Sports Information Systems: A systematic review

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Abstract

Many professional sport organizations are currently in the process of finding or already using *sports information systems (SIS)* to integrate data from different information and measurement systems. The problem is that requirements are very heterogeneous. That is why no consistent definition of *SIS* and their categories exist, and it is often not clear which fields and functions *SIS* must cover. This work aims to provide a structured comparison of commercial *SIS* available on the market to provide an overview of the relevant features and characterize categories. Following PRISMA guidelines, a systematic search for relevant *SIS* providers was conducted. A catalog of 164 review items was created to define relevant features of *SIS* and to conduct semi-standardized interviews with product representatives. Overall 36 eligible *SIS* from 11 countries were identified and 21 of them were interviewed. The analysis of the interviews has shown that there are features that are present in all *SIS*, whereas others differ or are generally less represented. As a result, different *SIS* categories have been defined. The study suggests a more differentiated categorization of *SIS* is necessary and terms need to be defined more precisely. This review should be considered when companies designing *SIS* or sport organizations select *SIS*.

KEYWORDS: INFORMATION SYSTEMS IN SPORTS, SPORTS INFORMATION SYSTEMS, ATHLETE MANAGEMENT SYSTEMS, REVIEW, SPORTS INFORMATICS

Introduction

In competitive sports, several specialized providers offer *information systems (IS)* dedicated to handle data from different sources and make this data available to the different users in the sport organization. Many clubs and associations are currently in the process of installing *sports information systems (SIS)* in their organizations and are challenged to find an appropriate solution for their requirements. Until now, no catalog of criteria approved by sports science and/or sports informatics is available concerning general requirements of these systems. Neither a systematic review of existing systems has been done. Therefore, the aim of this work is to provide a structured comparison of the different commercial *SIS* on the market.

There is a variety of terms for *sports information systems (SIS)* and as well as high variability in the scope of the available *SIS*-products. No binding definition exists of what exactly is meant by *SIS*. For that reason, it is not clear which fields such *SIS* have to cover and which features they must provide. Some of the *SIS* products offered were developed starting from a specific application (e.g. medical data), which was then extended to other areas in the sport organizations, or complex information systems from industry were applied to sports. As a result, we find largely different products involving different software architectures. These circumstances make it difficult to clearly compare these systems, to define their scope of performance, and to classify them precisely. In practice, this also led to the frequent use of the term *athlete management systems (AMS)* without a clear definition of the term and the features or areas such a system has to cover. Due to the novelty and diversity of *SIS*, which have only emerged in recent years, there is also no systematic overview of the various products, their foci and features. Despite the diversity of *SIS*, first of all, a systematic review requires a conceptual framework.

Sport science shows the need for sport organizations to merge information from different units to provide specific information to individual users and developed the concept of “*Sportart-Informationssystem*” (Lames, 1997). In the context of this work, all organizations related to sport are considered as sport organizations (e.g. sports clubs, sports associations and federations, and sports institutes). The related problem of different units and data sources involved in *training systems* (Schnabel, Harre, & Krug, 2014) was addressed by *sports informatics* already years ago (Baca, 2006).

Due to the many different terms and different scopes of the systems (Table 1), a working definition of *SIS* has to be defined, which mainly refers to *information systems* (Institute of Electrical and Electronics Engineers (IEEE), 2017) and “*Sportart-Informationssystem*” (Lames, 1997), and relates to the basic subjects of *sports informatics* (Baca, 2006):

Sports Information Systems (SIS) are information processing systems based on *Information Technology (IT)* which, together with the associated sports-organizational resources, serve to handle data from various sources in sport organizations within one system and to make this information available user-specific and location-independent via *user interface (UI)*. *SIS* should cover all areas of sport organizations, focus sport-specific processes, be scalable, and integrate methods of data science.

AIS/FIS and *CIS* are very similar and mainly differ in the structure of the sport organization. *Specialized information systems* present data from different sources and generate information with advanced analyses, typically highly specialized in a field of expertise. For example, a *training information system (TIS)* can cover the planning and analysis of training sessions and, for this purpose, contain a training exercise database and import and merge data from tracking systems or other sensors.

Table 1. Categories and short descriptions of information systems in sport.

Category	Description
Sports Information Systems (SIS)	The overarching term for all information systems used in sport, to handle data of different sources and generate information.
Association / Federation Information Systems (AIS/FIS)	SIS with a high focus of merging data from different decentralized locations and sources, for one sport (e.g. national football federation) or for different sports (e.g. Olympic sports federation).
Club Information Systems (CIS)	SIS used in sport organizations that are mainly located in one place in terms of facilities and staff (e.g. clubs).
Specialized Information Systems:	Specialized SIS to merge and present data from different sources, but with high focus and expertise on a specific field.
• Match Information Systems (MaIS)	Specialized in different sources for match data.
• Medical Information Systems (MIS)	Specialized in data of the medical department. The system does not necessarily have to be sport-specific, as the same requirements often exist in other medical facilities.
• Load Information Systems (LIS)	Specialized in data from different sources of load assessment, mostly analyzed by the fitness coaches or the medical department.
• Training Information Systems (TIS)	These systems support the coaches in the planning, implementation, and evaluation of training units.
• Scouting Information Systems (ScIS)	These systems integrate large player databases (player scouting) or match databases (match scouting) and support the scouts in planning events, centralizing reports and analyzing scouting data.
Athlete Management Systems (AMS)	IT-based systems, primarily used to manage individual athletes and groups, documenting and storing related data of different fields, and control objectives, with little focus on information generation and distribution.

There is considerable overlap between *SIS* and *AMS*, the latter term being quite common in the practical field. The Institute of Electrical and Electronics Engineers (IEEE) (2017) defines *management systems* as a “set of interrelated or interacting elements to establish policy and objectives and to achieve those objectives”. Referring to the notion that *AMS* could be defined as IT-based systems, primarily used to manage individual athletes and groups, documenting and storing related data of different fields, and control objectives, not covering the whole sport organization and with little focus on information generation and distribution. For this paper, *SIS* are considered as the overarching category, which includes various subcategories, and *AMS* are one of these subcategories.

In a recent paper, Blobel and Lames (2020) present a general concept of *club information systems (CIS)* based on models of *software engineering*, *training science*, and *business intelligence (BI)* from the perspective of an application in sports. It provides a *CIS*-architecture and lists different features of *CIS*. This *CIS*-concept was supplemented and generalized to *SIS*. The listed features of *CIS* provided a starting point for a criteria-based catalog with different *SIS* items in different categories. This catalog then may serve as a template for a comparison of the *SIS* products.

The general objective of this study is a structured and standardized analysis of the *SIS* products available on the market. Additionally, it seeks for a basic understanding of *SIS* and determines and defines relevant features for an *SIS*. The single products then are scrutinized with respect to whether they dispose of these features. The results should provide valuable information to *SIS* users or organizations in sports practice that intend to introduce an *SIS*.

