIL, *REGULATION (EU) 1169/2011 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 October 2011 on the provision of food information to consumers, amending Regulations (EC) 1924/2006 and (EC) 1925/2006 of the European Parliament and of the Council, and repealing Commission Directive 87/250/EEC, Council Directive 90/496/EEC, Commission Directive 1999/10/EC, Directive 2000/13/EC of the European Parliament and of the Council, Commission Directives 2002/67/EC and 2008/5/EC and Commission Regulation (EC) No 608/2004.* Official Journal of the European Communities, 2011.
8. THE EUROPEAN PARLIAMENT AND OF THE COUNCIL, *COMMISSION IMPLEMENTING REGULATION (EU) 931/2011 of 19 September 2011 on the traceability requirements set by Regulation (EC) 178/2002 of the European Parliament and of the Council for food of animal origin.* Official Journal of the European Communities, 2011.
9. GS1, *Traceability for Fresh Fruits and Vegetables. Implementation Guide.* 2010(2).

7. Appendix
Analysis of the state of the art: Legal requirements and voluntary standards for traceability of fruit, vegetables and ready meals

Alberto González de Zárate (AZTI) , Begoña Pérez Villarreal (AZTI) and Zhipeng Wu (UM)



Flexible robotic systems for automated adaptive packaging of fresh and processed food products

The research leading to these results has received funding from the European Union Seventh Framework Programme under grant agreement n° 311987.

Dissemination level		
PU	Public	X
PR	Restricted to other programme participants (including the EC Services)	
RE	Restricted to a group specified by the consortium (including the EC Services)	
CO	Confidential, only for members of the consortium (including the EC Services)	

Table of Contents

1 Introduction

This report presents the results of the surveillance on legal traceability requirements for fruit, vegetables and ready meals. The report accomplishes the objectives for the development of the tasks 3.1., of the WP3:

- Define the breadth, depth and precision of the traceable parameters.
- Set up specifications for the traceable information through the packaging process.
- Assess regulations and commercial practices for the food chains.
- Assess information flow between links in the food chains.
- Assign ID numbers, codes and ranges.
- Prioritize the traceable parameters.
- Highlight key parameters for process automation.

In the present surveillance it has been also analysed some voluntary standards and have been interviewed some operators of fruit and vegetable chain.

2 Traceability and labelling mandatory requirements

2.1 Traceability requirements for all food products

2.1.1 Regulation 178/2002

The Regulation 178/2002, in the Article 18 lays down that all food businesses must have in place a traceability system. The regulation has basic descriptions of what is required and it would, in no way, reflect what is considered to be best practice. The legal minimum is a system in which a food business records what ingredients/food products it receives and from who (including contact details) together with what product it dispatches to which customers (including their details) with the only exception of being direct supply to final consumers. This is called the one-up-one-down system. Traceability information must be transferred up/down the chain on the product or on accompanying documents.

2.2 Labelling requirements for fruit and vegetables

Labelling requirements for fruit and vegetables in the EU are considered in the following Regulations.

2.2.1 Regulation 1182/2007

The Regulation 1182/2007, in the Article 2 lay down that the Commission may develop marketing standards for fruit and vegetable sector, related to quality, grading into classes, sizing, packaging, wrapping, storage, transport, presentation, marketing and labeling.

The marketing standards shall apply at all marketing stages including import and export.

The holder of products covered by the marketing standards may not display such products or offer them for sale or deliver or market them in any manner within the Community other than in conformity with those standards. The holder shall be responsible for ensuring such conformity.

2.2.2 Commission regulation 1221/2008

Article 5 lays down that, at the retail stage, the information required by particulars shall be legible and conspicuous. Products may be presented for sale provided the retailer displays prominently, adjacent to and legibly the information particulars relating to **country of origin** and, where appropriate, **class and variety or commercial type** in such a way as not to mislead the consumer.

Annex I, Part A of the Regulation set the general marketing standard for fruit and vegetables not covered by a specific marketing standards.

Annex I, Part B of the Regulation set specific marketing standards regards the following products:

a) apples,
b) citrus fruit,
c) kiwifruit,
d) lettuces, curled leaved and broad-leaved endives,
e) peaches and nectarines,
f) pears,

g) strawberries,
h) sweet peppers,
i) table grapes,
j) tomatoes.

Therefore, the Regulation establishes specific standards for grapes and tomatoes that must be taken into account when defining the traceability information system.

GRAPES
VI PROVISIONS CONCERNING MARKING

Each package must bear the following particulars in letters grouped on the same side, legibly and indelibly marked, and visible from the outside:

A. **Identification**

The name and the address of the packer and/or the dispatcher.

This mention may be replaced:

- for all packages with the exception of pre-packages, by the officially issued or accepted code mark representing the packer and/or the dispatcher, indicated in close connection with the reference "Packer and/or Dispatcher" (or equivalent abbreviations);

- for pre-packages only, by the name and the address of a seller established within the Community indicated in close connection with the mention "Packed for:" or an equivalent mention. In this case, the labeling shall also include a code representing the packer and/or the dispatcher. The seller shall give all information deemed necessary by the inspection body as to the meaning of this code.

B. **Nature of produce**

- "Table Grapes", if the contents are not visible from the outside,
- name of the variety or, where applicable, varieties,
- "under glass", where applicable.

C. **Origin of produce**

Country (or, where applicable, countries) of origin and, optionally, district where grown, or national, regional or local place name.

D. **Commercial specifications**

- Class.

E. **Official control mark *(optional)***

TOMATOES

VI PROVISIONS CONCERNING MARKING

Each package must bear the following particulars in letters grouped on the same side, legibly and indelibly marked and visible from the outside:

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- for pre-packages only, by the name and the address of a seller established within the Community indicated in close connection with the mention “Packed for:” or an equivalent mention. In this case, the labeling shall also include a code representing the packer and/or the dispatcher. The seller shall give all information deemed necessary by the inspection body as to the meaning of this code.

B. **Nature of produce**

- “tomatoes” or “trusses of tomatoes” and the commercial type if the contents are not visible from the outside. These details must always be provided for “cherry” (or “cocktail”) tomatoes, whether or not in trusses,

- name of the variety (optional).

C. Origin of produce

Country of origin and, optionally, district where grown, or national, regional or local place name.

D. **Commercial specifications**

- class

- size expressed as minimum and maximum diameters (if sized) or the word “unsized” where appropriate.

- minimum sugar content, measured by refractometer and expressed in Brix degrees (optional).

E. **Official control mark (optional)**

2.2.3 Commission regulation 1580/2007

This Regulation, in Article 5 lays down that **pre-packaged products** the **net weight** shall be indicated, in addition to all the information provided for in the marketing standards.

However, in the case of products normally sold by number, the requirement to indicate the net weight shall not apply if the number of items may be clearly seen and easily counted from the outside or, if the number is indicated on the label.

Also, Article 6 lays down that the marketing of packages of a net weight of 5 kg or less containing mixes of different types of fruit and vegetables shall be allowed, provided that:

a) the products are of uniform quality and each product concerned complies with general o specific marketing standard.

b) the package is appropriately labeled, and the mix is not such as to mislead the consumer.

If the fruit and vegetables in a mix originate in more than one Member State or third country, the full names of the countries of origin may be replaced with one of the following, as appropriate:

a) “mix of EC fruit and vegetables”,
b) “mix of non-EC fruit and vegetables”,
c) “mix of EC and non-EC fruit and vegetables”.

