

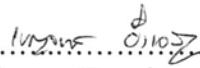
**TRACEABILITY SYSTEM IMPLEMENTATION IN ORGANIC
FARMING USING QR CODE TECHNOLOGY**


BENJAPORN EUNGJAROEN

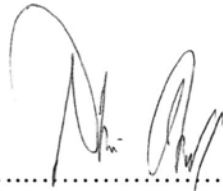
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OF THE REQUIREMENTS FOR
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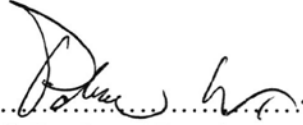
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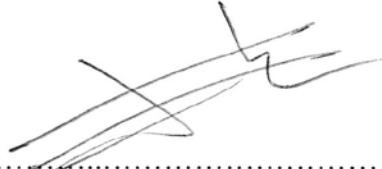
Thematic Paper
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.....
Lt. Benjaporn Eungjaroen
Candidate


.....
Lect. Sotarath Thammaboosadee,
Ph.D. (Information Technology)
Major advisor


.....
Lect. Smitti Darakorn Na Ayuthaya,
Ph.D. (Public Administration)
Co-advisor

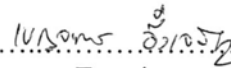

.....
Prof. Patcharee Lertrit,
M.D., Ph.D. (Biochemistry)
Dean
Faculty of Graduate Studies,
Mahidol University

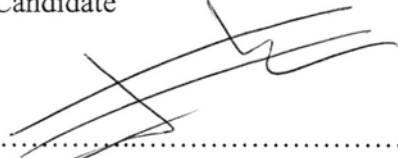

.....
Asst. Prof. Supaporn Kiattisin,
Ph.D. (Electrical and Computer
Engineering)
Program Director
Master of Science Program in
Information Technology Management
Faculty of Engineering
Mahidol University

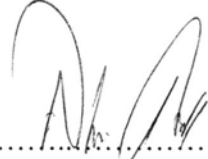
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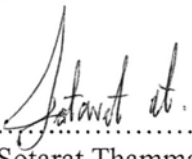
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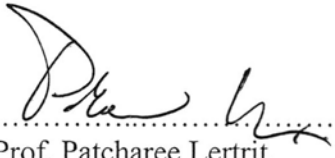

.....
Lt. Benjaporn Eungjaroen
Candidate



.....
Asst. Prof. Supaporn Kiattisin,
Ph.D. (Electrical and Computer
Engineering)
Chair


.....
Lect. Smitti Darakorn Na Ayuthaya,
Ph.D. (Public Administration)
Member


.....
Lect. Orasa Patsadu,
Ph.D. (Computer Science)
Member


.....
Lect. Sotarathammaboosadee,
Ph.D. (Information Technology)
Member


.....
Prof. Patcharee Lertrit,
M.D., Ph.D. (Biochemistry)
Dean
Faculty of Graduate Studies,
Mahidol University


.....
Asst. Prof. Jackrit Suthakorn,
Ph.D. (Robotics)
Dean
Faculty of Engineering
Mahidol University

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Benjaporn Eungjaroen

TRACEABILITY SYSTEM IMPLEMENTATION IN ORGANIC FARMING USING QR CODE TECHNOLOGY

BENJAPORN EUNGJAROEN 5836294 EGIT/M

M.Sc. (INFORMATION TECHNOLOGY MANAGEMENT)

**THEMATIC PAPER ADVISORY COMMITTEE: SOTARAT THAMMABOOSADEE, Ph.D.,
SMITTI DARAKORN NA AYUTHAYA, Ph.D.**

ABSTRACT

Nowadays, there is an increasing growth in the consumption of organic vegetables inside and outside the country, and at the same time, trade barriers have become stricter than in the past. As stated in Article 18 of European Food Safety Authority that the traceability of food showed established one step forward and one step back from the responsible food chain. the researcher designed the traceability system for organic vegetables which began with studying the information on organic farming, traceability system and relevant technology. Consequently, the design for business architecture, information system architecture, and technology architecture were carried out in line with the organic farming's supply chain process as well as International Federation of Organic Agriculture Movements Standard and ACT's Organic Farming Standards. The design also included the website of the traceability system for organic vegetables for the input and output demonstration. The QR Code technology was used in data collecting and the results could be used to enhance the efficiency of traceability system for organic vegetables accordingly. In the future, a study should be done on the design for traceability system that covers more agricultural products.

KEY WORDS: TRACEABILITY SYSTEM / ORGANIC VEGETABLES / QR CODE

71 pages

การนำระบบตรวจสอบย้อนกลับไปใช้ในสินค้าเกษตรอินทรีย์โดยใช้เทคโนโลยีคิวอาร์โค้ด
TRACEABILITY SYSTEM IMPLEMENTATION IN ORGANIC FARMING USING QR CODE
TECHNOLOGY

เบญจพร อึ้งเจริญ 5836294 EGIT/M

วท.ม. (การจัดการเทคโนโลยีสารสนเทศ)

คณะกรรมการที่ปรึกษาสารนิพนธ์ : โยทศร์รัต ธรรมบุษดี, Ph.D., สมิทธิ ดารากร ณ อยุธยา, Ph.D.

บทคัดย่อ

เนื่องจากในปัจจุบัน ความนิยมในการบริโภคผักอินทรีย์มีปริมาณเพิ่มมากขึ้นอย่างต่อเนื่องทั้งในประเทศและต่างประเทศ อีกทั้ง มาตรการการกีดกันทางการค้ามีความเข้มงวดมากขึ้นกว่าในอดีตที่ผ่านมา โดยมีการระบุในมาตราที่ 18 ของ European Food Safety Authority ว่า “ต้องมีการตรวจสอบย้อนกลับ เพื่อให้สามารถทราบแหล่งที่มาที่ไปของอาหารได้หนึ่งระดับ จากจุดที่ตนเองรับผิดชอบ” ดังนั้นงานวิจัยนี้จะดำเนินการออกแบบระบบการตรวจสอบย้อนกลับสำหรับผักอินทรีย์ โดยเริ่มจากการศึกษาข้อมูลเบื้องต้นของเกษตรอินทรีย์ ระบบตรวจสอบย้อนกลับ และข้อมูลเทคโนโลยีสารสนเทศที่เกี่ยวข้อง จากนั้นดำเนินการออกแบบ สถาปัตยกรรมทางธุรกิจ, สถาปัตยกรรมทางระบบสารสนเทศ และสถาปัตยกรรมทางเทคโนโลยี ให้สอดคล้องตามกระบวนการ Supply Chain ของเกษตรอินทรีย์และปฏิบัติตามมาตรฐาน IFOAM และ มาตรฐานเกษตรอินทรีย์ มกท. ทั้งนี้ได้ทำการออกแบบ website ระบบตรวจสอบย้อนกลับผักอินทรีย์สำหรับการกรอก และ การแสดงข้อมูล โดยเลือกใช้เทคโนโลยีสารสนเทศ QR Code เป็นตัวกลางในการจัดเก็บ และแสดงข้อมูล ทำให้ได้ระบบตรวจสอบย้อนกลับผักอินทรีย์ที่มีประสิทธิภาพ เป็นไปตามมาตรฐานเกษตรอินทรีย์ และ องค์การความปลอดภัยของอาหารแห่งยุโรป (European Food Safety Authority) ซึ่งในอนาคต จะดำเนินการออกแบบระบบตรวจสอบย้อนกลับให้ครอบคลุมผลิตภัณฑ์ทางการเกษตรเพิ่มมากขึ้น

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CHAPTER I

INTRODUCTION

1.1 Background and Problem Statement

Currently, consumption of organic vegetables has been consistently gaining popularity in Thailand and abroad. (Sansuk, 2016). Organic vegetables are defined as vegetables produced by natural methods with the use of organic fertilizers and natural extraction for preventing weed (Jingjit, 2012).

Each year, Thailand earns considerable income from vegetable exports and its products, with the year of 2015 accounting for 23,054 million Thai Baht (Ministry of Agriculture and Cooperatives, 2015). However, the country faces with issues on production and export process, for instance, trade sanctions on products' quality and standard.

Following stricter trade sanctions, the European Union then established the European Food Safety Authority (Public Health Security and Bioterrorism Preparedness and Response Act of 2002). It is indicated in Regulation EC 178/2002 Article 18 of the European Food Safety Authority that "traceability of food is required to track food one step forward and one step back from where the responsible person is." For instance, the central agriculture market is able to trace back which farm the vegetables it receives came from, where the farm is and who the owner of the farm is. This was implemented from 1st January 2005 and imposed exclusively upon food importers within the European Union.

International Federation of Organic Agriculture Movements (IFOAM) provided the definition of organic farming as the agricultural practice conducted by organic farming method recognized by international community. The method comprises of 4 aspects: ecosystem, health, attention and care, and fair practice (IFOAM General Assembly Resolution, 2006). For Thailand, the Organic Agriculture Certification of Thailand (ACT) was established to carry out the certification of

organic farming standard following IFOAM's practice. This unit was also accredited in 2001 (Organic Agriculture Certification Thailand, 2012) as shown in Figure 1.1.

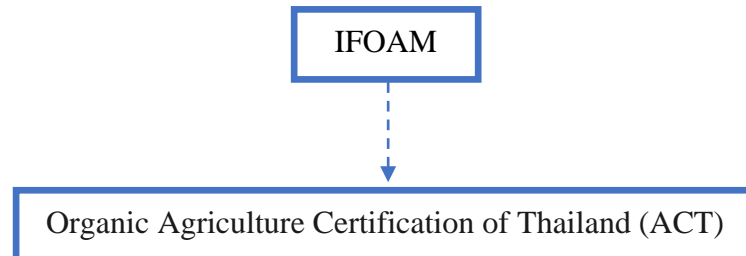


Figure 1.1 Organic Agriculture Certification of Thailand (ACT).

Traceability system is designed to ensure the consumers' confidence in selecting products for consumption. It helps trace the origin of the specific food and can lessen the possible loss from manufacturing firms' product recall in correct, accurate and swift manner (Waisayadamrong, 2006). Therefore, system can be beneficial to the business sector. When the buyer is confident in the food's origin and safety, the operator or the manufacturer gets bigger opportunity to access the market for expanded product distribution channel, resulting in higher profits. When problem arises, the operator or the manufacturer can either recall the products or take responsibility for the problematic lots only, which helps lessen the risk and loss in the business sector. Furthermore, the traceability system can screen food from inappropriate production process or fraud from the business sector. This helps put a fairer practice in the market competition as well as boosting the opportunity in the export of Thai food to markets abroad. (Office of Agricultural Affairs to the European Union, 2016)

It was found in the research of the traceability system for fresh vegetable imports by QR Code technology (Suejing, 2012) that the traceability system with QR Code technology was applied to level up the quality standard and to improve the product value as well as the safety of fresh vegetables. The production process and factors between organic and fresh vegetables are so different from farming practice, contamination prevention, use of production factors, and post-harvest management. The standard for organic farming is then incorporated into appointing the details

needed for the traceability system's accurate data in line with the organic farming standard.

According to the above motivation, this research is the design the traceability system for organic vegetables trading chain to ensure the efficient system in line with the organic farming standards of IFOAM and the European Food Safety Authority (EFSA).

1.2 Objectives

To design the system and details of data collection for the traceability of organic vegetables trading by using QR Code technology.

1.3 Scope of Work

To design information and technology architecture for traceability of organic vegetables based on IFOAM's organic farming and EU standards. Every step of the design follow the requirements of IFOAM's organic farming and organic supply chain standards.

1.4 Expected Result

Blueprint of the efficient traceability system for organic vegetables following the organic farming and EFSA is achieved.

- Consumer : Confidence in organic farming products assured by the data gained from the traceability system
- Seller and manufacturer : Increased value of products from consumers' confidence
- Product : Certification as indicated by the law and the international standard recognized by trading partners

CHAPTER II

LITERATURE REVIEW

For the research on traceability system for organic vegetables, the researcher has conducted studies on relevant information, theories and research works for this project as follows.