The detailed objectives of this paper are as follows: Objective 1 is to give a systematic overview of *SIS* products at the market and to provide general information about the products (type, domain). Objective 2 is to list the detailed features of the *SIS* and to assess whether the examined products dispose of them. Objective 3 is to characterize product categories of *SIS* and the classification of the reviewed *SIS*.

Methods

Systematic Search Strategy

According to the PRISMA (preferred reporting items for systematic reviews and meta-analysis) guidelines, a systematic search of relevant software providers was conducted (Moher, Liberati, Tetzlaff, & Altman, 2009). PRISMA guidelines have already been used in the field of sports, for example, in reviews on investigation trends and match analysis in football (Sarmiento et al., 2014; 2018).

Due to the unclear definitions and terms of *SIS* described above, complementary methods of identifying relevant software products were chosen: the initial approach was identification through personal contacts with experts in the field. Additionally, various lists on *SIS* were included, which were found during the research (a market analysis of a company, a product comparison of an *SIS* provider, and an *AMS* buyers guide (Glaeser, 2017), published in public domain). Finally, a web search was performed. In contrast to literature reviews that rely on literature databases like PubMed, IEEE Explore, or Science Citation Index, this is a product review. As commercial products are offered presumably without exception on the internet on product websites they may be found with major search engines. Therefore, the web search was conducted on Google as the largest provider with the most comprehensive search index. The web search via Google was done between 5th of May 2020 and 12th of May 2020 for relevant results updated within the last 24 months, using the keyword combinations shown in Table 2. Due to the large number of unspecific results, additional keywords were added as filter criteria.

As the number of hits per keyword combination showed high variability, below 100 hits, all results were examined, and above 100 hits, only results classified as most relevant by Google, were selected. This Google classification is based on an internal ranking system of Google using different algorithms, which are applied to the search string entered (Google LLC, 2020).

Table 2. Keyword combinations with additional terms to specify results at web search.

Keyword Combination	Additional terms to include (+) or exclude (-) results
sports information systems / information systems in sports	+software; -management
club information systems	+software
‘athlete management systems’	-site:google.com; -site:youtube.com; -site:facebook.com; -site:twitter.com; -site:reddit.com; -site:linkedin.com

The inclusion criteria for the companies were: (1) providers of sport specific software products; (2) commercially available products; (3) functionality for team/athlete management; (4) at least two different areas in the club must be covered; (5) merging different data sources; (6) language English or German.

Hits were excluded from this review if they (1) did not offer their own software, only used software from another provider or offered consulting services; (2) were custom made solutions; (3) applied unspecific software to sports data for a use case; (4) offered only software for private use and hobby athletes; (5) covered only one field within a sports club.

First, uniform resource locator (URL), title, and short description of the suggested hits were checked for exclusion criteria. Mismatches and duplicates were sorted out. Then, the website of the remaining hits was visited to get more details about the company and its product. The final hits were either existing software products that met the inclusion criteria, existing software that was just developing an extension to meet these criteria, or software in development that met these criteria with the first product version.

Development of the Review Item List

Due to the great differences between the *SIS*, their large scope, and the various features, it was important to create a standardized basis for the review. The requirements of such *SIS* led to a list of different required items for the review. This review item list allowed an independent and equal analysis of the different *SIS*. To define the requirements for *SIS*, the *CIS*-concept of Blobel and Lames (2020) was used as a starting point, where some system requirements are already mentioned.

Figure 1. Categories for items for comparison from the *CIS* concept of Blobel and Lames (2020).

Figure 1 shows the categories and sub-categories for the items of comparison and their origin in the different components of the *CIS* concept in Blobel and Lames (2020). The category “G. Company & Support” was added being obviously relevant for the purpose of this review. For each category, respective sub-category, specific items of comparison were developed. The item selection was mainly based on practical experiences with some *SIS* from a user perspective.

