

ORIGINAL ARTICLE



# A Measuring Tool for Kick Speed with Dynamic Targets: A Digital-Based Instrument Designed for Pencak Silat Learning

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## ABSTRACT

**Background.** Pencak silat in different areas of the globe has become a popular sport, and complexities combinations of punches, kicks, and both have been developed over the years. **Objectives.** This study focused on kick speed and the aim was to develop a digital-based instrument for measuring kick speed with dynamic targets in Pencak Silat learning. **Methods.** We used the research and development method to produce a product and then test its effectiveness. A study was conducted in which 185 participants were between 18 and 35 years old male and female through field trials and experts' decisions. Questionnaires feasibility (relevance, accuracy, convenience, and practicality) and study documents were the main instruments and sources employed during data collection. **Results.** After analyzing all of the data, the validity test results obtained from experts in Sports, Pencak Silat, and Information Technology were 92.5%, 91.0%, and 94.0%, respectively, which is considered to be in the very good category. Similarly, the reliability test results for both small groups of males and females were virtually equal, with scores of 0.968 and 0.983, respectively, indicating a very high level of reliability. The data obtained from large groups of both males and females also showed good results for the new product, with scores of 0.908 and 0.915, respectively. **Conclusion.** In conclusion, the results obtained from both experts and the product itself demonstrate that the digital measuring tool for kick speed can be used with ease, practicality, and accuracy to determine the speed of Pencak Silat kicks. This tool is expected to be useful for both learning and competition purposes, helping to assess kick speed and improve overall performance.

**KEYWORDS:** *Kick Speed, Dynamic Targets, A Digital-Based Instrument Designed, Pencak Silat Learning*

## INTRODUCTION

In a broad sense, Pencak Silat is defined as any of various fighting sports or skills, mainly of East Asian origins, such as kung fu (Pinyin gongfu), judo, and karate, focusing on fast and precise strikes that hit the selected point on the opponent's body (1). People use Pencak Silat for diverse reasons. They are codified systems and traditions of combat practiced for self-defense; military and law enforcement application (2); competition; physical, mental, and spiritual

development (3, 4); entertainment; and the preservation of a nation's intangible cultural heritage (5). The implementation and incorporation of various Pencak Silat competitions at the international level prove that Pencak Silat has globally extended its boundaries due to its existence in every corner of the world. The competition in Pencak Silat consists of four categories, namely: 1) fighting class; 2) single category; 3) double category; and 4) team

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category (6). The competition category is divided into several classes, and each class is determined by weight. The single and team categories are demonstrations of the moves that have been standardized, while the double category is the development of attack-defense movements that are done by two people.

However, for overall aforementioned purposes, speed and accuracy are crucial to achieve victory or respond to its objectives. An instrument based on performance is a crucial component for increasing performance since it allows one to understand their current level of competence and their level of training (2). In addition to class classification in Pencak Silat competitions, there is also an age classification (7, 8). Age classification in Pencak Silat competition consists of early age between 10-12 years, pre-teen between 12-14 years, teenager (14-17 years), adult (17-35 years), master-I (35-45 years), master-II (45 years and over). Then, age classification in matches is very important in sports competitions.

Specifically, in Indonesia, martial Arts known as Pencak Silat in the Javanese language is one of the physical education subjects learned and taught in schools at all levels from elementary schools up to higher education (9, 10). Despite being an educational sport, it is also a widespread subject in various regions in Indonesia both in state schools and private ones (11), marked by the number of clubs (Pencak Silat Schools) that preserve it as a competitive sport. As previously mentioned, kick speed is an essential trick that should be taught and well-excelled in Pencak Silat since it could affect the appearance and performance of the subject, especially during competitive matches.