2.1 Organic

2.1.1 Definition

Organic farming is carried out with natural method in which the land must not be contaminated, and that contamination of chemical substances in the soil, water and air must not be present to promote the soil's prosperity. This method also focuses on eco-diversity while prohibiting the use of chemical fertilizer and pesticide. (Development of Organic Production System Project for Temporary Correctional Facility under the Morale Program Supported by Her Royal Highness Princess Bajrakitiyabha)

Organic farming's production process focuses on the soil's conditions, the ecosystem and the people. Organic farming relies on ecology process, natural cycle and bio-diversity. Each area comes with distinct characteristics and thus is not worth the use of production resources that could send out negative effect. In addition, organic farming has combined local wisdom, innovation, scientific knowledge, promotion of fair relations, people's quality of life and all the living things concerned. (Resolution of IFOAM Commission's Convention in Italy, June 2008)

2.1.2 Procedure

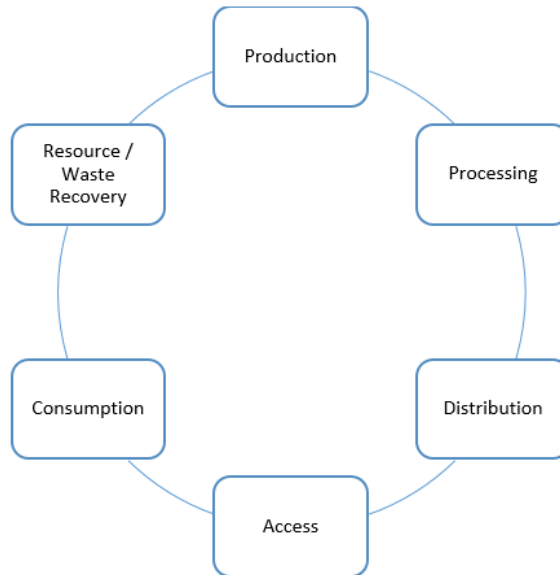


Figure 2.1 Organic Process.

2.1.3 Organic Farming Standard of the Organic Agriculture Certification Thailand (ACT)

This standard is established by the ACT’s Sub-Committee on Standard following the guidelines on basic organic farming standard from International Federation of Organic Agriculture Movements (IFOAM). It covers aspects on organic plant production, post-harvesting actions and processing stage of organic products.

Table 2.1 ACT Standard

1. General farm management
1.1 General Principles
<u>Standard</u>
1.1.1 All synthetic chemical inputs are prohibited, including artificial fertilizers, pesticides and hormones.
1.1.2 Hydroponic production is prohibited.

Table 2.1 ACT Standard (cont.)

1.1.3	The use of nanomaterials in organic production and processing, including packaging and food contact surfaces, is prohibited.
1.1.4	In case the producer does not convert all fields to organic farming, the organic plots and conventional plots must be separated clearly and all fields shall be inspected by ACT.
1.1.5	The certified lands shall not be converted back and forth between organic and chemical production. ACT may not certify new lands if organic farming on previously certified lands are ceased without appropriate reasons.
1.1.6	Clearing primary ecosystem for practicing organic agriculture is prohibited.
1.1.7	ACT may not certify producers who invades public forest for doing organic farming. ACT may reserve the right to consider case by case.
1.1.8	If there is any change of the production in the farm, such as increase or decrease of the farm land, change of crop type, etc. the producer is required to inform ACT immediately.
1.1.9	The producer shall train and inform employees, responsible persons or subcontracted persons responsible for organic production to ensure their understanding and compliance with ACT Organic Standards and certification requirements.
1.1.10	The producer shall maintain the following records that are clear and available for inspection by ACT: <ul style="list-style-type: none"> 1.1.10.1 Records of all production stages from planting, maintaining, using of inputs, harvesting to post-harvest cropping 1.1.10.2 Records and/or purchasing documents that specify the origins, types and quantities of purchased inputs 1.1.10.3 Record of sales of organic products shall specify “organic” or “ACT” on the sale document
1.1.11	The producer/operator shall keep a register of complaints received and corrective action taken so that it can be inspected by ACT.
1.2 Ecosystem in organic farm	
<u>Standard</u>	
1.2.1	A producer shall maintain and enhance biodiversity in the farm by conserving

Table 2.1 ACT Standard (cont.)

<p>at least 5% of the field to be habitats of diversified plants and animals. Such areas may be forest land, flooded forest, bushes or big trees in the field, hedges in the borders, integrated orchards, ditches, natural fish ponds and idle areas with natural plants.</p>
<p>1.3 Genetically Modified Organisms (GMOs).</p> <p><u>Standard</u></p> <p>1.3.1 Using genetically engineered organisms and products thereof is prohibited in organic production and processing.</p> <p>1.3.2 Inputs, additives, processing aids and all ingredients in organic products shall be traced back one step of the production process in order to verify that they are not produced from plants, animals or microorganisms derived from genetic engineering, both direct and indirect ways.</p> <p>1.3.3 When the operator buys input, e.g. farm inputs, additives, processing aids and all ingredients in organic products, the operator has to ask for declaration that products supplied have not been produced from or by GMOs. For the specific countries with compulsory GMO labeling regulations, the operator may assume that no GMOs have been used when the products are not labeled with GMOs.</p> <p>1.3.4 If it is found from the examination that organic product is contaminated by GMOs, although it is unintentional and uncontrollable by the producer, ACT may not certify the product including the farm.</p> <p>1.3.5 In case the producer does not convert the whole farm into organic farming, any GMOs shall not be used in the conventional production.</p>
<p>2. Organic crop production</p>
<p>2.1 Length of conversion period.</p> <p><u>Standard</u></p> <p>2.1.1 All fields applied for organic certification shall be put into the conversion period. In such period, a producer must follow ACT Organic Standards, and be inspected and certified by ACT but the produce grown under the conversion period cannot be sold as organic. The application date is the first date of</p>

Table 2.1 ACT Standard (cont.)

<p>conversion of organic farming and the first date of conversion period. The producer shall begin following ACT Organic Standards from that date.</p> <p>2.1.2 For annual crop production (vegetable and cash crops), the conversion period is 12 months. The product of crop sown after the conversion period can be “organic product” with ACT seal. Except biennial crops, e.g. local vegetables, bananas, papayas, etc. the produce can be harvested and sold as “organic products” after the conversion period of 12 months has been met.</p> <p>2.1.3 For perennial crop production, the conversion period is 18 months. The produce harvested after the conversion period can be sold as “organic product” with ACT seal.</p> <p>2.1.4 For organic crop production intended to export to the European Union, the conversion period for annual crops are 24 months, biennial crops 24 months and perennial crops 36 months.</p> <p>2.1.5 If prohibited input was applied in the farm before date of application with ACT, crop to be sold as organic must be harvested after 36 months since the last use of prohibited input.</p> <p>2.1.6 ACT may extend the conversion period by considering the history of chemicals used in the farm, the contamination problem on that land, and the measure to manage the contamination of agro-chemicals and pollution in the farm.</p> <p>2.1.7 ACT may grant exception of the conversion period if the field has been practiced according to the principle of ACT Organic Agriculture Standards for several years. Such cases have to be verified through any evidences submitted to ACT, e.g. input records, crop production records, statements from non-conflict of interest organizations indicating that no chemicals has been used for a long time and the soil has been improved naturally, articles in independent publications, etc. ACT will verify such evidence and do evaluation during field inspection and reserve the right to consider case by case.</p>
<p>2.2 Type and variety of crops</p> <p><u>Practice guidelines</u></p> <ul style="list-style-type: none"> - It is recommended that the variety of crops should be suitable with local environment and resistant to diseases and insects

Table 2.1 ACT Standard (cont.)

<p><u>Standard</u></p> <p>2.2.1 Seeds and plant propagation shall be from organic agriculture.</p> <p>2.2.2 If case seed and plant propagation cannot be from organic agriculture and none of alternatives of the same species are appropriate, using of conventional seed is allowed but chemical treatment is prohibited.</p> <p>2.2.3 In case the producer uses organic annual crop seedlings and encounters disaster (e.g. flooding, drought) that seedlings are damaged, ACT may allow the producer to use conventional seedlings.</p> <p>2.2.4 ACT may allow the use of chemically-treated seeds or plant propagations in case it is legally required for phytosanitary purpose but the treated seeds shall be cleaned before sowing.</p> <p>2.2.5 Plant propagation can be based on generative reproduction (seeds) as well as vegetative reproductions e.g. grafting, rhizomes and meristem culture. All propagation practices on the farm shall be under organic management, except meristem culture.</p> <p>2.2.6 Only propagation materials, bedding materials and substrates listed in Appendix 1 (part 1) are allowed.</p> <p>2.2.7 For perennial crops, growing plant propagation from non-organic agriculture in organic farm is permitted but the produce of the crop in the first 12 months cannot be sold as organic product with ACT seal.</p> <p>2.2.8 Plants varieties and pollen from genetically modified organisms (GMOs) as well as transgene plants are not allowed.</p>
<p>2.3 Diversity of plants in organic farm</p> <p><u>Standard</u></p> <p>2.3.1 In annual crop production, the producer shall establish diversity of plants in the farm by at least practicing crop rotation in order to reduce diseases, insects and weeds, including rotating leguminous crops in order to improve organic matter and soil fertility. Exception may be considered if the producer can demonstrate diversity of plants by other means.</p> <p>2.3.2 In perennial crop production, the producer shall establish diversity of plants in the farm by at least growing cover crop and/or other diverse plant species.</p>

Table 2.1 ACT Standard (cont.)

<p>2.4 Parallel production</p> <p><u>Standard</u></p> <p>2.4.1 Crops grown in conventional field and in conversion field may not be the same as those in organic field and need to be sold as organic product certified by ACT. Except they are different varieties and easily distinguishable e.g. different shape/form, colour etc. or has different harvest time.</p> <p>2.4.2 ACT may allow parallel production only perennial crop and when there is an expansion of organic land, leading to a parallel production of organic and in conversion crop. In this case, the producer shall:</p> <p style="padding-left: 40px;">2.4.2.1 Inform ACT of the production plan and measures to be implemented to prevent commingling of the crop before production;</p> <p style="padding-left: 40px;">2.4.2.2 Implement a record system of the harvest, post-harvest, handling and sale of the products showing a clear separation of these products; Transform the parallel production into the organic farming practice within 5 years in which ACT may add more conditions for the producer's conduct and impose further inspection. ACT retains the right of consideration based on each case.</p> <p style="padding-left: 40px;">2.4.2.3 Convert the non-organic parallel production to organic production within 5 years; ACT may impose additional conditions for the producer and require extra inspection, and ACT may reserve the right to grant certification case by case.</p> <p>2.4.3 In case a producer receives farm rent as crop which is the same as crop certified by ACT, the producer shall also follow the standards 2.4.2.1 and 2.4.2.2 and ACT may impose additional conditions for the producer.</p>
<p>2.5 Soil, water and fertilizer management</p> <p><u>Recommended practice</u></p> <ul style="list-style-type: none"> - There should be an annual soil sampling for nutritional assessment for soil improvement planning and fertilization programme, as well as for determination of appropriate crop type. - Maintain proper soil pH appropriate to crop type through additions of lime, dolomite, marl or sawdust ash.

Table 2.1 ACT Standard (cont.)

- Land surface should not be left unprotected. Leguminous crop should be sown.
- Planting of leguminous crop for green manure is recommended. This can be done before or after the main crop or as crop rotation.
- Avoid or reduce using heavy machinery as it will cause soil compaction.
- Measure for water conservation at farm level is recommended.
- Measure to prevent salination of soil e.g. planting cover crops, appropriate water management, should be taken.

Standard**Soil improvement**

2.5.1 A producer shall try to use organic matter from plant and animal produced within the farm for soil improvement and try to reduce the use of brought-in organic materials. ACT will follow on case by case basis the maximum amount of brought-in organic materials used in the farm, taking into account of local conditions and specific nature of the crop.

2.5.2 There shall be an organic fertilization plan of the use of integrated organic fertilizers. The organic fertilizer shall be used as necessary and in appropriate amount with consideration of nutrient balance in the soil and the need of nutrient of that crop.

2.5.3 Only fertilizers and soil conditioners listed in Appendix 1 (part 1) are allowed.

2.5.4 Fertilizers and soil conditioners which are not listed in Appendix 1 (part 1) may be allowed after inspection by ACT according to the Guideline for Evaluation Additional Inputs in Appendix 4.

2.5.5 Prohibit the use of fresh animal manures likely to cause contamination on part of the plant intended for consumption.

2.5.6 Organic matter contained excrement from human is prohibited.

2.5.7 Urban waste is not allowed for composting due to risk of heavy metal contamination.

2.5.8 In case of using brought-in poultry manure or farm animal by-products, they shall be brought from farms which all animals are raised together in free-ranged areas. Raising animals in the limited areas may let them grow up in an unnatural environment. The producer shall inform ACT of the source of the manure.

Table 2.1 ACT Standard (cont.)

