

# MyPharmaceutical: an interactive proof of concept

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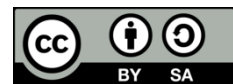
Named entity recognition

Web-based application

## ABSTRACT

With the rise of health awareness, pharmaceutical and cosmetic products should be verified to protect ourselves from health risks. MyPharmaceutical is a proof-of-concept proposed to provide a mobile application for users to carry out product verification and reporting and a web application for administrative purposes. The data on the registered pharmaceutical and cosmetic products were extracted from national pharmaceutical regulatory agency (NPRA) website. MyPharmaceutical mobile application provides functionalities such as searching the registered product, bookmarking products, reporting products, and tracking report status. The mobile application also implemented a barcode scanner feature to provide ease of product verification. A named entity recognition algorithm is applied with the NLP.js library to provide an improved product search feature for the users, where products can be searched with multiple search criteria in a single input. The web application is proposed to support the mobile application, where the NPRA data admins and officers can manage reported products, publish announcements, verify product data, and utilize the analytic dashboard. The system proposed is expected to provide ease of product verification and reporting to assist the public in choosing safe registered products and a platform for NPRA to manage data and deliver information to the users.

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## 1. INTRODUCTION

Healthcare is an important sector in Malaysia with the rise of health awareness in our population. According to a report published by the Malaysian Investment Development Authority (MIDA), the pharmaceutical industry is one of the areas targeted for promotion and development by the government [1]. As reported in the news, the country's market size of dietary supplements shows an upward projection of RM 2.27 billion [2]. The ease of purchasing health supplements in the e-commerce platforms contributed to increased sales of these products. However, this led to the illegal sales of unregistered health products in the online market, which caused many individuals who consume them to face health issues and side effects [3].

The current systems available, such as the websites of the national pharmaceutical regulatory agency (NPRA) [4], [5] and *program perkhidmatan farmasi* [6], assist consumers in verifying their pharmaceutical and cosmetic products or issuing a complaint about the products. However, the features provided by the existing systems are incomplete for the users to do both verification and reporting of products. Despite having such platforms, a survey shows that public knowledge regarding unregistered medications needs to be improved [7]. A survey conducted in [8] found that community pharmacists faced barriers to reporting adverse drug effects due to the need for knowledge on ways to report and the unavailability of reporting

forms. These surveys were conducted to show the need for a platform to verify and report pharmaceutical and cosmetic products. Besides, the ministry of health Malaysia might cancel the registered pharmaceutical and cosmetic products when harmful substances are detected in the products [9]. Therefore, the public should be notified easily to cater to this kind of scenario to prevent themselves from using these products.

To ease the users in verifying and reporting the products during daily activities [10], the MyPharmaceutical mobile application is proposed, with features such as searching registered products, bookmarking products, reporting products, and tracking report status. A named entity recognition algorithm is applied in the product search feature using the NLP.js library. It helps to improve users' experience in product search, where users can search for a product with multiple search criteria in a single input. Furthermore, MyPharmaceutical web application is proposed for data management of products and reports.

## 2. RELATED STUDIES

Existing applications allow verification or/and reporting of pharmaceutical and cosmetic products. Table 1 compares the features proposed in the MyPharmaceutical application with similar applications used in Malaysia [4]-[6], [11]-[13]. Table 2 shows the applications with similar features in other countries. For example, web applications are under the government of different countries [14]-[17], while mobile applications [18], [19] are used in Bangladesh. In Table 2, health sciences authority (HSA), food and drug administration (FDA), Ministry of Food and Drug Safety, and national medical products administration serve as platforms for the public to read information on the safety and regulations of health products. These platforms also assist in regulating the approval of pharmaceutical and cosmetic products. It was found that HSA and FDA websites provide product reporting sections. In contrast, the ministry of food and drug safety and national medical products administration websites did not show any sections related to product reporting. DIMS and drugbook are mobile applications in Bangladesh that aim to provide the public with drug details such as usage, dosage, and side effects. In Table 1, the / symbol represents the feature found in the application, and the X symbol represents that the feature is not found in the application. The \* symbol means the feature partially available or similar to MyPharmaceutical.