2.3 Labelling requirements for ready meals

2.3.1 Regulation 1169/2011

Labeling requirements for **ready meals** in the EU are laying down in the Regulation 1169/2011, on the provision of **food information to consumers**. This Regulation It shall apply from 13 December 2014, but falls within the temporal scope of the project.

Article 9 provides the list of mandatory particulars:

a) **the name of the food**;
b) **the list of ingredients**;
c) any i**ngredient** or processing aid listed in Annex II or derived from a substance or product listed in Annex II **causing allergies or intolerances** used in the manufacture or preparation of a food and still present in the finished product, even if in an altered form;
d) **the quantity of certain ingredients** or categories of ingredients;
e) **the net quantity** of the food;
f) **the date of minimum durability** or the "use by" date;
g) any **special storage conditions** and/or conditions of use;
h) **the name or business name and address of the food business operator** (the operator under whose name or business name the food is marketed or, if that operator is not established in the UE, the importer into the UE market);
i) **the country of origin** or place of provenance where provided for in Article 26;

j) **instructions for use** where it would be difficult to make appropriate use of the food in the absence of such instructions;
k) with respect to beverages containing more than 1,2 % by volume of alcohol, **the actual alcoholic strength by volume**;
l) **a nutrition declaration** (It shall apply from 13 December 2016).

This information shall be indicated with words, numbers and may additionally be expressed by means of pictograms or symbols according to the provisions of the Regulation.

Article 13 laying down provisions for adequate labelling, which must be clear and legible. For this purpose, a minimum font size is established for obligatory information of 1.2 mm. However, if the maximum surface of the package is less than 80 cm², the minimum size is reduced to 0.9 mm.

If it is less than 25 cm², nutritional information is not obligatory. On packages with a maximum surface area of less than 10 cm ², neither the nutritional information nor the list of ingredients is required.

Nevertheless, the name of the food, the presence of possible allergens, net quantity and the minimum shelf life must always be displayed, irrespective of the size of the package.

Obligatory labeling on nutritional information is introduced for the majority of processed foods (Section 3, Article 30). The elements which must be declared are as follows: **the energy value, fats, saturated fats, carbohydrates, sugars, proteins and salt**; all these elements must be displayed in the same visual field. In addition, information relating to the energy value may be repeated in the main visual field alone or with the quantities of fats, saturated fats, sugars and salt. The expression "per 100 g or per 100 ml" must be used, to facilitate the comparison of products, and in addition the declaration "per portion" should be allowed and be of voluntary nature.

With respect to trans fatty acids, the European Commission shall submit a report, within a 3-year period, that may be accompanied by a legislative proposal.

The obligatory nutritional information may optionally be supplemented with the values of other nutrients including: monounsaturated and polyunsaturated fatty acids, polyalcohols, starch, food fibre, vitamins or minerals.

2.3.2 Regulation 931/2011

This Regulation shall apply to unprocessed and processed food of animal origin (e.g.: roast beef ready meal), but not to food containing both products of plant origin and processed products of animal origin (e.g.: meat with sauce and potatoes).

Food business operators shall ensure that the following information concerning consignments of food of animal origin is made available to the food business operator to whom the food is supplied and, upon request, to the competent authority:

a) an accurate description of the food;
b) the volume or quantity of the food;
c) the name and address of the food business operator from which the food has been dispatched;

d) the name and address of the consignor (owner) if different from the food business operator from which the food has been dispatched;
e) the name and address of the food business operator to whom the food is dispatched;
f) the name and address of the consignee (owner), if different from the food business operator to whom the food is dispatched;
g) a reference identifying the lot, batch or consignment, as appropriate; and
h) the date of dispatch.

3 Voluntary standards

3.1 GS1 recommendations on labelling and traceability

GS1 is a global organization dedicated to the design and implementation of global standards and solutions to improve the efficiency and visibility of supply and demand chains globally and across multiple sectors. The GS1 System of standards is the most widely used supply chain standards system in the world.

3.1.1 GS1 traceability principles

- A company must determine what needs to be traced. This is commonly referred to as the "traceable item." A traceable item can be:

  - a product or traded item (e.g. case/carton, consumer item)
  - a Logistic Unit (e.g. bin, container)
  - a shipment or movement of a product or trade item

There must be agreement between trading partners on what the traceable item is. This ensures that both partners are tracking the same thing. Otherwise the chain will be broken. Each Trading Partner must define at least one level of traceable item for each shipment.

- All traceable items must be uniquely identified and this information is shared between all affected supply chain partners.

- At a minimum, the identification of products for the purpose of traceability requires:

  - The assignment of a unique GS1 Global Trade Item Number (GTIN)[1)]
  - The assignment of a batch / lot.

- When a product is reconfigured and/or re-packed, the new product must be assigned a new unique product identification (i.e. GTIN). A linkage must be maintained between the new product and its original inputs.

- When a Logistic Unit is reconfigured, the new Logistic Unit must be assigned a new unique identification (i.e. SSCC)[2)]. A linkage must be maintained between the new Logistic Unit and its original input. The SSCC numbers are shown in bar code format using GS1-128 symbology

- All supply chain parties must systematically link the physical flow of products with the flow of information about them. Traceable item identification numbers must be communicated on related business documents.

1) Global Trade Item Number (GTIN): The GS1 Identification Key used to identify trade items. The key comprises a GS1 Company Prefix, an Item Reference and Check Digit.

2) Serial Shipping Container Code (SSCC): The GS1 Identification Key used to identify logistics units. The key comprises an Extension digit, GS1 Company Prefix, Serial Reference, and Check Digit.

- Each Traceability Partner (company) must be able to identify the direct source (supplier) and direct recipient (customer) of traceable items. This is the "one step up, one step down" principle. This requires that supply chain partners collect, record/store and share minimum pieces of information for traceability.

- All supply chain parties require both internal and external traceability. (Implementation of internal traceability must ensure that the necessary linkages between inputs and outputs are maintained.).

- Any asset (e.g. returnable pallet) which needs to be traced forward or traced back must be uniquely identified.

- Labels showing the traceable item identification number must remain on the packaging until the traceable item is consumed or destroyed (by the next trading partner). This principle applies even when the traceable item is part of a larger packaging hierarchy.

3.1.2 GTIN

The Global Trade Item Number (GTIN) is the foundation of the GS1 System for uniquely identifying trade items, which includes both products and services that are sold, delivered, and invoiced at any point in the supply chain. GTINs provide unique identification worldwide. The GTIN is encountered most frequently at point-of-sale and on cases and pallets of products in a distribution/warehouse environment.

Companies can be confident that a GTIN will uniquely identify their products as they move through the global supply chain to the ultimate end user. This global identification system of GS1 ensures that the GTIN placed in a bar code is the same information contained in the corresponding electronic documents processed between trading partners.

EAN-13 symbology

GTIN-13 data structure

Used for point-of-sale identification of pre-packaged, fixed weight/count, consumer product

Figure 1- Example of GTIN-13 Symbology

3.1.3 GS1-128 Symbology

The GS1-128 symbology allows for the encoding of secondary information. This is done through the use of “application identificatiers”. In the example below the “application identificatiers” is encased in parentheses. The identification (01) indicates that what follows is a GTIN. The identification (13) indicates that what follows is the pack date expressed in the format YYMMDD. The identification (10) indicates the batch/lot.

