A Machine Learning-Based Framework for Optimizing Sports Talent Identification and Development

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ABSTRACT

This research aims to set a new standard in sports talent discovery, effectively addressing existing gaps and enhancing talent scouting in Indonesia. The validity and reliability of the instrument were assessed using a single-visit, cross-sectional descriptive design in the study. The statistical analysis makes use of the Measuring of Sampling Adequacy (MSA) and the Kaiser-Meyer-Olkin (KMO) test. SPSS Version 23 was used to create the validity test, which evaluates the assessment tool's reliability. The reliability test used in this study was the Cronbach's alpha coefficient. The required dependability score is 0.70 or higher. Reliability is therefore regarded as popular. The research's conclusions offer fresh perspectives on trustworthy and legitimate tools. An Indonesian sports instrument with two components—biomotor 91.4 & 92 and anthropometric 93.4 & 93—is the end product of this research. Because it satisfies the predefined requirements—expert judgment (content validation), theory test (logical validation), and data test (construct validation)—this instrument is valid and reliable. All aspects—self-instruction (94, 88, 98), self-contained (85, 89, 93), stand-alone (82, 84, 99), adaptive (84, 86, 87), and user-friendly (98, 88, 96)—showed encouraging results for material experts. Anthropometric 0.946 and bimotor 0.921 are the results of KMO and MSA Factor. The validity of the instruments is determined by the Anthropometric (0.801-0.981) and Biomotor (0.761-0.933) value ranges. The research concludes that the developed Indonesian sports instrument is valid and reliable, demonstrating high effectiveness across biomotor and anthropometric aspects, as supported by expert validation and rich statistical measures.
Keywords: Talent Scouting, Sport Talent, Validity, Reliability
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Introduction

Misidentification in sports talent scouting can have negative consequences. It can lead to wrong decisions and painful outcomes for talented individuals (Zvan & Čoh, 2018). Coaches and scouts are responsible for identifying talent and selecting athletes for teams, but there are challenges in accurately assessing talent (Vičar & Moudr, 2021). In addition, the identification of potential top athletes based on biological variables is almost impossible. Overall,

misidentification in sports talent scouting can result in unrealistic expectations, injury, and neglect of potential talent.

Sports talent identification can be improved by considering various factors. These factors include an individual's physical and psychological qualities, coach knowledge, and school identification policies (Xiang et al., 2022). Information and Communication Technologies such as IoT and the cloud can also facilitate remote talent identification (Khan et al., 2022). By applying these strategies and technologies, sports talent identification can be improved and optimized, leading to better sports development and performance outcomes.

Schools can be used as sports talent search programs. Several studies have focused on identifying and evaluating sporting talent among elementary and junior high school students (Matsuri et al., 2023; Saltos Palacios & Plúa Mata, 2023; Zulyaden et al., 2022). These studies have used various methods such as aptitude scouting tests, survey techniques, and sports aptitude software to identify students with potential aptitude or talent in a particular sporting discipline. These studies suggest that schools can be essential in identifying and nurturing sporting talent and developing and improving sporting success in different regions (Aliriad et al., 2024; Dwijayanti et al., 2024; Martinus et al., 2024). Recommendations from these studies include providing serious training for gifted students, additional training for less gifted students, and focusing on specific areas to improve the abilities of non-gifted students. By implementing effective talent scouting programs within schools, it is possible to identify and develop sporting talent among students, contributing to the overall advancement of the sports industry. Based on observations, talent scouting still uses general physical condition tests, and some use physical fitness tests, which is undoubtedly far from the ideal conditions of a talent scout. This research

aims to create a talent-scouting instrument based on current sports conditions. This activity includes content validity, criterion validity, and reliability.

Based on data collected through interviews with several coaches, 87.5% stated that their athletes' talent scouting had never been measured, and 12.5% stated that they had been evaluated only on physical abilities and physical fitness. The talent evaluation is only achieved by the athlete's getting a medal, so it cannot be used as a valid reference to measure the athlete's ability. While assessment is based on perceptions, one of the aspects of competence the coach must consider is that it has never been evaluated.

This research will be solved through the development method. It requires development, validation, and testing for several reasons. First, the lack of standardized assessment measures often hinders studies on specific topics (Winters et al., 2023). Second, the development and validation of a measure ensures that it accurately captures the construct of interest and has content validity (Milazzo et al., 2019). In addition, piloting allows for assessing the feasibility and implementation of the measurement tool, providing valuable insights into its efficacy and potential modifications (Goni et al., 2022). In addition, the development and piloting of questionnaires ensure the tool has good content and content validity, criterion validity, and reliability (Renner et al., 2023). Finally, developing, validating, and piloting survey instruments allows the exploration of complex multidisciplinary topics at the national level.