Table 1. Comparisons of similar applications used in Malaysia

| Features                   | NPRA | <i>Program perkhidmatan farmasi</i> | NPRA product status mobile app | MediQuest | FarmaChecker |
|----------------------------|------|-------------------------------------|--------------------------------|-----------|--------------|
| Search registered product  | /    | /                                   | /                              | /         | /            |
| Barcode scanner            | X    | X                                   | X                              | X         | *            |
| Bookmark product           | X    | X                                   | X                              | X         | X            |
| Report product side effect | /    | X                                   | X                              | X         | X            |
| Report product quality     | *    | X                                   | X                              | X         | X            |
| Track report status        | *    | X                                   | X                              | X         | X            |

Table 2. Comparisons of similar applications used in other countries

| Features                   | HSA       | U.S. FDA      | Ministry of Food and Drug Safety | National medical products administration | DIMS       | Drugbook   |
|----------------------------|-----------|---------------|----------------------------------|--|------------|------------|
| Search registered product  | /         | /             | /                                | /  | /          | /          |
| Barcode scanner            | X         | X             | X                                | X  | X          | X          |
| Bookmark product           | X         | X             | X                                | X  | /          | X          |
| Report product side effect | /         | *             | X                                | X  | X          | X          |
| Report product quality     | *         | *             | X                                | X  | X          | X          |
| Track report status        | X         | X             | X                                | X  | X          | X          |
| Country                    | Singapore | United States | Korea                            | China                                    | Bangladesh | Bangladesh |

All the existing applications do not provide a bookmark product feature besides DIMS [18]. The barcode scanner feature is also not found in these applications. Only farmachecker [11] can verify products by scanning the security hologram label feature similar to the barcode scanner. All the applications can search for registered products, with different robustness of search features provided. The research found that only the NPRA web application, HSA, and FDA allow product reporting, but the features provided are incomplete. For example, in the NPRA web application, the report product quality feature is supplied with forms in pdf only, and the users cannot track their report status in the application.

The proposed system, MyPharmaceutical, provides ease of product verification, where the search registered product feature was improved with the named entity recognition algorithm implemented. The barcode scanner feature proposed was not found in any of the existing applications, which is an improved approach from MyPharmaceutical to provide users the convenience of identifying the product status by scanning the product barcode. In addition, the bookmark product feature proposed in MyPharmaceutical

allows users to receive notifications whenever the bookmarked products have new status updates from the NPRA officers. This feature is unique because it adds to the benefit of the bookmark product feature in DIMS and Drugbook that provides easy access to the product info.

The report product side effect and product quality features were proposed to provide a user-friendly platform for the users to submit reports. Most existing applications do not provide product reporting features. At the same time, NPRA, HSA, and FDA websites had incomplete product reporting features, where pdf forms were provided for the user to submit through email. In MyPharmaceutical, users can fill in the reports online instead of emailing the respective officers with reporting forms that provide an information button and validated fields. With the reporting features provided in MyPharmaceutical, the track report status feature is handy for the user to receive notification updates on the report status. This feature was not found in similar applications, while NPRA provides report status tracking only for product side effects reports. MyPharmaceutical contributes by proposing improved ideas to ease product verification and reporting, which assists our community in being safe from unregistered pharmaceutical and cosmetic products.

### 3. METHOD

#### 3.1. Preliminary study

A short survey was conducted to analyze whether the public knows about pharmaceutical and cosmetic product verification and their willingness to report the products. The importance of the required features is also gathered to determine which features must be enhanced or implemented in the proposed project. A questionnaire was created with google forms and distributed online from the 3<sup>rd</sup> of November to the 10<sup>th</sup> of November 2021, where 31 responses were collected. From Table 3, most respondents are 18 to 25 years old (84%). There are 14 male respondents and 17 female respondents. The survey received opinions from different races, predominantly Malay, Chinese, and Indian respondents in this survey.

