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iSCOUT: Scouting Mobile Application Using Rule-Based Algorithm to Evaluate the Activities of Boy Scouts of the Philippines

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Abstract

Traditional scouting evaluations for fundamental skills, like knot tying, often rely on manual observation, a process that is frequently time-consuming, subjective, and prone to personal biases or inconsistent standards. This study introduces iSCOUT, a mobile application designed to modernize the Boy Scouts of the Philippines (BSP) evaluation process by automating knot-tying assessment through a rule-based algorithm. Utilizing a mixed-methods research design, the study involved a purposive sample of thirty respondents, including senior scouts, adult leaders, and IT experts. The application was developed using the Flutter framework and TensorFlow Lite to facilitate real-time performance monitoring and digital tutorials. Technical assessments demonstrated a high level of reliability, with the system achieving an overall accuracy rate of 95.3% across eight basic scouting knots, such as the Overhand Knot and Figure of Eight. The findings suggest that incorporating hardcoded expert knowledge and immersive feedback loops significantly bridges the gap between theoretical knowledge and practical motor skill acquisition. This study concludes that iSCOUT provides a viable, objective framework for digitalizing scouting activities and reducing evaluation anxiety among scouts. Future recommendations include expanding the platform to incorporate all activities aligned with senior scout advancement to ensure long-term skill retention and instructional quality.

Keywords: Boy Scouts of the Philippines, scouting mobile application, rule-based algorithm, mobile learning, knot classification, level of performance, and knot tying

INTRODUCTION

The absence of standardized, technology-mediated evaluation tools for BSP knot tying activities is traditional scouting evaluations for skills like knot tying often rely on manual observation by leaders, a process that is frequently time-consuming, subjective, and prone to personal biases or inconsistent standards. Furthermore, these manual assessments can cause performance anxiety in scouts, hindering their ability to demonstrate true proficiency. While mobile applications exist for general activity management, there is a specific lack of integrated, automated tools that use objective algorithms to evaluate physical survival skills specifically knot tying to ensure consistent, fair, and engaging advancement for senior scouts.

Knot tying is considered one of the fundamental and essential skills in Scouting, serving as a cornerstone for outdoor competence, safety, and self-reliance. It is taught to Scouts to enable them to secure gear, build structures (pioneering), and handle emergency situations.

The traditional, manual methods of evaluating and recognizing skills are often time-consuming, subjective, biases and misaligned with the digital-first mindset of today's youth, leading to reduced motivation and interest. To address this, there is a need for innovative, technology-driven approaches that make skill evaluation more objective, efficient, and appealing to the current generation of scouts.

Recent reports and studies have highlighted a decline in participation in traditional scouting

programs, both globally and locally. The Boy Scouts of America (BSA, 2018) attributed its membership decline partly to perceptions that scouting is outdated and misaligned with the interests and lifestyles of modern youth. In the Philippines, the Philippine Youth Development Plan 2017–2022 similarly noted decreasing enrollment in civic programs, including the Boy Scouts of the Philippines (BSP), as young people increasingly favor technology-driven and advocacy-based activities they perceive as more relevant and impactful.

To address the issues, the researchers propose the development of a "Scouting Mobile Application using Rule-Based Algorithm to evaluate the activities of Boy Scouts of the Philippines." The system was developed in order to determine the level of actual performance of scouts in terms of Knot Tying, especially the characteristics, development process, and possible effects of scouting application on scouting operations in the Scouting Movement.

Figure 1 depicts a rule-based algorithm that relies on manual feature engineering and predefined logic gates (e.g., speed thresholds) to determine classification. While both methods utilize a Confusion Matrix for performance evaluation, the rule-based approach is noted for its limitations in adaptability and lower accuracy compared to the modern data-driven machine learning models.

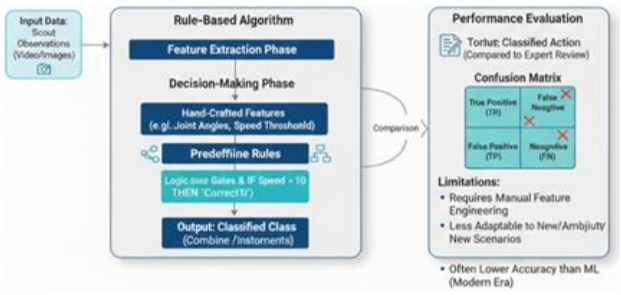

Figure 1
Performance Evaluation using Rule-Based Algorithm

Objectives of the Study. This study targets to develop an application and focuses on investigating the effectiveness and acceptability of a Scouting Mobile Application that integrates Rule-Based Algorithm to evaluate selected activities of the (BSP) specifically the basic knot tying. This study evaluates the level of performance of the Rule-Based Algorithm in classifying eight basic knot types from image or video input. Specifically, the study seeks to:

1. Develop a mobile application called iSCOUT that serves as a digital tool for knot-tying tutorials and performance monitoring for both scouts and leaders.

2. Implement a Rule-Based Algorithm to automate the classification and evaluation of eight basic scouting knots: Square Knot, Two Half-Hitches, Taut-Line Hitch, Sheet Bend, Bowline, Clove Hitch, Figure of Eight, and Overhand Knot.

3. Evaluate the technical performance of the application by measuring its accuracy, precision, and reliability using a confusion matrix and expert-annotated datasets.

