

CHAPTER V

CONCLUSION

This chapter presents the conclusions obtained from the implementation and testing results of the RSU X pharmacy information system, as well as development recommendations for future research.

5.1 Conclusion

Based on the implementation and testing results of the RSU X pharmacy information system that have been conducted, the following conclusions can be drawn.

1. The website-based pharmacy information system was successfully designed and built using the Laravel 12 framework, Livewire 4.1, MySQL 8.0, and Spatie Laravel Permission v6.24 by applying the Waterfall development methodology. The system encompasses 11 main functions (F-01 through F-11) covering user authentication, master data management for drug products, suppliers, and patients, drug purchase and sales transactions, dynamic stock reports, role-based account management, and system notifications. The three-layer architecture (Presentation Layer, Application Layer, Data Layer) was successfully implemented with 18 relational tables in the pharmacy database recording 79 drug products, 110 active substance content records, 152 active substances, and 24 permissions for three main roles (admin, pharmacist, patient). This system answers the first problem formulation, which is to design and build a website-based pharmacy information system capable of managing drug stock in real-time at RSU X.
2. The K-Nearest Neighbor (K-NN) algorithm was successfully implemented through the KNNHelper class to classify drug content and types and recommend substitution products automatically. The implementation uses feature vectors consisting of active substance strength values and scaled HET ($HET/1000$), as well as Euclidean Distance calculation $d(x,y) = \sqrt{\sum (x_i - y_i)^2}$ to measure inter-product similarity. Mathematical computational correctness testing of K-NN proves that all system-calculated Euclidean Distance values are identical to manual calculations with a difference of 0.000 for the three tested candidate products (Candidate A: 0.300; Candidate B: 250.002;

Candidate C: 125.144). The substitution product ranking order produced by the system fully matches the manual calculation order, proving that the `usort()` function on `KNNHelper` correctly sorts candidates based on the smallest distance value. This answers the second problem formulation, which is to implement K-NN for automatically recommending drug substitution products based on active substance content and price similarity.

3. System testing using the Black Box Testing method on 12 scenarios covering valid conditions and invalid conditions (boundary testing) resulted in a 100% success rate (12/12 scenarios Passed). All critical features tested including login authentication (F-01), drug product data management (F-02), K-NN classification (F-03), purchase transactions (F-06), sales transactions (F-07), stock reports (F-08), and account management (F-10) produced outputs consistent with expected results based on the functional requirement specifications established in Table 3.1. The real-time stock validation mechanism by `StockHelper`, automatic status management by `recalcTotals()`, and `SaleOrderNotification` delivery all function according to specifications. These results answer the third problem formulation, which is to verify the functionality of all critical system features using Black Box Testing.

5.2 Recommendations

Based on the research results that have been conducted, there are several recommendations that can be considered for further system development.

1. Addition of Testing Methods. System testing in this research only uses the Black Box Testing method to verify functionality. For future research, it is recommended to add usability testing methods such as the System Usability Scale (SUS) or User Acceptance Testing (UAT) involving end users of the RSU X pharmacy installation directly. This will provide a more comprehensive picture of the level of acceptance and ease of use of the system from the perspective of pharmacy staff as primary users.
2. Development of Drug Demand Prediction Features. The system developed currently focuses on managing drug stock reactively based on transactions that have occurred. For future research, it is recommended to integrate drug demand prediction features using time series methods such as Single Exponential

Smoothing (SES) or Double Exponential Smoothing based on historical sales data. This predictive feature will help the pharmacy installation in planning drug procurement more proactively so that the risk of stock shortages and drug expiration can be significantly minimized.

3. Integration with Medical Records System. The pharmacy information system developed currently operates independently and is not yet integrated with the RSU X electronic medical records system. For future research, it is recommended to integrate this system with the electronic medical records module so that physician diagnosis data can automatically trigger appropriate drug recommendations using the K-NN algorithm, creating a more integrated and efficient pharmaceutical service workflow from the diagnosis process to drug administration to patients.