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Evaluating the Effectiveness of the SIGNAL Digital Samsat Application Using the PIECES Framework and Technical Testing

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ABSTRACT

The SIGNAL application is a digital service provided by the Indonesian National Police's Traffic Corps (Korlantas Polri) to facilitate online STNK validation. However, several users have reported issues such as unsuccessful verification processes, delays in the delivery of physical documents, slow customer service responses, and login difficulties. This study aims to evaluate the performance of the SIGNAL application using the PIECES framework, which covers six dimensions: Performance, Information, Economic, Control, Efficiency, and Service. Data were collected through questionnaires distributed to 300 users of the SIGNAL application. Each questionnaire indicator was developed based on PIECES theory and statistically tested for validity and reliability using AVE and Composite Reliability. Descriptive and inferential analyses were conducted, including a one-sample t-test to assess user satisfaction. The results show that the average satisfaction score was 3.9 out of 5, with 76% of respondents expressing satisfaction or high satisfaction, 15% neutral, and 9% dissatisfied. The highest satisfaction was recorded in the Economic aspect (mean 4.06), while the lowest was in Control (mean 3.94). Technical testing using Apptim showed the app performed well, with an average response time of 2.4 seconds, CPU usage at 18%, memory usage at 170MB, and no crashes (0% error rate). These findings indicate that SIGNAL is generally effective and stable, though improvements are needed, particularly in service responsiveness and cross-device performance. This research contributes to the theoretical application of the PIECES model in evaluating public digital services and offers insights for improving the quality of e-government systems in Indonesia.

I. INTRODUCTION

Motor Vehicle Tax (PKB) is one of the main sources of Local Own-Source Revenue (PAD) that needs to be managed optimally. As the number of vehicles increases, the need for an efficient service system becomes increasingly important. To address this challenge, the government launched the SIGNAL (National Digital Samsat) application, a mobile-based platform for online vehicle registration certificate (STNK) validation and PKB payment [1]. SIGNAL was developed as part of efforts to strengthen e-Government, where public services are aimed to be faster, more efficient, and accessible without the need for face-to-face interaction [3]. The app is designed with digital features that integrate vehicle ownership data, electronic documents, and online payment methods into a single integrated system [2].

However, in practice, many users still face technical challenges, such as failed facial verification, undelivered OTPs, and crashes on certain devices [4]. These recurring problems indicate that the system has not yet achieved the expected level of stability or user-friendliness. This underscores the need for a comprehensive assessment of the SIGNAL application to determine its overall effectiveness as a digital public service platform.

To conduct this evaluation, the PIECES framework is employed, which examines six core dimensions of an

information system: performance, information, economy, control, efficiency, and service. The PIECES method offers more comprehensive advantages compared to other approaches, such as the Technology Acceptance Model (TAM). While TAM evaluates technology acceptance based on two key perceptions—perceived usefulness and perceived ease of use—PIECES incorporates six essential dimensions, allowing for a more detailed and multidimensional system assessment [5].This conceptual framework is further strengthened through technical performance testing using Apptim, a tool that measures real-time application performance metrics such as memory usage, response time, and crash behavior [6]. Unlike PIECES, which focuses on user perception, Apptim offers a technical perspective. Combining both allows for a more comprehensive system evaluation.

Various studies have examined the SIGNAL application as a digital platform for vehicle tax payment. For instance, the study by Rahman et al. (2024) [7] and research by Nurzaman et al. (2024) [8], and the study by Saju et al. (2023) [9] analyzed user sentiment or discussed technical and service-related challenges based on user reviews. While prior research highlighted user perceptions, these studies have not systematically evaluated the quality of those services. Therefore, this research not only addresses the *Service* aspect within the PIECES framework but also provides a more comprehensive evaluation by covering other dimensions such as *Performance, Information, Efficiency, Control,* and *Economy*, supported by technical testing to offer deeper insights into the application's overall system quality.

The findings of this study are expected to yield concrete insights into the functional and technical performance of the SIGNAL application. These results can be utilized by service providers to improve system management, and by developers to enhance application stability and reliability. Additionally, this research contributes to the academic discourse on evaluating public digital service systems using both conceptual and technical approaches.

II. METHODE

The methodology outlines the specific technical processes and procedures that will be carried out during the course of the research. This study will utilize a questionnaire developed based on the PIECES framework, which consists of six core dimensions: Performance, Information, Economic, Control, Efficiency, and Service. Each indicator in the questionnaire is carefully constructed by adapting relevant literature corresponding to each dimension. The questionnaire will be distributed to 300 respondents who have used or previously used the SIGNAL application, with the aim of obtaining empirical data regarding system quality and user satisfaction levels. In addition, the questionnaire will undergo validity testing using the Average Variance Extracted (AVE) method and reliability testing using Composite Reliability (CR), where all constructs are expected to meet the required thresholds to ensure accuracy and internal consistency of the measurements.

