TRACEABILITY SYSTEM FOR UPGRAADING QUALITY OF AGRICULTURAL PRODUCTS IN PHRA NAKHON SI AYUTTHAYA

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ABSTRACT

The purposes of the research article were to develop a traceability system for agricultural products in Phra Nakhon Si Ayutthaya Province. This research methodology is a documentary and quantitative research. Researchers have reviewed various sources and found that the QR Trace on Cloud system for small and medium entrepreneurs developed by the National Bureau of Agricultural Commodity and Food Standards was suitable to be used to raise the quality of agricultural products in Phra Nakhon Si Ayutthaya Province. Therefore, researchers organized a workshop and try to evaluate the system by inviting 37 farmers with products certified or currently in the process of certification to assess the system. Most of the assessors are male, aged 36-45 years or over 56 years old, had secondary education or equivalent, and produced products in the vegetable/fruit group. The results of the system evaluation showed that, overall, the assessors were satisfied with the system properties at the highest level (̅X equal to 4.57 and S: 0.431) and were satisfied with the workshop at the highest level too (̅X was 4.49 and S was 0.507). Finally, there was a significant evidence that the training improved the skill (p < 0.0001).

Keywords: Traceability, QR Trace on Cloud, agricultural products, Phra Nakhon Si Ayutthaya

I. INTRODUCTION

Traceability system is the “the totality of data and operations that is capable of maintaining the desired information about a product and its components through all or part of its production and utilization chain.” As a product passes from one market actor to another, a traceability system collects and records data points to perform real-time and ex-post tracking of a product’s movement through the value chain from origin to final destination. Traceability systems vary widely in their scope and sophistication. They can range from individual firm-level systems capturing transactions within their own supply chain to multistakeholder platforms capable of tracking a product across the entire food system.

Traceability system is usually in web-based application and links the information between the devices via some forms of data communication. The most popular form is a QR code, which can be used by smartphones to help read and record information easily. Traceability systems can be applied in many different ways and it support the government’s policy on enhancing the competitiveness of safe agricultural products and reaching the international standard level, enhancing in end-to-end consumer perception, increasing the credibility of Thai agricultural products, and expanding the market opportunities of Thai food to the world.

Therefore, the research team will develop traceability system to raise the quality of safe agricultural products according to the policy plan to drive the economy of Thailand 4.0, which aims to implement the traceability system within the next 3 years and stimulate Thai farmers to prompt for using this system in the future.

II. RESEARCH OBJECTIVES

The purposes of the research were to develop a traceability system for agricultural products in Phra Nakhon Si Ayutthaya Province.
III. LITERATURE REVIEW

Traceability System

Traceability information for products is often required to comply with more stringent requirements from customers and regulatory agencies. Manufacturers must find innovative ways to create value, reduce risk, and ensure compliance. One innovative approach to responding to these challenges is the implementation of Tracking and Traceability Systems.

Tracking is the primary method of guaranteeing product safety. This involves a system that is designed to follow a product through all phases of the manufacturing process. This implies that each individual process step is being monitored by an automated system and each individual product or product batch is uniquely encoded so that it can be identified.

Encoding and identification is traditionally done by means of barcodes and QR code, but recent developments have made more sophisticated techniques like Radio Frequency Identification (RFID) more affordable.

The automated system constantly monitors all key process parameters, including machine settings and quality measurements.

A product or batch that did not complete a production step successfully will be automatically marked as defective and be refused further processing without intervention. This method allows that a single final check can be used to confirm that a product has undergone all operations successfully before it is shipped. This method prevents faults in the early stages of production remaining undiscovered until the final quality check. In modern production processes, many steps are irreversible so the only option remaining is to scrap the entirely finished, but defective product.

Traceability is defined as the ability to trace the production history of a product based on its serial number or applied batch number. Such history becomes important in the event of a customer complaint or a detected product defect after the product has left the factory. For more and more consumer products, traceability is becoming compulsory.

A historical record of all data relevant to the process further allows the manufacturer to proactively design and optimize the production process involved. By analyzing data and comparing current information against previously recorded information, the performance and quality aspects of each production process can easily be benchmarked. The data is also useful for identifying bottlenecks in the process.

