Optimization of laboratory application by utilizing the ISO/IEC 25010 model

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Abstract. Public health center (puskesmas) as the driving force for health-minded development are responsible for improving the quality of its services through the delivery of relevant, fast, and targeted information. Likewise, the laboratory unit at the puskesmas is the frontline of the first level health care center. Especially in the Corona pandemic today, where the role of laboratories as a testing facility for Covid-19 virus testing is very important. Ease of obtaining data/information, a high level of readability, timely and minimal errors are needed. Therefore, this research has developed a lab application in puskesmas to collect, process, and present data in a structured, easy-to-read, timely, and accurate way (minimizing human error) using the Prototype model. The quality of lab application is evaluated by the ISO/IEC 25010 model and the evaluation results show that lab application meets the characteristics of ISO/IEC 25010 (valid).

1. Introduction
Lately, the laboratory is one of the most dynamic installations in health care, especially in the Corona pandemic as it is today. Therefore, the medical community puts more pressure on the laboratory to improve the quality of its services to patients. This means that all laboratory operational methods and procedures must be integrated, starting from sampling planning, handling, examination, and/or calibration to giving results to the patient.

An examination result can be said to be of high quality if the results of the examination/medical record can be traced to its examination history and well documented so that it can satisfy the patient while meeting scientific and legal rules [1]–[4]. The solution offered is to build a lab application which is a laboratory information system so that it can assist the public health center (puskemas) in collecting, processing, and presenting data in a structured, easy to read, timely and accurate/error-free manner [5].

Other benefits to be gained with the lab app are (1) reduced errors in reporting due to human error; (2) better data presentation; (3) increasing HR productivity due to efficient time of archiving and searching data/information [3]; (4) reduced use of paper; (5) increased level of report readability, because reports are printed/not written by hand [6]; (6) increased speed in collecting statistical data due to computerization [7].

To guarantee that the quality of lab application meets the standards, evaluation or measurement of software quality is required with international standards. One of them is by using the ISO/IEC 25010 model.
model. ISO/IEC 25010 is an updated model of ISO 9126 and is a standard that directs the development of software products with specifications and evaluation of quality requirements [8].

ISO/IEC 25010 is an international standard used to evaluate or measure software quality internally (the quality of the software itself) and externally (the quality of software concerning hardware, data, and other software incorporated in a computer system) [8]. The ISO/IEC 25010 model consists of 8 characteristics used to measure software quality internally and externally as shown in Figure 1.

2. Methodology

The software development model that will be used to build a lab application in this study is the prototype model (Figure 2). The Prototype Model is a software development model suitable for developing a system where the needs are generally defined but not specific so that developers and stakeholders can better integrate an understanding of what the system will be built [9].

![Prototype Model](image-url)

**Figure 2. Prototype Model**

The initial stage of the prototype model is communication. At this stage, a collection of application needs will be carried out. Followed by the second stage, namely planning. The second stage is the estimation and scheduling stage of lab application development. The next stage is the modeling stage where the analysis results are developed into a lab application design in the form of use case diagrams [10] as shown in Figure 3.
The fourth stage of the prototype model is the construction stage. At this stage, the coding process of the lab app is carried out and then proceed with the process of testing/evaluating the application. The lab app in this study will be evaluated using an ISO/IEC 25010 model that has been modified according to the needs as listed in Table 1 so that only the sub characteristics that influence the research will be tested [8].

Table 1. Evaluate characteristics of software quality models and tools used

| Characteristics | Sub Characteristics | Tools |
|-----------------|---------------------|-------|
| Functional Suitability | Func. Completeness, Correctness, and Appropriateness | Equation (1) and Table 2 |
| Performance Efficiency | Time Behavior, Resource Utilization, Capacity | Webserver Stress and Table 3, Resource Monitor, Webserver Stress |
| Usability | Appropriateness recognizability, Learnability, Operability, User Error Protection, User Interface Aesthetic, Accessibility | UEQ Data Analysis Tool |
| Reliability | Maturity, Availability | Webserver Stress, - |
| Compatibility | Co-Existence, Interoperability | Chrome, Firefox, IE, Opera |
| Security | Confidentiality, Integrity, Non-Repudiation, Accountability, Authenticity | Subgraph Vega, Lab app, - |
| Portability | Adaptability | Android |

Functional suitability characteristics consisting of functional completeness, functional correctness, and functional appropriateness sub characteristics will be evaluated by calculating the percentage of successful validation testing of all system functional requirements using Equation (1).

\[
\text{Percentage of success} = \frac{i}{r} \times 100\% \tag{1}
\]

Where:

- \( i \) = Number of functional requirements successfully implemented
- \( r \) = Total functional requirements
An evaluation of the functional suitability evaluation results will refer to Table 2.