Table 3. Demographics of respondents participated in survey of preliminary study

|        | Category | Frequency | Percentage (%) |
|--------|----------|-----------|----------------|
| Age    | 18-25    | 26        | 84             |
|        | 26-33    | 5         | 16             |
| Gender | Male     | 14        | 45             |
|        | Female   | 17        | 55             |
| Race   | Malay    | 6         | 19             |
|        | Chinese  | 21        | 68             |
|        | Indian   | 4         | 13             |

Part 1 to part 3 of the questionnaire gathered feedback for product verification. In part 1, input from the public regarding their experience in verifying pharmaceutical and cosmetic products was gathered. According to the results, 54.8% of the respondents never verified any pharmaceutical and cosmetic products registered under the health ministry, whereas 64.7% do not know any listed existing applications that can be used to verify the products. Furthermore, among the respondents who had confirmed pharmaceutical or cosmetic products, only around 40% of respondents would ascertain the products for their purchases regularly, where NPRA is the most popular among the existing applications. MyPharmaceutical hopes to close this gap so that more people periodically verify their products. Part 2 gathered feedback on the essential features of product verification. According to the results, reliable search features (90.3%), barcode scanners (83.9%), and user-friendly interfaces (74.2%) are essential to the users. Part 3 of the questionnaire identified the public's willingness to regularly use the mobile application for product verification. 58.1% of respondents are willing to use the application, while 41.9% may use the application to verify products.

Part 4 to part 6 of the questionnaire gathered feedback for product reporting. Part 4 gathered input from the public regarding their opinions on reporting pharmaceutical and cosmetic products. According to the results, 74.2% will report a product with a quality issue or cause serious side effects, while 25.8% might do so. Among the respondents that might report the products, 75% think it is troublesome to do so, while 37.5% still need to determine where to report the products. This implies that a mobile application that can provide users with easy reporting is required. Part 5 of the questionnaire gathered feedback on the critical feature of product reporting. The results show that the essential features to the users are tracking report status (80.6%), receiving notifications (77.4%), and having forms that are easy to fill in (74.2%). Part 6 of the questionnaire identified the public's willingness to use the mobile application for product reporting. Results show that 74.2% of respondents are willing to use the application, while 25.8% might use the application to report the products.

#### 3.2. Proposed solutions

Figure 1 shows the module diagram of the system. There are 4 main modules. The first module is user account management, which includes user registration, user login, and manage profile submodules.

Public users can register a new user account. In addition, the general users, NPRA data admin, and officers can log in to their accounts and edit their profiles with the manage profile feature. These features were proposed for the user to manage their accounts online.

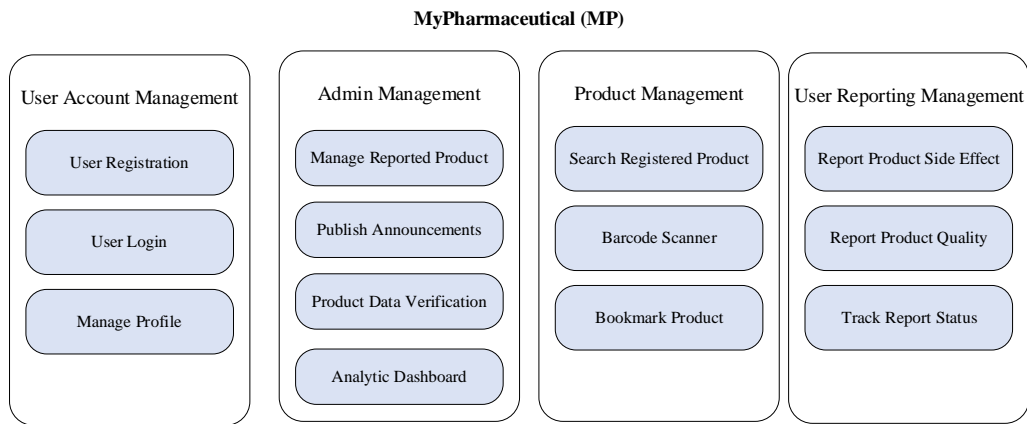


Figure 1. MyPharmaceutical overall modules

The second module is admin management, which includes manage reported product, publish announcements, product data verification, and analytic dashboard submodules built into the web application. Manage reported product feature was proposed for the NPRA officers (NPRA drug product officer, NPRA cosmetic officer, NPRA head of drug product officer, NPRA head of cosmetic officer) to manage the products reported by consumers due to side effects or quality issues. Besides, the publish announcements feature allows the NPRA data admin to publish announcements to the public regarding the latest news on approved or deny listed products. The product data verification feature was proposed to provide a platform for the admins and officers to manage the product info shown to the public. The analytic dashboard feature was proposed for the NPRA data admin and officers to view the statistics on reported products.

