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*Article*

# Cultivating Knowledge: Design and Development of the Infographic (Baja Sawit) Mobile Application to Enhance Oil Palm Fertilization Practices among Smallholders

**Azura Ishak[1,*], Ahmad Afandi Murdi[2], Khairuman Hashim[3], Abdullah Muhammed[4], Masura Rahmat[1], Shahrina Shahrani[1], Rohizah Abd Rahman[1], Noor Faridatul Ainun Zainal[1], and Nordiana Abd Aziz[2]**

1 Faculty of Information Science and Technology, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia
2 Agronomy and Geospatial Technology, Malaysian Palm Oil Board (MPOB), 6, Persiaran Institusi, Bandar Baru Bangi, 43000 Kajang Selangor, Malaysia
3 Smallholder Extension and Certification Division, Malaysian Palm Oil Board (MPOB), 6, Persiaran Institusi, Bandar Baru Bangi, 43000 Kajang Selangor, Malaysia
4 Faculty of Computer Science and Information Technology, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
*E-mail: azura.ishak@gmx.com (Corresponding author)

**Abstract.** This study presents detailed information for developing the Infographic Oil Palm Fertilize Mobile Application called Baja Sawit. The Infographic Baja Sawit Mobile Application development aims to promote good practices in palm fertilization among smallholders in a simple and accessible manner using Mayer's 12 Principles of Multimedia Learning approach. The study illustrates the systematic development of the application's content, marked by precision in integrating insights derived from a comprehensive literature analysis and interviews with five highly skilled professionals in oil palm fertilizers. The workshop done with the Malaysian Palm Oil Board (MPOB) used the Infographic Baja Sawit App, monitoring participants throughout. This study utilized the Mobile Application Development Life Cycle (MADLC) methodology, encompassing seven key phases: identification, design, development, prototyping, testing, deployment, and maintenance. The resulting Infographic Baja Sawit Mobile Application offers substantial advantages to oil palm smallholders by actively promoting best practices in palm fertilization. This study has substantial implications for developing a digital information infographic culture tailored to oil palm smallholders from various regions in Malaysia.

**Keywords:** Infographic, oil palm fertilizer, mobile application development, smallholders.

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## Glossary of Malay Terms

Asas Pembajaan - Basic Fertilization
Buah Tandan Segar - Fresh fruit bunches
Daftar Pengguna - Register
Direktori MPOB - MPOB's Directories
Formulasi Baja - Fertilizer Formulations
Jenis Baja Sawit - Oil Palm Fertilize Types
Kaedah Pembajaan - Fertilization Methods
Kenali Baja Sawit - Know Oil Palm Fertilize
Log Masuk - Login
Log Keluar - Logout
Lupa Kata Laluan - Forgot Password
Profil - Profile
Rekod Baja - Fertilization Record
Tanda Kekurangan Nutrien - Nutrient Deficiency Symptom
Tentang Aplikasi - About the Application
Sejarah Rekod Baja - History of Fertilization record
Tanda Kekurangan Nutrien - Nutrient Deficiency Symptoms

## 1. Introduction

Malaysia is well known for being an agricultural nation, with a wide variety of crops and commodities grown there thanks to the country's vast geographic diversity. The country's agriculture industry is vital to its economy and makes a substantial contribution to both local and foreign trade. Malaysia is a major producer of various agricultural products. Some of the important agricultural products in Malaysia include palm oil, rice, cocoa, durian, pineapple, coconut to name a few.

Malaysia is one of the world's largest producers and exporters of palm oil. Palm Fertilization is essential in optimizing Fresh Fruit Bunches Yield (Buah Tandan Segar -BTS). The lack of knowledge about fertilizer management contributes significantly to the low BTS production among oil palm smallholders in Malaysia [1]. Therefore, it is essential to implement best management practices to optimize the efficiency and effectiveness of fertilizer management [2]. The Malaysian Palm Oil Board (MPOB) inaugurated the TUNAS Center (Oil Palm Guidance and Advice) in late 2002. This center is dedicated to offering advisory services to oil palm smallholders through a range of training courses and workshops. [3]. The existing official media by the MPOB to convey palm oil information, including palm fertilization, is also through supporting media in the form of articles such as Warta Sawit and Risalah Sawit.

In recent years, Malaysia has witnessed a notable embrace of technology, with farmers increasingly adopting precision farming techniques. However, according to an interview from the MPOB, no mobile application platform regarding oil palm fertilization can be used as a guide to oil palm fertilization that is easily accessible via smartphone. Mobile applications enable the fast and efficient delivery of information. Users can access real-time information and get the latest updates quickly [4]. Moreover, mobile applications offer diverse data formats, including images, videos, and audio, to enhance the clarity and richness of news and information delivery [5]. The incorporation of various media elements in instructional design, guided by the 12 multimedia principles in the Cognitive Theory of Multimedia Learning, enhances memory retention, understanding, and motivation [6], while simultaneously alleviating individual cognitive load [7]. The infographic presentation is one form of multimedia approach that can assist individuals to understand information more easily and quickly as the information is presented visually and is easy to comprehend [6, 7].

Therefore, to meet the need for information on oil palm fertilization that is easy and quickly understood by users, this study was conducted to develop an Infographic Oil Palm Fertilize Mobile Application, which will serve as a mobile platform that can be accessed via a smartphone by all Malaysian oil palm smallholders. The main objective of this study is to develop an Infographic Oil Palm Fertilize (Baja Sawit) Mobile Application, apply 12 multimedia principles in the infographics presentation, and receive feedback on the usability of this application. The development process uses the Mobile Application Development Live Cycle (MADLC) model, which comprises seven phases: Identification, Design, Development, Prototype, Testing, Deployment, and Maintenance. The MADLC model served as a structured workflow guide in facilitating the seamless development of the application within the context of this research.

## 2. Literature Review

### 2.1. Mobile Application

A mobile application is a software program designed for execution on mobile platforms such as smartphones, tablets, and other electronic devices [8, 9]. Mobile applications can facilitate the rapid and effective delivery of information to users. Additionally, mobile applications can provide easy access, interactivity, and speed and use various media for updates and relevant notifications.

