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Usability Testing of Web-Based Anti-Doping Monitoring (Haloatlet 1.0) for Physical Impairment Athletes

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Abstract

Background: Athletes with disabilities still have limited access to digital anti-doping education, reflecting low digital readiness and unequal access to critical information. This gap increases the risk of unintentional doping, highlighting the urgency of improving digital anti-doping education for this population.
Purpose: This study aims to evaluate the usability of the Haloatlet 1.0 monitoring media, which has been developed as part of an effort to prevent doping use among athletes with disabilities, utilizing the Software Development Life Cycle (SDLC) with an iterative model. The research focuses on the usability testing phase of the developed media product.
Materials and methods: Data collection involved a sample of 30 athletes selected from 7 different sports. A Likert-scale System Usability Scale (SUS) questionnaire was used as the data collection instrument. The Curved Grading Scale (CGS) was used as a reference to represent the level of usability of Haloatlet 1.0.
Results: The usability evaluation of the Haloatlet 1.0 doping prevention monitoring website yielded a SUS score of 81.17 ± 10.74, corresponding to Grade A and falling within the Excellent usability category (top 90–95 percentile).
Conclusions: These findings demonstrate that the Haloatlet 1.0 website successfully provides a high level of usability in supporting athletes with physical disabilities in accessing anti-doping information and prevention resources. Effective anti-doping initiatives require continuous collaboration among key stakeholders to ensure clean and fair sports environments. Therefore, the results of this study offer valuable insights for enhancing inclusive and accessible digital anti-doping education policies, particularly for athletes with disabilities who often experience limited access to conventional learning platforms.

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INTRODUCTION

The global anti-doping program has evolved significantly since the establishment of the World Anti-Doping Agency (WADA, 2021a), which sets the World Anti-Doping Code as the legal basis for all international and national anti-doping programs (WADA, 2021b). Doping prevention efforts include education, prevention, detection, enforcement, and strengthening regulations. Nevertheless, anti-doping violations persist. Aguilar-Navarro (2020) noted an increase in the number of tests year after year, and the 2013–2020 Anti-Doping Rule Violations (ADRV) report shows that athletics, cycling, and weightlifting are the sports with the highest number of violations (WADA, 2023). This finding confirms that doping surveillance and education remain a global challenge that has not been fully addressed.

Doping in sports is a multidimensional problem. An athlete's decision to use banned substances is influenced by their knowledge, cognitive capacity, moral values, and social environment, including coaches, managers, parents, and peers (Hurst et al., 2022b). To strengthen prevention efforts, WADA developed the International Standard for Education (ISE), which focuses

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on providing integrated education to athletes and their support personnel (WADA, 2021a). However, a systematic review reported that anti-doping knowledge remains low in various countries (Listiani et al., 2024), while the athlete-coach relationship remains a significant factor in athletes' vulnerability to doping use (Naughton et al., 2025; Singh et al., 2022a). This confirms the need for interventions that can address issues at both the individual and systemic levels within the athlete support system.

A similar situation is happening in Indonesia. Official data from the IADO website (https://iado.id/h/index.php/en/public-disclosure/) indicate that several athletes have been sanctioned for various violations, including the presence of prohibited substances and failure to submit samples. Previous research has shown that the level of doping knowledge among Indonesian athletes is still low (Doewes et al., 2020; Sepriani et al., 2022). This condition demands more adaptive, accessible, and sustainable education and monitoring strategies. One approach that has been developing in recent years is the use of digital platforms to support anti-doping education and monitoring. A study reveals that mobile applications have significant potential in anti-doping education, as they provide accessibility, personalized learning experiences, and a broader user reach (Saragih, 2024).

However, research on digital applications designed explicitly for anti-doping is still limited, particularly in developing countries. Several usability studies have evaluated digital anti-doping education tools. For example, Barkoukis (2020) assessed the acceptability and usability of an e-learning course and an anti-doping information application used by fitness professionals, finding that the tools were easy to use and beneficial. Other studies on anti-doping serious games also show that these games have good usability and can improve users' understanding of doping (Chaldogeridis et al., 2020; Ziagkas et al., 2020). Additionally, the ADVICE application, tested through a randomized controlled trial, proved to be feasible and effective in increasing amateur coaches' knowledge of prohibited substances (Nicholls, Fairs, et al., 2020).

In the context of digital platform development, understanding technology acceptance becomes crucial. The Technology Acceptance Model (TAM) emphasizes that perceived ease of use and perceived usefulness are the two main predictors in determining the acceptance and actual use of a technology (Davis, 1989; Venkatesh & Davis, 2000). Meanwhile, Human–Computer Interaction (HCI) theory provides a framework for designing interfaces that are intuitive, accessible, and responsive to user needs (Sharp et al., 2007). In the field of sports, the TAM model and HCI principles have proven effective in evaluating the usability of various sports and health applications, including exercise tracking, performance monitoring, and digital education (Bae et al., 2017; Ruth et al., 2022). Thus, integrating TAM and HCI can provide a strong theoretical foundation for assessing the effectiveness of digital anti-doping platforms.

