Volleyball Practice Skills With Intelligent Sensor Technology Model To Develop Athlete'sCompetency Toward Excellence

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ARTICLE INFO	ABSTRACT
	In this research study, the investigator explored the utilization of intelligent sensor technology in the skills training process for volleyball players, aiming to enhance athletic performance and achieve specific goals. The research encompassed three key phases. The Volleyball Intelligent Sensor Technology (ViST) Model underwent evaluation by specialists, demonstrating its consistency and applicability for elevating the skills of elite-level volleyball players. Consequently, the ViST Model process was employed to design an intelligent sensor technology system tailored for volleyball skills training, featuring the ability to execute a predefined training program.This innovative system enabled volleyball players to engage in practice sessions with a robotic training partner, capable of following the training program meticulously. Functioning as both a trainer and a coach, the robotic partner assessed training outcomes, proposed corrective measures, and refined athletes' training approaches, thereby enhancing effectiveness. Athletes could engage in skill development at their convenience, fostering discipline in training and accelerating their performance and potential growth.
	Keywords: *Practice skills, Competency, Intelligent Sensor Technology, Volleyball*

1. INTRODUCTION

Sports, primarily designed to promote good health, also serve as entertaining and income-generating activities. Competent athletes not only garner reputations and societal acceptance but also instill pride and self-confidence. Beyond individual benefits, sports contribute to community bonding, fostering love, unity, generosity, and forgiveness. Acceptance of wins and losses cultivates valuable individuals for society. The evolution of sports has given rise to new knowledge in areas like sports science, encompassing anatomy, physiology, biomechanics, skills training, sports nutrition, sports psychology, sports medicine, and sports technology.

The Ministry of Tourism and Sports emphasizes athlete development, sports industries, and sports tourism. Sports excellence enhances a country's reputation, achieved through representative athletes' success at international events, utilizing knowledge and innovation in sports science and technology. The sports industry, notably in football, basketball, volleyball, beach volleyball, tennis, and badminton, relies on sports science for advancement. Integrating technological knowledge with sports science is vital for achieving diverse sports objectives.

Information technology has significantly impacted sports science, exemplified by the application of sensor systems in volleyball training. A study on the "Sensor system for augmented feedback applications in volleyball" explored sensor systems' use in volleyball, providing valuable insights into regulations and problem-solving. The proposed sensor system, cost-effective and capable of movement detection, proved suitable for biofeedback applications, assisting professional volleyball coaches.

Elevating athletic performance to excellence involves applying intelligent sensor technology to sports science. This enables athletes to practice without time constraints, with automated assessments and robots as training

partners for various tasks. These factors accelerate skill development, offering stable, accurate, and precise training sessions. Real-time monitoring by coaches, even remotely, and access to training records enhance the system's effectiveness. The intelligent sensor technology system not only helps athletes achieve high performance goals but also contributes to community prosperity, motivating people to prioritize sports and exercise for a healthy lifestyle. Successful competitions bolster global sports industry leadership for nations.

2.   OBJECTIVES OF RESEARCH

The research objectives are:
- To synthesize the process of training volleyball practice skills with intelligent sensor technology.
- To develop volleyball practice skills withintelligent sensor technology model.
- To evaluate volleyball practice skills withintelligent sensor technology model.

3.   RESEARCH HYPOTHESIS

The evaluation of the sports skills training model with intelligent sensor technology yielded exceptional results, indicating a high level of performance. The effectiveness of the model was evident in its ability to significantly enhance sports skills training. The assessment showcased positive outcomes, affirming the success of integrating intelligent sensor technology into the training process. These promising results suggest that the implemented model has successfully met or exceeded the predetermined performance standards, demonstrating its potential as a valuable tool for advancing sports skills training.