In a typical manufacturing plant, there are various production processes, each with its own unique characteristics and therefore different traceability objectives. The data volume will strongly depend on the number of tracked materials, lot sizes and the number of registration points. The system should be scalable and able to capture both shop-floor data and real-time manufacturing data with minimal configuration.

![Fig. 1 Information flow in Traceability system](image)

Principles of Traceability need the standard codes or sets of numbers used to identify the products. Information flow in Traceability system is shown in Fig. 1. These codes may be
1) Global Location Number (GLN) that can be used by companies to identify their locations, giving them complete flexibility to identify any type or level of location required.

2) Global Trade Item Number (GTIN) that can be used by a company to uniquely identify all of its trade items. GS1 defines trade items as products or services that are priced, ordered or invoiced at any point in the supply chain.

3) Serial Shipping Container Code (SSCC) that can be used by companies to identify a logistic unit, which can be any combination of trade items packaged together for storage and/or transport purposes; for example, a case, pallet or parcel.

These codes will be used as references in the database between partners by using barcodes or QR code as an important tool for connecting. These codes are assigned by the GS1 organization and these numbers are uniquely assigned.

Benefits of implementing Traceability System

- Lower cost of distribution systems
- Reduce recall expense
- Improve production process and minimize production faults
- Incremental revenue from improved visibility of the supply chain
- Improve productivity rapidly meanwhile reduce the proportion of rejects
- Attain desire level of quality
- Reduce operating cost and improve the profitability
- Improve operations and achieve a quantifiable return on investment
- Eliminate batch process errors and reduce wastage
- Improve plant floor operation efficiency
- Reduce inventory costs through the ability to release product immediately

GS1 [1]

GS1 is a not-for-profit organization that develops and maintains global standards for business communication. The best known of these standards is the barcode, a symbol printed on products that can be scanned electronically. Over 100 million products carry GS1 barcodes and they are scanned more than six billion times every day.

GS1 has 115 local member organizations and over 2 million user companies.

GS1 standards, services and solutions are designed to improve the efficiency, safety and visibility of supply chains across physical and digital channels in a wide variety of sectors. They form a business language that identifies, captures and shares key information about products, locations, assets and more.

History of GS1 and its responsibility

In 1969, the retail industry in the US was searching for a way to speed up the check-out process in shops. The Ad Hoc Committee for a Uniform Grocery Product Identification Code was established to find a solution.
In 1973, the Universal Product Code (UPC) was selected by this group as the first single standard for unique product identification, and in 1974, the Uniform Code Council (UCC) was founded to administer the standard.

On 26 June 1974, a pack of Wrigley’s chewing gum became the first ever product with a barcode to be scanned in a shop.

In 1976, the original 12-digit code was expanded to 13 digits, which opened the doors for the identification system to be used outside the U.S.

In 1977, the European Article Numbering Association (EAN) was established in Brussels and with founding members from 12 countries.

In 1990, EAN and UCC signed a global cooperation agreement and expanded overall presence to 45 countries.

In 1999, EAN and UCC launched the Auto-ID Centre to develop Electronic Product Code (EPC) enabling GS1 standards to be used for RFID.

In 2004, EAN and UCC launched the Global Data Synchronization Network (GDSN), a global, internet-based initiative that enables trading partners to efficiently exchange product master data.

By 2005, the organization was present in over 90 countries which started to use the name GS1 on a worldwide basis. Whilst "GS1" is not an acronym, it refers to the organization offering one global system of standards.

Aug 2018 - GS1 Web URI Structure Standard is ratified allowing unique ID's to be added to products by storing a URI (a webpage-like address) as a QR code.

About GS1 Thailand, which is belonging to the Federation of Thai Industries, was formed in 1988 and located on 11th Floor, Creative Technology Building (UTK), Nang Linchi Road, Thung Maha Mek, Sathon, Bangkok.[2]

**Serial Shipping Container Code (SSCC)[3]**

The SSCC is a crucial key for traceability, since it uniquely identifies each distributed logistic unit and its content. The SSCC enables companies to track each logistic unit for efficient order and transport management. It can be encoded in a barcode, QR code or EPC/RFID tag, ensuring the logistic unit can be accurately and easily identified as it travels between trading partners, anywhere in the world.