The overall research stages are illustrated in the research flow diagram, as shown in Figure 1.

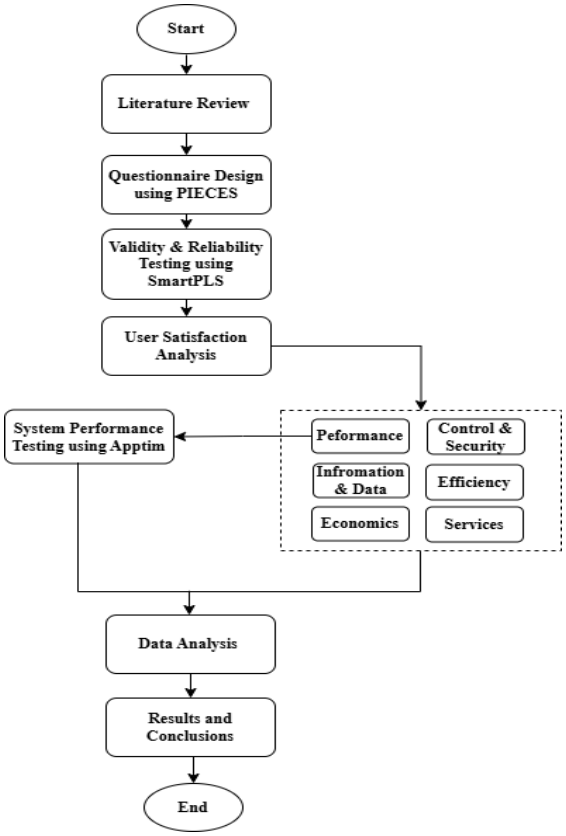

Figure 1. Research Methodology

A. Data Collection Technique

Data collection in this study was carried out through the preparation of questionnaires and their distribution to respondents who were active users of the SIGNAL application. The data collection technique in this study consists of several methods, namely: Literature study to obtain the theoretical basis, the questionnaire whose preparation stage is carried out based on the PIECES. evaluation framework which includes six main aspects (Performance, information, economic, control, efficiency, service) [10].

The complete list of indicators used in the questionnaire, organized according to the six dimensions of the PIECES framework, is presented in Table 1.

TABLE I
PIECES STATEMENT INDICATOR

Variable	Statements
Performance (X1)	1. The SIGNAL application is easily accessible without obstacles

	2. The features in the SIGNAL application are simple and useful 3. The SIGNAL application runs smoothly on various devices and operating systems 4. The SIGNAL application displays features well and according to user needs 5. The SIGNAL application completes transactions quickly without disruptions
Information and Data (X2)	1. The SIGNAL application presents vehicle tax information completely and accurately 2. The SIGNAL application always provides up-to-date information on vehicle taxes and current regulations 3. The SIGNAL application's data storage system is safe and organized 4. Data in the SIGNAL application is easy to download by users 5. The information provided by the SIGNAL application is easy to understand and learn
Economics (X3)	1. Using the SIGNAL application saves on internet data consumption 2. The SIGNAL application is free to access for users 3. The SIGNAL application helps users complete transactions quickly and efficiently 4. Using the SIGNAL application is economically beneficial in terms of cost and effort savings 5. The SIGNAL application provides significant benefits in vehicle tax payments
Control and Security (X4)	1. The SIGNAL application has a strong security system in user identity verification processes 2. The SIGNAL application is stable and rarely experiences errors during access 3. The SIGNAL application is free from spam or irrelevant ads 4. User data in the SIGNAL application is protected from unauthorized modifications 5. The SIGNAL application has a reliable security system to protect user transactions
Efficiency (X5)	1. The complaint process in the SIGNAL application is responsive and fast 2. Features in the SIGNAL application make it easier for users to complete transactions 3. The layout and interface of the SIGNAL application help users access available features 4. The information provided in the SIGNAL application matches user needs 5. The SIGNAL application processes transactions and input data smoothly with minimal errors
Services (X6)	1. The SIGNAL application's interface is easy to use and attractive 2. The SIGNAL application provides clear and accurate information about customer document delivery status 3. The SIGNAL application's customer service is responsive in handling user complaints 4. The SIGNAL application provides notifications that help users manage their obligations 5. The SIGNAL application is continuously updated to ensure ease of use 6. Procedures in SIGNAL are not confusing and easy to follow
Satisfaction (User Satisfaction)	1. I am satisfied with the SIGNAL application's performance because it functions well and is responsive 2. I am satisfied with the SIGNAL application's user interface which is attractive and easy to understand 3. I am satisfied because the SIGNAL application rarely experiences technical issues when used

