DIGI-SPORTING. A NEW STEP TOWARDS DIGITAL TRANSFORMATION THROUGH SPORTS SCIENCE

GUIDELINES ON THE APPLICATION OF NEW TECHNOLOGIES, PROFESSIONAL PROFILES, AND NEEDS FOR THE DIGITAL TRANSFORMATION OF SPORTS ORGANISATIONS

DIGI SPORTING

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PARTNERS

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PART 1. DESCRIPTION, STATE OF THE ART AND USEFULLNESS OF THE DIFFERENT TECHNOLOGIES IN CLUBS AND ACADEMIES

1.1. Technologies for club management

All Health Clubs, Gyms, Gyms, CrossFit Boxes, Studios, among other places, need to acquire management software. That software is necessary and can help in the control and financial management, control and management of users, control and management of group classes, among other needs that sports facilities may have. Thus, there are several companies on the market offering different management software. All this software is different and has different management tools, as well as different functionalities and costs.

RegiBox is a management software that belongs to the company RegiProf, which appeared in mid of the year 2015. The RegiBox software emerged in order to respond to a necessity, supporting classes scheduling from a smartphone or a computer. Currently, this software covers all the needs of a CrossFit Box, namely, from the management of athletes to financial management, scheduling classes, programming and training planning, recording athletes' results, among others. Another advantage of this software is the possibility of creating events, as well as managing them. These events can be race events, CrossTraining events, among others that need to have a classification. One of the most significant disadvantages of this software is that it is mainly directed to CrossFit Boxes. This is a disadvantage for a Gym or Health Club that would like to purchase this software because all it handles is directed to a Box (RegiprofGroup, 2020a, 2020b); furthermore, the use of this software is through a website.

Health Center is a software belonging to the company CEDIS. CEDIS is a company that was created in 1993 and was the first company (e.g., in Portugal) to consult and develop software for sports facilities management. This software was created to be able to manage all types of sports facilities. This software allows the management of customer payment control, financial management, activities of sports facilities, entry and exit of clients, management of employees, among others. It is computer software, which needs a good understanding of most users. Extremely complete, likewise, complicated software. The most significant disadvantage of this

software is linked to its degree of utilities, that is, for more specific management of certain situations, i.e., Spa, management of group class tickets, and physical assessment, it requires these packages to be purchased separately. In order, when all these components are affordable, it is a complete software (PROINF, 2020).

FitogramPro is a software that was created through the union of two other software. The creation of this software aimed to assist small sports facilities, specifically, Yoga studios, Boutique Gymnasiums and Small gymnasiums. This software allows proper management of clients, contracts with clients, scheduling classes, and also contains a financial management tool. It has the advantage of being quite simple to use, but it will be an incomplete software for large sports facilities (FitogramPro, 2020).

Training Gym is a software developed for Gyms and Fitness Clubs, intending to improve the customer's experience in the gym. It is a straightforward software to use, where it offers a smartphone application for the gym or fitness club clients. In this application, directed to the client, it is possible to book classes, receive assessment reports generated after the physical assessments and also receive training plans. This software also allows easy communication between gym workers and clients. The great advantage of this software is its simple use and gives the possibility of having excellent management over the clients, since it makes all the interaction between the client and the manager quite simple, and improves the communication between both, which improves clients' experience. Its disadvantage is that it only has these features. It does not contain any other type of functionality, so in order to manage other essential parts of the Gym's or Fitness Clubs, managers have to buy other software (Trainingym, 2020).

Management Software

- RegiBox
- Health Center
- FitogramPro

- Training Gym

Table 1. Management software.

Software	Practical Applicability	Cost	Reliability	Utilities
RegiBox	3	2	5	2
Health Center	4	3	5	5
FitogramPro	4	2	5	2
Training Gym	4	2	5	1

Legend: Practical Applicability: 1 - Very Low; 2 - Low; 3 - Reasonable; 4 - Practical; 5 - Very practical. Cost: 1 - Very Low; 2 - Low; 3 - Reasonable; 4 - High; 5 - Very High. Reliability: 1 - Very Little; 2 - Little; 3 - Reasonable; 4 - Reliable; 5 - Very Reliable. Utilities: 1 - Very Few; 2 - Few; 3 - Some; 4 - Many; 5 - Complete.

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1.2. Technologies for physical evaluation, physical tests, injury prevention, health, and medical technologies

1.2.1. Heart Rate

The Heart rate (HR) is a direct measure and expresses the heartbeat, which can be measured before, during, and post-training or at any moment during physical activity. The theoretical maximal Heart rate (HRmax) can be calculated using different formulas, being the most common 220 - age. However, it should be noted that there may be inter and intra-individual variability that will lead to a wrong extrapolation of the data found through calculations or submaximal tests(ACSM, 2013). The HR measurement is usually made through a band placed on the chest area or by using an accessory set on the wrist area (Gillinov et al., 2017), which is, therefore, ready to use and user-friendly. In this way, the value of heartbeats per minute is provided instantly.

Taking into account all the aspects mentioned above, HR is a measure that is recommended to be used as a quantifier of exercise intensity, due to its easy access and use. Therefore, this can be quantified through the reserve HR (HRmax - HRrest) or the HRmax, obtaining values indicating in which intensity level, light, moderate or vigorous, the training is.

Table 2. Description of the percentages and relative intensity of HRreserve and HRmax.

Intensity	HRreserve	HRmax
Light	30% e <40%	57% e <64%
Moderate	40% e <60%	64% e <76%
Vigorous	60% e <90%	76% e <96%
Near Maximum	>90%	> 96%

Adapted from ACSM (2013). Guidelines for exercise testing and prescription

That said, HR can also be accompanied, for example, by blood pressure and/or rate of perceived exertion aiming to obtain better control of the effort's intensity since

one of its disadvantages is to have a long response when faced with intermittent high-intensity stimuli (Tschakert et al., 2015).

Considering the two types of HR measurement, the chest band or a wristwatch, it should be noted that the assessment through the chest band has better reliability and a lower error when compared to the wristwatch, for example. This is probably due to the fact that the new HR monitors through wristwatch do not measure cardiac electrical activity, on the contrary, they are based on photoplethysmography, that is, the monitor illuminates the skin with an LED and measures the amount of light reflected in the photodiode sensor (Gillinov et al., 2017), which allows detecting variations in blood flow caused by cardiac contraction. Moreover, these HR monitors may have other sources of errors, such as the movement of the upper limbs, misalignment between the skin and the optical sensor, variations in colour and / or skin tone, ambient light, and poor tissue perfusion (Alzahrani et al., 2015). Even so, this way of controlling intensity is valid and reliable and recommended for activities such as running, cycling, and elliptical, for continuous and moderate intensities, as well as for quantifying daily activity in young and physically active populations. On the other hand, no evidence was found regarding the overweight and obese population, or Intermittent high intensities (El-Amrawy & Nounou, 2015; Stahl et al.,2016).

Practical applicability – ★★★★★
Cost – ★★★★
Reliability – ★★★★★

1.2.2. Rate of Perceived Exertion

The Rate of Perceived Exertion (RPE) is an indicator that measures the tolerance of individuals to exercise (ACSM, 2013). It is a scale that was developed for one to subjectively assess the feeling during the exercise, taking into account one's own level of fitness and level of fatigue. For this purpose, two scales are commonly used: the original Borg 6-20 scale, where specific phrases correspond to specific numbers; and the OMNI 0-10 scale, which in addition to numbers and corresponding phrases also has an image reflecting the type of effort. On the original Borg 6-20 scale, numbers 6

and 7 were classified as No exertion at all, 8 as Extremely light, 9 and 10 as very light, 11 and 12 as light, 13 and 14 as somewhat hard, 15 and 16 as hard (heavy), 17 and 18 as a very hard, 19 as an extremely hard and 20 as a Maximal exertion activity.

Table 3. Description of Borg´s Scale and respective exertion levels.

	Borg 6-20 scale
6	No exertion at all
7	
8	Extremely light
9	very light
10	
11	Light
12	
13	somewhat hard
14	
15	hard (heavy)
16	
17	very hard
18	
19	extremely hard
20	Maximal exertion

Adapted from ACSM (2013). Guidelines for exercise testing and prescription

On the OMNI 0 to 10 scale, the number has a classification associated with a figure, with 0 being an extremely easy activity, 1 and 2 an easy activity, 3 and 4 a somewhat easy activity, 5 and 6 a somewhat hard activity, 7 and 8 hard activity, 9 and 10 extremely hard activity. The associated image will vary depending on the activity, with the following examples being the OMNI-Cycle scale for cycling and the OMNI-RES scale for strength training.

The RPE is a scale of effort intensity with the following advantages:

i) easy access;

ii) low monetary cost;

iii) possibility of use during activity;

and disadvantages:

iv) indirect;

v) subjective;

vi) decreased effectiveness when used in untrained persons.

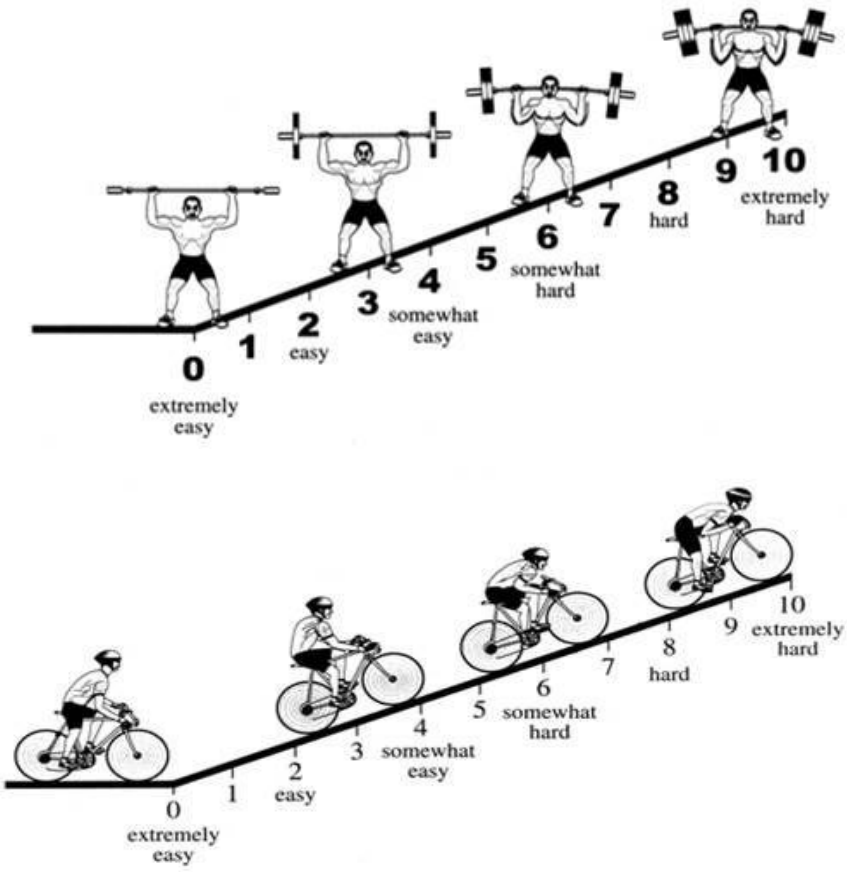

Figure 1. The OMNI-RES scale for strength training (top picture) and OMNI-Cycle scale for cycling.

Despite being a tool that has positive correlations with physiological variables such as lactate (Aniceto et al., 2015; Psycharakis, 2011; Scherr et al., 2013), HR (Psycharakis, 2011; Rodriguez-Marroyo et al., 2012; Scherr et al., 2013), and VO2 (Evans et al., 2014), it is suggested RPE to be used based on three points: i) the maximum test to be associated with the activity in question; ii) familiarization to the scale associated with the maximum test; iii) performed task known to the participant. Respecting to

these details, it becomes possible to overcome some of RPE's disadvantages and thus enhance its effectiveness, leading to a greater validity when RPE is taught and shown during the activity (Aniceto et al., 2015).

The RPE exists mostly to monitor the effort during cyclical and of longer duration activities, where its reliability is naturally higher, such as swimming (Psycharakis, 2011), running (Coquart & Garcin, 2007), and cycling (Green et al., 2006; Katsanos & Moffatt, 2005). However, its validity also exists in activities of anaerobic predominance such as resistance training, that is, short-duration stimuli and higher intensity (Lagally & Amorose, 2007).

In sports performance, where professional athletes live off their income, the objective is no longer to control or adjust training intensities previously or in loco, but to control it post-exercise, either after a workout or a game. Initially, this control started to be done using the Bannister's TRIMP formula:

(HR Reserve X non-linear factor Blood Lactate relationship) X Duration = Training Load

However, there was still the need for something more practical and less complex, such as Edwards' TRIMP formula:

(Training Zone X Duration) = Training Load.

This method, being more practical, has the inconvenience of having HR as a variable, which in addition to having some disadvantages that have been mentioned previously, in contact sports sometimes there are periods when it is not measured. In this case, important training data may be lost to understand the athlete's real condition. Thus, once again, there is a need for something practical, easy to use and access like RPE, being advised to be used as a quantifying mechanism of individual exercise intensity through the formula (Foster et al., 2001):

RPE X Duration = Training load

Therefore, there is a tool capable of being used for training load monitoring purposes. Nevertheless, it is advisable to combine RPE with other physiological parameters (Haddad et al.,2017). As for the moment of its use, it may vary, being more usual 30 minutes after the end of the activity (Govus et al., 2018; Jaspers et al., 2018; Wallace et al., 2014).

Practical applicability – ★★★★

Cost – ★★★★★

Reliability – ★★★

1.2.3. Blood Pressure

Blood pressure is overwhelming the most commonly measured parameter for the assessment of haemodynamic stability. BP measurement using an upper arm cuff dates back to 1896 when Riva-Rocci introduced it into clinical sphygmomanometry (Perloff et al., 1993). The use of sphygmomanometry is an indirect way to obtain BP values. The cuff pressure at the time of the initial increase in arterial oscillations corresponds to maximum systolic BP, and the lowest cuff pressure just prior to the time that oscillations stop decreasing in amplitude corresponds to the diastolic BP. Avoiding the inconvenience of auscultation and introducing automation made oscillometry highly preferable. As a consequence, the oscillometric method is broadly and confidently used in physician offices, emergency departments, hospital wards, and perioperative monitoring and treatment in the majority of general anaesthesia cases (Saugel et al., 2014).

Normal adult blood pressure is defined as a blood pressure of 120 mm Hg1 when the heart beats (systolic) and a blood pressure of 80 mm Hg when the heart relaxes (diastolic). When systolic blood pressure is equal to or above 140 mm Hg and/or a diastolic blood pressure equal to or above 90 mm Hg, the blood pressure is considered to be raised or high (WHO, 2015).

Physical Exercise (PE) has a hypotensive effect. This effect can occur since the finish of the exercise session, until 24 hours later. Blood Pressure values can be reduced by 8,3 mmHg and 5,2 mmHg, for SBP and DBP, respectively, whit aerobic continuous training with moderate intensity in hypertense people (Mcmillan, 2016). Strength Training has the same hypotensive effect in the next hours of PE in 5,5 mmHg and 3,3 mmHg for SBP and DBP, respectively, with moderate intensity (60% to 80% of 1 Maximum Repetition) (Bentes et al., 2015).

During PE, BP increase is caused by the muscle blood flow needed, and its increase can be higher in 100 mmHg to 130 mmHg than basal BP (Guyton, 1988). An indirect measure of BP is difficult to be obtained during PE, and it is the principal disadvantage of the method. However, it is a suitable method and can be applied in clinical or in an exercise context to ensure a good prescription for the client.

Digital Sphygmomanometer: Gima; Omron; Leo.

Practical applicability – ★★★★
Cost – ★★★★
Reliability – ★★★★

Manual Sphygmomanometer: Gima; Welch Allyn; Riester.

Practical applicability – ★★★
Cost – ★★★★
Reliability – ★★★★

1.2.4. Thermography

Thermography is a method that allows for the thermal mapping of the surface of the human body with the aid of a special camera. Thermography is a non-invasive method, harmless and obtained from a certain distance from the subject.

During the Second World War, there was a technological development regarding the use and detection for military use and, later, for public use with certain restrictions (Filho, 1999). Then, Doctor Lawson performed the first medical thermography in 1957,

discovering that his breast cancer patient had a higher temperature in that region (Ring, 2006). This heat loss is a physiologically regulated function and is controlled by the vasomotor activity of the cutaneous vascular network. The central body temperature is carried by the peripheral vascular network that is controlled to allow the loss of an appropriate amount of heat in order to maintain the core temperature. There are four mechanisms of physical thermal loss: conduction, convection, evaporation, and radiation.

Heat convection is an essential mechanism of thermal transfer in the thermographic diagnosis process. Heat transfer from one part of the body to another (for example, central to the periphery) is done through the movement of fluids (blood flow). The blood, heated by both visceral and somatic metabolism, is convected by the vascular network and transferred into the body first, and then to low-temperature areas (Brioschi et al., 2003). Therefore, convection is one of the most significant mechanisms of heat transfer within the body.

Thermal radiation in the infrared range that is emitted by the human body is not visible to our eyes and was first described in 1800, by Sir William Herschell, which he called "dark heat". In 1840, his son John Herschell was the first to create a thermographic image (Filho, 1999; Ring, 2006). Thermographic cameras were developed in order to capture the infrared radiation emitted by the human body. These infrared cameras use a sensor with a response in the infrared range (wavelength between 0.75 to 1000 μm) to convert the thermal radiation emitted by the skin surface into electrical signals. The electrical signals are quantified and presented as an image. In the grayscale image, the warmest regions are usually represented with light gray tones, and the colder regions are represented with dark gray tones. In order to facilitate the interpretation of temperature, pseudo-colors are assigned to the grayscale. An apparently healthy person has thermal symmetry between the left side and the right side. The difference in skin temperature on both sides of the human body is quite small, around 0.2 °C (Uematsu et al., 1988). Thermal asymmetries result from functional changes within the body (Wiecek, et al., 2006). In a thermographic image, each pixel is associated with a temperature value. Regions of abnormal vascularization

are detected in thermography as hot spots, which indicate areas of higher local blood circulation, resulting from inflammatory processes. On the other hand, cold spots indicate regions of affected vascularization (Renkielska et al., 2006).

Heat is continuously produced by the body as a product of metabolism. Three major factors determine the degree of heat production: basal metabolic rate, specific organic activity, and muscle activity. Due to physiological reflexes and heat distribution mechanisms, metabolic heat production remains constant within a wide range of ambient temperatures. Thermographic diagnosis is based on thermal asymmetry, between body dimensions and the relationship of discrete thermal differences with surrounding areas. (Brioshi et al., 2007). Muscle activity has a noticeable effect on heat production. Exercise can increase oxygen consumption ten times above rest level, corresponding to an increase in heat production (Brioshi et al., 2007). Therefore, through thermography, with the identification of the inflammatory focus, it becomes possible to evaluate muscle damage. According to Brioshi et al. (2003), and beyond the identification of muscle injury, thermography is an effective way in the assessment of cardiovascular diseases, such as varicose veins, early detection of deep venous thrombosis, diabetic microangiopathy, lesions of the vascularization of the head and neck as stenosis of the carotid artery. Alongside this, it is also suggested the use of thermography during cardiovascular surgery, to evaluate the degree of perfusion in certain areas (Brioschi et al., 2003).

Thermography Devices

	Thermal Pixel Size	Thermal Resolution	Thermal Sensitivity	Object Temperature Range
FLIR ONE Pro	12 **µm**	**19,200 pixels (160 x 120)**	**70 mK**	**-20 to 400°C**

Practical applicability – ★★★★★

Cost – ★★★★★

Reliability – ★★★

	Thermal Pixel Size	Thermal Resolution	Thermal Sensitivity	Object Temperature Range
FLIR ONE Pro LT	17 µm	**4,800 pixels (80 × 60)**	**100 mK**	**-20 to 120°C**

Practical applicability – ★★★★★
Cost – ★★★★
Reliability – ★★★★

	Thermal Pixel Size	Thermal Resolution	Thermal Sensitivity	Object Temperature Range
FLIR E4	7,5-13 µm	80 × 60 (4.800 pixels)	150 mK	-20 to 250 °C

Practical applicability – ★★★★★
Cost – ★★★
Reliability – ★★★★

	Thermal Pixel Size	Thermal Resolution	Thermal Sensitivity	Object Temperature Range
FLIR T1020	7,5 - 14 µm	800 x 480 pixels	<0,02 °C em +30 °C	-40 to 2000 °C

Practical applicability – ★★★★★
Cost – ★
Reliability – ★★★★★

	Thermal Pixel Size	Thermal Resolution	Thermal Sensitivity	Object Temperature Range
FLUKE Ti480 Pro	-	640 x 480 pixels	-	-10 to 1000 °C

Practical applicability – ★★★★★
Cost – ★★
Reliability – ★★★★★

1.2.5. Ultrasound

Ultrasonography (US) is a non-invasive assessment technique that can be used to monitor changes in muscle mass resulting from the effects of diet programs and/or

exercises aimed to promote health (Gomes et al., 2010). US has also been used to assess muscle damage and the quality of the active muscles themselves. This assessment is made through a grayscale obtained after placing the probe in the muscle to be evaluated (Pinto et al., 2013; Radaelli et al., 2013). Several studies have reported the application of this technique to trained and untrained individuals (Matta et al., 2010). Gomes et al. (2010), showed that the methodology of ultrasound assessment is relatively reliable concerning muscle thickness and when compared to bioimpedance, with a correlation of 0.65 for people with Body Mass Index (BMI) <25 and 0.77 for individuals with BMI ≥25 (Neves et al., 2013).

Ultrasonography Devices

	Ergonomics	Application	Options
MyLab™Alpha + eHD Technology + CrystaLine ESAOTE	Mobile	General Ultrasound	**Integrated Console**

Practical applicability – ★★★★★

Utility– ★★★★★

	Ergonomics	Application	Options
VIAMO™ C100 CANNON	Mobile with cart	General Ultrasound	Black and white, color doppler, with integrated console

Practical applicability – ★★★★★

Utility– ★★★★★

	Ergonomics	Application	Options
L7 HD CLARIUS	Pocket	For cardiovascular ultrasound, for anesthesia and intensive care ultrasound, for breast ultrasound, for musculoskeletal ultrasound, for skin ultrasound, for urgent care ultrasound, for intravascular ultrasound, for endocrine ultrasound	Color doppler, elastography, with needle guide, with "all-in-one" probe, with wireless probe

Practical applicability – ★★★★★

Utility– ★★★★

	Ergonomics	Application	Options
APOGEE 2100 SIUI	Mobile	General Ultrasound	Black and white, color doppler, with integrated console

Practical applicability – ★ ★ ★ ★ ★

Utility– ★ ★ ★ ★ ★

	Ergonomics	Application	Options
C7 ANASONIC	Mobile	General Ultrasound	With integrated console, color doppler, 3D / 4D, spectral Doppler

Practical applicability – ★ ★ ★ ★ ★

Utility– ★ ★ ★ ★ ★

	Ergonomics	Application	Options
3.5 - 7.5 MHZ | BEU-8200 BESTMAN	Mobile	General Ultrasound	Black and white, with integrated console

Practical applicability – ★ ★ ★ ★ ★

Utility– ★ ★ ★ ★ ★

	Ergonomics	Application	Options
SONIXONE BK ULTRASOUND	Mobile	General Ultrasound	With Touchscreen

Practical applicability – ★ ★ ★ ★ ★

Utility– ★ ★ ★ ★ ★

1.2.6. Maximum Repetition

In Resistant Training (RT) is usual to quantify the exercise intensity using the total load. This load that can be expressed in maximum repetitions (RM) represents the maximum number of repetitions correctly develop for the practitioner with a certain load (kg), or its relative percentages of the maximum load that the practitioner can resist in an only RM - %1RM (Schoenfeld, 2016). However, that could not be the best method to evaluate the maximum strength, cause there is significant variability inter and intra-individual to maximum number of repetitions with the same percentage of RM (%1RM) (Carpinelli, 2017); (Steele et al., 2017), for different exercises and muscles

groups (Shimano et al., 2006). Another disadvantage is the difficulty progression evaluation, once the practitioner can increase his RM from training to training.

Practical applicability – ★ ★ ★ ★

Cost – ★ ★ ★ ★ ★

Reliability – ★ ★ ★

1.2.7. Displacement Velocity

Speed4lift, ADR-Encoder, Push band, T-force, Velowin, Powerlift, Beast sensor, Trio-optitrack

The measurement of the bar displacement velocity (BDV) is an interesting variable to monitor and to adjust the intensity of the subject's load effectively, without the need to apply an exhaustive method. Several studies (Gonzalez-Badillo & Sanchez-Medina, 2010; Moran-Navarro et al., 2019) confirmed the relationship between BDV and relative intensity (% 1RM) where a strong and linear relationship between the BDV and% 1RM was observed (Gonzalez-Badillo & Sanchez-Medina, 2010). Thus, evaluation through the BDV becomes plausible, instead of an exhaustive test such as that of measuring the 1RM. The measurement of BDV becomes interesting, enabling athletes to undergo training with less volume and higher strength and power gains, and above all, causing the least possible training fatigue. Pareja-Blanco et al. (2017) verified that when training controlled by speed, and with a loss of only 20% of speed, subjects obtained more significant gains in strength and power and that, after 6 hours, all evaluated fatigue markers had returned baseline values. Due to technological advances, several devices for measuring BDV are available on the market. Consequently, there are several displacement velocity monitors available, from the golden standard Trio-Optitrack, which is composed of 3D motion capture. There are also isoinertial dynamometers, such as the T-Force (Garnacho-Castano et al., 2015), the Speed4lift (Perez-Castilla et al., 2019) or the ADR-Encoder. There are also camera-based optoelectronic systems, such as Velowin (Perez-Castilla et al., 2019), inertial gauges composed of a combination of 3-axis accelerometers and 3-axis gyroscopes, such as the Push Band or the Beast Sensor (Balsalobre-Fernandez et al., 2017). Finally,

there is also a smartphone application, the Powerlift (Balsalobre-Fernandez et al., 2017).