**Table 2.** Categories of Evaluation Results Evaluation [11].

| Score (%) | Interpretation     |
|----------|-------------------|
| 0 – 20   | Very Unworthy     |
| 21 – 40  | Not Feasible      |
| 41 – 60  | Feasible Enough   |
| 61 – 80  | Feasible          |
| 81 – 100 | Very Feasible     |

Testing the performance efficiency characteristics consisting of 3 sub characteristics namely time behavior, resource utilization and capacity where the sub characteristics of Time Behavior will be tested using the Webserver Stress Tool [12] then the test results will be evaluated with the Jakob Nielsen response time standard [13] as stated in Table 3. Whereas the sub-characteristics of Resource Utilization will be tested using the Task Manager tool [14]. This tool will capture the CPU Usage and Memory Usage used by the browser to run the lab app reduced by the amount of RAM and CPU used by the browser without running anything. While Capacity sub-characteristics will be tested with the Web Stress Tool [12] also wherein the initial stages, the lab app will be accessed by n users, then the number of users will be added gradually until the system becomes saturated.

**Table 3.** Web-Based Application Response Time [13]

| Response Time (sec) | Human Perceptual Abilities                                               |
|---------------------|--------------------------------------------------------------------------|
| 0.1 (0 – 0.1)       | They can manipulate objects in the UI directly                            |
| 1.0 (0.2 – 1.0)     | They can freely navigate in the UI without feeling the time lag          |
| 10.0 (1.1 – 10.0)   | The limit for users still pays attention to the User Interface.          |

Furthermore, testing the usability characteristics will use the User Experience Questionnaire (UEQ) Data Analysis Tool [15]. The questionnaire consisted of twenty-six comparison items with a rating scale of 1-7 [15]. This questionnaire was aimed at three respondents (one receptionist and two laboratory analysts) who had at least two years’ experience [16]. The reliability characteristics testing includes testing on the characteristics of maturity and availability. Maturity sub characteristics will be tested using the Web Stress Tool by involving n virtual users who click on the lab application every 5 seconds for 5 minutes. Meanwhile, the availability of sub-characteristics will be tested by running the lab/system for 24 hours.

Testing compatibility characteristics for the Co-existence sub characteristics will be evaluated by looking at the ability of lab app to share the environment and resources in the same browser without interfering with each other. Whereas the Interoperability sub-characteristic will be evaluated by looking at the ability of lab app to exchange information when operated on several different browsers. In testing the security characteristics, the confidentiality, integrity, and non-repudiation sub characteristics will be tested for system vulnerabilities using the Subgraph Vega application. This test will be carried out by inserting a lab app hyperlink into the Subgraph Vega application for scanning. While for the sub-characteristics of accountability will be evaluated by looking at user activity data on the admin page, and for the authenticity sub-characteristics will be evaluated by seeing whether lab app can identify the user who accesses it and gives the user authority according to their access rights.

The final test is testing the portability characteristics that will see the ability of lab app if used in different environments. For sub adaptability characteristics will be evaluated by looking at the ability of lab app to adapt if operated on different operating systems/hardware, whether lab app need modification. While the sub-characteristics of install ability and replace ability are not evaluated because they cannot be tested on new web-based application.
3. Result and Discussion
The deployment stage output of the prototype model is an interface as shown in Figure 4.

![User Interface](image1)

**Figure 4.** The user interface for managing laboratory check-up (in Indonesia)

The unit test results performed on the verify_login() method in the Login class, the verify_emr() method in the Patient class, the view_result() method in the Result class, the result_checkup() method in the Result class and the view_report() method in the Report class are valid. Furthermore, the integration test results of the insert_result() operation in the Analyst class, the result_checkup() operation in the Result class, and the edit_result() operation in the Result class are also valid. This means that the evaluation results for functional suitability characteristics are very feasible based on interpretation from Table 1 because the percentage of success is 100%.

The results of the Performance Efficiency characteristics test include: (1) the time behavior sub-characteristic test shows that the average system response time for all URLs is 111 ms as shown in Figure 5 when the system is loaded with 10 virtual users where each user clicks on every 5 seconds for 1 minute. Based on Jakob Nielsen's response time standards (Table 3) it can be concluded that the user can experience manipulating objects in the UI directly.