The accessibility needs of athletes with physical disabilities in education and anti-doping monitoring are still often overlooked, creating significant gaps in usability and inclusivity. Recent literature confirms that para-athletes have unique needs that are not adequately accommodated by traditional anti-doping education approaches, including variations in physical abilities and more complex assistive technology requirements (Boardley et al., 2025). Therefore, anti-doping education needs to be specifically designed so that information can be delivered in a relevant, easily accessible, and appropriate manner for these para-athletes. However, current anti-doping platforms lack usability assessments tailored to people with disabilities, which limits their effectiveness as educational and monitoring tools (Boardley et al., 2025; Strobel & Gerling, 2025). The absence of designs that consider the diverse experiences and physical limitations of para-athletes underscores the need for research on accessibility in digital anti-doping interventions. This condition has a broader impact because the absence of inclusive platforms could potentially reinforce structural inequalities in sports and undermine the principles of fairness and clean competition (Cooper, 2023). Bridging this gap is a crucial step toward creating a truly inclusive sports ecosystem, where increased accessibility not only benefits athletes with disabilities but also enriches the entire sports community through more responsive and participatory design (Kitchin et al., 2022).

In an effort to meet these needs, Haloatlet 1.0 was developed, a web-based anti-doping monitoring and education platform. To ensure this platform can be used effectively by athletes with disabilities, a usability evaluation is needed to assess ease of use, accessibility, and the suitability of features to user needs. Therefore, this research was conducted to test the usability of Haloatlet 1.0

on athletes with physical disabilities as an initial step in developing an inclusive, adaptive, and supportive anti-doping platform to create a clean sporting environment in Indonesia.

METHOD

Media Haloatlet 1.0 was developed as a doping prevention effort among athletes, utilizing the Software Development Life Cycle with an iterative model (Okesola et al., 2020), and has been validated by doping, medical, and media experts. This research focuses on usability testing of the developed media. The research design used is a field trial with a descriptive quantitative approach (Slater & Hasson, 2025; Kurniawati & Sunarso, 2019). Participants in this study consisted of 30 athletes with physical disabilities who were asked to use Haloatlet 1.0 and then complete the System Usability Scale (SUS).

Study Participants

The sampling technique used to determine the sample is purposive sampling. Purposive sampling is a technique for selecting a sample based on specific criteria (Nyimbili & Nyimbili, 2024). Considerations for sample selection in this study include athletes with physical impairments who can use gadgets, laptops, or tablets. A total of 30 athletes with physical disabilities were selected as the sample for this study. The sample's gender distribution consists of 19 males and 11 females. The selection of a sample size of 30 athletes was based on recommendations from usability research, which suggests that stability in SUS scores is generally achieved with 20–30 participants (Sauro, 2010; Sauro & Lewis, 2016). This number is also within the ideal range for identifying the majority of usability issues in digital system evaluations (Nielsen, 1995). The sample selection process in this study is presented in Figure 1 (Nicholls et al., 2020).