All of these monitors have their advantages and disadvantages. The Trio-Optitract (V120: Trio; OptiTrack, NaturalPoint, Inc.) is an optical motion detection system, which includes three infrared and pre-calibrated cameras fixed in a rectangular frame that provides 3D position data for a reflective marker, at a sampling rate of 120 Hz. The raw data of the marker's position in the space are obtained using Motive software v.1.5.0 (OptiTrack, Natural-Point, Inc.). Instantaneous speed is calculated by differentiating the displacement data with respect to time. The reflective marker is placed on one side of the bar, and the Trio-OptiTrack is positioned at a distance of 2.5 m from the marker. It is an impractical and quite expensive monitor, which makes it almost inaccessible to most professionals. Despite being considered the "Golden Standard," there was a need to create alternatives (Perez-Castilla et al., 2019).

In isoinertial dynamometers, we considered the T-Force (Sistema T-Force, Ergotech), which consists of a cable extension linear speed transducer connected to a computer. The instantaneous velocity is automatically calculated at a sampling rate of 1,000 Hz by the software. The cable is attached vertically to one side of the bar using a Velcro strip.

The Speed4lift (Speed4Lift) consists of a cable extension linear position transducer connected to the bar. The data is recorded directly by differentiating the displacement data in relation to time at a sampling rate of 1,000 Hz through the Wi-Fi connection with a smartphone using the Speed4Lift application. The cable is secured vertically to one side of the bar using a Velcro strip.

The ADR-Encoder (ADR-Encoder) consists of a cable extension linear position transducer connected to the bar. Data is recorded using a smartphone application. The cable is attached vertically to one side of the bar, using a Velcro strip.

These isoinertial dynamometers, although more practical, since they only require connecting a cable to the bar, have this same limitation, since the cable restricts its use to some exercises. Within these linear velocity transducers, some are more affordable than others.

The ADR-Encoder is the most affordable, followed by the Speed4lift and, finally, the T-Force. Regarding its validity, recently, in the study by Pérez-Castilla et al. (2019), it was found that the Speed4lift has higher reliability than the T-Force. However, T-Force does contain a calibration certificate that makes it more reliable for scientific studies. As for the ADR-Encoder, it presents a close relationship with these isoinertial dynamometers described above, and the study was carried out by the creators of the device.

The optoelectronic system Velowin (Velowin; DeporTeC) includes an infrared camera in interface with a computer, which measures the displacement of a fixed reflector on the bar. The data is recorded directly from the software by differentiating the displacement data in relation to time at a sampling rate of 500 Hz. The Velowin is placed at a distance of 1.7 m from the infrared reflector and is calibrated according to the instructions of the manufacturer. Although practical, since it can be used in several exercises, when compared to transducers, it needs software to be used and, consequently, to connect to a computer, which makes its portability more complex. Its cost is also high, which makes inertial monitors, isoinertial dynamometers, and smartphone applications more accessible to professionals. Its reliability was also analyzed by Pérez-Castilla and collaborators (2019), also proving to be quite reliable, just behind the Speed4lift.

In the inertial monitors, we have the Push Band (PUSH band, PUSH, Inc.), as a wearable band consisting of a 3-axis accelerometer and a gyroscope scope that provides 6 degrees of freedom in its coordinate system. The data is recorded directly by integrating the acceleration data in relation to time at a sampling rate of 200 Hz through the Bluetooth 4.0 LE connection with a smartphone via the PUSH application.

The PUSH band is on the subject's dominant forearm, immediately below the elbow fold, with the main button located proximally.

The Beast Sensor (Beast sensor, Beast Technologies Srl.) is a wearable band that includes a 3-axis accelerometer, gyroscope, and magnetometer. The data is recorded directly by integrating vertical acceleration in relation to time at a sampling rate of 50 Hz through the Bluetooth connection with a smartphone via the Beast application. The Beast sensor is placed on the bar using a built-in magnet. These devices seem to be the most practical in terms of their use, since it is only necessary to place them on the athlete's body or on the bar, and they only require a smartphone to view the data. In terms of cost, they are even more accessible, and their portability is quite simple, as they are small and easy to transport. They have the advantage of being able to be used in horizontal and vertical movements, having the disadvantage of presenting discrepancies in speed measurement. In the study by Pérez-Castilla et al. (2019), they proved to be the least reliable when compared to other devices.

Finally, the Velowin smartphone application involves a manual frame-by-frame analysis of a slow-motion video recording, recorded by the smartphone's camera, at a frequency of 240 frames per second, and a quality of 720 pixels. The average speed is calculated as the individual range of motion (i.e., vertical displacement of the bar from the starting position to the final position, divided by the movement time. This application is also very practical in use, and is the most affordable in terms of money, given its low cost. These applications have also demonstrated higher reliability than inertial monitors. Their major disadvantage is the impossibility of viewing the data in real-time, that is, it is necessary to select the start and endpoint of the exercise, in filming, to obtain data later (Perez-Castilla et al., 2019). Below is a summary table of all devices:

Table 4. Summary of devices to monitor Displacement velocity and further characteristics.

Device	Practical Applicability	Cost	Reliability
Trio-Optitrack	1	5	5
T-Force	3	4	4
Speed4lift	4	3	4
ADR-Encoder	4	2	4
Velowin	3	4	4
Push Band	5	3	2
Beast Sensor	5	3	2
Powerlift	4	1	3

Legend: Practical Applicability: 1 - Very Low; 2 - Low; 3 - Reasonable; 4 - Practical; 5 - Very practical. Cost: 1 - Very Low; 2 - Low; 3 - Reasonable; 4 - High; 5 - Very High. Reliability: 1 - Very Little; 2 - Little; 3 - Reliable; 4 - Very Reliable; 5 - Gold Standard.

1.2.8. Jump Height

Push Band, Chronojump, Optojump, My jump 2, Vertec, Just jump

The jump height is a measure that can be evaluated based on different movements, namely, Vertical Jump, Drop Jump, Squat Jump, or Countermovement Jump. Some of these movements can be observed in some specific sports, and other movements are used to acquire information related to the subjects, namely, the optimal strength-speed profile or the Reactive Strength Index (RSI) (Samozino et al.,2008). All of these data are important for exercise professionals, especially regarding decisions over the training method to be applied. They also allow to monitor athletes' entire training process and their evolution and can also be used as a test of readiness for training.

Vertical Jump aims to achieve the highest vertical distance possible. This movement can be observed in several sports, being the key factor for its practice, in some cases.

Squat Jump is a vertical jump from a static squat position. The subject has his knees at about 90° of flexion, and then the lower limbs are extended, in order to jump as high as possible. It is a ballistic exercise that can be used as a readiness test for training or as a training exercise in order to improve critical physiological mechanisms (Asmussen & Bonde-Petersen, 1974; Samozino et al., 2008).

The Countermovement Jump (CMJ) is similar to the Squat Jump (SJ), has the difference of not starting from a static position, but from a lower limb extension position to a squat position, followed by a new extension in order to jump as high as possible. This exercise becomes a plyometric movement with great action in the stretching-shortening cycle. It can, like the SJ, be used as a test of readiness for training and, likewise, be an exercise used to improve the various physiological mechanisms.

The Drop Jump (DJ) it is a deep jump in which the objective is to carry out a vertical jump reaching the highest possible height, as soon as the subject touches the feet with the ground, obtaining a very reduced contact time with the ground (Kopper et al.,2013). Since these exercises serve as a resource for assessment and training, professionals and coaches must have a wide range of tools for measuring jump height.

In the market, several materials allow measuring of the jump height, from technological materials to technology free materials. The materials that require more use of technology and, consequently, the use of own devices are the Push Band, Chronojump, Optojump, and Just Jump, switching to the use of smartphone applications such as My Jump 2, ending with an instrument, the Vertec.

The Push Band (PUSH band, PUSH, Inc.) is a wearable band consisting of a 3-axis accelerometer and a gyroscope scope that provides 6 degrees of freedom in its coordinate system. The data is recorded directly by integrating the acceleration data in relation to time at a sampling rate of 200 Hz through the Bluetooth 4.0 LE connection with a smartphone via the PUSH application. The band is placed on the subject's waist while performing the jump. With this band, it is possible to measure the height of the SJ, CMJ, and DJ, and it is also possible to obtain RSI data. Overall

the band is practical for measuring the jump height, as it is only necessary to place the band on the subject's waist and use the smartphone application. Its disadvantage is sometimes to overestimate some measures.

The Chronojump (Chronojump-boscosystem) (Blas et al., 2012) and the Just Jump are contact platforms connected to a microcontroller. Both platforms measure the height of SJ, DJ, and CMJ. The big difference between the two platforms is in terms of data visualization, where Chronojump needs a connection to software, which implies a computer, and Just Jump presents the data on its microcontroller. Their portability is also somewhat affected, as they are of considerable dimensions, which in turn facilitates jump testing. Regarding the cost of both, Just Jump is a lot more expensive than Chronojump. As for reliability, Chronojump proves to be quite reliable (Blas et al., 2012), on the other hand, Just Jump implies that a formula to correct data is used (McMahon et al., 2016) since the platform overestimates the values.

The Optojump (Optojump) is a system of optical measurement, consisting of two bars, one for transmission and one for reception. Two devices are required, each containing 96 LEDs. The LEDs on the transmission bar continuously communicate with those on the receiver bar. The system detects any interruption in the communication between the bars and calculates its duration. Thus, making it possible to measure the time of flight and contact during the execution of a series of jumps, with the precision of 1/1000 of a second. From these data, the software allows obtaining a set of parameters related to the athlete's performance with good precision (Glatthorn et al., 2011). The jump´s height is calculated through the duration of the jump. This device is portable, as it only requires two bars. The data can be viewed on the bars themselves, with the possibility of being connected to a computer using the software. The disadvantage of this device is in the measurement of the jump height, since the landing area has to be precisely in the same place, and is quite small, due to the communication between the two bars. Moreover, after the landing, the subject has to jump out of the two bars.

The My Jump 2 is a smartphone application that was launched to be a more accessible means for measuring various parameters of athletes, including the jump height. The application is very practical, as subjects only need a smartphone with a good quality camera (Haynes et al.,2019). In addition to being practical, the application is reliable in measuring jump height (Balsalobre-Fernandez et al., 2015; Haynes et al., 2019). The disadvantage of this application is that the access to data is not possible in real-time since it is necessary for the evaluator to review the video in slow motion and to select the frame from the moment the subject removes the feet from the floor and the frame from the initial moment of landing. Nevertheless, it is quite affordable.

The Vertec Vertical Jump Meter is composed of rotational plastic bars, placed at a distance of 1.25 cm between them, being attached to a telescopic metal pole. This pole is adjusted to the height of the reach of each subject. The test requires subjects to use their dominant hand to rotate the plastic bar as high as possible. The apparatus and the test are quite simple, and despite being extremely practical, the fact that the subjects use their dominant hand to touch the bars alters the jumping technique, which affects the reliability of the measurement (Buckthorpe et al., 2012; Muehlbauer et al.,2017). In comparative cost terms, this device is more expensive.

Table 5. Summary of devices to monitor Jump Height and further characteristics

Device	Practical Applicability	Cost	Reliability
Push Band	5	4	3
Optojump	4	3	4
Chronojump	4	3	4
Just Jump	4	4	4
My Jump 2	5	1	4
Vertec	5	5	2

Legend: Practical Applicability: 1 - Very Low; 2 - Low; 3 - Reasonable; 4 - Practical; 5 - Very practical. Cost: 1 - Very Low; 2 - Low; 3 - Reasonable; 4 - High; 5 - Very High. Reliability: 1 - Very Little; 2 - Little; 3 - Reasonable; 4 - Reliable; 5 - Very Reliable.

1.2.9. Energy expenditure

To assure daily living tasks, living beings require a certain amount of energy expenditure (EE). The Daily EE in humans is determined by: i) basal metabolic rate, and; ii) physical activity.

Basal metabolic rate (BMR) includes metabolic demands suffice to cover vital functions during sleep and the energy demand during awakening after sleep; being assessed after a minimum of 12-18h fasting and having the subject on a neutral environment and in a supine position (Kenney et al., 2012; Powers & Howley, 2003). The BMR is hard to measure in the laboratory, and thus the resting metabolic rate (RMR) is assessed with the subject resting for 30-60min after a fasting period. Both entities vary according to lean body mass, age, sex, measurement technique (Salbe & Ravussin, 2003), lifestyles, active vs. sedentary (Wahrlich & Anjos, 2001), body temperature, stress and hormonal levels (Kenney et al., 2012). Food thermogenesis amounts about 8 to 10% of daily EE.

Physical activity (PA) is considered an important component of EE. Exercise physiology measures the EE during PA, and EE is a function of intensity, duration and frequency of the physical exertion (ACSM, 2013). Overall daily EE depends partly on the PA, and this component, while representing 15-50% of daily EE is the fraction that varies more between subjects (Melby & Ho, 2003). The most accurate estimates of EE are those in common locomotion such as walking, running or swimming (Carter et al., 2000; McArdle et al., 2010). On the other hand, the EE is harder to measure in intermitent PA (i.e. tennis, football or basketball).

Measurement of energy expenditure

It is not possible to measure directly the energy produced at the muscle cell level; however, every metabolic process in the human body is deemed to produce heat (Kenney et al., 2012; McArdle et al., 2010). There are two methods to assess EE during rest and during PA: direct calorimetry and indirect calorimetry.

Direct calorimetry was first described in the second half of the XVIII century, with the studies by Lavoisier and Laplace; and Antoine Lavoisier was the first to conduct experiments on human respiration. Since 1890 with the appearance of the first human calorimeter, the relationship between energy intake and EE was confirmed (McArdle et al., 2010). The calorimeter consisted in a hermetic chamber able to quantify the body´s heat release and the body´s steam release (Pedrosa et al., 2017). By assessing heat production in the human body, it is possible to estimate the energy yield (Reis et al., 2000; Kenney et al., 2012). The direct calorimeter, although of high relevance and high accuracy, is a heavy and expensive construction which requires high maintenance and which limits the PA able to be performed within its limits. On the other hand, direct calorimetry is not bale to address fast energy turnovers involved in high-intensity exercise. Therefore, this apparatus is almost obsolete to most sports, recreational and occupational PA.

Indirect calorimetry is done by means of gas exchanges and is based on the oxygen uptake (VO2) and carbon dioxide excretion (VCO2) measurements and on its fractions on inspired and expired air (Melo et al., 2008). The amount the O2 and CO2 changes in the lings matches those occurring in human cells. Hence, it is possible to accurately estimate the EE by measuring gas exchanges at the lungs. By measuring VO2 during rest or at steady-state intensity exercise, the indirect estimate of EE is accurate, because the anaerobic fraction of energy is negligible. Indirect calorimetry is useful, with high reproducibility and with relatively low cost, to assess RMR, to assess the thermogenic effects of food and also to assess EE during PA. However, the main limitation to use the O2 energy equivalent is that only the aerobic sources of energy are considered. Thus, exercise must be mainly aerobic, so that VO2 can truly express the EE. Otherwise, when anaerobic energy fraction is important, VO2 measurements alone will result in EE underestimation. This can be seen in exercise where a steady-state VO2 is not attained (Krustrup et al., 2004; Scott, 2006; Scott & Kemp, 2005), once the anaerobic fraction is not included in the measurement. Therefore, this measure is less precise the more anaerobic the exercise (the higher the intensity). Nevertheless, indirect calorimetry with the O2 energy equivalent is the most common method to assess EE during PA in humans.

1.2.10. Quantification of aerobic energy

The fraction of aerobic energy during exercise is assessed by indirect calorimetry and is based on the VO2 measurement. The calculation of the O2 energy equivalent is based on the relative fraction of O2 and CO2 in the expired gases (warrants the measurement of VO2 and that of respiratory exchange ratio).

The former is determined by the ratio between VCO2 and VO2 and allows the estimation of the relative contribution of substrate utilization during exercise (Kenney et al., 2012). The use of this ratio to quantify the relative substrate utilization during exercise is accurate only under VO2 steady-state conditions. Hence, indirect calorimetry is vastly used to assess EE in prolonged, low- to moderate-intensity exercise, where a true VO2 steady-state is attained (Pescatello et al., 2014).

1.2.11. Quantification of anaerobic energy

The methods that are used to quantify anaerobic energy during exercise are less precise, and some present technical difficulties (Saltin, 1990). A variety od methods has been used but no universally accepted method is available (Gastin, 2001). Three methods are usually available: i) measurement of intramuscular metabolites; ii) estimation of energy equivalent of lactate in the blood; iii) estimation of the accumulated oxygen deficit (AOD). When the **lactate method** is used, the calculations refer solely to the lactic energy fraction. Therefore, the total anaerobic energy is found by adding an assumed value for the alactic energy fraction. This vale may vary and is usually calculated from the time-constant of the fast component of the post-exercise VO2 off-kinetics and according to Di Prampero (1981) may attain 36.8 ml.kg-1. When the lactate in the blood equivalent is used, the lactic energy is found from the difference between the peal post exercise lactate minus the resting vale. The difference is multiplied by body mass and by 3 ml O2 (Di Prampero & Ferretti, 1999), and the energy equivalent is obtained in units of $ml.kg^{-1}.min^{-1}$.

The use of the lactate energy equivalent involves several sources of unprecise errors. This technique uses a blood value, but the original metabolite is produced in the muscle. Therefore, every event between the formation of lactate and its

appearance in the blood are not controlled for (Astrand et al., 2003; Brooks et al., 2004; Lehninger, 1987). The lactate in the blood does not reflect lactate production but also lactate excretion and clearance (Cazorla et al., 1984). Although blood lactate indicates the rate of glycolysis in the muscle it does not quantifies lactate production itself nor the energy yielded by ATP and CP (Saltin, 1990). Despite the several sources of error, this is the most common method quantify anaerobic energy through the simple conversion of blood lactate units into O2 energy equivalents (DiPrampero et al., 1978; Laffite et al., 2004; Margaria et al., 1963; Reis et al., 2010; Zamparo et al., 2000).

As to the **accumulated oxygen deficit** (AOD), this a method that includes a single estimation of both anaerobic sources: lactic and alactic (Reis et al., 2010b) and that does not require invasive techniques (Gastin et al., 1991; Medbø et al., 1988; A. Russell et al., 2000; A. P. Russell et al., 1998). Its calculation is possible solely from VO2 measurements and allows the calculation of aerobic and anaerobic fractions of energy.

This method appeared in 1984 (Medbø e Hermanssen, 1984) and was validated by Medbø et al. (1988) a few years later. Since then is has been considered the most accepted measure of anaerobic capacity (Gastin, 1994; Medbø, 1996; Nakamura & Franchini, 2006; Reis et al., 2010; Scott et al., 1991), that is the most realistic measure of anaerobic energy during exercise. The anaerobic capacity as determined by the AOD is the difference between the O2 demand and the true O2 uptake during exercise. The validity if the measure is supported by its strong correlation with anaerobic energy measured by muscle metabolite during single muscle group exercise (Bangsbo et al., 1990).

The AOD method requires the linear extrapolation of the supra maximal energy cost from the submaximal energy cost. As a requirement, is it necessary to have several steady-state VO2 measurements above and below the anaerobic threshold (Reis, 2003). Several studies which applied this method found anaerobic energy estimaitons

similar to those calculations from intramuscular metabolites (Bangsbo et al., 1990; Medbø & Tabata, 1989, 1993; Withers et al., 1991).

There is some hardware available to assess energy expenditure in humans. Some are portable and some are not. However, all equipment is somehow expensive and less available to general population:

Indirect Calorimetry

- Cosmed Fitmate PRO;
- Cosmed K5;
- Cortex METAMAX® 3B;
- Cortex METALYZER® 3B;
- IMBRAMED VO2000;
- VO2 Master VM PRO;
- Aerosport TEEM100.

Applicability ★ ★ ★ ★ ★ –
Cost – ★
Accuracy – ★ ★ ★ ★

Lactate Analysers

- Lactate Scout 4;
- Lactate Pro 2;
- Lactate Plus;
- Accutrend Plus Analyser;
- EKF Diagnostics Biosen Lactate Analyser;
- LM5 Lactate Analyser;
- Yellow Springs 2500 Biochemistry Analyzer.

Applicability ★ ★ ★ ★ ★ –
Cost – ★ ★
Accuracy – ★ ★ ★ ★

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1.3. Electronical Performance and Tracking Systems (EPTS)

1.3.1. Introduction

The adoption of EPTS devices in professional and non-professional sections of sports teams has grown considerably during the last 5 years. From wearable devices with multiple types of sensors, to computer vision-driven tracking technology, EPTS devices are providing a great amount of performance data in daily-basis. Alongside the increasing adoption of these devices, the variety of brands and vendors have also increased up to tens of providers in this timeframe. While more data is being generated, the operational maintenance and integration of this information becomes everyday more complex. A central issue is that each different vendor defines its own format and specification for the data that is being provided. While is typical to also provide software to interpret this data, the increasing availability of sources of information and the need of data centralization makes very difficult for clubs to keep the growing pace of this industry, regarding the needs for continuous integration and maintainability of data. Also, the ad-hoc nature of provided formats makes harder to integrate information from different sources, making progress in this area slower (FIFA, 2018).

In the near future is also natural to envision an increased maturity of tracking and performance which would lead to demands of better integrability, faster implementation, and the ability to be transferred in a standardized way. An example of this is the collaboration between clubs, universities and companies to develop new mechanisms to obtain more refined insight from this data. This is also includes the possibility of clubs exchanging player performance information once a player is bought on the transfer market (Figure 2; FIFA, 2018).

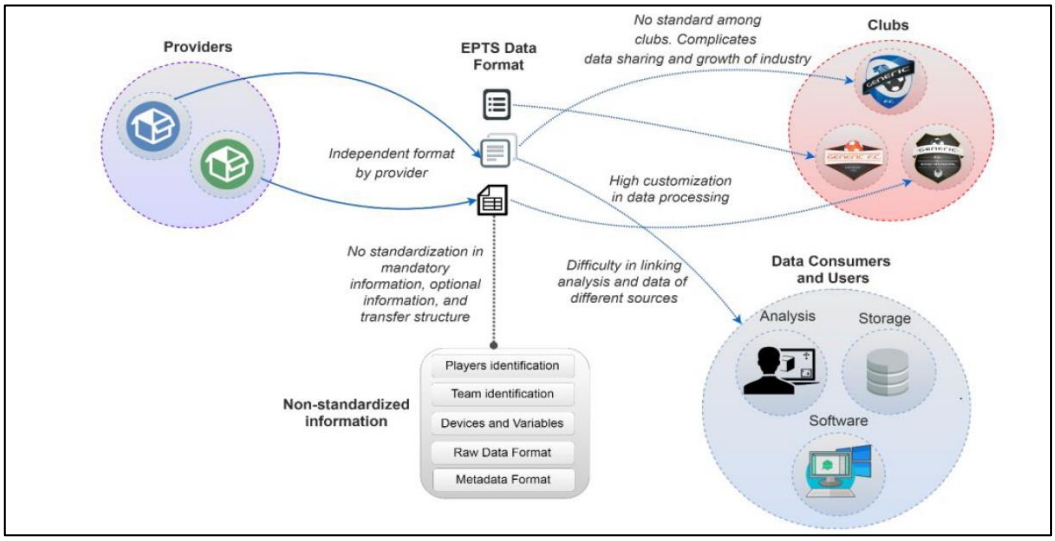

Figure 2. Current state of EPTS data transfer exchange (FIFA, 2018).

1.3.2. EPTS Typologies

According to FIFA (2018), EPTS are technologies used to monitor and improve player and team performance. EPTS primarily track player (and ball) positions but can also be used in combination with microelectromechanical devices (accelerometers, gyroscopes, etc.) and heart-rate monitors as well as other devices to measure load or physiological parameters.

1.3.2.1. Optical-based tracking system

Optical tracking systems make use of visual information to track the player. There are a number of ways this can be done. The most common is to make use of a video camera that acts as an electronic eye to "watch" the tracked object or person (Figure 3). The video camera is normally in a fixed location. Computer vision techniques are then used to determine the object's position based on what the camera "sees." In some cases, light-sensing devices other than video cameras can be used (Sherman & Craig, 2003). Some of the benefits or limitations of these technologies in sports are (FIFA, 2018):

Benefits

- Non-invasive to players
- Commonly used in the football market

- High sampling rate, ball tracking possible

Limitations

- Limited number of measurements
- Tracking occlusions require manual corrections
- Installation time

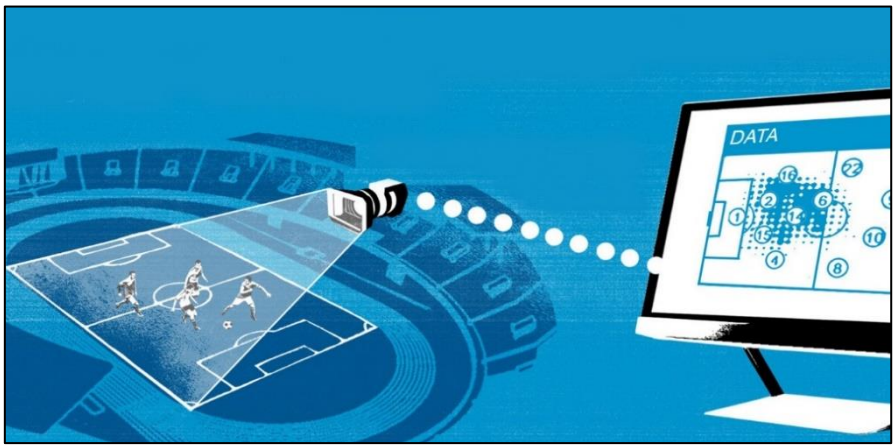

Figure 3. Optical-based tracking system (FIFA, 2018).

