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Original research

Development of an Android-based quality detection system for young coconut with ADDIE and ISD

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ABSTRACT

The demand for high-quality young coconuts is growing as public awareness of their health benefits continues to rise. However, manually identifying the quality of young coconuts is often inaccurate and time-consuming. This research aims to address this issue by developing an Android-based application for detecting the quality of young coconuts, utilizing the ADDIE (Analysis, Design, Development, Implementation, Evaluation) and ISD (Instructional System Design) models. The ADDIE model serves as the framework for system development, while the ISD model helps structure the application's content and functionality. Data collection involved a comprehensive literature review of relevant references, along with testing the application on various young coconut samples. The testing process measured the accuracy of the application's quality detection compared to traditional manual methods. The results demonstrate that the developed application can detect the quality of young coconuts with high accuracy, providing a reliable tool for farmers and consumers to select high-quality produce. Beyond improving accuracy, this application is expected to enhance efficiency in quality assessment, add value to the agricultural industry, and reduce reliance on subjective manual evaluations. By streamlining the process of identifying quality young coconuts, the application has the potential to optimize their distribution and sales in the market, benefiting both producers and consumers.

1. Introduction

Coconut is one of the most versatile plants, known for its high economic value [1, 2, 3]. Every part of the coconut tree can be utilized for human purposes, earning it the nickname "tree of life" [2, 4]. This is because nearly all its components—roots, trunk, leaves, stems, and fruit—can be used in daily life [5, 6]. When it comes to the origin of coconuts, there are several theories suggesting they originated in South America [7, 8]. This is supported by the discovery of many plants similar to coconuts in the region [9, 10]. Additionally, coconut fossils from the Pleistocene era have been found in the Pacific region, specifically in New Zealand [11, 12].

Coconuts are cultivated in 92 countries worldwide, covering approximately 11.8 million hectares (29.5 million acres) of land [3, 13]. Global production is estimated at 61.7 million tons, with an average yield of about 5.2 tons per hectare [14, 15]. The top 10 coconut-producing countries are listed in Table 1.

Table 1.
Top 10 countries as coconut fruit producers [5]

No	Country	Production (tonnes)	Percentage
1	Indonesia	3.200.000	27%
2	Philipine	2.800.000	23%
3	India	1.800.000	15%
4	Sri Lanka	700.000	6%
5	Thailand	650.000	5%
6	Vietnam	600.000	5%
7	Brazil	580.000	4%
8	Malaysia	500.000	4%
9	Papua New Guinea	470.000	4%
10	Cote d'Ivore	300.000	2%

The production figures shown in Table 1 are based on copra production reports, administrative estimates, or planted area data [16, 17]. This approach is necessary due to the traditional nature of coconut production, which makes it nearly impossible to accurately calculate the total amount of coconuts produced [18, 19]. As a result, it is reasonable to conclude that the production data may not fully reflect actual production levels [2, 20].

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Table 2.
Estimated coconut production in Indonesia [5]

No	Province	Estimated (tonnes)
1	Sulawesi Tengah	1.200.000
2	Sumatera Utara	500.000
3	Jawa Timur	400.000
4	Nusa Tenggara Barat	300.000
5	Kepulauan Riau	250.000
6	Bali	180.000
7	Lampung	150.000
8	Jawa Barat	140.000
9	Kalimantan Barat	100.000
10	Maluku	80.000

Additionally, there is often a gap between production and harvest, which is heavily influenced by price fluctuations [4, 6]. For instance, if coconut prices are too low, farmers may lack the incentive to harvest their coconut products [4, 8]. Now, turning to developments in Indonesia itself, the country is often referred to in many references as the "Land of Nyiur Kelapa" (Land of Coconut Palms) [10, 12].

Coconut is one of the most familiar tropical plants to the people of Indonesia [4, 6]. This is evident from the widespread distribution of coconut plants across nearly all regions of the country. Sumatra has approximately 1.20 million hectares (32.90%) of coconut plantations, while Java has around 0.90 million hectares (24.30%). Sulawesi accounts for 0.71 million hectares (19.30%), and the combined regions of Bali, NTB, and NTT have 0.30 million hectares (8.20%). Maluku and Papua together have 0.28 million hectares (7.80%), and Kalimantan has 0.27 million hectares (7.50%) [1, 7]. The map of the estimated distribution of coconut production in Indonesia is provided in Table 2.

The image provides an overview of coconut products nationally, most of which are export commodities [7, 9], accounting for about 75% of the market share, while the remaining percentage is consumed domestically [1, 2]. In 2003, the export value of various coconut products from Indonesia reached $396 million USD, with a total export volume of 708 tons sent to markets in the Americas, the Netherlands, Belgium, the United Kingdom, Ireland, Italy, Germany, France, Spain, Singapore, and other Asian countries, including Bangladesh, China, Malaysia, Sri Lanka, South Korea, Taiwan, and Thailand [11, 18]. Recently, the government has started to explore new markets for coconut products, targeting regions such as the Asia Pacific, Eastern Europe, and several Middle Eastern countries [19, 20]. To support the future development of the coconut industry, more strategic planning is needed from the government and other stakeholders [2, 9].

