The prerequisites for hardware and software support in the digitalization of sports

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Abstract

Objective of the study was to substantiation of requirements for the development of sports APC in the context of phygitalization.

Results of the study and discussion. A retrospective examination of scholarly articles and empirical investigations in the realm of the development and implementation of sports APC. The examination of the four stages of the evolution of the sports agro-industrial complex in the context of digitalization has led us to identify the following prerequisites:

The APC must encompass at least one stage of sports training, providing all the necessary tools for coaches and athletes in competitive activities. It should not only evaluate individual parameters but also a system of measured parameters. The coach should be able to combine, create, and modify existing programs. The system should allow for the collection of both raw data and data that has been processed using artificial intelligence technologies, at a selected level of generalization, while maintaining the declared accuracy parameters. It should also enable seamless interaction with data, ensuring that no qualitative or quantitative losses occur during active sports activities. Additionally, it should be immune to theft or malicious use, thanks to the use of wireless and cloud technologies. Collaborate with a wide range of digital offerings and engage with the community.

Keywords: *phygitalization of sports, Games of the Future, phygital sports, eSports, digital sports, digitalization of sports, phygital center.*

Introduction. After the International Multisport Tournament «Games of the Future» the demand for the creation of phygital centers is growing both in our country and abroad. Modern sports science in the context of phygitalization of sports [4] cannot avoid turning to high-tech solutions that allow obtaining data, including large data, managing and analyzing them to obtain new knowledge in the field of theory and methodology of physical education and sports [1, 2]. At the present stage, wireless communication, cloud technologies for accumulating the required amount of information and artificial intelligence technologies (including machine and deep learning) for processing the received data are used to improve the use of the APC [6, 7, 8, 12, etc.].

Objective of the study was to substantiation of requirements for the development of sports APC in the context of phygitalization.

Results of the study and discussion. A retrospective analysis of the development and application of sports APCs allowed us to identify four historical and technical periods:

Stage 1. Sports APCs are used to conduct scientific research and are not widely implemented not only in competitions, but also in the process of sports training. Today, it is precisely such APCs that are most widely represented in higher education institutions engaged in the training of qualified personnel for the sports industry (see table).

Stage 2. Sports APCs are integrated into the training process - they collect both urgent information about the process parameters and accumulate significant amounts of data for their in-depth analysis in order to improve the planning of the training process [3, 13, etc.]. It should be noted that this period chronologically coincides with the emergence of digital

Examples of hardware and software systems (HSS) used in organizations for training personnel in the sports industry

Organization	Equipment
RUS «GTSOLIFK» Research Institute of Sports[1]	1. Hardware and software complex Qualisys 2. Polar Team System 3. Universal Activation Meter AC-9K 4. Hardware and software complex for analyzing technical actions of athletes 5. Hardware and software complex for high-speed shooting and analysis of impact movements 6. Hardware and software complex «Plantovisor» (Cindy Grazia 2007) 7. Complex of psychodiagnostic studies «Psychophysiologist» 8. Multifunctional computer complex «Neuro-MVP-8» 9. DartFish system 10. Stabilometric complex «Stabilan-01»
NSU named after P.F. Lesgaft[2]	1. Delsys wireless hardware and software biofeedback system 2. Valenta hardware and software system 3. Tanita DC-360 body composition analyzer 4. Polar 625 heart rate monitor 5. Electromyogram recorder 6. ST-150 stabilotrainer game controller 7. GREENFOOT musculoskeletal system diagnostics device 8. KM-AR-01 Diamond V cardiorespiratory system and tissue hydration monitoring system 9. SCATT-biathlon training system
VNIIFK (self-examination 2022)[3]	1. Telemetric electromyography device with a set for analyzing the biomechanics of movement 2. Diagnostic PAC «DiaSled» 3. Automated complex for functional diagnostics of the body's condition MESKRIN-VOP (general practitioner) 4. Equipment complex for video analysis of movements 5. Medical device ABC-012 «Medass» with software 6. Polar command pulse measurement system
SPbNIIFK[4]	1. Software for video analysis Dartfissh Pro Suite 8.0 2. Hardware and software complex «PAKPF-Mirage» 3. Device «Poly-Spectrum-8/E» 4. Device «Stabilan-01-2» 5. Polar Team2 6. Multifunctional computer complex for EEG and VR research «NeuronSpectrum-2» 7. Software and hardware complex module for training and reaction assessment SIGVET 8. Complex KM-AR-01-»Diamant» 9. Wireless automated system for testing athletes Fusion SmartSpeed Lite
SibSUFK[5]	1. Hardware and software complex «APKKPF» (BioMouse) 2. Hardware and software complex «Valeoscan» 3. Heart rate variability analysis program «PolySpectrum-Rhythm» with a set of equipment 4. Hardware and software complex «BOSLAB» with multichannel interfaces 5. Multifunctional computer complex for studying EEG and evoked potentials «Neuro Spectrum-3» 6. 2-channel multifunctional computer complex for studying EMG and SSEP «Neuro-EMG-Micro» 7. Stabilotrainer ST-150 8. Computer stabilizer analyzer with biological feedback «STABILAN -01» 9. Computer complex «PolySpectrum-S» 10. Hardware and software complex «Sports psychophysiologist»