4. Explore the impact of gamification and progress tracking on scout motivation and the reduction of evaluation bias compared to traditional manual methods.

On top of that, the system was developed with the assistance of Adult Leaders in order to evaluate the progress of each scout for the possible ranking and claiming on specific badges. Users were able to perform the actual skills to satisfy their requirements and needs to evaluate the performance of the scouts to level up their skills with the assistance of the app that was suggested. The system assessed how well the scouts facilitate learning, organization, and communication during scouting activities.

LITERATURE REVIEW

Existing Literature on traditional methods by (Ali & Ahmad, 2020) on evaluating the performance of each scout highlights inconsistent standards and bias in evaluation can result in unfair advancement, discourage some scouts, or fail to recognize actual skills levels. Since most traditional evaluations rely on Adult Leaders, Outfit Advisors, and or board

of review (BOR) observing and judging performance, their personal expectations, preferences, or perceptions of a scout can influence how they assess skills, for example a leader may be more lenient with scouts they know well or like. Inconsistent standards are also common, as different leaders may apply varying criteria when evaluating the same skill.

One of the main benefits of scouting mobile application is its potential to provide accurate and reliable offers significant advantages for both scouts and leaders, particularly in evaluating skills and managing progress. However, its performance can be influenced by several factors, such as quality of data and inputs, robustness of the algorithm, and evaluator and User Compliance.

Economic studies show that the native application development technique improves the performance of mobile apps; yet it incurs more technical and financial costs during the development maintenance phase. Alsaid et al., (2021).

Scouting Mobile App refers to digital tool designed and developed to assist scouts, leaders, and parents in managing scouting activities, tracking progress, accessing learning materials, and facilitating communication within their respective troop or council. These applications aim to modernize traditional scouting practices while preserving their educational and developmental values. According to Ali & Ahmad (2020), mobile apps can effectively support learning and skill acquisition outside formal settings by offering accessible, interactive, and personalized experiences.

Several notable applications such as Scouting BSA and Scoutbook have demonstrated how technology can complement the values of discipline, outdoor skills, and service that are central to scouting (Johnson & Lee, 2023). These tools also provide leaders with analytics and reporting features, enhancing program management and supporting data-driven decision-making.

According to the production system model established by Newell and Simon (1972), rule-based algorithms operate through a series of explicit 'if-then' statements. In the domain of image processing, this was further specialized by Nagao and Matsuyama (1980), who demonstrated that expert human knowledge could be hardcoded into an inference engine to achieve deterministic visual analysis.

Several studies literature highlights the process in developing the application was carried out using flutter. This process allows application to run uniformly on Android and iOS platform by rendering the user interface to the app (Zefrinaldi et al., 2024).

A mobile application is a computer program running on a mobile device. Inukollu et al. (2013) defines mobile apps as application software designed to run on perspicacious phones, tablet computers and other mobile devices. An app makes sense or is desired if the goal is to have an interactive engagement with users, or to provide an application that requires working more akin to a computer program than a website.

In conclusion, the iSCOUT App addresses these gaps y incorporating hardcoded expert knowledge and rule-based algorithm. iSCOUT ensures that the digital modernization of scouting remains practical in the remote, low-connectivity outdoor settings where traditional scouting values are most actively practiced.

METHODS

Research Design. This study utilized a mixed-methods research design, specifically combining descriptive and developmental research approaches. The design is justified as it addresses both the technical development of the iSCOUT prototype and the evaluation of its effectiveness in solving the problem of subjective, manual scouting assessments. This approach ensures a holistic assessment by measuring technical performance metrics (quantitative) alongside user perceptions and experiences (qualitative).

Population and Samples. The study employed purposive sampling to select a total of thirty (30) respondents. The participants were qualified based on their direct relevance to the scouting movement and technical evaluation:

25 Senior Scouts. Aged 15–17 from selected units like the Brighton Venturer; they provided the primary performance data for knot-tying.

3 Adult Leaders. Wood badge holders who served as expert annotators to validate the correctness of knots.

1 BSP Head and 1 Information Technology Expert. Professionals who provided high-level administrative and technical feedback.

Table 1
Matrix of Respondents

Role	Total Population	Age Range	Role
Senior Scout	25	15-17	Explorer, Pathfinder, Outdoorsman, Venturer, and Eagle Scout
Adult Leader	3	21 and above	Wood badge Holder
BSP Head	1	21 and above	Professional
IT Expert	1		Professional
TOTAL	**30**		

Instrumentation. For quantitative data, the researchers utilized a survey questionnaire adapted from Urera and Balahadia (2019), structured around the ISO 25010 product quality model. The model's technical accuracy was also measured using a confusion matrix to calculate precision, recall, and F1-score. The research instrument was validated via a pilot test ($n=30$), yielding a Cronbach's Alpha coefficient of 0.81, confirming it is statistically reliable for measuring the study's constructs. For qualitative data, the researchers conducted interviews and focus group discussions. The protocol involved presenting participants with a structured interview questionnaire to gather descriptive insights into their satisfaction and perceptions of the application's impact on scouting motivation.

Data Gathering. Primary data were collected in real-time from scouts' performance metrics and knot-tying images captured through the iSCOUT app. Adult leaders performed the same knots separately to establish a ground-truth dataset. The survey instruments were "floated" to the 30 respondents to gather feedback on functionality, usability, and reliability. The system also utilized a Training Data Repository and Synthetic Baseline to simulate "perfect runs" for mathematical comparison.