Some previous studies have analyzed the kick in Pencak Silat with different skill levels (12) along with some kick speed attributes like weight classification, standing position, the sides of the foot used, and also the types of the kick (13, 14). An eventual agreement set showcased that to be a good performer in such physical activity, demonstrating it well requires some prerequisite and acquisition of staple techniques. Additionally, it is also believed that the target distance needs to be considered in self-defense learning for athletes who can adapt to different distances to achieve better performance during execution (15, 16). That said, a dynamic target for learning Pencak Silat kicks needs to be adapted to the situation during the match.

There is already a tool, such as the Instrument Speed Endurance Test (MET), which measures the speed of tendon contraction with a validity and reliability of 0.95 and 0.97 (17). In addition, speed kicks in Pencak Silat-based technology increase speed kicks with a CVR of 0.94 and a reliability range of 0.90-0.91 (18). So far, there is no tool to measure pencak silat specifically for technical kicks with dynamic targets so that it can indirectly measure the action speed of the kick reaction.

The importance of measuring Pencak Silat speed kicks is to measure the initial conditions before training and the final conditions before the match. Apart from that, it is very necessary for talent scouting done during training or when participating in competitions. The importance of striking speed in the sport of pencak silat. After the results of the typing speed measurements, the exercises can be trained and measured again to increase the typing speed. This of course increases the performance of Pencak Silat athletes. This instrument is mainly used to measure silat kicks with sickle techniques (with motion and sound sensors). Moreover, the advantage of the instrument which is made is dynamic so that it can increase the speed of action and reaction.

To our better understanding, nowadays many coaches have done and given speed training programs in Pencak Silat, especially kicking techniques for athletes. However, to measure whether there is an increase in kick speed, some coaches are still unable to specifically determine it. One of the reasons is that there is no standard instrument for measuring speed, especially for the specification of the Pencak Silat in kicking technique. The instruments that are often used are not reliable in terms of data yields. It is then suggested that the measuring instrument used should be able to measure what it is supposed to measure to maintain a high level of truth and a sense of credibility. Then, the immersion of technology chiefly in terms of measurement is all about and highly recommended for reducing erroneous and biased data and ensuring the information collected has a high level of validity and reliability. In tandem, some research has discussed and succeeded in revealing the role of technology in self-defense. Take, for example, Worsey et al., (2020) employed the Internet of Things (IoT) as inertial sensors to detect performance related to stroke quality, automatic attack classification, automatic scoring, head impact, athlete endurance, strength and mobility, and grappling technique (19). While

Ishac and Eager (2021) focused on inertial sensing to measure high-speed Pencak Silat techniques, such as Boxing, Taekwondo, Karate, Kung fu, etc. (20).

Therefore, this research aims to develop a kick speed measuring tool with a digital-based dynamic target for Pencak Silat learning with the expectation of collecting accurate results during training or matches and also facilitating the performance of athletes and better outcomes for coaches.

## MATERIALS AND METHODS

**Design.** The method used in this research is developmental research in the design of Borg and Gall (21, 22). It is broadly understood as a method used to produce a particular product and then test its effectiveness. Then, the present study in hands aims at designing and developing a Pencak Silat instrument to measure the kick speed of athletes/learners with dynamic targets. In other words, this study intends to design a new and efficient instrument equipped with microcontroller technology that utilizes sensors as measurement indicators. This new asset would

have an excellent measurement accuracy to measure the kick speed of Pencak Silat athletes compared to other speed instruments existing so far.

**Participant.** As research participant is concerned, a total of 185 athletes were selected from both the student sports education and training center and Pencak Silat schools in Padang City Indonesia. For the sake and the purpose of the study, participants aged 14-17 years old and having completed at least the regional training at the students' sports week level become the target of the data. The regional training in question is for students who are members of both colleges and student training centers in West Sumatra. More clearly Pencak Silat colleges include Pencak Silat Tangan Mas College, Tapak Suci, Satrya Muda Indonesia, and West Sumatra Student Education and Training Center (PPLP) which are several centers of Pencak Silat schools in West Sumatra.

