IJISCS (International Journal of Information System and Computer Science)
IJISCS, Volume 9, Number 2, August 2025
E ISSN: 2598-246X; P ISSN: 2598-0793, pp. 107-113
Accredited SINTA 4 Number 79/E/KPT/2023
https://jurnal.ftikomibn.ac.id/index.php/ijiscs

SYSTEM USABILITY EVALUATION OF THE DIGITAL AUTOMATIC WEATHER SYSTEM AT BMKG LAMPUNG PROVINCE

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Article history:
Received July 28, 2025;
Revised August 19, 2025;
Accepted August 28, 2025

Keywords:
System performance;
User satisfaction;
Digitalization;
MKG data

Abstract
The Digital Automatic Weather System (AWS) is a vital tool for real-time meteorological data collection, utilized by the Indonesian Agency for Meteorology, Climatology, and Geophysics (BMKG) to support weather monitoring activities. However, the effectiveness of this technology largely depends on its perceived usability among users. This study aims to evaluate the usability level of the Digital AWS implemented at BMKG Lampung Province by applying the System Usability Scale (SUS) method. Data were collected through SUS questionnaires completed by AWS users within the BMKG environment. The analysis revealed an average SUS score of 59.9, which falls into the Marginal Low category and below the industry standard benchmark of 68. These findings suggest that, although the Digital AWS is functional, several aspects require improvement, particularly in interaction simplicity, interface consistency, and usage efficiency. Recommendations are directed toward enhancing interface design, simplifying navigation, and providing user training to ensure that the Digital AWS can optimally support BMKG's operational activities.

1.0 INTRODUCTION

The Automatic Weather Station (AWS) is a weather monitoring system that automatically measures and records meteorological parameters. It represents one of the key innovations of the Indonesian Agency for Meteorology, Climatology, and Geophysics (BMKG) in the current digital era. Traditionally, weather parameters were observed manually, but this process has now shifted to digitalization. An AWS consists of various components, including sensors, data loggers, communication systems, power supply units, displays, cables, tripods or other mounting systems, grounding devices, radiation shields, rain gauges, smart solar panels, and supporting equipment. The AWS employs multiple sensors such as pyranometers for solar radiation, barometers for air pressure, anemometers for wind speed and direction, rain gauges for precipitation, and thermometers for temperature and humidity. Every ten minutes, real-time data are transmitted to BMKG servers and made accessible through awscenter.bmkg.go.id. Data loggers connected to computers can also be used to retrieve recorded datasets. In essence, AWS functions as a comprehensive weather measurement system, designed to monitor local weather patterns, temperature, and atmospheric changes, while documenting them as structured data for academic or operational use.

BMKG Lampung Province has adopted AWS to continuously conduct meteorological observations. However, not all individuals can easily understand or adapt to newly introduced

information technology-based services [1]. As illustrated in Figure 1, assessing the usability of the Automatic Weather System (AWS) is crucial, as some users may encounter difficulties in understanding, operating, or accepting the system. Although the Digital AWS is designed to simplify the process of automatic meteorological data collection and monitoring, its interface, procedures, and technical terminology may be unfamiliar patosers accustomed to manual systems. Factors such as technological literacy, prior experience, and established work routines strongly influence how quickly users can adapt to the new system.

Without usability evaluation, the potential benefits of AWS may be diminished due to adoption barriers, user errors, or resistance from operators. Employing usability measurement tools such as the System Usability Scale (SUS) helps identify issues that hinder understanding and acceptance, including navigation complexity, clarity of displayed information, or the need for additional training. Thus, usability evaluation serves not only as an indicator of technological implementation success but also as a foundation for system design improvements, training module development, and user support strategies, ultimately ensuring that AWS is effectively adopted and contributes optimally to BMKG's operational performance.

Furthermore, service quality within an organization may decline if information systems are not implemented effectively [2]. Therefore, system-using institutions must evaluate and understand the factors influencing system effectiveness to ensure the proper execution of responsibilities and the delivery of services that meet public expectations [3, 4].