Several studies have reported the advantages of using mobile applications. According to the literature, mobile applications can improve secondary school student's understanding, motivation, and interest in mathematics [10]. Another study on mobile applications suggested that mobile applications were promising in expanding the reach of Islamic preaching and facilitating access to Islamic information [11]. Likewise, within agricultural studies, mobile applications play a crucial role in assisting farmers by granting them access to up-to-date information on agricultural technologies, market pricing, and other relevant data [12]. In this study, the researchers aim to use a mobile application as a platform for the application of Infographic Baja Sawit, intended to meet the needs of palm oil smallholders across Malaysia.

## 2.2. Multimedia Learning Concept

The cognitive theory of multimedia learning posits that multimedia learning must involve presenting information in two formats without increasing cognitive load [13]. The two intended formats involve the use of text and images. These two multimedia elements are subjected to an active filtering process through human memory and then organized and integrated according to the importance of learning at that time [14]. As a result, students can relate the cognitive activities with the selection of knowledge, organization, and integration of knowledge by following the learning objectives [14, 15]. Students can experience better and more structured learning through multimedia presentations or multimedia learning that presents essential information in text and picture format.

In this study, the 12 principles of multimedia learning stated by Mayer were applied in the design of the Infographic Baja Sawit Mobile Application, as shown in Table 1:

Table 1. The 12 Principles of Multimedia Learning.

| Principle | Description | Methods |
|---|---|---|
| Coherence Principle | Humans learn best when they exclude extraneous, distracting material. | Use only the information that the learner needs. |
| Signaling Principle | Humans learn best when shown what to pay attention to on the screen. | Highlight important information or keywords with bold colors. |
| Redundancy Principle | Humans learn best with narration and graphics instead of narration, graphics, and text. | If there is a description through an audio element, include either graphics or text only, not both simultaneously. |
| Spatial Contiguity Principle | Humans learn best when relevant text and visuals are physically close together. | Place relevant text and graphics nearby. |
| Temporal Contiguity Principle | Humans learn best when corresponding words and visuals are presented together instead of in consecutive order. | The animation (or visual) should coincide with the audio description. |
| Segmenting Principle | Humans learn best from visuals and spoken words than from visuals and printed words. | Provides next and back buttons for each info display or allows video presentation control. |
| Pre-Training Principle | Humans learn more efficiently if they already know some of the basics. | Provides an introductory segment on the basic concepts of module content. |
| Modality Principle | Humans learn best from visuals and spoken words than from visuals and printed words. | Reduce the use of text in audio-assisted learning except for definitions, lists, and instructions. |
| Multimedia Principle | Humans learn best from words and pictures than just words alone. | Use a combination of relevant text and visual elements. |
| Personalization Principle | Humans learn best from a more informal, conversational voice than an overly formal voice. | The information is delivered directly and informally. |
| Voice Principle | Humans learn best from a human voice than a computer voice. | Using audio professionally recorded by humans. |
| Image Principle | Humans do not necessarily learn better from a talking head video. | It uses related animations and visuals that help reinforce audio dubbing. |

## 2.3. Infographic for the Information System

Infographics comprise various visual components such as pictures, drawings, diagrams, symbols, graphics, and text, used separately or combined to present information [16]. Infographics are also a popular visual approach to convey abstract, complex, and compact messages [17-19]. Learning becomes meaningful if the information is presented visually [20]. The presentation of information in an infographic format is exciting and stimulates students' interest and motivation to continue using the module for learning purposes [21]. Therefore, learning materials must be attractive to get students' attention, relate to their existing knowledge, increase their confidence, and then receive reinforcement to maintain learning.

The easy and entertaining information presentation is essential for students to use as learning reference

material. The challenging domain will be accessible if the selection of information delivery methods is interesting to understand [22]. Infographics are not only the presentation of visual elements of graphs or charts [23]. Additionally, integrate ideas or data representation into the information content [24, 25].

Therefore, presenting information based on infographics that use visual elements and support text elements affects student learning [26, 27]. Information through infographics alleviates the cognitive load for students when processing complex information [22]. Infographics make information processing easier and attract students' attention to continue exploring the information presented in learning materials. Studies show that information based on infographics that use visual elements and support text elements positively affects student learning [28]. Infographics have become a widely adopted visual strategy for communicating abstract, intricate, and condensed messages [17, 18, 19, 29, 30].

Infographics also allow students to remember information easily compared to text-based learning materials [31]. Previous studies revealed that learning materials based on infographics increase student motivation in the learning process [28, 32]. Visuals are pivotal in memorizing and remembering information received, such as visual and verbal information [33]. Using infographics also summarizes the teaching process and improves student learning [25, 32, 34]. Additionally, infographics are among the most effective strategies to improve the learning process by simplifying complex information [30]. More than 65% of people are visual learners, where information processing can be executed 60,000 times faster than reading text [28]. Thus, the application of the presentation or infographic information impacts the learning process and access to information.

This study presents that an infographic is an element of information delivery by utilizing graphics, text, video, and icons to develop the Infographic Baja Sawit Mobile Application module. The Palm Oil application processes information through infographics, specifically using visual graphics combined with the minimal use of text. The information delivery method in this application depends upon the 12 principles of multimedia learning guided by Mayer's Cognitive Theory of Multimedia Learning [13].

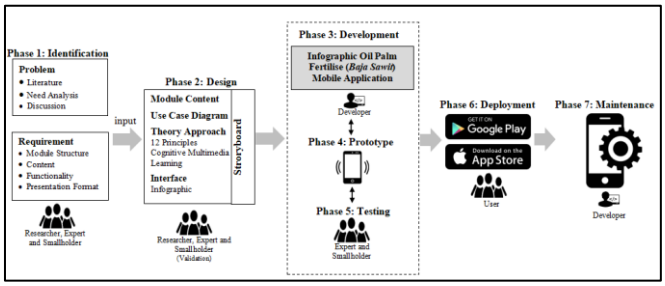


Fig. 1. Infographic Oil Palm Fertilize (Baja Sawit) Framework.

## 3. Methods

The design and development of the project follow a design and development research approach (Design and Developmental Research) [35]. The Infographic Baja Sawit mobile application development workflow follows the MADLC model. Various models, such as ADDIE, Waterfall, and Agile, can be used to develop an application. However, MADLC enables a systematic approach to developing Infographic Baja Sawit mobile applications. Developing a mobile application with complex functions is compatible with MADLC; it differs from the approach used for desktop applications [36]. The MADLC comprises seven phases: Identification, Design, Development, Prototype, Testing, Deployment, and Maintenance, as shown in Fig. 1.