4.SCOPE OF THE RESEARCH

4.1   Population and Sample
The research population was five experts in volleyball or sports science and six experts in information technology and communication for education. The research sample comprised eleven experts who have the following qualifications.
(1)   Experience as an expert in volleyball or sportsscience of more than five years or a graduate with a Doctorate of Philosophy.
(2)   Experience as an expert in information technology and communication for education who isa Doctor of Philosophy or an Assistant Professor.
4.2   Variables
The independent variable is the volleyball practice skills with intelligent sensor technology model. The dependent variable is a result of evaluating volleyball practice skills with an intelligent sensor technology model.
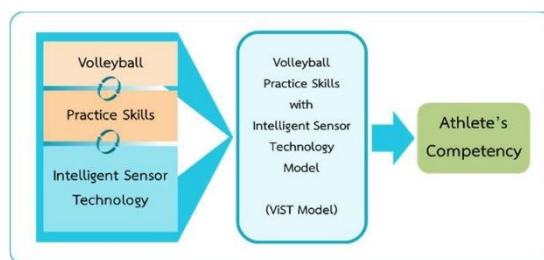
4.   CONCEPTUAL FRAMEWORK

Figure 1. Volleyball Practice Skills with IntelligentSensor Technology conceptual framework.

5.   RESEARCH INSTRUMENTS

- The volleyball practice skills with intelligentsensor technology model.
- The Evaluation form of volleyball practice skillswith intelligent sensor technology model.

6.   DATA COLLECTION

The data collection from the experts proceeded asfollows:
Step 1: Invitation letter with attachmentssubmitted to the experts.
Step 2: Response to the invitation letter receivedfrom the experts, with attachments.
Step 3: Importing of data and processing ofresults.
Step 4: The summary of results for the evaluationof volleyball practice skills prepared with an intelligent sensor technology model.

7.   LITERATURE REVIEW

8.1   Volleyball

Zhou's research stated that the sport of volleyball isa game in which the players were engaged in position rotations. In the game, there are both attackers and defenders. The volleyball tournament is very dynamic, and players often run to change direction or jump vertically to get the ball. During the game, the players always move quickly andcarefully with consciousness of their actions. Tian's research concluded that volleyball is a sport involving teamwork with a small ball and speedy movements, so it was difficult to analyze the degreeof volleyball movements with a visual system and wearable devices. Therefore, the algorithm for estimating the ball movements by a visual machine,wearable devices to detect different pictures, and wearable optical sensing devices for movements hadto be suitably adjusted to show that some parts of thebody played important roles in predicting ball throwing. Ying's research found that volleyball was one of the most popular sports. Spineand shoulder assessments in serving and attacking with asymmetrical movements might cause negativeeffects on postures and bodies, especially in teens. Most players in the higher levels of games had to exercise vigorously and regularly. Detchirakun'sresearch described that volleyball was a team sport with at least six players. The game is played on a ground divided with a net and uses a ball as a device.The players use parts of their body to hit, punch, andslap the ball over the net so that it falls in their opponents' area. In a similar manner, they defend sothat the ball does not fall in their area.

In conclusion, volleyball is referred to as a sport involving teamwork. The players can be of anygender and age. The game is played both indoors andoutdoors, with 12 players divided into two teams of six in each team and some substitutions. The court hasclear boundary lines and a net to separate each team.The players use their hands to hit the ball over the net,back and forth between the teams. It is prohibited tohold the ball; the ball must travel in the air by hittingit over the net. Each team can play the ball three times consecutively before sending it to the opponents' area.If no team member makes contact with the ball hit bythe opponent team, that team would be the loser andthe winning team will be awarded a score of one (rallypoint). The game must continue until the ball falls tothe ground or cannot be sent to the opponents' area.

8.2   Practice Skills

Barker's research emphasizes the systematic and regular training of emotional skills in sports, highlighting its positive impact on efficacy, pleasure, and participant engagement. While most behavioral interventions align with psychological skills training, they differ by focusing on modifying behaviors. Efficacy improvements directly result from psychological skills training, an integral aspect of sports psychology research. Onsoi & Khamduang underscore the scientific approach to sports skills and training, considering factors like age, gender, and individual differences. Panthong's research further delves into the systematic development of athletes, integrating scientific knowledge for physical, mental, and emotional growth. Long-term planning and collaboration between public and private sectors are crucial for optimal sports development.