<p>2.5.9 Both on farm and brought-in composts are allowed but only organic materials listed in Appendix 1 (part 1) shall be used as ingredients in composting. The producer shall inform ACT the ingredients of organic material used in the compost and the source of the compost.</p> <p>2.5.10 In compost production, mineral fertilizers may be used to improve nutrient of the compost, such as ground rock phosphate for phosphorous, or graphite dust for potassium.</p> <p>2.5.11 Organic industrial waste can be used for composting but the producer shall inform ACT of the source.</p> <p>2.5.12 In case of risks of contamination of heavy metals or other undesirable residues in brought-in organic fertilizers or soil conditioners such as composts, mineral fertilizers, industrial by-products, etc., ACT may require that the producer have them tested before being used.</p> <p>2.5.13 Mineral fertilizers may be allowed to use as a supplementary role in a program addressing long-term fertility needs together with other techniques such as the use of nutrient recycling, leguminous crops, crop rotation and organic matter.</p> <p>2.5.14 Micro nutrients (listed in Appendix 1, part 1) may be applied to crops if there is a clear lack of such nutrients on the crops. However, the producer shall notify the problem and the effort to solve it by other means and/or the result of soil and tissue testing to ACT.</p> <p>2.5.15 Use of microorganism for soil improvement^u, composting, water treatment and waste management in animal house are allowed but not microorganism from genetic engineering.</p> <p>2.5.16 Prohibit Chilean nitrate and all synthetic nitrogenous fertilizers, including urea.</p> <p>2.5.17 Producer shall restrict to the minimum the burning of organic materials on farm. Producer is prohibited to do land preparation by burning vegetation or crop residues. Exception is granted in case of:</p> <p style="padding-left: 40px;">2.5.17.1 A necessary condition such as to control a serious insect or disease infestation</p> <p style="padding-left: 40px;">2.5.17.2 Shifting cultivation on high land. However, the burning should be</p>

Table 2.1 ACT Standard (cont.)

<p>made only at the necessary field.</p> <p>2.5.18 If farm has a risk of soil erosion, the producer shall institute measure to prevent soil erosion such as growing preventing soil erosion plants, planting crops in contour line, etc.</p> <p>2.5.19 The producer shall have measure to prevent excessive exploitation of water and the preservation of water quality, water recycling as well as water extraction.</p> <p>2.5.20 When appropriate, the producer shall institute measure to prevent salination of soil.</p> <p>2.5.21 In case the certified plant production producer have livestock (include poultry) on the certified area, the grazing management measure not to degrade land or pollute water resources shall be set.</p> <p>2.5.22 Soil removal from farm is prohibited except that incidental removal when harvesting crops.</p>
<p>2.6 Prevention and control of disease, insect and weed</p> <p><u>Recommended practices</u></p> <ul style="list-style-type: none"> - Promoting the distribution of beneficial animals and natural pest enemies (predator, parasite), such as growing of flowers as companion crops, growing plants for their habitats or building nests for birds. - Growing of insect repellent plants as mixed crop can help to reduce pest such as onion with cabbage and citronella with kale. - Avoid growing the same crop repeatedly on the same plot in order to reduce pest problem. Crop rotation is recommended. - Use of good cultural practices to control weed such as plowing, rotation, mixed crop, mulching crop and mulching from natural materials. <p><u>Standard</u></p> <p>2.6.1 Production system shall promote the balance of natural creatures to reduce insect, pest and weed problem.</p> <p>2.6.2 Only methods, products, including additives used in pest control products listed in Appendix 1 (part 2 and part 5) are allowed.</p> <p>2.6.3 Methods and products used for plant protection which are not listed in Appendix</p>

Table 2.1 ACT Standard (cont.)

<p>1 (part 2 and part 5) may be allowed after examination by ACT according to the Guideline for Evaluation Additional Inputs in Appendix 4.</p> <p>2.6.4 “Hang Lai” (<i>Derris elliptica</i> (Roxb.) Benth.) is allowed. But when used with leafy vegetables, there must be at least 7 days withdrawal period before harvest and the use should be careful because it is toxic to cold blood animal like fish.</p> <p>2.6.5 Use of detergent or synthetic sticking agents is prohibited.</p> <p>2.6.6 Physical and biological pest control is allowed but should be careful not to affect balance to pest and beneficial insects and organisms in the farm.</p> <p>2.6.7 Thermal sterilization to combat pest and disease in the soil is allowed only in a nursery and only for vulnerable seeds and or seedlings.</p> <p>2.6.8 Use of rice straw as mulching to prevent weed and maintain soil moisture. Preference is given to straw from organic farm. But if it is not available, straw from conventional farm is permitted.</p> <p>2.6.9 Use of plastic, based on polyethylene and polypropylene or other polycarbonates, for mulching, fruit wrapping, insect netting is allowed. The plastic shall be removed from a farm and shall not be burned on farmland.</p> <p>2.6.10 For substances permitted for use in traps and dispensers, the producer shall take precautions while they are in use and after to prevent them from contact with crops and being released into the environment.</p>
<p>2.7 Growth hormones and others</p> <p><u>Standard</u></p> <p>2.7.1 Synthetic growth stimulants are not allowed, e.g. using IBA and NAA for plant propagation.</p> <p>2.7.2 Synthetic dyes are not allowed for dying fruits to be colourful.</p> <p>2.7.3 Only growth hormones and other substances listed in Appendix 1 (part 2) are allowed. Other substances which are not listed may be allowed after examination by ACT according to the Guideline for Evaluation Additional Inputs in Appendix 4.</p>
<p>2.8 Protection of contamination</p> <p><u>Standard</u></p> <p>2.8.1 When organic field could be contaminated with chemicals from adjoining</p>

Table 2.1 ACT Standard (cont.)

conventional field and any sources of pollution and contamination, the producer shall set up buffer area to prevent chemical contamination. The buffer area shall have at least 1 metre width and:

2.8.1.1 If contamination by air-drift, there shall be crop grown to prevent spray contamination. The buffer crop cannot be sold as organic product; therefore, that crop must be different variety with easily distinguishable from certified crops. Exception when the crops in the buffer zone are perennial plants and they are grown on the buffer zone before applying for certification, producer shall separate the harvests from the buffer zone from organic crops, record the harvests as well as their sales.

2.8.1.2 If contaminated by water source, earth bund or drainage shall be established to prevent such contamination. If there is a high risk of external contamination, ACT may require the producer to expand such buffer area.

2.8.2 When there is high risk of chemical or heavy metal contamination, both from external factors and historical use of chemicals or inputs in the farm, the producer shall permit ACT to sample water, soil or products for verifying a contamination at the expense of the producer.

2.8.3 In the case that organic farm is in high risk of genetically modified engineering from inputs or adjacent conventional farms, the producers shall have following measures :

2.8.3.1 Having confirmed letters to prove that inputs have not a risk of contamination

2.8.3.2 Finding information that organic farm or the neighbouring area has never had contamination history

2.8.3.3 If there is a high risk, the producer shall permit ACT to sample plants for analysis in a laboratory to verify a contamination at the expenses of the producer.

2.8.4 Sprayers used in the conventional farming are not allowed to use in organic farm.

2.8.5 In case of agricultural machine, e.g. harvesting machine, threshing machine,

Table 2.1 ACT Standard (cont.)

<p>etc., is used in both conventional and organic farms, the producer shall clean the machine before using in organic farm.</p> <p>2.8.6 Prohibited inputs shall not be kept on the organic farm. Organic and chemical inputs storage areas shall be clearly separated.</p>
<p>2.9 Harvest and post-harvest management</p> <p><u>Standard</u></p> <p>2.9.1 All steps of harvesting and post-harvesting must be inspected and certified by ACT.</p> <p>2.9.2 The operator shall comply with relevant part of the standards in Section 4: Processing and Handling.</p> <p>2.9.3 In case a producer packs his/her own organic product and/or processes only his/her own organic raw materials as a small processor (the product is not less than 95% organic ingredients), this handling and processing shall be simultaneously inspected and certified together with the farm inspection and certification. The producer shall notify ACT if s/he needs to operate his/her own handling and/or processing or not.</p> <p>2.9.4 In case the handling and processing is complex or using organic raw materials from outside the farm, the operator shall apply for the additional scope of processing and handling with ACT.</p> <p>2.9.5 In case of use of organic seal, the operator shall comply with relevant part of the standards in Section 7: Labeling and Use of Organic Seal.</p>
<p>2.10 Protected cropping</p> <p><u>Standard</u></p> <p>2.10.1 Artificial light is only allowed for plant propagation and to extend the day length to a maximum of 16 days.</p> <p>2.10.2 The operator shall monitor, record and optimize the energy use, e.g. artificial light and climate control.</p>
<p>2.11 Breeding of organic varieties</p> <p><u>Standard</u></p> <p>2.11.1 Organic plant breeders shall select plant varieties under organic conditions</p>

Table 2.1 ACT Standard (cont.)

<p>certified by ACT or equivalence. Propagation methods shall be managed under organic farming system and certified by ACT, except meristem culture.</p> <p>2.11.2 Organic plant breeders shall use the genetic material that has not been contaminated by products or genetic engineering.</p> <p>2.11.3 Organic plant breeders shall disclose the applied breeding techniques. Organic plant breeders shall make the information about the used methods available for the public latest from the beginning of marketing of the seeds.</p> <p>2.11.4 Technical interventions into the genome of plants are not allowed (e.g. ionizing radiation; transfer of isolated DNA, RNA or proteins).</p> <p>2.11.5 Technical interventions into an isolated cell on an artificial medium are not allowed (e.g. GE techniques; destruction of cell walls and disintegration of cell nuclei through cytoplasm fusion).</p> <p>2.11.6 The operator has to maintain the natural reproduction methods, except the techniques that reduce or inhibit the germination capacities (e.g. terminator technologies).</p>
<p>3. Processing and handling</p> <p><u>Recommended practices</u></p> <ul style="list-style-type: none"> - Management and processing procedures of organic products should comply with Good Manufacturing Practice as well as considering the hygienic practice and consumers' safety. - Management and manufacturing procedures that are best in preserving the nutritional properties of organic food, conserving energy and minimizing environmental impact should be preferred.
<p>3.1 General principle</p> <p><u>Standard</u></p> <p>3.1.1 All steps of handling and processing must be inspected and certified by ACT.</p> <p>3.1.2 In case of changes of production sites, manufacturing process and products, the operator needs to inform the details to ACT for approval before the products can be sold as organic.</p> <p><u>Operator</u></p> <p>3.1.3 An operator who takes packed organic products for trading without opening and</p>

Table 2.1 ACT Standard (cont.)

<p>re-packing is exempted from ACT certification.</p> <p>3.1.4 An operator shall train and inform employees or responsible person about the requirement of ACT Standards.</p> <p>3.1.5 The operator shall maintain the following records and make them available for inspection by ACT at any time:</p> <p>3.1.5.1 Raw material buying records that specify the quantities, dates and suppliers' names</p> <p>3.1.5.2 Production records that state the dates, times, types and amounts of raw materials being used and the quantities of finished products, and lot numbers for traceability</p> <p>3.1.5.3 Sale records that show the quantities of products sold and sales income and the sale documents shall specify "organic" or "ACT."</p> <p>3.1.5.4 Inventories of raw materials and finished products</p> <p>3.1.6 The operator shall issue lot numbers on organic products that can be traced back to the production records and the origins of raw materials.</p> <p>3.1.7 Documentation shall clearly separate organic products from non-organic products at all stages of production. The organic status shall be identifiable by using "organic" in all the records of organic products.</p> <p>3.1.8 An operator shall retain documents which notify that the organic raw materials used in handling/processing have been certified by ACT or equivalence.</p> <p>3.1.9 For EU Programme, when receiving organic raw materials into the facility, the operator shall check the package labeling that it corresponds with the delivery documents and record its own inspection for ACT inspector to check. The label shall specify name and address of the supplier, lot number or traceability code of the raw materials and name and/or EU code of the certification body. If the information is incorrect or incomplete, the operator shall ask for more information from the supplier or refuse to receive the products.</p> <p>3.1.10 The operator shall retain the records (including those related to the sub-contractors) for at least 5 years.</p> <p>3.1.11 When an operator considers or suspects that a product which operator has produced, prepared, imported or that has received from another operator is not</p>
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Table 2.1 ACT Standard (cont.)

in compliance with organic standards, the operator shall have measures to withdraw any reference to the organic production from this product. In case of such doubt, the operator shall inform ACT immediately. ACT may require that the product cannot be placed on the market with indications referring to the organic production method until it is satisfied, by the information received from the operator or from other sources, that the doubt has been eliminated..

Sub-contractor

3.1.12 Sub-contractor is not necessary to apply for ACT certification but an agreement must be drawn up with the contracting operator. Sub-contractor shall comply with ACT Processing and Handling Standards and allow the access to the facilities, information and cooperation for inspection. The contracting operator, the owner of the finished product, shall apply for certification and be responsible to pay inspection fees as well as responsible for ensuring that the sub-contractor is in compliance with ACT Organic Standards and conditions.

3.2 Raw materials, ingredients, additives and processing aids

Standard

- 3.2.1. Raw materials shall be organically-certified products.
- 3.2.2. In case organic raw materials are insufficient, ACT may allow using raw materials from conventional sources as ingredients. The operator shall inform ACT for examination. For EU Programme, only conventional raw materials listed in Annex IX in Regulations EC no. 889/2008 are allowed.
- 3.2.3. In each processed product, the same kind of raw materials cannot be a mixture of both organic and conventional produce.
- 3.2.4. Finished organic product which all ingredients are not organic produce may be certified when proportion of organic ingredients as follows:
- 3.2.4.1 Organic produce shall not be less than 95% by weight, excluding water and salt and other allowed ingredients of not more than 5%.
- 3.2.4.2 Organic produce shall not be less than 70% by weight, excluding water and salt and other allowed ingredients of not more than 30%.
- 3.2.5. In case of product certified under the ACT-EU equivalent programme, the products marked with an asterisk (*) in Annex 2.1 has to be calculated as

Table 2.1 ACT Standard (cont.)

