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Designing traceability information systems for processed apple products chain

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Abstract. Food security issues is a problem for consumers to choose the right food products. Consumers are often faced with a lack of knowledge about nutritional content, expiration, and availability of healthy food products, especially for processed apple products. Therefore a traceability system is needed that guarantees the authenticity of the product and provides reliable information. Lack of good information and infrastructure will hinder the formation of an effective traceability system that some producers have not considered because it has high costs, especially for Small and Medium Enterprises (SMEs). In general, producers and consumers need an information system that can provide food information effectively and efficiently. The purpose of this research is to design an information system that can be used for traceability of processed apple products. This study uses the Waterfall method which consists of several stages, namely: the data analysis stage, the planning stage, the implementation phase, and the testing phase. The design concept uses the object-oriented method using the Unified Modelling Language (UML), which consists of Use Case Diagrams, Activity Diagrams, and Sequence Diagrams. The results of this study are an information system design that can be used for traceability of the supply chain of processed apple products that can adapt to consumer needs.

1. Introduction

Apples are fruits that can be processed into several food variants. Unfortunately, some of these processed apple products are not supported by sufficient information, for example the information about the nutritional content, the expired date, or the benefits of consumption for health. In addition, there is a lack of information about the availability of products on the market; thus, there is a need of an information technology system that can cover all of the necessary information. One of the ways is by using traceability information system [1].

Traceability is defined as the requirements that must be possessed by a company to control and save information through unique identity that is inherent on products set in ISO 9000:2000. According to Christiansen [1], traceability is interpreted as the ability to identify and track the history, location, distribution and application of products, parts and materials to ensure the sustainable claim of reliability. Furthermore, Farooq et al. [2] also describe that traceability system is the efforts of controlling the process of a food product and important safety system for sustainable social development in food industry.
There are several studies related to the implementation of traceability in supply chain, for example, Li [3] explored the cost-benefit to the egg supply chain by examining the case on the actual analysis based on an economic standpoint that generated the structures of traceability system, traceability data and information systems, and traceability in the egg supply chain network in Van Beek business group, and displayed that the profit calculations on the traceability system can increase the market share. Memon et al. [4] showed that the benefits of implementing traceability at the strategy level was to increase the shareholders’ expectations in terms of existing losses that had an impact on decreasing the operational costs along the supply chain. Ene [5] produced the importance of traceability in the chain with several key elements. Zhang [6] produced the contributions of traceability to sustainable supply chains that had an impact on the economy and social.

Based on this explanation, an information system is designed to assist customers in performing traceability, especially on processed apple products. With the availability of this information system, it can help to provide information for customers about the nutritional content and inventory of products in addition to being able to make online purchases.

2. Research Methods
This research of information system design uses three system development methods, including [7]:

2.1. System development life cycle
System Development Life Cycle (SDLC) is a process employed by system analysts to develop information system, starting from determining the requirements, designing, validating, to training and submitting to customers. SDLC is a standard workflow commonly used by software/information system vendor companies in developing their production application software. SDLC is not only essential for the software production process, but also very important for the software maintenance process itself. Without archiving the development data of the software, the company will find that the software maintenance is very difficult in the future.

2.2. Waterfall method
Waterfall is a model used for this software development. The model develops systematically from one stage to another in waterfall-like mode. The model proposes an approach to systematic and sequential software development that starts from the level of system progress in the entire analysis, design, code, testing and maintenance. This model covers the following activities: engineering and modelling system, need analysis, design, coding, testing and maintenance.

This development model is linear from the initial stage of system development, i.e. the planning stage to the final stage of system development, i.e. the maintenance stage. The next stage will not be carried out before the previous stages have been completed and cannot return or repeat to the previous stage.

The waterfall methodology applied in this study includes: 1) Requirement: It starts from the preparation of the background of the problem to be studied, formulates the problem and the limitation of the problem while examining the object of the research, 2) Design: It continues with the design of the program using UML according to the observation and needs of the company, 3) Implementation: In this stage, the trial of the program is initiated to find its strengths and weaknesses, 4) Verification: After finding the shortcomings of this program, it is verified to repair it, and 5) Maintenance: After the verification, the program is fixed according to the latest needs of the company.

2.3. Unified modelling language (UML)
In the development of information system, a language is required to model the software that will be created and there is the need for standardization so that people in different countries can understand the software modelling.