Pimjan emphasizes sports skills and training as knowledge, urging consideration of various factors such as age, gender, and individual differences. The conclusion drawn is that sports skills training involves systematic learning and practice, tailored to individual suitability. Focus on consistency, designated training programs, and behavioral modification techniques contribute to trainees' efficacy improvement.

In the realm of intelligent sensor technology, Liu discusses the fundamental role of touch sensors in intelligent systems. Flexible, self-recovering, and high-resolution sensors hold promise for improving quality of life and human-computer interactions. Ahopelto and Batchelor highlight the evolution of smart sensors from basic sensing to intelligent sensing, combining analog and digital signal processing with power management and wireless connectivity. Xhafa notes the prevalence of smart sensing network technologies in daily life, enabling data collection and intelligent applications for smart homes and cities.

In conclusion, intelligent sensor technologies encompass multifunctional devices that detect data, exhibit self-recovery, and perform various tasks, contributing to increased measuring efficacy across diverse domains.

8.   RESEARCH METHODOLOGY

The purpose of this research was to developvolleyball practice skills with an intelligent sensor technology model which will support an athlete's practice and skills training. To achieve the research'sobjectives, the researcher undertook the following steps:

9.1   The synthesis of process training volleyball practice skills with intelligent sensor technology.

Table1. The synthesis element of volleyball practice skills. (Volleyball and Beach volleyball)

Constructs	Material						Measurement		Functions					
	Mobility Devices (wearable)	Fixed Devices	Application Software	Network/Wireless	Data / Database / Cloud database	Object (Data Source)	Body measurement	Environment measurement	Processing	Sensor / Detection	Object assay	Identify location/Tracking	Send/Receive data	Feedback, Investigation
[26]	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
[27]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
[28]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
[29]	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
[30]	✓				✓		✓	✓	✓	✓	✓	✓	✓	✓
[31]	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
[4]	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓

Form Table 1, The synthesis element of volleyball practice skills is shown in Table1 that 5 elements are as follows:
(1) Drill, Training program and Objective (i.e., body hardy, speedy, sequence and game, during,volleyball's skills parameters)
(2) Athlete's competency and measurement(i.e., movement, motion, fluency, speed, body)
(3) Training for personal
(4) Place for training
(5) Testing and Evaluation of practice skill
training

Table 2. The synthesis element of volleyball practiceskills. (Volleyball and Beach volleyball)

Constructs	Material						Measurement		Functions					
	Mobility Devices (wearable)	Fixed Devices	Application Software	Network/Wireless	Data / Database / Cloud database	Object (Data Source)	Body measurement	Environment measurement	Processing	Sensor / Detection	Object assay	Identify location/Tracking	Send/Receive data	Feedback, Investigation
[26]	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
[27]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
[28]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
[29]	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
[30]	✓				✓		✓	✓	✓	✓	✓	✓	✓	✓
[31]	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
[4]	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓

9.2   Development of volleyball practice skills with intelligent sensor technology model.
The results from the document synthesis according to Table1 and Table2 were used to analyze the design and development of the volleyball practice skills intelligent sensor technology model by applying smart sensor technology.

9.3 Evaluation of volleyball practice skills intelligence sensor technology model.
The researcher used the volleyball practice skills intelligent sensor technology model which had been evaluated with the experts' assessment form. The experts came from the fields of the sport of volleyball and information technology and communication for education.

9.   RESULT OF RESEARCH

10.1 The result of synthesize process training volleyball practice skills with intelligentsensor technology.
From Table 3, Analytic use of intelligent sensor technology to support the volleyball skilltraining process, it is found that the use of intelligentsensor technology supports the volleyball skill training process. The objectives of the skill training are defined, the equipment is used to measure and usethe data to process the performance of athletes. By measurement of movement athlete's agility and physiology are focus on individual measurements and evaluate on the performance of athlete's skills practice.