### 3.1. Identification

In this phase, ideas are collected and classified by the research team or users. The researchers have submitted ideas and the intention to develop an Infographic Baja Sawit Mobile Application for the palm-related agency (MPOB). The research team critically assessed several studies on the problems encountered during oil palm fertilization. The team has prepared the proposal documentation and formally presented this idea through an online discussion with the MPOB agronomy unit team responsible for oil palm fertilization. Conferences were held with representatives of smallholders to get their opinions on the specifications and features necessary for the proposed mobile application. The result of the discussion focused on the input structure of module content, application functionality, and application interface display. Additionally, we discussed the acquisition of module content materials and the application development period to ensure adherence to the established timeline for this module's development.

### 3.2. Design

The input from the research team, the MPOB Agronomy unit, and representatives of oil palm smallholders during the identification phase is organized and integrated into the design phase. The diagrams illustrate the content structure and application functionality, with detailed use cases in Fig. 2 and Table 2. Concurrently, we design the application interface based on the needs of users who seek a simple, attractive, and easily comprehensible display, employing the 12 principles of the multimedia learning approach [13]. The documentation of the use case diagram and its details to present this information collectively act as a comprehensive guide for transforming it into a storyboard, as illustrated in Fig. 3. The MPOB Agronomy unit collaborated with the researchers to provide module content materials for the infographic summary to launch storyboard development. The

storyboard was developed in detail using PowerPoint software, containing several links to other modules or functions to achieve a holistic picture and facilitate the development process in the next phase. The content of each module was verified through the storyboard discussion with five module content experts from the MPOB Agronomy unit, utilizing a module content verification questionnaire on the Google Form platform. The purpose was to validate the content of each module using a module content verification questionnaire on the Google Form platform. During the improvement phase, numerous adjustments were implemented based on the feedback provided by the Agronomy unit experts, resulting in the refinement of the storyboard until achieving an optimal version for proceeding with the development phase.

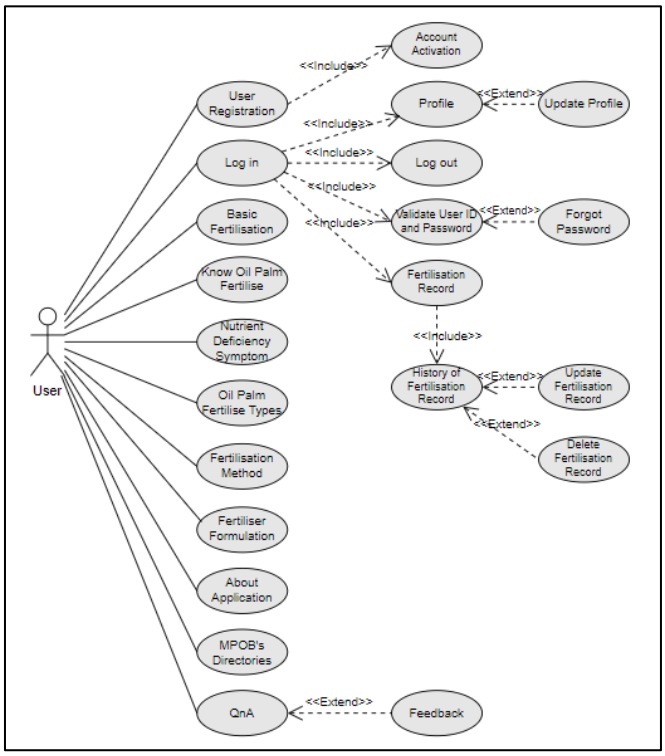


Fig. 2. Use Case Diagram.

Basic Fertilization (Asas Pembajaan), Know Oil Palm Fertilize (Kenali Baja Sawit), Nutrient Deficiency Symptom (Tanda Kekurangan Nutrien), Oil Palm Fertilize Types (Jenis Baja Sawit), Fertilization Methods (Kaedah Pembajaan) and Fertilizer Formulations (Formulasi Baja).

Table 2. Functional Use Case Details.

| Use Case Function | Description |
|---|---|
| User Registration (Daftar Pengguna) | Users can register users by entering information and pressing the send button to be processed. |
| Login (Log Masuk) | Registered users can enter their ID and password and press the login button. |
| Logout (Log Keluar) | Users logged in can exit the application by pressing the logout button. |
| Forgot ID and Password (Lupa ID atau Kata Laluan) | Users can click the forgot ID and password link if the entered ID and password are incorrect. |
| Profile (Profil) | Registered users can view personal profiles.<br>Registered users can update their profiles. |
| Basic Fertilization (Asas Pembajaan) | Users can see information about proper oil palm fertilization's needs, effectiveness, and success indicators. |
| Know Oil Palm Fertilize (Kenali Baja Sawit) | Users can see the display of Food Element Function, Fertilizer Nutrient Content, Fertilizer Source, and Fertilizer Form. |
| Nutrient Deficiency Symptom (Tanda Kekurangan Nutrien) | Users can see the display of nutrient deficiency information for Nitrogen (N), Phosphorus (P), Potassium (K), Magnesium (Mg), Boron (B), and Cuprum (Cu). |
| Oil Palm Fertilize Types (Jenis Baja Sawit) | Users can display information on Single, Compound, Mixed, Slow Release, Organic/Palm Residue, and Liquid fertilizers. |
| Fertilization Method (Kaedah Pembajaan) | Users can view information on Fertilization Concept, Fertilization Preparation, Fertilizer Sowing Area, Fertilizer Placement, Fertilizer Rate, and Fertilization Frequency. |
| Fertilizer Formulations (Formulasi Baja) | Users can view information on the formulation of Baja MPOB F1, MPOB F1 Extra K, MPOB F2, MPOB F2 Super K, MPOB F3, MPOB F4, MPOB F4 Premium and MPOB F5. |

| Use Case Function | Description |
|---|---|
| About Application (Tentang Aplikasi) | Users can see a display of general information about the purpose of use. |
| MPOB's Directories (Direktori MPOB) | Users can get the Google Maps location of each MPOB branch by zone.<br>Users can make phone calls directly to MPOB branch offices by zone. |
| QnA (Pertanyaan) | Users can make oil palm fertilization inquiries through an email link.<br>Users receive palm fertilization feedback. |
| Fertilization Record (Rekod Baja) | Users who are registered and logged in can record oil palm fertilization activities. |
| History of Fertilization record (Sejarah Rekod Baja) | Users can check the history of past oil palm fertilization records.<br>Users can update and delete existing record history. |


Fig. 3. The Example of Storyboard of Infographic Baja Sawit Mobile Application.