No.	Item	Count	No.	Item	Count	No.	Item	Count
A. Features and Departments (n = 21)			B.VI Video Analysis (n = 20)			E. Mobile Access (n = 21)		
1	A1 Team management	21	59	B45 Cloud video storage	17	116	E1 Ubiquitous access	21
2	A2 Medical	19	60	B46 Cutting tool	9	117	E2 Responsive design	21
3	A3 Strength & Conditioning	21	61	B47 Video drawing tool	12	118	E3 Mobile web page	13
4	A4 Scouting	14	62	B48 Tagging	13	119	E4 Mobile app	17
5	A5 Match analysis	16	63	B49 Live tagging	7	120	E5 General smartphones	20
6	A6 Video analysis	20	64	B50 Import external tags	12	121	E6 General tablet	19
7	A7 Training management	19	B.VII Training Management (n = 21)			122	E7 Mobile questionnaires	20
8	A8 Youth academy	14	65	B51 Training exercise catalogue	18	F. User Interface (UI) (n = 21)		
9	A9 Performance analysis	21	66	B52 Creating exercises	18	123	F1 Customizing UI	16
10	A10 Data analysis	21	67	B53 Exercise DB	17	124	F2 Multilingual	17
11	A11 System administration	21	68	B54 Training planning	19	125	F4 User specific user interface	19
12	A12 Education	14	69	B55 Training drawing tool	8	126	F5 User specific dashboards	20
13	A13 Club management	12	70	B56 Player availability	19	127	F6 User specific content	20
14	A14 Business	6	71	B57 Documentation	21	128	F7 User specific analysis	17
B. Features (n = 21)			B.VIII Sport Science (n = 21)			G.I Company (n = 21)		
B.I General Features & Team-Management			72	B58 Request whole DB	21	129	G1 Location	-
15	B1 Calendar	21	73	B59 Cross-correlation different sources	19	130	G2 Supported countries	-
16	B2 Communication	20	74	B60 Questionnaires	21	131	G3 Main sports	-
17	B3 Access to (whole) database	18	75	B61 Psychology	19	132	G4 Experience	-
18	B4 Manipulation of data model	10	76	B62 Individual player development	19	133	G5 Customers	-
19	B5 Unique/customize catalogues	19	77	B63 Planning	20	G.II Support (n = 21)		
20	B6 Ratings	18	78	B64 Cross correlation	19	134	G6 Handbook (digital)	18
21	B7 General info	16	B.IX Athlete (n = 21)			135	G7 Online Help	20
22	B8 Player	21	79	B65 Personal details	21	136	G8 Teaching	19
23	B9 Staff	20	80	B66 Personal data	19	137	G9 Tutorials	20
B.II Medical (n = 18)			81	B67 Athlete (cloud) storage	18	138	G10 Consulting	20
24	B10 Medical files	17	82	B68 Special attributes	15	139	G11 Demo access	19
25	B11 Medical history	18	83	B69 Match statistics	19	140	G12 Updates frequently	15
26	B12 Visual UI (body model)	15	84	B70 Match preparation	19	141	G13 Updates on demand	14
27	B13 Different incidents	18	C.I Technology and Licensing (n = 21)			142	G14 Updates irregularly	15
28	B14 Attachments	15	85	C1 Cloud version	21	H. Security (n = 21)		
29	B15 Player & staff	12	86	C2 Desktop version	8	143	H1 Backup	21
30	B16 Reporting	16	87	C3 Server version	14	144	H2 Data security	21
31	B17 Medical catalogues	18	88	C4 No general operating sys. limitation	18	145	H3 GDPR	19
32	B18 Medical cloud storage	15	89	C5 No general browser limitation	19	I. Interfaces (n = 21)		
B.III Strength & Conditioning (n = 21)			90	C6 License fee	21	146	I1 Import different file formats	21
33	B19 Performance data	21	91	C7 License fix price	8	147	I2 Import data of different sources	19
34	B20 Planning tool	20	92	C8 Licence hybride (fee & fix)	9	148	I3 Export different file formats	21
35	B21 Tracking data	20	93	C9 Open accessible prices/fees	12	149	I4 Export of full database	19
36	B22 Interface other tools	21	C.II Softw. Archit. (SWA) & Adjustm. (n = 21)			150	I5 Interfaces available	21
B.IV Scouting (n = 14)			94	C10 SB Moudles	20	151	I6 Auto feed possible	16
37	B23 Free text	13	95	C11 SWA fix	17	152	I7 Partnerships other	15
38	B24 Player reports	14	96	C12 SWA fix basis customizing	17	153	I8 General API available	16
39	B25 Match reports	12	97	C13 SWA building kit	6	J. Data Analytics and Reporting (n = 21)		
40	B26 Shortlists	12	98	C14 Adjustments consulting	16	154	J1 Data analysis are possible	20
41	B27 Player filtering	13	99	C15 Adjustments included	17	155	J2 Methods mach. learn. available	18
42	B28 Scouts activity overview	12	100	C16 Adjustements collecting demands	18	156	J3 Graphs / Charts / Calculations	21
43	B29 Scheduling	13	D. Right Governance (n = 21)			157	J4 Integr. programming languages	14
44	B30 Ticketing scouts	6	101	D1 Detailed right governance	15	158	J5 Predictive analysis	17
45	B31 DB other player/leagues	11	102	D2 Creating user profiles	17	159	J6 Access whole DB	19
46	B32 Mobile access	13	103	D3 User management	20	160	J7 Implementation Analysis into UI	16
47	B33 Reports	13	104	D4 Preset user profile	15	161	J8 Reporting available	21
48	B34 Video storage	13	105	D4.1 Business	4	162	J9 Team lists	20
49	B35 Ratings	13	106	D4.2 Scouting	9	163	J10 Player details	20
B.V Match & Match Preparation (n = 16)			107	D4.3 Coaches	13	164	J11 Different reports / report. tool	20
50	B36 Analysis	15	108	D4.4 Player	15	Frequency:		
51	B37 Reports	16	109	D4.5 Team-Organizer	9	4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21		
52	B38 Custom preperation	14	110	D4.6 Medical	11			
53	B39 Statistics	15	111	D4.7 Analyst	10			
54	B40 League data	16	112	D4.8 External	9			
55	B41 Strating lineup	16	113	D4.9 Youth academy	8			
56	B42 Different lineups	14	114	D4.10 Admin	14			
57	B43 Animation tool	7	115	D4.11 Management	11			
58	B44 Videofiles & data	16						

Figure 2. List of 164 review items and the number of products with the respective item as count and color coded.

Figure 2 shows the final item list. It contains 164 items that were checked for presence in each product. To avoid a second large table, the frequencies of each item among the 21 examined systems are given here numerically and color-coded as a leap ahead to the results section.

Assessing SIS-items

In principle, the required information on the items of comparison could have been obtained by a detailed study of the web pages of the provider. Some arguments speak against this method. First, given the large number of 164 items, it is more than likely that some items are not mentioned on the website although being present in the product. Second, as product descriptions on the web site of the provider try to draw a positive image of the product, it is necessary for a valid comparison to confirm the content expressed by an item. Finally, denomination and meaning of the items on the web site and in our catalog may differ, so that a common understanding is desirable. These reasons led to the conduction of semi-standardized interviews with product representatives (Berekoven, Eckert, & Ellenrieder, 2009).

The low number of available products made it necessary to ensure a high response rate, which is increased by personal contact. This also prevents companies' fears that the information might be requested from competitors. The required information was collected according to the review item list (Figure 2), which was transformed into a checklist for the interview questionnaire.

The interview procedure was semi-standardized and all interviews were conducted by the same interviewer (TB). When appointments had been arranged, the general conditions were explained. The interview was scheduled for one hour and was held in English or German, with the help of video conferencing tools. Interviews were prepared by prior transfer of information from the product website to the questionnaire. Each item of the checklist was gone through linearly via screen sharing, and answered by using the options 1 = Yes, product disposes of item; 2 = No, product does not dispose of item; and 0 = No Answer (NA). The answers were entered directly into the checklist. In case of uncertainties, the interviewer re-phrased the question, and the interviewed expert could explain the item further, which was taken note of. If needed, the interviewer could explain the questions further or, in case of doubt, ask for details. The product representative also had the opportunity to make additional comments (Meffert, Burmann, Kirchgeorg, & Eisenbeiß, 2019).

After the interviews, the companies were given the opportunity for debriefing. The general information and short description of the product, as well as the checklist reviewed by the interviewer, were sent to the company representative for review, and a deadline for response was defined. Any proposed changes were worked out with representatives of the company until they were accepted. Only after this the product was marked completed. The results on each product were entered in a spreadsheet and presented as tables and radar charts. Since the products are very different, a comparison can only be made on the number of criteria a particular product has.

Results

Systematic search

The identification through personal contacts and suggestions led to 29 products. The third-party lists delivered 27 products. Web search delivered a total of 139 results for the particular term combinations with the additional keywords for the selected period. After a more extensive analysis of the websites, this number decreased to 27 (Figure 3). After merging the results of these three sources and eliminating duplicates, a total of 47 products was remaining.

Figure 3. PRISMA flow chart of the different phases of the systematic review.

In a detailed analysis of each company website of the combined results, the inclusion and exclusion criteria were applied to all products, reducing the number to 36 for interviews. The reasons for the exclusions were: the same company distributed the software through two channels with a different focus ($n = 1$); the website was offline ($n = 1$); product was only a smartphone app for individual athletes ($n = 2$); product was offered by a consulting company ($n = 2$); product was a use case of business software by using sports data ($n = 4$).