Figure 2 - Example of GTIN-13 Symbology

3.1.4 GS1 Serial Shipping Container Code (SSCC) Further Explained

The SSCC’s a critical element when electronically exchanging information about the movement and location of logistics units. A Logistic Unit is defined as any composition established for transport and/or storage, which needs to be tracked through the supply chain (cartons or pallets). Data exchange and the tracking of logistics units is an application of the GS1 System. This can be accomplished through the use of the SSCC.

The SSCC is the “license plate” to identify specific information about cartons, pallets or even trailer loads of products. The SSCC moves products from one trading partner to another quickly and efficiently. More importantly, the costs associated with moving and receiving products are greatly reduced.

(00) 034531200000002527 where (00) = AI 00 (SSCC)

Example of SSCC case label

Figure 3 - Example of SSCC case label Symbology

3.1.5 Traceability for fresh fruits and vegetables. Implementation Guide

Implementation Guide is a best practice guide for implementing traceability in the Fresh Fruit and Vegetable (Produce) Industry. The best practices recommended are based on GS1 global standards for supply chain management and product identification. These standards were developed by industry to optimize business practices across supply chains world-wide.

The scope of the guideline is:

- Fresh fruit and vegetables for human consumption.
- Traceability practices from grower to retail store or foodservice operator (i.e. external
- traceability).
- Applies to all levels of product and shipping containers, including pallets, cases and consumer items.