In this phase, the Infographic Baja Sawit Mobile Application utilized a 3-Tier architecture for application design. Figure 4 is a 3-tier architecture with three layers: Application Layer, Business Layer, and Access Layer. The Application Layer will only display the interfaces to the users. Users will interact with the interface by inserting data or viewing the data. The application forwards inserted data to the business layer for processing and then to the data access layer. The business layer stores and accesses data from the data access layer. The functionality of these layers is like a bridge to organize data sending between the layers.

Although the Data Access Layer constructs a Query and sends the data as a parameter to the database server, using the 3-Tier architecture makes the application easy to develop and maintain. All components at each level are independent, allowing for implementing updates and improvements without affecting the entire application.

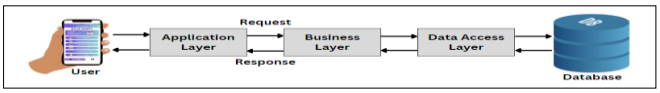


Fig. 4. 3-Tier architecture for Baja Sawit Mobile Application.

### 3.3. Development

In this phase, the storyboard is handed over to the development team to commence the creation of the Infographic Baja Sawit Mobile Application, encompassing the coding process and the development of specification requirements essential for the application. Ensuring that both software and hardware specifications align with the project requirements is crucial for the successful development of the proposed mobile application. Key software components include a stable operating system like Windows 10 or macOS, and an Integrated Development Environment (IDE) such as Android Studio for Android applications and Xcode for iOS applications. Table 3 depicts the specifications of the leading software and hardware requirements used to create the application, and the login interface is shown in Figure 5.

Table 3. Software and Hardware Specification.

| Component | Specification | Description |
|---|---|---|
| Framework Development | Flutter | A framework for building an Infographic Baja Sawit Mobile Application and creating an attractive interface for both iOS and Android platforms. |
| Multimedia | Adobe Photoshop<br>Adobe Illustrator<br>Canva Premium | Software to edit photos and design graphics and mobile app icons for Infographic Baja Sawit Mobile Application. |
| Database | MySQL | A platform to build and manage a database of user profiles and fertilizer records. |
| API | PHP RESTful | A platform to access and manipulate data from the server through the HTTP |

| | | |
|---|---|---|
| | | protocol. |
| Server | CPanel Cloud Server<br>- 35 GB NVMe Disk Space<br>- Ultra Fast SSD<br>- Added SSL Certificate | A platform to manage all data and files related to the Oil Palm application easily using FTP (File Transfer Protocol). |

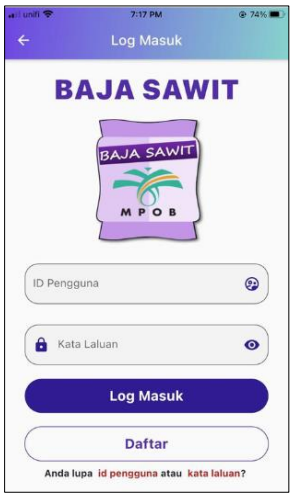


Fig. 5. Login Interface for the developed mobile app.

```
Form(
  key: _formKey,
  child:Column(
    children: <Widget>[
      SizedBox(height: 20,),
      Container(
        padding: EdgeInsets.only(left: 10, right: 10),
        child: TextFormField(
          controller: _username,
          decoration: InputDecoration(
            hintText: 'ID Pengguna',
            //border: InputBorder.none,
            fillColor: Color(0xfff3f3f4),
            filled: true,
            suffixIcon: IconButton(
              icon: Icon(
                Icons.supervised_user_circle_outlined,
                color: Colors.deepPurple[900],
              ), onPressed: () {  },  // Icon
            ),  // IconButton
            border: OutlineInputBorder(
              borderRadius: BorderRadius.circular(20.0),
            ),  // OutlineInputBorder
          ),  // InputDecoration
          validator: (value){
            if (value.isEmpty) {
              return 'Sila masukkan ID pengguna';
            }
          },
        ),  // TextFormField
      ),  // Container
      SizedBox(
        height: 30,
      ),  // SizedBox

      Container(
        padding: EdgeInsets.only(left: 10, right: 10),
        child: TextFormField(
          controller: _password,
          obscureText: !_isShowPassWord,
          decoration: InputDecoration(
```

Fig. 6. The codes for ID and Password verification.

The development of the Business Layer is the coding of the back logic and algorithms to process user input from the application layer. Figure 6 depicts how this layer verifies that the ID and Password entered by the user from the application layer match the data from the data access layer to allow the user to log into the application. The data access layer involves the development of a MySQL database, which serves as the database utilized by this application to access the server database, as illustrated in Fig. 7.

```
Future<Null>  _loginApps(BuildContext context) async{

  var url =  Uri.parse("https://www.triplet-lab.com/BajaSawit/Login.php");

  try{

    final response = await http.post(url,body:{
      'token':'Wht@11650',
      'username':_username.text,
      'password':_password.text,
    });

    if(response.statusCode == 200){

      var data = json.decode(response.body);
      print(response.body);


      setState(() {

        appData.userid = int.parse(data['USERID']);
        appData.username = data['USERNAME'];
        appData.FullName = data['NAME'];
        appData.Phone = data['PHONE'];
        appData.password = data['PASSWORD'];
        appData.negeri = data['NEGERI'];
        appData.daerah = data['DAERAH'];
        appData.kampung = data['KAMPUNG'];
        appData.date = data['DATECREATED'];
        appData.Image = data['IMAGE'];
        appData.usertype = data['USERTYPE'];

        _scaffoldKey.currentState.showSnackBar(SnackBar(content: Text('Berjaya'),
          backgroundColor: Colors.green,
        ));  // SnackBar


        new Timer(new Duration(seconds: 3), (){
          Navigator.pushReplacement(context, MaterialPageRoute(builder: (BuildContext context) => new BottomBar()));
        });  // Timer
```

Fig. 7. The codes for records from the MySQL database.