B. Validity Test

Validity testing in this study employed the Average Variance Extracted (AVE) method, which aims to assess the extent to which the indicators used in the questionnaire are able to explain the latent variable or construct being measured**.** Validity is essential to ensure that the instrument accurately measures what it is intended to measure. This measurement can also be used to evaluate the reliability of the component scores for the latent variables, and it is considered more conservative compared to other methods [11]. An indicator is considered valid if the AVE value exceeds 0.5. Conversely, if the AVE value is below 0.5, the

indicator is deemed less valid and may need to be revised or replaced with a more representative item [12].

C. Reliability Test

Reliability testing is essential to determine the consistency and stability of an instrument in measuring a construct across repeated applications [12]. Reliability testing in this study was conducted to assess the internal consistency of the indicators within each construct. Composite Reliability (CR) is a reliability measure used to evaluate the internal consistency of a latent construct measured by multiple indicators. Unlike Cronbach's Alpha, Composite Reliability takes into account the loading weights of each indicator, thus providing a more accurate estimation of construct reliability. The recommended threshold for composite reliability is greater than or equal to 0.7 [13]. A high CR value suggests that the indicators within a construct are capable of consistently producing reliable measurements across repeated tests, and are therefore suitable for further analysis [14].

D. User Satifaction Level Analysis

The reliability test is carried out using Composite After conducting data quality testing, the next step is to analyze the level of satisfaction of SIGNAL application users based on the six aspects of the PIECES framework. The analysis is carried out by calculating the average level of satisfaction for each indicator in the framework. To find the average level of satisfaction can be calculated using equation (1).

$$RK = \frac{JK}{JSK}$$

RK : Average User Satisfaction

JSK : Total Questionnaire Score

JK : Number of Questionnaires

TABLE II
AVARAGE SATISFACTION LEVEL

Answer Options	Value Range	Score
Very Dissatisfied	1.00 – 1.79	1
Dissatisfied	1.80 – 2.59	2
Undecided	2.60 – 3.39	3
Satisfied	3.40 – 4.19	4
Very Satisfied	4.20 – 5.00	5

The results of the calculated average score are then interpreted to provide important information, including whether users are overall satisfied, which aspects still experience obstacles or limitations, as well as recommendations that can be given to improve the quality of the SIGNAL application. The average value of this calculation is then classified based on the satisfaction level table using the model defined by Kaplan and Norton, with the following levels [15].

E. Application Performa Testing with Apptim

To complement the analysis of user satisfaction levels, research also conducted performance testing of the SIGNAL application using Apptim, which is a software specifically designed to test the performance of mobile applications on Android and iOS devices[16]. Testing with Apptim aims to evaluate the technical aspects of the application directly from the user's side, under real usage conditions. Apptim provides various important performance metrics, including:

- CPU Usage: Shows how much processing load the app is putting on the device during the test.
- Memory Usage: Analyzing the memory consumption used by the application while it is active.
- Crash Reports: Detects if a crash (crash or sudden stop of the application) occurs during testing.
- App Render Time and Network Performance: Provides information on the smoothness of the app's visual display and the quality of data communication.

The results of these tests help to provide an overview of the application's actual performance and detect potential technical issues that may not be revealed through user satisfaction surveys. Thus, the use of Apptim as a test tool adds validity to the evaluation results, as it is able to objectively assess the system from both a technical and user experience perspective.

F. Hypotesis Test

Hypothesis testing in this study was carried out using a one sample t-test, with the aim of knowing whether user perceptions of each aspect of PIECES differ significantly from the neutral value, which is 3.00. The value of 3.00 is used as a reference value because it represents a neutral or "undecided" position on a Likert scale of 1-5. A one-sample t-test was used because the data were obtained from a single group of respondents and compared against a reference value, rather than comparing two different groups. Therefore, this approach is appropriate for testing whether each PIECES aspect statistically reflects a significant level of user satisfaction with the SIGNAL application.