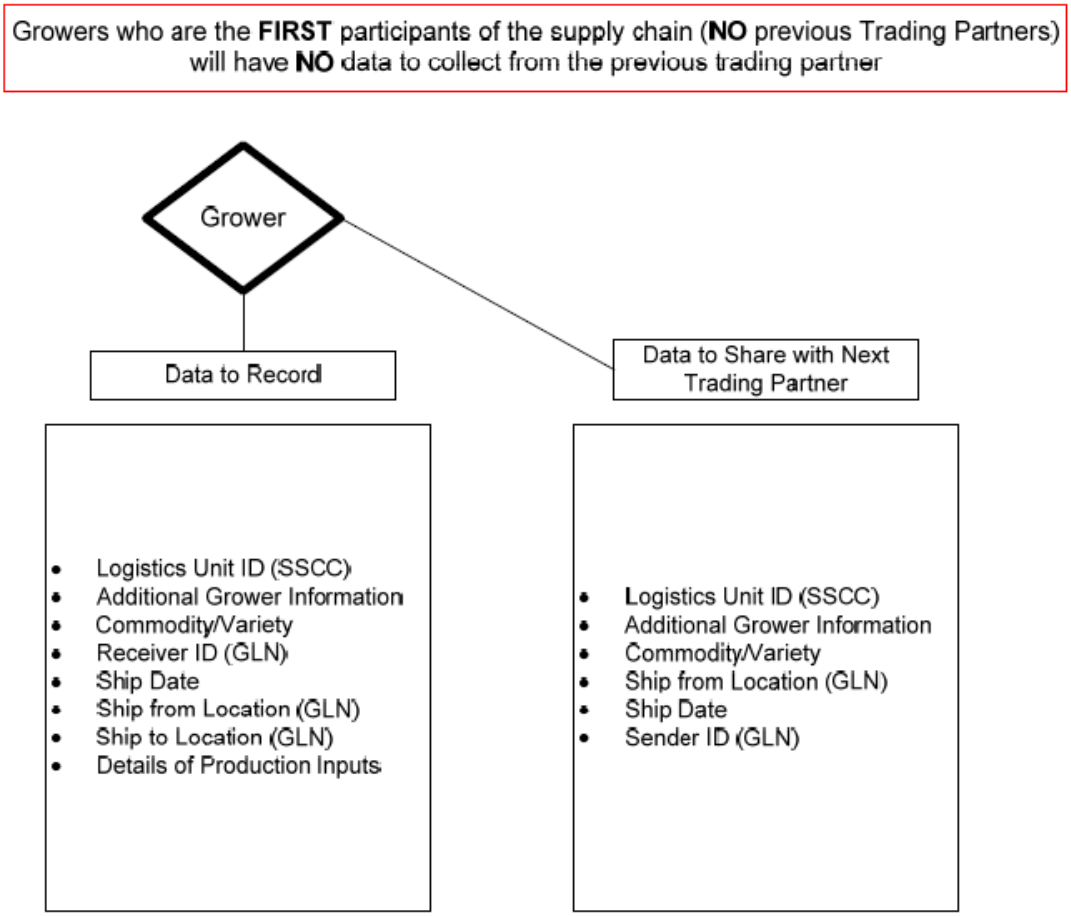


Figure 4 – Data requirements for Growers

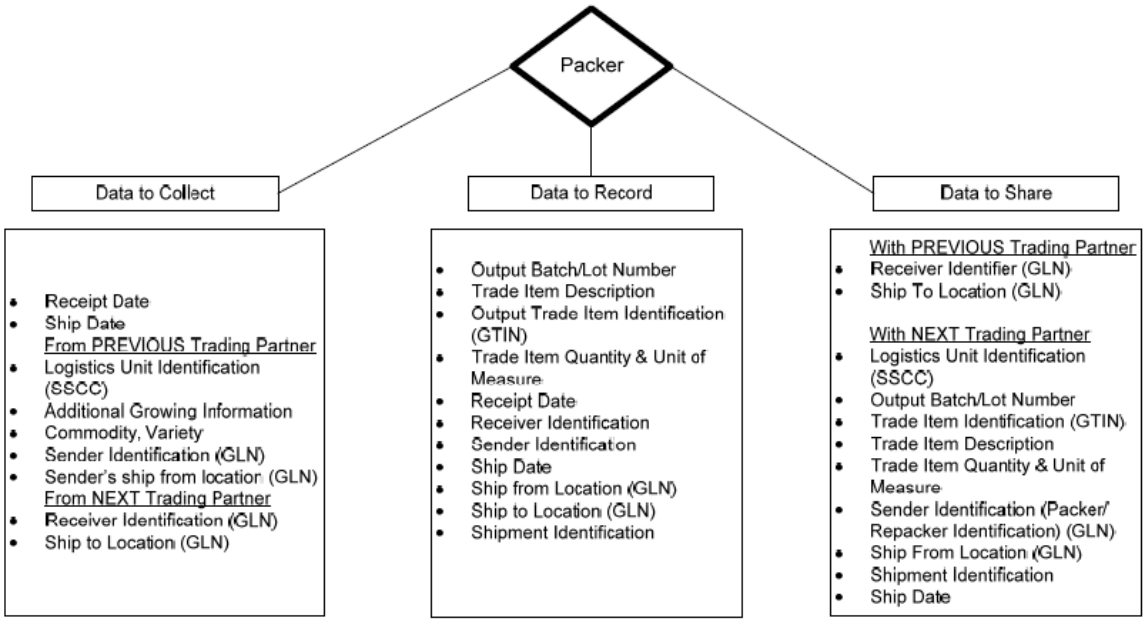


Figure 5 – Data requirements for Packers

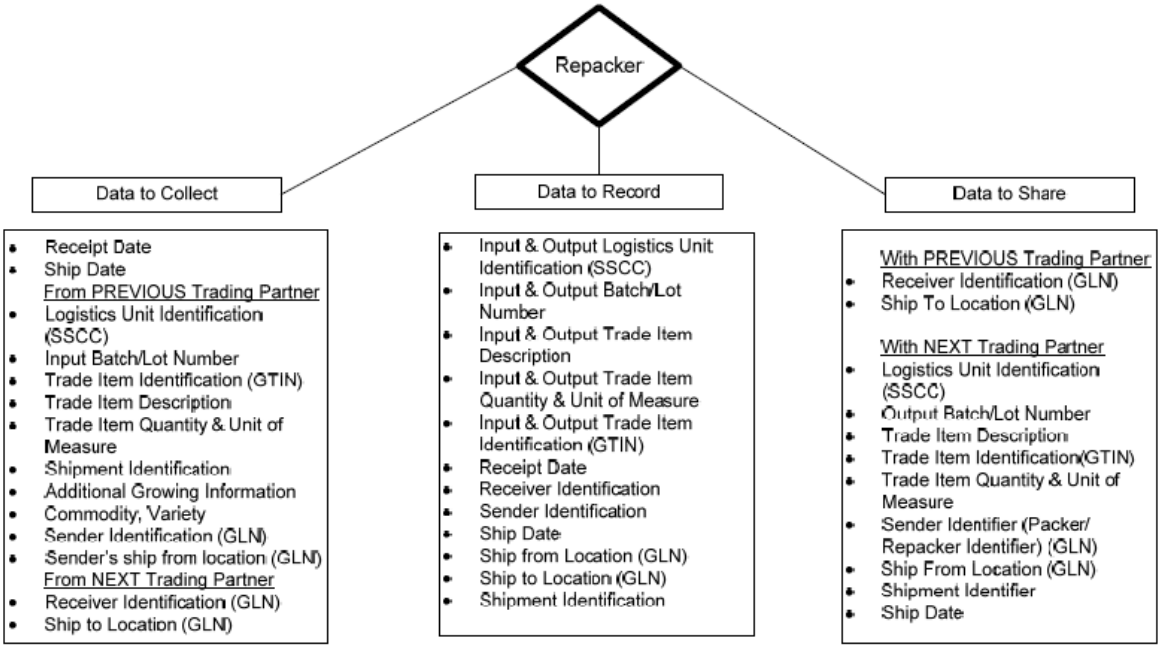


Figure 6 – Data requirements for Repackers

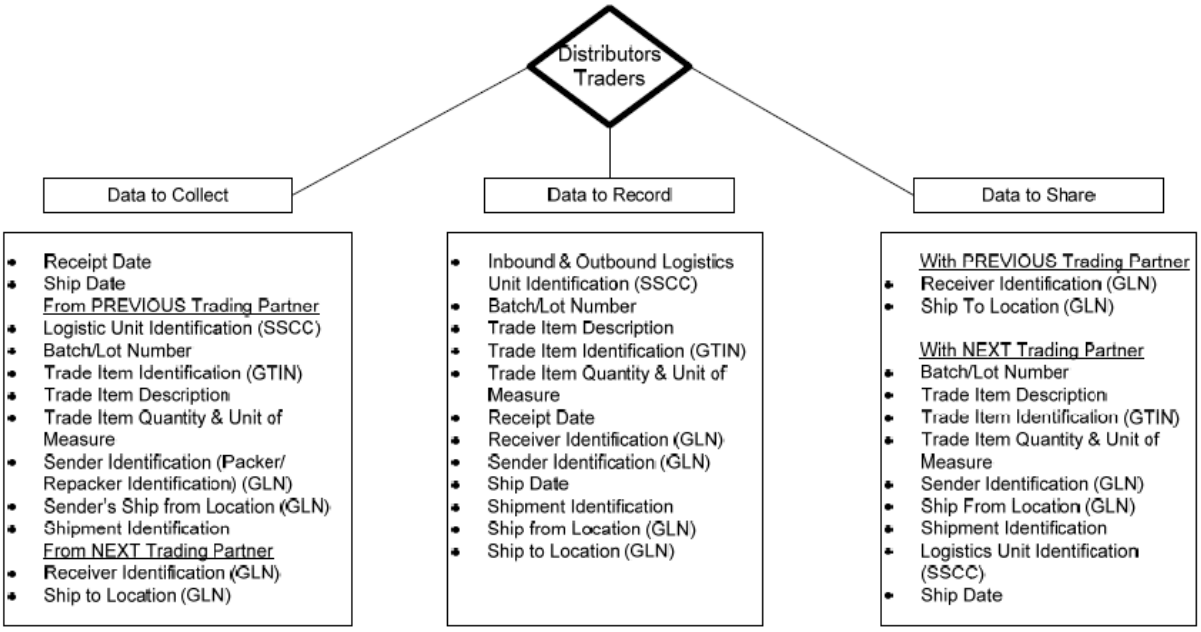


Figure 7 – Data requirements for Distributors/Traders

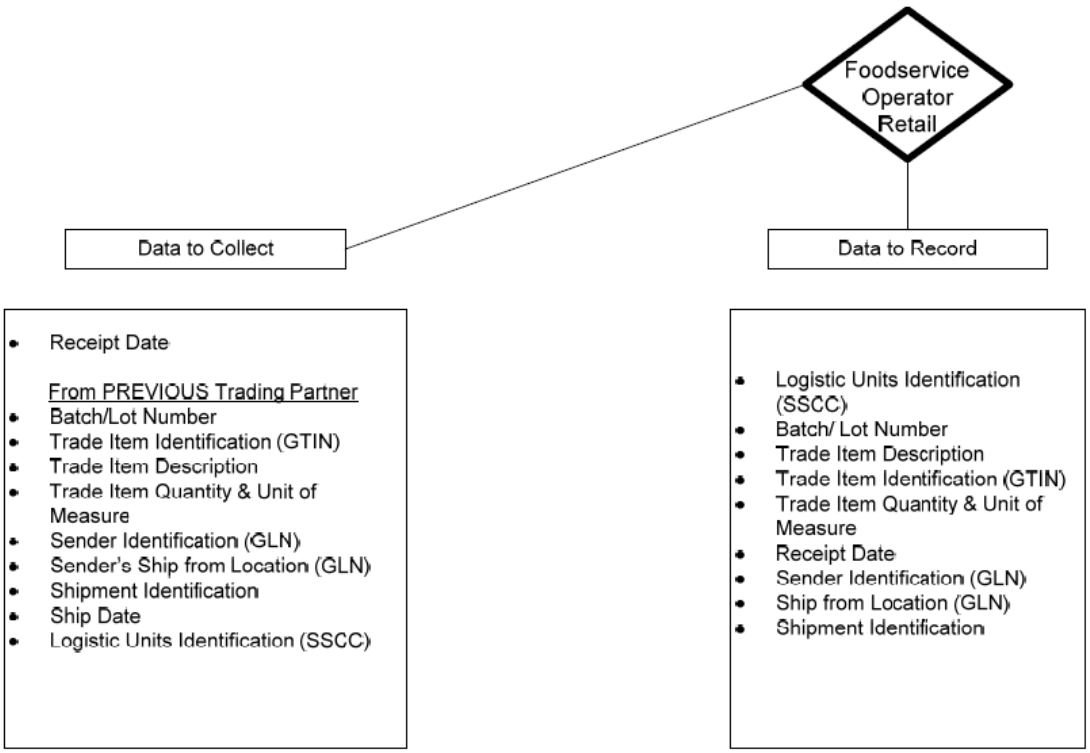


Figure 8 – Data requirements for Operators/Retailers

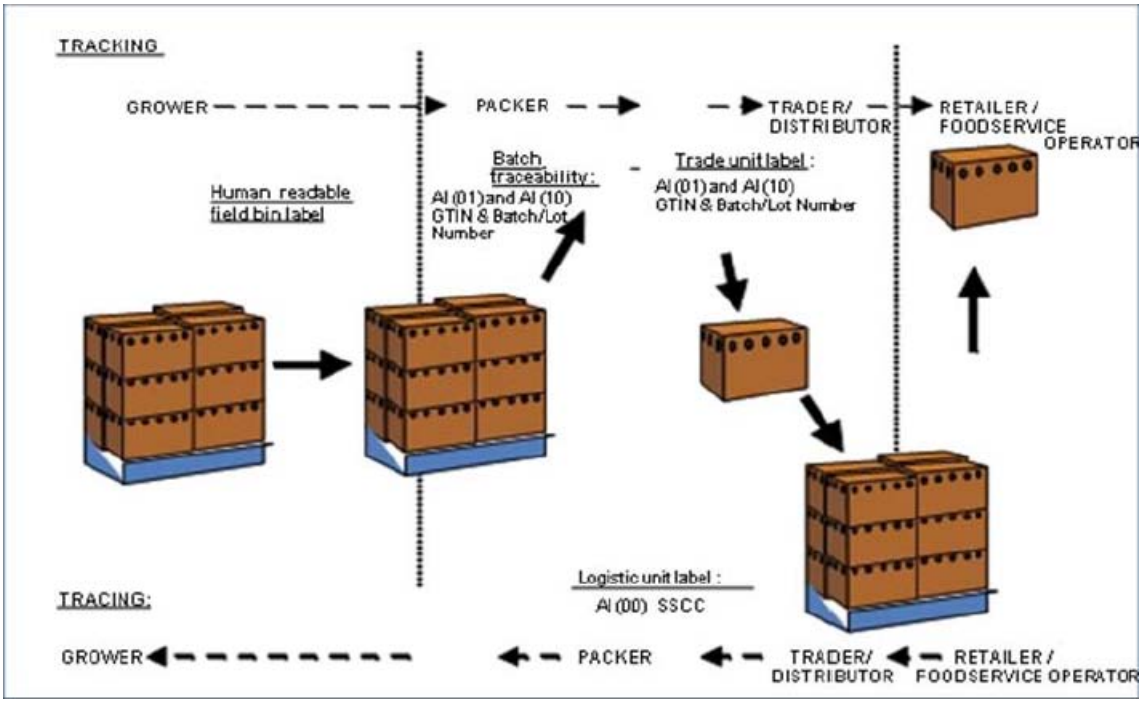


Figure 9 – GS1 Application Identifiers through the produce supply chain

3.2 ISO 22.000: Food safety management systems

This International Standard specifies the requirements for a food safety management system that combines the following generally recognized key elements to ensure food safety along the food chain, up to the point of final consumption:

- Interactive communication;
- System management;
- Process control;
- Hazard Analysis and Critical Control Point (HACCP) principles;
- Prerequisite programs.

The standard provides that organization shall establish a traceability system, which enables the identification of product lots and their relation with batches of raw materials, processing and distribution records.

The traceability system shall be able to identify incoming materials from the immediate suppliers and distribution of the end product to the immediate distributors.

Traceability records shall be maintained for a defined period sufficient for system assessment, for enabling handling of potentially unsafe products and for the event of a recall, and shall be in accordance with customer and regulatory requirements and may be based on the end product shelf life.

3.3 ISO 22005: Traceability in the feed and food chain

This International Standard gives the principles and specifies basic requirements for the design and implementation of a feed and food traceability system. It can be applied by an organization operating at any step in the feed and food chain.