The companies were contacted through different channels, depending on availability. Existing personal contacts were used to find an appropriate interview partner. Otherwise, the website was searched for contact details and a mail to a specified contact person was sent. If this was not possible, the contact form was used. The contact persons were approached in each case by e-mail with a predefined and personalized text explaining the context of the survey, offering an initial talk, and giving a deadline for response. If no answer came before the deadline, a second mail was sent and another deadline set. The response rate was quite high (100 %) for personal or direct contacts, but much lower for contacts through a web form (25 %). After a positive answer, an appointment for an interview via video conference was scheduled. At the end of the PRISMA process, 21 companies were interviewed and included in the review.

Overview of the different reviewed SIS provider and general information

Table 3 shows a list of all interviewed companies with general information and a short description of product-specific characteristics. 18 companies operate worldwide, three are restricted to regions (Europe/USA, Europe, or Germany). For companies with two locations, only the main location was included. 16 companies stated that they supply all sports. Three cover team sports, one individual sports, and one only football. The mean experience of the companies in the field of SIS is $9.8 (\pm 5.5)$ years.

Table 3. Overview of the reviewed *SIS* with additional information and short description.

No.	Company	Country	Supported Countries	Main Sports	Founded in	Short description and characteristics of the sport information systems (SIS) based on review
1	ApolloV2	GBR/ USA	Worldwide	Teamsport	2006	Focusing on team sports, this IS covers 13 out of 14 defined fields for CIS. Their key features are: Integration of different sources via API; flexibility because of the framework approach; focus on data science; using powerful tools for data analysis (e.g. Python). apollov2.com
2	Athlete Monitoring	CAN	Worldwide	All sports	2000	The focus of this CIS (and also AIS/FIS) are: load monitoring and controlling; medicine; training planning, testing and assessment. Interfaces connect different data sources. They have a strong relation to research (illness/injury prevention) and are located in many different sports and types of organizations. athletemonitoring.com
3	Athlete Readiness Solution	CAN	Worldwide	All sports	2018	A platform for measuring athlete readiness, fatigue, and injury risks in real-time. This start-up addresses player load control and monitoring, injury prevention, and focuses on data analysis. athletereadinessolutions.com
4	Athlyzer	GER	Worldwide	All sports	2018	This startup has developed a platform-independent video analysis software for various individual and team sports. Their focus is on sports with low to high budgets (modular structure). Based on this, further areas such as tracking and an AMS are now being developed, which is to be extended to a CIS. athlyzer.com
5	Boom Stats Analysis	AUS/ GBR	Worldwide	All sports	2016	The focus of this platform is performance analysis, with great relation to (automated) video analysis. This IS also enables to capture wellness, training, and fitness data. Their focus is on team sports, but other sports are also addressed. boomstatsanalysis.com
6	Bridge Athletic	USA	Worldwide	All sports	2012	Strengths and conditioning software for professional and elite athletes, focussing coaches, personal trainers, and physicians. The software allows customized training plans, planning in different cycles, and tracking the athletes' performance for controlling and monitoring the development. bridgeathletic.com
7	Catapult	AUS	Worldwide	All sports	2006	Primarily known for its tracking system, they also offer video analysis and an IS. The AMS covers the fields of performance, medical, and wellness. A big advantage will be the interaction of their three products within one sport organization. catapultsports.com
8	Datco	GER	Worldwide	All sports	2019	The main characteristic of this startup is the platform based and general framework, focussing integration of different sources for data centralization. This could be adapted to the specific structures of the sport organizations. Different modules and the detailed license structure allows scalability. datco.com
9	DokuMe	GER	Worldwide	Individual Sports	2012	This IS is primarily designed for individual sports and offers users a high degree of flexibility, as many settings can be adjusted very precisely. But still, this IS covers all fields for a CIS and additionally, it considers the specific demands of sports federations (FIS). dokume.net
10	Firstbeat	FIN	Worldwide	Teamsport	2002	Primarily known for analytics (i.e. heart rate), there is also a specialized IS that covers different fields of AMS, to create player profiles and groups, document, monitor, and control their data. There are also interfaces to other tools to combine athletes' data. firstbeat.com
11	Force8	SUI	EU	All sports	2008	A modular and platform-based SIS that provides the relevant core functions and puts a strong focus on the integration of different data sources via interfaces. This keeps the system lean, uses the functions of powerful source systems instead of replicating them, and provides the central distribution of club data. force8.net
12	ForzaSys	NOR	Worldwide	Football	2011	This specialized IS was spun out from a research project and is mainly represented in the Scandinavian region. It covers two fields, a video system, and player load monitoring and is focussing football. forzasys.com
13	Fusionsport	AUS	Worldwide	All sports	2003	This central SIS covers all fields of CIS (and also AIS/FIS) with an extended infrastructure and single sign-on (SSO). It prefers configuration over customization, using native tools to change the behavior and features of the platform. Many interfaces to data providers allow them to integrate and centralize different data sources. For data analysis, they follow an open strategy and connect different BI tools. fusionsport.com
14	IDA	GER	GER	All sports	2015	This IS is developed for the German federal institute for sport science (BISp) and focuses mainly on German olympic sports (AIS). It is a platform for documentation of training and performance data of different sources. Due to the different requirements of the different sports, it offers a modular structure and puts great emphasis on detailed customization. www.iat.uni-leipzig.de/organisation/fachbereiche/mint/sportinformatik
15	Kinduct	CAN	Worldwide	All sports	2010	A platform-based system that covers most of the fields of CIS (and also AIS/FIS) and could be used for teams and single athletes. It provides an open API for data integration of different systems. To visualize data they use Tableau. One key feature is the interaction and integration of training and rehabilitation programs for planning, communicating, monitoring, and controlling training plans and progress. kinduct.com
16	Kitman Labs	IRL	Worldwide	All sports	2011	IS for performance and health data, focussing on sports performance analytics to generate information out of sports data. They promote their ability to adapt the system strongly to the processes of the sport organizations. At the beginning of the year, Kitman Labs acquired 'The Sports Office'. The merger of the two individual systems could result in CIS. kitmanlabs.com
17	Metrifit	IRL	Worldwide	All sports	2010	This system is specialized on health and well being and provides advanced methods for data analysis and presenting. They emphasize simplicity for better user experience, provide athlete lifestyle profiling analysis, are represented in various sport organizations, and have a strong connection to research. metrifit.com
18	MyCoach	FRA	Worldwide	All sports	2016	A modular and platform-based IS that covers most of the fields of CIS. It was developed for football but is now offered for all sports and also offers individual solutions for federations (FIS). Different source systems are integrated via interfaces and provide the data centralized within this platform. mycoachsport.com
19	Rockdaisy	USA	Europe/ USA	Teamsport	2014	This system has a strong focus on the analysis, visualization, and presentation of sports data. Their business intelligence driven approach allows accessing and integrating different data sources. Therefore, it is not limited to any particular field if already accessible data sources exist. rockdaisy.com/sports
20	SAP SportsOne	GER	Worldwide	All sports	2014	By using the infrastructure of different SAP business tools, this IS was developed for football (now also provided for other sports) and covers all fields of CIS. Some fields are already included (e.g. video analysis), but they also provide interfaces to source systems for centralizing club data. For data analysis they use SAP Analytics Cloud. sap.com/germany/products/sports-one.html
21	Soccer Lab	BEL	Worldwide	All sports	2004	Central IS that covers all defined fields for CIS to centralize different data sources of football clubs. The modular structure, combined with the licensing model, allows scalability. Besides the different fields, a central feature is their advanced video module. soccerlab.com