<p>ingredients of agricultural origin. The substances not marked with an asterisk * are not to be calculated as ingredients of agricultural origin.</p> <p>3.2.6. Use of additives and processing aids should be as little as possible. When it is necessary, only additives and processing aids listed in Appendix 2 are allowed. Additives and processing aids which are not listed in Appendix 1 may be allowed if the operator reports to ACT for examination and approval according to Guidelines and Processing Aids in Appendix 5.</p> <p>3.2.7. The following substances are not allowed for food processing: saccharin, borax, mono sodium glutamate, synthetic anti-oxidants, synthetic preservative, synthetic flavour, bleaching agents (sulfur dioxide). Vitamins and minerals shall not be used in organic processing.</p> <p>3.2.8. Raw materials from conventional sources, additives, processing aids, microorganisms and enzymes used in processing shall not be GMOs.</p> <p>3.2.9. Microorganisms and enzymes used in processing shall be cultured or prepared preferably from organic materials. This also applies to household production. Only additives and processing aids listed in Appendix 2 can be used.</p> <p>3.2.10. Water that is used as ingredient in the processing or comes in direct contact with organic products shall be of drinking standard; the equipment and materials used in water filtration shall contain no asbestos.</p>
<p>3.3 Processing method</p> <p><u>Standard</u></p> <p>3.3.1. The following processes are allowed:.</p> <ol style="list-style-type: none"> 1. Physical processes such as milling, pressing (liquid extraction), oil extraction; 2. Biological processes such as fermentation. Produce from GMOs however is not allowed. 3. Wind drying and sun drying, drying by heat, frying, stir-frying, evaporation, smoking; 4. Extraction only by water, ethanol, animal and plant oil, vinegar, carbon dioxide, nitrogen; 5. Precipitation

Table 2.1 ACT Standard (cont.)

<p>6. Filtration</p> <p>7. Distillation</p> <p>3.3.2. Microwaving and ionizing radiation of raw materials, ingredients and additives are not permitted.</p> <p>3.3.3. Substances and techniques that compensate the loss for nutritional properties due to the processing and storage of organic food shall not be used.</p> <p>3.3.4. Radiation of organic produce and products is prohibited.</p> <p>3.3.5. Only filtration techniques that have no chemically reacted or modify food on a molecular basis are allowed. Filtration substances shall not be made of neither asbestos nor substances which may negatively affect the product.</p> <p>3.3.6. Use of ethylene as ripening agent is allowed.</p> <p>3.3.7. Waste from processing shall be managed appropriately to have minimum effect to the environment. When appropriate, waste should be reused.</p> <p>3.3.8. All equipments, containers and processing method shall be clean and hygienic and there shall be measure to prevent contaminants (e.g. microorganism, pest and chemicals and nanomaterials)</p> <p>3.3.9. Aluminum containers are not allowed for alkali food processing.</p> <p>3.3.10. If the same processing equipment, machine and area is used for conventional product and organic product, the operator shall:</p> <p>3.2.10.1 Not process conventional and organic products at the same time.</p> <p>3.2.10.2 After processing conventional products, clean the areas, containers, equipment and machines with cleaning agents and rinse with water or allow time for them to evaporate. The operator shall check and make sure that no residue is left before starting the processing of organic products. Cleaning records shall be kept for inspection by ACT.</p> <p>3.3.11. Only cleaning agents listed in Appendix 1 (part 4) are allowed to be used for cleaning containers, equipment and processing areas.</p> <p>3.3.12. Solvents used to extract organic products shall be either organically produced or food grade substances listed in Appendix 2 and consistent with limitation.</p>
<p>3.4 Storage of produce and product</p> <p><u>Standard</u></p>

Table 2.1 ACT Standard (cont.)

<p>3.4.1. All storage facilities of produce and final product shall be inspected by ACT. In case the storage is situated out of the farm or processing unit, a producer/operator shall notify Act.</p> <p>3.4.2. Organic produce/products must be stored separately from conventional or non-certified produce/products, except they are packed in packaging with different colour or clear labeling. Such separation and identification must be made during transportation until it reaches consumers. Measures shall be put in place to prevent stored organic produce and products from being contaminated by prohibited substances at all times.</p> <p>3.4.3. Organic raw materials must have a clear label specifying organic product all the time, except when all raw materials kept in the storage house are ACT certified organic sources.</p> <p>3.4.4. Storage produce and product in controlled atmosphere by using carbon dioxide, nitrogen or oxygen is permitted.</p> <p>3.4.5. Vacuum packing and carbon dioxide fumigation are permitted.</p> <p>3.4.6. Cold and frozen storage is permitted.</p> <p>3.4.7. Humidity regulation is permitted.</p> <p>3.4.8. Fumigation with chemicals e.g. ethylene oxide, methyl bromide, aluminum phosphide, dichlorvos and products not listed in Appendix 2 is prohibited.</p> <p>3.4.9. Pest control in the storage shall be prioritized in compliance with the followings:</p> <p>3.4.9.1 The operator shall try to use preventative methods such as cleaning the storage, elimination of storage pest, habitat, etc.</p> <p>3.4.9.2 Mechanical, physical, biological methods and products listed in Appendix 1 (part 3) are allowed.</p> <p>3.4.9.3. Products which are not listed in Appendix 1 (part 3) may be allowed after examination by ACT according to the Guideline for Evaluation Inputs in Appendix 4. The producer/operator shall report ACT before using those products.</p> <p>3.4.9.3. In case that chemical pest control in processing areas or warehouses in necessary, the operator shall notify ACT of the plan and types of</p>
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Table 2.1 ACT Standard (cont.)

<p>chemical pesticides to be applied for approval before implementing. To implement the approved synthetic chemicals for pest control, those chemicals shall not be persistent chemicals and all organic products shall be removed from the storage house before spraying, and before moving the organic product in, an operator must check to assure that no residue is left to contaminate in organic products. The spray of pesticide in storage area must be recorded. In case there is suspicion of contamination, ACT may require residual analysis in the products at the expenses of the operator.</p>
<p>3.5 Packaging</p> <p><u>Recommended practices</u></p> <ul style="list-style-type: none"> - The producer/operator should adopt a policy to reduce waste from packaging. <p><u>Standard</u></p> <p>3.5.1. Packaging materials for organic produce shall never be used for packing chemicals, fertilizer or any substance which may harm consumer’s health.</p> <p>3.5.2. Packing materials shall not be treated with chemicals or fungicide.</p> <p>3.5.3. Packing materials for finished products shall be clean, never used for packing any other food or materials, except glass container.</p> <p>3.5.4. Use of packing materials should have less pollution to the environment. Packaging materials which can be recycled should be chosen.</p> <p>3.5.5. Multi-layer packaging is not recommended.</p> <p>3.5.6. Styrofoam is not allowed to use as packaging.</p>
<p>3.6 Transportation</p> <p><u>Standard</u></p> <p>3.6.1. Transportation of organic products shall not have the contamination or commingling with conventional products. If it cannot do so, the organic products shall have a clear labeling and are packed in container, which can prevent contamination. The producer/operator shall take responsibility of organic products during transportation.</p> <p>3.6.2. For organic produce or products delivered or sold wholesale or in bulk to processors, packers, traders, etc., the operator shall label the products as per</p>

Table 2.1 ACT Standard (cont.)

requirement of 7.12.
4. Labeling and use of organic seal
<u>Standard</u>
4.1. Organic products certified by ACT can be labeled as “organic product” with ACT seal on them or their packages.
4.2. Unprocessed products can be labeled as “organic product” with ACT seal provided that all the ingredients in containers, packages, sacks, etc. are certified by ACT.
4.3. Processed products certified and approved by ACT can be labeled with ACT seal if they are:
4.3.1. Product containing at least 95% (by weight and excluding water and salt) of their agricultural ingredients as organic
4.3.2. Products containing at least 70% (by weight and excluding water and salt) of their agricultural ingredients as organic.
4.4. A product with at least 95% of its agricultural ingredients as organic can be labeled as “organic product” and use ACT seal on its package.
4.5. A product with at least 70% of its agricultural ingredients as organic cannot be labeled as “organic product.” However, its label can include claims of product from organic raw materials and shall place the percentage of organic ingredients, e.g. “82% organic materials”, near ACT seal.
4.6. Produce and products that are certified and approved by ACT but cannot be labeled with ACT seal are:
4.6.1 In-conversion products.
4.6.2 Products with less than 70% of their agricultural ingredients as organic excluding water and salt.
4.7. A product with less than 70% of its agricultural ingredients as organic cannot be claimed as “organic product”, certified by ACT and labeled with ACT seal. However, ACT may allow claims of containing organic ingredients certified by ACT to be included in its label which shall list their percentages as verified by ACT.
4.8. Using ACT seal or ACT’s name as product brand name is prohibited. The

Table 2.1 ACT Standard (cont.)

	word specifying the organic certification and ACT seal shall not exceed $\frac{3}{4}$ size of the product brand name.
4.9.	Inputs certified by ACT shall use special ACT seal particularly for inputs.
4.10.	The labels shall have the names of ACT-certified producers or operators and contacting addresses. For processed products, the labels shall include manufacturing and/or expiring dates and net weight.
4.11.	For multiple-ingredient processed products, the labels shall list the ingredients and their percentages of weight from more to less and identify those which are organic. For additives, it shall specify the full name. For herbs and/or spice that constitute less than 2% of the total product weight, they may be listed as “spices” or “herbs” without stating the percentage.
4.12.	Labels on organic produce or products delivered or sold wholesale or in bulk to processors, packers, traders, etc., shall contain the names of the producers or operators certified by ACT, lot numbers, organic status and contacting addresses. In case of EU certification, the operator must add the following information on the label: operator’s address and ACT’s name or ACT’s EU Code.
4.13.	Using ACT seal as claimed that ACT certified organic product is “GM free product” is not allowed, for not to be misled that this is the certification of GM free product.
4.14.	Only producers and operators who have signed contracts on seal use with ACT are allowed to use the phrase “organic product” and ACT seal in the labels.
4.15.	Before printing product label with ACT seal or ACT’s name on the package, producer and/or operator must inform ACT and submit the layout of package indicating the size and position of ACT seal for approval by ACT.
4.16.	In case of product certified under the ACT-EU equivalent programme: 4.16.1. Processed product is allowed to use EU organic seal when at least 95% of the product is comprised of organic ingredients. 4.16.2. Product labeling with EU organic logo shall follow the relevant EU regulations. For full details, please refer to this website: http://ec.europa.eu/agriculture/organic/eu-policy/logo_en



Figure 2.2 Organic Agriculture Certification Thailand.

Traceability system is mentioned in section 1.3.2, 3.1.5.2, 3.16 and 3.1.9 of ACT Organic Agriculture Standards on which information needs to be collected to facilitate the traceability.

2.2 Traceability System

It means the system designated for boosting consumers' confidence in making a purchase of product that is not contaminated and safe. It helps tracing the route of the specific food and can reduce the manufacturing firms' damage in product recall in accurate, precise and swift manner. (Chalermchon Waisayadamrong, 2006)

Traceability procedure traces the route of raw materials from production process to delivery to customer so that the specific product can be recalled in case of trouble with the raw materials or production process. Further inspection shall be made to find out the cause of the product's damage and that preventative measure can be made to prevent the same issue. The traceability procedure consists of 2 procedures as follows: (Orapin Udomtanateera, 2014)

1. Tracking is the system that's able to trace the focus's location. An example would be a food manufacturer finds out that there was a problem with the raw material used in one lot of his/her food production. The product however was already distributed for sale. The manufacturer then needs to recall all the products from the problematic lot. (S)he has to trace the production and distribution route, so that (s)he

will know where those products are located and can perform the right product recall. Such practice is the way to trace the product's destination.

2. Tracing is the ability to inspect information of the problematic product such as where and when it is manufactured, which production line it was from and where the raw materials came from. This is to pinpoint where the problem starts and from that point on, how many products are manufactured along with details on the production process. This is done with the objective to perform a correct product recall. Such practice is the way to trace the origin of the product, so that the information can be used in tracing the product's destination.



Figure 2.3 Traceability System.

2.3 QR Code

QR Code is shortened for Quick Response Code which was developed by Denso Wave Inc., a subsidiary of Toyota Japan in 1994. It features 2-dimension barcode and was developed from the 1-dimension type. QR Code can record information in various languages and in either vertical or horizontal orientation. Apart from the capacity of 4,000 alphabets for data collection, QR Code can respond swiftly to data reading or decoding as well as reading QR Code by QR Code scanner on mobile phones with camera or Smartphone.

There are different types of QR Code.