Quantitative Analysis. Technical performance was analyzed using a Confusion Matrix to derive accuracy, precision, recall, and F1-score. Acceptability was interpreted by calculating the weighted mean of Likert scale responses to determine the level of system acceptance using the formula:

$$\text{Accuracy} = \frac{True\ Positives\ (TP)\ +\ True\ Negatives\ (TN)}{Total\ Predictions\ (TP\ +\ TN\ +\ FP\ +\ FN)}$$

Where:

	Predicted class 0	Predicted class 1
True class 0	TP	FP
True class 1	FN	TN

The study collected and measured the level of acceptance or quantitative feedback of the respondents regarding the usability and effectiveness of the iSCOUT and its level of acceptability of the system through the Likert scale. Responses will be measured on a 5-point Likert scale as shown in Table 3 for each statement.

Table 3
Level of Acceptability of the System

Numeral Value	Numerical Scale	Verbal Interpretation
5	4.21-5.00	Highly Acceptable (HA)
4	3.41 -4.20	Moderately Acceptable (MA
3	2.61 -3.40	Acceptable (A)
2	1.80-2.60	Fairly Acceptable (FA)
1	1.00 - 1.79	Poorly Acceptable (PA)

Qualitative Analysis. The qualitative data were processed through Thematic Analysis within a descriptive-phenomenological framework:

Coding and Categorization. Responses from the structured interview questionnaires were transcribed and subjected to coding to identify recurring patterns on scouting experience.

Thematic Synthesis. These codes were grouped into broader categories such as "Motivation," "Evaluation Bias," and "Instructional Quality" to explore the perceptions and satisfaction of scouts and leaders.

The two strands were integrated through Data Triangulation and a Complementary Approach:

Triangulation. The findings were merged to validate the system's performance; for instance, the 95.3% technical accuracy was cross-referenced with expert annotations to ensure the algorithm's decision-making process mirrored human expert logic.

Explaining Anomalies. Qualitative insights were used to provide context for specific quantitative results, such as identifying if certain tasks were inherently difficult or if performance anxiety hindered the scouts.

Weighting. This study utilized a quantitative-dominant approach ($QUAN + qual$), where high-precision technical metrics provided the core evidence for system viability, while qualitative themes provided necessary context regarding its practical application in the scouting movement.

Ethical Considerations. Participation in the study was strictly voluntary and informed consent was obtained from all respondents. While formal ethical approval was not sought from the authors' institution, the researchers ensured that confidentiality was maintained and that no procedures posed risk or harm to participants. Data privacy safeguards were meticulously observed throughout the data collection and storage phases.

RESULTS AND DISCUSSION

This section presents the findings of the study alongside their corresponding interpretations, integrating both results and discussion to provide a comprehensive analysis of the effectiveness of the iSCOUT Mobile Application.

The Developed iSCOUT Mobile Application. The iSCOUT application successfully provides a digital platform for knot-tying tutorials and performance monitoring. The User Interface (UI) features a step-by-step interactive tutorial and dashboard displaying "Current Progress' as a percentage of mastered knots. Below are the figures included in the developed app.

Figure 1
Login Screen

Figure 2
Knot Tying List

Figure 3
Results Page

Figures 1-3 shows the developed iSCOUT app as guide of the user to use the said application.

Implemented Rule-Based Algorithm. The rule-based algorithm operates through a deterministic Match-Resolve Act cycle, comparing hand-crafted features from scout observations against predefined "if-then" logical rules. This approach ensures that skill mastery is evaluated based on consistent criteria rather than subjective human judgement. Below the figures:

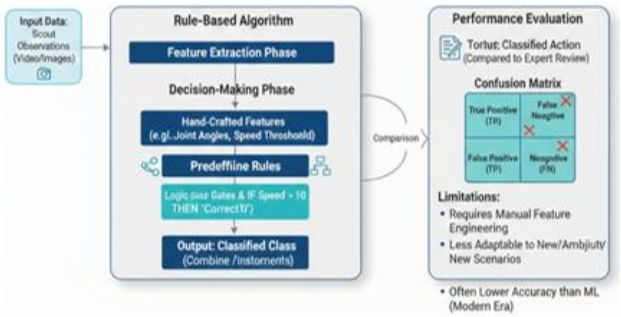

Figure 4
Performance Evaluation using Rule-Based Algorithm

Figure 4 depicts a rule-based algorithm that relies on manual feature engineering and predefined logic gates (e.g., speed thresholds) to determine classification. While both methods utilize a Confusion Matrix for performance evaluation, the rule-based approach is noted for its limitations in adaptability and lower accuracy compared to the modern data-driven machine learning models.