[1]Russian University of Sport, Equipment Available at: https://gtsolifk.ru/nauka/nii_sporta_i_sportivnoy_meditsini/oborudovanie (access date: 20.03.2024).
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sports (including eSports), but has its own specifics in methodological terms - the need to use a complex technical device with modern software and hardware parts to prepare an athlete for participation in competitions, as well as the digitalization of the competitive activity itself, is recorded. However, IT companies create sports APCs without scientific justification.

Stage 3. Sports APCs began to cover not only training, but also competitive processes. Therefore, to study the problem of designing and using hardware and software support, the method of modeling business models was used, including the design of software and hardware and software products (Figure 1).

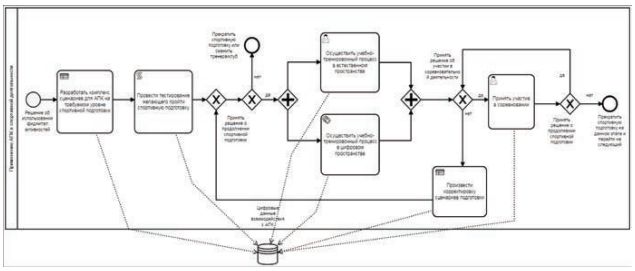

Figure 1. Modeling the use of sports APC in training and competitive activities using the BPMN methodology (the third stage of APC development)

As a result of modeling (service rating 8.2). We received a process with a high degree of automation, where the coach (head of sports training) has the ability to pedagogically influence the athlete and receives additional opportunities to organize the management of the sports training process based on data (Data Driven approach). For example, it was implemented by various authors in managing the activities of football players depending on the trajectories of their movement on the field [10, 11].

Stage 4. Sports APCs expand their functionality due to interactive interaction with the sports community (fans) [5, 14, etc.]. Research by European scientists has shown the need for mandatory consideration of this factor, which affects both the behavior of athletes and judges [9, 15, 16, etc.]. For example, Cisco has developed an APC to create a management system based on sports and fan activity data (Figure 2).

Conclusions. An analysis of four stages of development of sports ACS in the context of phygitalization allowed us to formulate the following requirements submitted for discussion:

1. Compliance – the ACS should fully cover at least one stage of sports training.

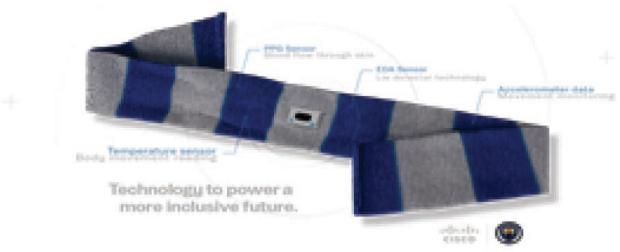

Figure 2. Cisco developed an automated control system to create a management system based on sports and fan activity data

2. Sufficiency – the ACS should contain all the tools necessary for a coach and an athlete in competitive activities.

3. Integrity – the ACS should evaluate not only individual parameters, but also a system of measured parameters.

4. Flexibility – the ACS should allow a coach to combine, create original methods and make changes to existing programs.

5. Informativeness – the ACS should allow receiving both "raw", unprocessed data and data that has already undergone intellectual processing (using artificial intelligence technologies) at the selected degree of generalization and maintain the declared accuracy parameters.

6. Reliability – the ACS should interact with data without the possibility of qualitative and quantitative losses (during active sports activities, using wireless and cloud technologies), theft or malicious use.

7. Openness – the APCS must be able to integrate with various digital services and products, as well as interact with the community.

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