![Time Behavior Chart](image2)

**Figure 5.** Simulating 10 simultaneous users – 5 seconds between clicks

(2) testing sub-characteristics of resource utilization shows an average RAM usage of ± 7% (140 MB of 2 GB) and CPU of ± 3% as shown in Table 4. The results of this evaluation meet the Performance
Efficiency standard which is less than 15%. (3) sub-capacity characteristics testing shows the results that the system becomes saturated when the number of users reaches 110 users.

Table 4. RAM and CPU usage before and after lab app is operated.

| Condition                        | CPU  | RAM   | Disk | Network | GPU |
|----------------------------------|------|-------|------|---------|-----|
| Lab app has not been operated    | 2%   | 75%   | 0%   | 0%      | 0%  |
| Lab app already operated         | 5%   | 82%   | 4%   | 0%      | 0%  |

The results of usability characteristic testing using the UEQ Data Analysis Tool show that the average UEQ score is 2.34 as shown in Figure 6. Based on the UEQ value range [15] the 2.34 score gets an interpretation of the value "In the range of the 10% best results". In other words, the usability characteristics of the lab application are included in the best 10% scope.

Sub-test results of maturity characteristics with the Webserver Stress Tool show that lab app reaches a level of stability when accessed by 110 virtual users – 5-second between clicks, without causing errors and with an average user waiting time of 5.47 second (Figure 7).

While the test results of the availability sub-characteristics show that lab app can operate without causing errors for 24 hours in the system environment.
Furthermore, the results of compatibility characteristics testing for the Co-existence sub characteristics of the Chrome browser show that all applications that are in the Chrome browser can perform their functions properly without experiencing interruptions. Likewise, the test results for the Interoperability sub characteristics through the Chrome, Mozilla, and IE browsers on Axioo x5-Z8350 CPU @ 1.44 GHz devices show that lab app can exchange information when operated in all browsers.

The results of security characteristics testing for confidentiality, integrity and non-repudiation sub characteristics produce recommendations that the lab application uses https, the login file is not on the web root, and disables directory listing. However, the results of this recommendation do not make the system vulnerable because the lab app operates intranet (local) so that it can state that the system remains safe. As for the results of the accountability testing that shows data on the activities of the lab app users, it can be seen on the admin homepage.

The authenticity sub-test results show that lab app can identify users and give authority to users according to their access rights. This shows that the test results are following the expected test scenarios so that the authenticity test is valid. Finally, the results of testing the portability characteristics on the adaptability sub characteristics show that lab app can operate without problems on the Android operating system. This shows that lab app is a very feasible application based on Table 2. The summary of the results of the evaluation of the characteristics and sub characteristics of the lab software quality model can be seen in Table 5.

Table 5. Results of evaluation of the lab software quality model

| Characteristics/Sub Characteristics | Evaluation Result |
|------------------------------------|-------------------|
| 1. Functional Suitability           | valid             |
| 2. Performance Efficiency          |                   |
|   • Time Behavior                  | 111 ms for 10 users – 5-second between clicks. |
|   • Resource Utilization           | RAM: ± 7% (140 MB of 2 GB) and CPU: ± 3% |
|   • Capacity                       | 110 user          |
| 3. Usability                       | score 2.34 with the interpretation of the value “In the range of the 10% best results” |
| 4. Reliability                     |                   |
|   • Maturity                        | 5,472 ms for 110 users – 5-second between clicks. |
|   • Availability                   | Lab app can operate 24 hours without error |
| 5. Compatibility                   |                   |
|   • Co-Existence                   | Running well      |
|   • Interoperability               | Running well      |
| 6. Security                        |                   |
|   • Confidentiality                | Lab app must use https, login files cannot be on the webroot, and directory listings must be disabled |
|   • Integrity                     |                   |
|   • Non-Repudiation                |                   |
|   • Accountability                 | valid             |
|   • Authenticity                   | valid             |
| 7. Portability                     | Very feasible     |

4. Conclusion
Based on the results of testing all sub characteristics of the ISO/IEC 25010 standard on the lab application, it can be stated that all application functions have been running as expected or have a valid value. This shows that the application of the lab app at the puskesmas has succeeded in collecting, processing, and presenting data in a structured, easy-to-read, timely manner and minimizing human error. Therefore, the integration of lab app as part of the puskesmas information system needs to be considered to be implemented in all puskesmas in the city of Palembang.

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