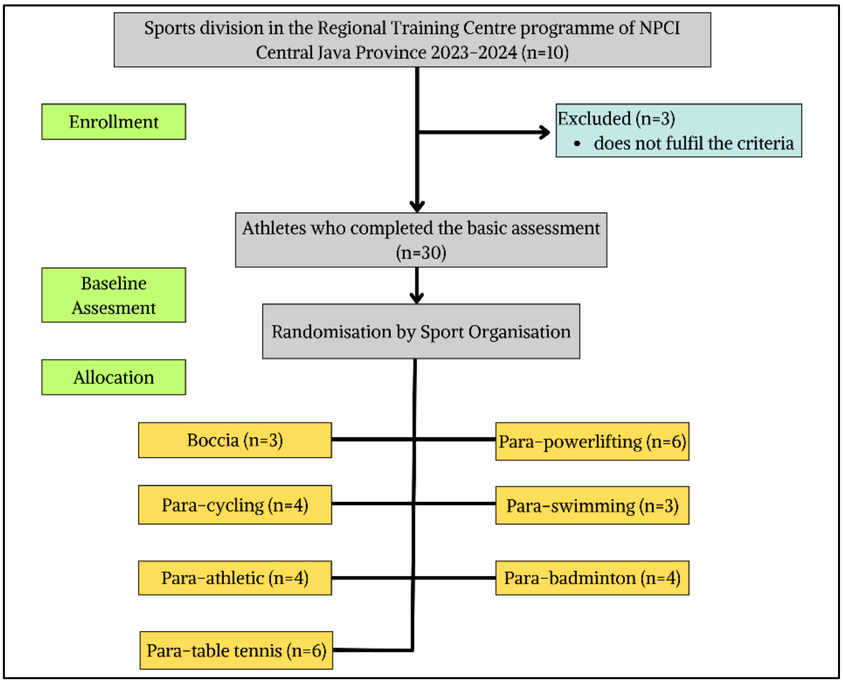


Figure 1. Participants Flow Diagram

The Central Java Province NPCI training camp program includes ten sports: blind judo, boccia, para-powerlifting, para-athletics, para-badminton, para-chess, para-archery, para-swimming, para-cycling, and para-table tennis. A total of seven sports were involved in this study: boccia (n=3), para-cycling (n=4), para-athletics (n=4), para-table tennis (n=6), para-powerlifting (n=6), para-swimming (n=3), and para-badminton (n=4).

Environmental Control

Usability testing was conducted in a systematically controlled environment at the NPCI office in Central Java Province. All participants took the in-person testing session in a quiet training room with adequate lighting and minimal distractions, allowing athletes to focus on using the media. The space is designed to be disability-friendly, including wheelchair access and sufficient maneuvering space. Participants are allowed to use their personal devices (Android/iOS smartphones, tablets, or laptops), according to their individual motor skills. The facilitator ensures that each device can run the media without technical issues. For participants who need it, accessibility features such as screen readers or screen magnification are permitted during testing. Each athlete was given 15–20 minutes to explore Haloatlet 1.0 based on simple use cases provided by the facilitator. Instructions were given in a standard manner, following basic usability testing procedures (Nielsen, 1995; Sauro & Lewis, 2016). After the exploration is complete, participants are asked to fill out the System Usability Scale (SUS) questionnaire according to Brooke's (1996) procedure.

Ethical clearance

This research has obtained ethical approval from [name of ethics committee] with permit number [approval number]. All participants were informed of the research objectives, procedures, potential risks, and their right to withdraw from participation at any time without consequences. Every athlete with a physical disability provides written consent before undergoing the testing process.

Instrument

The questionnaire used in this study is the System Usability Scale (SUS) Questionnaire. The SUS questionnaire consists of two types of items: positive items at odd-numbered questions and negative items at even-numbered questions (Lewis, 2018). The System Usability Scale (SUS), often referred to as a "Quick and Dirty test," was developed by John Brooke in 1986 (Brooke, 1986). Since its development and public availability, experts and researchers have widely used SUS as one of the evaluation methods (Brooke, 2013). The questionnaire items in SUS have undergone reliability and validity testing through the distribution of 2,324 questionnaires. These tests showed that SUS consists of two factors: usability (8 items) and learnability (2 items) (Sauro, 2011). The reliability tests yielded Cronbach's Alpha values of 0.91 and 0.70, respectively.

The original language of the SUS questionnaire is English. In its Indonesian translation, Sharfina & Santoso conducted reliability testing of the SUS questionnaire (Sharfina & Santoso, 2017). The study produced a reliability value of 0.841, indicating that the Indonesian translation of the SUS questionnaire is suitable for use.

Data Analysis

The SUS questionnaire uses a Likert scale with a score range of 1 to 5. A score of 1 indicates "Strongly Disagree" (SD), 2 "Disagree" (D), 3 "Neutral" (N), 4 "Agree" (A), and 5 "Strongly Agree" (SA). The contribution score for each item ranges from 0 to 4 due to a deduction of 1 point (-1) applied to each item score.

Table 1. Range of Odd Numbers

Strongly disagree				*Strongly agree*
1	2	3	4	5
0	1	2	3	4

Table 2. Range of Even Numbers

Strongly disagree				*Strongly agree*
1	2	3	4	5
4	3	2	1	0

The SUS score is calculated according to the formula presented by Lewis (Lewis, 2018). The total score on the SUS questionnaire ranges from 0 to 100, with an average benchmark score of 68.

This means that scores above 68 indicate a high level of user satisfaction. As a reference for interpretation, the following is the representation of usability levels according to the Curved Grading Scale (CGS) by Lewis (Lewis, 2018):

Table 3. Curved Grading Scale

Score range	*Grade*	*Percentile range*
84.1–100	A+	96–100
80.8–84.0	A	90–95
78.9–80.7	A–	85–89
77.2–78.8	B+	80–84
74.1–77.1	B	70–79
72.6–74.0	B-	65–69
71.1–72.5	C+	60–64
65.0–71.0	C	41–59
62.7–64.9	C-	35–40
51.7–62.6	D	15–34
0.0–51.6	F	0–14

RESULTS AND DISCUSSION

Results

Demographic Data Sample

The sample criteria defined in this study were athletes with physical impairments. The researcher conducted observations to ensure that the participating athletes were capable of operating a gadget, tablet, or laptop—this was part of the inclusion criteria for the sample. The total sample in this study consisted of 30 athletes (n = 30, SD = 1.25), comprising 19 male athletes (n = 19, 63%) and 11 female athletes (n = 11, 37%). The demographic data for the sample are presented in Table 4.

