JKSCI

한국컴퓨터정보학회논문지
Journal of The Korea Society of Computer and Information
Vol. 25 No. 9, pp. 117-123, September 2020
https://doi.org/10.9708/jksci.2020.25.09.117

The Performance Evaluation System for the Modern Pentathlon based on the Concept of Performance Analysis of Sport

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[Abstract]

This study intended to develop the Performance Evaluation system for the modern pentathlon such as an Olympic sporting event. The performance evaluation index system for the modern pentathlon was developed by Microsoft Excel 2016 with Visual Basic for Application that it is able to be understandable for the practical field in sport. Consequently, the system for the performance evaluation index is able to be developed within the concept of performance analysis of sport such as a notational analysis of sport. And the performance indicators for the performance evaluation index were selected by the skills to make successful outcomes. Finally, the simulation with big data gathering by the developed system would be requested that systematic reviews on successful outcomes in other sporting events would be necessary.

▸ **Key words**: Indexing, ratio of improved performances, performance analysis of sport, Performance Evaluation system

[요 약]

본 연구는 올림픽 정식 종목 중 하나인 근대5종 경기의 경기력 평가 시스템을 개발하는데 주된 목적을 두었다. 근대5종을 위한 경기력 평가 지표 시스템을 위하여 마이크로소프트사 엑셀 2016을 VBA와 함께 사용하였으며, 현장 적용을 고려하여 개발하였다. 결론적으로 경기력 평가 지표를 위한 시스템은 스포츠부호화분석 이론의 적용으로 구현이 가능하였으며, 경기력 평가 지표 시스템에 사용되는 분석인자는 성공적인 운동수행 기술에 기초하여 선정하였다. 마지막으로 향후 개발된 시스템을 활용한 빅데이터의 시뮬레이션이 요구되며, 타 스포츠종목의 성공적인 운동수행 결과를 토대로 한 체계적인 고찰이 필요하다고 사료된다.

▸ **주제어**: 인덱싱, 경기력 향상 비율, 스포츠경기분석, 경기력 평가 시스템

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• Received: 2020. 09. 14, Revised: 2020. 09. 22, Accepted: 2020. 09. 23.

http://www.ksci.re.kr pISSN:1598-849X | eISSN:2383-9945

I. Introduction

Computer science has been developed and affected to different domains such as economy, social science, accounts, or sport science. Among different domains against the computer science, the quotation or application of computer science into a particular area in academic has not been immediately expended in sport science. The main reason of slow application from the concept of computer science to practical field in sports was that main contents in sport science have been not easily accessible. In terms of convergences, it would be very important precondition that the contents of linkage between difference domains or principles would be understandable [1]. Current research relevant to the sport science and computer science shown that there would be greater expectations when the environment of convergence between both domains [2]. Obviously, the convergent research between both domains, such as computer science and sport science have to consider many attempts in order to understand and to develop potential environment of convergence.

Therefore, this study is willing to suggest how to understand between the computer science and the sport science with the development process of performance evaluation for the modern pentathlon such as a fundamental event in Olympic Games.

II. Preliminaries

1. The modern pentathlon

The modern pentathlon is a sport event that Pierre Coubertin who suggested the modern Olympic Games create the modern pentathlon [3]. The modern pentathlon includes 5 different sports' events such as swimming, fencing, horse riding, running and shooting. 5 different events indicate that in era of ancient the solders should have abilities of running, throwing the javelin, throwing a stone, wrestling with enemies and escaping from the enemies in the era of ancient. The ancient events have quoted to the modern abilities for solders such as riding a horse (horse riding), shooting enemies(shooting), competing with enemies(fencing), escaping toward to river(swimming) and escaping on the ground(running). Thus, the modern pentathlon as a sport events request multi-sporting abilities such as strength, speed, and endurance. Recently, a major change of rules in the modern pentathlon was in a combination between running and shooting that athletes would be required the concentration during high intensity of performance. It assumed that the rule change could affect the performance levels and strategies during a competition [4]. Thus, to analysis of match contents in the modern pentathlon would be worthy that it could be a comprehensive research when the result of performance analysis of sport would be applied in the practice efficiently.