10.2 The result of develop volleyball practice skills with intelligent sensor technology model.
The document synthesis data is provided inTable 3. The Volleyball Practice Skills Intelligent Sensor Technology Model was designed as depictedin Figure 2.

Table 3. Analysis and synthesis the intelligent sensor technology support to volleyball practice skills.

Analysis of Practice skills (Volleyball & Beach Volleyball) and Intelligent Sensor Technology		Material						Measurement		Functions				
		Mobility Devices	Fixed Devices	Software (Application)	Network (Wireless)	Data (Database)	Object (Data Source)	Body measurement	Environment	Processing	Sensor (Detection)	Object (any)	Location Tracking	Send (Receive) data
Drills Training program (objective)	Hardy	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓
	Speedy	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
	Sequence & Game	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
	During	✓	✓	✓	✓	✓	✓			✓	✓			✓
	Skills parameters	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
Athlete's competency measurement	Movement		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
	Fluency Speed	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
	Body	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓
Personal for training		✓		✓	✓	✓	✓	✓			✓	✓	✓	✓
Place for training			✓	✓	✓	✓	✓		✓			✓	✓	✓

Practice Skills (Volleyball & Beach Volleyball)

1. Objective
Analysis and Design for Beach volleyball practice skills
Define objective

1. Volleyball practice skills
 - Basic skills
 - Advance skills
2. Volleyball practice skills for Strengthen
 - Body
 - Mind
 - Accuracy & Preciseness
 - Fluency & Speed
3. Improve training program and smart sensor intelligent technology system
 - Feedback result & summary analysis

2. iPractice
Volleyball practice skills with Intelligent Sensor Technology

1. Practice skills **Pre-test**
2. Athlete and Practice skills program **Intelligent Automatic Matching**
3. Begin training program and **Assessment Smart Testing** until finish

** iPractice <= Intelligent Sensor Technology and Practice skills

4. Feedback
Result and Summary respond

- Test report (Compares and summary)
- Analysis and Improvement report

3. Evaluation
Athlete's competency evaluation automate

1. Practice skills **Post-test**
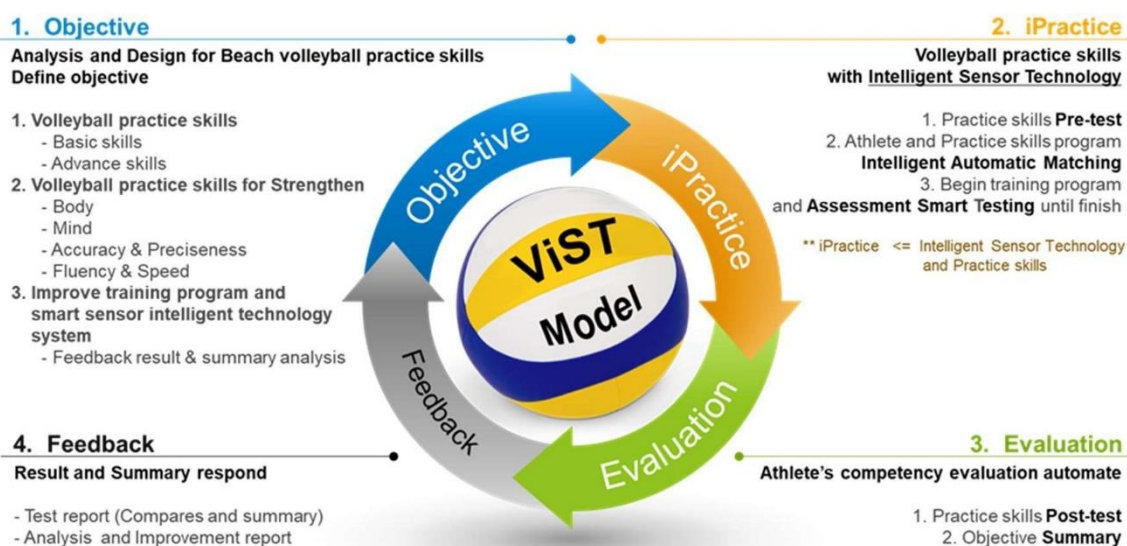2. Objective **Summary**

Figure 2. Volleyball Practice Skills with Intelligent Sensor Technology Model (ViST Model)