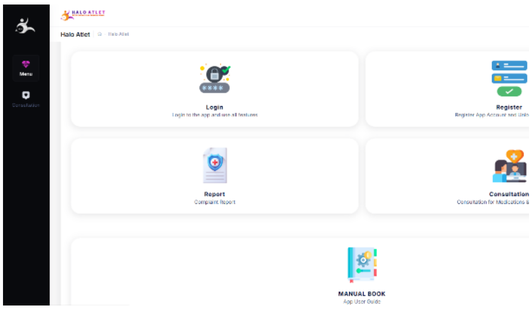
Table 4. Sample Data Demographics

	N	*%*
Sex		
M	19	63%
F	11	37%
Sports		
Boccia	3	10%
Para-Cycling	4	13%
Para-Athletic	4	13%
Para-Powerlifting	6	20%
Para-Badminton	4	13%
Para-Table Tenis	6	20%
Para-Swimming	3	10%
Total	**30**	**100%**

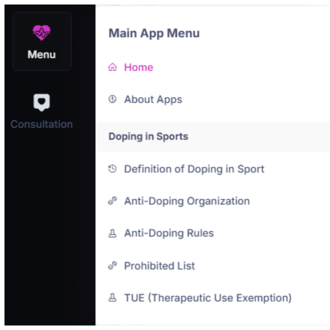
Data collection was conducted concurrently with the Regional Training Center (PELATDA) program, organized by the Central Java Provincial NPCI. The researcher collected data by visiting the training venues of each respective sport. During the data collection process, the researcher followed the research procedures without disrupting the training sessions. The data from the athletes were collected after they had completed their training sessions.

HaloAtlet 1.0

The Haloatlet 1.0 media features two main menus: the "Consultation" menu and the "Report" menu. The "Report" menu serves as a tool for recording athletes' medical histories, complaints, and any medications or supplements they are taking. The "Consultation" menu serves as a platform for consultations between athletes and medical doctors. In addition to the main menus, this media also includes supplementary menus that provide information and knowledge about doping in sports. Users can utilize a search feature to look up substances listed on the Prohibited List. The interface of the Haloatlet 1.0 media is presented in Figure 2.

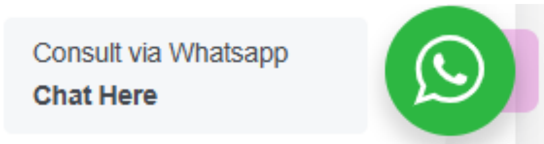


a) Hompage

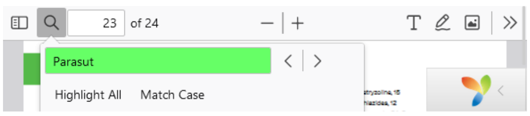


b) Menu Display

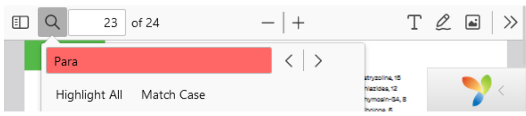
c) Consultation Menu



d) WhatsApp Consultation Display



e) Names of Substances Not Detected in the Prohibited List



f) Names of Substances Detected in the Prohibited List

Figure 2. Media display

Analysis of the Haloatlet 1.0 interface reveals that the principles of visibility and consistency have been applied effectively, although some elements, such as button labels and system status indicators, remain inconsistent. The feedback aspect is the weakest point because several interactions do not provide adequate visual responses. Therefore, improvements in design consistency and feedback clarity are needed to make the user experience, especially for athletes with disabilities, more intuitive and predictable.