### 3.4. Prototype

In this phase, five MPOB experts and users conduct testing on each function of the Infographic App. Creating an Android Package Kit (.apk) file for 'alpha-testing' allows user to collect input for potential updates. Subsequently, the development phase incorporates the implementation of essential changes. This iterative process continues until the final prototype is prepared to advance the testing phase.

### 3.5. Testing

The testing phase involves utilizing real devices: making the application downloadable through the Play Store or App Store for Android and iOS smartphone platforms. To test this application, we randomly selected users from TUNAS officials and smallholders engaged in oil palm cultivation. Testing the functionality of each available interface is carried out using the black box method, an essential aspect of testing systems without looking into the internal structure of the software [37]. The purpose of black box testing is to determine the smoothness of each system function. This test is essential to ensure the system can provide correct input and output results. In this test, we evaluated the effectiveness of the Infographic Baja Sawit mobile application's flow, incorporating verification of input and output within the developed system. Test data are produced and executed on the software, and the output is analyzed to determine

whether the expected results are successful [38]. The results of testing feedback are analyzed and documented, and final improvements are made based on user feedback.

Usability testing ensures proper use of the Infographic Baja Sawit Mobile Application. Fifty-five users, comprising smallholders and budding officers, were purposively and randomly selected with the assistance of the MPOB. A usability questionnaire, adapted from Sauro and Lewis [39] was utilized and translated into Malay to gather user feedback after testing the developed system.

### 3.6. Deployment

In the deployment phase, the improved Infographic Baja Sawit Mobile Application, ready in the final version, is re-uploaded through the Play Store and App Store platforms for official use. Android and iOS users can download this application through the platform for free. "The official distribution of the Oil Palm Fertilizer Application was facilitated and officiated by the Deputy Minister of Plantation and Commodities during the National Oil Palm Smallholder Conference on September 16, 2022. Figure 8 shows the icon for the program that users can download for both versions.

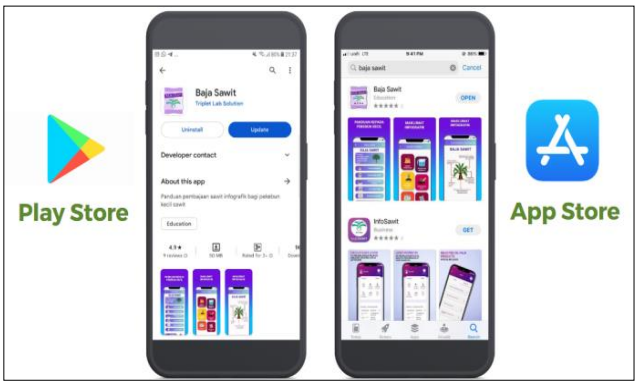


Fig. 8. Application Availability on Play Store and App Store.

### 3.7. Maintenance

The maintenance phase involves continuous improvement to update or enhance the developed application, ensuring its long-term functionality and relevance. This phase is essential to guarantee that users of the Infographic Baja Sawit Mobile Application can operate it consistently and without interruptions. Maintenance activities include regular updates to fix bugs, improve performance, and add new features in response to user feedback and technological advancements. Additionally, this phase encompasses the annual operation cost associated with Data Loss Prevention (DLP) measures. These measures are crucial to protect user data and ensure that both Android and iOS users can securely and continuously access the application. By investing in robust maintenance practices, the application remains reliable, secure, and aligned with users' evolving needs.

## 4. Results

The findings of this study are based on the objective setting of the study to produce an Infographic Baja Sawit Mobile Application guided by the 12 multimedia principles of the Cognitive Theory of Multimedia Learning and to get feedback on the usability of the application. The following subsections present each of the broad results.

### 4.1. The Interface for Infographic Baja Sawit Mobile Application

Figure 9 depicts the interface for the main menu in the Infographic Baja Sawit Mobile Application, along with interfaces for each of the components for Palm fertilization: Basic Fertilization (Asas Pembajaan), Know Oil Palm Fertilizer (Kenali Baja Sawit), Nutrient Deficiency Symptoms (Tanda Kekurangan Nutrien), Oil Palm Fertilizer Types (Jenis Baja Sawit), Fertilization Methods (Kaedah Pembajaan), and Fertilizer Formulations (Formulasi Baja). Each module consists of a sub-module, as specified in the design phase. To construct the interface displays, we incorporate a mix of text, visuals (images, graphics, and videos), and icons relevant to each module using infographics. Figure 10 illustrates the functionality of the components: Register (Daftar Pengguna), Login (Log Masuk), Logout (Log Keluar), Forgot Password (Lupa Kata Laluan), Profile (Profil), About the Application (Tentang Aplikasi), MPOB's Directories (Direktori MPOB), QnA (Pertanyaan), and Fertilization Record (Rekod Baja).

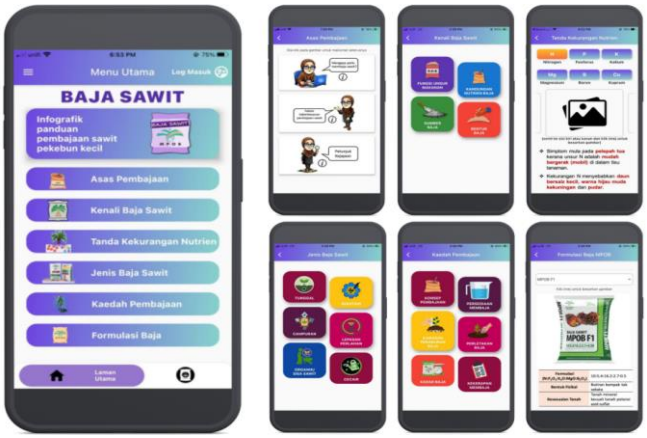


Fig. 9. The component and the module of the palm Fertilization information Interface.

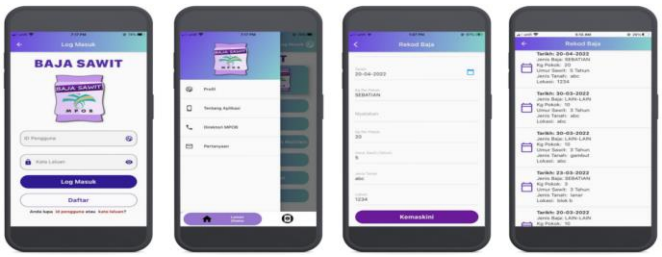


Fig. 10. The component in palm Fertilization function Interface.