**Procedures.** In more detail, the demographics of the participants can be viewed in the demography of the Small group test sample and demography of the large group test in Table 1 and Table 2.

**Table 1. The Demography of Small Group Test Sample**

No	Male	Female	Sample Trial Place
1	20	25	Pencak Silat Tapak Suci Kota Padang School

**Table 2. The Demography of Large Group Test Sample**

No	Male	Female	Sample Trial Place
1	40	25	Pencak Silat Tangan Mas Kota Padang School
2	13	13	Pencak Silat SMI Unit 32 Kota Padang School
3	20	15	Pencak Silat Pat Ban Bu Kota Padang School
4	7	7	PPLP Prov. Sumatera Barat

Following the type of research in hand, namely research development, the type of research follows some stages or steps adjusted to the procedures in development research. According to (Borg and Gall into Sugiyono), The stages or steps of this research and development are showcased and comprehended as follows:

a. **Potential Problems or Need Analysis:** The potential issue in this research is to design and develop an instrument that can help in measuring the kick speed with dynamic targets in Pencak Silat. That means this new tool will automatically enable measuring the ability of kick speed according to the needs and situations of the athletes/trainees in the Pencak Silat match with

the help of IT tools such as sensors. The idea of developing this instrument was supported by the personal discussions we have had with some coaches and athletes. Overall, here are some main points in terms of weaknesses to existing instruments we came up with 1) lack of practicality in doing speed tests manually, 2) trainers tend to give monotonous tests on kick speed tests, 3) possible errors in counting results are reported, 4) less practical in determining the results due to using manual calculations, 5) speed tests have not been specifically designed to meet the needs of Pencak Silat athletes in Padang.

b. **Information and Data Gathering:** At this stage, data obtained was in the form of

information related to the material for product planning expected to be able to develop the existing instrument. The literature review and discussions with experts on the existing instrument were the initial data to begin with.

c. **Product Design:** We designed an instrument test that enables us to measure the kick speed in Pencak Silat with a dynamic target with the help of sensors, software, and displays outputs/results on the LCD screen involved: a) Arduino Uno, b) LCD 20 x 4, c) MPU sensor 6050, d) Bluetooth module HC05, e) Microsensor module mic condenser, f) Patching pad (can be viewed in [Figure 1](#)).

d. **Design Validation:** Design validation is a process to assess whether the product designed describes the fundamental changes from the previous one by experts' viewpoints (23). Then, in this study, the assessors consist of experts in sports evaluation and measurement, IT experts, and Pencak Silat experts.

e. **Design Revisions:** This stage asks for theoretical considerations from experts and practitioners regarding the product developed in the wake of responding to the research objectives.

f. **Product field Trials or Tests and Retest (small group):** It was carried out at the school Pencak Silat Tangan Mas in Padang City. The gist of this stage includes planning, implementation, observation, and analysis, this stage is the process used by researchers to obtain data from field testing results. This stage is intended to determine the level of reliability by using the test and retest method which will be analyzed using the product-moment correlation formula.

g. **Product Inputs, Correction, and Revisions:** At this point, we revised the product design that will be developed based on inputs and advice from the experts' judgments.

h. **Usage Trials or Large Group Trial:** Product trials were conducted to determine whether the resulting product had good quality. Then product trials would be carried out through field trials with a big sample as recommended with youth athletes from Perguruan Pencak Silat Tangan Mas, Perguruan Satria Muda Indonesia Dan Perguruan Pat Ban Bu di Kota Padang in PPLP West Sumatra Province. This stage is

intended to disclose the level of reliability using the test and retest method which will be later analyzed using the product-moment correlation formula.

i. **Product Revisions and Production in Bulk:** We determine the assessment norms and revise the shortcomings of the product after the large group trial. In this case, the norm is intended to provide high- and low-level results in kicking speed for Pencak Silat athletes by using a new instrument developed with dynamic targets.