1.3.2.2. Local Positioning System (LPS)

Position data of players and athletes are widely used in sports performance analysis for measuring the amounts of physical activities as well as for tactical assessments in game sports. However, positioning sensing systems are applied in sports as tools to gain objective information of sports behavior rather than as components of intelligent spaces (Figure 4). Radio wave based tracking systems have proven to be a more accurate alternative under training conditions, for both indoors and outdoors (Leser et al., 2011). Some of the benefits or limitations of these technologies in sports are (FIFA, 2018):

Benefits

- High number of measurements possible
- Accuracy of measured data in real-time
- Ultra-wide band technology reduces chances of interference in transmission path

Limitations

- Fixed installation

- Installation costs
- Installation time

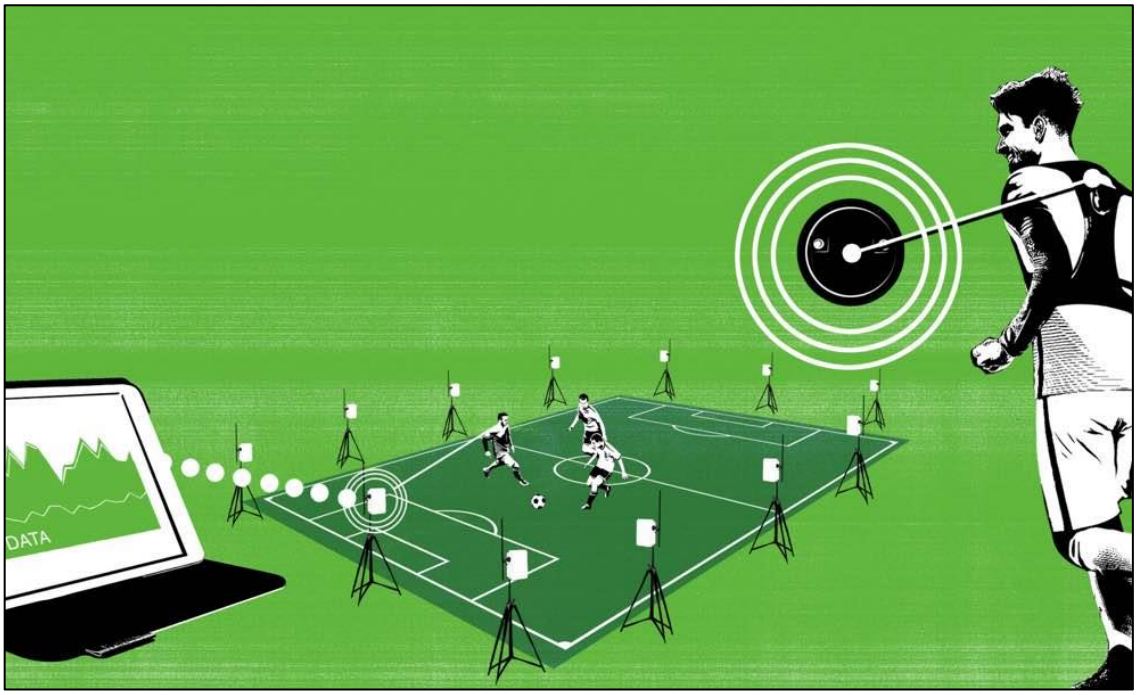

Figure 4. Local Positioning System (LPS) (FIFA, 2018).

1.3.2.3. GPS/GNSS satellite system

Global positioning system (GPS) devices are commonly used in elite-level team sports as a way of tracking player movements and quantifying workloads (Figure 5). The limitations of current GPS technology need to be taken into account when attempting to quantify player movements. Improvements in player-tracking technologies, which increase the resolution of devices so that they are more sensitive to rapid changes in speed or direction, are a potentially beneficial innovation in overcoming the current limitations of GPS technology. One possible solution to improving the aforementioned shortcomings with existing GPS units might be the global navigation satellite system (GNSS), a collective term used to encompass all satellite navigation systems providing geospatial positioning with global coverage (Jackson et al., 2018). Some of the benefits or limitations of these technologies in sports are (FIFA, 2018):

Benefits

- High number of measurements possible
- Short installation time
- Operator not needed

Limitations

- Device attached to player and device size are issues for match day usage
- Satellite signal line of sight in stadium
- Accuracy concerns of measured data

Figure 5. GPS/GNSS satellite system (FIFA, 2018)

1.3.2.4. Current Systems for sport analysis

Optical-based tracking system

- SportVU 2.0 (Stats Perform): It delivers performance statistics by extracting coordinates of players and the ball with statistical algorithms to provide greater match insights and generate the data behind the latest Artificial Intelligence analysis software. 4K resolution cameras leverage high-quality imaging in complex situations to provide accurate data and power tactical and physical insights to fulfil team performance needs. Realistic, uninterrupted player and ball trajectories supplement traditional technical insights.
- Tracab: It uses non-intrusive technology. All game video is captured using its camera array. Intruding into the field of play is never an issue. Leagues,

teams, players and referees do not have to make any special provisions or change game rules. TRACAB tracks players and balls optically and without interference. It is the only system capable of calculating player and ball positions LIVE. Player performance and game-play metrics, such as distance run, speed, acceleration, stamina, team formations, set-plays and many more are captured. This data is instantly available for play-by-play video analysis and viewed as compelling graphical visualizations. It uses Super-HD cameras and patented image processing technology to deliver live tracking of all moving objects with a maximum delay of just three frames. Two compact TRACAB Super-HD Camera units use stereo technology to ensure that the entire playing surface is constantly filmed from several angles. The cutting-edge software analyses every image to extract X, Y and Z positions for each object resulting in true three-dimensional tracking in real-time.

- ASPOGAMO System: It includes a tracking system that determines player trajectories in camera views based on TV broadcasts. To do so, ASPOGAMO solves a complex probabilistic estimation problem that consists of three subproblems that interact in subtle ways: estimation of camera direction and zoom factor, detection of players and team affiliations and tracking of multiple players, and disambiguation of tracked players after occlusions. The Aspogamo game perception component consists of four components: Vision, State Estimation, Track Editor, and Motion Model Generator. The Vision is responsible for image processing tasks and the State Estimation is used to estimate camera parameters and player positions as well as forming player tracks. ASPOGAMO processes a video-stream by performing the following steps for each image: First, the Camera Parameter Estimation predicts camera parameters for the current frame using optical flow from the Correspondence Finder. Second, the Player Detection determines player blobs taking into account the hypotheses generated by the Tracker. Third, knowing the camera parameters, player positions and their uncertainties are calculated in the Player Position Estimation from the measurements made by the Player Detection.

They are forwarded to the Tracker, where individual positions are combined and associated over time, and hypotheses for the next time step are generated.

- Mediacoach: It is a multi-camera tracking system that has a frequency of 25 Hz. To collect data, 8 different cameras were situated strategically in order to follow and track the players on the field throughout the match. It records from several angles and analyzes X and Y positions for each player, resulting in three-dimensional tracking in real time (tracking data were recorded at 25 Hz per second). Mediacoach® is also based on data correction of the semi-automatic video technology (the manual part of the process). This correction is made by an overlay of the X coordinate, provided automatically by the system for each player on the real video image of the match. This detects and visually corrects the situations in which the positioning coordinates are erroneous because they move away from the position of the player to whom the data belong.

- Instat: Video is captured with professional video cameras, installed in pairs on each of the two main stands of the field. The portable InStat fitness system set includes 2 video cameras installed on tripods on one of the stands and each of the cameras covers its half of the field. The data is sent to the production center of InStat where it is processed. The data processing procedure consists of several stages. Primarily automatic video materials processing including generation of 2D field model of the materials received during the system field capture considering the field size and generating primarily trajectories of moving. Secondary video materials processing including InStat analysts processing the primarily trajectories, eliminating potential errors which can occur in complicated moments of the data processing. That data-checking stage includes supervisor's checking the secondary processed data by comparing the trajectories received by system with the real player's moving. For that supervisor uses the special InStat software. This stage is carried out for verification of all the players and referee's moving on the field at the same time. During the last stage the most experienced specialists of the

of the production center make the super checking at providing the final version of InStat fitness report.

Local Positioning System (LPS)

- CATAPULT ClearSky T6: It is an athlete tracking technology developed by Catapult Sports which focuses on physical and tactical performance of the players. It provides an unparalleled insight to both the players and the trainers on the potential of each individual on the team. This system is composed by accelerometer 3D, magnetometer 3D, Real-Time data by using license-free ultra wideband up to 120 players simultaneously at 10Hz, Wireless (bluetooth connection for imbibing external wireless device connectivity) and gyroscope 3D.
- ChyronHego ZXY Arena: It is a high precision tracking system for sport performance analysis. It is designed for fixed installations, such as dedicated training facilities, sports science research installations, or competition arenas. ZXY Arena uses advanced technology for both its positioning and data communication, and it can be used in either indoor or outdoor environments. It is a high performance system, with tracking data rates of up to 100Hz and higher from each wearable transponder with zero data packet-loss. Stationary radio frequency sensors, called ZXY RadioEyes®, capture radio signals emitted from wearable transponders. Stereographic images are presented live when two or more stationary sensors are in simultaneous operation. When four stationary sensors are operating, ZXY's RadioEyes' proprietary features makes it possible to realize accurate live tracking of all players on the field. Data is provided live and is complemented by additional data from highly sensitive, integrated motion sensors such as accelerometers, gyroscopes and magnetometers. Integrated Bluetooth connectivity enables other sensors and devices, such as heart-rate monitors, to be attached and their data communicated live. All collected data is transmitted live back to analysis and management software, and is available for monitoring through live data visualization.

- Inmotio: It is a precise wearable technology for capturing sports data. Based on its Local Positioning Measurement system (LPM) it provides accurate position data in real-time (Figure 6). It is a RFID-technology (Radio Frecuency Technology - Frequency Modulated Continuous Wave) based system that measures the position of players and athletes directly. Inmotio's LPM technology is famous for the precise measurement of agility (acceleration) and explosivity which both are critical variables in modern football. Although the system delivers extra inertial sensor data, the speed and agility metrics are purely based on position data. By combining precise performance data, heart rate, video and comprehensive coaching software, the LPM system measures everything professional performance teams require. Through the coaching application, accurate real-time data is processed based on your preferred settings and presented through tailor-made reports in combination with personalized video.

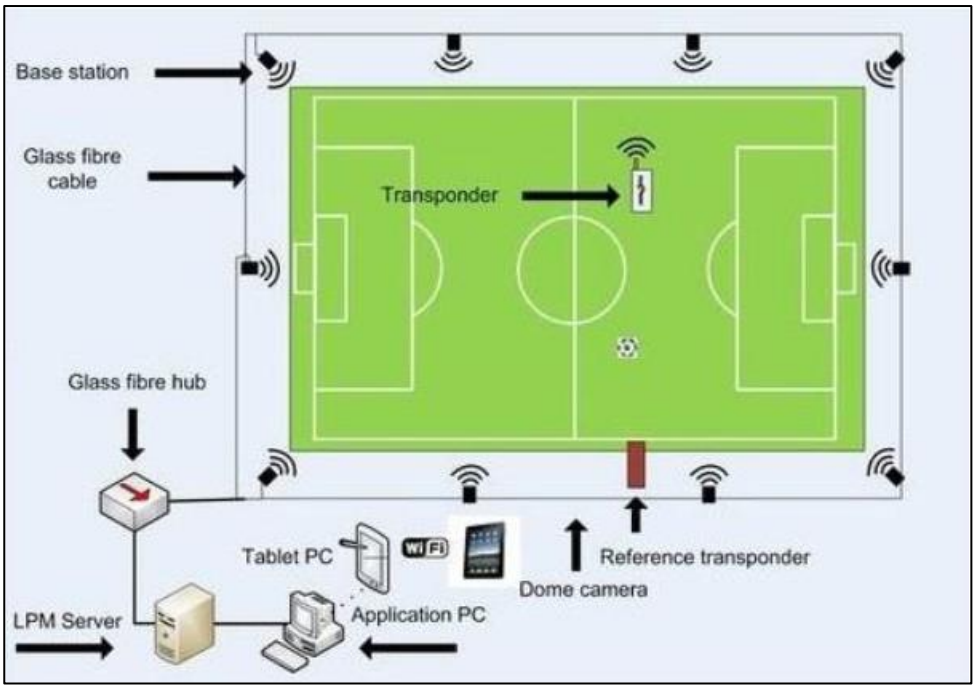

Figure 6. LPM technology (Silva et al., 2015; Adapted from Inmotio, 2015).

- Kinexon: It provides player tracking and delivers athlete monitoring data in real-time. The RF technology guarantees a centimeter-accurate 3D-position tracking data – both indoor and outdoor. Benefit from motion data and detect

accelerations, decelerations and changes of direction. Integrate add-on data such as heart rate that is transmitted on the fly. The system incorporate triaxial accelerometer, gyroscope and magnetometer.

- NBN23: The system is commercially known as NBN23 (Nothing But Net, Valencia, Spain) and is composed of two different elements. First, the system hardware was created by the Finnish company Quuppa (Nokia Corporation, 2014). This technology consists of locators and the devices that the players carry (tags) which were placed on the waist, at the back of the trousers at the height of the sacrum. This position represents the approximate position of the center of mass of the subject and avoids a possible shielding of the signal with the participant's own body. Tags are emission devices, and the system works by triangulating the signal they emit. The frequency at which they send information can be varied between 9, 17, 33, and 50 Hz. The frequency band is 2.4 GHz, the system delay is 100 ms with a capacity of 400 information packets per second. Secondly, the specific software for the LPM system is Nothingbutnet v1.1.3 (Spain, 2016). This software adds a Kalman filter to the position coordinates (given in terms of *X* and *Y*) provided by Quuppa to reduce noise and measurement error with a cut-off frequency of 3 Hz. The distance traveled is calculated through the position changes on the *X* and *Y* axes.

GPS/GNSS satellite system

- VECTOR S7 (CATAPULT): Catapult Vector combines GPS and LPS functionality, enabling the seamless transition between indoor and outdoor environments for both training and competition. Engineered to perform in demanding team sport conditions, Catapult Vector utilises the latest Global Navigation Satallite Systems (GNSS) technology and a carefully-considered design to deliver market-leading tracking data. Catapult Vector derives heart rate via ECG directly from the sensor-embedded premium garment. This delivers high quality heart rate data and completely eliminates the need for any additional heart rate hardware.

- EVO (CATAPULT GPSports): EVO's rapid download speeds give users immediate access to insights. Using FastSync, EVO is designed to deliver a powerful, efficient and user-friendly experience. EVO combines load management capability with a compact, ergonomic design. Providing critical performance insights, EVO creates a framework for preparation, recovery and rehabilitation. EVO is a seventh-generation device from GPSports (now a Catapult brand), bringing to market the smallest and most powerful device from 14 years of research and development. EVO has the fastest download speeds of any elite athlete tracking device.
- ZXY GO (ChyronHego): It is part of ChyronHego's portfolio of wearable tracking technology solutions for sports, is a comprehensive and portable satellite-based tracking system designed with the highest precision positioning components and live radio transmission technology. It can be used in outdoor environments in any sport, and it comes in a self-contained flight-case for taking on the road when training or playing away from home. It is designed using the very latest in satellite tracking technology, including GPS, GLONASS and Galileo-ready, to provide highly accurate positioning. ZXY GO is further enhanced by a reference station that provides real-time correctional information to raw satellite positioning data, which compensates for the large variations that can occur with changing atmospheric conditions and other contributing factors. ZXY GO comes with a handy tool, the Coach GO Remote App. Coaches are able to control sessions, see live and captured data, and review performance post-session.
- WIMU PRO (RealTrack): WIMU PRO is a team player, designed to incorporate and collect data from a variety of external devices, wearables and sensors, process the data and deliver to one single platform where all values and results can be viewed and worked along the same timeline. No saturation, loss of data or variation. It offers this world of possibilities with a User Friendly wearable tracking system, to deliver real time and Post session data, easy to install and mobile both indoor and outdoor to capture all performance data during home matches, away games and all coaching, training and gym sessions. One

system, compatible with any external ANT+ devices to deliver you the most complete key data, in one secure platform, available to you anywhere at anytime. It has powerful processors, raw Data and WIMU Cloud Systems; GPS/GNSS and UWB within 10 cm accuracy. Unique Hybrid System GPS/GNSS + UWB to within 10 cm. WIMU PRO can collect and process data from any such device and deliver the results on screen within the WIMU PRO system menu, no need to create separate software User applications or files, no need for multiple systems, all you need - in one place. There is an ever growing number of interesting and valuable devices, what started with Heart Rate monitors and chest straps now includes complex Muscle Oxygen readers, Blood Oxygen levels, Potentiometers and many more.

- APEX PRO (STATSports): Apex integrates the latest technologies on the market, including; augmented 18Hz GPS, 400Hz accelerometer and Bluetooth LE. Using a highly optimised and powerful embedded processor, Apex has the capability to calculate over 50 metrics in real time on the device. The custom GNSS engine uses the maximum number of visible satellites from multiple GNSS systems to provide accurate and reliable positioning data. Apex positional data is augmented by utilising satellite-based augmentation systems (SBAS). This positional data is further augmented by the unique MAPPS technology to ensure accurate data feedback. STATSports Apex utilises the latest Bluetooth LE to connect with multiple devices at any one time including; heart rate sensors, EMG shorts, smart watches and tablet devices. This connectivity allows Apex to become the centre of a full body network. Apex collates data from these devices and presents it all in concise reports through of an innovative, user-friendly software solution. All Statsports Apex data can be transferred, stored and accessed from a cloud infrastructure. This allows, coaches, managers and federations access to the information they need in any place at any time on different device platforms including mobile, tablet and desktop.

1.3.3. State of art

Sports teams are a complex system which combines high intensity period and recovery phases, related to frequents accelerations and change of directions, as well as technical actions (Barbero-Álvarez et al., 2010). In this sense, physic and tactic behavioural is a crucial factor in the performance match, so it is required to specified space management, time and individual actions of the team in order to win the game (Fradua et al. 2013). For the purposes of assuring a successful execution in all tactics levels, the coach has to understand the situation of the team, adversary and contextual factors as a home play or even the weather (Mackenzie & Cushion, 2013). Previous studies revealed that tactic successful depending on the individual capacity to deal with the situation and the actions required (Rein & Memmert, 2016). The influence of opponent level in total distance covered and the time spent by players in different speed zones. Carling (2011) evidenced a variety in physiological, technical and distance cover parameters between two differents tactical formations (4-2-3-1 y 4-4-2). Finally, authors as Sampaio et al. (2014) discovered the effect of the tactical imbalance of team in physiological load from players.

Furthermore, a direct relation between technical parameters and tactic performance of the team. The conducted research proved that actions such as possessions, the start of the attack in the final third of the field or passes in depth would increase the success (odd ratio) against balanced defences, but in the case of unbalanced defences, other types of variables had a greater role. Fernández-Navarro et al. (2016) found that the possession, lateral passes and passes from the third defensive to the third attacker as predictors variables of team play style. Thus, multivariant models (Figure 7) which include intrinsic and contextual variables are the solution to the analytical evaluation of tactical parameters (Fernández-Navarro et al., 2016; Rein & Memmert, 2016).

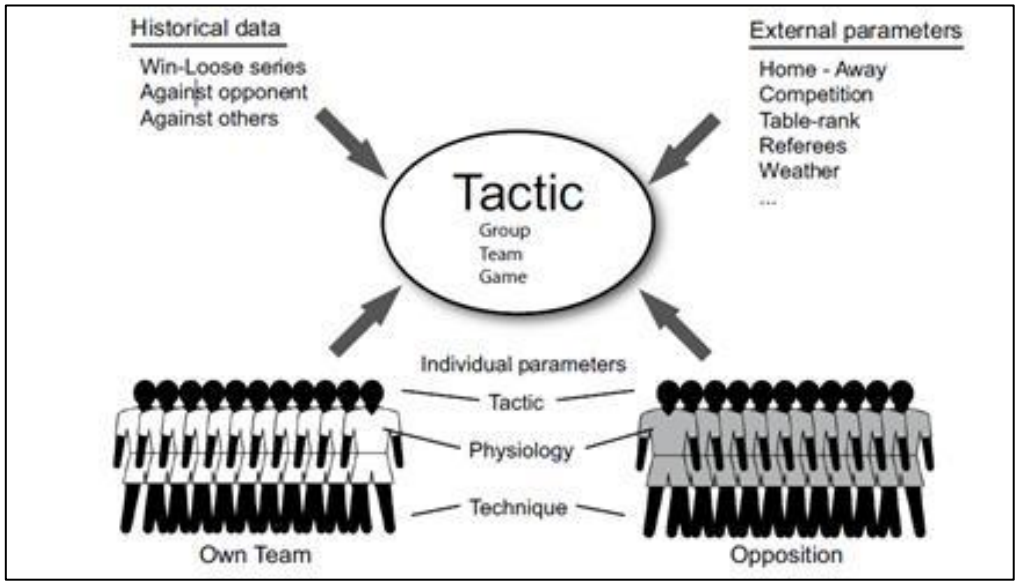

Figure 7. Triggers for tactical performance in football.

Technological advancement of elite football has facilitated the analysis of the tactic parameters through multiples cameras analysis system, deployed in all European leagues. Those analysis systems have evidenced a similar validation to GPS devices, with a standard error of less than 5% (Di Salvo et al., 2006). In this way, although current technology has allowed processes underlying tactics in team sports to increase over the years, scientific approach has not developed at the same velocity. A possible solution related to the creation of predictive models and combining various data sources of tactical variables, an increase of Big Data technology could be materialized. The Big Data definition is associated with the 3 "V": volume, variety and velocity (Noor et al., 2015). Big Data aims to provide a standardized methodology for researchers to access complex processing algorithms that make it possible for non-expert users to apply novel analysis technologies to their data (Goecks et al., 2010).

The progress of computing has made it possible to obtain position data on the movements of players (Baca et al., 2009). Position tracking systems establish the player and ball position in the x coordinates (parallel to lateral lines) and *y* coordinates at 25 frames per second, equivalent to approximately 135,000 positions per subject and game, and a total of about 3,100,000 positions between all players and the ball. The compilation of all this data and its subsequent analysis will facilitate the simplification

of theory and practice in sports. In this sense, while physical parameters such as distance travelled or speed have already been analyzed in recent years, there is little scientific evidence evaluating tactical parameters in team sports.

To determine the tactical behaviour of the players or teams, a series of variables are required to demonstrate the behavioural dynamics of these agents. The centroids, stretch rates, depth and width, as well as the surface areas of the equipment seem to provide a solid basis for analyzing the collective behaviour in attack and defence team dynamics (Memmert et al., 2017). Within these concepts, the team centroid, defined as the middle position of all the players in a team, presents low variability when trying to measure the coordination between players in a soccer match. However, the variation between each player and their specific position (individual centroid) has been identified as a potential variable to know the dynamic behaviour of the player with greater precision (Sampaio & Maças, 2012). From a dynamic system perspective, the high variability in the distance between teams (distance between the centroid of two teams) is expected to reflect disturbances in the balance between team behaviour, which precede critical events of the game such as game occasions goal (Memmert et al., 2017).

The variables that can be obtained through the Multiple-camera match analysis system and the other technologies mentioned above, allow us to differentiate physical, tactical and technic load indicators, as well as their combination into possible new calculation variables.

The use of these data together in predictive models is one of the high topics for research in Sports Science (Rein & Memmert, 2016). Specifically, previous researches have included intrinsic variables of physical performance [Maximum speed (Vmax) and medium speed (Vmedium) in 15 min intervals; Distances traveled at different speeds: stopped (0-2 km / h), walking (2-7 km / h), smooth running (7-13 km / h), fast running (13-18 km / h), high-speed running (18-21 km / h) and sprint (> 21 km / h), in 15 min intervals; Number, medium distance traveled and a maximum speed in sprints (> 21 km / h); Peak acceleration; Number of accelerations of soccer players in different

speed ranges 1.5 and 2 m / s2; 2 and 2.5 m / s2; 2.5 and 2.75 m / s2; > 2.75 m / s2, in 15 min intervals] and technic [Number of passes, ball control, tackles, headed shots, shots on goal, corners and free kicks by areas: defensive area (third of the field closest to the defensive zone), central area of the field of play (central third of the field of game) and offensive area (third of the field of play closest to the rival goal) at 15 min intervals; Number of short distance passes (<10m), average (> 10m) and minimum distance (<2m) by area, in 15 min intervals; Number of shots on goal in 15 min intervals; % ball possession at 15 min intervals; Tackles and interceptions at 15 min intervals].

1.3.4. Utility

The technologies described in this chapter facilitate the information collection connected with physical and technical-tactical parameters in indoor and outdoor sports. This information is a tool which reduces uncertainty in the decision-making process of trainer or the coaching staff of the football teams or athletes.

The applicability of the information obtained by this technology can be oriented in different areas of execution:

- Injury prevention: physical load control of the players is one of the major objectives searched by the physical training department of the teams or athletes. Knowing the internal and external diary load of the athlete allow to readjust training objectives and optimize physical performance patterns. These systems can be synchronized with heart rate monitoring, which facilitates the knowledge of internal load generated by training stimulus, as well as a mechanical load which the athlete is subjected.
- The orientation of training tasks: the information provided by this technology allows identified critical competition sceneries, in other words, the highest demands which an athlete is subjected to when facing a match and/or sports competition in which their objective is to achieve the best result. The identification of these physical demands allows training tasks to be oriented,

as well as their planning and the adaptive process consecution which enables the athlete to cope with these competing demands when subjected to them.