Level of usability

To calculate the SUS score, the researcher used Microsoft Excel. Based on the scores, the results of the SUS score calculation are shown in Table 4:

Table 5. Calculation of SUS Value

SUS Calculation Score										*Total*	*Value*
Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10		(sum x 2.5)
4	3	4	4	3	4	3	2	3	2	32	80
3	2	3	1	2	3	3	3	3	1	24	60
4	4	4	4	4	3	4	3	2	2	34	85
4	4	4	4	4	4	4	4	4	4	40	100
4	4	4	4	3	3	4	4	4	2	36	90
4	3	2	3	3	4	2	2	4	1	28	70

SUS Calculation Score										Total	Value
4	4	4	3	4	4	4	3	4	0	34	85
3	3	3	3	3	3	3	3	3	3	30	75
4	4	4	3	4	4	4	4	4	3	38	95
4	4	3	3	4	4	4	3	3	3	35	87.5
4	4	4	3	4	4	4	4	4	3	38	95
3	3	3	2	3	3	3	3	3	2	28	70
3	3	3	2	3	3	3	3	3	0	26	65
3	3	3	2	3	3	3	3	2	1	26	65
3	3	3	2	3	3	3	4	3	2	29	72.5
3	3	3	2	3	3	3	3	3	2	28	70
4	3	4	3	4	3	4	3	4	3	35	87,5
4	4	4	3	4	3	3	4	4	2	35	87.5
4	4	4	3	4	3	3	4	4	2	35	87.5
4	4	4	3	4	4	4	3	4	3	37	92.5
4	4	4	3	4	3	3	4	4	3	36	90
4	3	4	3	4	3	3	3	4	3	34	85
4	4	4	3	3	4	4	4	3	4	37	92.5
3	2	4	4	3	2	4	2	4	2	30	75
3	3	4	3	3	3	3	3	3	3	31	77.5
4	3	4	3	4	3	4	3	4	4	36	90
4	3	4	3	4	3	4	3	4	4	36	90
3	2	4	2	4	4	2	4	2	1	28	70
3	3	4	2	3	2	4	3	2	1	27	67.5
4	3	3	3	3	2	4	3	3	3	31	77.5
										Average Score	**81.17**

**Q=Questionnaire SUS*

Table 5 shows that the average usability score of Haloatlet 1.0 is 81.17. Based on the Curved Grading Scale in Table 3, this score falls within the range of 80.8–84.0, which corresponds to a grade of "A" and a percentile range of 90–95%.

Descriptive Statistics of SUS Scores

To gain an overview of user perceptions regarding system usability, descriptive statistical analysis was performed on the System Usability Scale (SUS) scores obtained from 30 respondents. This analysis includes measures of central tendency and data dispersion, such as the mean, standard deviation, and range of values. Additionally, variance and skewness were calculated to assess the level of variation and the shape of the data distribution. The results are presented in the following table:

Table 6. Descriptive Statistics

Statistical Measures	*Value*
Mean	81.17
Standard Deviation (SD)	10.74
Minimum	60.00
Maximum	100.00
Range	40.00
Variance	115.40
Skewness	-0.24

Descriptive statistical analysis of usability level measurement using the System Usability Scale (SUS) on 30 respondents yielded an average score of 81.17. This value falls into category A (Excellent), indicating that the system has an excellent level of usability according to user perception.

The standard deviation (SD) value of 10.74 and the variance of 115.40 indicate that the level of dispersion or variability in user ratings is in the moderate category. This means that although the majority of respondents gave positive ratings, there was a variation in the experiences felt by some of the other respondents. Meanwhile, the minimum score given by respondents was 60, and the maximum score reached 100, resulting in a range of 40 points. This range confirms the existence of differences in usability perception, although not to an extreme degree.

To strengthen the results of the descriptive statistical analysis performed on the System Usability Scale (SUS) scores, data visualization using histograms and boxplots was employed. Both types of visualization provide a clearer understanding of the characteristics of the data distribution and the consistency of ratings among respondents, as seen in Figures 3 and 4.