There are many people who have made languages of modelling software development in accordance with the programming technology developing at that time, for example, the one that was developed and used by many parties was Data Flow Diagram (DFD) as model software that uses procedural or structural
programming. There was State Transition Diagrams (STD) that was used to model real time system as well. UML diagram can help make the computational intelligence approach into a good optimization [8-10].

3. Discussion
This traceability information system designed with several stages that include [11]:

3.1. Running system analysis
In order to describe the system that runs on the traceability process, it can be described through Conceptual Framework that covers the entire traceability process.

3.2. Requirement analysis phase
The needs of data and information in the form of both physical and non-physical in this study are based on data collection techniques performed.

3.3. Need analysis results
After the data collection technique was implemented, the author identified and analysed the problems faced by customers who will buy processed apple products [11]. Some of the problems faced by the customers are:
   a. Lack of information on the nutritional content of the product
   b. Lack of information on the inventory of the products in the stores/warehouses

3.4. Need analysis of the running system
The required needs of the data and information are illustrated through the use case diagram of the running system.

![Use case diagram of running system](image)

Figure 1. Use case diagram of running system

Figure 1 explains that two administrators can run this system, namely customer and administrator. Customers can access the website to get some information about nutrition or product tracking. While the administrator controlled the running of the system.

3.5. Design phase
The design information system mainly applies in the design of products, its main functions are the inquiry, modification, and comparison of design information, and it offers designers a lot of useful information [12]. The same design information may be useful at some stage in the design process, may also be useless at another stage [12]. The design of information system traceability can be described through the activity diagram in figure 2.
The Activity diagram illustrated the activities that are taking place in the system. This activity started when the consumer enters the system then traces the product. Consumers can also make purchases directly through the system. The system will process all traceability activities that have been updated by the administrator.

3.6. Implementation / coding phase
In this phase, information system design comes to the implementation process. The designed applications connected to the database system must be in accordance with the administrative requirements and working procedures that are carried out for traceability. The implementation and coding of designs are illustrated through the following sequence diagram [7].

Figure 3 to 5 show the process sequence of the running system. The process that occurs in this system includes editing products, delete products, purchase orders, stock updates, nutrition information updates, and select stocks.
3.7. Document draft
The following is the forms of data that will be processed on the implementation of the designed information system.

3.7.1. Data on product nutritional content
The designed information system will contain the data on the nutritional content of the products. The data will then be processed into information that can be accessed by customers [7].
3.7.2. Store inventory data
Traceability information system will contain the data on the quantity of the products in the store/distributor. This data will be processed into information to customers regarding the number of inventories of each store.

3.7.3. Purchasing data
This information system will also be designed to make online purchases. With this system, it will be easier for customers to make purchases.

3.8. Hardware and software specifications
The system is considered good and will be successfully used or applied if it is supported by several elements or several aspects, which among others is the hardware and the software [11]. Among these elements, the infrastructure or supporting equipment needed must be in accordance with the proposed system specifications.

3.8.1. Hardware
Hardware is the whole components that make up a computer system and other equipment that allows a computer to carry out its duties. The hardware specifications proposed are shown in Table 1.

| Front end user | Back end |
|----------------|----------|
| Smartphone (OS android 4.0+ ice cream sandwich) | PC or notebook with specifications : a. RAM 4 GB b. Harddisk 500 GB c. Processor AMD E2-2000 APU d. VGA AMD Radeon HD 7340 HSDPA, 2G, 3G and 4G internet connection |

3.8.2. Software
In addition to hardware, software is also needed to build this web-based system, which include windows 10 pro 64-bit, Browsers (Mozilla Firefox, Google Chrome), Notepad ++ or Adobe Dreamweaver, Virtual web server (XAMPP), Filezilla Client.

![Information system interface](image)

Figure 6. Information system interface

3.9. Testing
Several test-cases must be carried out with differences in strategies of transaction, query, or navigation path that represent the use of the system. The test must include unit testing, which checks the validation
of each procedure and function that is run independently of other system components. Then, the testing module must be run next to find out whether the merging of several units in one module has been running well, including the execution of several interconnected modules [7].

4. Conclusions
From the various explanations that have been described above, it can be concluded that the application presented the information on the nutritional content of processed apple products intended for customers. This application presented the inventory of processed apple products in the store, making it easier for customers to check the traceability. This application allows the marketing area to be more widespread.

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