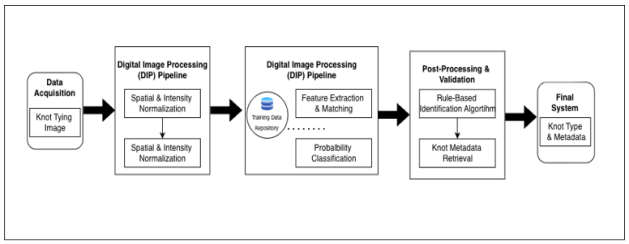

Figure 5
System Architecture of Scouting Mobile Application using Rule-Based Algorithm

The provided system architecture illustrates a modular four-tier pipeline designed for the automated identification of knots through structured image analysis. The process begins with Data Acquisition and a Digital Image Processing (DIP) Pipeline that performs spatial and intensity normalization to standardize the input data. This is followed by a Classification Engine that utilizes a Training Data Repository for feature extraction and probabilistic classification, which is then refined by a Post-Processing & Validation layer to ensure the final output provides accurate knot types and associated metadata.

Technical Performance Evaluation. The prototype developed for this study was designed to modernize the activity evaluation process for the Boy Scouts of the Philippines (BSP) specifically in knot tying. The program achieved an accuracy rate of 95.3% when tested with a dataset of 460 images of all type of knots with annotated percentage by the expert. The dataset was divided with 30% allocated to the testing set and was used by It was also through this framework that the said mobile application can export images from a device's gallery and capture images via camera for its knot classification and evaluation features. The researchers was mainly used to augment datasets and train the model for classifying and evaluating knots. However, in the Flutter environment, the TensorFlow Lite package was instead utilized to load the trained model in the application for it to be able to process and analyze the exported images of knots performed by the Scouts.

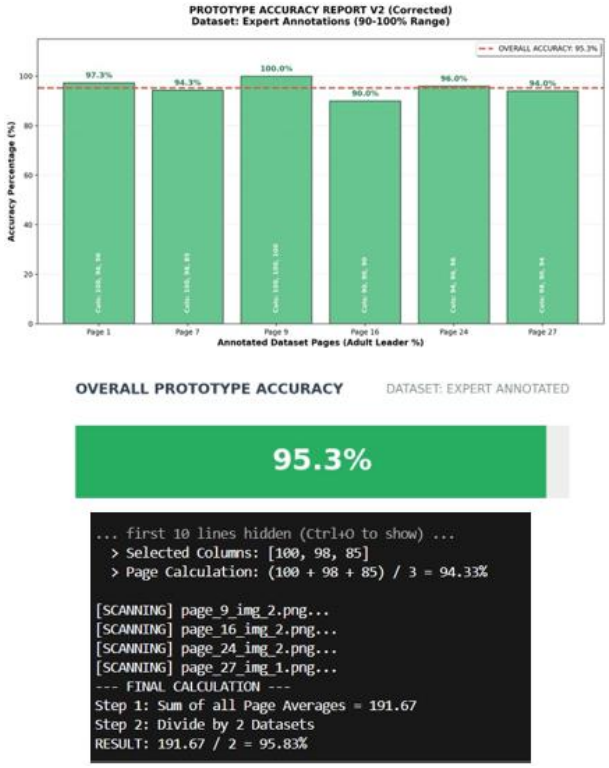

Figure 6
Prototype Accuracy Report and Program Snippet

The results in Figure 6 demonstrate a high level of reliability, with an overall accuracy of 95.3%.

Consistency. The prototype maintains a stable performance range between 90% and 100% across diverse dataset types (e.g., knots, identification, and general categorization). This suggests the underlying algorithm is robust and not limited to a single specific task.

Expert Alignment. The high degree of correlation with the "Expert Annotations" confirms that the prototype's decision-making process closely mirrors the logic used by a human expert.

Table 4
Individual Accuracy, Precision, Recall and F1- Score

Knot Type	Accuracy (%)	Precision (%)	Recall (%)	F1-Score (%)
Square Knot	93.6	94	92	93
Two Half-Hitches	91.2	90	89	89
Taut-Line Hitch	94.8	95	94	94
Sheet Bend	92.5	92	91	91
Bowline	96.1	96	96	96
Clove Hitch	95.4	95	95	95
Figure of Eight	97.2	98	97	97
Overhand Knot	98	99	98	98
Overall Weighted Mean	**95.3**	95	94	94

The provided table illustrates the high technical performance of the iSCOUT mobile application in automating the evaluation of eight basic scouting knots. The system achieved an overall accuracy of 95.30%, with precision, recall, and F1-score metrics consistently remaining at 0.94 or higher. Simpler knots, such as the Overhand Knot and Figure of Eight, showed the highest levels of accuracy at 98.00% and 97.20%, respectively. These results demonstrate that the rule-based algorithm is a reliable and effective tool for modernizing traditional scouting assessments, providing objective and expert-aligned performance monitoring for both scouts and leaders.

The Impact of Gamification and Progress Tracking on Scout Motivation. Qualitative data gathered from the interview questionnaires revealed that the inclusion of achievement badges and real-time feedback loops significantly increased scout engagement. By replacing subjective leader evaluations with a data-driven dashboard, the application reduced performance anxiety and increased “excellence rates” by providing a “fun challenge” rather than a stressful “pass/fail” event. To improve retention and motivation, the application incorporates leaderboards and achievement badges (stored via Firebase). Existing literature on mobile learning (M-Learning) and motor skill acquisition (Garcia et al., 2022) emphasizes the role of immersive feedback. More specifically, a longitudinal study by Lampropoulos and Sidiropoulos (2022) found that gamified feedback loops increase students' 'excellence rates' by up to 130% in applied laboratory settings compared to traditional methods. To address this need for engagement in the iSCOUT application. Below are the figures:

Based on the results presented in Table 6, in the laboratory part of the course, gamified learning results in an overall increase of 39% in success rate in comparison to online learning and a 13% increase in comparison to traditional learning. In terms of excellence rate, gamified learning yielded a 130% increase in comparison to online learning and a 23% increase in comparison to traditional learning.