Based on previous research, there are several limitations, namely: special programs for sports-gifted students are limited to high school age (Tanujaya & Safitri, 2023), there is no correlation between body type and sports talent (Wulansari et al., 2017), TID research in team sports is often monodisciplinary (Barraclough et al., 2022), many youth sports coaches lack

expertise in navigating the problem (Crisp, 2019), lack of indication of related sports for predictor-criteria relationships (Bergkamp et al., 2018).

More research is needed on talent scouting in Indonesia. Researchers reinforce novelty by using vos viewer to find out which countries have researched topics related to sports talent scouting in the last three years in sports science. There is very limited research related to talent scouting in Indonesia. Researchers reinforce novelty using vos viewer to find out which countries have researched related to sports talent scouting and topics in the last 3 years in the field of sports science.

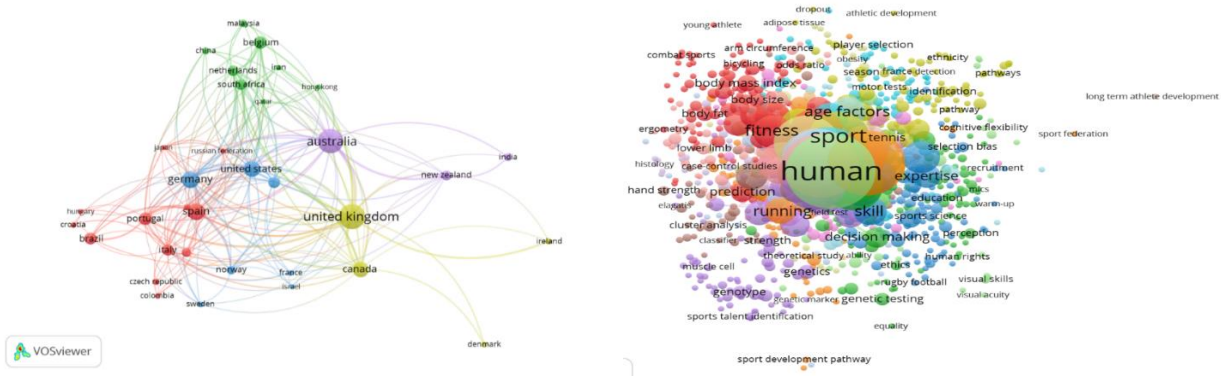

Figure 1: Bibliometric Country Distribution of Similar Studies and Research Topics

Researchers strengthen the novelty by analyzing research on Scopus as many as 1000 articles in the last 3 years to find research trends that are often researched. The keyword typed was Sport Talent Scouting. Countries that often conduct research related to this topic are USA, Germany, Australia and Canada. Indonesia does not appear in the graph analysis. Researchers assume that research related to sports search must be done to spark other similar research. The next graph illustrates that the keywords Human, Sport, Fitness are often researched. While sport talent identification and sport development pathaway are the least. It introduces a holistic system specifically designed for the Indonesian context, integrating advanced methodologies and

technologies. The study's unique contribution includes a structured development process that encompasses thorough validation and real-world pilot testing, ensuring both theoretical robustness and practical applicability. By incorporating novel validation techniques and providing actionable insights from pilot testing, this research aims to set a new standard in sports talent discovery, effectively addressing existing gaps and enhancing talent scouting in Indonesia.

METHOD

Study design

The validity and reliability of the instrument were assessed using a single-visit, cross-sectional descriptive design in the study. Expert judgment (content validation), theory testing (logic validation), and data testing (construct validation) are examples of qualitative methods. Google Forms was used to distribute questionnaires for the study.

Participants

The sample method employed was random cluster sampling. Given the dispersed position of the research population, this approach is used. The sample method used is two-stage cluster sampling. There are two sampling phases in this method. In the first stage, the local community is selected, and in the second, the sample region (Fika et al., 2021).

There were five participants in this study. Strength training and sports performance specialists are experts in their domains. Participants in this study must be actively involved in improving sport performance for a minimum of one year. This data collection does not use gender-specific criteria.