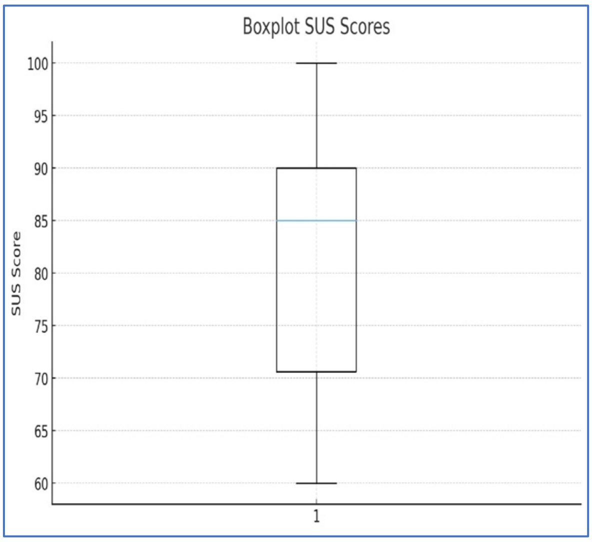


Figure 3. Boxplot SUS Score

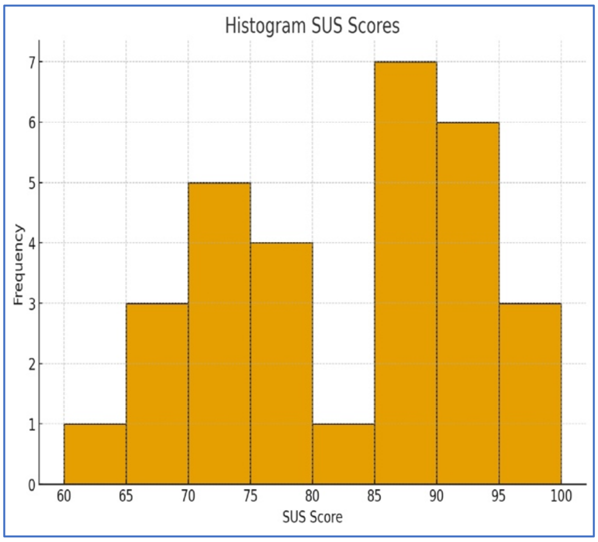


Figure 4. Histogram SUS Score

The histogram displays the overall distribution pattern of SUS scores based on their frequency. Through the histogram display, it can be observed that most scores are concentrated in the high range, indicating that the majority of users have an excellent perception of usability. Meanwhile, visualization through boxplots shows that the median value is close to the upper quartile boundary, while the lower whisker appears longer than the upper one. This pattern indicates that the data tends to be more dispersed at lower values. These findings are consistent with the results of the skewness analysis, which showed a negative value of -0.24. Therefore, it can be concluded that the distribution of System Usability Scale (SUS) scores is skewed to the left (negatively skewed).

Thus, it can be concluded that the system has successfully provided an excellent experience for the majority of users, but further evaluation is still needed to understand the causes of dissatisfaction among a small percentage of respondents.

Discussion

Implication

The SUS findings, which show a high average score (81.17), confirm that Haloatlet 1.0 has met several key principles in Nielsen's Usability Heuristics, while also demonstrating its effectiveness in supporting anti-doping prevention education for athletes with physical disabilities. High scores on usability and clarity of function aspects reflect the application of heuristics, such as visibility of system status and the match between the system and the real world. Meanwhile, simple navigation and consistent icons demonstrate alignment with the principles of consistency and standards, thereby minimizing user cognitive load. The absence of a barrier report means the system has implemented error prevention and user control elements, which are crucial for users with specific accessibility needs. This result is also significantly above the average SUS benchmark (68, SD ± 12.5), as reported in the metaanalysis of digital health applications (Hyzy et al., 2022). The findings support the notion that systems with high SUS scores generally have a greater chance of being accepted and used in the long term (Ong et al., 2024). Nevertheless, the variation in individual scores, particularly those in the 60–70 range, suggests a need for improvement in navigation and ease of learning, as noted by Khan et al. (2025), so that the user experience can be further optimized for all athletes.

In the context of anti-doping education effectiveness, Haloatlet 1.0 has direct implications for efforts to build a culture of clean sport. Platforms with high usability have been shown to increase engagement, information retention, and behavioral compliance in clean sport education (Petróczi et al., 2021). Ease of navigation, content clarity, and feature accessibility enable athletes, including those with disabilities, to understand anti-doping materials more thoroughly, thereby supporting the development of stronger anti-doping attitudes and behaviors. This is important because "clean athletes" are the foundation of sports integrity (Martinelli et al., 2023). Yet, recent qualitative research shows that even athletes who uphold moral values are still vulnerable to the threat of doping due to competitive pressure, performance expectations, and the normalization of supplements (Veltmaat et al., 2023). Thus, the high usability score on Haloatlet 1.0 not only reflects the quality of the design, but also its potential to strengthen the effectiveness of anti-doping education in Indonesia. Literature confirms that a user-friendly interface facilitates quick and seamless access to information, while clear and structured content enhances understanding (Saragih, 2024; Woolf, 2020).

On the other hand, accessibility features ensure inclusivity, allowing all athletes to participate meaningfully in the learning process. Empirical evidence suggests that educational platforms with high usability contribute to improved long-term adherence, particularly when participatory approaches, such as educational games, are employed (Filleul et al., 2025; Ziagkas et al., 2020). Nevertheless, the overall effectiveness of anti-doping education remains debated because many previous programs failed to produce significant improvements in athletes' knowledge or attitudes, highlighting that high utility must be integrated with strong learning designs to bring about the desired behavioral changes (Filleul et al., 2025; Woolf, 2020).