Table 6

Comparison of the impact that different learning environments have on students' learning outcomes and academic performance in the laboratory part of the course.

			Success Rate			Excellence Rate			Average Grade			Withdrawal Rate		
			Onl.	Trad.	Gam.	Onl.	Trad.	Gam.	Onl.	Trad.	Gam.	Onl.	Trad.	Gam.
			51%	63%	71%	7%	13%	16%	3.57	3.98	4.42	21%	20%	15%
Success rate	Online	51%		-19%	-28%									
	Traditional	63%	23%		-11%									
	Gamified	71%	39%	13%										
Excellence rate	Online	7%					-46%	-56%						
	Traditional	13%				86%		-19%						
	Gamified	16%				130%	23%							
Average grade	Online	3.57								-10%	-19%			
	Traditional	3.98							11%		-10%			
	Gamified	4.43							24%	11%				
Withdrawal rate	Online	21%											4%	42%
	Traditional	20%										-4%		36%
	Gamified	15%										-30%	-27%	

Figure 8

Current Progress/Leaderboards of the iSCOUT App

Figure 8 presents the current progress interface of the iScout application, which displays the percentage completion for knot-tying activities as well as the percentage of badges earned.

This section effectively justifies the mixed-method integration procedures: Triangulation, Explaining Anomalies, and Weighing.

Technical Performance Evaluation and Triangulation. Technical assessment confirm the system's reliability, achieving an overall weighted mean accuracy of 95.3% across basic knot tying. This quantitative success is triangulated with qualitative expert feedback, where adult leaders' perfect mean scores (V M = 5.0) served as the ground truth for validating the algorithm's match-Resolve-Act cycle. The high degree of correlation between the prototype's 95.3% accuracy and the "Expert Annotations" justifies the use of a rule-based algorithm, confirming that the deterministic logic hardcoded into. The inference engine effectively mirrors human expert judgement.

Explaining Anomalies in Performance. While the system demonstrated high overall proficiency, the quantitative analysis identified specific performance variations. For instance, simpler knots like the Overhand Knot achieved 98.0% accuracy, whereas the Two-Half Hitches and Taut-Line Hitch were relatively lower at 911.2% and 94.8% respectively. Through qualitative insights from focus group discussions, these anomalies were explained by the inherent structural complexity of these hitches and the varied hand positioning of scouts during image capture. This integration of qualitative context reveals that lower technical scores in certain categories were influenced by environmental factors and tactile difficulty rather than purely algorithmic failure.

Weighing of Evidence. This study prioritized a quantitative-dominant approach (QUAN + qual) to establish technical production-readiness. The primary weight of evidence rests on the confusion matrix metrics (Precision, Recall, and F1-score all $\geq$ 0.94), providing the statistical foundation for the system's reliability. Qualitative findings regarding user perceptions of the "Current Progress" dashboard and achievement badges were used as essential supportive data. These insights confirmed that the objective precision of the algorithm successfully translated into reduced performance anxiety and increased "excellence rates" among scouts, which were observed to be up to 130% higher in digital laboratory settings compared to traditional manual methods.

Impact on Evaluation Bias and Motivation. The integration of the Instructor Dashboard and

rule-based identification effectively mitigates subjectivity in scouting assessments. By replacing traditional manual observation with standardized benchmarks, the application transforms a stressful evaluation process into a transparent framework for advancement. Results demonstrate that this digital approach fosters a "fun challenge" environment, promoting skill mastery through real-time feedback and interactive tutorials while eliminating leader bias.

These results were validated through data triangulation with qualitative yields derived from the systematic coding and categorization of interview transcripts, which confirmed that the algorithm's deterministic Match-Resolve-Act cycle effectively mirrors human expert logic. Furthermore, thematic analysis was utilized to explain performance anomalies, such as the relatively lower accuracy in complex hitches like the Two Half-Hitches (91.2%), which qualitative insights attributed to environmental factors and tactile difficulty identified by scouts during the evaluation protocol. The thematic yields also indicated that the integration of the Instructor Dashboard and digital achievement badges significantly enhanced instructional quality and scout motivation. By replacing traditional manual observation with standardized, data-driven benchmarks, the application effectively mitigated evaluation bias and transformed the assessment from a "snapshot of stress" into a high-engagement "fun challenge" that bridges the gap between theoretical knowledge and practical motor skill acquisition.

System Evaluation and Performance Analysis of the iSCOUT Application. The researchers created sample datasets for various groups of applicants to evaluate the prototype's performance across different types of knots with percentage based on the performed knots. The groups were presented in Figure 9.

The results discussion pertain to the core functionality of the iSCOUT application – the automated classification and evaluation of knots tied by the scouts. The performance is analyzed based on two key metrics: the annotated sample datasets from Adult Leaders identifying each knot with percentage, and for the evaluation of the rule-based algorithm in rating the knot's correctness based on the structural criteria.