Opportunities in the development of coconut agribusiness lie in products with very high economic value [3, 8]. However, several challenges persist in the field, particularly regarding feedback from consumers who purchase these products [3, 4]. One of the primary factors contributing to consumer dissatisfaction is the quality of the coconuts [1, 4]. Green coconuts, commonly referred to as young coconuts, are widely consumed [4, 8]. Traditionally, various conventional methods have been used to assess coconut quality, such as tapping the shell, observing the color of the husk, and other similar techniques [6, 9]. However, the reliability of these conventional methods cannot be accurately measured, often resulting in coconut quality that fails to meet expectations [4, 13].

Table 3.
State of the art (SOTA)

No	Authors	Highlights and findings
1	[21, 22]	The café was able to carry out digital-based buying and selling transactions in a more structured and simple manner.
2	[22, 23]	The results are very good, and the user interface test results of 49% are very good.
3	[24, 25]	The process to make an Android-based barcode scanner has proven to be more effective than using a barcode scanner .
4	[26, 27]	Through the use of this application, lecturers can make student presentations with a QR code contained on the student card through an android smartphone that functions to read QR codes, so that lecturers no longer need to manually record their student attendance.
5	[28, 29]	The research that has been carried out has resulted in an Augmented Reality application of Nusantara Fabric that is able to encourage and help the general public and the world of education in getting to know the Nusantara Fabric.
6	[26]	With the existence of this application, it is able to help warehouse employees to carry out inventory management , including incoming goods, outgoing goods, as well as final inventory and reports.
7	[30, 31]	By using a scan through QR Code, customers can monitor the car that is being serviced without being constrained by distance so that it feels easier and more efficient.
8	[32, 33, 34]	Through the design of an android-based application, it is hoped that the store management process starting from the transaction process, stock data, input of goods and checking of goods data through the use of smartphone-based barcode scanners can make it easier for business actors to carry out the store management process.
9	[35, 36, 37]	The main purpose of designing a katakana letter recognition learning application with Augmented Reality software aims to create easier and more interesting katakana recognition learning.
10	[38, 39, 40]	The results of the research obtained are applications that apply Scan QR Code to obtain information and digital maps from a tourist attraction location.

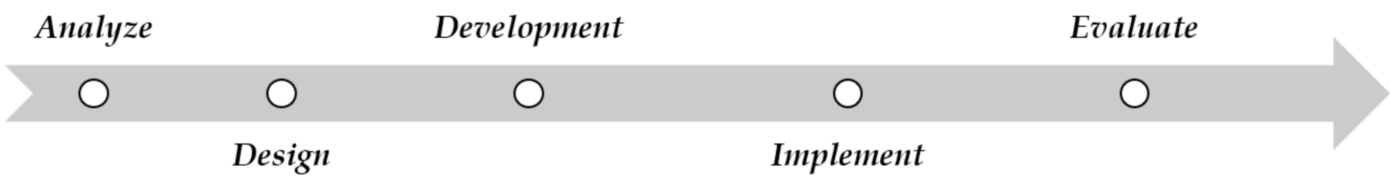

Figure 1. Development flow

Given the advancements in science and technology, this study aims to develop a more accurate method for determining coconut quality [9, 18]. Si-coco, an application currently in the development stage, is designed to provide a user-friendly solution for this purpose [10, 18]. Leveraging modern technological advancements, the application can scan coconuts to assess their quality [5, 9].

Based on the State of the Art (SOTA) analysis presented in Table 3, the gap between this study and previous research lies in its focus on an Android-based application capable of scanning coconuts [10, 12]. This approach simplifies the process while addressing the lack of maturity level assessment in conventional methods [4, 7]. Consequently, this study introduces innovations and updates to enable the determination of coconut maturity levels [8, 9].

2. Material and method

This writing is carried out through a Research and Development (RnD) approach to find out the answers to known problems. RnD is carried out to obtain the results of a certain product that is accompanied by testing the effectiveness of the product [41]. So the following is the flow of the stages carried out in the development of this writing, as shown in Fig. 1.

Through Fig. 1. we can infer that the flow of the development stages that will be carried out. The development of this writing is by using the Analyze, Design, Development, Implement, and Evaluate (ADDIE) Model. Furthermore, each stage flow in the ADDIE Model is developed with the Information System Design (ISD) Model. This aims to explain each stage flow in the ADDIE Model. The ADDIE Model has been judged to be very suitable for writing that focuses on the development of instructive analysis and system design [42, 43]. The following is the application of the ADDIE Model for the writing carried out.