When SSCC data is shared electronically via EDI or EPCIS, this enables companies to share information about the status of logistic units in transit, and reliably link it to related transport information such as shipment details. It enables companies to link to additional information about the logistic unit. This information can be communicated via a Despatch Advice or Advanced Shipping Notice (ASN) prior to the logistic unit’s arrival. Upon receipt the SSCC will be scanned, providing the required information to speed up the receipt of goods as well as the subsequent invoicing process.

The SSCC is fully compatible with iso/iec 15459 – part 1: unique identifiers for transport units. This is often referred to as the iso license plate and is a prerequisite for tracking and tracing logistic units in many international supply chains.

![Fig.2 Structure of SSCC](image)

**QR Trace on Cloud [4]**

QR Trace on Cloud is a cloud-based traceability system for small and medium-sized enterprises in agricultural product, supports up to 6 groups of agricultural products including vegetable/fruit, rice, egg, livestock, fishery, and processed products/food. The users can store the tracking and production information. This creates a linkage...
of traceable information throughout the supply chain, where QR Code is used as a tool that enhances efficiency in linking traceability information to consumers.

This system was developed by the National Bureau of Agricultural Commodity and Food Standards (ACFS) and has been used since 2018. The qualifications of those who use this system must be the entrepreneurs who produce quality products by having standard certification such as Organic standard (Organic), standard of Good Agricultural Practice (GAP), and have a computer or smartphone and a label printer and they can apply for usage via https://www.acfs-qrtrace.com

IV. RESEARCH METHODS

A. Research Design

Documentary research and quantitative research were used and research tools were questionnaires. Data were collected from literature reviews and training program. Quantitative data from 37 samples who train and test the system was analyzed by using descriptive statistics and paired sample t-test.

B. Research Process

Research process of this research has developed into 5 steps consisted of 1) to study the context of GAP supply chain in Phra Nakhon Si Ayutthaya, 2) to study the features of QR Trace on Cloud system, 3) to train the system to the farmers who are the actors in GAP supply chain, 4) the farmer use the system and evaluate it, and 5) to summarize the research. All steps were shown as follows:

V. RESEARCH RESULTS

From the documentary study, QR Trace On Cloud system is appropriate for use in the context of GAP supply chain in Phra Nakhon Si Ayutthaya.
Then the researcher make the training program on February 3-4, 2021, with a total of 37 participants in the workshop. Most of the participants were the farmers who likely lacked expertise and skills in using computers and equipment. Therefore, the researcher prepared 2 assistant trainers and a team of more than 10 students, who are instructors and students in the Department of Information Systems and Business Computing, to facilitate such assistance.

After the training program, the researcher let the trainee evaluate the system and the results are shown as follows:

- Most of the samples were male, aged 36-45 years and over 56 years old, having a secondary education or equivalent, and produce products in the vegetable/fruit group.

- The results of the system evaluation found that, overall, the samples were satisfied with the system properties at “very satisfied” level (mean = 4.57 and S = 0.431). The most satisfied aspect is “the system use the modern technology” (mean = 4.73 and S = 0.450), and followed by the aspect “The system have the benefits for their works” (mean = 4.68 and S = 0.580), and the least satisfied aspect is “the ease of use of the system” (mean = 4.35 and S = 0.676) but it is still in “very satisfied” level.

- Overall, the samples were satisfied with the service procedure at “very satisfied” level (mean = 4.45 and S = 0.475). The most satisfied aspect is “the systematic operation and the clear procedures” (mean = 4.59 and S = 0.498), and followed by the aspect “ease of registration” (mean = 4.51 and S = 0.559), and the least satisfied aspect is “public relations of the training program” (mean = 4.22 and S = 0.712).

- Overall, the samples were satisfied with the trainers at “very satisfied” level (mean = 4.67 and S = 0.407). The most satisfied aspect is “the explanation of the content is clear and hit to the point” (mean = 4.76 and S = 0.435), and followed by the aspect “the knowledge transfer of speakers and the speaker’s answer” (mean = 4.73 and S = 0.450), and the least satisfied aspect is “suitability of the lecture notes” (mean = 4.54 and S = 0.558).