Table 4 shows the 15 companies that were identified as eligible *SIS* but did not participate in the review as they did not respond to the request (Figure 3). Since no information could be requested directly, information available on the internet was used. Therefore, the categories

supported countries and main sports were not included, as this information was incomplete on the websites. The mean experience of the excluded companies in the field of *SIS* is 10.0 (± 6.4) years. The founding date of the companies was mainly taken from the online database Crunchbase (www.crunchbase.com, accessed: 14th of November 2020).

Table 4. Overview of the excluded SIS with additional information and short description based on information available on the internet.

No.	Company	Country	Founded in	Short description and characteristics based on information available on the internet
1	Athletic Lodgic	AUS	2005*	This IS covers most areas of sports clubs and could therefore be categorized as CIS. They list sport clubs, sports institutes and organizations as clients. The information on the website is very limited.
2	SportsOffice	GBR	2006*	Now part of Kitman Labs (see review), this IS covers most areas of sports clubs and could be categorized as CIS. They also have sport organizations as customers, so they could maybe also be AIS/FIS.
3	AMP-recover	USA	2016*	This IS is focussing the medical area and could be classified as MIS. It was created for US olympic athletes and for that reason, they have experience in working with elite athletes.
4	CoachMe Plus	USA	2013*	Focussing coaches and athletes in strength and conditioning, this IS could be mainly seen as TIS/LIS. But it also integrates league data. Depending on their mentioned customization, it may cover other areas.
5	TeamBuildr	USA	2011*	Online strength and conditioning platform for coaches and athletes. It could be mainly seen as TIS/LIS. Their customers are sports clubs, sports institutes, schools and colleges and sports facilities.
6	TrainHeroic	USA	2012*	Online strength and conditioning platform for coaches and athletes. It could be categorized as TIS.
7	PLT4M	USA	2013*	Online strength and conditioning platform for coaches and athletes. It could be categorized as TIS. They have a strong focus on educational organizations, but have also (professional) teams as customers.
8	MaxOne	USA	2014*	Online strength and conditioning platform for coaches and athletes. It could be categorized as TIS.
9	Coacha	GBR	2018	This cloud based platform is a sports club management software focussing on administration of clubs, managing memberships, groups and payments.
10	Fair Play Athlete	AUS	1994	They call themselves AMS, covering performance, training, medical and personal details. For these covered fields, it could also be considered as CIS. The website provides very little information.
11	Edge10	GBR	2009*	This IS offers an performance and analytics solution, electronic medical records (EMR) and physical testing. Their customers are elite athletes, teams and leagues in more than 40 different sports.
12	Benchmark 54	GBR	-	Described as a multi-sport and multi user AMS, it covers the medical area and training management. Also providing data visualization and analysis it could be categorized as CIS.
13	Orreco	IRL	2010*	This software platform uses biomarkers and data science to identify athletes individual thresholds for player load management. It is offered for different sports and countries and could be categorized as LIS.
14	Easy2Coach	GER	2009	This cloud based software covers the areas of team and athlete management, training management, match analysis, and video analysis for football clubs (amateurs and professionals). It covers different areas of football clubs and could therefore be categorized as CIS.
15	Microsoft	USA	-	A sports performance platform for performance and fitness data, using Microsoft products. Different professional sport teams are listed. No product website is available, information are difficult to get and articles are older then two years. It seems to be customized solutions and no standard product.

* www.crunchbase.com, access: 14.11.2020

Figure 4. Number of all eligible *SIS* systems (n = 36) and the country of the product company.

A total of 36 products from ten different countries were identified as eligible *SIS* (Figure 4). The majority (n = 19) came from Europe; the country with the most systems was the USA.

Results for *SIS* Items

The following section presents the detailed analysis of the interview items. The single data points show the summarized answers of the interviewed experts for each item (maximum = 21).

Figure 5. Number of *SIS* covering different fields within clubs.

Figure 5 provides an overview of the different fields/departments the *SIS* cover. Five fields were included in all *SIS* in the review (*team management; strength & conditioning; performance analysis; data analysis; system administration*). Only six *SIS* include the *business area* (e.g. marketing, ticketing, or accounting). The coverage of the other areas is quite different in the various systems. This is revealed by an item-based look on the particular fields.

Figure 6. Detailed analysis of different fields within SIS.

Figure 6 provides a more detailed view of the different fields of SIS. It is notable, that less than half of the SIS allow changes in the *data model* (B4). *Strength and conditioning* (B.III), *training management* (B.VII), *sport science* (B.VIII), and *athlete* (IX) seem to be standard fields for SIS because they are provided at every reviewed product. Except for the *training drawing tool* (B55) and *special attributes* (B68), the specific features within these fields are balanced at a high appearance and have been named in at least 17 of the products.

The situation is different with *video analysis* (B.VI). Although 20 providers noted that they covered this field, the distribution of the included features was different. Except for *cloud video storage* (B45), all other features in this area were mentioned less than 14 times. The opportunity to *live tagging* (B49) was mentioned least often (n = 7). Most SIS that cover the medical field (n = 18) are balanced in terms of features and eight of the nine features are presented in at least 15 products. In *scouting* (B.IV), the *ticketing for scouts* (B30) stands out, which less than half of the products stated. For *match and match preparation* (B.V), eight of nine features were named in at least 14 of the 16 products. Only the *animation tool* (B43) is less represented.

Figure 7. General of an SIS and general right governance for user.

Figure 8. Charts of different fields of SIS.

As can be seen in Figure 7 at *technology and licensing (C.I)*, all 21 companies offer their *SIS* as a *cloud-based (C1)* solution and charge a *license fee (C6)*. The other features here are quite diverse. At *software architecture (SWA) and adjustments (C.II)*, 20 of the products offer *modular (C10)* architecture, and six provide an architecture in the form of a *building kit (C13)*. For *detailed right governance (D)*, 15 of the products offer *detailed right governance (D1)* and/or also 15 offer *preset user profiles (D4)*.