Table 2.2 Type of QR Code






Category	Format	Attribute
QR Code Model 1 and Model 2		<ul style="list-style-type: none"> - QR Code Model 1 is the original QR Code that can contain data up to 1,167 alphabets at maximum. The most developed version for this type is Version 14 (73*73 modules). - QR Code Model 2 which was developed from Model 1 can contain data up to 7,089 alphabets. The highest version is Version 40 (177*177 modules).
Micro QR Code		<p>This one is the smallest QR Code which can contain data at maximum 35 alphabets. The highest version is Version M4 (17*17 modules).</p>
iQR Code		<p>This type can produce code in the form of square or rectangular shape and can contain data up to 40,000 alphabets at maximum. The highest version is Version 61 (422*422 modules).</p>
SQRC		<p>This type of QR Code restricts the reading right. It is used for personal or corporate data. It looks like the normal QR Code.</p>

Table 2.2 Type of QR Code (cont.)

Category	Format	Attribute
Frame QR		This type of QR Code comes with “Canvas Area” in which alphabets or pictures can be inserted.

In this research, the type QR Code Model 2 is selected because it is in popular demand and comes with the right size for data collection.

2.4 Related research

Jiraphon Suejing (2012) studied the traceability system for export of fresh vegetable export by QR Code technology. The QR Code which was implemented in the traceability system can be used as evidence for the fresh vegetables’ identity. Usage guidelines for QR Code were divided into 4 parts: farmer system, packing factory system, wholesaler system and central market, and exporter system. This helps in finding the fresh vegetables’ origin easily and rapidly as well as improving the import’s capacity. However, there are some restrictions because the implementation knowledge of QR Code in agricultural products is not sufficient and the product’s identity can be rewritten. Moreover, development is more difficult due to lack of knowledges and skills. To continue the development, knowledge and understanding about QR Code as well as significance of traceability system are the priority that needs to be provided to farmers in the first place. The standard of Central database system and records should be established for information exchanges.

Madeena Noitubtim and Kanokwan Sukkajornwong (2013) studied the adaptation of the traceability system in food industry. Their research explained the guidelines of the European Food Safety Authority (EFSA) and steps for food safety in Regulation EC 178/2002 which indicated that a person must be able to trace back the origin of food at one step back from where it is in charge of. The traceability system can help reduce burdens for manufacturers as well as contributing great benefits to consumers in receiving safe food. However, there are some restrictions on the traceability system, for which it cannot cover all types of food products. Thus,

development for traceability system's software should be made to cover all types of food products. Operators and farmers can then implement the traceability system while the system will be very useful for Thailand's food industry development.

Anuwat Jaidee and Pathusadee Sirisaengtrakun (2014) studied the traceability and inspection system of mushroom spawn using barcode and RFID technology. The study also included the system's development in user contact in the form of application developed by PHP language as well as data collection with MySQL Relational Database Management System to level up Thailand's agricultural products following the requirements of the National Bureau of Agricultural Commodity and Food Standards, Ministry of Agriculture and Cooperatives. The research however has not been installed and tested with the actual system, resulting in its lack of efficiency testing and the system's compatibility with every platform. Thus, it should be retested for efficiency and assessment so that the traceability system can be developed, and that the collected data can be used to support the decision-making system in the right and appropriate manner.

CHAPTER III

RESEARCH METHODOLOGY

The research on the traceability system for organic vegetables is conducted with the objective to design the system and details needed for data collection necessary in the system, so that the efficient traceability system for organic vegetables can be achieved. The research process is carried out in these following stages:

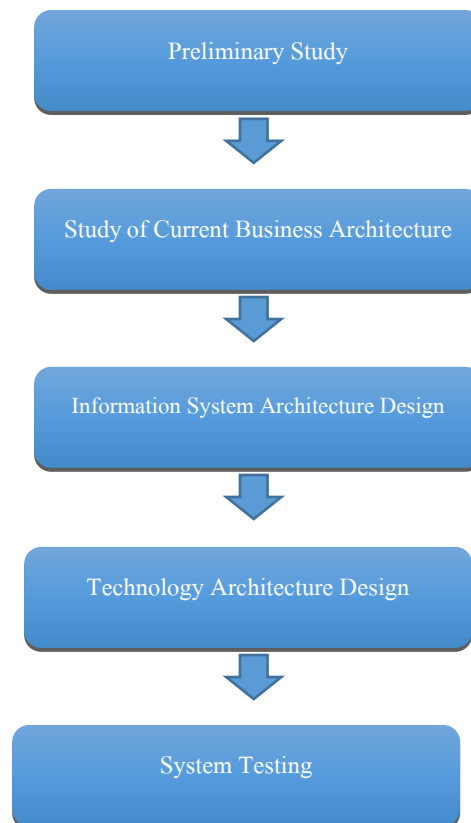


Figure 3.1 Research Methodology.

3.1 Preliminary Study

3.1.1 Organic farming

From the preliminary studies on organic farming standard, it is found that there are various types relevant to organic farming at both domestic and international levels. Such are Organic Farming Standard, Agricultural Products Standard, IFOAM, EU and NOP. This research meanwhile will base its studies on the IFOAM version which was developed by the International Federation of Organic Agriculture Movements. For Thailand, the organic farming standard certified by IFOAM is the Organic Agriculture Certification of Thailand or ACT which is upheld as the main standard in the design of information system architecture.

This also includes studies on organic vegetables' supply chain, which shows the components and stages.

Outcome from the study provides the insight that, in ACT, the details for data collection needed for the traceability system consist of production factors, additives, processing chemicals and ingredients in organic products, which must be able to trace back one step backward or forward in the production line. This is to ensure that the ingredients are not produced from any direct or indirect genetic engineering process of plant, animal or microorganism. Also, manufacturing papers must provide date and time of the production as well as types and quantity of the featured ingredients and the amount of the finished product. To be able to conduct the traceability process, operators must feature lot number on the products to ensure that the papers and origins of ingredients can be traced back. In terms of obtaining EU certification on organic ingredient receipt in the place of production, operators must verify the information featured on the ingredients' labels if they are matched with the products or not before recording such verification for ACT supervisors' further inspection. The labels must state the ingredient sender's name and address, lot number or traceability code, status of organic certification, name and/or EU code of the certification unit. In case of inaccuracy or incomplete data, the operator has to gain more information from the sender or refuse to receive the products.

3.1.2 Traceability System

Studies on the details of the traceability system were carried out to perceive the conditions of operations. It is found that if the traceability system is available, it will help expand the market and boost the value of organic vegetables. This research meanwhile will inspect the traceability at two steps in which consumers can trace back that the products they bought came from mall A, and that mall A had imported the specific products from company B, for instance.

3.1.3 Information Technology Study

Studies on information technology in data collection were carried out, with the main focus on QR Code. The reason for this focus is that QR Code technology can contain data the most, with the capacity up to 4,000 alphabets, respond swiftly to data reading or data decoding and read QR code by the QR code scanner on mobile phones with camera or smartphone. These qualities make this technology an ideal alternative for collecting data of organic vegetables for the traceability.

3.2 Study of Current Traceability System

The traceability process for organic vegetables used to be carried out in this way as shown in Figure 3.2 :

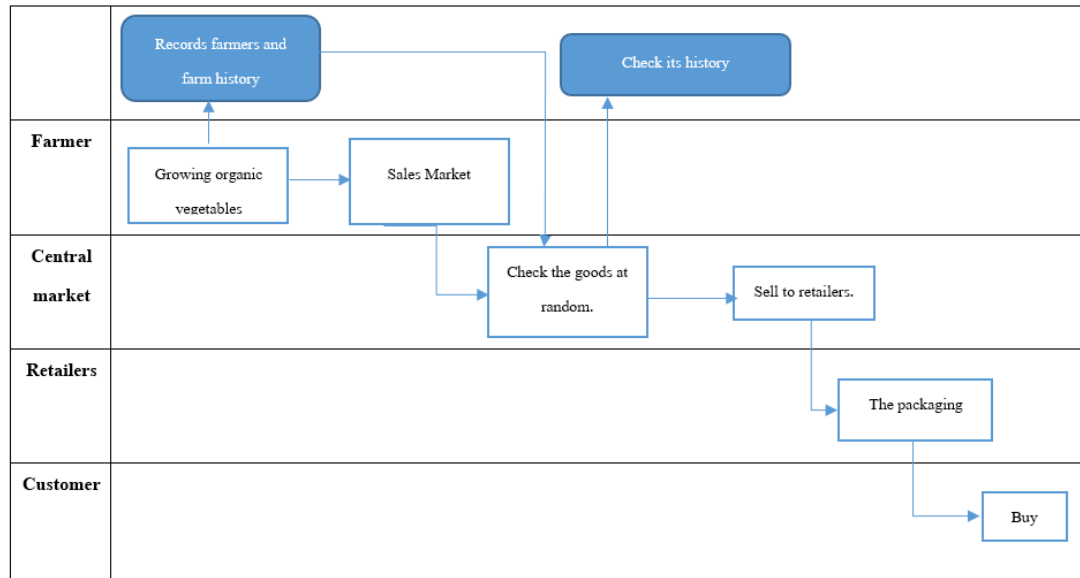


Figure 3.2 Original Traceability System.

The problem found in the aforementioned process is that buyers cannot make an immediate traceability. If they want to, they have to bring the data on the purchase date for inquiry to the central market. Also, the record which tells who purchase the product is not available, terminating the traceability at the central market only.

Thus, the researcher design the blueprint of efficient traceability system for organic vegetables in line with the Organic Farming Standard and European Food Safety Authority. It will consist of these following steps as shown in Figure 3.3:

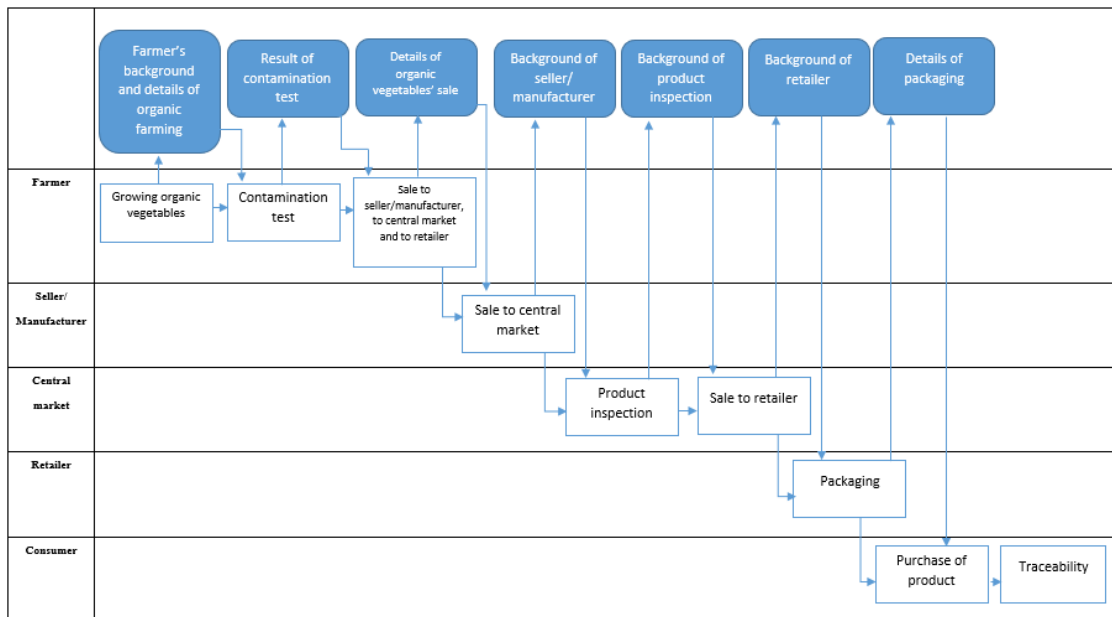


Figure 3.3 New Traceability System.

The new procedure will include more purchasing history between farmers, buyers/sellers, central market, retailers and consumers. Data and details occurred during the procedure will also be recorded, so that traceability can be done at every stage.

3.3 Design of Information System Architecture

This stage deals with information architecture necessary for the collection in which the information concerned are data related to farmers and land used in growing organic vegetables, details about organic vegetables, information of buyer and seller as well as product transportation.

The relationship model of the process concerned in the production of organic vegetables will be designed to illustrate the source and destination of organic vegetables. This will be presented in the relationship concept between consumer, seller and producer that can indicate the process and its relativity. Aspects included in the infrastructure here will be backgrounds of farmer and farm as well as that of seller, product verification, retailer and details about packaging. The outputs of this phase will shown in the next chapter.

3.4 Technology Architecture Design

Organic or not, types of packaging are not really different; only that organic products are featured with the symbol “organic.” (International Trade Center, 2012).

Materials used in the packaging consist of:

- Biodegradable packaging.
- Packaging Paper
- Packaging plastic.
- Packaging metal aluminum.
- Glass packaging
- Wood packaging

Technology that can be implemented in the process comprises barcode, RFID and QR Code, which will be selected solely following the right packaging conditions and the traceability system.