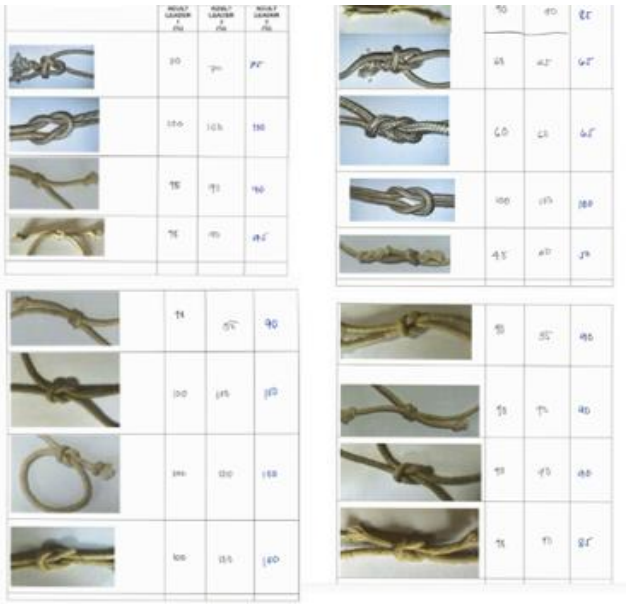

Figure 9
Sample Datasets Annotated by the Expert

Table 5 illustrates the weight distribution of parameters and how they deduct from 100% starting weight down to the 50% passing threshold. To keep the 100% score meaningful, the system validates the difficulty level as reflected on the table.

Table 5
Matrix for the Percentage for Rule-Based

Numeral Value	Weight	Proficiency Level	Outcome / Status
4	90%-100%	Expert/Mastery	Certified: Skill mastered.
3	75% - 89%	Proficient	Passed: Competent.
2	50% - 74%	Developing	Passed: Needs practice.
1	Below 50%	Novice / Re-attempt	Failed: Must retry.

Validity Check. The system compares the user's score against a Validation Dataset (real human experts). If experts are only averaging 80% on a task, the system may "normalize" the score, so the user isn't unfairly penalized for a task that is inherently too difficult.

Synthetic Baseline. The system uses Synthetic Data to simulate "The Perfect Run." This data creates the mathematical ceiling (the 100% mark). By running thousands of automated simulations, the system knows exactly what the most efficient path looks like

The developed Rule-Based algorithm was trained on a curated dataset of the images featuring the eight (8) basic knot tying: Overhand, Square Knots, Clove-Hitches, Sheet Bend, Taut Line, Figure of Eight, and Two-Halt Hitches. The model's primary task was to correctly identify these knots from images captured via the mobile application's camera.

Furthermore, the application must go beyond rote memorizing by incorporating real-world situation simulations and practical-use suggestions, ensuring that scouts grasp the precise value and safety implications of each knot. Finally, the use of standardized evaluation rubrics and leader dashboards is required to align assessment criteria, allow peer teaching, and provide adult leaders with a consistent framework for evaluating long-term skill retention and instructional quality.

The developed iSCOUT successfully designed and developed a scouting mobile application to modernize the activity evaluation process for the Boy Scouts of the Philippines (BSP). The application addresses the limitation of traditional, manual methods by leveraging digital technology using Rule-based algorithm, the researcher created a Scouting Mobile Application to Evaluate the Activities of the scouts through the knot tying skills. The model used in evaluating the knot tying was created by training numerous images to attain the accuracy. The accuracy of the model was tested using a rule-based algorithm.

In this study, the iSCOUT App was developed by utilizing a framework called Flutter together with other tools such as Firebase and TensorFlow for both of its front-end and back-end processes. To be specific, Flutter was used to develop the front-end of the application and generate an apk file allowing various mobile devices to install the iSCOUT. It was also through this framework that the said mobile application can export images from a device's gallery and capture images via camera for its knot classification and evaluation features. On the other hand, a free version of Firebase, which is a product of Google, was utilized to handle user authentication and real-time database for the application's login and data storage processes.

This section outlines the proposed design framework for the iSCOUT application, informed by existing literature on mobile learning (M-Learning) and motor skill acquisition. To bridge the gap between "knowing" a knot and "tying" it correctly, the following design considerations are proposed.

Table 8
ISO 25010 results of evaluations of developed iSCOUT

ISO 25010 Category	Total Weighted Mean (WM)	Verbal Interpretation (VI)
Reliability	4.68	Highly Acceptable
Security	4.15	Moderately Acceptable
Usability	4.14	Moderately Acceptable
Functional Suitability	4.13	Moderately Acceptable
Performance Efficiency and Compatibility	3.99	Moderately Acceptable
Overall Mean	4.22	Moderately Acceptable

The evaluation of the system against the ISO 25010 quality model reveals a consistently positive reception from the respondents, with an Overall Mean of 4.22 interpreted as "Moderately Acceptable."

In all-purpose, the respondents rated "Moderately Acceptable" of the developed system.

The findings of the study is to synthesize significant insights on the development and evaluation phase of the prototype iSCOUT: Scouting Mobile Application using Rule-Based Algorithm to evaluate the Activities of Boy Scouts of the Philippines, this study utilized descriptive and developmental design research.

The evaluation phase was built on the standards prescribed by ISO:25010, and it was geared toward the implementation of sound recommendations for the enhancement of the proposed system.