Figure 8 shows for *mobile access (E)* that all of the systems provide *ubiquitous access (E1)* and *responsive design (E2)*. For *user interface (F)*, all features are named by at least 16 of the products. At *support (G)*, six of the nine features (*G6 – G11*) are named by at least 16 products or more. It was slightly different for the *update policy (G12 – G14)*. For *security (H)*, the answers are highly balanced. Within the field of *interfaces (I)*, nearly all products (≥ 19) provide features to *import and export data (I1 – I5)*. For *data analytics and reporting*, only the features of *integration of programming languages (J4)* and *implementation of analysis into the UI (J7)* were represented by less than 17 of the products. At *reporting (J.II)*, all features were named for at least 20 products.

Product Categories of SIS and Classification of the Reviewed Products

Figure 9. Taxonomy of sports information systems to show different categories, their relations and dependencies.

Based on the definitions of Table 1, a model of the various systems and their relations to each other has been developed (Figure 9). The overarching category is *SIS*, as defined in the introduction. Within this *SIS*, there are two categories: *AIS/FIS* and *CIS*. There is a big overlap between these two categories. Both categories cover all or at least most of the fields within a sport organization and also have a strong focus on information generation and distribution. The main difference is the structure of the location of the sport organization, i.e. centralized for *CIS* and decentralized for *AIS/FIS*, which requires different system architectures. In the intersection between these two categories, *specialized information systems* are placed that may have a similar structure like systems on a higher level, but which are limited to a specific field of expertise. For this reason, they can exist independently or act as a part of the higher-level systems. *AMS* play a special role in this scheme because they could also contain *specialized information systems*, but with a focus on management instead of information generation.

The result of the classification of the reviewed products in product categories was as follows: four products have been classified as *AIS/FIS*. *CIS* represented the largest group with nine products. Three products have been classified as *AMS*. Within the category of *specialized information systems*, there are two sub-categories: *MaIS* ($n = 2$) and *TIS* ($n = 1$). As none of the reviewed products was a classic *MIS* or *LIS*, because in each case a system for player load monitoring was included in the *MIS*, both system categories were combined in this review, and two *SIS* fell into this combined category. No stand-alone *ScIS* participated in this study, instead the scouting field was typically part of the higher system categories of *AIS/FIS* or *CIS* ($n = 14$).

Figure 10. Different strategies for *SIS* software architectures.

Two basic strategies can be distinguished in software architecture of *SIS* (Figure 10). On the one hand, there is an all-in-one approach of a large software provider with many components offered either as a whole or as different modules. Within this strategy, almost no suite can cover all areas, and very often, additional third-party add-ons are required. In this case, one selects the suite that best meets the requirements (= best-of-suite (*BoS*)). That strategy means that the processes within the organization will be determined strongly by the process and functions of the specific software architecture and must perhaps be adopted. The advantage is a well synchronized all-in-one solution. The disadvantage is that probably not all areas are covered and one cannot use the best individual systems on the market. With the best-of-breed (*BoB*), on the other hand, specialized standard software components from different providers, as well as custom software, are integrated. The organization selects the software for each area, or even specific process, that best addresses their needs. This strategy focuses on internal processes and searches for the best software solutions, but neglects cohesion between departments, limiting overall perspective. That leads to fragmented and isolated data silos that could be overcome and merged by a central platform that combines the data of the specific software and provides it to all users. But therefore, another software platform is needed that interfaces each single software solution used within the organization. The advantage is that the platform can grow and systems can also be replaced. As a disadvantage, there could be problems in the interaction of the systems (Light, Holland, & Wills, 2001). For the reviewed *SIS*, a third approach is the most common. It can be described as a hybrid approach of *BoS* and *BoB*. The *SIS* has basic integrated components as well as connections to other special software serving just as platform. The number of integrated and externally connected components varies considerably between the products examined.

Discussion

The aim of this paper was to systematically review available *SIS* on the market and to provide an overview of the relevant features, based on the *CIS*-concept of Blobel and Lames (2020).

Systematic Search

Within this work, 36 products were identified as eligible *SIS* based on the PRISMA Guidelines. Despite this systematic approach, it cannot be guaranteed that all systems on the market were detected which raises the issue of representativity. The problem lies in the missing binding standardized (= retrievable) product definitions but even more in the dynamics of the market. New products continuously enter the market, existing products disappear, providers are taken over by other companies with or without continuing to offer the product under the same or a different name, or specialized systems become *SIS* by adding functionalities.

The decision to do an interview-based instead of a web-based review has reduced the number of *SIS* products included in this review to only 21 of the 36 detected products. This is regrettable, but in this case quantity was sacrificed to completeness and validity. As website entries are meant for advertising the product, information on specific items may be biased. Also, it would have remained unclear whether an item is not detected because it is not part of the product or just not listed. Moreover, items could be described in a way making it difficult to attribute unambiguously a certain category and thus make sure comparability between products. For these reasons, interviews with product representatives were conducted accepting a reduced number of reviewed products.

Overview of Different Reviewed *SIS* Products and General Information

The objects of this review are quite diverse, as it included established *SIS* as well as start-ups, complete solutions, and special solutions. The major objective was not to conduct a detailed qualitative comparison per item, but to give an overview on the *SIS* market and the prevalence of a list of potentially relevant features based on a catalog of criteria. For this purpose, it was sufficient to cover a large number of existing systems and to take a detailed view only on presence and absence of the respective fields at each *SIS*.

An examination of the countries of origin shows that all products included here come from Western countries (Figure 4). One reason for this is the limitation to English and German. It may be assumed that countries, such as China or Russia, with their highly structured sports programs, also have systems to manage athletes and their data. Moreover, it is also possible that national and customized solutions have been developed for own purposes but are not available on the open market. The comparatively high number of systems from Germany is most likely a result of the search strategy relying besides a web search also on personal contacts of the authors. Nevertheless, 36 systems from 11 different countries in a comparatively small market document a high degree of diversity and shows that this topic is of relevance in many countries, both justifying a systematic review.

Detailed Fields and Features of the Reviewed *SIS*

The following section focuses on selected *SIS* items, discussing them in detail, and explaining their general impact and their importance for sport organizations.

When looking at the different fields at sport organizations, it is obvious that certain standard fields are part of all or most of the *SIS*. It is notable that the *business area (A14)* is covered by very few *SIS* (Figure 5). This shows that *SIS* were primarily designed for the sports area at the clubs. One reason may be the strong separation between sports and business within most sport organizations, even though there is a strong overlap here as well. For example, an official

diagnosis of an injury is important for the public relations department or a player's playing time affects the bonuses that are defined in his contract and are therefore relevant for accounting and controlling. Thus, many reasons speak in favor of integrating a business component.