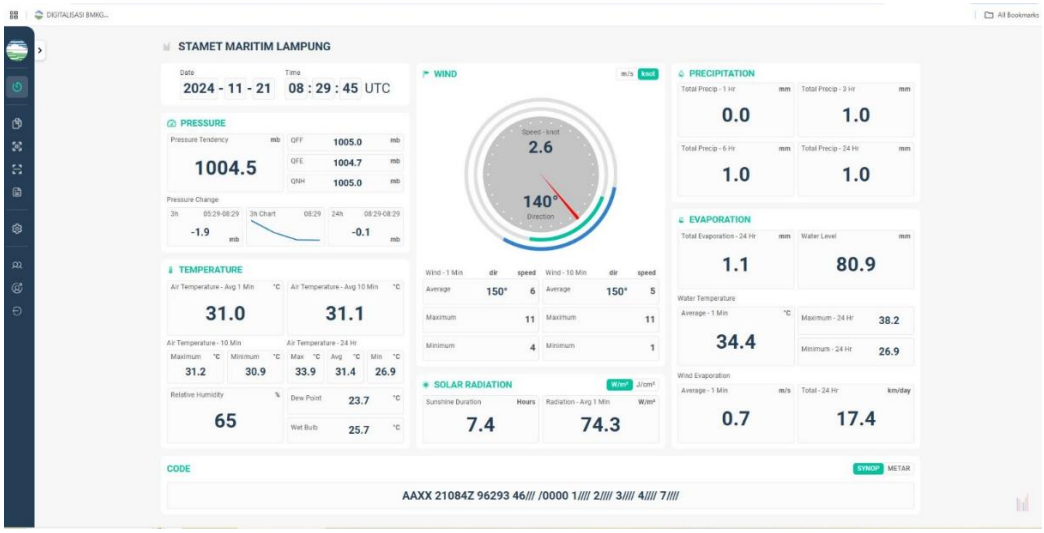

Figure 1. Display of Digital Automatic Weather System BMKG (http://192.168.1.23:3127/display/main)

Several previous studies have employed the System Usability Scale (SUS) to measure the acceptance of information systems. For instance, [5] explored the validity of SUS evaluation results for an e-budgeting system and found that SUS is a quick method for measuring user satisfaction. Other researchers have also applied SUS to assess e-commerce websites [6], e-government systems [7], educational applications [8], healthcare systems [9][10], diabetes management applications [11], point-of-sale applications [12], and web-based English qualification tests [13]. More recently, [14] reported a final SUS score of 67 in evaluating user satisfaction, while usability testing revealed a learnability score of 100%, efficiency of 93.12%, memorability of 78.9%, and an error score of 0.05. These findings highlight the novelty of combining SUS with usability testing, offering a more comprehensive evaluation of user experience for sports applications.

Furthermore, [15] examined user satisfaction using SUS for mobile exergames, which integrate exercise and interactive gaming to promote physical activity among specific demographics. The study reported high usability with an overall SUS score of 93.4, reflecting strong user satisfaction. Users considered the application intuitive and easily accessible, with high task completion rates. Nonetheless, areas for improvement were identified, including the need for customization options, simplified navigation for complex tasks, and the integration of gamification elements to enhance user engagement and motivation.

The System Usability Scale (SUS) is employed in this study because it has been proven reliable and effective in prior research for measuring acceptance and ease of use of various applications and systems. Based on this foundation, this research applies the SUS method to evaluate the satisfaction level and perceived usability of the Automatic Weather Station (AWS) in Lampung Province, Indonesia. The findings are expected to serve as a basis for system improvement and service development.

2.0 RESEARCH METHOD

This study was conducted among users of the Digital Automatic Weather Station (AWS) within BMKG Lampung Province, specifically targeting weather observation officers. The questionnaire was distributed across four Technical Implementation Units (UPTs) in Lampung Province, specifically the Maritime Meteorological Station, Radin Inten II Meteorological Station, Pesawaran Climatology Station, and Kotabumi Geophysics Station. To ensure that the research process was systematic, structured, and well-directed, the research flow was designed as illustrated in Figure 2.

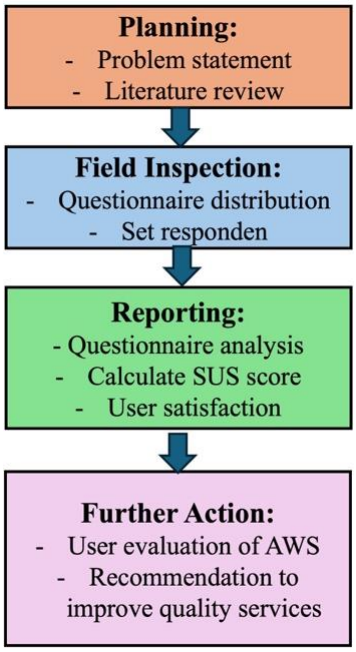

Figure 2. Research Method

2.1. Planning

At this stage, the research problem and objectives were formulated, the research object (weather observers within BMKG) was determined, and a literature review was conducted regarding definitions, frameworks, and other supporting concepts.