2. Performance Analysis of sport

Performance analysis of sport is able to gather the performance analysis with objective perspectives based on the notational analysis of sport[5]. The notational analysis of sport is willing to notate every single event during the performances in sport such as passes, dribbles and shootings in soccer. In order words, the events would be the factors or variables relating to successful outcomes. The definition of successful outcomes would be in subjective perspectives, but the concept of performance analysis of sport keens to guide the objective way to observe performances [6]. The objective observation is the most important to the field of sports that it could be great effects to athletes' training. Hughes and Franks(2004) have proven that the subjective observation was not suitable to be used in coaching process because of ineffectiveness of data uses [7]. Thus, the subjective observation should be reduced, and the objective observation should be increased in the process of analysis in sport according to the concept of coaching process [8]. The needs of performance analysis of sport with the objective observation [9] has been already suggested within

the routine of coaching process that continuous research on the evidence of the needs of performance analysis of sport. Fig 1 is shown the needs of objective observation in the routine of coaching process.

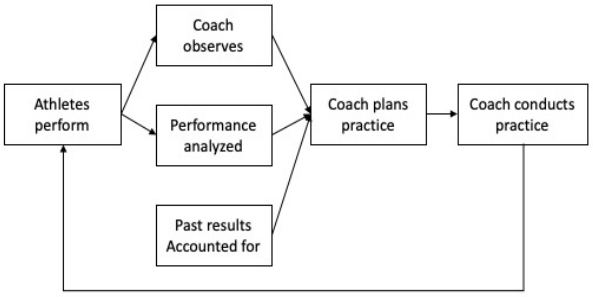

Fig. 1. A simple schematic diagram representing the coaching process (Hughes& Franks, 1997, p. 7).

However, the objective observation is notable to be efficient that the system design and development should be also concerned as much as the concept of objective observation has been greater value of the main concept of performance analysis of sport.

3. System for performance evaluation in sports

As the development of ICT technology comes into the field of sport, the application of ICT technology has been applied for the system design of performance analysis of sport as well as Digital pad [10], Concept keyboard [11], and wearable devices [12]. The evaluation of performances in sport is used to determine the data with statistical approaches such as individual evaluation for tennis player [13], team performance in soccer world cup [14], individual evaluation for swimmers [15]. Previous researches based on the statistical approaches in order to analyze the performance within the evaluation of individual performance or team performance, but it is only the theoretical perspectives and not the practical aspects. Therefore, recent researches are willing to bring the performance analysis of sport from theory to practice in the field of sport science [16]. Technical evaluation on the system developed has been usually concerned in the computer science area, however, it has been depending on the technical report in the area of performance analysis of sport. The accuracy of data collection has been considered in the field of performance analysis of sport that the tracking information system using the GPS(Global Positioning System) technology has even concerned [17]-[20].

III. The System of Performance Evaluation for the Modern Pentathlon

1. Performance Indicators

Performance Indicators which are main variables to analyze the performances have selected within the official regulation of the modern pentathlon. Table 1 is shown that the performance indicators were separated in each sport event such as fencing, swimming, laser run and horse riding.

Table 1. Performance Indicators in each event

Events	Performance Indicators
Fencing	Name of athlete, Name of opponent, Action time, Scoring point on body, Scoring skill, scored location
Swimming	Name of athlete, Lane no., Time duration by distance, Final time
Laser Run	Name of athlete, Time duration by categories, Final time
Horse Riding	Name of athlete, Timing by obstacle, successful /unsuccessful action, rejected/falling-down