3.5 System Testing

The system will be tested its accuracy and reliability by input the information follow the purchase order process form including

1. Farmer to vendor, vendor to central market, central market to retailer
2. Farmer to central market, central market to retailer
3. Farmer to retailer

3.6 Timeline

Table 3.1 Timeline

Objective Plan	December 2016	January 2017	February 2017	March 2017	April 2017
Preliminary studies					
Study of Current Business Architecture					
Design of Information System Architecture					
Design of Technology Architecture					
System Testing					
Research Conclusion					

CHAPTER IV

RESULTS

The research methodology on Traceability System Implementation in Organic Farming Using QR Code Technology mentioned in chapter 3 comprises related information, education business architecture, information system architecture design, design technology architecture and evaluation. The results from carrying out the research methodology consist of these following details:

4.1 Information System Architecture Design

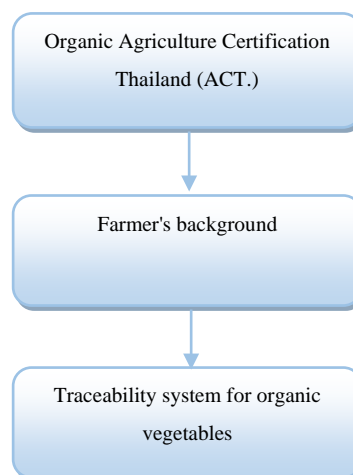


Figure 4.1 Data Integration.

In the process of Information System Architecture Design, details for design can be illustrated as follows:

1. ER – Diagram

Entity Relationship Diagram or ER is a model which is used to show the relational structure of information (Iamsiriwong, 2015). It consists of:

1. Entity - object or thing relevant to database

2. Attribute - entity's features

3. Relationship - relationship between entities

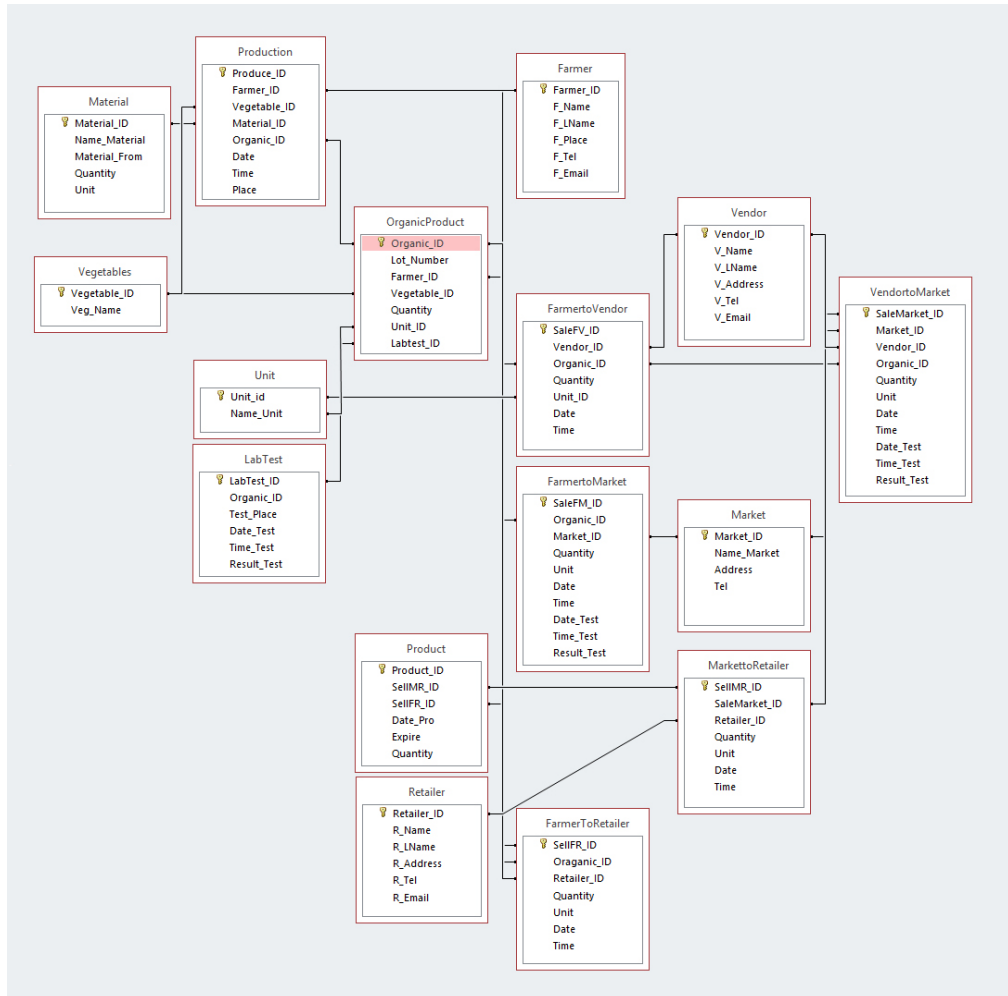


Figure 4.2 ER – Diagram.

2. Data Dictionary

Data Dictionary is shown in Appendix A.

The process of organic vegetables' sale and purchase is categorized in 5 forms of:

1. Farmer to vendor
2. Farmer to central market
3. Farmer to retailer
4. Vendor to central market
5. Central market to retailer

The website provides 3 main steps as follows:

1. Selecting category between farmer, seller/manufacturer, central market or retailer
2. Completing information in which each category comes with

different details for filling in

3. Providing QR Code from the details that are filled in

Details for each category that need to be taken into account can be classified as:

1. Farmer, with data details as follows:



1.1 Details of farmer

เกษตรกร

รหัสเกษตรกร

ชื่อเกษตรกร นามสกุลเกษตรกร

สถานที่ทำการเกษตร

Email address

หมายเลขโทรศัพท์ หมายเลขอื่นๆ

Figure 4.4 Details of farmer

For farmers' details, farmer's ID which connects to ACT is available. The ID that is filled in must be the same one from the farmer who is certified by ACT. This can help verify whether the farmer is really certified by ACT.

1.2 Organic vegetables' details

ผักอินทรีย์

รหัสการผลิต
00001

รหัสผัก
veg_01

รหัสผักอินทรีย์
01001

งวดการผลิต
1

วันที่ผลิต
23/1/2017

เวลาที่ผลิต
09:00

สถานที่ผลิต
อำเภอไชโย จังหวัดอ่างทอง ประเทศไทย

รหัสวัตถุดิบ
mat_01

ชื่อวัตถุดิบ
ปุ๋ยพืชสด

แหล่งที่มา
อำเภอไชโย จังหวัดอ่างทอง ประเทศไทย

ปริมาณวัตถุดิบ
30

หน่วย
กิโลกรัม

ปริมาณผักอินทรีย์
500

หน่วย
กิโลกรัม

Figure 4.5 Organic vegetables' details.

Details of organic vegetables consist of:

- Production ID: meaning the time that the farmer performs organic farming
- Vegetable's ID: meaning type of vegetables that are planted
- Organic vegetable's ID:
- Lot number of production: meaning the lot in which the vegetables are produced
- Manufacturing date: meaning the date when the farming begins
- Manufacturing time: meaning the time when the farming is carried out
- Manufacturing place: meaning place of farming
- Material's ID: meaning ID of raw materials used in farming
- Material's name: meaning name of the raw materials which need to be in accordance with the ID
- Source: meaning where the raw materials came from
- Amount of materials: amount of raw materials used in the farming
- Unit: the unit to indicate the amount such as kilogram or ton
- Amount of organic vegetables: amount of organic vegetables from harvesting

1.3 Details of contamination test

ผลการทดสอบสารปนเปื้อน

รหัสการทดสอบ

สถานที่ทดสอบ

วันที่ทดสอบ

เวลาที่ทดสอบ

ผลการทดสอบ

Figure 4.6 Details on contamination test.

Details for the contamination test consist of:

- Test ID: meaning ID for contamination test in organic vegetables
- Test place: meaning the place where the test is carried out
- Test date: meaning the date when the test is carried out
- Test time: meaning the time where the test takes place
- Test result: meaning the result from the contamination test

1.4 Details of sale and purchase

การซื้อขาย

รหัสการขายให้ผู้ซื้อ/ขาย

รหัสการขายให้ตลาดกลาง

รหัสการขายให้ผู้ค้าปลีก

ปริมาณ

วันที่ขาย

รหัสผู้ซื้อ/ขาย

รหัสตลาดกลาง

รหัสผู้ค้าปลีก

หน่วย

เวลาที่ขาย

Figure 4.7 Details of sale and purchase to vendor, central market and retailer.

Details of sale and purchase consist of:

- Sale ID to vendor: meaning sale ID of organic vegetables to vendor
- Vendor's ID: meaning to which vendor the transaction is made
- Sale ID to central market: meaning sale ID of organic vegetables to central market

- Central market's ID: meaning at which central market the transaction occurs

- Sale ID to retailer: meaning sale ID of organic vegetables to retailer
- Retailer's ID: meaning which retailer the translation takes place with
- Amount: amount of sale
- Unit: the unit of the sold amount
- Sale date: meaning the date when the sale takes place
- Sale time: meaning the time when the sale takes place

2. Data details for seller/manufacturer are as follows:



2.1 Details of seller/manufacturer

ผู้ขาย/ผู้ผลิต

รหัสผู้ขาย/ผู้ผลิต	
<input type="text" value="11232"/>	
ชื่อ	นามสกุล
<input type="text" value="สมิททานุภาพ"/>	<input type="text" value="สิ่งเจริญ"/>
ที่อยู่	
<input type="text" value="ต.ศาลายา อ.พุทธมณฑล จ.นครปฐม"/>	
เบอร์โทร	อีเมล
<input type="text" value="0994535979"/>	<input type="text" value="lyensha@gmail.com"/>

Figure 4.8 Details of seller/manufacturer

Details of seller/manufacturer consist of:

- Seller/manufacturer's ID: which tells the ID of seller/manufacturer
- Name: meaning name of seller/manufacturer
- Family name: meaning family name of seller /manufacturer
- Address: meaning address of seller/manufacturer
- Telephone number: meaning telephone number of seller/manufacturer
- E-mail: meaning e-mail of seller/manufacturer

2.2 Details of purchase/sale histories

การซื้อ/ขาย

รหัสการขายให้ตลาดกลาง รหัสตลาดกลาง รหัสผักอินทรีย์

ปริมาณ หน่วย

วันที่ เวลา

Figure 4.9 Details of purchase/sale histories to central market.

Details of the purchasing histories consist of:

- Sale ID to central market: meaning sale ID for organic vegetables to central market
- Central market's ID: meaning which central market the sale is made to
- Organic vegetable ID: meaning which organic vegetables are sold
- Amount: amount of sale
- Unit: the unit of the sold amount
- Date: date of sale
- Time: time of sale

3. Data details for central market are as follow:



1.1 Details of central market

ตลาดกลาง

รหัสตลาดกลาง ชื่อตลาดกลาง

ที่อยู่

เบอร์โทร

Figure 4.10 Details of central market.

Details of central market consist of:

- Central market's ID: meaning identification number of central market
- Name: meaning central market's name
- Address: meaning the location of central market
- Telephone number: meaning contact number of central market

1.2 Details of contamination test

การตรวจสอบสารปนเปื้อน

รหัสการตรวจสอบสารปนเปื้อน		
<input type="text" value="00121"/>		
รหัสผู้ซื้อ/ขาย	รหัสผักอินทรีย์	
<input type="text" value="11232"/>	<input type="text" value="01001"/>	
วันที่ทดสอบ	เวลาที่ทดสอบ	ผลการทดสอบ
<input type="text" value="25/3/2017"/>	<input type="text" value="15:00"/>	<input type="text" value="ผ่าน"/>

Figure 4.11 Details of contamination test.

Details of contamination test consist of:

- Sale ID: meaning ID of the sale made to central market
- Vendor's ID: meaning ID of vendor whose sale is made to central market
- Organic vegetable's ID: meaning ID of the sold organic vegetables
- Test date: meaning the date when the contamination test takes place
- Test time: meaning the time when the contamination test takes place
- Test result: meaning the result from the contamination test

1.3 Details of product sale

การขายสินค้า

รหัสการขาย	
<input type="text" value="21101"/>	
รหัสผู้ค้าปลีก	รหัสผักอินทรีย์
<input type="text" value="14359"/>	<input type="text" value="01001"/>
ปริมาณ	หน่วย
<input type="text" value="100"/>	<input type="text" value="กิโลกรัม"/>
วันที่	เวลา
<input type="text" value="25/3/2017"/>	<input type="text" value="16:00"/>

Figure 4.12 Details of product sale to retailer.

Details of product sale consist of:

- Sale ID: meaning sale ID between central market and retailer
- Retailer's ID: meaning ID of the retailer the sale is made to
- Organic vegetable's ID: meaning the ID of the sold organic vegetables
- Amount: amount of organic vegetables in the sale
- Unit: the unit amount of the organic vegetables that are sold
- Date: date of sale
- Time: time of sale

4. Data details of retailer are as follows:



4.1 Retailer's details

ผู้ค้าปลีก

รหัสผู้ค้าปลีก

ชื่อ

นามสกุล

ที่อยู่

เบอร์โทร

อีเมล

Figure 4.13 Details of retailer.