The third module is product management, which includes search registered product, barcode scanner, and bookmark product submodules. In the mobile application, the users can search for a registered product with different search criteria, such as product name, manufacturer name, and active ingredients. The search registered product feature was proposed to allow users to identify a product's status before purchase, preventing them from falling prey to unregistered products. The barcode scanner feature was proposed to ease users in obtaining the details of pharmaceutical and cosmetic products, where they can identify the products easily by scanning the product barcode. The bookmark product feature was introduced to allow users to receive notifications on bookmarked product status. The users will receive status updates when the product registration date was expired, or the product was deny listed.

The fourth module is user reporting management, which includes report side effects, report product quality issue, and track report status submodules. The report side effects and report product quality features were proposed for the public users to report a product when they have allergy symptoms or identify any quality issues after using the product, allowing the NPRA officers to act after receiving these reports. The track report status feature was developed to ease the users in tracking their report status in the mobile application, where real-time updates of the report status will be sent to the user after the NPRA officers update the report status.

### 3.3. MyPharmaceutical architecture diagram

Figure 2 shows the architecture diagram of MyPharmaceutical with 2 platforms provided, which include a mobile application for public users and a web application for NPRA data admin and officers. The mobile application runs the front end in react native, a framework capable of generating hybrid mobile applications across platforms [20]. The web application runs the front end in react, an open-source front-end javascript library [21]. For the backend of both platforms, Node.js is used for server-side application logic and as the integration between the front-end and database due to its scalable and lightweight features [22]. For the integration of system modules, the backend server has separated business logic to communicate with the mobile and web applications. Lastly, MySQL, a popular open-source SQL database management system [23], is utilized as the database to store data.

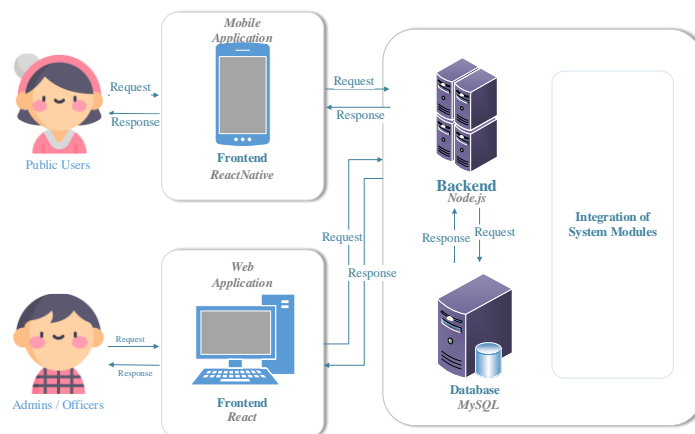


Figure 2. MyPharmaceutical architecture diagram

### 3.4. Pre-process of pharmaceutical and cosmetic product information

Firstly, the pdf files that contain registered pharmaceutical and cosmetic product data were downloaded from the new products approved section on the NPRA website. Then, website links were generated from the product ID retrieved and run in a web scrapping tool, ParseHub [24], to extract all the product information in the search product section. The data obtained from these two sections were merged and stored in excel tables. Next, the data were cleaned and normalized. Then, the pharmaceutical products were categorized according to the product ID as specified in the drug registration guidance document [25]. Lastly, the data were uploaded to the MySQL database.