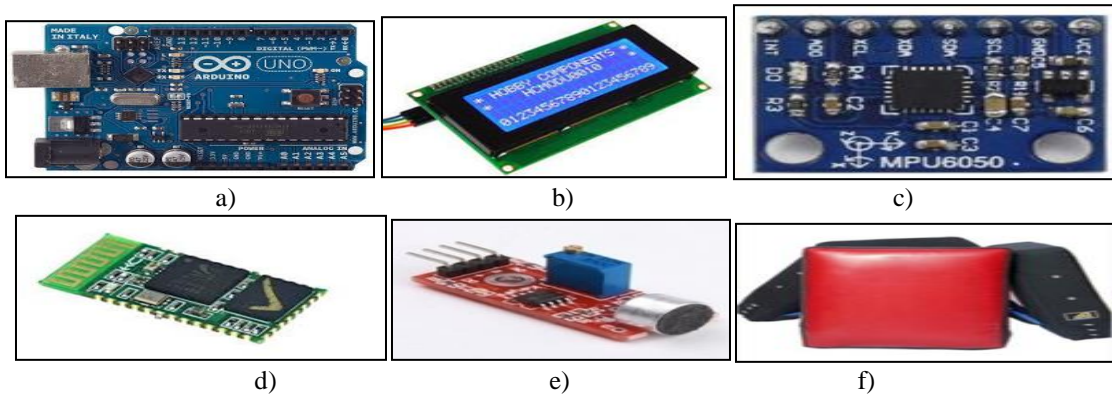
**Instrument Items Development.** The data obtained from the expert judgment questionnaire will be first analyzed using the percentage analysis techniques (content validity: 0.89). The data obtained from the Likert scale questionnaire will be analyzed using the average analysis technique with values ranging from strongly agree (5), agree (4) undecided/neutral (3), disagree (2), and strongly disagree (1). Then a total assessment is carried out to get the percentage of the feasibility of the tool using mathematical calculations as follows:

$$\text{Peresentase (\%)} = \frac{\text{Earned score}}{\text{expected score}} \times 100$$

The reliability test was calculated based on standard test criteria following existing statistical procedures, such as validity and reliability tests using the analytical technique as the correlational analysis between test and retest data in the following formula:

$$r = \frac{\sum XY - \frac{(\sum X)(\sum Y)}{n}}{\sqrt{\left[\sum X^2 - \frac{(\sum X)^2}{n}\right] \left[\sum Y^2 - \frac{(\sum Y)^2}{n}\right]}}$$

**Data Analysis.** The statistical analysis was based on the validation of experts who used a questionnaire as an instrument to calculate the feasibility of the product in terms of percentage which can be viewed in [Table 3](#). In tandem, the test and retest method used the correlational r formula to test the level of reliability of the measuring tool as depicted in the tables below:



**Figure 1.** a) Arduino Uno, b) LCD 20 x 4, c) MPU sensor 6050, d) Bluetooth module HC05, e) Microsensor module mic condenser, f) Patching pad.

**Table 3. Convert Quantitative Data to Qualitative Data and Measuring Tool Reliability**

Percentage	Classification	Correlation coefficient interval	Reliability
81-100	Excellent	0.00-0.19	Very weak
61-80	Good	0.20-0.39	Weak
41-60	Enough	0.40-0.59	Enough
21-40	Less	0.60-0.79	High
0-20	Poor	0.80-1.00	Very high

**RESULTS**

Demographic Information for Respondents can be seen in [Table 4](#).