Details of retailer consist of:

- Retailer's ID: meaning identification number of retailer
- Name: meaning name of the retailer
- Family name: meaning family name of the retailer
- Address: meaning address of the retailer
- Telephone number: meaning contact number of retailer
- E-mail: meaning e-mail or retailer

4.2 Details of packaging

บรรจุภัณฑ์

รหัสผลิตภัณฑ์	
<input type="text" value="11009"/>	
รหัสการขายเกษตรกรขายให้ผู้ค้าปลีก	
<input type="text" value="รหัสการขายเกษตรกรขายให้ผู้ค้าปลีก"/>	
รหัสการขายตลาดกลางขายให้ผู้ค้าปลีก	
<input type="text" value="21101"/>	
วันที่ผลิต	วันหมดอายุ
<input type="text" value="26/3/2017"/>	<input type="text" value="4/4/2017"/>
ปริมาณ	หน่วย
<input type="text" value="2"/>	<input type="text" value="ลูก"/>

Figure 4.14 Details of packaging.

Details of packaging consist of:

- Product's ID: meaning ID of the product in the packaging
- Sale ID from farmer to retailer: meaning sale ID of organic vegetables between farmer and retailer
- Sale ID from central market to retailer: meaning sale ID of organic vegetables between central market and retailer
- Manufacturing date: meaning the date of the packaging
- Expiration date: meaning the expiration date of the product
- Amount: amount featured in the packaging
- Unit: the unit or amount in the packaging

After filling in details for each type of information, QR Code for each category will be ready at the end when all the processes are completed.



Figure 4.15 QR Code from filling in information.

When the QR Code is scanned for carrying out the traceability, the data of the organic vegetables' traceability will be provided differently based on the purchasing procedures which consist of:

1. Farmer to vendor, vendor to central market, central market to retailer
2. Farmer to central market, central market to retailer
3. Farmer to retailer



Figure 4.16 Results from QR Code scan following the 1st form of sale/purchase (Part 1).

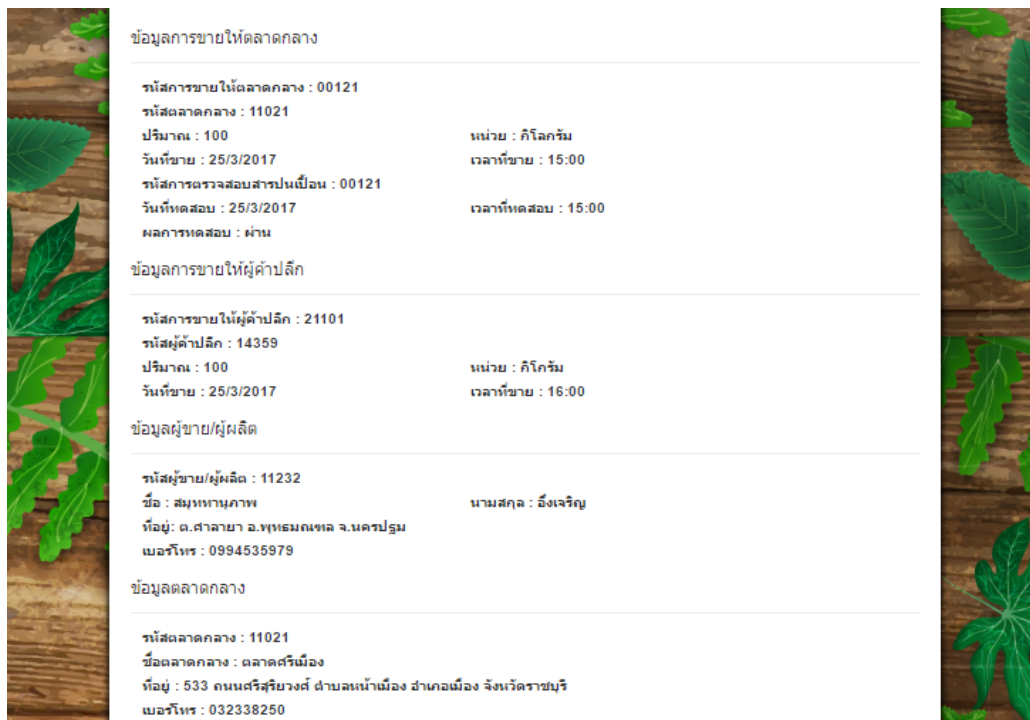


Figure 4.17 Results from QR Code scan following the 1st form of sale/purchase (Part 2).

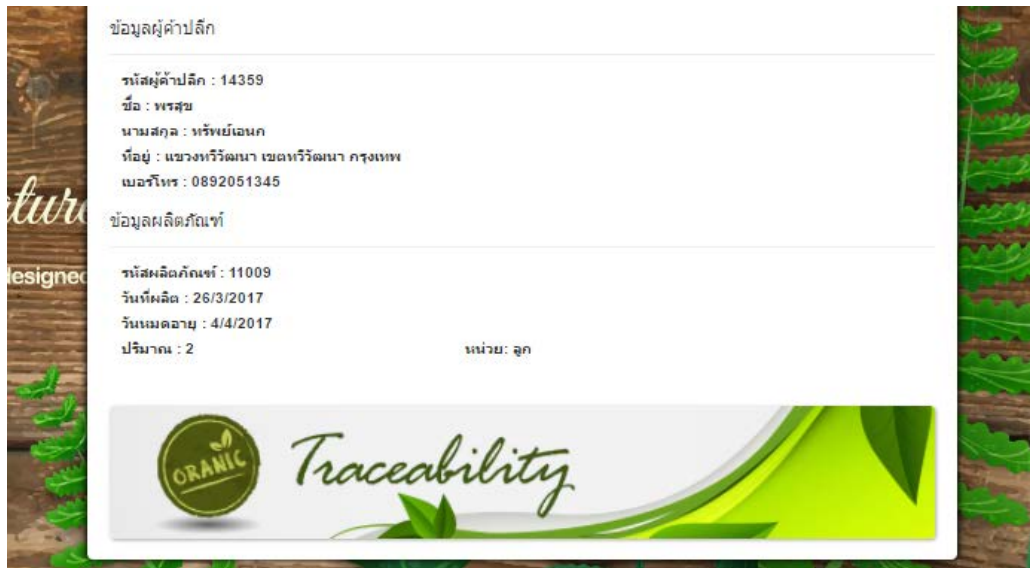


Figure 4.18 Results from QR Code scan following the 1st form of sale/purchase (Part 3).

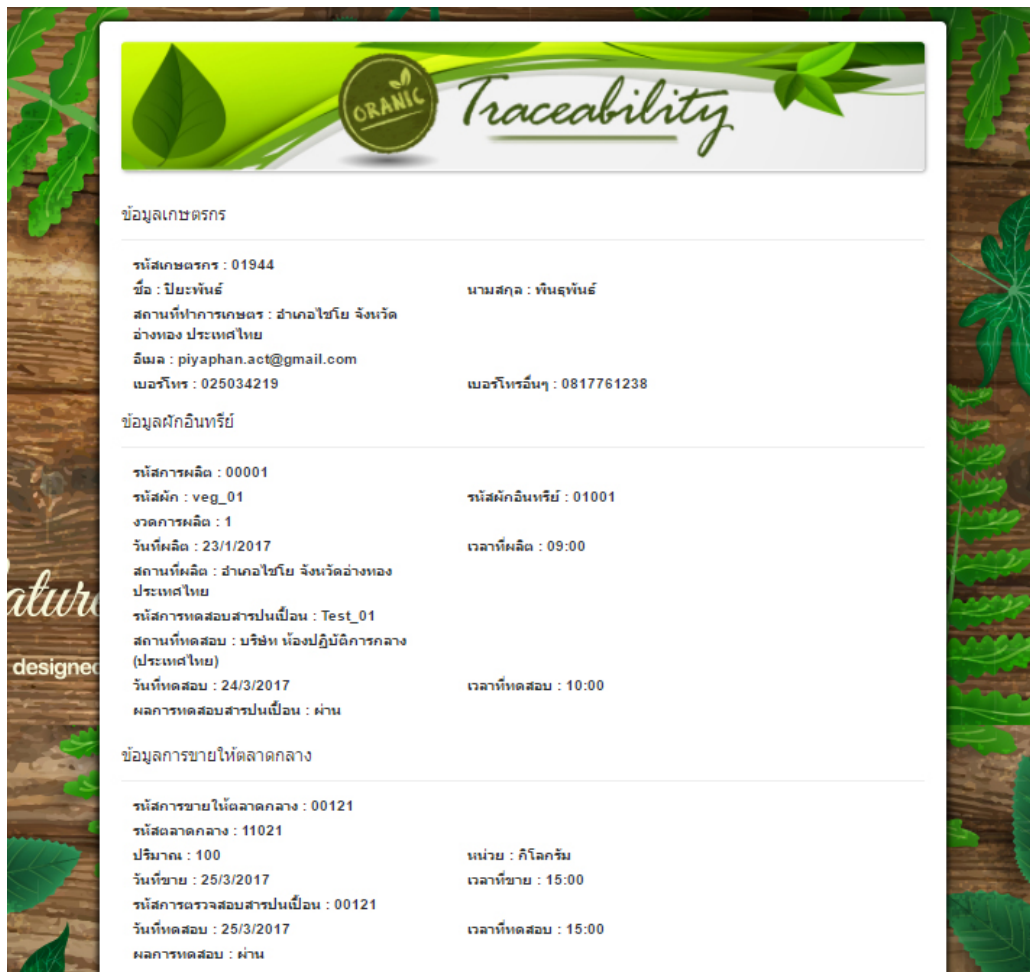


Figure 4.19 Results from QR Code scan following the 2nd form of sale/purchase (Part 1).



Figure 4.22 Results from QR Code scan following the 3rd form of sale/purchase (Part 2).

4.2 Technology Architecture Design

In terms of design technology architecture, the technology of QR Code Model 2 is selected. With its capacity of data collection up to 7,089 at maximum, it can contain all the necessary information for the traceability of organic vegetables. QR Code Model 2 is featured in every step of the traceability.



Figure 4.23 QR Code Model 2.

Meanwhile, direct thermal sticker is also selected. The sticker is coated with chemical substance on the front and relies on thermal printhead system that applies print to the sticker's surface. It is suitable with non-durable and temporary work. This type of sticker does not need any aid in printing and is easy to use as well as cost-saving.

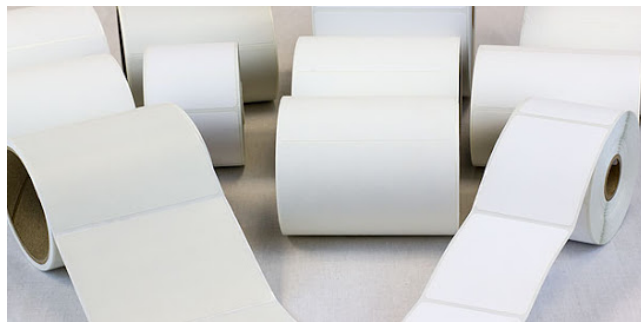


Figure 4.24 Direct Thermal Stickers.

4.3 Limitation

In terms of evaluation, examples of situations to test the system's ability to collect and show the data accurately are provided as follows:

1. Change in farmer's name

In case that the farmer's name or family name is changed, the products which were issued QR Code would still show the previous data. After information update with ACT, however, the issuing of QR Code will reverse to the current name of the farmer because the traceability system for organic vegetables has included the information of farmers certified by ACT as part of itself. The farmer's code meanwhile is not changed and thus the traceability can be carried out as normal.

2. Inadequate light for scanning QR Code

If the QR Code scan is to take place in an area with inadequate light or at lower-than-usual brightness, it might not be possible. Flash attached to smartphone or use of torchlight to brighten the area may be needed for scanning QR Code. The result of using flash from smartphone or torchlight is that the QR Code scan can be performed.

3. Price tag covering part of QR Code

Even in the case of price tag's partial cover over QR Code, QR Code can show the result as normal. In terms of covering over QR Code, it must not cover the whole QR Code. Thus, QR Code should be placed at one angle of the packaging or next to the product's name to avoid the price tag's cover which could obstruct the QR Code scan.

4.4 Comparison

Details of the data collected for the traceability system were compared by scanning QR code of the currently available products to see their details.

Table 4.1 Comparison

Proposed System	Super Fresh	CHIANG DAW Organic Farm
<u>Farmer detail</u> - Farmer ID - Name - Last Name - Address - Email - Telephone Number - Other Telephone Number	<u>Producer</u> - Source of production - Farmer - Address - Telephone number - Fax - Area - Crop - Standard - Youtube - Facebook - Suggestion	<u>Product information</u> - Product Lot - Brand - Manufacturer - Certified Standard - Certified Standard No - Address - Description
<u>Details of organic vegetables</u> - Production ID - Vegetable's ID - Organic vegetable's ID - Lot number of production	<u>Manufacturer</u> - Company - Owner - Address - Telephone	<u>Farm information</u> - Material Lot - Grower - GLN/GLN No - Address

Table 4.1 Comparison (cont.)