- Technical-tactical development: the provision of the positional data of the athletes enables to identify the limitations and strengths of them regarding the tactical behaviour. In team sports, the interaction between the components of the same team, as well as the presence of the opponent position which is essential for obtaining the results. For this reason, the information provided by these technological systems allows the establishment of interaction networks with the aim of knowing the tactical behaviour of the team, in order to enhance the identified weaknesses and guide training task based on quantitative information.

1.3.5. Accessibility

These technologies have been consolidated in professional sport. However, they present limitations related to their implantation, due to some of them required permanent installation which is incorporated into the facilities where the competitions take place but are not available in the training. The price of technology with maximum functionality is high. However, the increase in supply in an increasingly competitive market has allowed the development of more affordable technologies that can be applied in amateur sports and facilitate individual use.

Low-cost lines of these technologies allow amateur sport to technological evolution, as well as obtaining sufficient information to promote the development of the non-professional sport. The emergence of companies such as Instat, Footer or Wyscout, which include non-professional sports in their framework of action, have facilitated greater knowledge and development of amateur sports.

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1.4. Technologies for data storage, data analysis and visualization

1.4.1. General description

Access to large database and the large number of technical, tactical and physical performance parameters that exist in sport field have led to the emergence of powerful technologies and methodologies for technicians and clubs. Many of them have adapted from existing tools in different companies and sectors, with great applicability to the sports field. However, many other systems have been developed specifically for certain areas of training and analysis in sport. The technology identified in this section is composed of three interrelated elements: data storage, data analysis and visualization.

1.4.1.1. Data storage. Cloud systems

Data storage consists of computer systems that allow you to save information in real time and to be able to access it at any time and place. Even the possibility of synchronizing information collected from different sources easily and directly. The key in the development of this technology is the wide variety of servers or 'clouds' that allow data to be stored on the network, instead of the classic physical format. In addition, this also includes those database technologies, which allow access and unification of data from different (SQL technology or similar) points. With minimal knowledge, it is possible to save large amounts of time when taking advantage of all the information accessible to clubs and academies. It should be noted that cloud services have evolved and currently offer different services to their users, among which we highlight:

- **Infraestructure-as-a-Service (IaaS):** Infrastructure as a service that the client rents and is fully scalable depending on the needs.
- **Platform-as-a-Service (PaaS):** Platform as a service where you can have the right tools for cloud development avoiding system overloads.
- **Software-as-Service (SaaS):** Software as a service that allows the rental of licenses depending on the needs of each user.

With these new systems integrated in the cloud, a very important cost reduction is guaranteed for clubs, since the capital allocated for hardware is reduced to 0 and, above all, data security is maximized when stored on a server.

Within the data storage, we can highlight the following clouds applicable to the sports sector:

- **Microsoft Azure:** It is defined as a cloud platform which offered its service and hosted in Microsoft data centers. Azure has different services for applications. These range from services hosted in their data processing centers (Microsoft Cloud Computing) to secure communication services. One of the most interesting services offered by this cloud is Congnitive Services. This product combines many APIs and encompasses different scenarios within the data analysis. All its services are supported by Machine Learning systems, a branch of artificial intelligence whose objective is to create programs capable of generalizing behaviours based on the information provided in the form of examples. This type of learning is very interesting since it allows to automate the process of relationship of entities, and in this way save a great deal of time in the search for sports performance patterns. The APIs offered by this cloud can be divided into 5 groups: Language; Speech; Knowledge; Search; Vision. In addition to the APIs, Microsoft Azure offers us other very interesting services for the topic at hand, such as Azure Stream Analytics. This is a real-time analysis service in bulk in several data streams or in other languages such as SQL. This cloud has the advantage that it uses simple models, which facilitate its use and eliminate the need for specific knowledge in data processing systems. In addition, it offers a free portfolio of tools available in the cloud to carry out activities with order, agility, security, privacy and effectiveness.

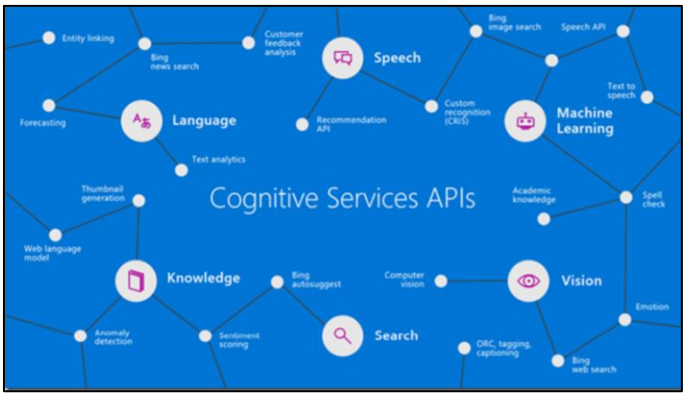

Figure 9. Congnitive Services APIs Microsoft Azure.

Google Cloud: It is a platform that brings together all the web development applications that Google was offering separately. It is used to create solutions through the technology stored in the cloud and allows highlighting the speed and scalability of its infrastructure in the applications of the search engine. Google Cloud, like the rest of the clouds in the market, allows you to eliminate hardware, facilitating access, storage and data management. One of the great advantages of this system is its interface. It is clean and easy to navigate; it also becomes a very attractive tool for data analysis. Cloud Machine Learning is integrated into Google Cloud, which also offers machine learning services with TensorFlow, a collection of very interesting APIs for: Image analysis (Vision API), Speech-to-text conversion (Speech API), Text translation automatic (Translate API), and written text analysis (Natural Language API). However, the value to highlight is the Cloud Datalab service, an interactive tool created for data analysis and visualization, as well as the creation of Machine Learning models, offering:

- **Integration and Open Source:** Based on Jupyter (old IPython). It allows data analysis with Google BigQuery or Google Cloud Engine, using the Python, SQL and JavaScript system, which are simple programming languages for all audiences.
- **Data management and visualization:** It allows obtaining information from the data, exploring, transforming, analyzing and interactively viewing the information.

- **Machine Learning:** Like Microsoft Azure, Google also has learning models ready for predicting models to improve data exploration and evaluation.

Figure 10. Services offered by Google Cloud Platform.

IBM Cloud: This service, old Bluemix, is the IBM open cloud platform, where the Watson service is hosted. Perhaps the service par excellence of this cloud. We are facing a pioneering technology in cognitive computing. Thus, IBM gets users to interact with machines in a similar way to how people do it. Watson reads and understands natural language. The company itself describes it as an application of advanced technologies designed for natural language processing, information retrieval, knowledge representation, automatic reasoning and machine learning to the open field of search for answers, which is built on the basis of IBM DeepQA technology for the generation of hypotheses, the collection of massive tests, their analysis and qualification. This cloud offers the services of Watson, IoT, APIs, Network, Storage, security, DevOps and application services. Within the APIs integrated in the Watson service, it is necessary to highlight Watson Analytics. It is a technological platform in the cloud that helps the exploration and analysis of data through a very advanced system of visualization and analytical prediction. The main advantage of this API is to interact with the user through a natural language

together with an incredible ease of use, which make the extraction of knowledge from the data can be taken to any field. In addition, another very interesting API is included, such as the SPSS Modeler for data analysis and treatment.

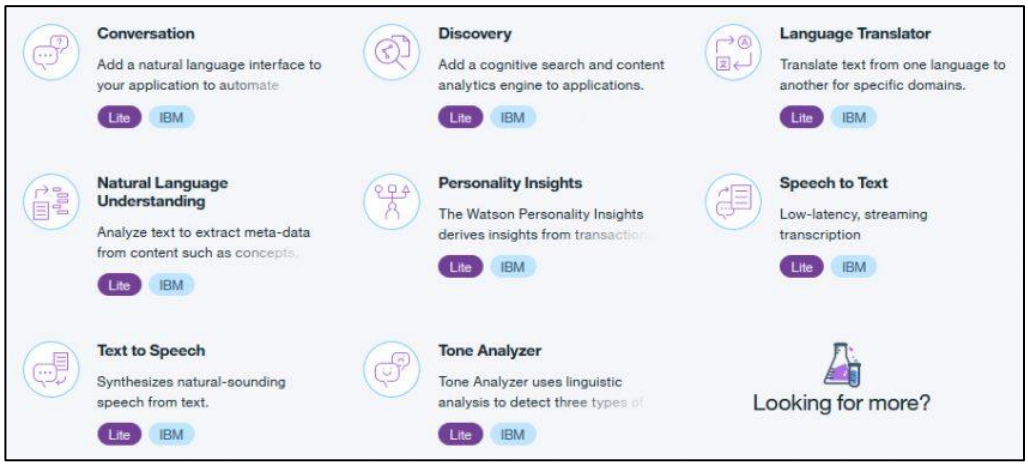

Figure 11. APIs IBM Cloud.

1.4.1.2. Data analysis

Data analysis is one of the most complex areas in any sport. It should be noted that, although it is not necessary to achieve a statistical inference as happens in research in Sports Sciences, semi-causal patterns and relationships must be detected, which allow decisions to be made at all levels of technical staff. Thanks to data storage and synchronization of different sources of information it will be possible to identify relationships and be able to perform specific analyses for the different training objectives. In this way, coaches can optimize the performance of their teams or athletes by improving their position on the pitch or polishing technical details. They can also review the volume and typology of training or adjust the intake of carbohydrates or proteins depending on the time of the season or the effort made to ensure a correct recovery. The ultimate goal of uniting Big Data and Sport is to gather all this information to help professionals make the best decision at all times. To do this, a correct analysis and interpretation of the data is essential in order to maximize sports success. Among the possibilities of data analysis in Big Data environments applicable to the sports sector, we can highlight:

R: This is one of the most widely used Big Data data analysis tools. It is free software (GNU GLP license) and interpreted programming language, that is,

executes the instructions directly, without a prior compilation of the program to machine language instructions. The main features of this software are: Effective handling and storage of data; A set of operators for performing calculations with arrays; A large collection of tools for data analysis; Graphical utilities for data visualization; A well-developed programming language that includes conditional hops, loops, recursive functions, utilities for data input and output, and so on; It has a documentation format based on LaTeX, which is used to provide complete documentation in both physical and digital format. In the field of Big Data it is used for the manipulation, processing and graphical visualization of the data. A allows us to: Create high quality data visualizations; Create dashboards to visualize and analyze data; Create automatic reports; Have statistical analysis tools to delve into the knowledge of the data. It is used in all phases of data analysis, from the acquisition of data from available sources: databases, text files, etc., the preparation of the data: deletion of duplicates, incorrect data, extreme values, etc., subsequent analysis of the data: construction of predictive models, classification, grouping, etc., the communication of the results: reporting to present the results and conclusions and the application of the results obtained: for example, use of predictive models developed based on a series of historical data (training data and model test) predict certain outputs.

Python: Python is an open source, object-oriented programming language that is very simple and easy to understand. It has a simple syntax that has a vast library of tools, which make Python a unique programming language. One of the main advantages of learning Python is the ability to create readable, time-saving, resource-saving code, making it easier to understand and implement. In addition, it is an easy to learn tool and excellent for beginners, also great for experts; it is suitable for large projects or for small single-use programs known as scripts; it is a stable and mature system, with a large community of users. These factors have made Python one of the most widely used programming languages. From web applications to artificial intelligence, Python uses are endless. The use of Python is widespread in data analysis and business-critical

information extraction. In addition to its simplicity, Python has countless libraries that make it easy to analyze data and create charts and reports. Python is fast and easily scalable, features that help you generate information in real-time environments and convert that information to the languages used in Big Data.

- **Matlab:** Software that runs a variety of operations and mathematical tasks. It is a powerful tool, and can handle the calculations involved in engineering and science problems. Matlab can be used to solve a wide range of problems related to large databases, from evaluating a simple task to numerical resolution of work systems. You can also solve symbolic problems and present the results in a pleasant and visual way so that the results obtained are easier to visualize and report. Among the advantages offered by this software, we can highlight: It is interactive, that is, it is not always necessary to create code, or define variables explicitly. For many uses, you only need to use simple instructions and get the answer immediately. It also allows you to easily modify the statement to see other scenarios through few instructions. It supports a lot of software widely used in the scientific and technical fields: it can interact with Microsoft Excel sheets, software developed using C+, Fortran and others. It has a lot of tools, called Toolboxes, that can be used graphically to solve advanced engineering problems, such as fuzzy logic, neural networks, genetic algorithms, numerical optimization, machine learning, image and video processing, process control, among many others.

- **SPSS:** SPSS is a popular software among Windows users, it is used to perform data capture and analysis to create tables and graphs with complex data. It allows to manage large volumes of data, being able to perform simple statistics (descriptive such as tabulation and crossover frequencies, statistics of two variables, T tests, ANOVA, correlation, etc.), to more complex analyses such as general linear models, generalized linear models, hierarchical linear/linear models, procedures of generalized estimation equations, generalized linear mixed models or survival analysis procedures. This software allows as to incorporate advanced data managementoptions. Orfry a simple spreadsheet

format for data entry that is intuitive and easy, aspects that improve its usability, such as pull down menus. They need to be added to their data documentation capabilities that help ensure consistency in data entry. One of the main differences of this tool is that you don't need to master any programming language to interact with it, since all the options can be controlled through a menu-driven interface. It has very complete graphical display options. Includes a wide range of statistical models. Flexibility is an attribute to consider in any data analysis-oriented tool, and one of the reasons is that it is usually difficult to define a priori the type of statistical model that will be most appropriate for each project.

1.4.1.3. Data visualization and reporting

Data visualization is the last step in this technology area. It is of little good to provide a powerful database management system and advanced knowledge in analytics if an effective reporting method is not implemented, which will coordinate the information and send it in the language indicated to the different profiles of the technical staff. Again, here it is possible to find different technologies, mostly in the form of software, that allow you to quickly analyze the collected data and express the results in easy-to-understand graphs and conceptual maps. In addition, another useful system for any club and academies is also involved here: the generation of dashboards. There are very useful tools that will allow the creation of a specific working interface to relate data quickly, obtaining visualizations and reports instantly. There are two tools that stand out for their versatility and applicability to the sports sector:

- **Tableau:** It is a powerful data visualization tool used in the area of Business Intelligence (better known as Business Intelligence). Simplifies raw data in a very easy-to-understand format. The essence of Tableau is simple yet very relevant–helping people and businesses see and understand all their data. And this achieves this by offering users a whole selection of useful and intuitive business intelligence tools. Through simple drag-and-drop features, anyone can easily access and analyze data, and even create reports and share this

information with other users. With Tableau, you can generate dashboards with intelligent control of the relationship between different KPIs and with a Drill-total down level, developing corporate analytics and reporting solutions in a flexible and extremely efficient way. It should be noted that Tableau incorporates extremely easy-to-use mathematical analysis and statistics capabilities. It is independent and autonomous which allows to use it at any point in the existing data processing process, without breaking the current approach, allowing to generate both analyses in a simple way or as dashboards with a very high complexity.

PowerBI: Power BI is the collective name for a variety of cloud-based applications and services that help companies collect, manage, and analyze data from a variety of sources, through an easy-to-use interface. Power BI gathers data and processes it into intelligible information, often using visually compelling and easy-to-process charts and tables. This allows users to generate and share clear and useful reports immediately. Power BI is based on Microsoft Excel, and as such, the learning curve from Excel to Power BI is not as steep; Anyone who can use Excel can use Power BI, but the latter is much more powerful than the spreadsheet. Power BI helps users see not only what happened in the past and what's happening in the present, but also what might happen in the future. It is steeped in machine learning capabilities, which means it can detect patterns in the data and use those patterns to make informed predictions and run "what if" scenarios. These estimates allow users to generate forecasts and prepare to meet future demand and other key metrics. Among its main advantages we could highlight: Integrated machine learning features can analyze data and help users detect important trends and make useful predictions. The information can be visualized using very intuitive templates so that companies can better understand their data. Powerful customization capabilities allow users to create dashboards so they can access the data they need quickly. It has an intuitive interface that makes it much easier to use and easy to navigate than complex spreadsheets. The platform

integrates with other business management tools such as SharePoint, Office 365, and Dynamics 365.

1.4.2. State of the art

The use of different technologies and IT solutions for the collection of performance variables in sport is not new. From the moment data can be collected in an automated manner, the first technologies for its treatment and visualization (Franks et al., 1987) also appear. This development begins with the variables in physical and physiological performance tests (speed test, heart rate, etc.), or also called external and internal load, as they are automatically evaluated by non-invasive devices (pulse gauges, automatic stopwatches, etc.). In addition, more than 50 years ago, the first software for monitoring the competition (Darst, 1989) also appear. First, these systems helped to quantify and codificate events (technical and observational analysis) that occur in a natural or usual context, such as competition or training (Castellano et al.,2008). Later, time–motion analysis video systems appear, which for the first time allow you to quantify time spent in different situations, such as speed zones (Barris & Button, 2008). We could say that these systems have been the real drivers of the need for tools for data storage, data analysis and visualization, because they generate a lot of data that is impossible to manage manually.

The first Time-motion analysis video systems were manual (Ali & Farrally, 1991), where the technician had to spend a great deal of time on the analysis. This type of system, also referred to as notational analysis, required a greater amount of resources of human rather than economic origin. Since voluntary labor in clubs and academies is one of the most accessible resources, this type of systems continues to improve and develop (Barris & Button, 2008; Bongers & Eijsvogels, 2018). However, the automatic Time–motion analysis video systems subsequently appear. These systems are equipped with algorithms that allow to automatically capture different variables of physical and technical performance (Barris & Button, 2008, Felipe et al., 2019). However, they are extremely expensive and also required a great work of specialized labor for the filtering and quality improvement of the data obtained (Schlipsing et al.,2017). For this reason, in between means are also the global positioning system

(GPS), which allow to automatically capture a large number of variables of a physical character, including both external and internal load, in an automatic way (Bourdon et al., 2017). In addition, they are sufficiently developed to require virtually no human work prior to obtaining the data. Currently it is already possible to find tools of this type, with different levels of quality, specific for different sports modalities such as the race, outdoor equipment sports (Cummins et al., 2013), and even, the latest technological incorporation in the market, positioning systems for indoor sports, where it is not possible to locate the GPS signal (Colino et al., 2019).

Alongside these tools are the first solutions for data analysis and visualization, but that focus specifically on the presentation of data from a single measuring device. It is usually the commercial home of the device that supplies the software. However, as we have presented in the previous sections, the market is saturated with tools for data collection. Since many of this data is complementary to each other, it is necessary to have independent tools that allow the data to be combined, to give the possibility to analyze it in an agile and intuitive way and to present the information in a direct and useful way for the different technical staff positions in clubs and academies. This section of the chapter will show the advances in the scientific literature, exposing different ways of combining and presenting the information and its level of validity and rigor.

1.4.2.1. Storage

Performance analysis in sport is mainly based on data collection and interpretation. However, in many cases, the use of a single source of information in isolation requires us to discard other complementary and contextual information, which can often provide very important information for sports control and decision-making. This fact is especially manifested in collective sports, where many more factors are involved. Therefore, the proper use of information requires detailed data from various sources including technical skill, individual physiological performance, and team formations among others to represent the complex of this sports (Rein & Memmert, 2016). Even in individual sports, where there are technologies that

integrate by default a lot of different source information, technical staff are often forced to work with different databases.

The amount of useful data in sport is an important benefit for the sector, however, this amount of information is also a problem. The advancement in computing has given the possibility of using database management tools that allow the proper management of information in sport, combining and filtering different databases, obtained by different devices or media. When it comes to data storage, it could be summarized that there are three basic types of information (Rein & Memmert, 2016):

- Summary reports (structured). They are the simplest databases, they can almost have a direct interpretation. They could be for example the distance traveled in each training session of a swimmer or an athlete, or a summary of a football training with the number of passes, distance traveled, etc.
- Full reports (semi-structured). They include the same information as in the previous case, but in detail. This could be for example the time spent in each speed zone or the time spent on each maximum heart rate intensity. This will be the type of database most used by clubs and academies.
- Raw data (unstructured). It is the most complete type of data, but also the one that includes the greatest number of possibilities in the analysis of information. It consists of downloading the raw data from the measurement system, in data per second based on the number of hertz. This type of data is accessible in a large number of devices, specifically all those that require analysis over time to obtain the utility variables. One of the most relevant databases at this level is the positioning provided by GPS systems, with great possibilities at the tactical level.

As you level up at this scale, you'll need to apply storage and data management tools. From the second level will be necessary to be able to access different databases, which are originally in different files, in an integrated way. In the third level they will be needed simply to be able to make the information readable, due to the large amount of data that is included in those databases. These storage and information integration systems have been called Big Data, which has been already suggested as shaping the

future of performance analysis in many sports. Thus, the use of Big Data will be characterized by three concepts (Noor et al., 2015; Rein & Memmert, 2016): volume, concerning the amount of information; variety, referring to heterogeneity; velocity, characterizes the data production rate. For example, due to the amount of information that a GPS produces in a training it would not be possible to manually create and organize a single database. It would be necessary to have the databases that the system generates automatically, and then combine them with storage systems or Big Data. An excel sheet to use could not scale well with these data, while Big data technologies in contrast provide specific solutions for storing such data sets and make them accessible through specific user interfaces and application programming interfaces or API (Rein & Memmert, 2016).

On the other hand, as we said before, sport data could refer to position, video, rotational analysis, physical and physiological variables, technical and skill performance and even psychological or perceived stress variables. Big data technologies provide specific solutions to combine the information distributed across such datasets (Rein & Memmert, 2016). Systems that allow all this information to be integrated are called Structured Query Language, or SQL. More advanced, these systems can be improved with simple Machine Learning (ML) systems, which perform automated data processing, as we will see in the next point (Figure 12).

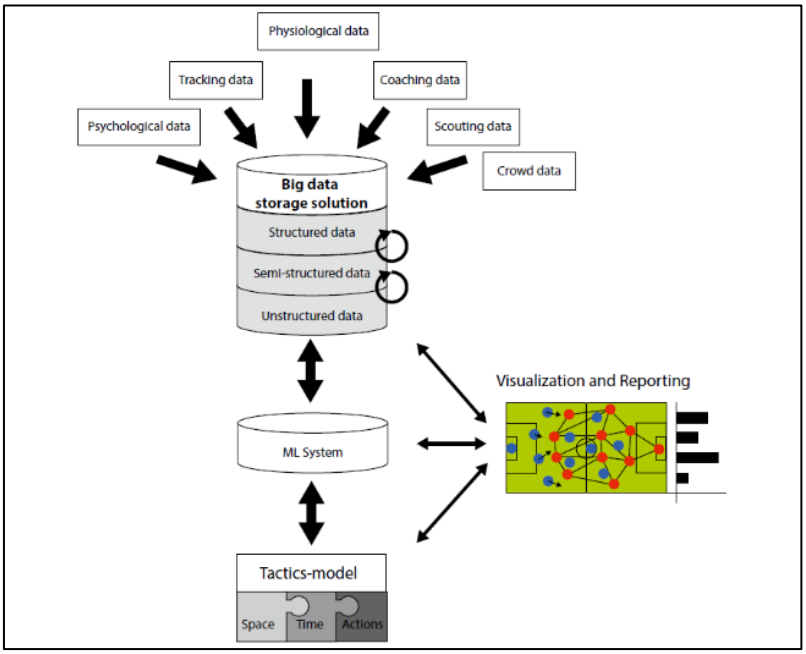

Figure 12. Big data technological stack for tactical analysis in sport (Rein & Memmert, 2016).

The use of such technologies to its full potential for clubs and academies is highly difficult today, if there is no expert staff in computer science (Bishop, 2013). However, it is highly recommended to use it simply for the control of information and the grouping of databases, in order to be able to accumulate in an organized and efficient way all the information that can be obtained. However, we are immersed in a process of change and at this time new software is being designed to facilitate the use of this information in the sports sector, with user-friendly dashboards (Low et al., 2019).

1.4.2.2. Analysis

The scientific literature on information analysis is very comprehensive and complex, ranging from very basic variable comparison systems to complex tactical analytics systems. The ways in which the information provided by the different technologies can be analysed and used will be covered in the practical useful section of each of the chapters. Therefore, a specific review of analytics directly applied to operations with large databases or combined databases will be carried out at this point.

First, any analysis technique that deals with databases created through the unification of different databases must be evaluated and processed:

- Integrity analysis: Knowledge of the distribution of the information in the data sources (distribution patterns, maximum values, minimum, percentage of zero values, white or zero, etc.).
- Quality analysis on areas: knowledge of correct areas, possible corrections and trajectories with low quality.
- Dependency analysis: Dependency of content between columns of the same data source.
- Redundancy analysis: Analysis of data redundancy of different columns in two sets of data.
- Uniqueness analysis of values: Analysis of the number of unique values in a column.
- Uniqueness analysis: Analysis of uniqueness on data suppliers (different sources of data).

From a technical and physical performance point of view in the quantification of training or competition, as well as from a physiological point of view in health and performance tests, information analysis is much easier. This type of analysis should be essential for the control of athletes, both in their performance levels and in competition (Thorpe et al., 2017). The complexity lies in the above section, the need for a good data management system that allows to unify the information obtained from individual devices (such as a heart rate monitor or heart rate variability indicator), isolated fatigue or performance tests, as well as self-reporting information, in the same database, for example.

But without a doubt, as defended by Bourdon et al. (2017), the key is to evaluate athletes individually, monitor them regularly, and compare the obtained data longitudinally. The time series expressed in graphs and detecting specific events and periods (contextual variables) will be key to being able to understand the performance of the team or the athlete and make decisions regarding the improvement of trainings (García-Unanue et al., 2018; Thorpe et al., 2017). Likewise, it is also very useful and

recommended to develop average measurements in different time periods, which allow to analyze the performance in the short and long term on the same graph (Halson, 2014). Although in essence it is simple, it is necessary to take into account certain quality criteria when we want to confirm changes in the performance and indicators of athletes (Hughes & Bartlett, 2002). In addition to observing descriptive data, when analyzing changes in performance, it is necessary to determine the size of those changes, to determine how far they may be due to training or any other factors that you want to control. In this sense, there are several very useful measures.