1. The flow of the analysis stage is to identify problems. This aims to determine the formulation of problems, goals, and benefits from the results of the writing that has been carried out. This writing uses literature studies and field studies. The literature study is based on the results of theoretical studies, such as through journals, books, proceedings, and several other scientific articles. Meanwhile, the field study is based on the results of direct observation, interviews, and filling out questionnaires with several respondents in previous studies [44].
2. The flow of the design stages, the system is designed from the results of problem identification. Several stages are carried out in system design, such as use case modeling, context diagrams, data flow diagrams, unified modeling languages, and entity relationship diagrams. This aims to design a systematic system and adapt to the needs of the system users [45].
3. The flow of the development stages is carried out from the results of system design. At this stage, it focuses on developing the appearance of the system to be used. In addition, it comes with the creation of concepts to support the system well received. This aims for development that will be implemented in the next stage [42].
4. The flow of the implementation stages is carried out from the results of development. At this stage, it focuses on the implementation of the system that has been created from the results of previous development. In addition, with the addition of outside the system, namely the business catalog. This aims to make consumers more interested in the addition of the system [43].
5. The flow of the evaluation stage, the system is tested from the results of the implementation. At this stage, it focuses on testing the system from the results of the system design that has been carried out. The system test is carried out by literature study from the results of previous writing/research that is similar to the current research. This is because system design with the ADDIE Model approach has been done a lot, but what distinguishes it from the function of the system [44].

3. Results and discussions

3.1. Functional needs analysis

Functional needs refer to a set of functions embedded within a system, software, or application, enabling users to utilize it according to its intended purpose. In this application, users are divided into two roles: the manager, who oversees and controls the application, and the user, who interacts with and utilizes its features. The lists of the manager's functional needs, comprising seven requirements, is presented in Table 4, whereas the functional need for user is presented in Table 5.

Table 4.
Functional needs of managers

No	Code	Information
1	SL1	Log in and out
2	SL2	View manager accounts
3	SL3	Edit your manager account
4	SL4	View a list of user accounts
5	SL5	Add app information and features
6	SL6	Edit app information and features
7	SL7	Remove outdated information and features
8	SL8	Scanning coconuts
9	SL9	Get coconut ripeness scan results

Table 5.
Functional needs of users

No	Code	Infromation
1	SL1	Log in and out
2	SL2	View user accounts
3	SL3	Edit a user's account
4	SL4	View app information and features
5	SL5	Scanning coconuts
6	SL6	Get coconut ripeness scan results

3.2. *Non-functional needs analysis*

In accordance with the results of the analysis in the application planning and development process, apart from functional needs, there are also non-functional needs, including the following: 1) Usability, users must be able to use the application easily and the application is user friendly for users. 2) Portability, namely the ease of accessing applications, especially at any time and with any location through Android Mobile. 3) Reliability, the need for application reliability, especially in security factors or security systems. 4) Compability, the ability of applications to be run using a minimum device of Android 7.1 Nougat. 5) Supportability is the need for usage support in operating the application.

3.3. *Design*

Based on the results of the problem identification, the next step is the system design stage, which consists of several phases, namely use case modeling, serving as an overview of the functional requirements between the manager and the user for the application, with the results of the use case modeling illustrated in Fig. A1 (see Appendices). The Context Diagram serves to identify the content of the application, including the scope and limitations of the system, and to visualize the processes and dependencies between systems that will be used by the user. The results of the context diagram are shown in Fig. A2 (see Appendices). The Data Flow Diagram (DFD) serves to illustrate the flow and stages within the application, showing how processes are connected to each entity. The results of the data flow diagram are shown in Fig. A3 (see Appendices). Unified Modeling Language (UML) serves as a programming language framework for defining the structure and behavior of each entity in the application. The results of the UML design are shown in Fig. A4 (see Appendices). Entity Relationship Diagram (ERD) has the function of showing the relationship of each entity with the attributes owned by each entity. The results of the entity relationship diagram that has been created are shown in Fig. A5 (see Appendices).

3.4. *Development*

In this stage, development is carried out from the results of system design. At this stage, focus on developing the app displayed. Fig. 2-18 show the app's display.