Less than half of the *SIS* allow the *manipulation of the data model* (B4). Especially for data analysis, this could be important, because a predefined data model often does not provide the necessary data structure for specific analyzes, making it impossible or complicated workarounds are necessary. The *medical field* (B.II) as a standard in sport organizations is not covered by all of the systems. On the one hand, this may have to do with the special characteristics of this area or, on the other hand, with the fact that special legal requirements and certificates are necessary in some cases. The features at *scouting* (B.VI) are covered quite similar. Only the *ticketing for scouts* (B30) is an outlier, but as part of the planning and organization of many scouts at different events and locations, this is a very important requirement in sports practice. For *league data* (B31 & B40), there is an overlap to *match preparation* (B.V), because both fields use match data, but in a different way. Well-structured and effective access to these data for both areas can create synergies and thus enhance the added value of such *SIS*. The structure of *video analysis* (B.VI) is very diverse at the reviewed *SIS* products. The reason could be the complexity of these tools. There are specialized software products, and it is difficult to reproduce the full functionality, which some *SIS* providers have learned the hard way. Here, we find *BoS* and *BoB* (Figure 10) solutions as well. While the former may have the advantage of being an all in one solution, the latter offers greater independence by replacing or adding video analysis tools. For storage, various *SIS* offer *video cloud storage* (B45) for media files, others integrate external cloud storage optimized for video files into their *SIS* or linking streaming platforms. Practice shows that *live tagging* (B49) is a priority demand of coaches, especially in the youth sector, to set their pre-defined tags directly during the match. If there is no separate video analyst this can be helpful to reduce the work for post-processing. Surprisingly, not all *SIS* include the management of *training exercises* (B51 – B53). A closer look shows that these features are not included in the actual system but could be integrated by a third-party tool. One positive finding is that *sports science* (B.VIII) aspects are strongly represented in the reviewed products. This creates a sport-specific focus, to become more than just a general information system. *Accessing the whole database* (B58) is an important feature of it to develop analyses in other data analysis tools, especially if they are more advanced and not included in the *SIS* standard analysis.

All systems offer *cloud services* (C1), and only a few still offer *desktop* (C2) solutions, mostly for special applications like video analysis to have better performance. The possibility of hosting the *SIS* on club *servers* (C3) is still important for some sport organizations, as they do not trust cloud solutions. However, these concerns are now disappearing more and more. Most *SIS* support common *browsers* (C5) and therefore have no limitation on the *operating system* (C4). The difference between C4 and C5 is explained by the fact that one *SIS* only supports one operating system for its desktop application for video analysis. Because cloud services generate regular costs for running and maintenance server and update the software, *SIS* providers follow modern standards of regular *license fees* (C6). Most *SIS* providers have recognized the need for scalability due to different initial situations and sporting developments and offer different *modules* (C10). *Software architecture* (SWA) is usually fixed. Open architecture could pose a threat to the stability of the system, and sport organizations typically do not have the capabilities to develop their own software to be integrated.

Not all *SIS* offer *detailed right governance (D1)*, but instead only *preset user profiles (D4)*. Sport organizations are structured very differently in terms of size, departments, and responsibilities. Inflexible user profiles can, therefore, become a challenge in terms of access governance.

For *mobile access (E)*, the *SIS* are very similar. Only *mobile web pages (E3)* do not seem to be so common ($n = 13$). This technology is maybe not very popular, or companies prefer to invest the resources in developing and maintaining *mobile apps (E4)* to provide more regulated applications. *Mobile web pages* could be an interesting opportunity, to provide more flexible, device independent and easier to maintain solutions for mobile access. Especially in the diverse and fast changing environment of sport organizations. However, this must be decided depending on the specific requirements.

A *user-specific presentation (F4 – F6)* of content seems to be important for *user interfaces (F)*. But if it becomes more specific, there are differences between the *SIS* that have to be considered.

In principle, all typical *support (G)* services are offered for the selection and implementation of *SIS*. The update policy is slightly different and must then be checked more closely when selecting the *SIS*.

All *SIS* provide general *security (H)* standards. Only *GDPR (H3)*, as a European regulation, was not covered by two non-European providers.

Since *SIS* should help to centralize different data sources, the products in general offer corresponding *interfaces (I)* for importing and exporting data. Because these questions have not been further specified, problems may occur with unusual formats and interfaces and must be checked before. In the case of common source systems, *auto feeds (I6)* and *partnerships (I7)* can be relevant to simplify data import. Especially for unusual source systems, a *general API (I8)* of the *SIS* could be useful to import the data.

At first glance, the area of *data analytics and reporting (J)* seems to be well covered. It appears that the topic of *machine learning (J2)* is also relevant here, but the results do not provide any insights on how it is implemented in each case. It is important to make the results of the data analyses directly accessible to the users in the organization to increase the acceptance and use of these methods. But not all *SIS* allow the *integration of the analyses into the user interface (J7)* or *integrate programming languages (J4)* in the architecture of the *SIS*. This means that access to the analyses and the workflow for the analyses differ enormously between different *SIS*. It can range from direct integration of the developed analyses in the *SIS* user interface to intricate access via external tools and extensive import and export processes. One consequence of this may even be that analyses demanded by staff cannot be realized at all. However, this does not hold in general but requires a qualitative inspection of the specific *SIS* with precise use cases.

Product Categories

The categorization (Table 1 and Figure 9) was made only for the 21 reviewed *SIS* since there was not enough information available for all eligible *SIS* to also classify and include them. However, it also illustrates the diversity of the *SIS*, which requires a more detailed classification, even if it is difficult to make a strict distinction between the different categories. This often depends on the areas covered in sport organizations and the focus of the particular *SIS*. In general, each system requires athlete management and the integration of different data sources. For this reason and referring to the results of the classification it appears, that very few systems can be classified as real *AMS*. The majority are information systems with different

foci. Nevertheless, for a better understanding, it is important to define different categories and to assign the systems according to their characteristics and scope.

The classification of the *SIS* cannot be strictly separated into *BoS*, *BoB*, or *hybrid* system architecture (Figure 10). In sports, there are too many different fields and source systems for one provider to cover all of them. Therefore, it is rather a wide range of different hybrid models, which tended either more strongly to *BoS* or *BoB*. Each *SIS* must offer interfaces to different source systems, sometimes even to other *SIS*. However, such a classification is important for the strategy of the software providers, but also for the selection of *SIS* at the clubs.

Limitations of this work

In some cases, there are quite large time differences between the different interviews, as the identification of the product and the execution of the interview lasted long. Therefore, and due to the dynamics of the *SIS* market, this study can only provide a snapshot. However, this is only partially relevant for this study, since the main objective is to provide a general overview of existing *SIS* and the representation of the different features from a *CIS* concept. It would be worthwhile to build up and continuously update an *SIS* product database.