Proposed System	Super Fresh	CHIANG DAW Organic Farm
<ul style="list-style-type: none"> - Manufacturing date - Manufacturing time - Manufacturing place - Test ID - Test place - Test date - Test time - Test result 	<ul style="list-style-type: none"> - Fax - Standard - Youtube - Facebook 	<ul style="list-style-type: none"> - Certified Standard - Certified Standard No
<u>Details of sale to vendor</u> <ul style="list-style-type: none"> - Sale ID to vendor - Vendor's ID - Amount - Unit - Sale date - Sale time 	<u>Collector</u> <ul style="list-style-type: none"> - Company - Authorities - Address - Telephone number - Fax - Standard 	
<u>Details of sale to central market</u> <ul style="list-style-type: none"> - Sale ID to central market - Central market's ID - Amount - Unit - Sale date - Sale time - Test date - Test time - Test result 		
<u>Details of sale to retailer</u> <ul style="list-style-type: none"> - Sale ID to retailer 		

Table 4.1 Comparison (cont.)

Proposed System	Super Fresh	CHIANG DAW Organic Farm
<ul style="list-style-type: none"> - Retailer's ID - Amount - Unit - Sale date - Sale time 		
<p><u>Details of seller/manufacturer</u></p> <ul style="list-style-type: none"> - Seller/manufacturer's ID - Name - Family Name - Address - Telephone number - Email 		
<p><u>Details of central market</u></p> <ul style="list-style-type: none"> - Central market's ID - Name - Address - Telephone number 		
<p><u>Details of retailer</u></p> <ul style="list-style-type: none"> - Retailer's ID - Name - Family Name - Address - Telephone number - Email 		
<p><u>Details of packaging</u></p> <ul style="list-style-type: none"> - Product's ID - Sale ID from farmer to retailer - Sale ID from central market to retailer 		

Table 4.1 Comparison (cont.)

<u>Proposed System</u>	Super Fresh	CHIANG DAW Organic Farm
- Manufacturing date - Expiration date - Amount - Unit		

The result of the QR Code scanning showed that our traceability system contained more collected details and can facilitate the traceability from the beginning to the end of the supply chain.

CHAPTER V

CONCLUSION

The research on the Traceability System Implementation in Organic Farming Using QR Code Technology focused on designing the traceability system for organic vegetables. The research's objective was to obtain the efficient traceability system for organic vegetables that is in line with the Organic Farming Standard and that of the European Food Safety Authority.

5.1 Conclusion

Studies of the traceability system for organic vegetables found that the system itself was not yet complete and was not in line with the Organic Farming Standard. This resulted in the lack of precision and accuracy in the traceability system. The researcher then conducted studies and designed the organic vegetables' supply chain by indicating the type of information needed to be collected for the traceability system of organic vegetables. The information was as follows:

1. Information on organic vegetables
2. Information on farmer
3. Information on buyer/seller
4. Information on central market
5. Information on retailer
6. Information on product

Afterwards, the researcher designed the page of the website to be used in filling in all the information, which was later transformed into QR Code form. This stage also included designing the features of the website after QR Code scan. Following the type of organic vegetables' sale, there were 3 forms from QR Code scan as follows:

1. Farmer to buyer/seller, buyer/seller to central market, central market to retailer

2. Farmer to central market, central market to retailer

3. Farmer to retailer

It was found that the use of QR Code technology still posed some limitation when these following incidents occurred:

1. There was a change in the name of the farmer. However, the code of the farmer remained unchanged and thus enabled the traceability of the organic vegetables as normal.

2. The light was not enough for the QR Code scan. This can be fixed by using flash from smartphone or using torchlight to scan QR Code.

3. Part of QR Code was covered by price tag. Thus, QR Code should be placed at one corner of the packaging or next to the product's name to prevent the QR Code from being covered by price tag.

5.2 Recommendation

The research's limitation was that the traceability system was compatible only with organic vegetables in Thailand, not with other types of products. In the future, further studies on the standard and design of the traceability system should be conducted to cover all types of products.

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APPENDIX

Data Dictionary

Table A1 Tbl_Vegetables: a table which records types of vegetables.

No	Name	Description	Type	Size	Key	Reference
1	Vegetable_ID	Vegetable's ID	Text	10	PK	
2	Veg_Name	Vegetable's name	Text	30		

Table A2 Tbl_Material: a table which records details of raw materials used in growing organic vegetables.

No	Name	Description	Type	Size	Key	Reference
1	Material_ID	Material's ID	Text	5	PK	
2	Material_Name	Material's Name	Text	30		
3	Material_From	Source	Text	100		
4	M_Quantity	Amount	Number	10		
5	Unit	Unit	Text	20		

Table A3 Tbl_Produce: a table which records details in the production of organic vegetables.

No	Name	Description	Type	Size	Key	Reference
1	Produce_ID	Production's ID	Text	10	PK	
2	Farmer_ID	Farmer's ID	Number	5	FK	
3	Vegetable_ID	Vegetable's ID	Text	10	FK	Tbl_Vegetables
4	Material_ID	Material's ID	Text	5	FK	Tbl_Material
5	Organic_ID	Organic vegetable 's ID	Text	10	FK	Tbl_Organic
6	Date	Manufacturing date	Date			
7	Time	Manufacturing time	Time			
8	Place	Manufacturing place	Text	50		

Table A4 Tbl_Unit: a unit table which show the amount of organic vegetables.

No	Name	Description	Type	Size	Key	Reference
1	Unit_ID	Unit's ID	Number	5	PK	
2	Name_Unit	Unit's name	Text	20		

Table A5 Tbl_Farmer: a table which records the farmers' details.

No	Name	Description	Type	Size	Key	Reference
1	Farmer_ID	Farmer's ID	Number	5	PK	
2	F_Name	Farmer's name	Text	30		
3	F_LName	Farmer's family name	Text	30		
4	F_Place	Farming address	Text	100		
5	F_Tel	Telephone	Number	10		
6	F_Email	E-mail	Text	20		

Table A6 Tbl_Organic: a table which records the details of organic vegetable products.

No	Name	Description	Type	Size	Key	Reference
1	Organic_ID	Organic vegetable's ID	Text	10	PK	
2	Lot_Number	Production lot	Text	10		
3	Farmer_ID	Farmer's ID	Number	5	FK	Tbl_Farmer
4	Vegetable_ID	Vegetable's ID	Text	10	FK	Tbl_Vegetables
5	V_Quantity	Amount	Number	10		
6	Unit_ID	Unit	Number	5	FK	Tbl_Unit
7	Result_Test	Test result	Yes/No			

Table A7 Tbl_Labtest: a table which records the results of organic vegetables' lab inspection for contamination.

No	Name	Description	Type	Size	Key	Reference
1	Labtest_ID	Lab test ID	Text	10	PK	

Table A7 Tbl_Labtest (cont.):

2	Organic_ID	Organic vegetable's ID	Text	10	FK	Tbl_Organic
3	Test_Place	Test place	Text	100		
4	Date_Test	Test date	Date			
5	Time_Test	Test time	Time			
6	Result_Test	Test result	Yes/No			

Table A8 Tbl_SaleFM: a table which records details of sale and purchase histories between farmer and central market.

No	Name	Description	Type	Size	Key	Reference
1	SaleFM_ID	Sale's ID	Text	10	PK	
2	Organic_ID	Organic vegetable's ID	Text	10	FK	Tbl_Organic
3	Market_ID	Central market's ID	Number	5	FK	Tbl_Market
4	Quantity	Amount	Number	10		
5	Unit	Unit	Text	10		
6	Date	Date	Date			
7	Time	Time	Time			
8	Date_Test	Test date	Date			
9	Time_Test	Test time	Time			
10	Result_Test	Test result	Yes/No			

Table A9 Tbl_SaleFV: a table which records details of sale and purchase histories between farmer and vendor.

No	Name	Description	Type	Size	Key	Reference
1	SaleFV_ID	Sale's ID	Text	10	PK	
2	Vendor_ID	Vendor's ID	Number	5	FK	Tbl_Vendor
3	Organic_ID	Organic vegetable's ID	Text	10	FK	Tbl_Organic

Table A9 Tbl_SaleFV (cont.):

4	Quantity	Amount	Number	10		
5	Unit	Unit	Text	10		
6	Date	Date	Date			
7	Time	Time	Time			

Table A10 Tbl_SaleFR: a table which records details of sale and purchase histories between farmer and retailer.

No	Name	Description	Type	Size	Key	Reference
1	SaleFR_ID	Sale's ID	Text	5	PK	
2	Retailer_ID	Retailer's ID	Number	5	FK	Tbl_Retailer
3	Organic_ID	Organic vegetable's ID	Text	10	FK	Tbl_Organic
4	Quantity	Amount	Number	10		
5	Unit	Unit	Text	10		
6	Date	Date	Date			
7	Time	Time	Time			

Table A11 Tbl_Market: a table which records details of central market.

No	Name	Description	Type	Size	Key	Reference
1	Market_ID	Central market's ID	Number	5	PK	
2	Name_Market	Central market's name	Text	30		
3	Address_M	Address	Text	100		
4	Tel_M	Telephone number	Number	10		

Table A12 Tbl_Vendor: a table which records details of vendor.

No	Name	Description	Type	Size	Key	Reference
1	Vendor_ID	Vendor's ID	Number	5	PK	

Table A12 Tbl_Vendor (cont.):

2	V_Name	Name	Text	30		
3	V_LName	Family name	Text	30		
4	V_Address	Family name	Text	100		
5	V_Tel	Telephone number	Number	10		
6	V_Email	E-mail	Text	30		

Table A13 Tbl_Retailer: a table which records details of retailer.

No	Name	Description	Type	Size	Key	Reference
1	Retailer_ID	Retailer's ID	Number	5	PK	
2	R_Name	Name	Text	30		
3	R_LName	Family name	Text	30		
4	R_Address	Family name	Text	100		
5	R_Tel	Telephone number	Number	10		
6	R_Email	E-mail	Text	30		

Table A14 Tbl_SaleMarket: a table which records sale and purchase details between vendor and central market.

No	Name	Description	Type	Size	Key	Reference
1	SaleMarket_ID	Sale's ID	Number	5	PK	
2	Market_ID	Central market's ID	Number	5	FK	Tbl_Market
3	Vendor_ID	Vendor's ID	Number	5	FK	Tbl_Vendor
4	Organic_ID	Organic vegetable's ID	Text	10	FK	Tbl_Organic
5	Quantity	Amount	Number	10		
6	Unit	Unit	Text	10		
7	Date	Date	Date			
8	Time	Time	Time			

Table A14 Tbl_SaleMarket (cont.):

9	Date_Test	Test date	Date			
10	Time_Test	Test time	Time			
11	Result_Test	Test result	Yes/No			

Table A15 Tbl_SaleMR: a table which records sale and purchase details between central market and retailer.

No	Name	Description	Type	Size	Key	Reference
1	SaleMR_ID	Sale's ID	Number	5	PK	
2	Market_ID	Central market's ID	Number	5	FK	Tbl_Market
3	Retailer_ID	Retailer's ID	Number	5	FK	Tbl_Retailer
4	Organic_ID	Organic vegetable's ID	Number	5	FK	Tbl_Organic
5	Quantity_R	Amount	Number	10		
6	Unit_R	Unit	Text	10		
7	Date_R	Date	Date			
8	Time_R	Time	Time			
9	Date_Test	Test date	Date			
10	Time_Test	Test time	Time			
11	Result_Test	Test result	Yes/No			

Table A16 Tbl_Product: a table which records details of organic vegetables which are undergone packaging process.

No	Name	Description	Type	Size	Key	Reference
1	Product_ID	Product's ID	Number	5	PK	
2	SellMR_ID	Central market's sale ID to retailer	Number	5	FK	Tbl_SaleMR
3	SellFR_ID	Farmer's sale ID to retailer	Number	5	FK	Tbl_SaleFR
4	Date_Pro	Manufacturing date	Date			

Table A16 Tbl_Product (cont.):

5	Expire	Expiration date	Date			
6	Quantity_P	Amount	Number	10		
7	Unit_P	Unit	Text	10		

BIOGRAPHY

NAME	Miss Benjaporn Eungjaroen
DATE OF BIRTH	16 Sep 1986
PLACE OF BIRTH	Bangkok, Thailand
INSTITUTIONS ATTENDED	Rajamangala University of Technology Rattanakosin, 2005-2008 Bachelor of Business Administration (Computer Information System) Mahidol University, 2015-2017 Master of Science (Information Technology Management)
HOME ADDRESS	186/159 Borommaratchachonnani Rd., Salaya Phutthamonthon Nakhonpathom 73170 (Thailand) Tel. 099-453-5979 E-mail: yensha_b@hotmail.com