Development of mobile-based health center information system with feature-oriented software development (case study in North Kuta health center)

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Abstract. Health center is a district/city official technical unit that responsible for handling health development. At North Kuta Health Center, the medical record has been managed using a web-based application information system. Most of the patients access this system via smartphone. However, the system interface is not optimal if accessed via smartphone, such as the buttons on the system are covered by other interface elements and image sizes exceed the smartphone screen. For this reason, a mobile-based information system was developed from the existing health center system. When developing the system, a Feature-Oriented Software Development (FOSD) method was applied. The FOSD method applied the stages of domain analysis, domain design and specifications, domain implementation, product configuration, and generation. The domain analysis stage produced a needs analysis. At the domain design and specification stage, requirements analysis was processed into system design. The system design was created into a system prototype at the domain implementation stage. At the product configuration and generation stages, the system prototype was tested with User Acceptance Test (UAT) and running time. Running time testing shows the average time needed by the prototype system to complete each process was 432 ms. The UAT test shows that the prototype system was running well under the health service business process at the North Kuta Health Center. The system prototype has also provided convenience in the operation of health services in the North Kuta Health Center.

1. Introduction

Medical record according to the regulation of the Minister of Health RI No.269/MENKES/PER/III/2008, is a file containing records and documents about patient identity, examination, treatment, actions and other services that have been provided to patients [6]. Medical Record supports the achievement of administration in the context of improving health services in health centers. An order medical centers administration will be successfully achieved if it is supported by a good medical record management system. Medical record data is also useful for paramedics since it provides the patient's medical history when conducting treatment.

At the North Kuta Health Center, the medical record data has been managed using a web-based information system application. This system has been used by the administration officers, paramedics on duty, and patients seeking treatment at the North Kuta Health Center. In the patient-user section, this system shows patient medical record information when treatment is complete. This system is
already connected to the BPJS (the Indonesian national health care insurance) database, making it easier for the administration to record BPJS patients. However, active users in this system are very low. Statistical data in the system records showed that from all patients who have registered, only 30% were logged in or used the system actively. According to a survey of 125 patients, most of the patients accessed the system via smartphone. Preliminary observation revealed, one of the problems that might triggered the low percentage of loggings from the active user was the system interface, which poses some weakness when via smartphone, such as the buttons on the system are covered by other interface elements and image sizes that exceed the smartphone screen. To overcome this problem a mobile-based health center information system was developed from the existing system. Feature-Oriented Software Development (FOSD) method was applied when developing the system.

According to Kästner & Apel (2013), FOSD is one of the used methods that support the systematic application of the concept of features in all stages of the software life cycle. The basis of this FOSD method is to break down a piece of software into sections based on the features provided by the software. The FOSD method has sequential stages starting from Domain Analysis, Domain Design and Specifications, Domain Implementation, and Product and Generation Configuration [1]. The decomposition has a purpose to build well-structured software and can be adapted to the scenario of user needs. FOSD aims essentially at three properties: structure, reuse, and variation. Developers use the concept of a feature to structure the design and code of a software system. Kästner & Apel (2013) said in their research that the concept of features is useful for describing the similarity and variability in the analysis, design, and implementation of software systems. FOSD is a paradigm that drives software systematically towards the concept of features in all phases of the software life cycle [2]. The features are used as first-class entities to analyze, design, implement, adjust, debug, or develop software systems [3]. Accordingly, the relevant FOSD method is used to develop a mobile-based health center information system based on the existing system.

The current study was intended to:
1. find out and analyze how FOSD method works in mobile-based North Kuta Health Center information system development.
2. find out and analyze the test results of mobile-based North Kuta health center information system with the UAT and running time methods.

2. Object of The Study
The problem of using web-based information system at North Kuta Health Center and how to implement FOSD method in mobile-based health information system development were included as the object of this study.