The study was given ethical approval with the conditions that participants had to be willing to take part, be able to opt out at any moment, have their privacy respected, and have

their personal data kept private. Each participant was given a permission form explaining the purpose, procedures, and rights of the study before they could sign it. There was no incentive or extra credit offered for taking part. All study data were collected over a two-month period.

Procedure

A questionnaire was utilized as the means of data collecting. Google Forms and hybrid (online and offline) communication were used. This study was validated using three tests: a construct validation test, a theory validation test, and a reliability test (content validation). Simultaneously, the product's reliability was assessed using professional judgment. The goal of expert judgement is to find any defects in the design so that it can be corrected in compliance with the experts' suggestions. Theories are tested by compiling relevant past research to bolster current investigation. To conduct the data test (construct validation), the collected data is analyzed using SPSS version 23 software and the percentage formula. The following is a description of how expert judgement instruments and product practicality tests are classified:

The sport performance expert grids consisted of 20 questions, the material expert grid of 20 questions, and the trial evaluation to determine validity and reliability consisted of 95 questions. The tool utilized in all phases and methods of data gathering in expert judgment and product testing is a rating scale questionnaire with statements evaluated from one to 10. A numerical rating scale is a statement that a particular quality is to be evaluated by a number, followed by a score of the quality being measured.

The expert collects the data from the validation step, and the trial results are carried out on a tiny scale. Rather than relying on observation, the % technique is used to determine the product's reliability. According to (Stewart et al., 2021), when data is presented as percentages,

proportions, and ratios, decisions can be taken and the answer can be changed. Additionally, factor analysis was performed on the data that was gathered during the field testing phase. The following items are included in this factor analysis: Step one is to reduce unnecessary instrument elements. Collecting logic, construct validity, and content is the second step. The collection of legitimate and trustworthy instruments is possible since the necessary conditions have been met (Rahmawati et al., 2018). According to (Firmansyah & Hariyanto, 2019)., the expert assessment criteria used are outcomes that are invalid and unqualified (0–20%), less valid and qualified (20–40%), valid and moderately qualified (40–60%), valid and qualified (61–80%), and exceptionally valid and qualified (81–100%).

Analytical Statistics

The preconditioning test must be completed before proceeding with the factor analysis of the instrument items that were developed. This approach can be used to establish factor analysis. The following required tests must be passed: 1) The Kaiser-Meyer-Olkin (KMO) test (Larassary, 2020) is used to assess the accuracy and compliance of factor analysis with the 0.5-1.0 standards. A factor analysis that was performed incorrectly was indicated by a score of less than 0.5. 2) The Measuring of Sampling Adequacy (MSA) is the main requirement that must be satisfied in order to apply the KMO test, and it is more than 0.5. With a significant provision of less than 0.5, Chi-Square utilizes Bartlett's Test Of Sphericity (Hanief & Purnomo, 2019) methodology. Further analysis is allowed if the significance is more than 0.5; otherwise, it is not. Using SPSS Version 23, a validity test was developed to evaluate the reliability of the assessment tool and streamline the calculation procedure. The reliability test used in this study was the Cronbach's alpha coefficient (Tomoliyus & Sunardianta, 2020). to aid researchers in comprehending the

measurement's level of reliability. A dependability score of 0.70 or above satisfies the criteria. Consequently, dependability can be viewed as popular.

RESULTS

The information was provided by five experts, comprising two experts in sport performance and three experts in materials. The judgment that the created instrument is suitable for usage and testing can be supported by the data. Details about the information achieved's accuracy are provided below:

Table 1. Sport Performance Expert Judgement

	SP 1	SP 2
Biomotor	91.4	92
Antrophometric	93.4	93

Table 2. Material Expert Judgement

	EJ 1	EJ 2	EJ 3
Self Instruction	95	87	92
Self Contained	86	91	91
Stand Alone	84	86	90
Adaptive	85	88	87
User Friendly	96	90	95