Haloatlet 1.0 is very competitive compared to international anti-doping education platforms. Evaluation of the WADA eLearning (ADeL) shows that user satisfaction levels are generally in the "fairly good" to "good" category (around 70–80). However, some users still face barriers such as complex navigation and a high content load (Deng et al., 2022). Similarly, a study on the Clean Sport Hub found that although the platform is informative, users reported limitations in accessibility and device compatibility, particularly for athletes with special needs (Kitchin et al., 2022). Broader findings on ADeL and the Clean Sport Hub also show that the effectiveness of both anti-doping education programs still varies; these programs often fail to significantly improve athletes' knowledge and attitudes due to a mismatch between educational activities and expected outcomes (Woolf, 2020). Accessibility challenges also remain prominent, with several studies emphasizing the need to apply universal design principles to ensure platforms are truly inclusive for athletes with disabilities (Królak, 2017; Navarrete et al., 2016). Additionally, athletes' experiences are significantly influenced by the quality of content and delivery methods, as effective anti-doping education can foster a culture of clean sport and reduce doping intentions (Saragih, 2024), while also promoting the strengthening of athletes' personal competence and agency for more meaningful social impact (Blank & Petróczi, 2023). In this context, the higher usability score of Haloatlet 1.0 and its accessibility-based design indicate that the platform provides a more inclusive and responsive user experience, particularly for athletes with physical disabilities who are often overlooked in the development of anti-doping educational technology.

Doping prevention efforts are insufficient if they rely solely on information delivery; interventions must be able to change how athletes perceive risk while also influencing ethical decision-making in sports. In this context, the development of Haloatlet 1.0 aims to bridge the gap in anti-doping education by providing clear, practical, and easy-to-use information access. Educational features and substance status check navigation enable athletes to make safer decisions in high-risk situations (Umar et al., 2024). However, as Petróczi (2021) points out, successful doping prevention requires concrete interventions that go beyond simply providing educational materials. The need for an evidence-based approach to improve the effectiveness of anti-doping education programs

(Backhouse, 2015) supports this research, highlighting the importance of preserving the ethical and educational values of sports while rejecting the commercialization of sports (Gallien, 2002).

Furthermore, the effectiveness of anti-doping education is not only determined by the quality of the materials and technology. Still, it is also heavily influenced by the moral dimension and psychosocial context of the athletes. Research indicates that moral identity and perceptions of fair play are negatively correlated with pro-doping attitudes, confirming that moral aspects are essential predictors in anti-doping stance-taking (Hauw, 2017; Sukys et al., 2021). Another finding reveals that athletes' decisions regarding doping are more influenced by personal moral standards and the psychosocial environment than by mere exposure to formal anti-doping education (MacNamara & Collins, 2014). In line with this, anti-doping programs should provide space for reflection and discussion that allows athletes to reevaluate their personal values, thereby improving the quality of their decision-making (Petróczi et al., 2025). In this context, platforms like Haloatlet 1.0 should be understood as part of a broader educational ecosystem, not a single solution where technology-based doping literacy must be integrated with the reinforcement of sportsmanship values and the formation of athletes' moral identities.

In addition to individual factors, there are also significant external influences at play. High supplement consumption, for example, is associated with an increased potential for doping use (Hurst et al., 2022a). At the same time, studies in India indicate that the role of pharmacy staff can reinforce a doping culture within the community (Singh et al., 2022). These findings underscore the need for cross-stakeholder collaboration, including athletes, coaches, support staff, anti-doping agencies, and drug regulatory authorities, in building a healthy and integrated sporting environment. Within that framework, integrating anti-doping content into the formal education curriculum is also crucial to ensure continuous and systematic understanding (Ignjatović et al., 2017). Thus, Haloatlet 1.0 functions not as a standalone approach but as a supporting tool that strengthens value education, regulatory practices, and overall collaboration within the anti-doping ecosystem.

The findings of this research indicate that Haloatlet 1.0 has strong potential for integration into national anti-doping education programs. A high SUS score indicates that athletes, including those with physical disabilities, can easily access educational materials, thereby increasing their engagement and information retention (Brooke, 1996; Ong et al., 2024). Additionally, the substance status check feature serves as a decision-making tool that can minimize the risk of accidental use of prohibited substances, especially given the high consumption of supplements related to doping vulnerability. On the other hand, because individuals' moral values highly influence attitudes toward doping (Hurst et al., 2022b). The use of Haloathlete 1.0 needs to be integrated with ethics and sportsmanship education programs. Risk patterns that also involve external actors, such as pharmacy staff, underscore the need for cross-stakeholder collaboration to enhance the effectiveness of prevention efforts. Finally, the variation in individual scores guides further development, particularly in terms of accessibility and navigation, to align more closely with the principles of ISO 9241-11 and Nielsen's heuristics. This will ensure the platform functions optimally as part of the anti-doping education ecosystem in Indonesia.