The standard includes the following issues:

- Design of traceability system.
- Implementation.
- Internal audits.
- Review.

3.4 The Produce Traceability Initiative (PTI)

The Produce Traceability Initiative, sponsored by Canadian Produce Marketing Association, GS1 US, Produce Marketing Association and United Fresh Produce Association, is designed to help the industry maximize the effectiveness of current traceback procedures, while developing a standardized industry approach to enhance the speed and efficiency of traceability systems for the future.

Best Practices for Formatting Case Labels is a PTI standard to utilize barcodes GS1 based in food industry and to determine what information is necessary to include on the label.

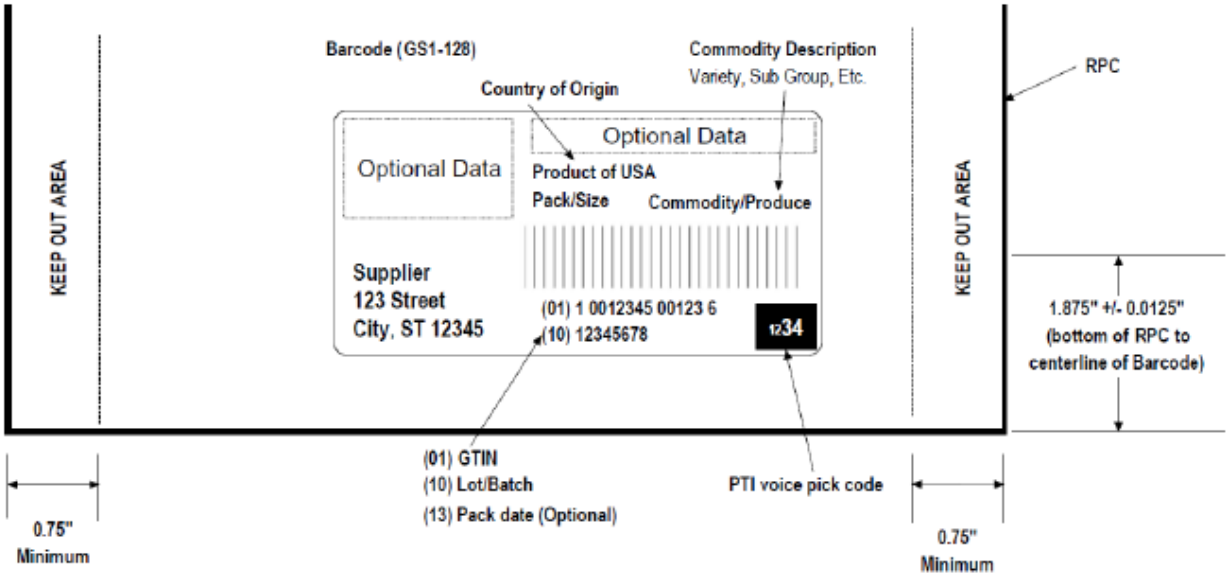


Figure 12 – Basic PTI RPC Case Label

://www.producetraceability.org/documents/Best_Practices_Case_Label-_010312_FINAL.

4 Technology

Radio-frequency identification (RFID) and barcodes are two common technology methods used to deliver traceability.

4.1 RFID

Radio Frequency Identification (RFID) is based on the principle that any object can be equipped with tags, transponders or microchips that provide information readable from a short distance using small portable readers. The information is contained in the marker and can be used to track inventory or trace products.

A RFID system consists of three parts:

1. A tag, which can be packaged in a number of formats (cards, tags, tokens, capsules, labels, etc.).
2. An interrogator (or reader) which ensures communication with the tag.
3. The information system (IS) which manages the functions and processes that either acts on the data exchanged with the tag, or uses them.

Some produce traceability makers use matrix barcodes to record data on specific produce.