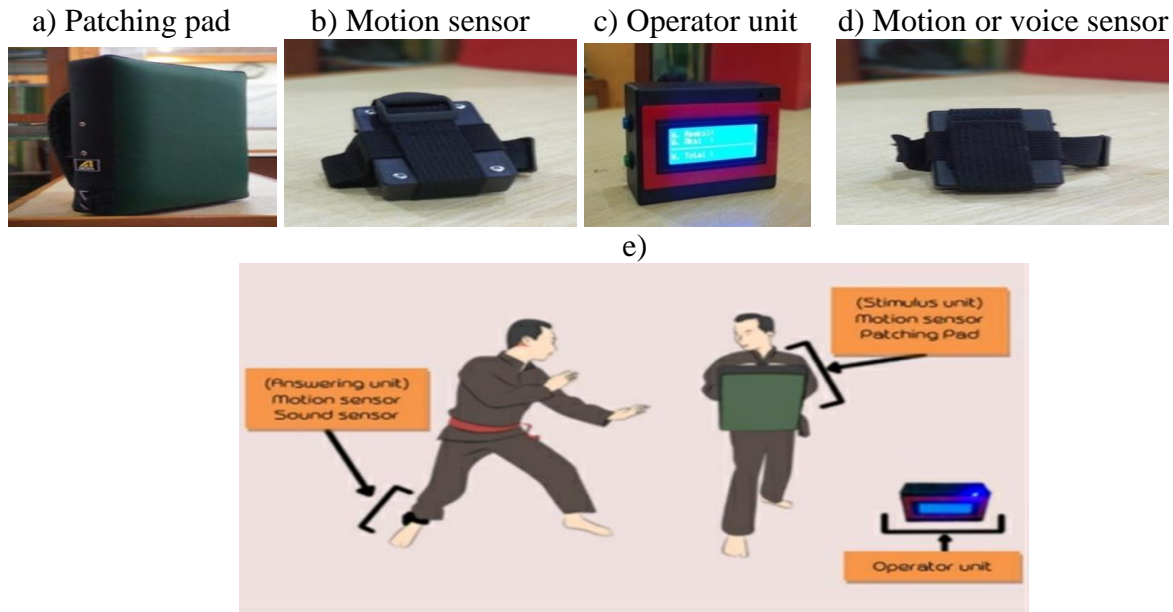
**Stimulus Unit.** Based on the results of expert validation, it was found that the development of a kick speed measuring tool with a digital-based dynamic target was in the very good category, with an average percentage of 92.5%. The average value of suitability, accuracy, ease, and practicality of tools was used to obtain percentages of 92.5%, 91.0%, and 94.0% for two experts on sports measurement tests, Pencak Silat,

and information technology respectively ([Figure 2](#)).

From the results of the table especially on the correlation coefficient, the tool developed is said to be reliable and consistent in taking the kick speed of Pencak Silat athletes. Based on the results of the reliability test in small and large groups, a very high correlation coefficient was obtained, as shown in [Table 5](#), [Table 6](#), and [Figure 3](#). The test-retest method also showed a linear relationship between the trials of the two groups. This indicates that the measuring tools are reliable and consistent with data collection.

**Table 4. Subject Description**

Subject	Gender		Pencak Silat school
	Male	Female	
Small group	20	25	Tapak Suci Martial Art School, Padang City
	40	25	Tangan Mas Martial Art School, Padang City
Large group	13	13	SMI Unit 32 Martial Arts Schools, Padang City
	20	15	Pat Ban Bu Martial Art School, Padang City
	7	7	Student Sports Education Training Center, West Sumatra
Sum	100	85	
Total	185		