### 4.2. The 12 Principles in the Cognitive Theory of Multimedia

The presentation of information about oil palm fertilization depends upon infographics guided by the 12 principles of multimedia learning. Figure 11 reflects the application of the Principle of Coherence and Signaling, where only essential information is available on a topic. Concurrently, the red text serves as a keyword, enabling users to identify vital information regarding fertilizer requirements. Figure 11 also demonstrates the application of the Spatial contingency principle and signals, wherein related text and graphics are close together, aiding users in comprehending the text as an explanation for the co-displayed graphics or pictures.


Fig. 11. Principle of Coherence, Signaling, and Spatial Contiguity.

Figure 12 illustrates the implementation of the Principle of Redundancy, where information is conveyed through audio, accompanied by only one related visual element or image. At the same time, the Principle of Temporal Contiguity connection emphasizes the display of the image and audio description played simultaneously. The Principle of Segmenting provides video presentation control and the button function to allow users according to their learning levels. The Principle of Voice uses the authenticity of the human voice to explain the presentation of information.

Fig. 12. Principle of Redundancy, Temporal Contiguity, Segmenting Principle, and Voice.


Fig. 13. Principle of Pre-Training.

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Fig. 14. Principle of Modality.


Fig. 15. Principle of Multimedia and Personalization.

The Principle of Pre-Training in Fig. 13 reflects that this application provides basic information about fertilization to facilitate the user's understanding of the basic concepts of the module. Figure 14 also demonstrates the implementation of the Principle of Modality, connecting audio explanations with concise text for definitions related to the display of pictures. Meanwhile, the Principle of Image is only sufficient for audio description accompanied by the reinforcement of relevant images and text without displaying the individual image of the person conveying the information.

The Principle of Multimedia in Fig. 15 displays that this application uses a combination of relevant text and visual elements and delivers information in a simple and easy-to-understand manner in line with the Principle of Personalization.

### 4.3. The Usability of Infographic Baja Sawit Mobile Application

To assess the usability of the developed Baja Sawit Mobile Application Infographic, we utilized a usability instrument as the assessment tool [39]. A workshop was conducted at MPOB to assess the usability using the Infographic Oil Palm Fertilizer mobile application, involving 55 small oil palm smallholders. The selection of smallholder zone was carried out by MPOB, and field officers intentionally chose these smallholders from their respective zones which are the Central Zone and the Southern Zone located near the MPOB HQ office. The purposive sampling method was used in this study to gather information from a specific group of samples that represent the entire smallholder population. The findings are based on the interpretation scale as follows: 1.00 - 2.33 (low), 2.34 – 3.66 (moderate), and 3.67 – 5.00 (high) [40]. The present findings revealed that all items obtained a mean score above 4.0 (out of 5.0), reflecting a high usability level (Table 4). Overall, the usability of this application is high among users. As a result, it is possible to infer that using the Baja Sawit Mobile Application with infographic presentation benefits the target users.

Table 4. Usability of Baja Sawit Mobile Application.

| Item | Statement | N | Mean and Level |
|---|---|---|---|
| 1. | Overall, I am satisfied with how easy it is to use this application. | 55 | 4.51 (High) |
| 2. | It was simple to use this application. | 55 | 4.55 (High) |
| 3. | I was able to complete the tasks and scenarios quickly using this application. | 55 | 4.58 (High) |
| 4. | I felt comfortable using this application. | 55 | 4.49 (High) |
| 5. | It was easy to learn to use this application. | 55 | 4.55 (High) |
| 6. | I could become productive quickly using this application. | 55 | 4.55 (High) |
| 7 | The application gave error messages that told me how to fix problems. | 55 | 4.25 (High) |
| 8 | I quickly recovered from any mistakes made in the application. | 55 | 4.27 (High) |
| 9 | The information, such as | 55 | 4.47 |

| | | | |
|---|---|---|---|
| | online help, on-screen messages, and other documentation, provided with this application was understandable. | | (High) |
| 10 | It was easy to find the information I needed. | 55 | 4.47 (High) |
| 11 | The information was effective in helping me complete the tasks and scenarios. | 55 | 4.38 (High) |
| 12 | The organization of information on the application screens was clear. | 55 | 4.45 (High) |
| 13 | The interface of this application was pleasant. | 55 | 4.53 (High) |
| 14 | I liked using the interface of this application. | 55 | 4.36 (High) |
| 15 | This application has all the functions and capabilities I expect it to have. | 55 | 4.42 (High) |
| 16 | Overall, I am satisfied with this application. | 55 | 4.44 (High) |

## 5. Conclusion

Farming mobile apps provide farmers with an easy-to-use way to obtain up-to-date information, which improves productivity and helps them make better decisions. The design of the Infographic Baja Sawit Mobile Application utilized the 12 principles of the Cognitive Theory of Multimedia Learning. The primary aim of this application is to enhance comprehension and facilitate greater exposure to fundamental information on palm fertilization. The interface and infographic presentation are easier to understand, meet users' usability, and can be used realistically and practically by smallholders through a smartphone platform. The Baja Sawit application could be the primary reference for oil palm fertilization, which can support the palm commodity sector led by the MPOB under the Ministry of Plantation and Commodities. The results from this research shows that the development of this mobile application holds significant implications for fostering a culture of digital information infographics customized for oil palm smallholders across diverse regions in Malaysia.

For future work, several features can be embedded into the developed system such as collecting real-time data for crop health, use of satellite imagery for precise field mapping and monitoring and use of artificial intelligence for crop disease detection and yield prediction can further enhance the useability of the proposed system.

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## References

[1] T. S. Peng, N. Lyndon, and K. Hashim, "Hubungan Demografi Terhadap Tahap Pengetahuan Amalan Baik Pembajaan oleh Pekebun Kecil Sawit Di Malaysia," *Jurnal Sains Sosial dan Kemanusiaan*, vol. 7, no. 8, pp. 234-238, 2020.