The size of the effect most applied today, largely due to its ease of calculation is Cohen's d (Cohen, 1988). This system consists of calculating the size of the differences based on the number of typical population deviations. Similarly, there is the concept of smallest worthwhile change (SWC). The SWC could be defined as 0.2 multiplied by the between-subject SD (Ferioli et al.,2018; Hopkins et al.,2009). The standard deviation of the differences must be larger than the SWC to consider that the change is representative, otherwise the change will be due to the sport's own heterogeneity. More complex regression models exist. This type of analysis is widely applied in sport to more accurately detect the risk of injury to athletes against certain training loads (Carey et al.,2018; Sperandei, 2014).

But without a doubt, the biggest revolution in the field of data analysis in sport because of technology has come hand in the hand of tactical performance, mainly applicable to team sports and especially invasion. Its use is much more complex, but it should not be overlooked (Memmert, 2010). Increasingly, the methods and types of analyses to be used are being clarified, so it could be applied in any club or academy that has positioning data. The use of this type of analysis allows to obtain indicators of collective performance and allow to understand the dynamics of a match and the patterns before critical events (Memmert et al., 2017). These same authors summarize the analytics that are being evaluated as candidates for the correct evaluation of tactical performance.

More recently, the same group of authors have developed a thorough systematic review covering both the conclusions obtained by all studies that have applied advanced tactical performance analyses and a review of the formulas and statistics applied (Low et al., 2019). Its practical conclusions are that there is still an important gap between research and practice. But, on the contrary, they also claim that there are more and more positioning-related variables that are easier to obtain and do not require more complex analyses, such as average distances between lines. Likewise, they emphasize the need to work on the correct integration of databases and their visualization, as they will be the perfect method to familiarize and enter this data in the decision-making of the technical staff (Memmert et al.,2019; Perl & Memmert, 2018).

1.4.2.3. Display

Data visualization is the tool capable of moving the large set of information existing in a database to a summarized structure, easy and quick to interpret by the different staff of the technical body. The data visualization begins the moment scorecards are provided with the main records of a match, to the present day where it is possible to break down different key indicators and display them in dynamic charts. As Wood (2015) explains, today's technology and, above all, affordable technology has greatly improved the way performance can be presented in sport, especially in aspects as useful as the evolution of performance in time lines. To summarize the state of the art in this field, we will rely on the recent bibliographic review of Perin et al., (2018). These authors differentiate how data is presented in three different areas: Box-Score Data, Tracking Data and Meta-Data. The first two areas are the most widespread, give their practical usefulness.

Box-Score Data has been the most classic way to present results. In its simplest form, it does not require great technologies. However, this method has made a significant leap in the moment that more data can be recorded, faster and longer. This makes it possible to set timelines and detect performance patterns or relationships that take effect (as described in the previous analysis point). The easiest way to represent this data is to present the evolution in points, victories or similar values over a given time, being able to compare athletes or teams. However, this visualization can

be expanded including instead specific or more specific performance indicators, per allow to observe performance or recovery patterns in athletes and, thus, act accordingly. For example, one of the most used charts today is the one that represents the acute: chronic workload ratio (Blanch & Gabbet, 2016; Bowen et al.,2017), as it is easy to represent, can be calculated in various ways and allows you to control some of the risk of injury. More globally, other works have shown how individual variability in individual performance throughout a competition (coefficient of variation) can be related to greater or less success in competitions. Examples of these works can be found in Mateus et al. (2015) for basketball, Kempton et al., (2015) for Australian football or Liu et al., (2016) for football. Halson (2014) presents examples where the same chart includes the evolution over time of different performance variables, but calculated in averages of different time periods, such as daily performance in a certain indicator and average weekly performance of the same indicator, to see the performance patterns that best suit the training goals. Competition in many sports (race or match) has a high duration. In such cases, and thanks to the high sampling frequency of the new monitoring equipment it is possible to observe the evolution of performance over a single match or race and superpose it with certain events or with the performance of other competitors. A clear example may be the evolution in speed or heart rate throughout a football match or position in an endurance race.

While the above visualization focuses primarily on two-axis graphs, the visualization of data within the tracking data area is displayed in a more abstract or qualitative way, using heat maps or positional maps. This type of visualization is more aimed at team sports, with a greater tactical component related to position. In this case, it requires an appropriate use of positioning devices to be able to generate maps of the pitch. The possibilities in this area are limitless. First, it is necessary to determine that the simplest way to present this information is statically, i.e. to show a photo showing the situation at the end of the match or at specific times. However, it is also possible to display this information dynamically, being able to analyze a match or competition from a more tactical view, determining which formations or decisions have determined the events of the match. Hence the great relationship between the progression in the knowledge of sports analytics and the usefulness of data in sport,

as mentioned in the previous section. Again, some simple visualizations can be the average distance of the different lines in team sports or the average position of each player at different times of a match. More complexly, you can even analyze from which points of the field have been fired more shots, their direction and the success of them. These are clear examples of this type of data visualization.

In any case, as represented throughout the document, the use of a proper visualization lies in an adequate management of the databases, their automatic analysis and the possibility of creating specific dashboards for the technical staff of clubs and academies. A dashboard that allows you to select the desired data, the temporality and present default charts in the system.

1.4.3. Utility

In high performance, especially in team sports, there are different technology providers that already provide integrated solutions with the three elements together. The tracking systems of the major football leagues in Europe, for example, provides servers where all the technical and tactical information of all players is collected in all matches and gives clubs access to a software that gives direct access to the information, allows to perform different analyses to the technical body and also allows to create specific reports for the visualization of information, highlighting Venatrack, Mediacoach, Orad-Cam Track, Tracab Track, Tracab Track, ProZone or Amisco (Hughes et al., 2019). However, in base and amateur sport there is no such specific type of tools, but there are a lot of accessible technologies that can support. There is a project that compares all the technology available for amateur, semi-professional and professional level for the sports sector https://www.comparesportstech.com/. The rise of this technology in the sports field has not gone unnoticed by science. Figure 13 and 14 show the proliferation of studies with monitoring and GPS technology in the sports sector.

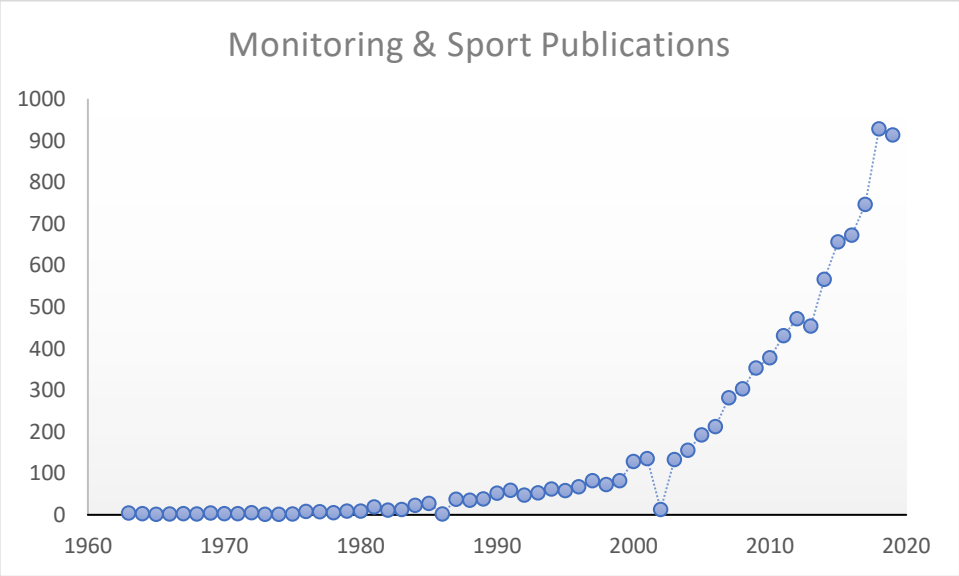

Figure 13. Publications in PubMed about Monitoring & Sport topic.

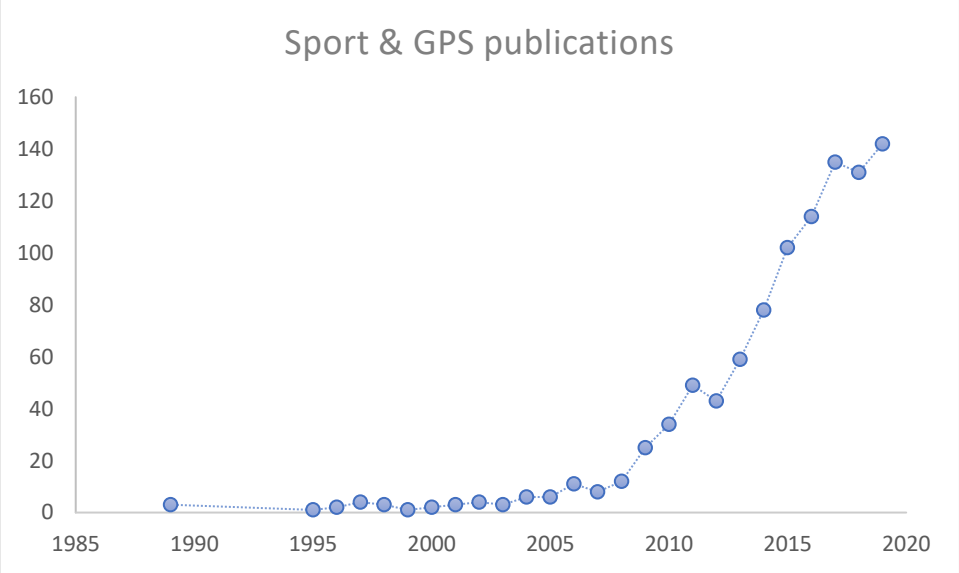

Figure 14. Publications in PubMed about GPS & Sport topic.

For example, any club can have heart rate monitors or GPS systems for its players, which typically integrate their own data visualization software at an individual level. The problem in this case stems from the limitation of each software to the data collected by the associated wearables, but the difficulty or inability to synchronize data from different sources. Such synchronization and combination is the key to the advancement of clubs and academies. Although it can be done manually, the vast amount of data available makes it unfeasible. Therefore, it was decided to create a

specific section for these elements, with the aim of knowing the specific technologies that allow to store in a combined way data from different sources and facilitate in an agile and simple way the analysis and correct visualization of the information for each of the agents involved in the preparation of athletes.

For a few years now, in the world of football it is common to see players with the typical GPS petos. This is the result of the successful implementation of new technologies in an area (professional sport) eager for new technological elements that can bring a competitive advantage over rivals.

Figure 15. Football application of GPS devices

It should be noted that these devices, or any other technology applied to the sports sector, can be a huge competitive advantage over other equipment (even competitive or financially more powerful), but it requires the provision of important human resources, knowledge and infrastructure. Thus, we could say that the application of new technologies produces a lot of data per training session or match, but clubs must have the means to store it, polish it, evaluate it and draw conclusions in almost real time. Effective and efficient data management can be considered as the holy grail of the sports sector today, but mismanagement, either because of lack of resources or knowledge, will generate frustration and waste of time and money to the teams.

Therefore, it is very important that the sports sector is constantly trained in terms of resources, possibilities and techniques of obtaining data, management of them and application to the day of the athlete. Continuous training has always been considered

as an essential resource in the business sector, but continuous training in the sector of new technologies applied to sport is essential for the survival of sport competition, sport for all and the management of sports policies at any level.

1.4.4. Accessibility

As we've seen before, any sports professional has a multitude of tools, softwares and devices to deploy in their day-to-day life. Many of them are free or easily accessible, as they integrate directly with traditional operating systems like Mac, Windows, etc., and their learning curve is quickly and easily applicable at any level. It simply takes an average economic effort, a motivation for learning and its implementation that makes it possible to become a reality. The sports sector is facing its great industrial revolution. Machines and technology are here to stay.

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1.5. Technologies for retransmission and digital media

1.5.1. General description

These technologies go from manually operated to automated production solutions that allow to capture, distribute and monetize sporting events which are not usually followed by a large public and were not usually covered in the past. This usually concerns to competitions or events whose perceived value is too low to generate much interest by broadcasters, including underdeveloped sports from all sectors: secondary leagues, women's sports, youth competitions, minority sports and amateur sport.

Some of these sports sectors gather millions of athletes belonging to thousands of associations and clubs all around Europe. However, amateur and semi-professional games and competitions receive little attention on traditional sports TV channels. For this reason, technologies consisting of automated sports production solutions which enable lower league and youth clubs to affordably and effortlessly produce their own high-quality content are crucial in the growth and development of the sports world.

The development of these technologies is creating a growing demand for content beyond the traditionally televised first-league events, and a massive usage of sports video services that let people watch their friends, children, or local clubs is expected in the near future.

1.5.2. The technology applied to sport

The world of sport is constantly evolving, and the majority of teams or entities in the sports sector ensure that they are better prepared to meet long-term objectives if they have data, analytical information and cutting-edge technology to further support their performance analysis and strategic planning.

Nowadays, any organization or club needs to have a set of tools and resources that help them boost their weight in the sector, through the use of data, as well as improving performance and making informed decisions.

The distribution and dissemination of multimedia content through the Internet and social networks (Twitter, Facebook or Instagram, mainly) have become a relatively cheap and accessible communication tool, which is why it is increasingly used by educators, professionals, scientists, researchers and the general public. In addition to this, at present, there are different intelligent sports platforms that have become information centers that allow clubs, leagues and associations to manage their scouting and analysis workflows. Analysts, scouts and other staff are more likely to succeed if they have the latest technology and if they know the latest advances in the current technological revolution of amateur and elite sports.

Currently existing platforms usually customize their services and offer a variety of possibilities beyond the day to day that support decision making since they are aware that each club is different and has a different philosophy, culture, structure and objectives.

In addition to the above, there are different applications that provide live data and provide a minute-by-minute analysis, allowing analysts to quickly identify trends and make decisions during the match. These streaming applications offer real-time data, videos synchronized with the data, compare images or study all the interventions of each player with an important range of possibilities that facilitate the proper management of each situation.

1.5.3. Features and applications to the world of sport

This new way of knowing information during training and matches is based, on the one hand, on the accumulated Big Data and on the other, on a new form of development of the sector created from the fusion between technology and sport. The analysis systems stand out through streaming technology, webcasting and podcasting and their increasing applications in the field of sport.

- Streaming consists of a data transfer service that allows the distribution of multimedia content continuously through the internet and in real time, from a

server to a client in response to a request from the client, without having to download them previously on a computer.

- Webcasting consists of the live transmission of content through the internet, and is used successfully in the retransmission of videoconferences since it even allows attendees to interact.
- Podcasting refers to the act of distributing audio files on the internet for listening on a computer, an mp3 player or a mobile device. Many associations and societies of a scientific or professional nature, educational, magazines, congresses and meetings of a similar nature in the field of sport use this technology today, which is widely accepted among our sector.

1.5.4. State of the art

The state of the matter concerns mainly to the edition of metadata on the Internet, the constant growth of the video, the separation of the other multimedia elements, the choice of a normalizing format, the exponential increase in broadband as a true driving force and driving force. the audiovisual elements, the ergonomics and comfort in the visualization in front of the screens, the complex work of recovery in comparison with the text, the tags in natural language as identifiers of the document, the documentary languages as "invisible" normalizers of the searches, the labeling standards, philosophy 2.0 and a breakthrough in new techniques for recovering videographic information, such as automatic text transcription.

When sending content live (or as close to live as possible) to viewers, this content may be shared by "broadcasting" or "live streaming". Although essentially the two terms refer to the same concept, particularly in the sports content context, the terms "broadcasting/broadcasters" have traditionally been used to describe television broadcasters, while "live streaming" is being used as a differentiating term to describe the internet broadcasters.

As a content rights holder, a provider may actually be both "broadcasting" to a local TV station while also "live streaming" on a web-based platform. The main options

available in the market to do so are described below. It would be the task of the provider to select the solution that best fits his organisation, taking into consideration the equipment, manpower, budget and internet conditions available.

1.5.4.1. Live streaming with a smartphone

Anyone, literally, can become a content producer nowadays. Smartphone camera technology has evolved to such a high degree of quality that it can be used to create content suitable to be distributed to a wider audience. And nearly 90% of the population owns one of these devices in almost all of the world's developed countries, so accessibility and affordability are the main advantages of using a smartphone to provide sport content.

Besides, this option also presents the advantage to be extremely flexible and quick to install. Thus, a personal smartphone and a stable internet connection with a minimum upload speed of 2.5 mbps (4G is better than Wifi for stability) will suffice to broadcast a certain sporting event or competition with a proper quality. There are many online platforms that already allow live streaming, some of them also providing sports specific features which will help to enhance the production value. These sports specific features include sports graphics (think scoreboard and timer), highlights tagging, metadata and statistics creation which can be activated in real time and directly through the filming smartphone.

1.5.4.2. Live streaming with a video camera

This option requires a slightly more complex setup and at least a two-person operation, but also allows to produce a better-quality feed and zoom in and out with ease.

The basic setup consists of 1) Camcorder with HDMI input/output, 2) 4G router or Ethernet, 3) tripod and 4) streaming device. This technology offers a high degree of flexibility and is usually compatible with all existing streaming devices in the market. Besides, it does not require using additional external software or to connect the camcorder to a laptop. Instead, the backend interface where the match will be

"produced" can be operated remotely with a stable internet condition being the only requirement. This means that the camera operator needs to be in the stadium, but the "producer" does not, and he can tag the various match events such as kickoff, goals, fouls etc. from his office or home.

These systems allow to include a series of features such as live commentary or multi-camera production to enrich the viewers' experience and add more value to the production.

1.5.4.3. Automated sportscasting solutions

These systems usually consist of a network of cameras that are fix-installed on indoor and outdoor courts and allow the live recording of the sporting events celebrated in them. Computer-vision algorithms create TV-like footage using the live signal without human intervention. Then, game footage is automatically streamed from the venue to a web portal or even integrated into existing sport portals. Game videos can also be available through interactive mobile apps where fans choose their view, create clips and share them on social media.

These technologies include several features which can add more value and enrich the viewers' experience, although they may carry significant costs compared to the previous options.

1.5.5. Usefulness

The application of data, analysis and technology in different teams and sports can vary very significantly. Each team has its own processes and objectives. Many teams around the world are applying data and analysis to inform decision making and improve performance.

Examples

Monitoring and tracking: Tracking the trajectories of the players or monitoring their performance are some of the resources most demanded by clubs and federations. Information files on players and teams are created for training and support staff to

manage their evolution over time. Applying this qualitative information effectively is crucial to discuss and evaluate players in the system and monitor their performance.

Learning: Involving the players themselves can also mean an improvement in their knowledge. This technology offers the possibility of generating previous and post-match reports that combine statistics, subjective comments and videos, and are a very interesting resource for the protagonists of sports practice

Match analysis

- **Live analysis***:* Home games always offer more analysis opportunities, as there is more access to the playing field (connected analysis rooms, etc.), but the challenge is to use data during a game, during the break. Normally there are only 15 minutes for everything, rest, stretch, hydrate, etc. and in that period the analysts must offer information and conclusions to the coach pointing out the key aspects. Some technological developments also offer tracking, which consists in measuring the displacement of a player to show his heat map, how much he ran and at what speed. To do this, microchips can be integrated into players' boots to measure their movement.
- **Post-match analysis**: The data collected during a match offers a multitude of specific aspects of the game that allow a quick analysis of the performance and the aspects to be improved. Due to the busy calendars that many teams have, the need to provide concrete analysis to the coach and his coaching staff to support future decisions is crucial. Also the individual feedback to each player at the end of the matches can be something well received by the players, who can take a look at their statistics to be able to compare and improve their performance.

Culture of analysis

Players or workers should see the data as something normal and useful, which is provided to draw conclusions and improve their performance. This is based on creating a culture that goes beyond analyzing and learning from the classic statistics on possession, shots on goal or yellow cards of a team. These are techniques that

involve constant monitoring of the match and, after analysis, can help solve errors and improve. The audiovisual and multimedia equipment for recording, producing and streaming live sporting events has the potential to revolutionize outside broadcasting by providing broadcasters as well as home viewers and team coaches the following benefits:

- Unique game views – This technology goes from conventional smartphones to effectively automate broadcasting systems which allows to share content and new insights that were not yet accessible to the fans.
- All-in-one sports production package – Some of these technologiesuse high-resolution live video to capture every detail within the arena, as well as audio, broadcast graphics and 3rd party applications like statistics and advertisements.
- Unprecedented broadcast quality – The high-resolution capabilities of these systems enable all types of views, including high-definition close-ups.
- Affordable solution for broad-ranging venues – Usually fixed video capture devices cover the entire field all the time, eliminating the need for costly, portable, field cameras and cameramen. The affordability of these technologies makes them an attractive solution for video capture in lower-profile venues, such as second tier events, youth competitions or practice games.
- Opportunities for all athletes – These technologies also contribute to the development of the sport by giving the athletes a chance to showcase themselves to their fans, receive more support in terms of promotion and sponsorship, and possibly develop their value locally and globally.

1.5.6. Accessibility

Access does not only refer to coaches, technicians, etc. but also to the general public, since the appearance of these platforms has revolutionized the offer of sports content making it an element of mass consumption for almost any sport modality. For example, the increase in subscriptions for which sports streaming services are paid increased by 24% in 2018.

Nowadays matches and other sporting events can be followed from a wide variety of devices: smartphone, tablet, computer, smart TV or traditional television, live or deferred. Any of the specialized platforms make it possible to track multiple sports from different parts of the world, although some of this platforms, mainly those that are free, have a significant load of advertisements and generally lower image-audio quality.

Some companies specialized in technological services for sports are taking another step in the goal of creating new experiences for sports fans and are trying to produce and distribute content through virtual reality, through the development of a multiplatform to include various glasses and boost experiences from the mobile. These proposals have already had tests with the Premier League, Roland Garros and The "classic" football in Spain.

Even sports associations such as the NBA had already signed an agreement with Twitter and Turner Sports (January 2019), to offer a live broadcast option during the last two quarters of 20 games of the regular season, the All-Star Game, and 16 playoff games, including the Western Conference finals.

On Twitter, the user is the protagonist of this new proposal: there is an individual tracking camera for a certain NBA player chosen by the users plus influencers making live broadcasts. This is one of the most innovative proposals, although for now they are only available in the United States.

1.5.7. Some facts and trends

- The video has been consolidated as the users' favorite format. They spend 2.6 times more time on pages with videos than without them.
- There is an increasing demand for live videos. Of all the video traffic, currently 13% already corresponds to those that are broadcast live and the trend continues to rise.
- In the sports sector, 360 videos and virtual reality are becoming popular. Consumers are increasingly looking for more realistic experiences that allow

them to fully take part in the action. The 360-degree video and virtual reality are expected to continue growing.

- More and more specialized companies are working on personalized videos focused on a single user instead of wanting to reach mass audiences.

1.5.8. Difficulty levels

Different categories (from the most basic to the most complex) could be identified that could be defined based on the analysis of an individual player or group:

1) Individual technique.
2) Technique and tactics (in attack and defense) and their creativity.
3) Team tactics (in attack and defense).

At different levels it is important to detect when and where there is a player who stands out. Also, another way to classify web applications is the one proposed by authors such as O'Reilly (2009), which would be divided into 3 levels.

- Level 3. It is made up of applications that can only work on the Internet, where they develop their full potential. Some of these examples would be Ebay, Wikipedia, Delicious or Skype, which are driven primarily by online activity. Google for its part has developed its potential to also extend to desktop computers offline, thanks to the Google Desktop application, which in a step further would maximize the virtues of the Network and offer them on the local hard drives themselves.
- Level 2. It is made up of applications that can operate offline, but offer a strategic advantage if they are online. Flickr would be a good example. We could have a program to manage photos, but only if this edition and labeling is done online will it enjoy an added value since it can be shared, recovered, known and valued by an entire community. In addition, the default status of that photograph would be "public" so more people could know it.
- Level 1. The application can work just as well without being online, but it has some advantage if it is online. Google Docs would be a good example, since its collaborative edition allows you to manage a document by several people

at once; even so it would work perfectly being on a local computer and would not present different potentialities.

- Level 0: The application is created to work online, but it would still work exactly the same on a local computer as long as the database it feeds on is also on it. Google Maps could be the case, since if we have all the maps downloaded it is the same to work outside the Network. Now, if these maps include user contributions (restaurant, local, leisure, etc.) would become a level 2 application.

1.5.9. Consumption and prices

Usually the streaming service are offered for free, financed through ads and sponsorships, or as an ad-free premium subscription. From the point of view of users, a study by Deltatre (2018) emphasizes a 53% increase in the amount of minutes spent streaming sports content in 2018, compared to 2017. In terms of service penetration, a 32% increase in devices is indicated. In terms of prices, the report detects that two thirds of consumers are willing to spend a maximum of € 39 total per month on sports streaming packages and not just Millennials or Generation Z.

References

Trad. O'Reilly, Tim. Levels of the game: the hierarchy of web 2.0 applications. [online]. O'Reilly Media Inc, 17-07-2006. Disponible en: http://radar.oreilly.com/archives/2006/07/levels-of-the-game.html

PART 2. FIELD STUDY. ANALYSIS OF THE USE AND DEVELOPMENT OF THECNOLOGY IN CLUBS AND ACADEMIES

2.1. Introduction

The global assessment of technology in the sports environment cannot end only with a review of the state of the art and the market. To understand the true needs of clubs and academies it is completely necessary to listen to the target population. For this reason, the second part of this handbook is intended to show and interpret the results of the field study developed in the first work package of the Digi-Sporting project.