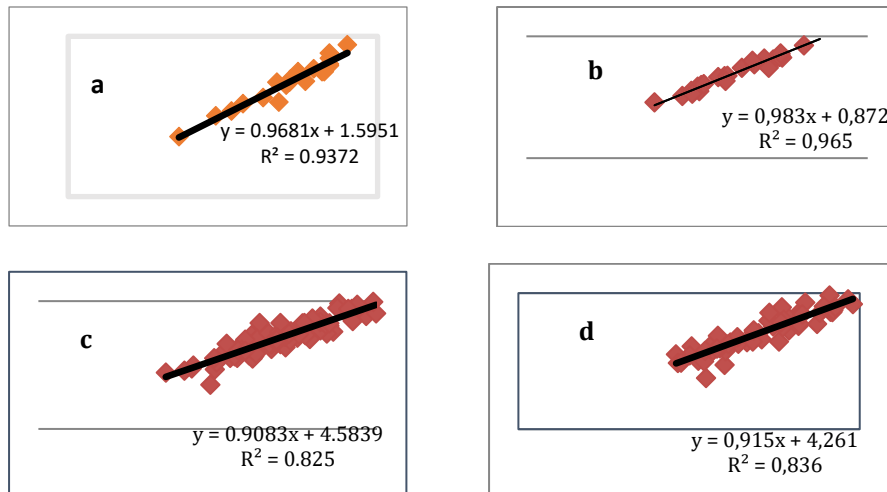
**Figure 2.** a) Patching Pad, b) Motion Sensor, c) Operator Unit, d) Motion or Voice Sensor, e) The Complete Simulation of the Use of the Developed Tools.

**Table 5. Experts Validity Score**

Description	Average	Total	Score	Practicality	Convenience	Accuracy	Suitability	Rating Indicator		
								Score (%)	Expert	Expert
Very Good	92.5%	75	72	13	15	20	24	Score (%)	Expert 1	Sports Measurement Test Expert
		100%	96%	17%	20%	27%	32%	(%)	Expert 2	
		75	67	13	13	20	21	Score (%)	Expert 2	
		100%	89%	17%	17%	27%	28%	(%)	Average Indicator	
		100%	92%	17%	18.5%	27%	28%	Average Indicator		
		50	44	8	9	18	9	Score (%)	Expert 1	Martial Art Expert
		100%	88%	16%	18%	36%	18%	(%)	Expert 2	
		50	47	9	8	20	10	Score (%)	Expert 2	
		100%	94%	18%	16%	18%	36%	(%)	Average Indicator	
		100%	91%	17%	17%	38%	19%	Average Indicator		
		65	61	20	15	13	13	Score (%)	Expert 1	Information Technology Expert
		100%	94%	29%	22%	22%	22%	(%)	Expert 2	
65	61	19	14	14	14	Score (%)	Expert 2			
100%	94%	29%	22%	22%	22%	(%)	Average Indicator			
100%	94%	30%	22.5%	21%	21%	Average Indicator				

**Table 6. Product Moment Correlation Coefficient**

Tool trial subject	Gender	N	Coefficient (r)	Reliability
Small group	Males	20	0.968	Very high
	Females	25	0.983	Very high
Large group	Males	80	0.908	Very high
	Females	60	0.915	Very high



**Figure 3.** a) Linear Regression Male of Small Group Trial, b) Female Small Group Trial, c) Male Large Group Trial, d) Female Large Group Trial.

## DISCUSSION

A coach is someone who should have the ability and knowledge of ways to train or develop the abilities and skills/for the effective development of one or more people (24, 25). However, it is also believed that training and developing the ability of an athlete will be easier if it is supported by sports technology (26, 27). Meanwhile, collecting valid and tangible data requires an instrument or device that has a level of trust and reliability. Then, accuracy in the selection of instruments is one of the important factors that must be considered by the coach in taking data on his athletes (28). Likewise, with Pencak Silat a professional coach certainly needs all the data related to the athlete's physical ability or technique for effective performance. Blažević et al., (2006) stated that one of the important elements in Pencak Silat is speed. Speed is needed in various situations and conditions both in attack and in defense (29). Also, in a match situation, kicking is the most common technique used both offensively and defensively (30, 31). According to Nugroho (2020), kicking is the dominant technique used in the competition which occupies 47%. This shows that it is very important for a Pencak Silat athlete to have and regulate the kick speed. To obtain data related to whether or not a fighter's kick speed is needed a valid and reliable instrument to measure it (32). Scholtes et al., (2011) stated that a test or measurement instrument is valid if it can measure what should be measured. In the same vein, data collection tools or instruments

determine the quality of the data obtained and the quality of the data determines the quality of the research (33).