As the NPRA website lacks product barcode information, the barcodes were obtained from products purchased from healthcare stores to showcase the barcode scanner feature. The barcode data were extracted with the product name and mapped to the corresponding product previously stored in the MySQL database. Then, the barcode data were inserted into the database with SQL queries. In addition, the descriptions of active ingredients were extracted from drugbank [26] datasets to improve the active ingredient info provided for the products. Upon clicking on the information button, the description of the active ingredient will be shown to the users, as illustrated in Figure 3.

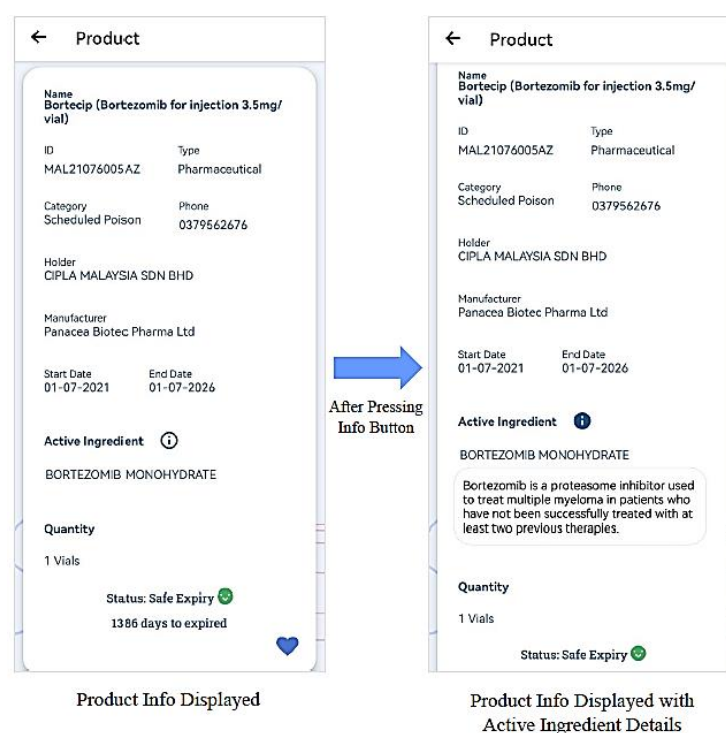


Figure 3. Mobile interface of product info with active ingredient description

### 3.5. Implementation

#### 3.5.1. Product search feature with named entity recognition algorithm

In the search product submodule, named entity recognition (NER) algorithm is implemented to search products with multiple search criteria in a single input. NER is a type of natural language processing that assists in information retrieval and data processing [27], [28]. It allows information to be extracted and classified into their respective named entities. For example, when we entered the search input as “scheduled poison that is verified, mal16105”, the entities such as category (scheduled poison), product status (verified), and product ID (mal16105) will be extracted.

The results are utilized in the search query after extracting the data with the respective entities. Using the named entity recognition algorithm helps to allow better search functionality [28]. It will enable the user interface to be clean and straightforward without using multiple fields for filtering to obtain accurate results. The algorithm was implemented by integrating the NLP.js library, where one of the tools supported, NLP manager, was utilized to extract the entities from the search input. The type of named entity recognition approach implemented was a rule-based system, where rules were defined to extract the respective entities. As entities such as product categories and product status had a pre-defined list of values, and the product ID and dates had an identifiable format, the rule-based system was chosen as the main named entity recognition approach.

#### 3.5.2. Mobile barcode scanner

The expo-barcode-scanner library is utilized in the mobile barcode scanner feature. The barcodes need to be in UPC or EAN format to be detected. Before a barcode can be scanned, the user’s mobile device must grant permission for the barcode scanner. When a barcode is scanned and detected, the method *handleBarcodeScanned* retrieves info such as barcode type and data. The barcode detected will be passed to the backend, where the product info with the corresponding barcode will be recovered. If the barcode detected is not found in the system, the user can submit a request requiring them to fill in a form to map the barcode to a registered product.

#### 3.5.3. Emails and notifications

After submitting a report, the user’s email address will be sent to the backend with the description and report type. SMTP in nodemailer is used for delivering messages, where the host, port number, and credentials are provided to initialize the transporter. Then, the *transporter.sendMail* method is used to send the email. For notifications, the user ID, title, description, date, and time stamp are stored in the database upon successful report submission. To trigger notifications, the method *Notifications.scheduleNotificationAsync* is used. Any notification with a “New” status will be triggered in the mobile application and then updated to “Sent” status after the notification is prompted to the user.