3. Research Method
This research applied the FOSD method which consisting of the following stages:
1. Domain Analysis. At this stage, the data were collected using the method of observation, interviews and literature studies. The data obtained included problems in the use of information systems in the North Kuta Health Center and sample applications used as a reference to get a need analysis.
2. Domain Design and Specifications. At this stage, the system architecture was designed according to requirements analysis. The design included defining the features implemented and the input or output produced by the system. This stage produced a system design that will be realized in the form of a prototype.
3. Domain Implementation. The domain implementation phase was aimed to build one by one mapping between features arose from system design. In this stage, the system design was realized into a system prototype.
4. Product and Generation Configuration. At this stage, testing of the prototype was generated from the domain implementation stage. This test used UAT, and running time methods [1].
4. Main Result
The results of this study can be seen from the process of implementing the FOSD method and the results of the tests carried out on the prototype of the system that has been developed.

4.1. Domain Analysis
At the stage of domain analysis, the needs analysis was developed into a list of features needed by the system, as can be seen in Table 1.

Table 1. Functional List Features.

| No. | Feature                          | Details                                                                 | Mandatory |
|-----|----------------------------------|------------------------------------------------------------------------|-----------|
| F.01| Displays News List               | Displays news and announcement that entered by officers in the form of a list. | No        |
| F.02| Displays News in Details         | Displays details of the selected news from the list of existing news by the users. | No        |
| F.03| Displays the Service List        | Displays available data service at the Kuta Utara Health Center.       | Yes       |
| F.04| Displays On Duty Doctors         | Displays data of doctors who are currently on duty.                    | Yes       |
| F.05| Service Registration             | Registers health services. If the registration is successful, user will get a queue number. | Yes       |
| F.06| Queue Check                      | Checks the active queue.                                               | Yes       |
| F.07| Displays the Medical Record List | Displays the patient's medical record data in the form of a list.       | Yes       |
| F.08| Displays Medical Record Details  | Displays the details of medical record data that has been selected by the user from the list of medical records. | Yes       |
| F.09| Manage Profile                   | Manages user profile data such as changing personal data.              | Yes       |
| F.10| Customer Care                    | Submits complaints from patients to the North Kuta Medical Center as a feedback improvement. | No        |
| F.11| Change Password                  | Changes account password for login.                                    | Yes       |
| F.12| Login                            | Authenticate user data to use the application.                         | Yes       |
| F.13| Logout                           | Delete a session from user after using the application.                | Yes       |
4.2. Domain Design and Specifications
At the domain design and specification stage, the functional list of features was described as a use case diagram [5], as in Figure 1.

![Use Case Diagram](image)

**Figure 1.** Use Case Diagram.

4.3. Domain Implementation
At the Implementation stage of the system design, domain was realized into a system prototype. The results of the domain implementation stage can be seen in Figure 2.

![Domain Implementation Results](image)

**Figure 2.** Domain Implementation Results.

4.4. Product and Generation Configuration
The product configuration and generation stages were carried out, namely testing of the prototype generated from the domain implementation stage. Table 2 shows the results of the UAT testing.
Table 2. Results of UAT testing.

| No | Question                                                                 | A  | B  | C  | D  | E  | Total | Average | Maximum Value Percentage |
|----|--------------------------------------------------------------------------|----|----|----|----|----|-------|---------|--------------------------|
| 1  | Is the menu layout and contents on each menu in the system orderly?       | 0  | 16 | 3  | 0  | 0  | 19    | 3.8     | 76%                      |
| 2  | Are the menus in the system easy to understand?                          | 5  | 4  | 9  | 0  | 0  | 18    | 3.6     | 72%                      |
| 3  | Are the features in the system running well?                             | 0  | 12 | 3  | 2  | 0  | 17    | 3.4     | 68%                      |
| 4  | Is the medical record information generated by the system complete?      | 5  | 8  | 6  | 0  | 0  | 19    | 3.8     | 76%                      |
| 5  | Is the online registration feature can help patient treatment services?  | 0  | 16 | 3  | 0  | 0  | 19    | 3.8     | 76%                      |
| 6  | Does the customer care feature help patients?                            | 10 | 12 | 0  | 0  | 0  | 22    | 4.4     | 88%                      |
| 7  | Is this system in accordance to the health service business process at the North Kuta Health Center? | 5  | 8  | 3  | 2  | 0  | 18    | 3.6     | 72%                      |
| 8  | Does this system provide convenience in the operation of health services in the North Kuta Health Center? | 5  | 12 | 3  | 0  | 0  | 20    | 4.0     | 80%                      |

Table 3 shows the results of the running time test [4].