Table 3. Research Instrument Metadata

Sports	Antropometric	Biomotor
Gymnastics	(Taboada-Iglesias et al., 2017) (Santos et al., 2014) (Akther & Boby, 2023) (Sukamti & Pranatahadi, 2018). (Bago et al., 2013).	(Brooks, 2003) (Douda et al., 2018) (Budiarti, 2018)
Swimming	(Dingley et al., 2015; Ferraz et al., 2020; Grimston & Hay, 1986; Mezzaroba & Machado, 2014; Peulić et al., 2023)	(Babu & Nimkar, 2020; Bergkamp et al., 2021; Falk et al., 2004; Mavi & Mavi, 2014; Parakhonko & Khimich, 2022).
Muaythai	(Matarazzo & D Anastasio, 2022) (Diniz et al., 2021).	(Cappai et al., 2012) (Jungman & Wilson, 2016).
Kempo	(Saraya et al., 2018) (Pion et al., 2014)	(Gunawan et al., 2022).
Roller skates	(Pantoja et al., 2014) (Cattle et al., 2023)	(Rebelo et al., 2022)
Track and Field	(Chaware, 2022)(Sánchez-Muñoz et al., 2012)(Keulen et al., 2024)	(Vorovenci, 2019)

Each test item has a different need from other sports. Athletics: anthropometry (height, weight, arm span, leg length) biomotor (sit-up, 40 m run, shocked test, standing broad jump, Step frequency test, and 800m running test), Gymnastics: anthropometry (height, weight, sitting height, arm span) biomotor (sit and reach, vertical jump, 20m run, bridge test). Swimming: anthropometry (height, weight, leg length, arm span, palm width, foot length) biomotor (sit-up,

pull-up, sit and reach, standing broad jump), Muaythai: anthropometry (height, weight, sitting height, arm span, chest circumference, leg length) biomotor (rast, hexagonal, 20m run), Kempo: anthropometry (height, weight, arm length, leg length), biomotor (basketball throw, hexagonal, 20m run), roller skating: anthropometry (height, weight, sitting height, leg length, body fat) biomotor (vertical jump, sit and reach, balance). The Kaiser-Meyer-Olkin (KMO) Test, Measure of Sampling Adequacy (MSA), Bartlett's Test of Sphericity, and the comparison of r count with r table for validity are used to evaluate the factor analysis, validity, and reliability of the instruments. Cronbach alpha is used to compare the coefficient in order to evaluate reliability.