Research Contributions

This study makes several significant contributions to the field of anti-doping education and digital sport technologies, particularly for athletes with physical impairments. First, it provides empirical evidence that a web-based anti-doping monitoring platform, Haloatlet 1.0, can achieve an excellent level of usability (SUS = 81.17; Grade A) when designed explicitly with accessibility and inclusivity in mind. This addresses a notable gap in the literature, where most anti-doping platforms and e-learning systems have been developed for able-bodied athletes and rarely evaluated with para-athletes as the primary users. Second, the study operationalizes the integration of TAM and HCI principles in the context of anti-doping, demonstrating how perceived ease of use, usefulness, and heuristic-based interface design can be translated into a concrete, disability-aware platform. Third, this research contributes methodologically by demonstrating that a relatively small but carefully selected sample of 30 para-athletes is sufficient to produce stable and interpretable SUS benchmarks in a real-world training camp setting. Finally, in the Indonesian context, the study presents one of the first data-driven evaluations of a locally developed anti-doping education tool, offering a model that can be adapted by national anti-doping organizations, sport federations, and policymakers to strengthen clean sport initiatives for marginalized athlete groups.

Limitations

Para-sports serve as a means of self-development for individuals with special needs (impairments). In addition to athletes with physical impairments, there are also athletes with sensory impairments (such as visual or hearing impairments) and intellectual disabilities. This study only involved athletes with physical disabilities. Therefore, future research is expected to develop similar media that can reach athletes beyond those with physical impairments. With the advancement of technology, Artificial Intelligence (AI) can now assist users by providing instant answers to questions. Adding AI features could enhance the educational aspects of the platform, making anti-doping education more accessible and engaging for athletes.

Suggestions

Future research and development efforts should build on these findings in several strategic directions. First, subsequent usability studies need to involve a broader range of impairment types, including athletes with visual, hearing, and intellectual disabilities, to ensure that Haloatlet 1.0—or its future versions—truly reflects universal design principles. Mixed-method approaches that combine SUS with think-aloud protocols, in-depth interviews, and task-based performance metrics would provide richer insights into specific barriers and facilitators experienced by different user groups. Second, longitudinal and experimental designs are needed to evaluate whether high usability translates into meaningful outcomes, such as improved anti-doping knowledge, stronger clean-sport values, reduced risk of unintentional doping, and better decision-making in real competition and training contexts. Third, integrating AI-based features, such as intelligent chat support, adaptive learning paths, or personalized warning systems for medication and supplement use, could further enhance the platform's educational impact and responsiveness. Finally, closer collaboration with national and international stakeholders—such as IADO, NPCI, WADA, coaches, and medical teams—is recommended so that Haloatlet 1.0 can be embedded into formal anti-doping curricula, coach education programs, and daily training routines, rather than standing as a standalone tool used in isolation.

CONCLUSION

This research confirms that utilizing digital platforms, such as Haloatlet 1.0, has strategic potential in strengthening the anti-doping education ecosystem in Indonesia. The high level of acceptance and ease of use demonstrated by athletes, including those with physical disabilities, indicates that a technology-based approach can be an essential bridge in improving doping literacy and supporting safer decision-making. Furthermore, these findings offer a new perspective on the literature, suggesting that the effectiveness of anti-doping education depends not only on the delivery of information but also on providing relevant, easily accessible, and supportive means for internalizing ethical values in sports. Theoretically, this research enriches the discourse on technology integration in shaping athletes' moral behavior, particularly in the context of doping prevention. Practically speaking, the research findings provide a basis for developing more inclusive and adaptive digital services, opening up opportunities to integrate platforms like Haloatlet 1.0 into national education programs through cross-stakeholder collaboration. Although the results indicate a high level of usability, this study is limited by the sample scope, which only includes athletes with physical disabilities, and the use of a single assessment method, the System Usability Scale (SUS). Therefore, future research needs to involve a more diverse user base and combine various usability evaluation methods to ensure that the development of Haloatlet 1.0 is more comprehensive and effective in supporting anti-doping education.

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AUTHOR CONTRIBUTION STATEMENT

Study design, data collection, statistical analysis, manuscript preparation, and funds collection (FU); study design, data collection, manuscript preparation (DW & GP); Study design, data collection, manuscript preparation, and funds collection (MM); Study design, data collection, statistical analysis, and manuscript preparation (DL).

AI DISCLOSURE STATEMENT

The authors declare that this manuscript was entirely conceptualized, conducted, analyzed, written, and revised by the authors themselves without the use of any artificial intelligence (AI) tools or technologies.

CONFLICTS OF INTEREST

The authors guarantee that no conflicts of interest exist. All analyses, interpretations, and conclusions presented in this study were conducted independently and without any influence from external parties. This research did not receive any funding or support that could potentially affect the objectivity of the results. The authors take full responsibility for the integrity and originality of the content reported in this publication.

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