Table 3. Results of the running time test.

| No | Task                          | Test 1 | Test 2 | Test 3 | Average |
|----|-------------------------------|--------|--------|--------|---------|
| 1  | Displays News List            | 495    | 528    | 469    | 497     |
| 2  | Displays News in Details      | 42     | 36     | 34     | 37      |
| 3  | Displays the Service List     | 853    | 185    | 147    | 395     |
| 4  | Displays On Duty Doctors      | 189    | 277    | 415    | 294     |
| 5  | Service Registration          | 341    | 811    | 667    | 606     |
| 6  | Queue Check                   | 215    | 206    | 266    | 229     |
| No | Task                                | Test 1 | Test 2 | Test 3 | Average |
|----|-------------------------------------|--------|--------|--------|---------|
| 7  | Displays the Medical Record List    | 154    | 233    | 204    | 197     |
| 8  | Displays Medical Record Details     | 363    | 305    | 282    | 317     |
| 9  | Displays Data Profile               | 683    | 486    | 544    | 571     |
| 10 | Saving Data Profile                 | 304    | 237    | 307    | 283     |
| 11 | Sends Customer Complaints           | 157    | 196    | 157    | 170     |
| 12 | Saving Password                     | 1001   | 1087   | 951    | 1013    |
| 13 | Logout Process                      | 370    | 210    | 239    | 273     |
| 14 | Login Process                       | 977    | 1388   | 1142   | 1169    |

From the running time test, the average time needed to complete each process was 432 ms. The login process was the longest running process. This happens because before performing the authentication process, the password was encrypted using the MD5 method and encrypted again with the SHA1 method.

The results of UAT test analysis concluded that the menus and contents in the layout of the system were orderly and understandable. The features in the system also ran well. The medical record information produced by the system was complete and under the health service business process at the North Kuta Health Center. Overall, the system has provided convenience in the operation of health services at the North Kuta Health Center.

5. Conclusion
In this study, analysis of features in the sample application (E-Health Surabaya & Infokes) obtained the results in 10 mandatory features and 3 optional features used for system development. Based on the developed system prototype which is in accordance with the results of feature analysis with FOSD method, 13 features have been implemented to develop mobile-based North Kuta health center information system. In running time testing, the average time taken by the system to complete each process was 432 ms. From the results of the analysis of the purpose of UAT, the conclusion is that the layout of the menus and the contents of each menu in the system were orderly and understandable. The features in the system were running well. The medical record information produced by the system was complete and following the health service business process at the North Kuta Health Center. Overall, the system has provided convenience in the operation of health services at the North Kuta Health Center.

Based on studies and trials that have been carried out, it is recommended to reproduce the applications used as samples. For application to domain analysis, it can be done using the Feature-Oriented Domain Analysis (FODA) method. Further research can investigate the users’ satisfaction with the systems that have been developed to determine system performance in the field.

References
[1] Kästner, C., & Apel, S, Feature-oriented software development a short tutorial on feature-oriented programming, virtual separation of concerns, and variability-aware analysis. Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), Science of Computer Programming, Volume 77, Springer-Verlag, Berlin, 2013, pp. 346-382.
[2] Kiczales G. et al, Aspect-oriented programming. In: Akşit M., Matsuoka S. (eds), Lecture Notes in Computer Science, vol 1241. Springer, Berlin, 1997.
[3] Olszewski, M, Scaling Up Stepwise Feature Introduction to Construction of Large Software Systems, (2013), TUCS Dissertation, 161.
[4] Khan, J. et al, Response Time Calculation of Feature Oriented Software Development, International Journal of Computer Science and Information Security, Volume 14, 2016, pp. 544–554.

[5] Pressman, R. S, Software Engineering A Practitioner’s Approach 7th Edition, A Brief History of Computing, 2010, 0014-2972.

[6] Indonesian Ministry of Health, Indonesian Ministry of Health Regulation, Available online: http://dinkes.surabaya.go.id/portal/files/permenkes/dok_dinkes_87.pdf. (accessed 10.12.19)