In this test, the average score of respondents' responses will be compared with the reference value, to determine whether there is a statistically significant difference. The following are the research hypotheses developed in this study:

- First Hypothesis: Evaluation of Performance Aspects against the Reference Value (3.00)
  H0 : Average user perception of performance aspects = 3.00
  H1 : Average user perception of the performance aspect ≠ 3.00
- Second Hypothesis: Evaluation of Information & Data Aspects against the Reference Value (3.00)

H0 : Average user perception of information & data aspects = 3.00
H1 : Average user perception of information & data aspects ≠ 3.00

- Third Hypothesis: Evaluation of Economics Aspects against the Reference Value (3.00)
  H0 : The average user perception of the Economic aspect = 3.00
  H_1 : The average user perception of the Economic aspect ≠ 3.00
- Fourth Hypothesis: Evaluation of Control & Security Aspects against the Reference Value (3.00)
  H0 : Average user perception of control & security aspects = 3.00
  H_1 : The average user perception of the control & security aspect ≠ 3.00
- Fifth Hypothesis: Evaluation of Efficiency Aspects against the Reference Value (3.00)
  H0 : Average user perception of efficiency = 3.00
  H_1 : The average user perception of the efficiency aspect ≠ 3.00
- Sixth Hypothesis: Evaluation of Services Aspects against Reference Value (3.00)
  H0 : Average user perception of services = 3.00
  H_1 : The average user perception of the services aspect ≠ 3.00

III. Result and Discussion

This research combines user perception analysis and technical testing to evaluate the SIGNAL application. User feedback was collected through a PIECES-based questionnaire and analyzed with SmartPLS, showing valid and reliable results with average satisfaction scores above 3.00. For the technical evaluation Apptim was used as a tool to monitor application performance metrics during real-time interactions

A. Validity Test

The validity test is used to determine the extent to which the statement items on the questionnaire are able to measure the aspects included in the study. The test uses Average Variance Extracted (AVE) which has the criteria that a construct is declared valid if the AVE value is> 0.50. By using AVE, it can be ensured that each indicator in the instrument is able to present its variable well and is suitable for further analysis.

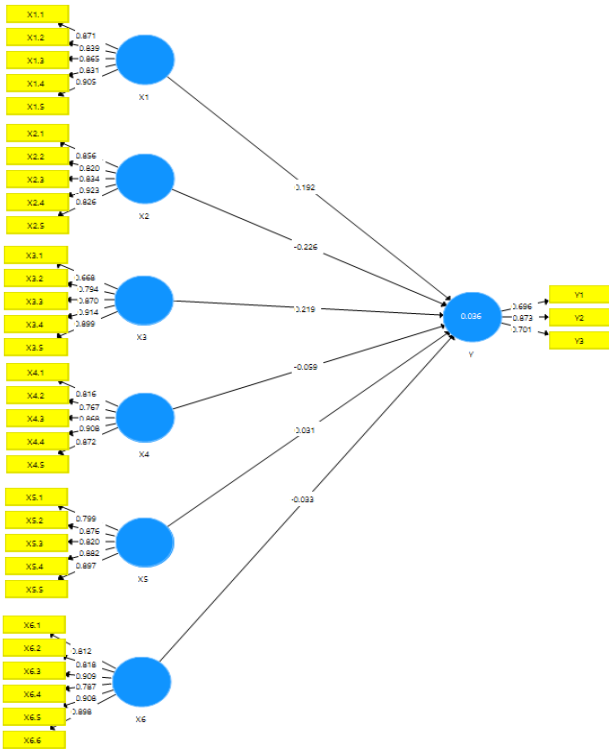

Figure 2. Stuctural Model in Smartpls

The results of the validity test using SmartPLS modeling show that of the 36 statement items tested, 34 statement items were declared valid with a value> 0.7. In other words, about 94.4% of the items in the instrument meet the predetermined validity criteria, so it can be ascertained that the instrument used has a very high level of reliability and relevance in measuring the intended concept.

TABLE III
Convergent Validity Test Result

Variabel	Indicator	Outer Loading	AVE	Status
Performance	X1	0.871		Valid
	X2	0.839		Valid
	X3	0.865	0.744	Valid
	X4	0.831		Valid
	X5	0.905		Valid
Information & Data	X1	0.856		Valid
	X2	0.820		Valid
	X3	0.834	0.726	Valid
	X4	0.923		Valid
	X5	0.826		Valid
Economics	X2	0.794		Valid
	X3	0.870	0.695	Valid
	X4	0.914		Valid
	X5	0.899		Valid
Control & Security	X1	0.816		Valid
	X2	0.767		Valid
	X3	0.868	0.718	Valid
	X4	0.908		Valid
	X5	0.872		Valid

Efficiency	X1	0.799		Valid
	X2	0.876		Valid
	X3	0.820	0.732	Valid
	X4	0.882		Valid
	X5	0.897		Valid
Services	X1	0.812		Valid
	X2	0.818		Valid
	X3	0.909	0.734	Valid
	X4	0.787		Valid
	X5	0.908		Valid
	X6	0.896		Valid
Satisfaction	Y2	0.873		Valid
	Y3	0.701	0.579	Valid

Based on the results of validity testing using SmartPLS, it was found that there were 2 questionnaire statement items that were quite valid. The following table displays the results of the validity test which has a fairly valid value.