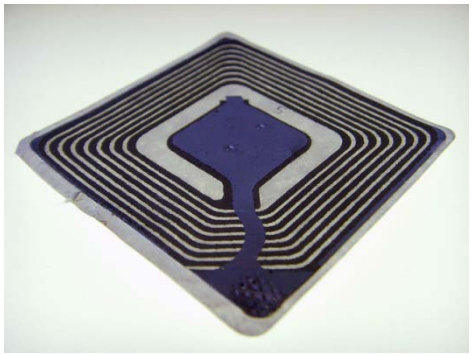


Figure 10 – example of a generic RFID chip

4.2 RFID and the EPC (Electronic Product Code)

Initiated by several players, including EAN and UCC, the EPC (Electronic Product Code) is a RFID microchip-based identification system consisting primarily of:

- A product identifier (based on the same structure as the GTIN code)
- An individual item identifier via the addition of a sequential number.

Barcode and RFID technologies are often spoken of as if the first will eventually replace the latter. It now seems that the technologies will be used in a complementary way by combining the advantages of both. One-dimensional barcodes are cheap and electronic tools labels can store information. RFID is a solution whenever dynamic information is required.

4.3 Bar codes

Barcoding is a common and cost effective method used to implement traceability at both the item and case-level. Variable data in a barcode or a numeric or alphanumeric code format can be applied to the packaging or label. The secure data can be used as a pointer to traceability information and can also correlate with production data such as time to market and product quality.

One-dimensional barcodes have been widely discussed in the section 3: Voluntary standards.

4.4 The QR codes (Quick Response Code)

The QR code is a two-dimensional barcode (matrix code) consisting of black modules arranged on a square white background.

The name QR is the acronym for "Quick Response", because its data content can be decoded quickly.

Intended for use with a QR code reader, a mobile telephone, or a smart phone, it has the advantage of being able to store more information than a regular bar code.

QRs can store up to 7.089 numeric characters or 4.296 alphanumeric characters which is far above the capacity of barcodes.

They are found on many different media: they simply have to be scanned using the photo mode of a mobile telephone and sent in order to receive information (composition, origin, lot number, manufacturing date, etc.). QR applications are being rolled for many food products (e.g.: olive oils, wines, salads, packed fruits, etc.).

Figure 11 – example of a QR code

5 Traceable information in fruit and vegetable chain

The supply chain of fruits and vegetables in Spain is very complex because of the number of operators that can take part and the different combinations that can be established between them. In principle, there are two distinct distribution channels: Traditional channel, in which the product passes through the central markets and modern channel, which is done primarily through collection centers, logistic platforms or large chains distribution.

Traditional channel

The traditional channel is the basic circuit distribution of fruit and vegetables in Spain and can be in turn "long radius" or "short radius", depending on the distance between the points of production and consumption.

The long radio channel is the one done through the wholesalers installed in central markets, near large cities, in which is marketed the 60% of the national production of fruit and vegetables. In this channel, the farmer sells the product to a wholesaler or gives it to an agricultural cooperative, collection center o auction to prepare the product (selection, grading, packaging and palletizing) and to sale it to a wholesaler of a central market. In the central market the product is resells to retailers or restaurateurs of the nearby cities. The auctions (“alhondigas” in Spanish) are intermediaries that receive the product of the farmer (usually vegetables) and are responsible for their selling and billing, charging a fee for the service. They perform weighing operations, exhibition and stowing the goods and have a very high market share.

Besides the long radio channel, in which the product is brought to the great centers of consumption, there are short radius close to the production areas, with many small-scale operators and little added value.

Modern Channels

Along traditional channel, large supermarket chains have launched logistic platforms or distribution centers, which grouped the product purchased from producers or their organizations, and then distribute it to through its own network of retail outlets in Spain and other EU countries. This channel combines, under the direction of a single agent, several of the traditional channel intermediary agents, resulting in a shorter channel.

Some supermarket, instead of creating their own platforms, have established exclusive distribution agreements with collecting centers for the supply of fruits and vegetables from their facilities, in and out of Spain.

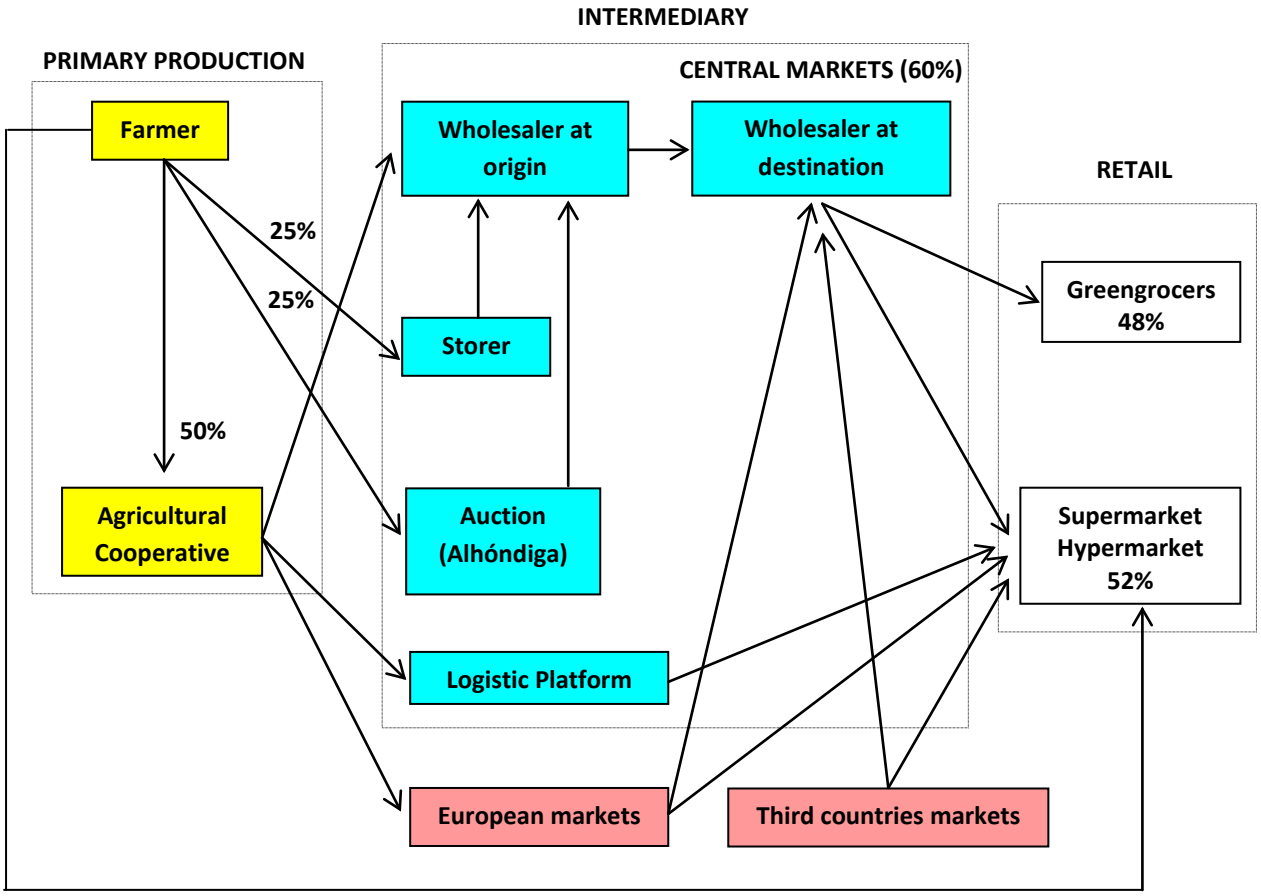


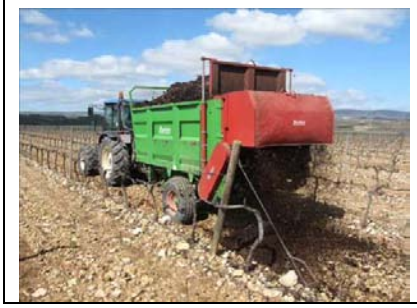
Figure 13 – Spanish fruit and vegetable chain

The current situation of traceability in Spain is that operators of food chain have implemented internal traceability systems but that are not connected to each other.