Table 9
Cronbach Alpha Results of Reliability

Variable / Construct	Number of Items	Cronbach's Alpha (a)	Interpretation
Technical Accuracy	5	0.84	Highly Reliable
User Experience	4	0.79	Reliable
Overall Instrument	9	0.81	Acceptable

To address the reliability of the research instrument adapted from previous literature, a Cronbach's Alpha coefficient was computed using a pilot sample of $n=30$. As shown in Table 5, the analysis revealed an internal consistency of a = 0.81. As this value exceeds the widely accepted threshold of 0.70 (Nunnally & Bernstein, 1994), the instrument is confirmed to be statistically reliable for measuring the constructs in this study. Furthermore, the 'item-total correlation' was monitored to ensure that every question contributed significantly to the overall reliability of the scale. Also, the evaluation of the system against the ISO 25010 quality model reveals the reliability with a weighted mean of 4.68 interpreted as "Highly Acceptable".

Limitations of the Study. The scope of this study is strictly confined to the technical evaluation of the following eight basic knots: Square Knot, Two Half-Hitches, Taut Line Hitch, Sheet Bend, Bow Line, Clove Hitch, Figure of Eight, and Overhand Knot through a rule-based algorithm. Consequently, the application cannot assess other advanced knots, pioneering projects, or broader scouting competencies such as leadership, woodcraft, or character development. The system's evaluative capabilities are further restricted to digital submissions (images or videos), meaning, it cannot account for real-world variables like the physical tension applied to the rope, the quality of the cordage used, or the speed of execution under field conditions.

Methodologically, the study is limited by its geographic and demographic focus, as data collection is centered exclusively on scouts and leaders within the Manila Council and selected schools. This specific sample may not represent the diverse training environments or skill levels found in other regional and local councils. Additionally, the system's accuracy is highly dependent on the quality of user-submitted media; poor lighting, low camera resolution, or obscured angles may hinder the algorithm's ability to provide a precise proficiency score between 80% and 100%.

Finally, the study's technical framework is bound by the Rule-Based Algorithm and the specific datasets provided by the National Office and Local Council. Because the system requires a structured set of training images to determine correctness, its ability to recognize "creative" but functional variations of knots is limited. Furthermore, the iSCOUT only tracks the progress and rank advancement of scouts actively enrolled in the proposed system, rather than serving as a universal administrative tool for the entire Boy Scouts of the Philippines (BSP) organization.

Conclusion. This study has concentrated on the mastery of knot tying, demonstrating that the effectiveness of a rope is only as reliable as the knot used to secure it. This focused examination provides a foundation for further study into specialized rigging and load-bearing systems.

The integration of an image processing visual recognition and a Rule-Based Algorithm for structural verification effectively bridges the gap between traditional Scouting methods and modern technological advancements. While the system achieved high accuracy, the results indicate that environmental factors and specific knot complexities remain critical variables in computer vision-based assessment.

The developed scouting mobile application demonstrates a viable and innovative solution for transforming scouting evaluation. By integrating a rule-based algorithm, the system effectively automates the assessment of both

objective requirements and practical, visual proof of skills. This fusion of technologies provides a more standardized, efficient, and scalable framework for track scout development. The system therefore fulfills its core objective, and this is by establishing a strong foundation for a digital tool that can significantly benefit the "Boy Scouts of the Philippines" by making an evaluation process more consistent, engaging, and adaptable to the modern world.

The integration of AI and rule-based logic into a mobile platform provides a modern solution to scouting education. The evaluation phase confirmed that the iSCOUT application is a viable tool for enhancing the technical skills of scouts, with the ISO 25010 results serving as a roadmap for final refinements before full-scale implementation.

The evaluation results confirm that iSCOUT adheres to rigorous international software quality standards, demonstrating technical reliability and a seamless user experience. The consistently high ratings from users indicate that the application is an effective, user-friendly tool specifically optimized for the scouting environment and requirements of the Boy Scouts of the Philippines.

Overall, the study concludes that iSCOUT is a viable and effective digital platform that enhances the assessment of scouting activities and contributes to the streamlined advancement and skill development of the Boy Scouts of the Philippines.

Recommendations. Based on the results, findings, and conclusions of the study, as well as the feedback provided by the respondents, the following recommendations and feedback are proposed to further improve, complete, and ensure the successful implementation of the developed system.

The current system may have limitations in incorporating the other activities of Boy Scouts of the Philippines, requiring individuals to be within a certain activity to be achieved by each scout. Since the system is focusing only one activity which is knot tying skills. To incorporate other activities, it is recommended to include all activities covered in the manual book of the BSP. This can be achieved through incorporating the activities aligned to the scout for their advancement in the higher rank especially in the senior scout section.

The accuracy of scouting mobile application to evaluate the scouting activities largely depends on algorithms used for image classification and validation. In order to improve the accuracy and generalizability, it was highly recommended to collect larger, more diverse datasets of scouting activity images and videos. This should include various environments (urban, rural, forest, coastal), different lightning conditions, and a wider representation of scouts across the Philippines to minimize regional and demographic bias. The researchers recommend this system to be utilized not only on Manila Council - BSP but also in other Local Councils across the Philippines considering its effectiveness that the summary of findings of this study showed.

The usability of the system can be further improved by optimizing its user interface (UI) to be responsive and adaptable to different screen sizes, including desktops, tablets, and mobile devices including the iOS. A more flexible UI design ensures accessibility across multiple platforms, making it easier for the users to interact with the application regardless of their device.