[2] N. H. Mansor and Z. Hashim, "Risalah sawit (36)," Unit Khidmat Pengembangan, Bahagian Penyelidikan Pembangunan Pekebun Kecil MPOB, 2021.

[3] O. Idris and D. Nursuhana, "Enhancing oil palm productivity through participative technology transfer: Malaysian experience," in *Proceedings of the International Palm Oil Congress 2009*, vol. 1, pp. 337-365.

[4] M. R. A. Samad, Z. H. Iksan, and F. Khalid, "Analisis Keperluan: Pembangunan Aplikasi Mudah Alih Sains Tahun Lima Sekolah Kebangsaan Luar Bandar di Malaysia," *Jurnal Pendidikan Sains Dan Matematik Malaysia*, vol. 12, no. 2, pp. 1-15, 2022.

[5] W. N. A. W. Yusof, "Pembangunan Aplikasi Mudah Alih untuk Topik Perwakilan Data: JomKira," Universiti Pendidikan Sultan Idris, Tesis Ijazah Sarjana Muda Pendidikan Teknologi Maklumat yang Tidak Diterbitkan, 2019.

[6] H. D. Surjono, *Multimedia Pembelajaran Interaktif: Konsep dan Pengembangan*. Karangmalang, Yogyarkarta: UNY Press, 2017. [Online]. Available: http://doi.org/10.1109/ITPRO.2014.7029289

[7] A. Hassan, M. Ali, and A. Zamzuri, "Teknologi Instruksi Dalam P&P: Animasi Bersegmen Dan Bebanan," Teknologi Instruksi Dalam P&P: Animasi Bersegmen Dan Bebanan Kognitif, 2014. [Online]. Available: https://www.researchgate.net/publication/263084318_T [Accessed: July 29, 2023].

[8] R. Schnall, M. Rojas, S. Bakken, W. Brown, A. Carballo-Dieguez, M. Carry, and J. Travers, "A user-centered model for designing consumer mobile health (mHealth) applications (apps)," *Journal of Applications*, vol. 5, no. 5, pp. 15–34, 2016. [Online]. Available: http://doi.org/10.5121/ijsea.2014.5502

[9] V. N. Inukollu, D. D. Keshamon, T. Kang, and M. Inukollu, "Factors influencing quality of mobile apps: Role of mobile app development life cycle," *International Journal of Software Engineering & Biomedical Informatics*, vol. 60, pp. 243-251, 2014. [Online]. Available: http://doi.org/10.1016/j.jbi.2016.02.002

[10] L. T. Boon, M. H. Husin, and M. A. Osman, "Implementation of an automated smart home control for detecting human emotions via facial detection," 2015.

[11] N. H. Razali and F. B. Khalid, "Penggunaan Aplikasi Pembelajaran Mudah Alih dalam Pembelajaran Matematik Bagi Pelajar Sekolah Menengah," *Malaysian Journal of Social Sciences and Humanities*, vol. 6, no. 6, pp. 73-85, 2021.

[12] MARDI, "Aplikasi Mudah Alih MARDI Bantu Petani," Blog Rasmi MARDI, 2017. [Online]. Available: https://blogmardi.wordpress.com/2017/02/07/aplikasi-mudah-alih-mardi-bantu-petani/. [Accessed: July 29, 2023].

[13] R. Mayer, *Multimedia Learning*. Cambridge: Cambridge University Press, 2001. doi:10.1017/CBO9781139164603.

[14] M. A. R. Nordin, M. L. Yuzarimi, and M. Farham, "Applying rough set theory in multimedia data classification," *International Journal on New Computer Architecture and Their Applications*, vol. 1, no. 3, pp. 706-716, 2011.

[15] A. Zakaria, M. Ismail, and S. Ghavifekr, "Promoting meaningful learning via an online project-based module," *International Journal of e-Learning and Higher Education (IJELHE)*, vol. 6, no. 6, pp. 71-96, 2017.

[16] M. Dick, "Interactive infographics and news values," *Digital Journalism*, vol. 2, no. 4, pp. 490-506, 2014.

[17] G. R. Lamb, J. L. Polman, A. Newman, and C. G. Smith, "Science news infographics: Teaching students to gather, interpret, and present information graphically," *The Science Teacher*, vol. 81, no. 3, pp. 25-30, 2014.

[18] M. Smiciklas, *The Power of Infographics: Using Pictures to Communicate and Connect with Your Audiences*. Indianapolis, IN: Que Publishing, 2012.

[19] P. Vanichvasin, "Enhancing the quality of learning through the use of infographics as visual communication tool and learning tool," in *Proceedings of the International Conference on QA Culture: Cooperation or Competition 2013 (ICQA 2013)*, Bangkok, 2013.

[20] R. E. Mayer and R. Moreno, "Nine ways to reduce cognitive load in multimedia learning," *Educational Psychologist*, vol. 38, pp. 43-52, 2003.

[21] R. Krum, *Cool Infographics: Effective Communication with Data Visualization and Design*. Indianapolis, IN: Wiley, 2014.

[22] N. Meeusah and U. Tangkijviwat, "Effect of data set and hue on a content understanding of infographic," in *Proc. ACA2013 Thanyaburi: Blooming Color for Life*, December 11-14, 2013. [Online]. Available: http://www.repository.rmutt.ac.th/xmlui/handle/123456789/1263. [Accessed: Mar. 26, 2018].

[23] E. H. Gebre and J. L. Polman, "Developing young adults' representational competence through infographic-based science news reporting," *International Journal of Science Education*, pp. 1-21, 2016.

[24] A. Borucu, "Güzel Sanatlar Liselerinde Grafik Dersinin İşlenişinde İnfogragik'in, Öğrenme Yöntemine Katkısı," M.S. thesis, Süleyman Demirel Üniversitesi, Isparta, 2015.

[25] S. Yıldırım, G. Yıldırım, E. Çelik, and M. Aydın, "Bilgi Grafiği(İnfografik) Oluşturma Sürecine Yönelik Öğrenci Görüşleri," *Eğitim ve Öğretim Araştırmaları Dergisi*, vol. 3, no. 4, pp. 247-255, 2014.

[26] Y. Serkan, "Infographics for educational purposes: their structure, properties and reader approaches," *The Turkish Online Journal of Educational Technology*, vol. 15, no. 3, pp. 98-110, 2016.