Figure 2. Loading screen

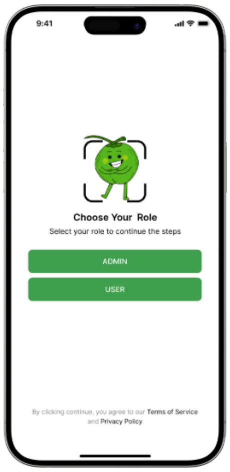

Figure 3. Choose role

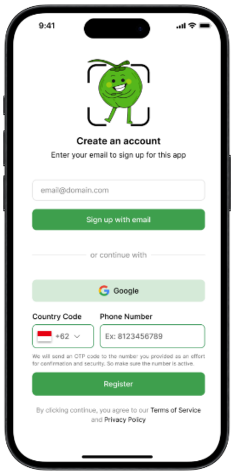

Figure 4. Login

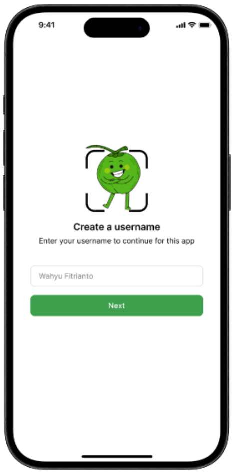

Figure 5. Username

Figure 8. Scan

Figure 6. Porch/Home

Figure 9. Confirmation page

Figure 7. History

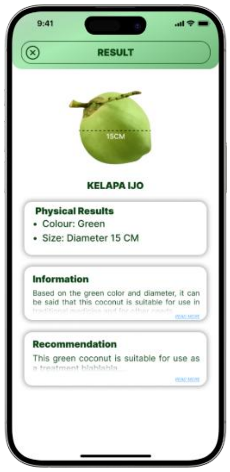

Figure 10. Result

Figure 11. Loading screen

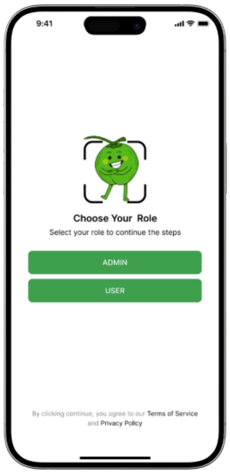

Figure 12. Choose 5ole

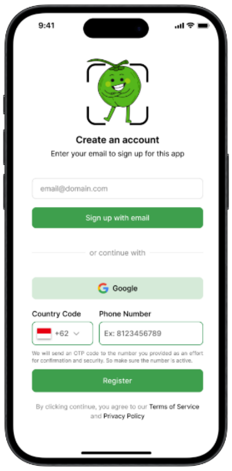

Figure 13. Login

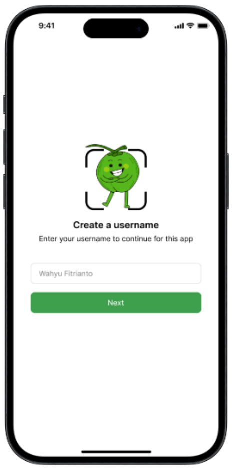

Figure 14. Username

Figure 15. Porch/Home

Figure 16. History

Figure 17. Confirmation page

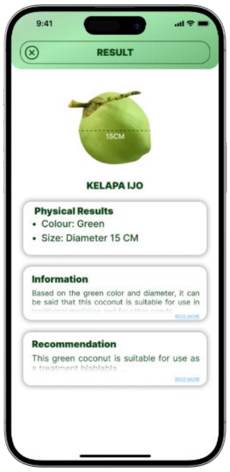

Figure 18. Result

(a) Module front cover (b) Module content cover

Figure 19. Tutorial module

3.5. *Implement*

In this stage flow, the application of the development results is carried out. At this stage, it focuses on the implementation outside of the system, namely the existence of a guidance module as shown in Fig. 19.

3.6. *Evaluate*

In this stage of the flow, a system test was carried out from the results of the implementation. At this stage, it focuses on profitability testing on multiple software and white box and black box testing. In this stage, the flow is the same as the previous writing which is similar to the previous writing. So that the test results take parameters from the results of the writing test that has been carried out. In addition, the results of the completed application will then be analyzed whether it is appropriate or not through the Technology Acceptance Model (TAM). The model focuses on testing based on the results of user feedback about this application. So that this application can better adjust to the needs of users in the future.

4. Conclusions

The conclusion of this study shows that the Android-based young coconut quality detection application developed using the ADDIE and ISD models has high accuracy in detecting the quality of young coconuts. This application not only makes it easier for farmers and consumers to choose quality young coconuts but also increases efficiency and accuracy in the quality determination process. Thus, this application has the potential to reduce dependence on subjective manual assessment methods, while providing added value for the agricultural industry and optimizing the distribution and sales process of young coconuts in the market. In addition, this research also opens opportunities for further development in the field of agricultural technology, especially in the development of similar applications for other commodities, as well as the improvement of application features based on user feedback. This shows that digital technology can play an important role in improving the quality and efficiency of the agricultural sector.

Declaration statement

We, the undersigned, declare that the research entitled "Android-Based Young Coconut Quality Detection Application with ADDIE and ISD Model" is the result of joint work carried out by the team with the following division of tasks: **Wahyudin** as the Head of the Research Team responsible for the management and direction of the research, **Dene Herwanto** as the Vice Chairman of the Research Team who assists in the coordination and supervision of research activities, **Firda Ainun Nisah** as the Secretary who manages the documentation and administration of the research, **Billy Nugraha** as the Research Draftsman who designs concepts and methodologies based on the ADDIE and ISD models, **Taufik Nur Wahid** as a Programming Language Designer who selects and implements programming languages for application development, and **Wahyu Fitrianto** as an Application Builder who develops Android-based applications according to design and specifications. We are hereby fully responsible for the validity of this research, including the process of its implementation and the results achieved.

Acknowledgement

We would like to express our deepest gratitude to several villages in Karawang Regency who have provided full support in collecting data and information that is very important for the success of this research. The participation, cooperation, and friendliness of the village community has been an integral part of our research process. We also express our highest appreciation to the University of Singaperbangsa Karawang for fully supporting in terms of administration and providing adequate facilities to support the smooth running of this research. Without the support of this academic institution, this research would not be able to run as it should. For all the assistance that has been given, we would like to express our sincere gratitude and appreciation. Hopefully this cooperation will provide benefits for the community and the advancement of science.