2.2. Field Inspection/Observation

At this stage, an online questionnaire was distributed via Google Forms regarding the use of AWS. The research sample consisted of weather observation officers from four BMKG Technical Implementation Units (UPTs) in Lampung Province: the Maritime Meteorological Station, Radin Inten II Meteorological Station, Pesawaran Climatology Station, and Kotabumi Geophysics Station.

2.3. Reporting

At this stage, the questionnaire data were analyzed using quantitative calculations based on the System Usability Scale (SUS). The obtained SUS scores were then interpreted to evaluate user satisfaction and acceptance of AWS.

2.3. Further Action/Recommendation

At this stage, recommendations were formulated based on the analysis of AWS usability from the perspective of weather observers. These recommendations serve as input for future evaluation and improvement of services.

3.0 RESULT

3.1. Questionnaire Design

To evaluate the usability of the Digital Automatic Weather System, this study utilized the SUS, a widely recognized and validated instrument for assessing user perceptions of system effectiveness, efficiency, and satisfaction. The questionnaire consists of ten standardized statements, which respondents were asked to rate based on their experience using the system. The complete set of SUS items is presented in Table 1. The SUS testing instrument consists of ten (10) statements [16].

Table 1. System Usability Scale (SUS) Questionnaire Items

No	Questionnaire Statements	Scale
1	Using the Digital AWS helps in carrying out daily tasks.	1 to 5
2	The user interface is easy to use, making it easier to read AWS data results.	1 to 5
3	The system improves efficiency in conducting weather parameter observations.	1 to 5
4	The features in the Digital AWS are complete, making it easier to access AWS data	1 to 5
5	The features are user-friendly, so they are not difficult to understand the first time.	1 to 5
6	It is easy to access the menus in the Digital AWS	1 to 5
7	Downloading data from the Digital AWS is simple	1 to 5
8	The menu settings in the Digital AWS are clear and easy to use.	1 to 5
9	The features and display of the Digital AWS are simple and attractive	1 to 5
10	The Digital AWS is easily accessible anywhere, either from a desktop or mobile device, if the user has an account and password.	1 to 5

The scores and descriptions of the questionnaire response options are shown in Table 2, Likert Scale.

Table 2. Likert Scale Variable

Likert Scale	Score
Strongly Disagree	1 to 5
Disagree	1 to 5
Neither Agree nor Disagree	1 to 5
Agree	1 to 5
Strongly Agree	1 to 5

3.2. Respondents Description

The population in this study consisted of BMKG Lampung Province staff who actively use the Automatic Weather Station (AWS) Digital application across four BMKG operational units: the Maritime Meteorological Station, Radin Inten II Meteorological Station, Pesawaran Climatology Station, and Kotabumi Geophysical Station. The sampling technique employed was simple random sampling, with a total of 50 respondents. This method was chosen to ensure that every staff member in the study population had an equal chance of being selected, thereby minimizing bias and enhancing the representativeness of the collected data.

3.2. System Usability Scale (SUS) Evaluation Results

To evaluate the usability level of the AWS Digital application, the System Usability Scale (SUS) instrument was employed. The calculated SUS score was then mapped into the interpretation chart to provide a clearer visualization of the application's usability level. The SUS Score interpretation is presented in Figure 3.