Although the questionnaire already contained 164 items, the results were too general in several fields. For some questions, not only further details but also the specification of the features would have been of interest. The interview was consciously kept at this level, as each interview already lasted about one hour, and a more detailed interview would have considerably reduced the participation of the companies. Besides, more detailed questions in the individual fields would probably have required several experts from the company. This study intended to provide a more general overview, but one the entire range of *SIS*. More detailed follow-up studies of individual fields of such *SIS* can then be based on this.

The categories were developed based on *SIS* definitions. The term *athlete management systems (AMS)*, which is commonly used in practice, was restricted. This can lead to controversies, as definitions in other studies on this topic may be different. *SIS* and its subcategories in the context of this study are IT-based systems, and therefore a corresponding definition from the field of information technology has been used. The standards of IEEE (Institute of Electrical and Electronics Engineers), IEC (International Electrotechnical Commission), and ISO (International Organization for Standardization), which can be regarded as valid and widely used, were chosen for this work.

Conclusion

As this study shows, the term *AMS* applies to only a few available systems or may be misleading, as it does not include the essential component of information generation. It is therefore recommended to refer to the systems in general as *SIS* or then more specifically as *AIS/FIS* or *CIS*. The study entails conclusions for at least three different areas addressed below.

Conclusions for Sports Informatics

A large number of different IT systems in sport, with different data and informatics methods, requires an interdisciplinary approach, which sports informatics should address as a linking discipline. Sports informatics disposes of the necessary interdisciplinary knowledge from computer science, sports science, and sports practice that is required for the development and implementation of such *SIS* (Perl, 2003).

Sports informatics must demonstrate more strongly that it has the necessary domain know-how that is relevant for the development of such SIS. To this end, sports informatics should be more aware of its potential as an applied science in order to combine specific theoretical knowledge of the disciplines involved and transfer it into SIS development and sports practice. In practice, theoretical models from the field of sports science should guide the design of SIS.

Conclusions for SIS Companies

The review provides a market overview for *SIS* companies to position their product. For example, missing features can be identified to adapt their product and close gaps to other providers. On the other hand, it can also be used to cover a niche if necessary, if the company is not big enough to develop a complete *CIS/FIS/AIS*.

Central findings from the review and the *CIS* concept of Blobel and Lames (2020) can also be used to adapt the respective product. For example, the modularity, integrated analyses, user-specific content, and usability of the systems are very relevant.

The review also shows that the providers offer opportunities for using the SIS from a sports science perspective. This indicates that sports science is primarily seen from the user perspective of SIS, which requires access to such systems but has less influence on the basic architecture. Therefore, it is recommended to include domain know-how from sports science in the development of such SIS. Especially the integration of sports informatics is suggested, which can build an interdisciplinary bridge between SIS providers, sport practice and sport science.

Conclusions for Sport Organizations

This study provides a product overview to sport organizations and also lists the various features they should consider for a precise product selection. Besides, this work can be used to carry out the requirements analysis of the sport organization in advance. This must be done independently of the possible products and requires the determination and documentation of the internal source systems, data structures, processes, stakeholders, and fields of application of such *SIS*. It is important to be able to map essential internal processes in *SIS*. For example, major problems could arise if the software architecture of the *SIS* is not suitable. Furthermore, the analysis of short, medium, and long-term goals is necessary to select a product that not only fits the current needs but also future demands.

The selection of a suitable *SIS* is only one step and requires the integration of the *SIS* into the internal processes and the adaptation of these processes. Clear communication within the sport organization is important, which explain the investment and commits to the use of the system. It also requires the employment of a qualified staff, who is acknowledged by the other departments, is given sufficient time resources and a clear mandate to implement the *SIS* in the sport organization as a continuous task in collaboration with all users. These fundamental steps are necessary not only to buy suitable and powerful *SIS* but also to fully exploit its potential for advancing the entire organization.

References

- Baca, A. (2006). Computer science in sport: An overview of history, present fields and future applications (Part I). *International Journal of Computer Science in Sport*, 5, 25–35.
- Berekoven, L., Eckert, W., & Ellenrieder, P. (2009). *Marktforschung: methodische Grundlagen und praktische Anwendung [Market research: methodological principles and practical application]* (12th ed.). Wiesbaden: Gabler.
- Blobel, T., & Lames, M. (2020). A Concept for Club Information Systems (CIS) - An Example for Applied Sports Informatics. *International Journal of Computer Science in Sport*, 19(1), 102–122.
- Glaeser, C. (2017). A Buyer's Guide for Athlete Management System Software. Retrieved May 28, 2020, from <https://simplifaster.com/articles/buyers-guide-athlete-management-system-software/>
- Google LLC. (2020). Google Search - Discover How Google Search Works. Retrieved July 27, 2020, from <https://www.google.com/intl/de/search/howsearchworks/algorithms/>
- Institute of Electrical and Electronics Engineers (IEEE). (2017). ISO/IEC/IEEE International Standard - Systems and software engineering - Vocabulary [PDF file].
- Lames, M. (1997). Unterstützung von Training und Wettkampf [Support of Training and Competition]. In J. Perl, M. Lames, & W.-D. Miethling (Eds.), *Informatik im Sport: Ein Handbuch [Computer science in sports: A handbook]* (pp. 170–187). Schorndorf: Hofmann.
- Light, B., Holland, C. P., & Wills, K. (2001). ERP and best of breed: a comparative analysis. *Business Process Management Journal*, 7(3), 216–224.
- Meffert, H., Burmann, C., Kirchgeorg, M., & Eisenbeiß, M. (2019). *Marketing: Grundlagen marktorientierter Unternehmensführung: Konzepte, Instrumente, Praxisbeispiele [Marketing: Basics of market-oriented corporate management: Concepts, instruments, practical examples]* (13th ed.). Wiesbaden: Springer Gabler.
- Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *BMJ (Online)*, 339(7716), 332–336.
- Perl, J. (2003). Sportinformatik [Sports Informatics]. In H. Haag & B. Strauß (Eds.), *TW4.5 Theoriefelder der Sportwissenschaft [Theoretical Fields of Sports Science]* (2nd ed., pp. 77–95). Schorndorf: Hofmann.
- Sarmiento, H., Clemente, F. M., Araújo, D., Davids, K., McRobert, A., & Figueiredo, A. (2018). What Performance Analysts Need to Know About Research Trends in Association Football (2012–2016): A Systematic Review. *Sports Medicine*, 48(4), 799–836.
- Sarmiento, H., Marcelino, R., Anguera, M. T., Campaniço, J., Matos, N., & Leitão, J. C. (2014). Match analysis in football: a systematic review. *Journal of Sports Sciences*, 32(20), 1831–1843.
- Schnabel, G., Harre, H.-D., & Krug, J. (2014). *TW2 Trainingslehre - Trainingswissenschaft: Leistung - Training - Wettkampf [Training theory - training science: performance - training - competition]* (3rd ed.; J. Krug, Ed.). Aachen: Meyer & Meyer Sport.