To do this, an online questionnaire has been designed that has been sent to technical staff and sports coordinators of clubs and academies in all the countries participating in the project. The initial objective was to achieve an average of 50 responses per country (a total of 350 responses). **However, a total of 569 responses have been obtained, thus obtaining a sufficiently representative sample of the sector**.

One representative from each country, sent the questionnaire in a personalized way to previously contracted contacts to get valid answers for the project, who met the condition of being part of coaches, physical trainers or coordinators in non-professional clubs and academies, without import the type of sport. The questionnaire had a total of 6 versions, one per language, which allowed the analysis to be segmented to achieve more personalized results.

The main objective of this study was to know the level of use and importance of the different technological areas in a sports entity, as well as to evaluate the development of associated skills. Specifically, the specific objectives are:

- Know the level of use of each type of technology.
- Evaluate the perceived importance of technologies.
- Analyze the GAP between the use and importance of technologies, to identify priority development areas.
- Check the technical and economic accessibility of the different technologies.

- Evaluate the relative importance of technologies per position in the sports entity.
- Know the level of development of associated skills.
- Assess the perceived importance of associated skills.
- Analyze the GAP between development and importance of competencies, to identify priority development areas.

Thanks to this, the sector will be known in more depth. In addition, key information is obtained for the development of the training program in the second Intellectual Output of the project.

2.2. Methods

The instrument consisted of an ad-hoc online questionnaire for the project. For its development, the following steps were followed:

First, the technological areas were determined. There is no unitary classification of technologies applicable to clubs. For this reason, a group of experts was developed including all project partners, as well as other external experts in the use of technology in clubs and academies. Firstly, 8 areas were identified that were finally unified into 5 different areas, the same that structure the first section of this guide:

- Technologies for club management
- Technologies for physical evaluation, physical tests, injury prevention, healthy and medical technologies
- Technologies for training quantification and training activities
- Technologies for data analysis, data storage and visualization
- Technologies for retransmission and media

These areas were divided into 7 groups of technologies that divide the questions in the questionnaire:

- Technologies for club or entity or entity management.
- Technologies for data analysis.
- Technologies for reporting and visualization.
- Technologies for physical evaluation, physical tests, injury prevention, healthy and medical technologies.
- Technologies for training quantification. Physical monitoring.
- Technologies for training quantification. Technical-tactical monitoring.
- Technologies for retransmission and media.

The competences to be evaluated were selected taking as a reference the recently completed NASME project: New Age for Sport Management in Europe (KA203-2017-006) where 72 competencies for the management of sports entities were defined. Those competences directly related to technology and digitization were chosen:

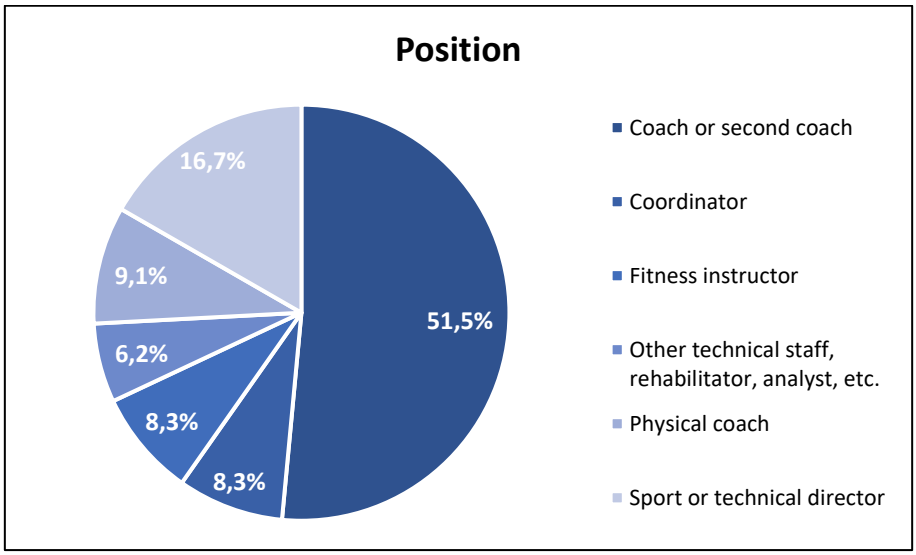
- Analytical skills.
- ICT skills.
- Data management skills.
- Ability to make conclusions from research data.
- Digital marketing and social media skills.
- Skills in the digital management of Big Data

After that, the questionnaire questions were prepared, including general questions to describe the sample and a question for each objective of the study. The first version was developed by those responsible for the work package and subsequently reviewed by all partners. After including all the changes, a pilot test was developed and the comments of the respondents were heard. The final version was developed in 6 versions, one for each language of the project.

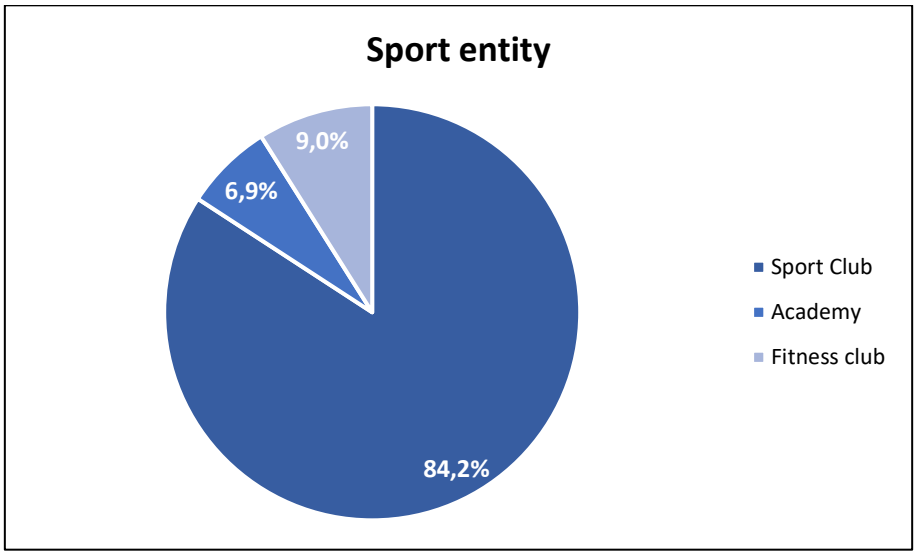
The results of the study are shown below, both in global terms, as well as comparing according to the different versions of the questionnaire. Furthermore, in addition, a brief individual report is shown for each version of the questionnaire in Annexes.

2.3. Sample

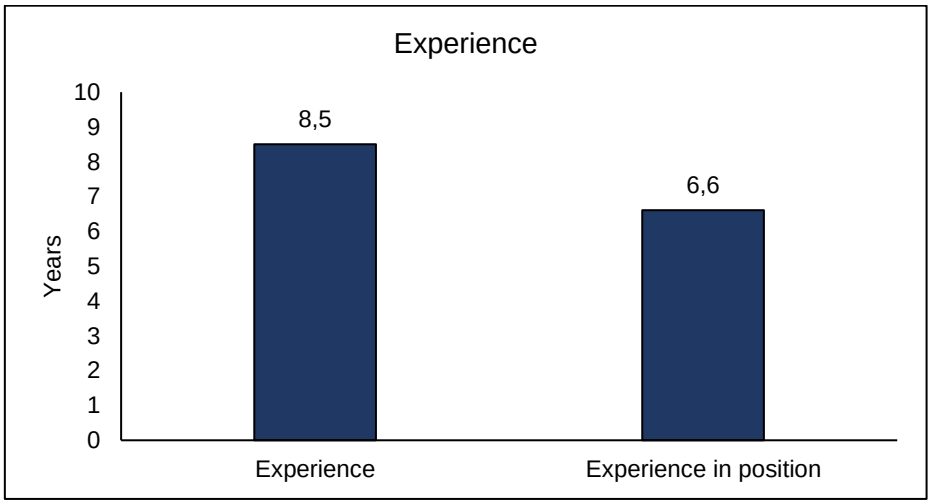
569 professionals answered the questionnaire. 51% were coaches or second coaches. 24% worked in technical positions, such as physical trainers, fitness instructor or analyst. Finally, 25% worked in managerial positions, such as coordinators or directors.



As expected, most of the responses came from sports club staff. A minority responded from academies or fitness clubs.



Finally, respondents had an average of 8,5 years of experience and 6,6 years of experience in the position.

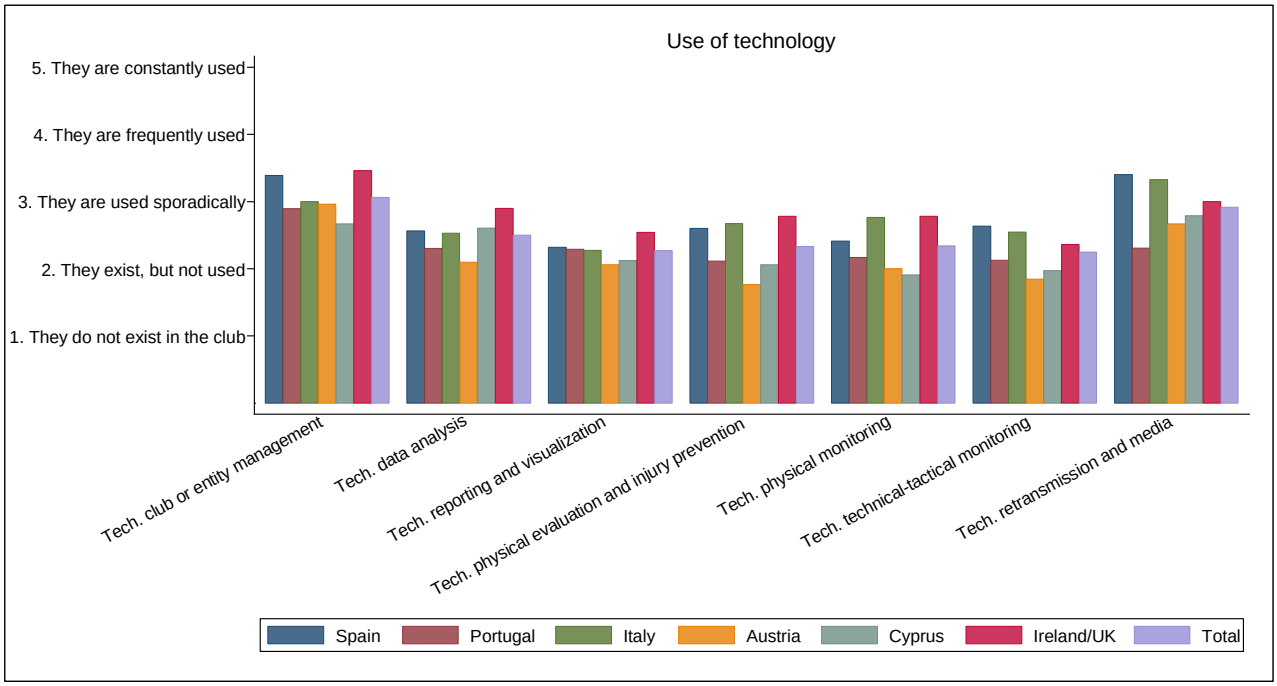


2.4. Results

2.4.1. Use of technology

Technologies for club management and retransmission and media are the more used. However, the rest of the technologies are used sporadically in most cases. Spain, Italy, Ireland, and the United Kingdom are the countries with more declaration of use. Austria and Cyprus declare less use of technology.

This result suggests that the sport entities have good development of transversal and support technologies. However, more technical sport technologies are little used, something that is very characteristic and important.

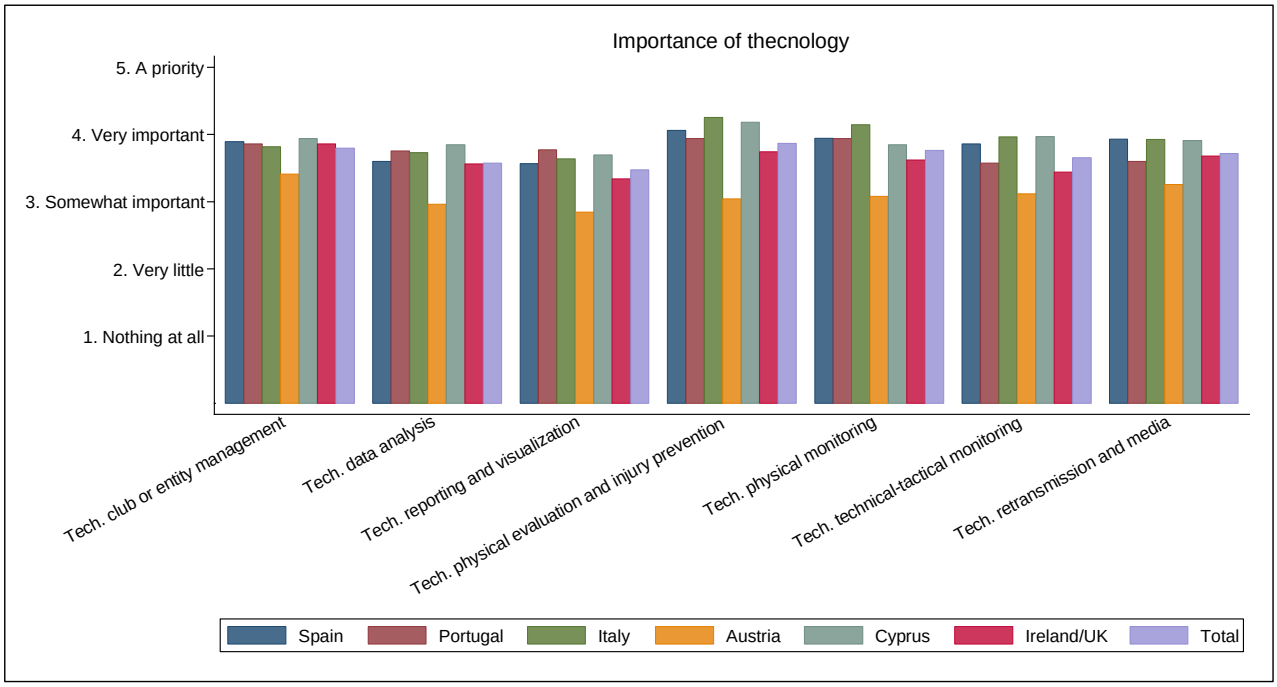


2.4.2. Importance of technology

Significant results contrast sharply with use results. All technologies are very important for clubs and academies in global terms. Furthermore, three of the less used technologies (i.e., Tech. physical evaluation and injury prevention, Tech. physical monitoring, and Tech. technical-tactical monitoring) are the important technologies.

Italy has a greater perception of importance. On the other hand, Cyprus declares a lot of importance in comparison with the level of use. Austria has a lower level of use and lower perception of importance.

The importance of sport complex technologies seems to be high for clubs and academies. It should be noted that the sports technology market has advanced enormously in products with a wide variety of utilities and prices; therefore, they are the areas with the most development potential.

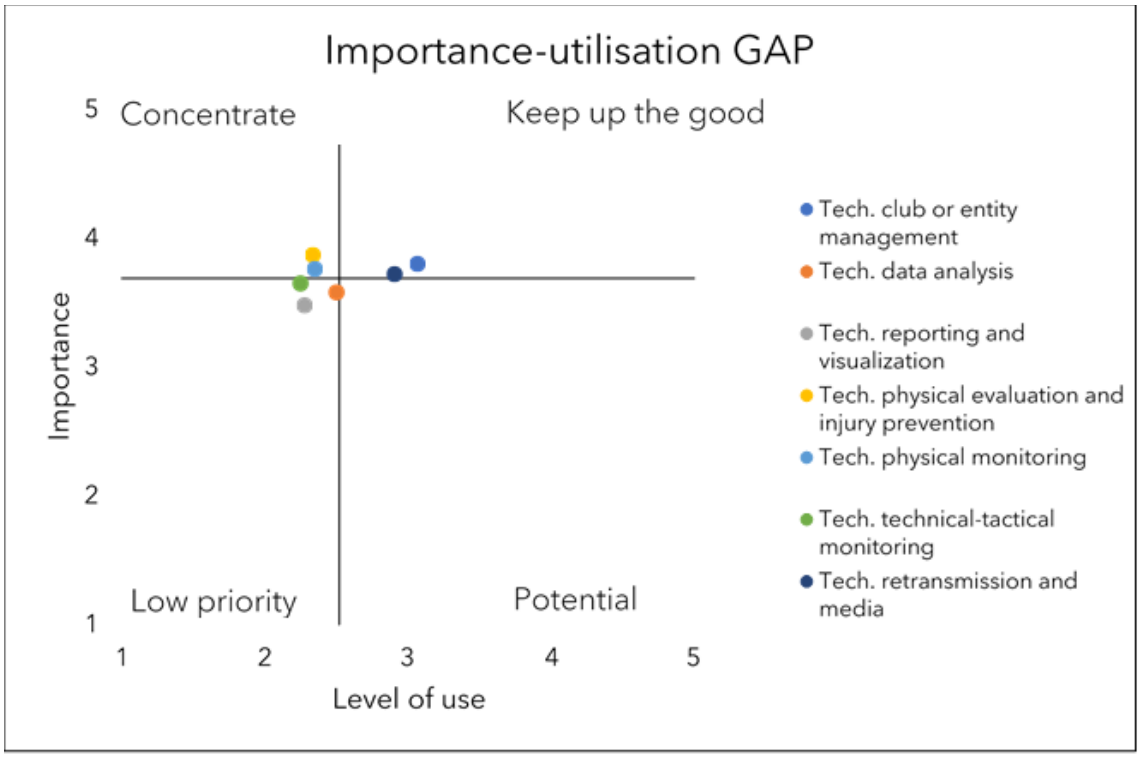


2.4.3. GAP analysis. Use vs importance of technologies

This analysis is based in the IPA analysis (importance–performance analysis) that allows to classify the answer in four quadrants and determine the order of priorities. This information is a key indicator for the development of the training package and syllabus in the second intellectual output of the project.

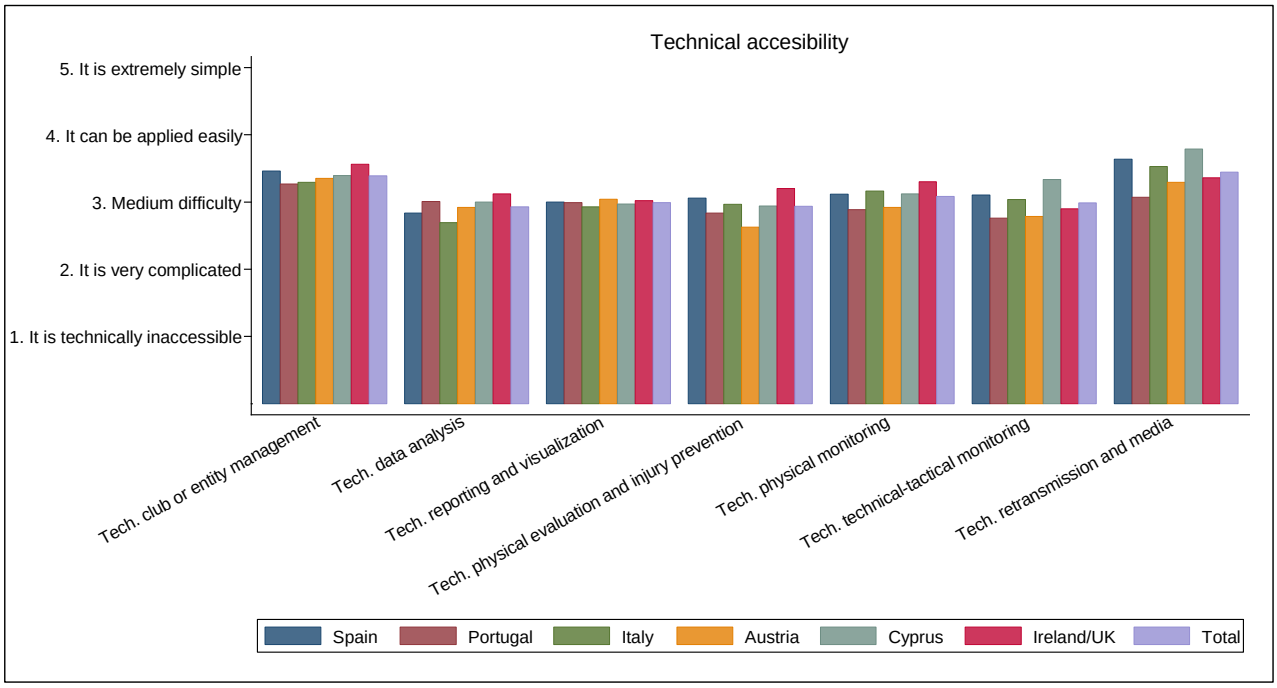
- Responses with great importance and much use must be maintained.
- Responses with great importance and little use should be strengthened.
- Responses with little use and little importance should be kept secondary.
- Responses with a lot of use and little importance should be reduced.

In this case, Tech. club or entity management and Tech. retransmission and media are technologies that must be maintained and require continuous formation and development. On the other hand, the three main sport technologies must be developed (i.e., Tech. physical evaluation and injury prevention, Tech. physical monitoring, Tech. technical-tactical monitoring). This result is key and decisive for the Digi-Sporting project. It confirms the need to develop profiles of sports technologists for the development of training tasks and physical preparation in clubs and academies. As has been seen in the first section of this document, there is great development and market alternatives for these technologies, and yet there is a great difference in how important they are to clubs and the level of current use. Therefore, it will be necessary to develop specific comprehensive training for sports technologists-analysts who know how to select and apply these technologies effectively in sports entities.



2.4.4. Technical accessibility of technology

The results of the perceived technical accessibility are similar among countries, with practically no notable differences. The global results are fully coherent with the level of use. Tech. club or entity management and Tech. retransmission and media are the more accessible technologies. However, no technology gets a rating lower than 'medium difficulty' on average.

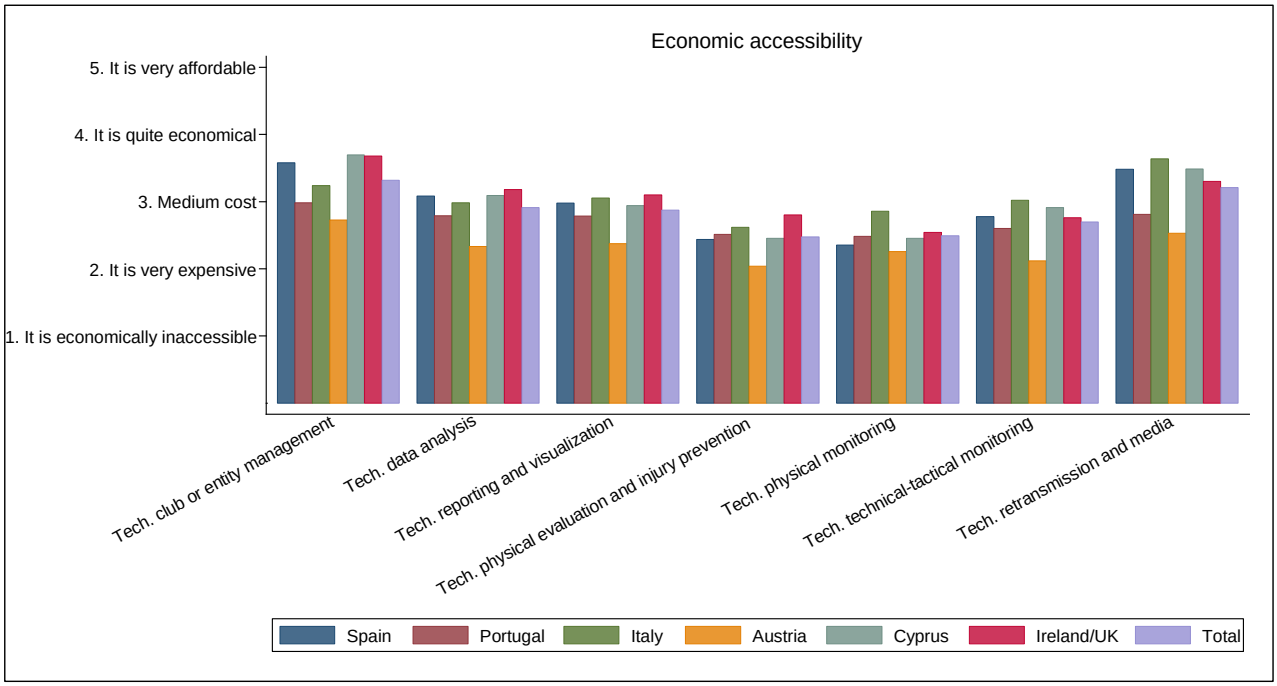


2.4.5. Economic accessibility of technology

Tech. physical evaluation and injury prevention, Tech. physical monitoring, and Tech. technical-tactical monitoring are the more expensive technologies in the opinion of the respondents. These technologies respond with wearables and technological devices; therefore, they usually require high investment costs for non-professional clubs and academies. Again, Tech. club or entity management and Tech. retransmission and media are the more accessible technologies.