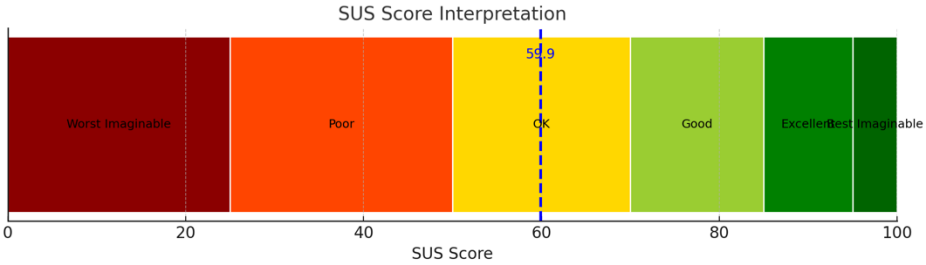

Figure 3. SUS Score Interpretation

Based on the calculation results, the AWS Digital application obtained a SUS score of 59.9. According to the standard SUS interpretation, this score falls into the "Marginal" category or at the "OK" level. This indicates that the application is still acceptable to users but has not yet reached an optimal usability level. Although users can utilize the application to support their tasks, several aspects still require improvement, such as simplifying navigation, enhancing feature clarity, and improving data access efficiency. Therefore, this result provides a crucial foundation for further development, enabling the AWS Digital application to enhance the user experience and achieve a "Good" category or higher in future SUS evaluations.

3.2. SUS Score Calculation Using the Toolkit

In addition to graphical representation, the SUS score was also calculated using the online toolkit available at https://sus.mixality.de/. The questionnaire data in .csv format was uploaded into the system, and the toolkit automatically generated the corresponding results. The output includes a dashboard plot that provides a visual interpretation of the SUS score for AWS Digital, as illustrated in Figure 4. This complementary approach ensures the accuracy of the manual calculation and facilitates a clearer understanding of the usability evaluation outcomes.

Figure 4. SUS Score Calculation Results Using the Toolkit

According to Figure 4, the SUS score analysis for the AWS application resulted in an overall score of 59.9, which provides several insights when examined through the visualization toolkit.

1. Data Distribution (Boxplot)
   The boxplot shows the distribution of SUS scores across all respondents. The median value is around 58.75, which is consistent with the overall SUS score of 59.9. The spread of responses indicates moderate variability, as represented by the interquartile range. Some scores fall below the acceptable threshold, but the majority are clustered around the 50–70 range, suggesting that user perceptions of usability are relatively consistent, though not particularly high.
2. Quality Interpretation
   Based on the SUS benchmark, a score of 59.9 falls into the "Marginal" category, which indicates that the system's usability is neither poor nor excellent, but in a borderline area requiring improvement. The grading scale categorizes the result as Grade D, meaning that while the system is functional, it may present usability barriers that prevent a seamless user experience.
3. Radar Chart
   The radar chart displays the average scores for each SUS item. It reveals variations in user perceptions across the 10 questions. For example, certain items, such as Question 2 (7.8) and Question 4 (6.6) received higher ratings, indicating stronger satisfaction with aspects of ease of use or learnability. Conversely, lower ratings on Question 1 (4.35) and Question 6 (3.6) suggest challenges in initial usability impressions and consistency, pointing to areas that require targeted design improvements.
4. Quartile Position
   The quartile analysis places the SUS score in the "Marginally Acceptable" range, situated between the 25th and 50th percentiles of benchmark data. This position implies that the usability of AWS is below average compared to other systems measured with SUS. While not in the "Not Acceptable" range, it highlights that improvements are necessary to elevate the system into the "Acceptable" or "Good" categories.

5.0 CONCLUSION

The results of the System Usability Scale (SUS) evaluation show that the AWS application obtained a score of 59.9, which falls into the marginally acceptable category (Grade D). This finding indicates that, although the system demonstrates certain strengths, its overall usability is still below the industry benchmark of 68 and therefore requires targeted improvements.

The distribution of responses illustrated in the boxplot suggests that most user ratings are concentrated around the lower to mid-range, with a limited number of higher outliers. This pattern reinforces the view that users perceive the system as usable but not yet optimal. The quartile position further supports this interpretation, as the score lies close to the lower quartile of acceptable usability, emphasizing the need for refinement.

From the radar chart analysis, it can be observed that specific items, such as ease of use and confidence in operating the system, obtained relatively higher scores, showing that users recognize certain advantages in the interface. However, lower scores on other aspects, such as system complexity and integration with work processes, highlight areas where the application still falls short.

Taken together, the analysis suggests that the AWS application offers a basic level of usability that allows users to complete tasks, but it lacks the efficiency, consistency, and intuitiveness expected from a high-performing digital system. Therefore, to improve overall user satisfaction and adoption, it is recommended that system developers focus on simplifying navigation, enhancing task support features, and reducing unnecessary complexity. By addressing these weaknesses, the system has the potential to reach the "good" or even "excellent" usability category in future evaluations, thereby ensuring more effective use among BMKG staff and contributing to improved operational performance.

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