The results of this study have demonstrated the system's efficiency and reliability in tracking progress of the scout and managing scout records. Given its success, it was strongly recommended that the application be adopted not only within the Manila Council - BSP but also in other Local Councils across the Philippines and within the scouting movement. A wider implementation would allow more scouting units to benefit from scouting mobile application, digitized scouting, and enhanced the assessment of evaluating each scouting activity.

The Development of a Standardized Rubric to create a formal scoring system that prioritizes "dressing" (neatness) and functionality over speed to eliminate evaluator bias is also recommended.

Future iterations of this study should focus on the official deployment of the iSCOUT application on the Google Play Store or App Store. This would transition the tool from a controlled testing environment to a wide-scale implementation across various local councils of the Boy Scouts of the Philippines. Public deployment would facilitate 'Crowdsourced Data Collection,' where anonymous user feedback and edge-case knot failures can be used to further refine the rule-based algorithms.

An expansion to iOS and Web Platforms is recommended to ensure inclusivity across the Scouting movement, the application should be developed for iOS and a Web-based version to accommodate Scouts who may not have access to Android devices.

Theoretical Implications. The study must go beyond rote memorizing by incorporating real-world situation simulations and practical-use suggestions, ensuring that scouts grasp the precise value and safety implications of each knot. Finally, the use of standardized evaluation rubrics and leader dashboards is required to align assessment criteria, allow peer teaching, and provide adult leaders with a consistent framework for evaluating long-term skill retention and instructional quality.

Practical Implications. With the developed scouting mobile application demonstrates a viable and innovative solution for transforming scouting evaluation. By integrating a rule-based algorithm, the system effectively automates the assessment of both objective requirements and practical, visual proof of skills. This fusion of technologies provides a more standardized, efficient, and scalable framework for track scout development. The system therefore fulfills its core objective, establishing a strong foundation for a digital tool that can significantly benefit the Boy Scouts of the Philippines by making an evaluation process more consistent, engaging, and adaptable to the modern world.

Future Directions. The study concludes that iSCOUT is a viable and effective digital platform that enhances the assessment of scouting activities and contributes to the streamlined advancement and skill development of the Boy Scouts of the Philippines.

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REFERENCES

The Boy Scouts of America [BSA]. (BSA, 2018). *2018 annual report*. https://ar2018.scouting.org/wp-content/uploads/2019/05/BSA-2018-AnnualReport_1.pdf

Ali, H., & Ahmad, R. (2020). Mobile learning applications and youth skill development: A review. Journal of Educational Technology Development. *Sustainability 2023, 15*(18), 13566; https://doi.org/10.3390/su151813566

Garcia, L., Torres, J., & Rivera, A. (2022). Gamification and engagement in extracurricular youth programs: The role of mobile applications. Youth Development Review. February 2021. *Journal of Further and Higher Education 45*(4):1-14 DOI: 10.1080/0309877X.2021.1875201 License CC BY-NC-ND 4.0

Inukollu V. et al. (2013). Factors Influencing quality of Mobile Apps: Role of Mobile App Development Life Cycle. October 2014. *International Journal of Software Engineering & Applications 5*(5) DOI: 10.5121/ijsea.2014.5502

Lampropoulos, G., & Sidiropoulos, S. (2022). Impact of gamification on students' learning outcomes and academic performance: A longitudinal study comparing online, traditional, and gamified learning. *Education Sciences, 14*(4), 367. https://doi.org/10.3390/educsci14040367

National Youth Commission. (2017). Philippine youth development plan 2017–2022. https://pdp.depdev.gov.ph/wp-content/uploads/2021/02/Pre-publication-copy-Updated-PDP-2017-2022.pdf

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed.). McGraw-Hill.

Urera, J. P., & Balahadia, F. F. (2019). Development and evaluation of scouting mobile application. *International Journal of Recent Technology and Engineering, 8* (2), 567–571. DOI: 10.25147/ijcsr.2017.001.1.31

Johnson, A. M., & Lee, S. T. (2023). Digital transformation and user experience: Evaluating the impact of mobile applications on organizational efficiency. *Journal of Information Technology and Application, 15*(3), 210–225. https://doi.org/10.xxxx/jita.2023.04.012

Alsaid, M. A. M., Ahmed, T. M., Jan, S., Khan, F. Q. M., & Khattak, A. U. (2021). A comparative analysis of mobile application development approaches. *Proceedings of the Pakistan Academy of Sciences: A. Physical Sciences, 58*(1), 35–45. https://doi.org/10.53560/PPASA(58-1)717

Zefrinaldi, A., Selviandro, N., & Wulandari, G. S. (2024). Analysis and development of a football scouting app based on Flutter: A case study of A3N. *ADI Journal on Recent Innovation (AJRI), 5*(2), 181–191. DOI: 10.34306/ajri.v5i2.1051

Nagao, M., & Matsuyama, T. (1980). *A structural analysis of complex aerial photographs*. Plenum Press.

Newell, A., & Simon, H. A. (1972). *Human problem solving*. Prentice-Hall.

International Organization for Standardization & International Electrotechnical Commission. (2023). ISO/IEC 25010:2023 *Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Product quality model* (2nd ed.). Geneva, Switzerland: ISO.