ViST Model
From Figure 2. The ViST Model consists of4 sections: First session in blue (Objective) define toobjectives of training and improving the practice skillstraining program accordingly. Second session in orange (iPractice) mean to the skills training processwith intelligent sensor technology. Third session in green (Evaluation) mean to the assessment of resultseach objective skill testing. And the last session in gray (Feedback) means sending the evaluation resultsfeedback to develop and improve training methods. Each session is described as follows.

Section 1 Objective
Define objectives of training andimprovement skills training program accordinglyconcordant that includes design analysis to improvedeficiencies of skills training program and applied technology.
Define objectives of skill training to categorizeskills training programs such as Program 1 is suited to athletes who want to improve in their basic skills, Program 2 is used to strengthen muscles which use toplaying each sport. Example in case volleyball has basic skills requirement for new athletes that skills need to be trained for higher performance. And athletes can play these skills effectively and naturallyfor maximum effective. Training is required to properly design.
(1) Volleyball skills training program is divided into 2 parts.
a. Volleyball basic skills training programis a practice skill exercise in basic posture use in volleyball such as use of venue, basic rules of volleyball.
b. Volleyball advanced skills program thatis practice skills in this section are unique to volleyball. About advance techniques of volleyball that is strategies, rules of offensive and defensive games. In competitive to gain an advantage that is requires the strategic optimization of volleyball by experts.
(2) Volleyball practice skills training programto reinforcement competency. Define practice skills training program according to objectives is veryimportant. A required of sports science knowledge are required to design practice skills for training program.The goals of practice skills design for training program are follow

as:
a. Strengthens to endurance of the athlete's body.
b. Enhance to mental strength of athletes.When they confront with pressure or stress.

c. Make to accuracy in the required skills.
d. Make to agility for athletes.
(3) Analysis and improvement details asfollows:
The assessment results from skills training thathave been tested in 3 parts.
Part 1 Pre-testing before training
Part 2 Assessment test during to trainingprogram.
Part 3 Post-testing after training Analysis and improvement as follow:
a.   Improvement program and drills volleyball skills to achieve results of athlete's competency to requirement.
b.   Fix bugs and improve the system of intelligent sensor technology to enhance efficient, up-to-date, ready-to-use.

Section 2 iPractice

This section is the process of training skills with intelligent sensor technology. The skills trainingprocess is divided into 3 steps.
Step 1: The process before training is to collectathlete's history. Competency and skill testing. Before attending to training program. (Pre-test)
Step 2: Intelligent matching system between skill training program with athlete. (Athlete and Practice Skills Program Intelligent Automatic Matching System)

Table 4. Approach table (Approach of Model)