[27] W. V. Siricharoen, "Infographic role in helping communication for promoting health and well-being," in *Proceedings of the Second International Conference on Computer Science, Computer Engineering, and Education Technologies (CSCEET 2015)*, Kuala Lumpur, Sep. 8-10, 2015.

[28] M. Shafipoor, R. Sarayloo, and A. Shafipoor, "Infographic (information graphic); a tool for increasing the efficiency of teaching and learning processes," *International Academic Journal of Innovative Research*, vol. 3, no. 4, pp. 39-45, 2016.

[29] J. Oetting, "The science behind why our brains crave infographics (in an infographic)," Agency Post, 2015. [Online]. Available: http://blog.hubspot.com/agency/science-brains-crave-infographics. [Accessed: Jan. 17, 2019].

[30] M. Amin, M. Noh, M. Salihin, H. M. Fauzi, H. F. Jing, and M. F. Ilias, "Infographics: teaching and learning tool Infografik: alat untuk pengajaran dan pembelajaran," *Malaysian Online Journal of Education Attarbawiy*, vol. 1, no. 1, pp. 58–63, 2017.

[31] J. Medina, *Brain Rules: 12 Principles for Surviving and Thriving at Work, Home, and School*. Seattle, WA: Pear Press, 2008.

[32] N. S. Alrwele, "Effects of infographics on student achievement and students' perceptions of the impacts of infographics," *Journal of Education and Human Development*, vol. 6, no. 3, pp. 104-117, 2017.

[33] F. S. Mohamadi and H. Asadzadeh, "Testing the mediating role of teachers' self-efficacy beliefs in the relationship between sources of efficacy information and students achievement," *Asia Pacific Education Review*, vol. 13, pp. 427-433, 2012.

[34] M. A. Alshehri and M. Ebaid, "The effectiveness of using interactive infographics at teaching mathematics in elementary school," *British Journal of Education*, vol. 4, pp. 1-8, 2016.

[35] R. C. Richey and J. D. Klein, *Design and Developmental Research*. New York, NY: Routledge, 2007.

[36] T. Vithani and A. Kumar, "Modeling the Mobile Application Development Lifecycle," in *Proceedings of the International MultiConference of Engineers and Computer Scientists 2014 (IMECS 2014)*, 2014, vol. I, pp. 1–27.

[37] E. K. Fenty, "Applying Mobile Application Development Life Cycle in the Development of Zakat Maal Mobile Web Application Using JQuery

Mobile Framework," in *International Conference on Cyber and IT Service Management*, 2014.
[38] D. S. Syahril, R. R. Isnanto, and R. Kridalukmana, "Aplikasi Panduan Ibadah Haji Berbasis Android," *Jurnal Teknologi dan Sistem Komputer*, vol. 4, no. 3, pp. 442-449, 2016.
[39] J. Sauro and J. R. Lewis, "Post-Study System Usability Questionnaire (PSSUQ version 3)," in *Quantifying the User Experience Practical Statistics for User Research*. Elsevier, 2012.
[40] J. Ahmad, "Pemupukan budaya penyelidikan di kalangan guru sekolah: satu penilaian," Ph.D. dissertation, Universiti Kebangsaan Malaysia, 2002.

**Azura Ishak,** photograph and biography not available at the time of publication.

**Ahmad Afandi Murdi,** photograph and biography not available at the time of publication.

**Khairuman Hashim,** photograph and biography not available at the time of publication.

**Abdullah Muhammed,** photograph and biography not available at the time of publication.

**Masura Rahmat,** photograph and biography not available at the time of publication.

**Shahrina Shahrani,** photograph and biography not available at the time of publication.

**Rohizah Abd Rahman,** photograph and biography not available at the time of publication.

**Noor Faridatul Ainun Zainal,** photograph and biography not available at the time of publication.

**Nordiana Abd Aziz,** photograph and biography not available at the time of publication.

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## Appendix:

```
Form(
  key: _formKey,
  child:Column(
    children: <Widget>[
    SizedBox(height: 20,),
    Container(
      padding: EdgeInsets.only(left: 10, right: 10),
      child: TextFormField(
        controller: _username,
        decoration: InputDecoration(
          hintText: 'ID Pengguna',
          //border: InputBorder.none,
          fillColor: Color(0xfff3f3f4),
          filled: true,
        suffixIcon: IconButton(
          icon: Icon(
            Icons.supervised_user_circle_outlined,
            color: Colors.deepPurple[900],
          ), onPressed: () {  },  // Icon
        ),  // IconButton
        border: OutlineInputBorder(
          borderRadius: BorderRadius.circular(20.0),
        ),  // OutlineInputBorder
      ),  // InputDecoration
      validator: (value){
        if (value.isEmpty) {
          return 'Sila masukkan ID pengguna';
        }
      },
      ),  // TextFormField
    ),  // Container
    SizedBox(
      height: 30,
    ),  // SizedBox

    Container(
      padding: EdgeInsets.only(left: 10, right: 10),
      child: TextFormField(
        controller: _password,
        obscureText: !_isShowPassWord,
```

```
Future<Null>  _loginApps(BuildContext context) async{

  var url =  Uri.parse("https://www.triplet-lab.com/BajaSawit/Login.php");

  try{

    final response = await http.post(url,body:{
      'token':'Wht@11650',
      'username':_username.text,
      'password':_password.text,
    });

    if(response.statusCode == 200){

      var data = json.decode(response.body);
      print(response.body);


      setState(() {

        appData.userid = int.parse(data['USERID']);
        appData.username = data['USERNAME'];
        appData.FullName = data['NAME'];
        appData.Phone = data['PHONE'];
        appData.password = data['PASSWORD'];
        appData.negeri = data['NEGERI'];
        appData.daerah = data['DAERAH'];
        appData.kampung = data['KAMPUNG'];
        appData.date = data['DATECREATED'];
        appData.Image = data['IMAGE'];
        appData.usertype = data['USERTYPE'];

        _scaffoldKey.currentState.showSnackBar(SnackBar(content: Text('Berjaya'),
          backgroundColor: Colors.green,
        ));  // SnackBar


        new Timer(new Duration(seconds: 3), (){
          Navigator.pushReplacement(context, MaterialPageRoute(builder: (BuildContext context) => new BottomBar()));

        });  // Timer
```