2. System Design and data processing

The system design was to consider the feedback to practice of the field of the modern pentathlon that it included data input, data storage, data analysis, results reporting and feedback as above Fig 2. For the data input, the system was developed by Microsoft Excel 2016 with Visual Basic for Application (VBA). The reason of selection for programming as Excel with VBA was for catholicity in the practical field of sports that easier database for the practice would be the Excel. All sport events such as fencing, swimming, laser run and horse riding, were concerned within conveniency of data collection that it would be necessary to

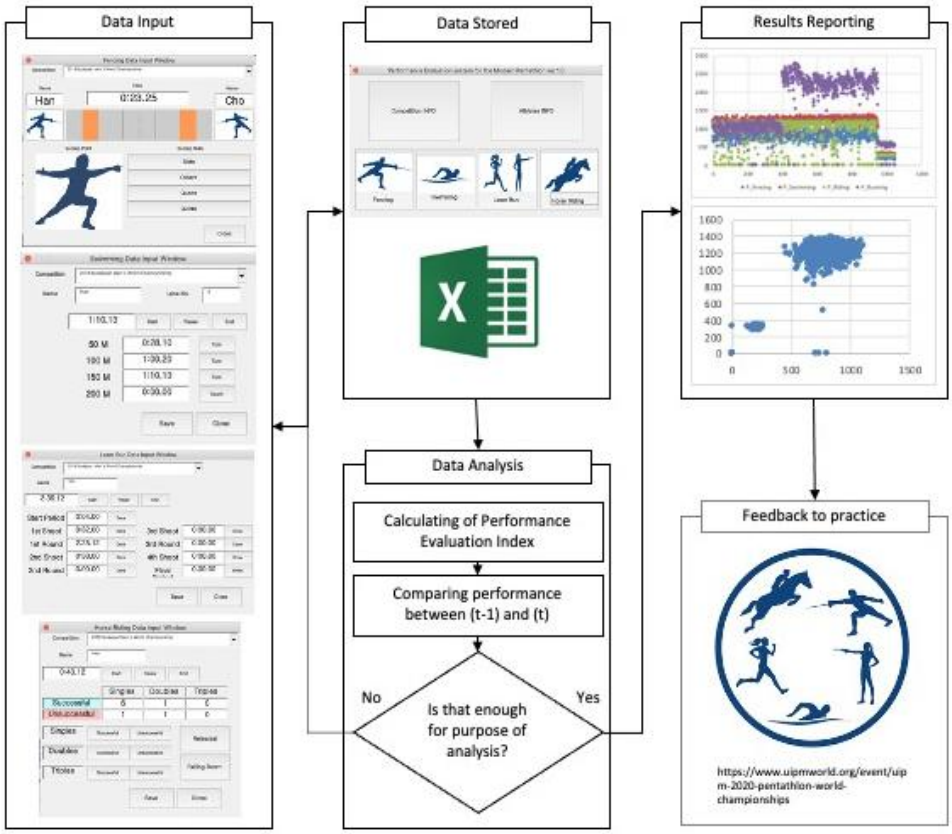

Fig. 2. Flow chart of system design and data processing

consider data collection time, easy data input, and training of data collectors. Particularly, in data input for fencing, the data of 2 athletes who have a match in fencing event were collected at same time that timing of point scored, location of point scored, scored body part, and skills (attacking and defending) were collected by orders. In data input for the swimming, only 1 athlete's data was collected that a stop-watch were designed for record timing by distance categories (every 50 m). The time data was also importantly collected in an event of laser run that collected data was based on the distance categories and the data was collected by a second. For data input for the horse riding, the results of riding obstacles (i. e. single, double and triple obstacles) after the performances were separately collected within the outcomes of performance such as successful/ unsuccessful, rejected by horse, or falling down from a horse. All concepts of system design were considered that an advanced analysis of performance evaluation was required even though the official data has not been provided. After the data input done, all data was stored into excel worksheets in order to apply the performance evaluation index on stored data. Within the stage of data analysis, firstly, the performance evaluation index was calculated on each sporting event and combined into total performance evaluation index. Secondly, the performances were compared with performance evaluation index between previous competition (t-1) and current competition (t). After the data analysis done, all performance indicators were visualized on the report sheets and were ready to feedback to the practical field of modern pentathlon.