TABLE IV
VALIDITY TEST RESULTS MODERATELY VALID

Variabel	Indicator	Outer Loading	Status
Economics	X1	0.668	Sufficiently Valid
Satisfaction	Y1	0.696	Sufficiently Valid

The table above shows statement items that are quite valid, but are still retained because they have strong theoretical relevance, so they are still considered important in measuring latent constructs. In addition, although there are indicators with values below 0.7, the Average Variance Extracted (AVE) value for the construct concerned remains valid (>0.5). This shows that the construct still has a good ability to explain the variance of its indicators.

B. Reliability Test

The reliability test aims to assess the internal consistency of each indicator used in the research variable. In this test the test results are seen and assessed using Composite Reliability (CR). A good CR value is> 0.70, which indicates that the instrument has a high level of reliability and can be trusted in measuring the intended construct.

TABLE III
REABILITY TEST RESULT

Variabel	Composite Reliability	Status
Performance	0.9356	Reliabel
Information & Data	0.9300	Reliabel
Economics	0.9185	Reliabel
Control & Security	0.9271	Reliabel
Efficiency	0.9318	Reliabel
Services	0.9429	Reliabel
Satisfaction	0.8032	Reliabel

Based on the results of the reliability test using the Composite Reliability (CR) value, all variables in the model have a value> 0.7. This shows that all constructs are declared reliable, meaning that the indicators in each variable are able to consistently measure the intended construct.

C. Results Of User Satisfaction Level Analysis

The analysis of user satisfaction in this study presents data derived from the average responses of 300 participants. The mean values for each aspect reflect the extent to which the SIGNAL application meets the expectations and needs of its users.

1) *Performance*: The performance variable is used to determine the level of reliability and performance of the SIGNAL application based on user perceptions.

TABLE IVI
PERFORMANCE QUESTIONNAIRE ASSESSMENT RESULTS

Performance					
Answer	**SA**	**A**	**N**	**D**	**SD**
Score	5	4	3	2	1
Total Score	539	606	217	84	54

$$\text{RK: } \frac{(539 * 5) + (606 * 4) + (217 * 3) + (84 * 2) + (54 * 1)}{5 * 300}$$

$$\text{RK: } \frac{2.695 + 2.424 + 651 + 168 + 54}{5 * 300}$$

RK: 3.99

The calculation results show that the SIGNAL application achieved an average score of 3.99, which falls into the "satisfied" category. This indicates that most users perceive the application as having good performance, being easy to access, offering well-displayed features, and enabling smooth transaction processing. However, a small portion of respondents selected “Neutral” or “Disagree,” particularly on statements regarding the app’s smooth operation across different devices. This suggests that although the overall performance of the application is considered good, cross-device stability still requires attention.

It is recommended that developers conduct compatibility testing across various device types and operating system versions to ensure consistent accessibility, and that periodic improvements to specific technical aspects are needed to maintain the application’s stability and optimal performance.

2) *Information & Data:* This information & data variable is to assess the extent of information quality, data completene.

TABLE VI
INFORMATION QUESTIONNAIRE ASSESSMENT RESULTS

Information & Data					
Answer	**SA**	**A**	**N**	**D**	**SD**
Score	5	4	3	2	1
Total Score	570	592	196	83	59

$$\text{RK: } \frac{(570 * 5) + (592 * 4) + (196 * 3) + (83 * 2) + (59 * 1)}{5 * 300}$$

$$\text{RK: } \frac{2.850 + 2.368 + 588 + 166 + 59}{5 * 300}$$

RK: 4.02

The calculation results show an average score of 4.02, which falls into the “satisfied” category. This score reflects that the SIGNAL application has provided accurate and easy-to-understand information for users. Additionally, the data storage system is considered secure and well-organized, and the information presented is deemed helpful in assisting users to understand their tax obligations. However, although most respondents selected “Agree” or “Strongly Agree,” a small number chose “Neutral” regarding the ease of downloading data. This indicates that the data download feature still requires improvement in terms of accessibility. Optimization of the download feature is recommended, along with clearer usage instructions within the application.