SEASON TRAINING PROGRAM OVERVIEW																																	
Period	Preparatory Period (PP)								Competitive Period I (CPI)					Competitive Period II (CPII)										R	Competitive Period III (CPIII)								
Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
Mesocycle	I	II				III		IV	V					VI											VII		VIII		IX		X		
	Adap	Intensification				Transfor.		Realiz.	Competition											Competition					Comp.		Comp.		Comp.		Comp.		
Objective (ST)	A	H			MS				ES/V					MS/ES/V						ES/V				R	MS		MS/ES		MS		MS/ES		
Strength Training (ST) - Superset Method																																	
N° of sessions	4	4	6	6	6	6	5	3	5	4	3	4	2	2	3	4	3	4	2	4	4	3	2	0	5	2	2	5	3	3	4	3	2
N° of exercises	13		14						12								14			12	14	10			10	14	12			14	12	14	
Effort	3x12		3x8-10			2-4x4-6			4x4 v.		4x4			4x4 v.			4x4	4x4 v.		4x4 v.					3-4x6-8		3x6v	3x6	3x6v		3x6	3x6v	
Rest	60-90s		60-90s			120-180s			120s		120s			120s		120s		120s		120s					120s				120s				
Load	70-80%					85-90%			60-85%		85-90%			60-85%			85-90%			60-85%					85-90%		85-90% / 60% v.						
Technical Training (TECT)																																	
N° of sessions	2	4	3	5	3	3	3	3	2	2	1	1	3	3	2	2	3	4	3	3	4	3	2	0	3	3	3	4	4	3	2	3	3
Games of the season																																	
Games	0	0	0	0	0	0	1	1	1	2	1	2	5	2	1	0	2	2	2	1	2	1	2		1	2	2	0	2	2	2	1	1
Local Game						OH	AH	AH	OH	AH	AH	OH		OH	OH		AO	AH	AO	OH	AH	OH	AO		OH	AO	OH		AO	AO	AH	OH	AH
Game Type						SC	SC	SC	SC	SC	IF	IC		SC	SL		SL	SL	SL	SL	SL	SL	SL		BC	SL	SL BC		SL	SL	FG	SL	SL

Step 3: The process of attending sports trainingwhen received results of matching to training program.Athletes begin to enter the skill training process. During training has sub-competency test. (AssessmentSmart Testing) And processing system to process sub-testing that is immediately adjust skill training to athletes to finding their desirable characteristics. Drillsof skill is conducted until program training period tofinish and assessment smart test is complete 100%.

Section 3 Evaluation

Assessment of results with objective skills testing that is automatic processing.
(1) Take competency and skills tests afterattending a training program. (Post-test)
(2) The system automatically analyzes to all tests.
(3) The system will send a summary report thatincludes to trainer or coach automatically.

Section 4 Feedback
Delivery to results of evaluation for develop and improve training methods. Submit to assessment results obtained from the volleyball practice skills with intelligent sensor technology system. Return to analysis for bug fixes and further developments i.e.,Test report (Compares and summary), Analysis and Improvement report, for training methods and intelligent sensor technology system.

10.3 The result of evaluate volleyball practice skills with intelligent sensor technology model.]
The researcher collects data from the evaluate form by experts to process the results as show in Table 5.

11.   DISCUSSION AND CONCLUSION

The evaluation of volleyball skills practices using intelligent sensor technology yielded consistently high results across all four assessed parts. The ViST Model, employed to enhance athletes' skills, received commendation for its appropriateness at the highest level. Experts suggested further refinement by splitting and analyzing the evaluation results, enhancing the model's completeness.

The ViST Model, conceptualized in this research, serves as a framework combining smart sensor technology with a volleyball skills training program, aiming to cultivate potential athletes aligned with program standards. Its applicability extends beyond volleyball to sports with similar practical skill processes and methods.

Implementing the ViST Model for a volleyball skills training system with intelligent sensor technology addresses constraints of time and workforce, allowing athletes to optimize training opportunities. The system's objectives include designing a comprehensive structure to fill training gaps, ensuring athletes utilize their training time effectively, considering their individual needs. This involves providing necessary training supports, such as environments, locations, coaches, database management systems, intelligent programs, automation equipment (like robots), and wireless connection networks (e.g., Cloud, Wi-Fi), along with maintenance planning and improvement.

The ViST Model's adoption in developing a training skills system offers the precision of computer technology, enabling athletes to enhance their volleyball skills with high efficacy. This approach facilitates problem-solving and rapid development of athletes with desirable traits, ultimately leading to positive reputations and rewards in international competitions.

12.   ACKNOWLEDGMENTS

13. DECLARATIONS

Conflicts of Interest: The authors declare no conflict of interest.

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