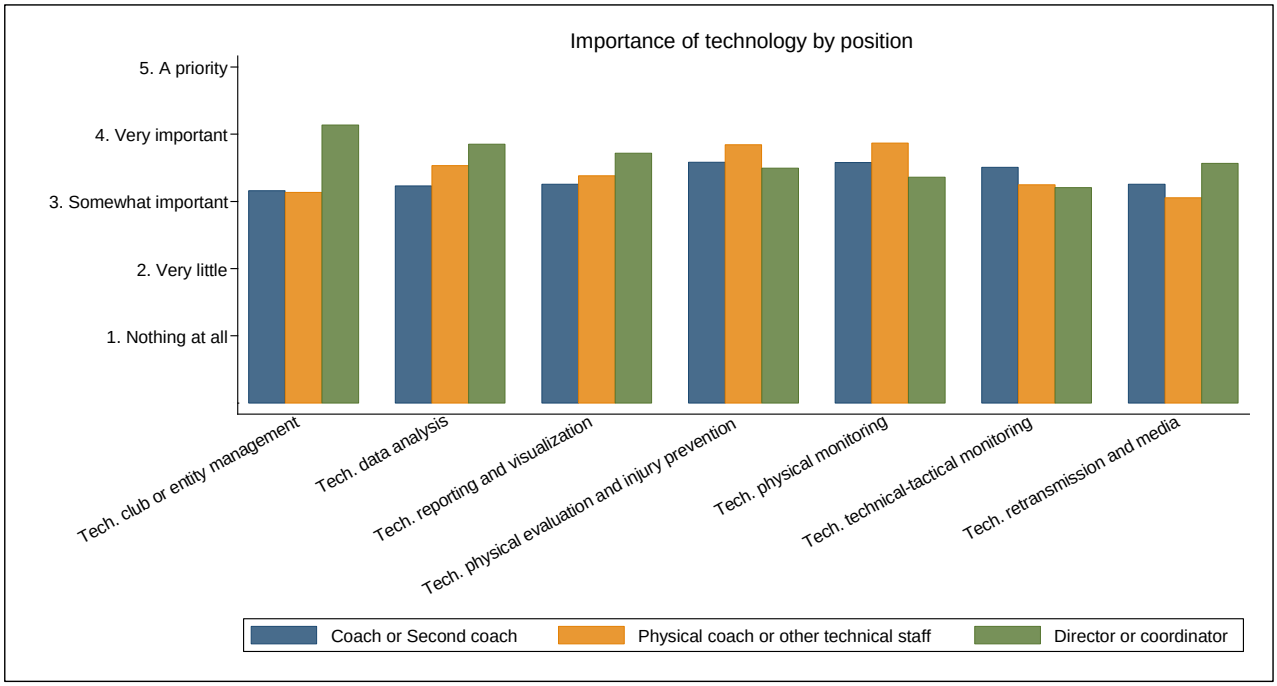
A Áustria é o país que percebe menos a acessibilidade económica da tecnologia, seguida, embora em menor grau, por Portugal. Espanha, Itália, Irlanda e Reino Unido são os países que percebem maior acessibilidade económica às tecnologias. Assim,

pode-se indicar que estes países têm um maior desenvolvimento do futebol profissional, o que pode levar a uma maior competitividade nas categorias mais baixas e, portanto, à necessidade de investir mais nesses dispositivos.



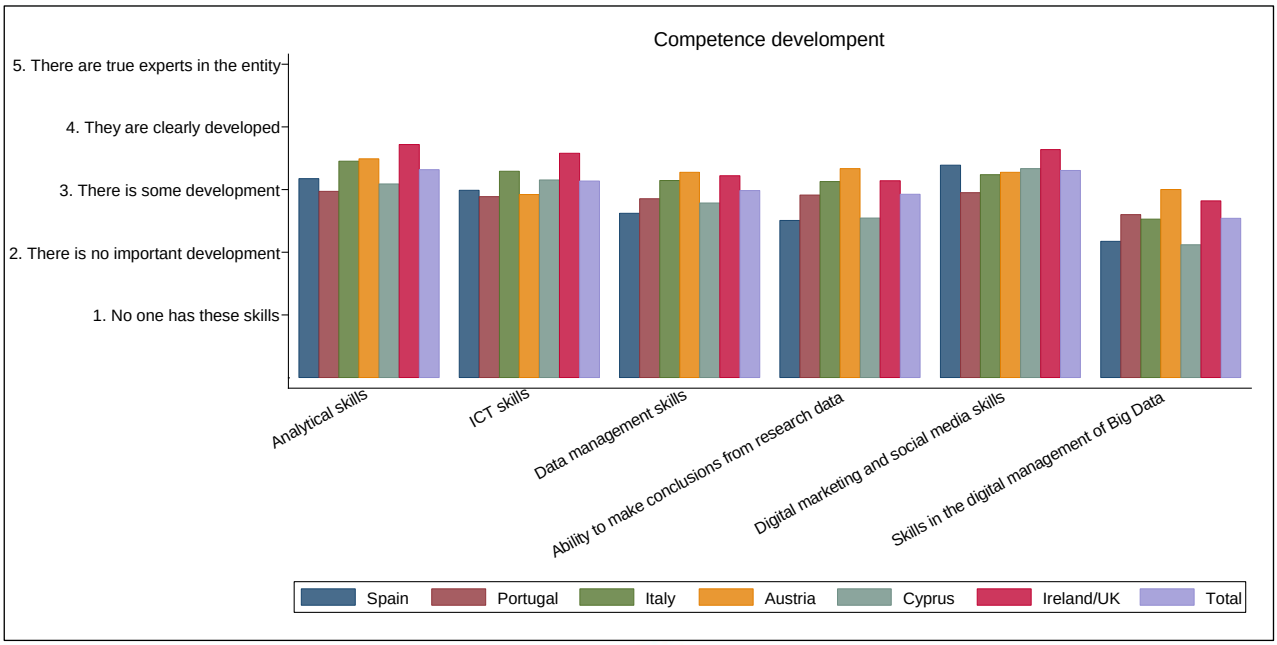
2.4.6. Importance of competences by position

The results show a clear priority of use per position, in line with expectations. Management positions require greater use of Tech. club or entity management and Tech. retransmission and media and, to a lesser extent, Tech. data analysis and Tech. reporting and visualisation. The physical coach and other technical staff, however, value more the use of Tech. physical evaluation and injury prevention and the use of Tech. physical monitoring. The coaches, however, reported a similar importance for all the technologies, although with a higher value in Tech. technical-tactical monitoring compared to the other positions.



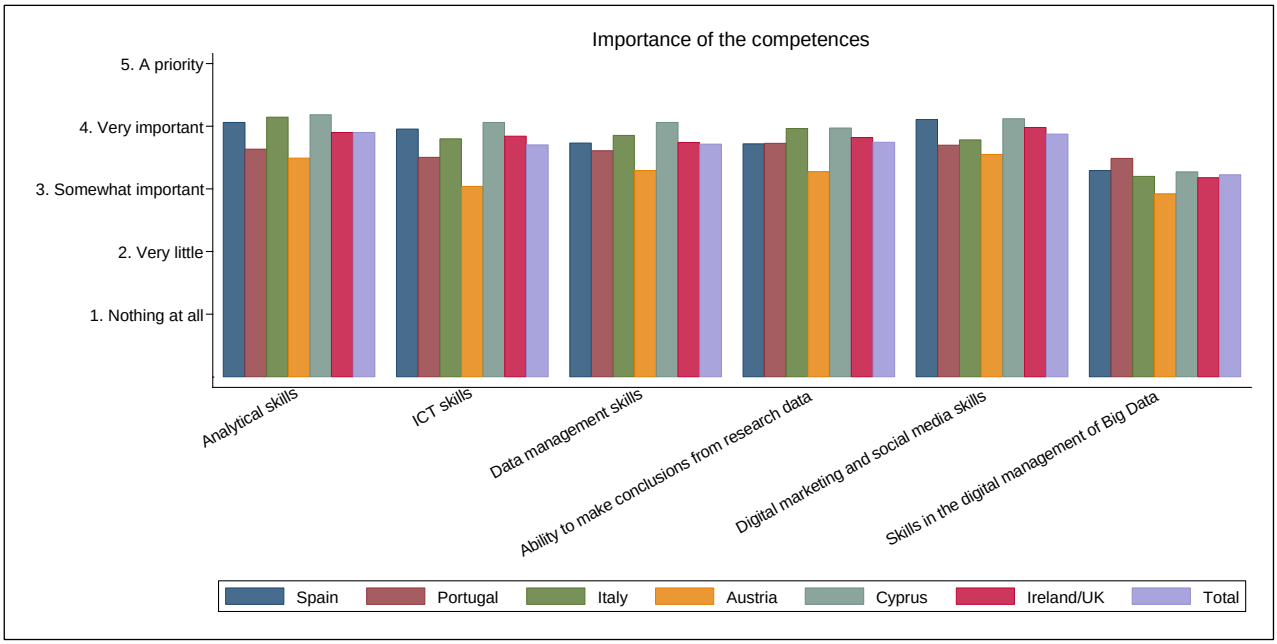
2.4.7. Digital competence development

Skills related to the management of Big Data are clearly less developed. The rest of the competences are near the response 'there is some development' in global terms. Ireland and the United Kingdom are the countries with more perceived development, followed by Austria and Italy. Furthermore, Spain and Cyprus declare very slow development in skills related to research data and Big Data.



2.4.8. Importance of the digital competences

Big Data are perceived as the competence with less importance. However, data management and research data have high values if we compare with the level of development. All competences except Big Data were considered very important in global terms. Austria reported the lowest level of importance, in contrast with the high level of perceived development in the same country. In the opposite situation, Spain and Cyprus report the highest perceived importance, in contrast with the low development reported.

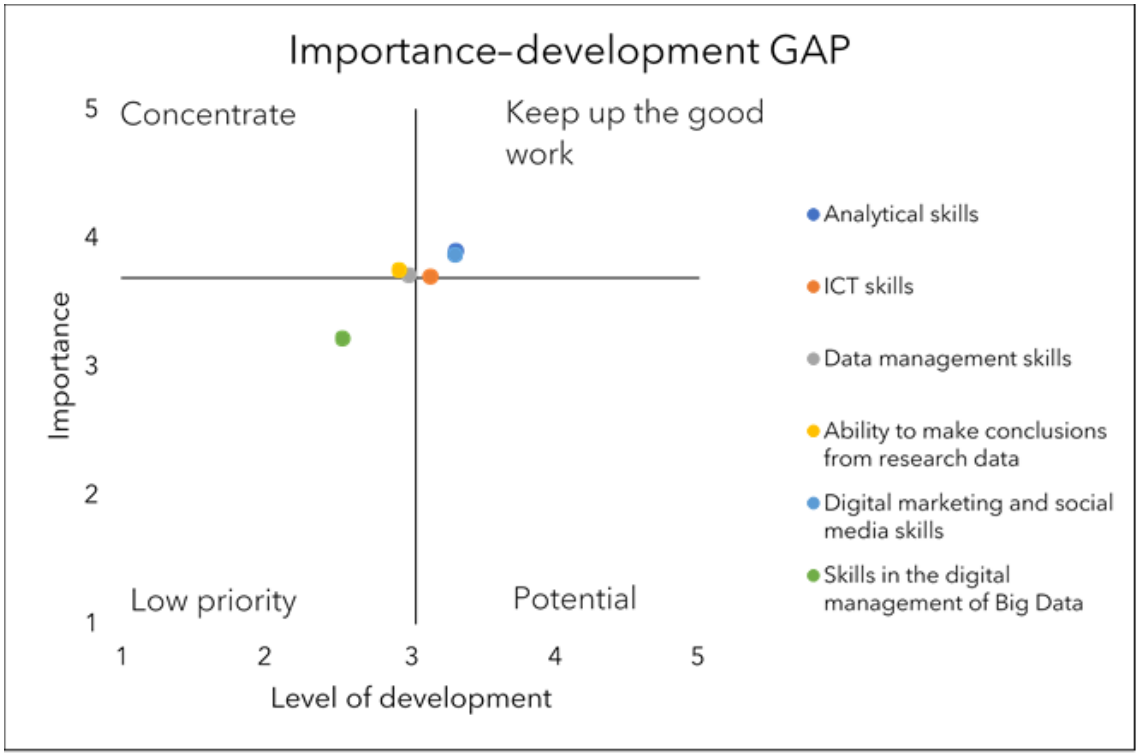


2.4.9. GAP analysis. Development vs importance of competences

The IPA analysis again shows clear guidelines for the development of skills for technologists-analysts in sport. The more transversal skills such as analytical skills, ICT skills, and digital marketing and social media skills require job maintenance. It is important to develop continuously updating resources for the promotion of sport and its results.

The technical skills such as data management and ability to make conclusions from research data are pending subjects, which need to be developed to achieve good profiles of technologists-analysts in sport in the labour market.

Finally, surprisingly, the skills in the digital management of Big Data require less development, despite current trends. Possibly it is a subsequent step to the effective implementation of the previous competences.



2.5. Conclusions

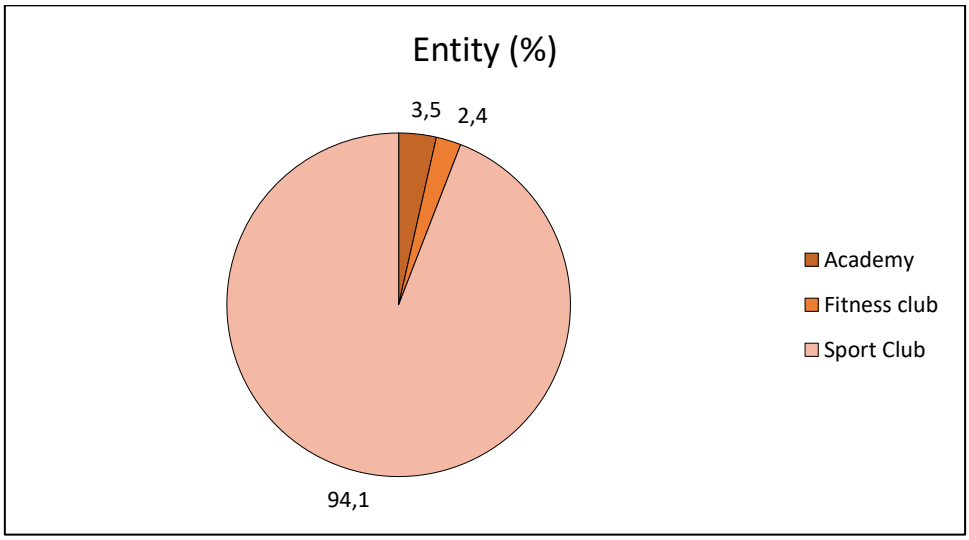
- In general, the staff of sport clubs and academies consider all technological areas very important. Very few differences between countries were found
- Clubs and academies have a good level of use of technologies related to management and promotion.
- Specific sport technologies related to physical evaluation, physical monitoring, and tactical monitoring require significant development. They are technologies with a high level of importance and little level of use today.
- Big Data and advanced analytical techniques are not considered as such a priority at present, possibly due to the need to develop the specific sport technologies.
- Specific sport technologies also need more development in terms of training experts, as they are considered the most difficult to use.
- Specific sport technologies are perceived as the most inaccessible at the economic level. Therefore, it will be necessary to exploit their use and possibilities to the maximum to justify their integration in clubs and academies.
- Technologies for management, promotion, and data analysis are more useful and important for sport directors and coordinators. Technologies for physical evaluation and physical monitoring are the priority of physical coaches and other technical staff. Finally, technologies for tactical monitors are a strong toll for coaches. However, all positions must know the usefulness and application of all technological areas, as at some point, they are important to their functions.
- Competences of data management and ability to make conclusions for research data have to be developed, as they are related to the use of all technologies in general and especially sports-specific ones.

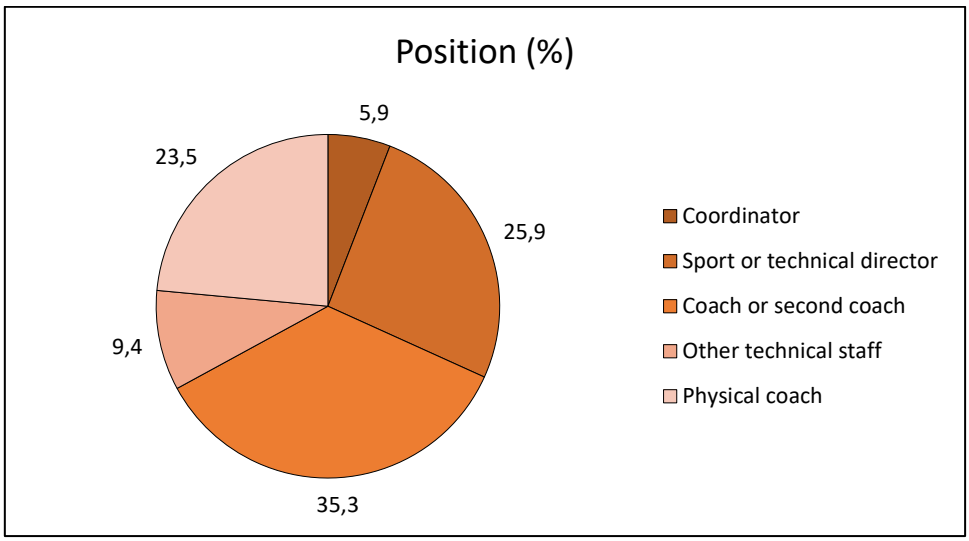
ANNEXES

ANEX I. INDIVIDUAL REPORT. QUESTIONNARIE SPANISH VERSION, SPAIN

1. Sample

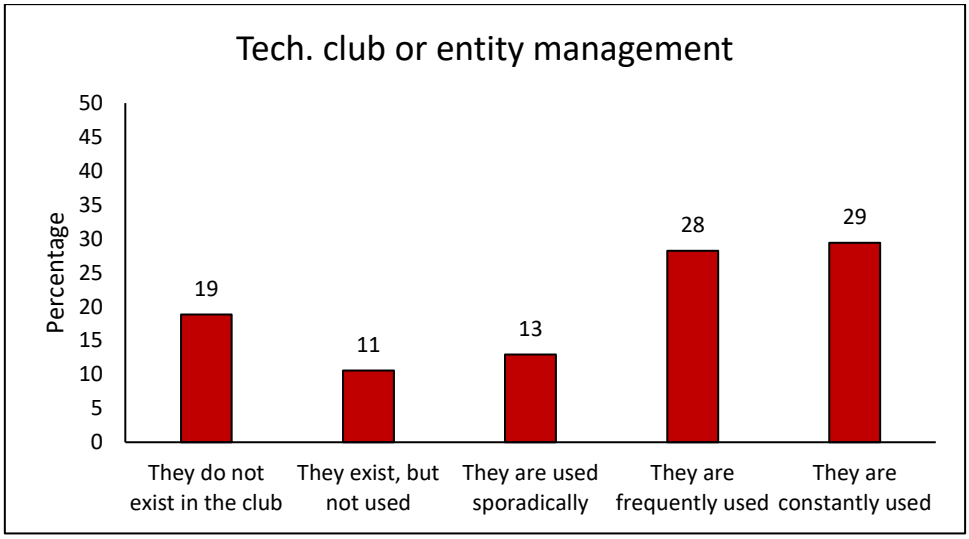
The figures show the general characteristics of the sample, depending on the type of entity, position in it and years of experience in the entity and in your current position in percentage. Most of the respondents (94.1%) are part of the Sports Club. The percentage of responses per position is widely distributed. 26% are managerial positions (Sport or the technical director), 35% coaches (Coach or second coach) and 33% technical and physical preparation positions (Fitness instructor, physical coach, and other technical staff). The years of experience in the entities show an average of 7 years, while the years in their current position are 5 years.

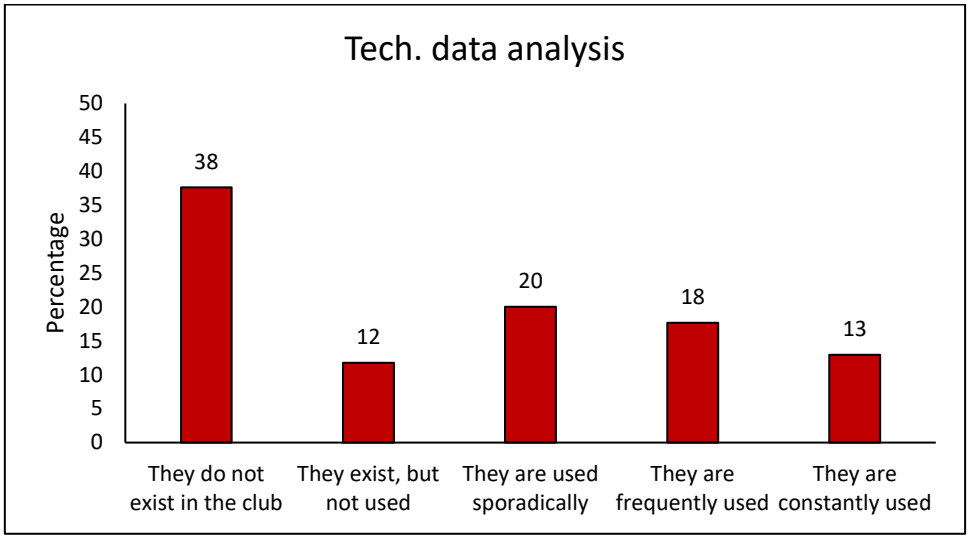




2. To what extent are you currently using these technologies in your club or sport entity?

The results of the use of technology in different aspects within a club or entity, indicate a greater use of club or entity management technology. Regarding the data analysis technology (38%), reporting and visualization (44%), physical evaluation and injury prevention (36%), physical monitoring (44%) and technical-tactical monitoring (35%) indicate that they do not exist in your sports club or entity. However, only retransmission and media technologies show more use in comparison with others (31%) within a sports club or entity reflecting the fact that those four areas are more developed.




Tech. data analysis
Percentage
50
45
40
35
30
25
20
15
10
5
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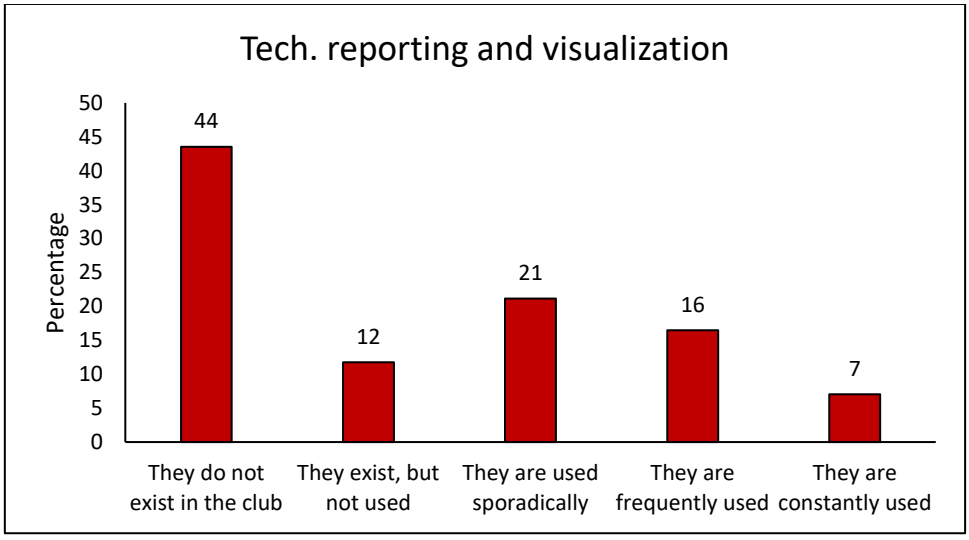
38
12
20
18
13
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used


Tech. reporting and visualization
Percentage
50
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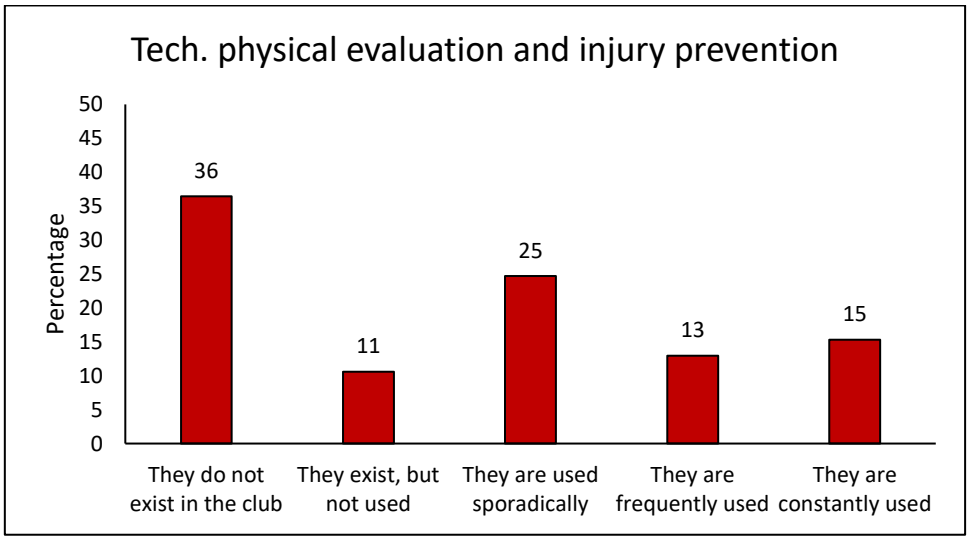
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used


Tech. physical evaluation and injury prevention
Percentage
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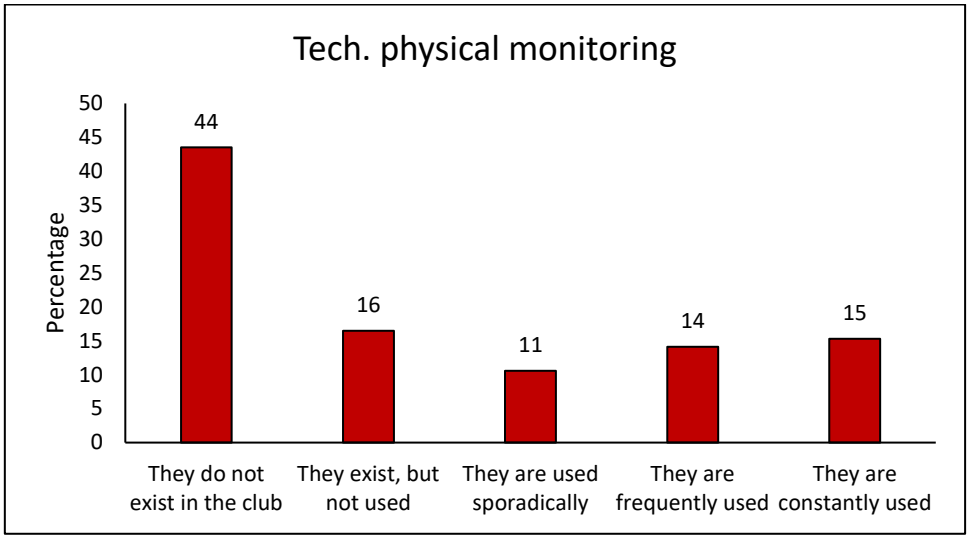
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used