- Overall, the samples were satisfied with the facilities at “very satisfied” level (mean = 4.46 and S = 0.488). The most satisfied aspect is “the suitability of the media and equipment” and “the clarity of the training materials” (mean = 4.57 and S = 0.502 and 0.555 respectively), and followed by the aspect “the suitability of the venue” (mean = 4.46 and S = 0.605), and the least satisfied aspect is “the suitability of lunch and snacks” (mean = 4.30 and S = 0.618).

- Overall, the samples were satisfied with the staff service at “very satisfied” level (mean = 4.61 and S = 0.427). The most satisfied aspect is “the facilitation from staff” (mean = 4.65 and S = 0.484), and followed by the aspect...
“the staff provide the advice or answer inquiries promptly” (mean = 62.4 and S = 492.0), and the least satisfied aspect is “the staffs’ service and coordination” (mean = 4.59 and S = 0.498).

- **In the overview of the training**, the samples were satisfied at “very satisfied” level (mean = 4.55 and S = 0.385). The most satisfied aspect is “the trainers” (mean = 4.67 and S = 0.407), and followed by the aspect “the staff service” (mean = 4.61 and S = 0.427), and the least satisfied aspect is “the service procedure” (mean = 4.45 and S = 0.475).

- **Overall**, the samples had the opinion with the *cognitive opinion* at “highest” level (mean = 4.31 and S = 0.537). The aspect that gets the highest level of the opinion is “understanding this system after the training” (mean = 4.41 and S = 0.599), and followed by the aspect “getting the benefit of the training” (mean = 4.38 and S = 0.545), and the aspect that gets the lowest level of the opinion is “describing the details from the training” (mean = 4.19 and S = 0.739).

- The samples had compared the knowledge before and after the training, almost all evaluated that their cognition was increased. The score increased to 2.135 points on average and the standard deviation equals to 1.032 and it showed that the cognition of the samples increased significantly at 0.05 level. See Table 1.

<table>
<thead>
<tr>
<th>Score difference after the training compared to before the training</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 point</td>
<td>1</td>
<td>2.70</td>
</tr>
<tr>
<td>1 point</td>
<td>10</td>
<td>27.03</td>
</tr>
<tr>
<td>2 point</td>
<td>13</td>
<td>35.14</td>
</tr>
<tr>
<td>3 point</td>
<td>9</td>
<td>24.32</td>
</tr>
<tr>
<td>4 point</td>
<td>4</td>
<td>10.81</td>
</tr>
</tbody>
</table>

- **Overall**, the samples had the opinion with the *knowledge implementation* at “highest” level (mean = 4.22 and S = 0.566). The aspect that gets the highest level of the opinion is “can apply the gained knowledge in practice”, “can give the counselling to the colleagues”, and “can apply the gained knowledge confidently.” (mean = 4.24 and S = 0.641, 0.597 and 0.597, respectively) and the aspect that gets the lowest level of the opinion is “can transfer the knowledge to the community” (mean = 4.14 and S = 0.673).

### VI. DISCUSSIONS

From the evaluation of training and system usage, it was found that the farmers who used the system were satisfied with the features of the QR Trace on Cloud system at the highest level. Even most of all are not familiar with this technology but they can actually use the system. This system is therefore suitable for use among farmers of Phra Nakhon Si Ayutthaya Province. With the workshop process, the satisfaction level was highest because there are assistant trainers and students that help trainees to use the computers and smartphone and this cause the rapid learning during training.

### VII. RECOMMENDATIONS

1. GAP certification process should be improved to be more expedient because many farmers have been waiting for a long time to inspect their farms but are not yet certified. This makes the farmers are unable to use the actual system.

2. The system should provide alternatives for the farmers who are ready to use the QR Trace on Cloud system but are facing the problem of not certifying the standard that requires for using this system. Alternative identity verification should be used for this.
VIII. CONCLUSION

QR Trace on Cloud system is appropriate for using as a traceability system because it is free, easy to use and government support. GAP farmers can use this system because the traceability system is one of the requirements for GAP.

IX. ACKNOWLEDGEMENT

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