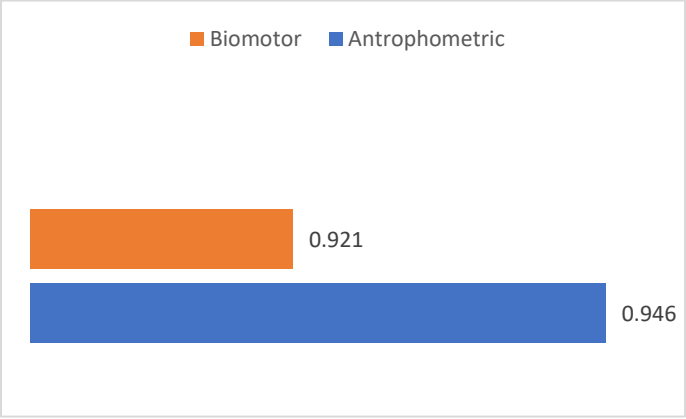

Figure 3. KMO and MSA

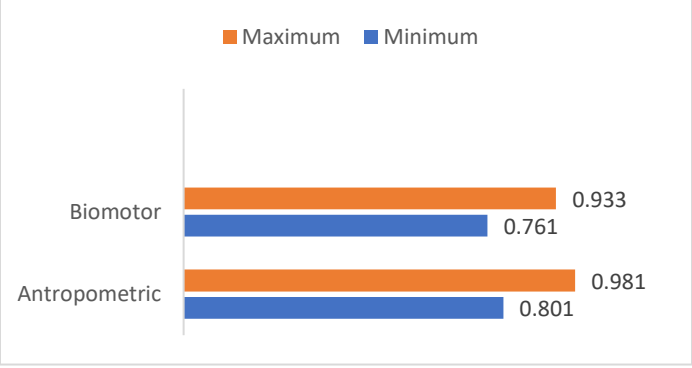

Figure 4. Validity test by using SPPS version 23

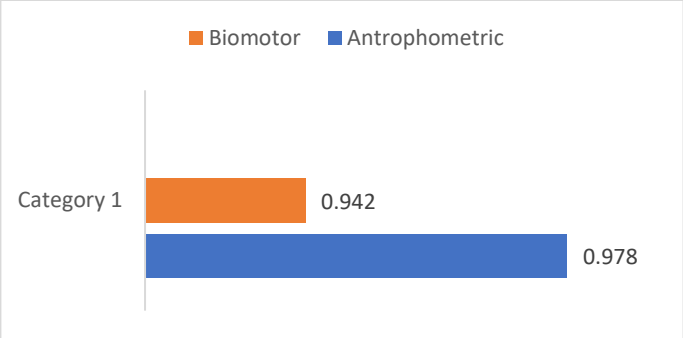

Figure 5. Reability Aspect

Discussion

Based on the factor analysis—which requires a number of steps—the instruments can be deemed reliable and put to use. They are as follows: 1) eliminating instrument items that are highly irrelevant; and 2) meeting the requirements for content, logic, and construct validity. Valid and reliable instruments are essential in conducting robust quantitative research projects, to ensure consistency and validity of results (Dean, 2021). Reliability and validity are important in research because they ensure the correctness of the data and control random errors, which are crucial for valid data collection techniques (Ahmed & Ishtiaq, 2021). Instruments must be valid and reliable to measure local wisdom-based computational thinking skills effectively (Ria & Susilowati, 2023).

The six sports studied are superior sports. The selection of the sport is based on the number of medals won in previous competitions. Effective talent search methods, such as the

Sport Search method, can also be used to identify and develop sports talent in school students (Afrian et al., 2021). In addition, combining machine learning-based approaches with feature selection, can help in the identification of talent in specific sports (Atradinal et al., 2020). Sports talent scouting is important in sports as it helps identify and select individuals who have the potential to become elite athletes. Talent scouting involves evaluating various factors such as motor skills, morphological characteristics, functional tests, and cognitive abilities to determine an individual's suitability for a particular sport (Lamarche et al., 2020). The best time to explore sports talent identification is in early childhood (Xiang et al., 2022). This is because each child is born unique with different talents, and it is important for teachers and coaches to identify these talents early (Larkin & Reeves, 2018). Therefore, a combination of physical tests, genetic analysis and other factors such as anthropometric and fitness data can be used to differentiate future career achievements in sports.

The use of statistical analysis can contribute to the talent scouting process by diagnosing a person's physical fitness profile and identifying those with above-average abilities for sports performance (Muniroglu & Subak, 2018). Talent scouting also helps in systematizing the identification of sporting talent among students, which enables the development of specific sports based on their abilities (Utamayasa, 2021).

By identifying talent early, it allows for a long process of development and training to hone those talents. In addition, physical tests and genetic analysis can also be used to identify talent in the field of performance (Simonek & Židek, 2019). However, it has been found that genetic analysis results may not always match fitness test results (Till et al., 2016). However, sociocultural factors, such as extracurricular sports participation, sports structure, and parental pressure, can influence athlete development (DeCouto et al., 2021). Sociocultural factors shape

an athlete's developmental journey, including the types of training designed and the characteristics of a good coach (Sullivan et al., 2021).

This study was limited to six leading sports. Future research needs to be conducted with a broader scope through various sports. Traditional coaches or sports organizations may resist new talent identification methods. To overcome this resistance, researchers need to provide solid scientific evidence (table 3) regarding the effectiveness of new methods in talent identification. Using data and statistics from other studies can strengthen the argument for change. To facilitate acceptance, researchers integrate new approaches with existing practices so that coaches do not have to abandon everything they already know. This can include training or workshops to introduce new methods gradually. Involving coaches and athletes in the instrument development process can help reduce resistance. Feedback from them can provide valuable insights and increase ownership of new methods.

Conclusion

The findings of this research provide new insights into valid and reliable instruments. The result of this research is an Indonesian sports instrument consisting of 2 aspects: biomotor 91.4 & 92, & anthropometric 93.4 & 93. This instrument is valid and reliable because it has met the predetermined prerequisites, namely expert judgment (content validation), theory test (logical validation), and data test (construct validation). For material experts, all aspects showed promising results, namely: self-instruction (94, 88, 98), self-contained (85, 89, 93), stand-alone (82, 84, 99), adaptive (84, 86, 87), and user friendly (98, 88, 96). KMO and MSA Factor result in bimotor 0.921 and anthropometric 0.946. The instruments are valid based on the value range of Anthropometric (0.801-0.981) & Biomotor ((0.761-0.933). The instrument's reliability is more

than 0.7, which means instrument reliability. Future research recommendations are to conduct comparative studies between various models of sports talent discovery. They were implemented in other countries to identify best practices that can be adapted in Indonesia. Deeper exploration of the influence of environmental factors, such as family and community support, on athlete talent development. Finally, an ongoing evaluation of the implemented programs will be conducted to ensure the sustainability and effectiveness of the approach in discovering future sports talent.

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