3) *Economics*: This Economics variable evaluates the economic value of SIGNAL application users, both in terms of cost efficiency, internet data consumption, and its usefulness in the vehicle tax payment process.

TABLE VII
INFORMATION QUESTIONNAIRE ASSESSMENT RESULTS

Economics					
Answer	**SA**	**A**	**N**	**D**	**SD**
Score	5	4	3	2	1
Total Score	596	590	180	75	59

$$\text{RK: } \frac{(596 * 5) + (590 * 4) + (180 * 3) + (75 * 2) + (59 * 1)}{5 * 300}$$

$$\text{RK: } \frac{2.980 + 2.360 + 540 + 150 + 59}{5 * 300}$$

RK: 4.24

The calculation results show that the average score for this aspect is 4.06, which falls into the "very satisfied" category. This high score indicates that users perceive tangible benefits in terms of time and cost savings. SIGNAL is considered lightweight, free to access, and does not impose additional burdensome costs, thereby offering direct economic advantages to users. Nevertheless, for the statement related to "saving internet data consumption," a small portion of respondents selected "Neutral." This suggests the need for further optimization of the application to reduce data usage. Optimizing the app size and managing cache more efficiently is recommended to minimize users' internet data consumption.

4) *Control & Security*: This control & security variable measures how well the application's control and security system protect user data and transaction processes.

TABLE VIIX
CONTROL & SECURITY QUESTIONNAIRE ASSESSMENT RESULT

Control & Security					
Answer	**SA**	**A**	**N**	**D**	**SD**
Score	5	4	3	2	1
Total Score	512	590	247	94	57

$$\text{RK: } \frac{(512 * 5) + (590 * 4) + (247 * 3) + (94 * 2) + (57 * 1)}{5 * 300}$$

$$\text{RK: } \frac{2.560 + 2.360 + 741 + 188 + 57}{5 * 300}$$

RK: 3.94

The calculation results show an average score of 3.94, which falls into the "satisfied" category. The majority of users feel that the SIGNAL application is safe to use, personal data is well protected, and the app is free from spam and advertisements. However, some respondents selected “Neutral” regarding data security and application stability, indicating that user trust in data protection still needs to be strengthened. It is recommended to enhance data security standards, such as implementing double encryption and providing regular notifications to users regarding data protection measures.

5) *Efficiency*: The Efficiency variable assesses how efficient the application is in terms of use, appearance, and ease of access to features.

TABLE VIII
EFFICIENCY QUESTIONNAIRE ASSESSMENT RESULTS

Efficiency					
Answer	**SA**	**A**	**N**	**D**	**SD**
Score	5	4	3	2	1
Total Score	541	617	193	94	55

$$\text{RK: } \frac{(541 * 5) + (617 * 4) + (193 * 3) + (94 * 2) + (55 * 1)}{5 * 300}$$

$$RK = \frac{2.705 + 2.468 + 579 + 188 + 55}{5 * 300}$$

$$RK = 4.00$$

The calculation results show that the average score for this aspect is 4.00, which falls into the "satisfied" category. This indicates that users feel supported by the application's design and interface, which help them complete transactions more easily. A minor issue lies in the response speed of customer service, as some respondents selected "Neutral" regarding how quickly complaints are handled. It is recommended to improve customer service response time by strengthening the complaint ticketing system or shortening the response duration, as well as refining the transaction flow to make it faster and more efficient.

6) *Services*: The services variable aims to evaluate the quality of service provided by the SIGNAL application, including clarity of document delivery information, notifications, and ease of use of procedures.

TABLE IXI
SERVICES QUESTIONNAIRE ASSESSMENT RESULTS

Services					
Answer	**SA**	**S**	**N**	**D**	**SD**
Score	5	4	3	2	1
Total Score	541	617	193	94	55

$$RK: \frac{(641 * 5) + (715 * 4) + (263 * 3) + (107 * 2) + (74 * 1)}{5 * 300}$$

$$RK: \frac{3.205 + 2.860 + 789 + 214 + 74}{5 * 300}$$

RK: 4.76

The calculation results show the highest average score of 4.76, categorized as "very satisfied." This indicates that the SIGNAL application's services are highly helpful to users, particularly in terms of notifications, ease of procedures, and the responsiveness of customer service in addressing complaints. However, based on respondents' feedback regarding the delivery of physical documents, a considerable number selected the "Neutral" category. This is related to frequent complaints about the lengthy delivery time of physical documents (such as the TBPKP), not due to unclear information. Therefore, improvements are needed in the efficiency of the physical document delivery process, including better distribution management and stronger collaboration with courier services. The application administrators should also enhance partnerships with delivery providers to shorten delivery times and provide clearer shipping time estimates within the app.