3. Modelling for the Performance Evaluation Index

The evaluation of performances was commonly utilized with statistical approaches [21]-[23]. The percentile was easily used to determine the categories of performance as well as advanced

statistics used [24]. However, previous studies relevant to the development of evaluation index were concentrated to team sports such as volleyball, baseball, soccer and rugby, but not an individual sport event. In other words, the performance evaluation index for the modern pentathlon would be differently developed.

Thus, the modelling of the performance evaluation index in this study was concerned within the improvement of individual performances between previous and current competition. Equation 1 is indicated performance evaluation index for Fencing where PFW is frequence of winners in previous competition(t-1), PTM is total number of fencing matches in previous competition(t-1), CFW is frequence of winners in current competition(t), and CTM is total number of fencing matches in current competition(t).

$$P.E.I.\ \text{for}\ fencing = \frac{PFW}{PTM} - \frac{CFW}{CTM}$$

Equation 1. Performance Evaluation Index for fencing

Equation 2 is for performance evaluation index for swimming where WRP_{sm} indicates for "World Record in Previous competition for swimming", PRP_{sm} for "Personal Record in Previous competition for swimming", WRC_{sm} for "World Record in Current competition for swimming", and PRC_{sm} for "Personal Record in Current competition for swimming".

$$P.E.I.\ \text{for}\ swimming = \frac{(WRP_{sm} - PRP_{sm})}{(WRC_{sm} - PRC_{sm})}$$

Equation 2. Performance Evaluation Index for swimming

Equation 3 is about the performance evaluation index for laser run where WRP_{lr} indicates for "World Record in Previous competition for laser run", PRP_{lr} for "Personal Record in Previous competition for laser run", WRC_{lr} for "World Record in Current competition for laser run", and PRC_{lr} for "Personal Record in Current competition for laser run".

$$P.E.I.\ \text{for}\ laser run = \frac{(WRP_{lr} - PRP_{lr})}{(WRC_{lr} - PRC_{lr})}$$

Equation 3. Performance Evaluation Index for laser run

Equation 4 is shown the performance evaluation index for horse riding where ODP is for "frequencies of Obstacle Dropped in Previous competition", FDP is for "frequencies of Falling Down from horse in Previous competition", ODC is for "frequencies of Obstacle Dropped in Current competition", and FDC is for "frequencies of Falling Down from horse in Current competition".

$$P.E.I.\ \text{for}\ riding$$
$$= \left\{\left(1 - \frac{ODP}{15}\right) - \frac{FDP}{0.25}\right\} - \left\{\left(1 - \frac{ODC}{15}\right) - \frac{FDC}{0.25}\right\}$$

Equation 4. Performance Evaluation Index for horse riding

IV. Conclusion

This study was intended to develop the performance evaluation index system for the modern pentathlon. As a part of introduction mentioned that the convergence between computer science and sport science would guide to provide efficiencies of application from the concept of computer science to the field of sports' practice. The development of the performance evaluation index system was concerned within the perspectives of sports' practice that the layout of data input in the system was designed for convenience. According to the results of this study, potential guides are found as following conclusions in order to concern the development of performance evaluation index system for other sports. According to the results of this study, potential guides are found as following conclusions in order to concern the development of performance evaluation index

system for other sports.

1) The system for the performance evaluation index is able to be developed within the concept of performance analysis of sport such as a notational analysis of sport.

2) The performance indicators for the performance evaluation index were selected by the skills to make successful outcomes.

3) The simulation with big data gathering by the developed system would be requested that systematic reviews on successful outcomes in each sporting event would be necessary.

Consequently, the prospect of the convergence between computer science and sport science is brightly potential, so that further researches on the convergence based on the contents from sport science would be worthy for both domains in academical perspectives.

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