Disclosure statement

We, the undersigned, declare that this research has been conducted by upholding the principles of honesty, transparency, and research ethics. All data and information used in this study were obtained legally through cooperation with several villages in Karawang Regency, which have given full permission and support in data collection. We also ensure that this research has no conflicts of interest, either personally or institutionally. Each stage of the research, from data collection to application development, is carried out independently without any external influences that can affect the objectivity of the research results. The administrative support provided by the University of Singaperbangsa Karawang is completely facilitative and does not affect the content or results of this research. All research results are the full responsibility of the research team. Hereby, we declare that this research is carried out in accordance with scientific principles and can be accounted for.

Funding statement

We declare that this research was fully carried out without receiving funds or financing from any party, be it institutions, governments, or external sponsors. All costs incurred during this research process are borne independently by the research team. This statement is made as a form of transparency and our responsibility in carrying out this research.

Data availability statement

We state that all the data used in this study were obtained from the results of data collection in several villages in Karawang Regency. The data that has been used in this study is available in a structured form and can be accessed based on reasonable requests. We are committed to maintaining the confidentiality and privacy of data, and will provide access to data only for academic and research purposes in accordance with the provisions of research ethics.

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Appendices

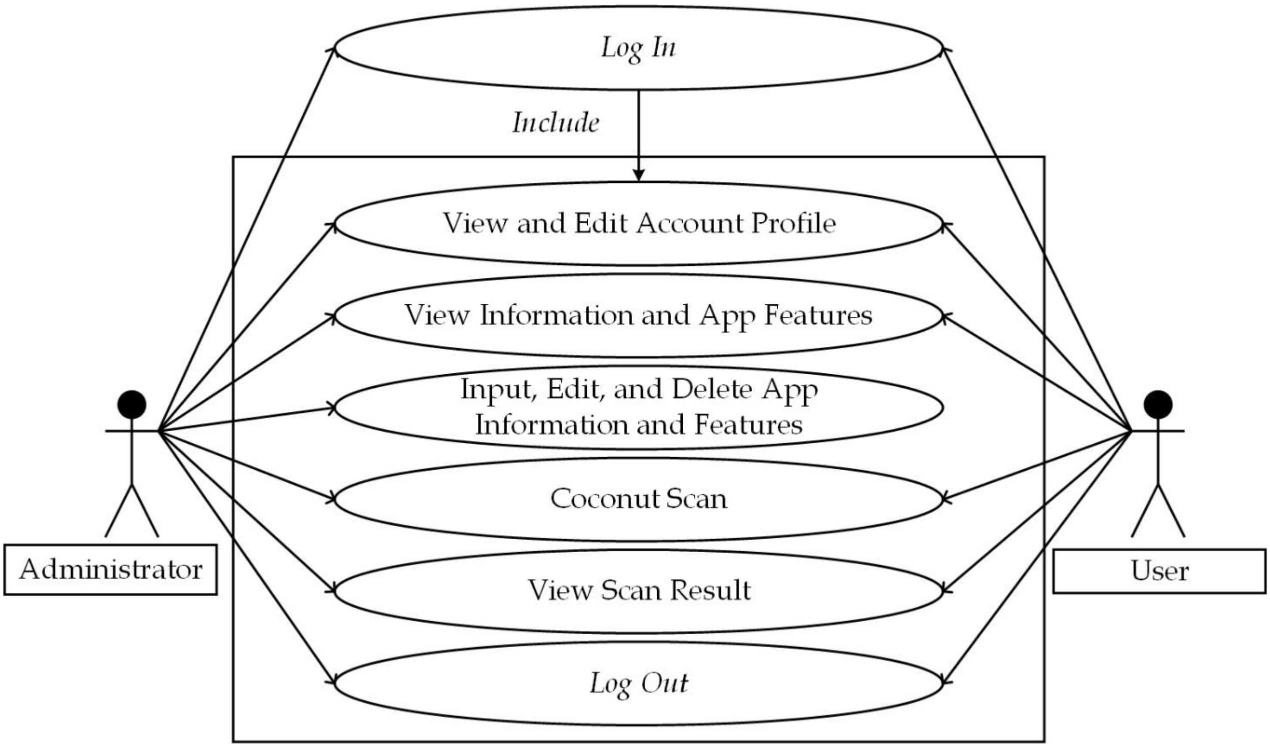

Figure A1. Use Case Modeling

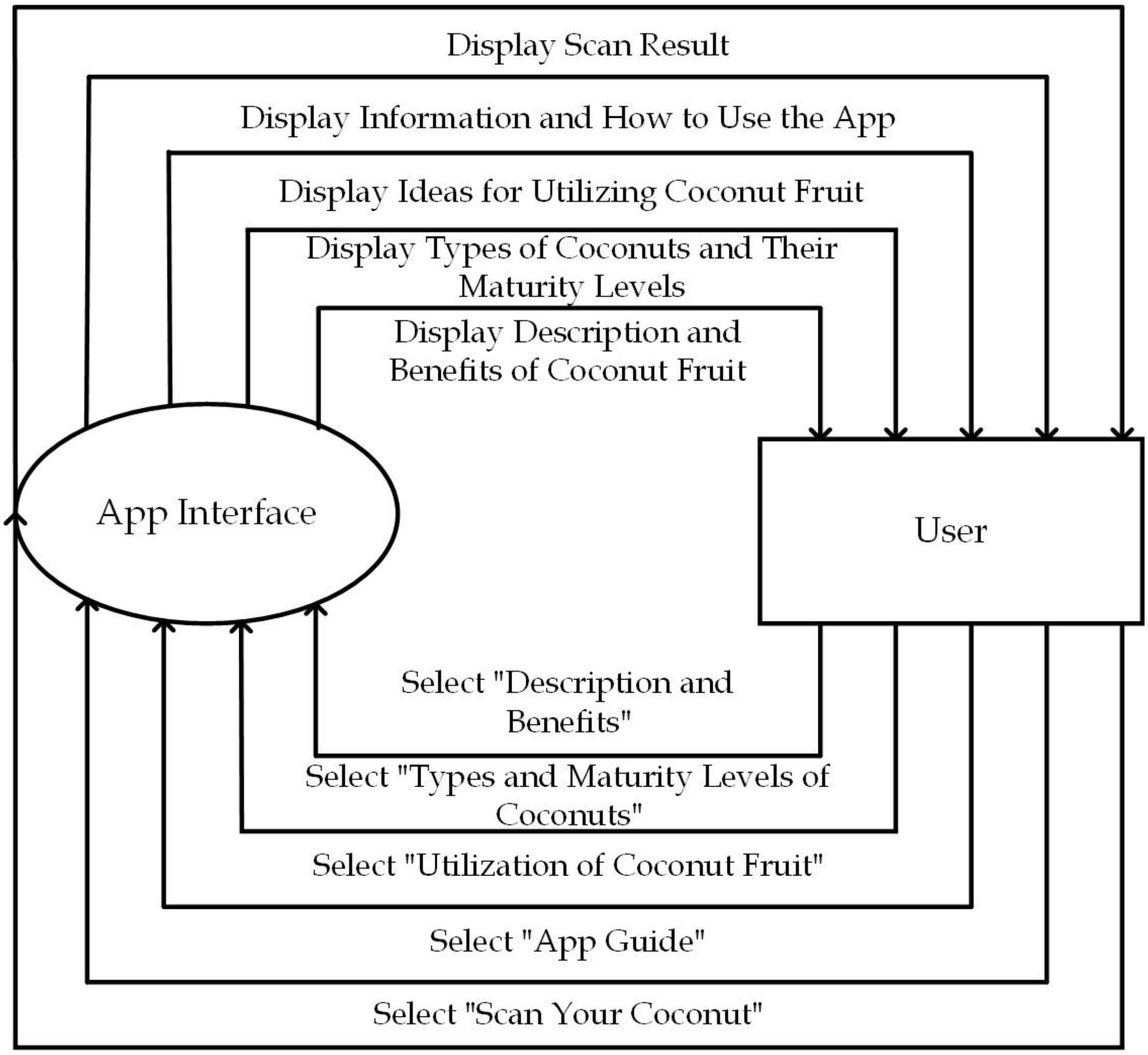

Figure A2. Context Diagram

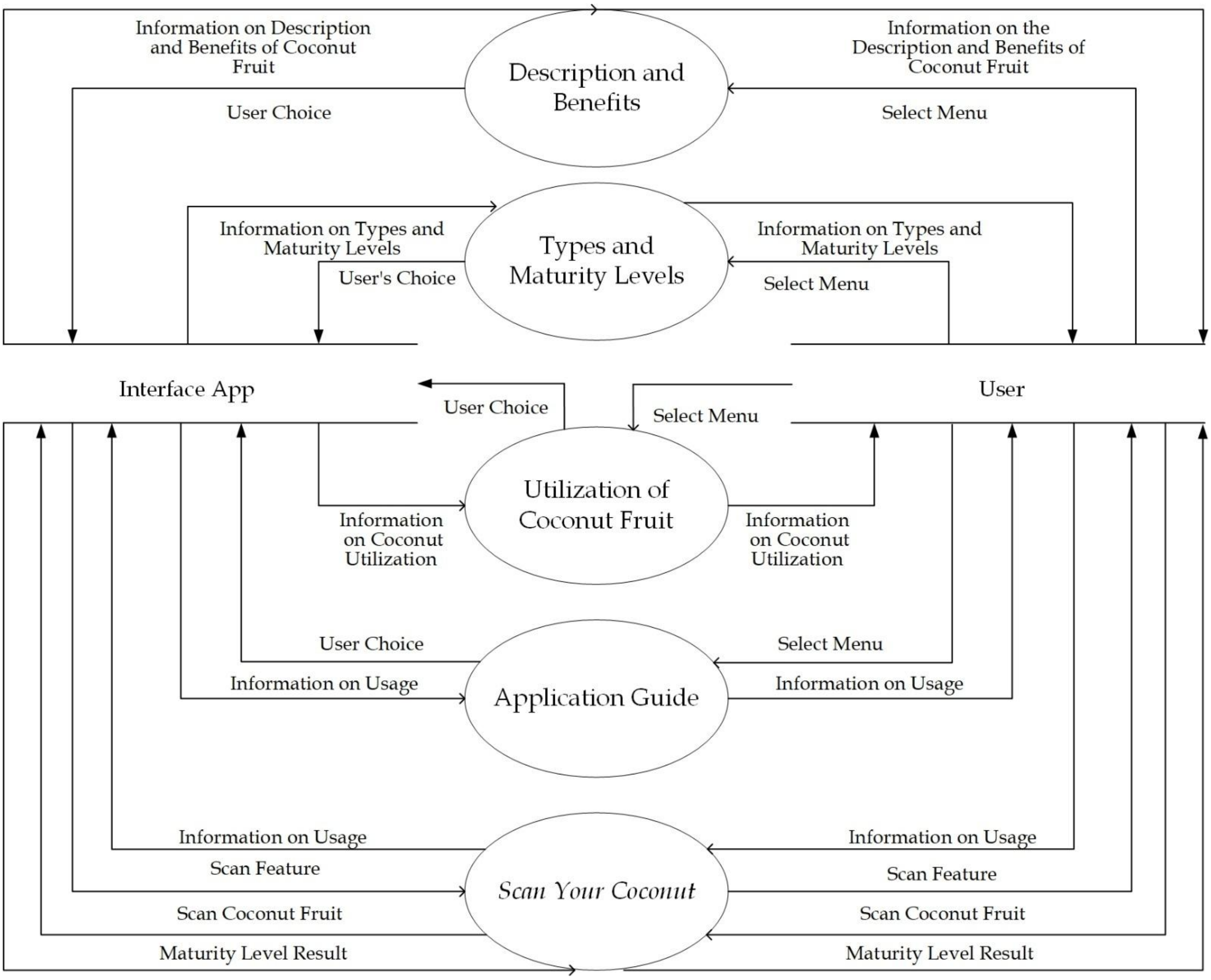

Figure A3. Data Flow Diagram

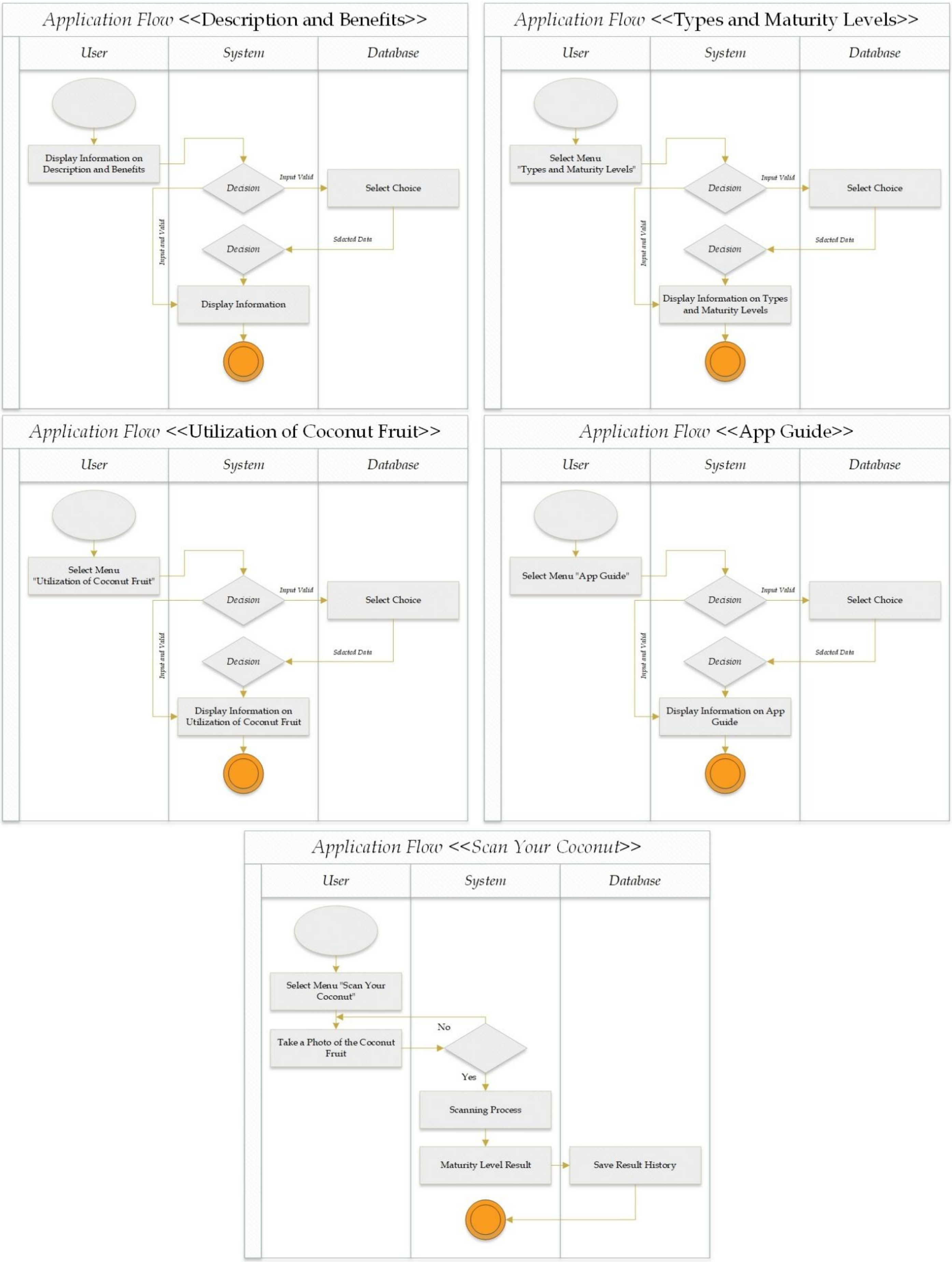

Figure A4. Unified Modeling Language

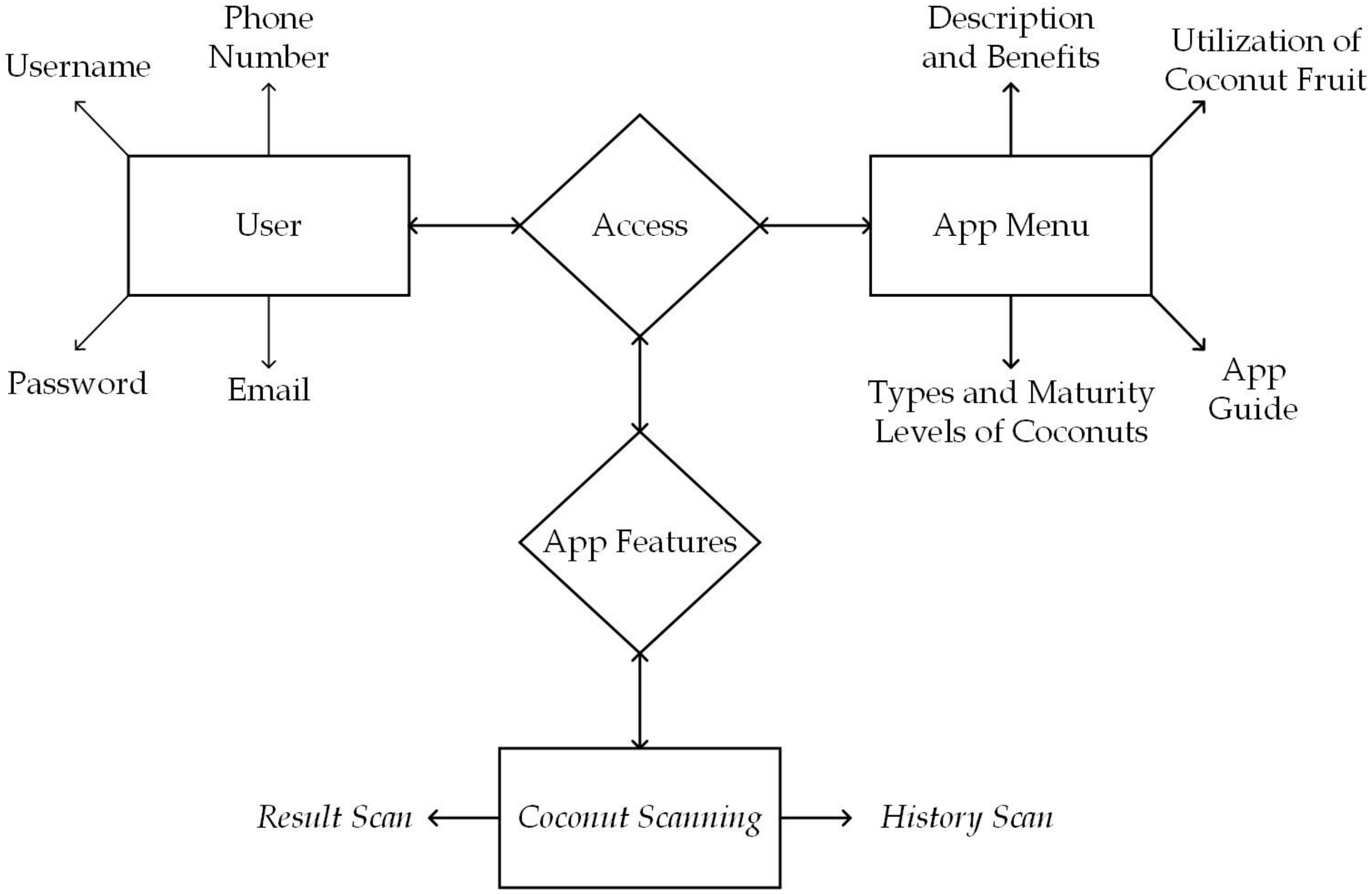

Figure A5. Entity Relationship Diagram