D. Application Performance Test Result

After testing the SIGNAL application using the Apptim tool, various performance metrics were obtained including CPU usage, memory, network, rendering, and energy consumption. This test aims to evaluate the stability, resource efficiency, and responsiveness of the application while running on Android devices. The performance testing was conducted on an Android 13 device using a Xiaomi Redmi Note 12 Pro 5G. The application was tested once under a stable Wi-Fi network condition, with the session simulating common user interactions such as logging in, viewing transaction history, accessing service menus, and using the live chat feature.

The data obtained will be the basis for analyzing the technical performance of the application under normal usage conditions. The test results can be summarized as follows:

1) *Application Resource Measurement Results:* In the summary section, Apptim presents a performance test overview of the application based on the usage of key resources such as CPU, memory, and graphics performance (FPS). Additionally, this section also indicates whether any warning or moderate conditions occurred during resource usage throughout the testing process.

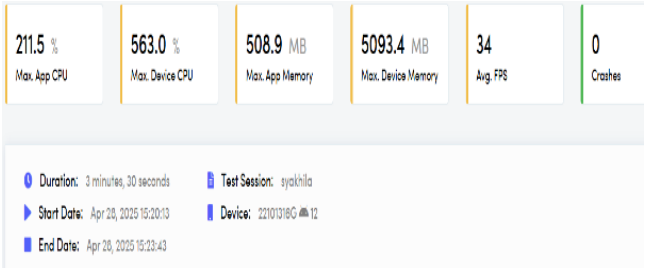

Figure 3. Application Resource Measurement Results

Performance testing showed that the SIGNAL app used an average of 34.0% CPU, peaking at 211.5%, while device-wide CPU usage averaged 315.4% with a maximum of 563.0%. The app's memory usage averaged 281.4 MB and reached a maximum of 508.9 MB, exceeding the moderate threshold (>400 MB), indicating a need for optimization. Device memory usage averaged 4820.5 MB. No crashes occurred during testing, indicating stable operation. However, the app's rendering performance averaged 34 FPS—below the optimal 60 FPS—suggesting the interface may appear less smooth during use.

2) *Recapitulation of measurement results (summary)*: During the performance testing, Apptim also recorded the activities of the SIGNAL application in the form of video documentation. This video aims to provide a visual overview of the application usage process during testing, including interactions, screen transitions, and application responses to user commands. With this video, testers can evaluate application performance in more depth, both in terms of rendering and system response.

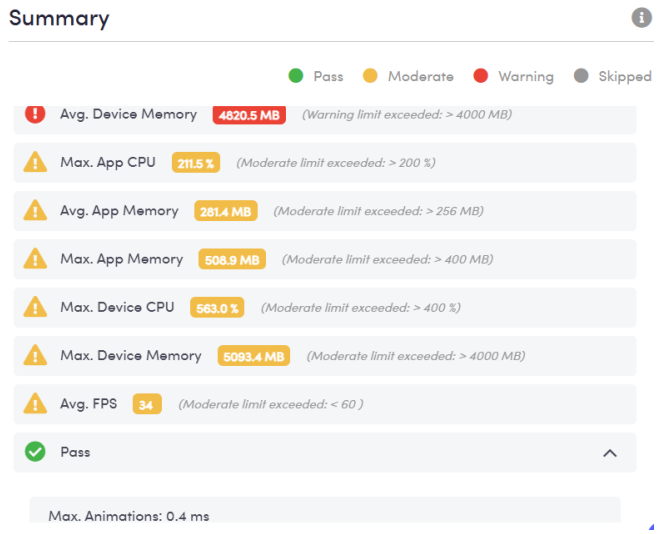

Figure 4. Summary View of Test Results

In conclusion, although the SIGNAL application does not crash and continues to run, there are some aspects such as memory consumption and CPU usage that exceed the normal moderate limit. This shows that the application still needs optimization, especially in resource usage efficiency so that performance is more optimal and battery usage is more efficient.

3) *Application Metrics Measurement Results*: In the Metrics section, Apptim presents a more detailed visualization of the app's resource usage in graph form. These graphs include CPU usage, app memory, device memory, rendering performance (FPS) and app energy score over the test period. With this view, users can monitor resource usage fluctuations in real-time to identify usage patterns and potential performance issues. The following shows the results of the app's metrics measurements during the test:

Figure 5. Signal Application Testing Metrics Chart

Performance testing of the SIGNAL application using Apptim showed that key resource usage, such as CPU and memory, occasionally exceeded moderate thresholds, but the app remained stable without crashes. CPU usage reached over 200%, and app memory peaked at 508.9 MB. Although considered high, the app performed smoothly, though better memory efficiency is recommended for lower-end devices.