The main reason is that most growers do not direct their marketing strategy to end users, but to their sales channel (wholesale or retail). This channel, in most cases, has no interest in traceability because part of the profit that they get comes from speculative movements, keeping the product when price is low and selling it when price goes up. This is the reason that often the product deterioration occurring in their facilities.

The traceability of fruits and vegetables supply chain is therefore conditioned by reducing the number of operators and brand development, mainly by large producers.

The following table provides a proposal for traceable information for fruit and vegetable chain.

TRACEABILITY INFORMATION IN FRUIT AND VEGETABLE CHAIN	
FARMER	
STAGE	**INFORMATION**
NURSERY 	- **Variety.** - **Seed source.** - **Crop treatments.** - **Type of nursery:** GMO/Non-GMO. - **Type of substrate.** - **Type of fertilizer:** Mineral/organic. - **Irrigation:** Source and method.
ORCHARD/FIELD 	- **Producer identification.** - **Address.** - **Orchard/field/plot identification.** - **Type of seedings:** GMO/Non-GMO. - **Origin of seed.** - **Planting or sowing date.** - **Grafting date.** - **Origin of grafts:** Internal/external. - **Number of plants.** - **Area.** - **Worker(s)/operator(s).** - **Type of fertilizer** (Mineral/organic) **and composition.**
IRRIGATION 	- **Date.** - **Source:** Drilling, lake, river, other. - **Method:** Drip, sprinkler, furrow, other. - **Water analysis results** (physical, chemical or microbiological). - **Irrigation date, plot, area number of plants, amount of water used and worker(s)/operator(s).**
FERTILISATION 	- **Date.** - **Orchard/field/plot identification.** - **Variety.** - **Type of fertilizer** (mineral/organic) **and composition.** - **Brand name, batch nº and origin** (if organic). - **Total amount used.** - **Application method and equipment.** - **Worker(s)/operator(s).**

PESTICIDE TREATMENT 	- **Date.** - **Orchard/field/plot identification.** - **Variety.** - **Targets.** - **Brand name.** - **Formulation.** - **Dose per hectare.** - **Quantity measured.** - **Volume of diluted spray product prepared.** - **Time to harvest.** - **Appliance nº.** - **Worker(s)/operator(s).**
HARVESTER 	- **Date.** - **Crop/Season.** - **Producer identification.** - **Orchard/field/plot identification.** - **Variety.** - **Number of cases/bins/containers and gross weight.** - **Worker(s)/operator(s).**
AGRICULTURAL COOPERATIVE / AUCTION / COLLECTION CENTER / WHOLESALER	
STAGE	**INFORMATION**
RECEPTION, WASHING AND DRYING 	- **Date.** - **Number of cases/bins/containers and gross weight.** - **Producer identification** (It can be expresses by **GLN** number). - **Carrier identification:** License plate, driver name, etc. - **Number of cases/bins/containers and gross weight.** - **Batches allocation.** - **Hazard analysis and critical control points (HACCP) records:** • Product quality control (organoleptic, physical, chemical or microbiological): Soluble Solids Content (SSC), sugar content, water content, pH, firmness, etc.. • Wash water analysis and amount of water used. • Etc.

SELECTION AND SORTING 	- **Date.** - **Identification of the line, machine/table, work shift, etc.** - **Batches identification.**
POST-HARVEST TREATMENT Wax application Chlorine SO2 generators O3 generators 	- **Date.** - **Identification of the line, machine, work shift, etc.** - **Identification of the batches treated.** - **Reason for treatment.** - **Type of treatment and brand name.** - **Dose/concentration.**
PACKING AND PALLETIZING 	- **Date.** - **Identification of the line, machine, work shift, etc.** - **Batches identification.** - **Trade unit identification (GTIN).** - **Logistic unit identification (pallet-SSCC).** - **Number of boxes.**
WAREHOUSE STORAGE 	- **Date and time of input and output** - **Identification of the warehouse, cooling/freezing room, etc.** - **Trade unit identification (GTIN).** - **Logistic identification (pallet-SSCC).** - **Batches identification.** - **Quantity incoming.** - **Quantity outgoing.** - **Remaining stock.** - **Destination of the product.** - **Hazard analysis and critical control points (HACCP) records:** Temperature/time log, relative humidity, cleaning and sanitizing, etc.

GOODS DISPATCH 	- **Date and time of dispatch.** - **Carrier identification:** license plate, driver name, reefer container number, etc. - **Work shift.** - **Trade unit identification (GTIN).** - **Logistic identification (pallet-SSCC).** - **Batches identification** - **Next food business identification (GLN) or destination of the product.**

6 Traceability information in ready meal

Modern lifestyle has increased demand for nutritious snacks and convenience foods, ethnic dishes and other special/gourmet products.

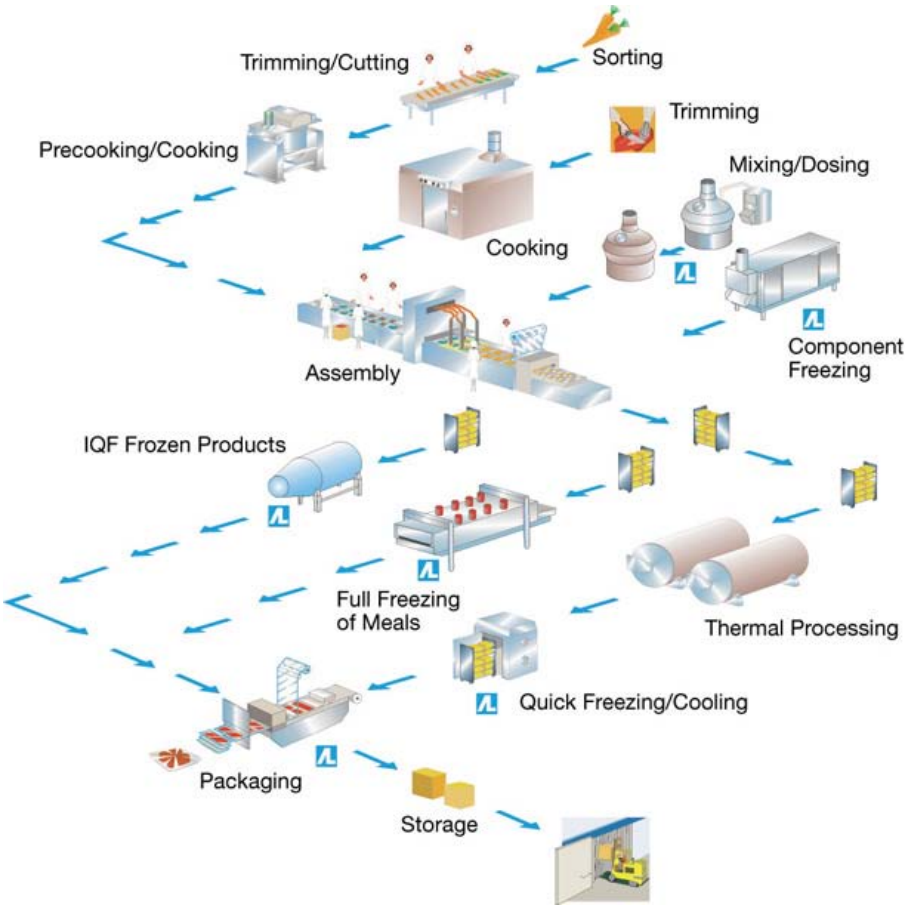


Figure 14 – Ready meal process (AIR LIQUIDE)

The following table provides a proposal for traceable information for ready meal chain.