## 4. RESULTS AND DISCUSSION

### 4.1. User acceptance test

30 users participated in the UAT of the MyPharmaceutical mobile application. During UAT, the background, problem statements, objectives, and features of the MyPharmaceutical system were explained to the users before testing. As only limited products can be searched via a barcode scanner, sample products that can be scanned were provided to the users. During the UAT of the mobile application, the users answered the questions in google forms at the end of the session.

Among the 30 users, 43.3% had verified pharmaceutical and cosmetic products before, while only 6.7% of respondents reported pharmaceutical and cosmetic products with side effects or quality issues. Most features, such as product search, bookmark product, and user profiles, have more than 80% of the users rated 5 on the linear scale, while the others rated a 4 out of 5. For product reporting, more than 80% of the users rated 5 for ease of navigation, user-friendliness, and ease of submission and tracking of reports. In addition, 70% of the users rated 5 for the statement regarding the sufficiency of email and notifications in helping them get notified on report status. In comparison, 30% of the users rated 4 for this statement. They feedbacked that MyPharmaceutical can provide more details in the email. Almost all the users (96.7%) rated 5 for ease of viewing the announcement, while 76.7% rated 5 on the announcement feature helps them to get informed on the latest info. According to the results, 93.3% and 76.6% of users rated 5 as willing to use the MyPharmaceutical mobile application for product verification and reporting, respectively.

In addition, several suggestions were provided by the users, including a chat feature, discussion forum, providing hotlines of organization, and a share product feature to share product info to social media. Enhancement on product reporting was suggested where one of the users feedbacked to support upload of files in the future. Sample user acceptance test results are shown in Table 4.

Table 4. Product search feature user acceptance test results

| MyPharmaceutical helps me to search for verified products effectively | Frequency | Percentage (%) |
|---|-----------|----------------|
| 5   | 25        | 83.3           |
| 4   | 5         | 16.7           |
| 3   | 0         | 0              |
| 2   | 0         | 0              |
| 1   | 0         | 0              |

## 4.2. Discussion

The UAT helps assess whether the MyPharmaceutical system can deliver the features to the end users. The system is proven to have a high user satisfaction rate, with further improvements suggested. As the system is built with minimal cost by running the prototype in a local environment, non-functional requirements such as security and system availability require further testing and future improvements. Overall, the search product feature has a high satisfaction rate among the users, while the barcode scanner feature requires improvement to enhance the sensitivity and accuracy of detecting the barcode. In addition, the product reporting features can be improved by supporting file upload in the future, while the email and notifications provided can be improved by showing more valuable details to the users.

## 5. CONCLUSION

In conclusion, MyPharmaceutical is expected to support public users in verifying and reporting pharmaceutical and cosmetic products. With the implementation of the named entity recognition algorithm and barcode scanner feature, MyPharmaceutical is believed to provide ease of product verification to the users. The bookmark product feature also allows users to retrieve product info easily and receive emails and notifications when the product is denied listed. Besides, user-friendly reporting forms are provided for the users to report quality issues or side effects of the products. Integrating online forms in the mobile application reduces the burden of emailing or delivering the pdf forms to the respective officers and simultaneously allows the implementation of the track report status feature. Users can easily track the current report status and receive emails and notifications on any status updates. MyPharmaceutical web application is expected to support the mobile application. The NPRA data admin and officers can perform administrative features, including managing reported products, product data verification, publishing announcement, and analytic dashboard. This proof of concept allows MyPharmaceutical helps the ministry and public manage its data and system conveniently. For future works, more features can be introduced, and usability aspects can be further enhanced.

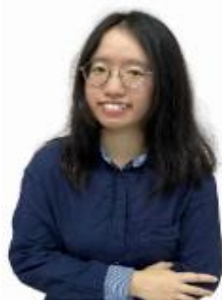
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