Network activity during testing was minimal, with no significant upload or download detected. Rendering averaged 34 FPS, with slight frame sync delays due to high processing load. Energy consumption was mostly in the light to medium category, with occasional spikes caused by CPU usage. Overall, performance and power consumption remained within acceptable limits and did not impact device functionality.

4) *Testing environment configuration*: In testing the performance of the SIGNAL application with Apptim, it can also identify device specifications and test environments to ensure that test results can be accurately analyzed. The following test environment information is available:

- The Android version used on the test device.
- The amount of RAM of the device.
- CPU specifications include processor type, number of cores, and CPU architecture.
- The resolution and screen density of the device.
- The version of the application being tested as well as the application package name.
- The host environment where the test process runs, such as the operating system and version of Apptim used. This information serves to provide context to the performance test results, ensuring that the analysis takes into account the device specifications and environmental conditions during the test.

This information serves to provide context for the performance test results, ensuring that the analysis takes into account the device specifications and environmental conditions during the testing process.

5) *Results of Monitoring Errors*: In the application In addition to measuring performance, Apptim also monitors for errors or crashes that occur while the application is running. Based on the test results, no errors or crashes were found in the SIGNAL application during the test session. This shows that the application runs stably and does not experience interruptions that cause forced termination by the operating system. This information is important to show the level of stability of the application from a technical perspective during normal use within the app.

E. Signal App Improvement Recommendations

Based on the evaluation results using the PIECES framework and technical performance testing with Apptim, the following are recommendations for improvement for the SIGNAL application according to each aspect:

TABLE X.
RECOMMENDATION FOR IMPROVEMENT

PIECES Aspect	Recommendation
Performance	1. Background process optimization 2. Reduced load on the home page 3. Conduct profiling to identify heavy features
Information & Data	1. Show more detailed status information 2. Add a download feature or automatic sending of digital evidence to email/WhatsApp
Economics	1. Improve the process flow so that there is no repetition 2. Reduce heavy data processing to save quota
Control & Security	1. Improve the error notification system, and stabilize the system during high-traffic times
Efficiency	1. Provide a more interactive chat feature. 2. Strengthen input validation to minimize errors.
Services	1. Add document delivery tracking. 2. Implement an automatic reply system or prioritized responses during peak hours.

F. Hypothesis Test Results

The following hypothesis test presents a summary of the results of the one-sample t-test for the six aspects in the PIECES framework. This table shows the mean, standard deviation, t-value, and hypothesis testing decision based on a t-table value of 1.967. Table XII also serves as a descriptive summary of the PIECES variables, presenting the mean and standard deviation for each dimension to give an overview of user responses.

TABLE XI.
RECAPITULATION OF ONE – SAMPLE T TEST RESULTS

PIECES Aspect	Average ($\bar{x}$)	Standar Deviation (s)	t-count	t-table	Decison
P	3.99	0.89	19.8	1.967	H_0 is rejected (significant)
I	4.02	0.90	20.4	1.967	H_0 is rejected (significant)
E	4.06	0.89	21.2	1.967	H_0 is rejected (significant)
C	3.94	0.90	18.8	1.967	H_0 is rejected (significant)
E	4.00	0.90	20	1.967	H_0 is rejected (significant)
S	3.97	0.90	19.4	1.967	H_0 is rejected (significant)

Based on the table above, all t-count values are greater than the t-table, so all null hypotheses (H_0) are rejected. This shows that users' perceptions of each aspect of PIECES are significantly different from the neutral value (3.00). Thus, it can be concluded that users are satisfied with each aspect of using the SIGNAL application.

IV. CONCLUSION

Based on the evaluation using the PIECES framework and technical testing through Apptim, it can be concluded that most users are satisfied with the SIGNAL application, particularly in aspects such as Performance, Information & Data, and Economics. Although the Service aspect recorded a relatively high average satisfaction score in the user questionnaire, technical observations and user feedback revealed several challenges, including delays in physical document delivery and limited responsiveness of customer service.Technical testing also showed that the application performed stably, with quick startup times, moderate CPU and memory usage, and no crashes. However, occasional spikes in memory consumption and delays in rendering frames were noted, which could affect user experience under certain conditions.This study contributes theoretically by demonstrating the applicability of the PIECES framework in evaluating public sector digital services comprehensively. Practically, it provides insights for policymakers to improve the quality of e-Government services, and offers a reference model that can be applied to other digital public platforms beyond SIGNAL.

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