TRACEABILITY INFORMATION IN READY MEAL CHAIN	
STAGE	**INFORMATION**
GOODS RECEIPT Raw materials Ingredients Packaging material 	- **Date and time of receipt.** - **Previous food business identification (GLN).** - **Carrier identification:** license plate, driver name, reefer container number, etc. - **Trade unit identification (GTIN).** - **Logistic identification (pallet-SSCC).** - **Work shift.** - **Hazard analysis and critical control points (HACCP) records:** Reception control (organoleptic, physical, chemical or microbiological), temperature of products when received, etc.
RAW MATERIAL STORAGE Freezing room Cooling room Warehouse 	- **Date and time of input and output.** - **Identification of the warehouse, cooling/freezing room, etc.** - **Trade unit identification (GTIN).** - **Logistic identification (pallet-SSCC).** - **Batches identification.** - **Quantity incoming.** - **Quantity outgoing.** - **Remaining stock.** - **Work shift.** - **Destination of the product:** Production, return, another warehouse, etc. - **Hazard analysis and critical control points (HACCP) records:** Temperature/time log, relative humidity, cleaning and sanitizing checks, etc.

PRODUCTION • Sorting • Trimming/Cutting • Precooking/Cooking • Assembly • Freezing/Cooling • Thermal processing • Packaging 	- **Date and time of production.** - **Production line identification.** - **Work shift.** - **Trade unit identification (GTIN).** - **Logistic unit identification (SSCC).** - **Batches identification and relation between raw materials and finished products.** - **Name/type of product.** - **Product specification:** Composition, type of packaging, date of durability, etc. - **Net weight.** - **Process specification:** Treatments applied to the product and characteristics (times, temperatures, pressures, etc.). - **Quality control** (organoleptic, physical, chemical or microbiological). - **Hazard analysis and critical control points (HACCP) records:** Temperature/time log, quality control checks, etc. - **Prerequisite programs (ISO 22.000) records:** ***Infrastructure and maintenance programs*** • Lay-out, design and construction of buildings and facilities, including workspace, employee facilities, and associated utilities. • Supplies of air, water, energy and other utilities. • Equipment including its preventative maintenance, calibration, sanitary design and accessibility for maintenance and cleaning for each unit. • Supporting services including waste and sewage disposal. ***Operational prerequisite programs*** • Personnel hygiene. • Cleaning and sanitizing. • Pest control. • Measures for the prevention of cross contamination. • Packaging procedures. • Management of purchased materials (e.g. raw materials, ingredients, chemicals), supplies (water, air, steam, ice, etc.), disposals (e.g. waste and sewage) and handling of products (e.g. storage and transportation).

PACKAGING AND PALLETIZING 	- **Date.** - **Packaging line identification.** - **Work shift.** - **Trade unit identification (GTIN).** - **Logistic unit identification (pallet-SSCC).** - **Number of boxes.** - **Batch identification.**
FINISHED PRODUCT STORAGE Freezing room Cooling room Warehouse 	- **Date and time of input and output.** - **Identification of the warehouse, cooling/freezing room, etc.** - **Trade unit identification (GTIN).** - **Logistic identification (pallet-SSCC).** - **Batches identification.** - **Quantity incoming.** - **Quantity outgoing.** - **Remaining stock.** - **Destination of the product.** - **Hazard analysis and critical control points (HACCP) records:** Temperature/time log, relative humidity, cleaning and sanitizing, etc.
GOODS DISPATCH 	- **Date and time of dispatch.** - **Carrier identification:** license plate, driver name, reefer container number, etc. - **Work shift.** - **Trade unit identification (GTIN).** - **Logistic identification (pallet-SSCC).** - **Next food business identification (GLN) or destination of the product.**

7 Recommendations

Labeling requirements provided in Section 2 are mandatory and therefore must be taken into account in the development of traceability software.

There are different technologies and standards that can help implementing traceability in the food industry which are summarized in Section 3 and 4. Our recommendation is to use, where possible, the most recognized international standards, as GS1 standards. If the RFID is finally decided to be used, the EPC (Electronic Product Code) can be a good choice.

Tables in section 5 and 6 are a proposal for traceable information in fruit/vegetables and ready meal chains. This is only an approximation, since the traceable information to handle for each operator depends on the type of activity, position in the chain, processes and technologies used, etc.

8 References

1. REGULATION (EC) 178/2002 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety.
2. COUNCIL REGULATION (EC) 1182/2007 of 26 September 2007 laying down specific rules as regards the fruit and vegetable sector, amending Directives 2001/112/EC and 2001/113/EC and Regulations (EEC) 827/68, (EC) 2200/96, (EC) 2201/96, (EC) 2826/2000, (EC) 1782/2003 and (EC) 318/2006 and repealing Regulation (EC) 2202/96.
3. COMMISSION REGULATION (EC) 1221/2008 of 5 December 2008 amending Regulation (EC) No 1580/2007 laying down implementing rules of Council Regulations (EC) 2200/96, (EC) 2201/96 and (EC) 1182/2007 in the fruit and vegetable sector as regards marketing standards.
4. COMMISSION REGULATION (EC) 1580/2007 of 21 December 2007 laying down implementing rules of Council Regulations (EC) 2200/96, (EC) 2201/96 and (EC) 1182/2007 in the fruit and vegetable sector.
5. REGULATION (EU) 1169/2011 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 October 2011 on the provision of food information to consumers, amending Regulations (EC) 1924/2006 and (EC) 1925/2006 of the European Parliament and of the Council, and repealing Commission Directive 87/250/EEC, Council Directive 90/496/EEC, Commission Directive 1999/10/EC, Directive 2000/13/EC of the European Parliament and of the Council, Commission Directives 2002/67/EC and 2008/5/EC and Commission Regulation (EC) No 608/2004.
6. COMMISSION IMPLEMENTING REGULATION (EU) 931/2011 of 19 September 2011 on the traceability requirements set by Regulation (EC) 178/2002 of the European Parliament and of the Council for food of animal origin.
7. GS1 traceability for Fresh Fruits and Vegetables. Implementation Guide. Issue 2, May-2010.
8. Traceability. Comité de Liaison Europe-Afrique- Caraïbes-Pacifique (COLEACP).
9. Canadian Food Traceability Data Standard. Version 2.0.
10. Traceability System for Agricultural Products Distribution Based on RFID Technology. Koji Sugahara, Kazunori Sato, and Yoshinobu Kono.
11. ISO 22.000: Food safety management systems.
12. ISO 22005: Traceability in the feed and food chain.