As the type of this study is a research and development (R&D), we have designed and developed an instrument that can help to measure and provide accurate data on kicking speed for Pencak Silat athletes. As recommended, this new tool was developed and tested its effectiveness based on the inputs from different media and IT experts. Then after going through all the steps the validity test results from the experts fall in the very good category. Equally, the reliability test results in small and large groups showed reliable and consistent measuring tools for data collection with very high and significant correlations. Just for a record, the application of this new tool and technology can provide a significant and competitive advantage in the sport of Pencak Silat. In other words, the learning process (training) is not only given in a traditional form but must be arranged in a systematic, fun, and inspiring way by utilizing the help of digital technology. Technology in learning is broadly understood as a medium employed to help succeed in teaching, thereby changing the learning process to be interesting, motivating, and fun (34, 35).

This innovative learning refers to demands that are integrated using technology according to the development of the digital era. It is of great concern, even in physical education and physical exercise.

Hasil dari penelitian ini menjadi pertimbangan untuk para pelatih yang ingin mengukur

kecepatan tendangan pada pencak silat dengan teknik sabit, secara dinamis. Sehingga hal ini tidak hanya dapat meningkatkan ketepatan tendangan akan tetapi, juga dapat meningkatkan kecepatan aksi dan reaksi.

As mentioned in the preceding sections, the product development is a kick-speed measuring tool with a dynamic target, which was a swap from a manual to an automatic process with the help of digital technology. This is corroborated by the research of Chow et al., (2008) and Diedrichsen et al., (2010) stating that the dynamic movement of the target can change the movement coordination pattern using various steps adapted to the match situation (36, 37). Bolander et al., (2009) also stated that the target distance affects kick performance because as the distance increases, the impact of force decreases, with a rise in reaction time (38). Based on the measuring tool developed and scores and judgments attributed by experts, like the reliability test in the men's small group trial that obtained an r-value of 0.819 with the "High" category and in the women's small group trial the r-value of 0.988 was obtained with the "High" category, for instance, it would be one of the advancements in products designed to be more effective than learning models and assessments that still use manual methods. Therefore, this tool is suitable for assessing the speed of martial arts kicks, both for learning and competitions.

This research produced a prototype tool that can measure the speed of Pencak silat kicks, but in the implementation and results of the study, there were several limitations, including for consideration of subsequent research, namely, 1) There was no calibration test for each component of the tool, due to the time and cost that had to be delivered, which cannot be fulfilled by the

researcher himself; 2) Validity tests are only limited to the validity tests used.

## CONCLUSION

In conclusion, the developed kick speed measuring device with a digital-based dynamic target for Martial Arts learning was named the "Co Patuih Kick Test" This measuring tool can also be used in training and matches, thereby making it easier for the performance of teachers, athletes, and referees to assess the speed of kicks both during the training or competitions.

## APPLICABLE REMARKS

- Co Patuih Kick Test a measuring tool can be used in training and matches, thereby making it easier for the performance of teachers, athletes, and referees to assess the speed of kicks both during the training and competitions.
- A measuring digital tool for kick speed "Co Patuih Kick Test" can readily, practically, and accurately be used to determine the speed of Pencak Silat kicks.

## AUTHORS' CONTRIBUTIONS

Study concept and design: Damrah, Nurul Ihsan. Acquisition of data: Alfi Muharel. Analysis and interpretation of data: Anton Komaini. Drafting the manuscript: Ilham. Critical revision of the manuscript for important intellectual content: Ilham. Statistical analysis: Muhamad Sazeli Rifki. Administrative, technical, and material support: Ilham. Study supervision: Sepriadi.

## CONFLICT OF INTEREST

The authors mention that there is no "Conflict of Interest" in this study.

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