Tech. physical monitoring
Percentage
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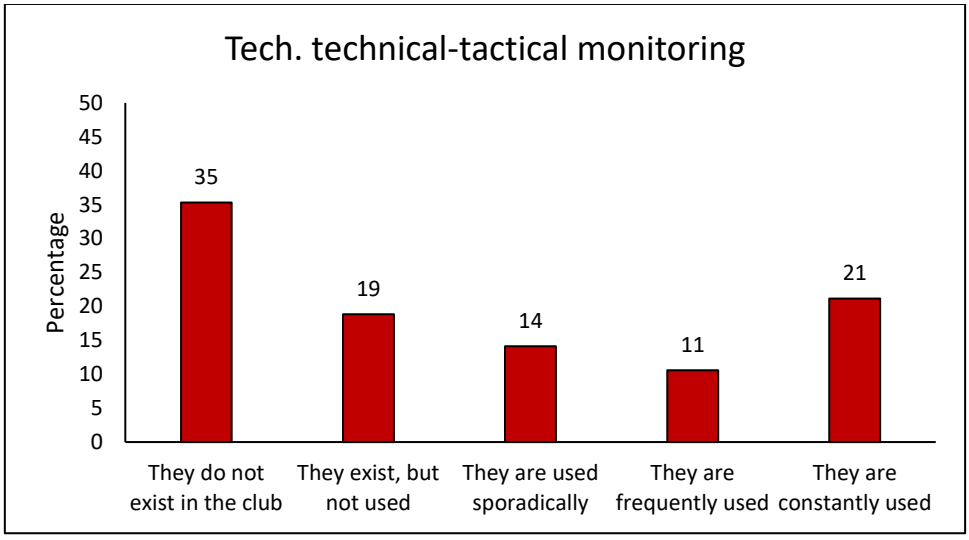
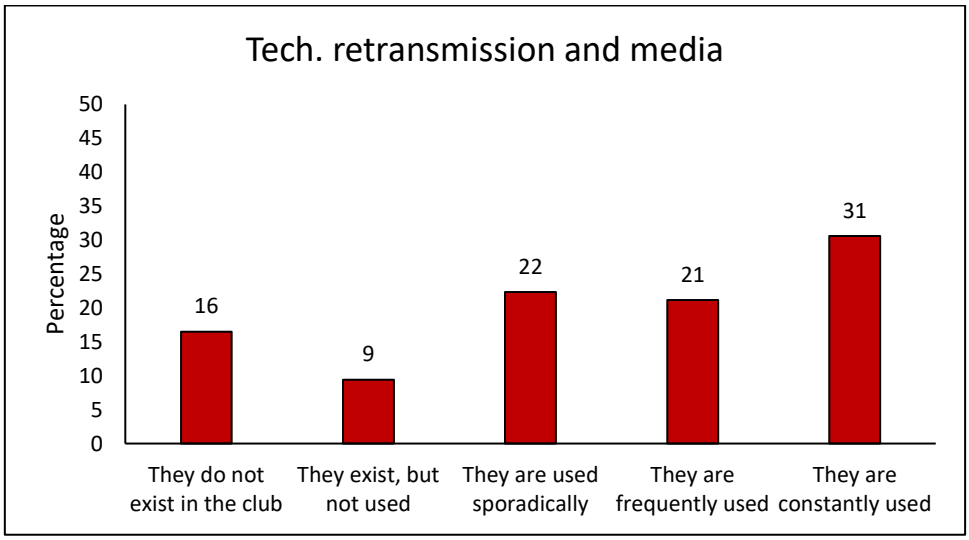
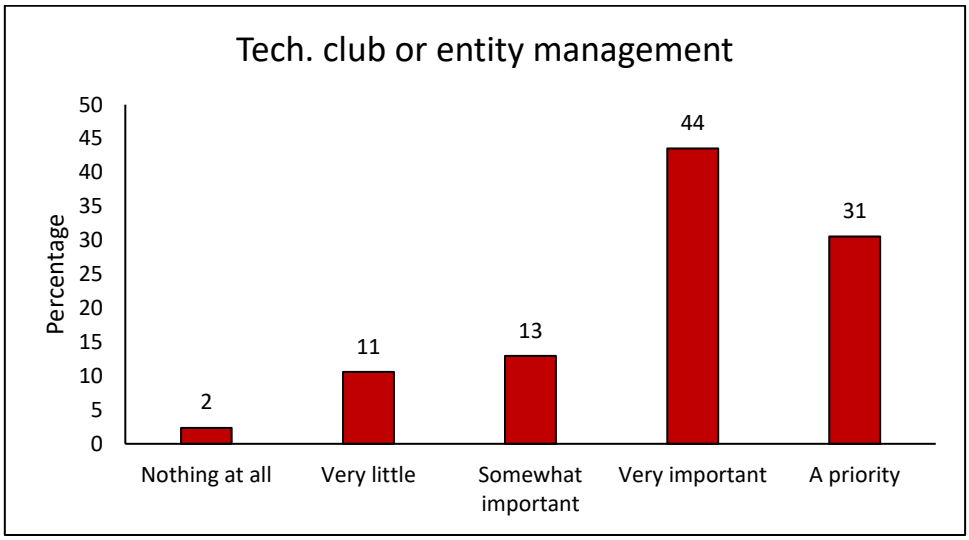
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

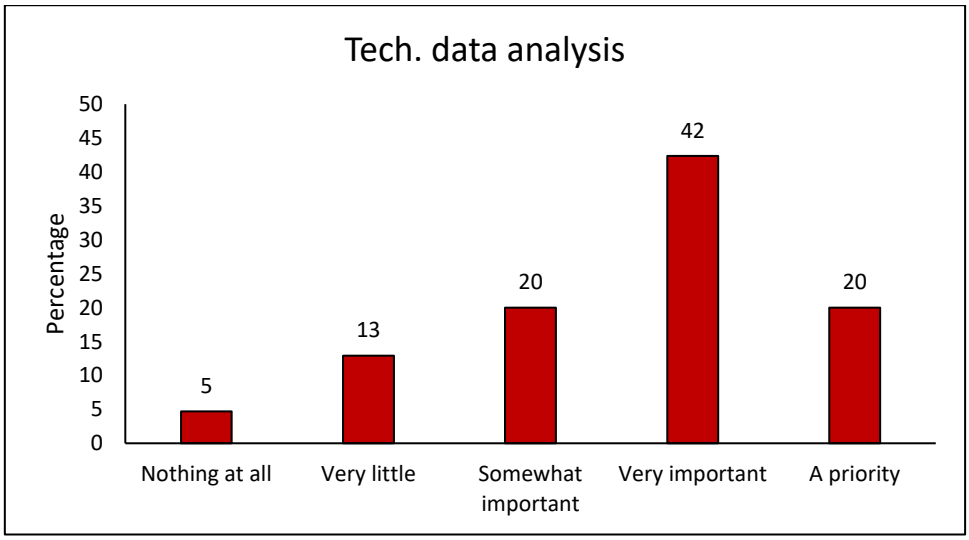

Tech. technical-tactical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
35
19
14
11
21
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

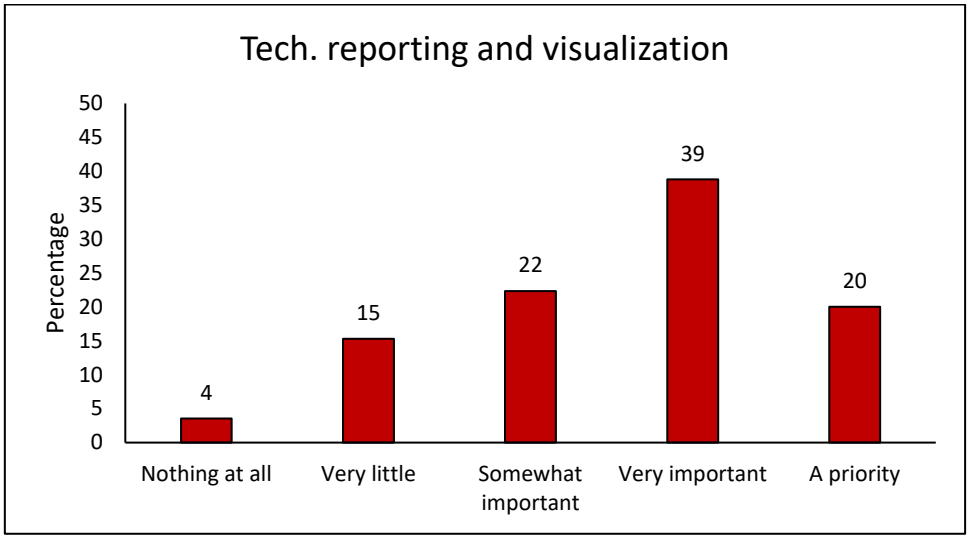

Tech. retransmission and media
Percentage
50
45
40
35
30
25
20
15
10
5
0
16
9
22
21
31
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

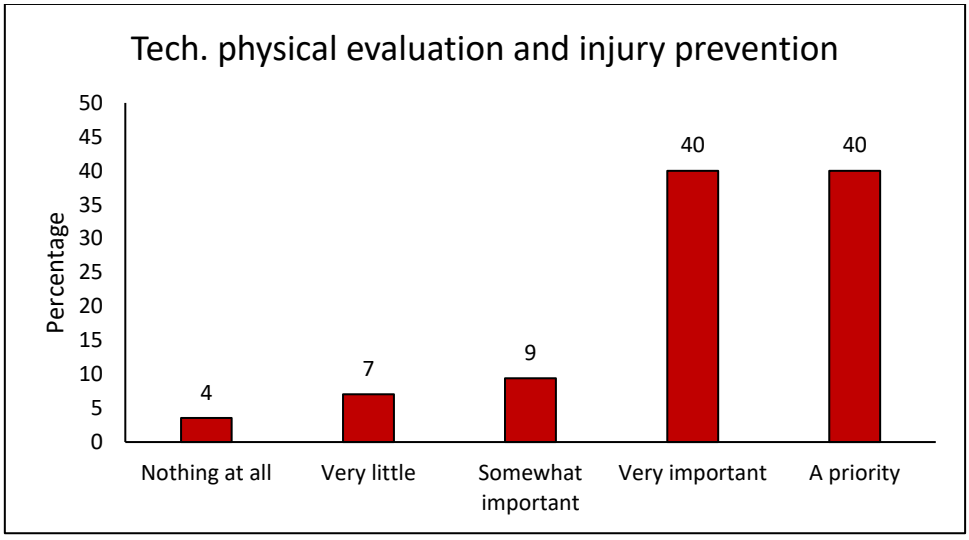
3. How important do you think using these technologies are or would be for your club or sport entity?

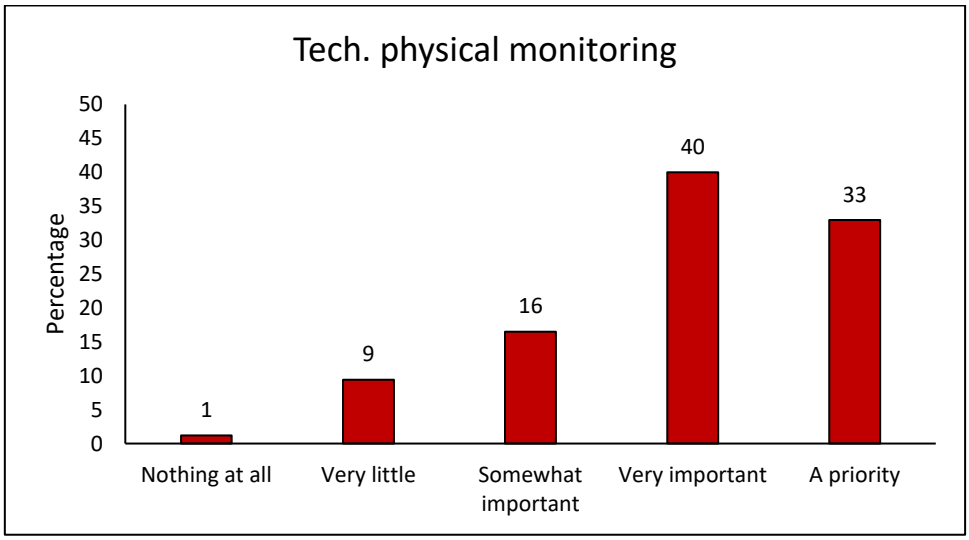
The previous graphs show us how important they think the use of different technologies is in sports clubs or entities. As can be clearly seen, club or entity management, data analysis, reporting and visualization, physical monitoring, technical-tactical monitoring and consider the use of technology very important (38-44%). Even physical evaluation and injury prevention retransmission and media believe that it is a priority (35-40%). In general, they consider that the use of these technologies is a very important in their sports entities or clubs.

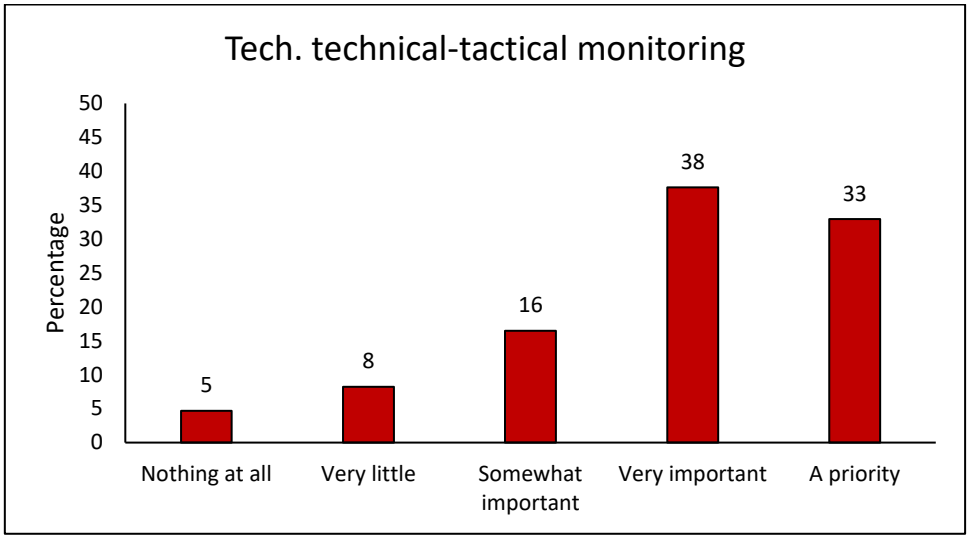


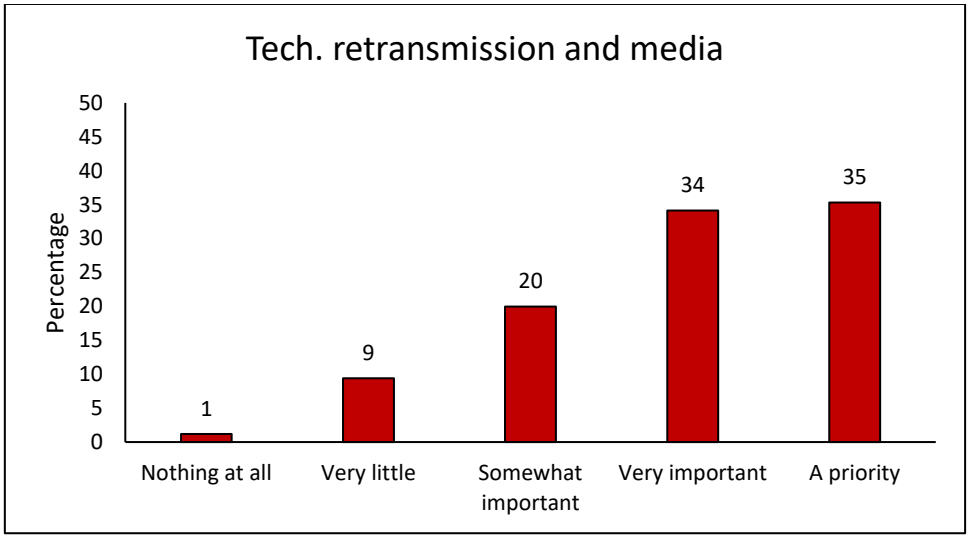



Tech. reporting and visualization
Percentage
50
45
40
35
30
25
20
15
10
5
0
4
15
22
39
20
Nothing at all
Very little
Somewhat important
Very important
A priority


Tech. physical evaluation and injury prevention
Percentage
50
45
40
35
30
25
20
15
10
5
0
4
7
9
40
40
Nothing at all
Very little
Somewhat important
Very important
A priority

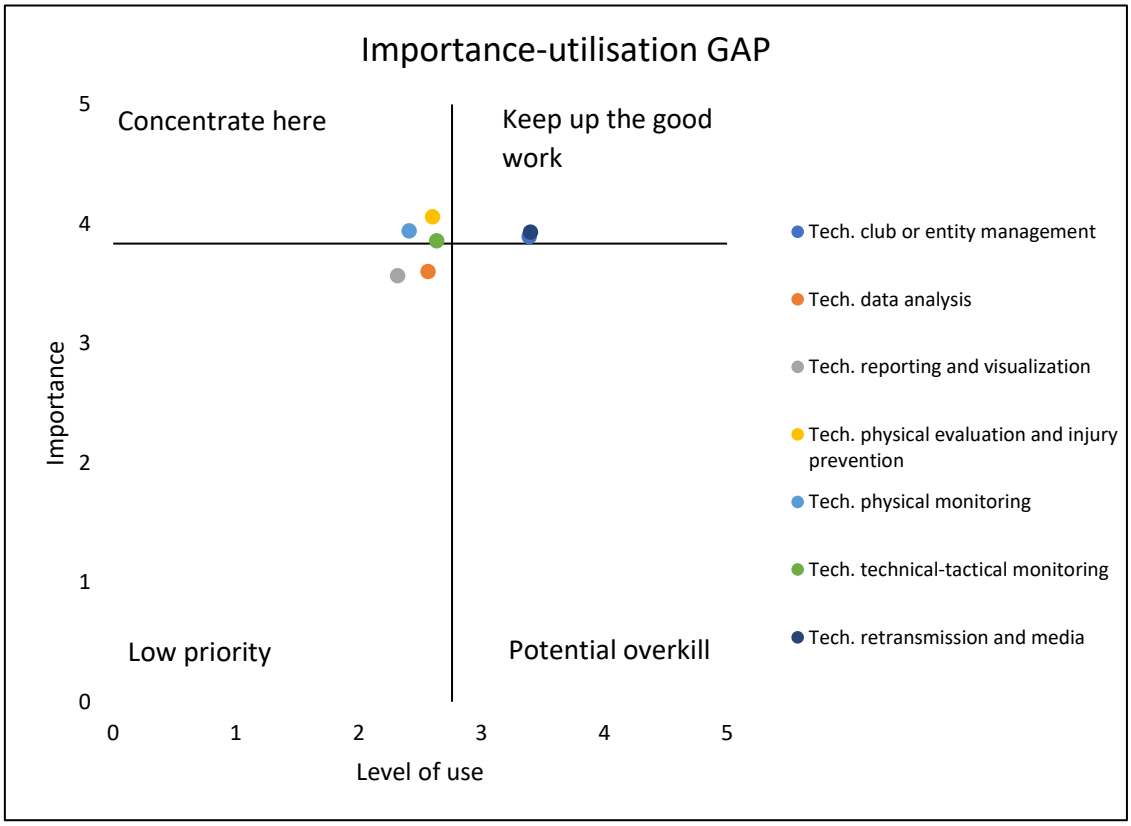

Tech. physical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
1
9
16
40
33
Nothing at all
Very little
Somewhat important
Very important
A priority





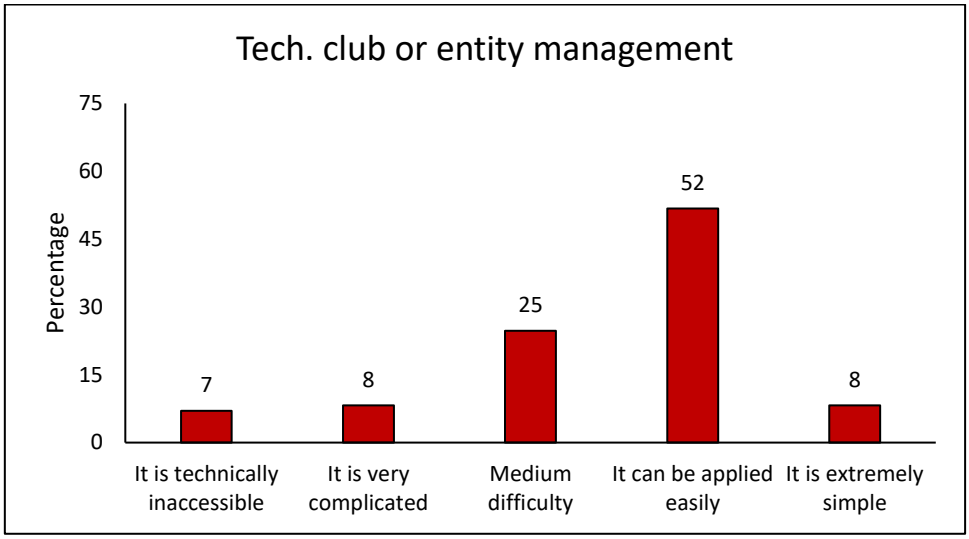
4. GAP analysis between use and importance of technological areas

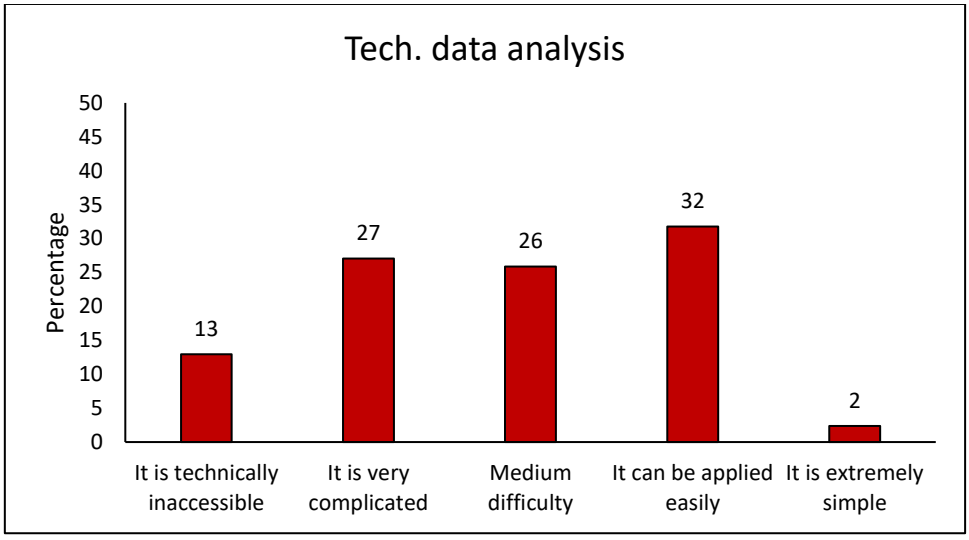
In this graph that we observe based on the responses of the Spain sports managers, it follows that the Tech. The management and retransmission of the club or entity and the media are of great importance and high use; therefore, it must be maintained. However, Tech physical evaluation and injury prevention, physical monitoring and technical-tactical monitoring are of high importance, but little use, so they require further development. Finally, data analysis and reporting and visualization have little use and little importance, therefore they are not a priority for managers in Spain.

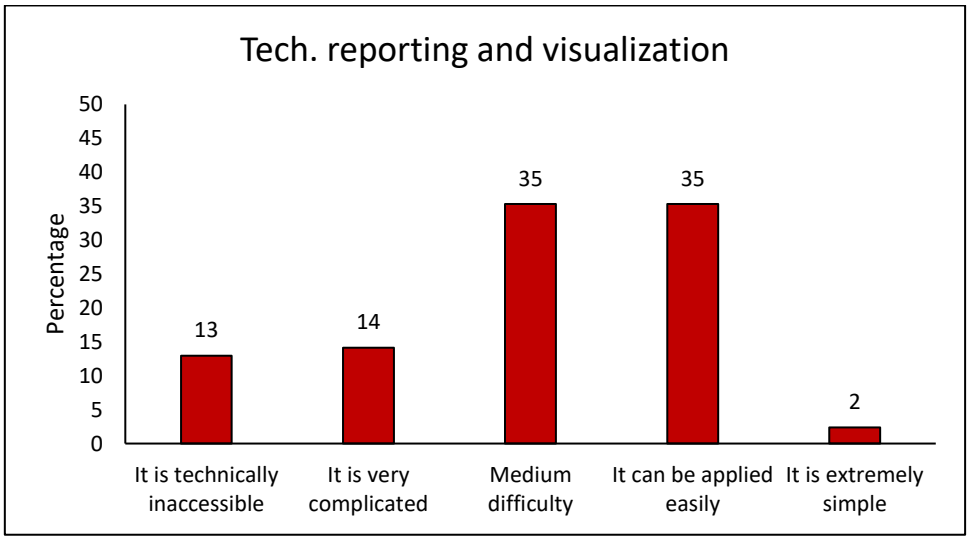


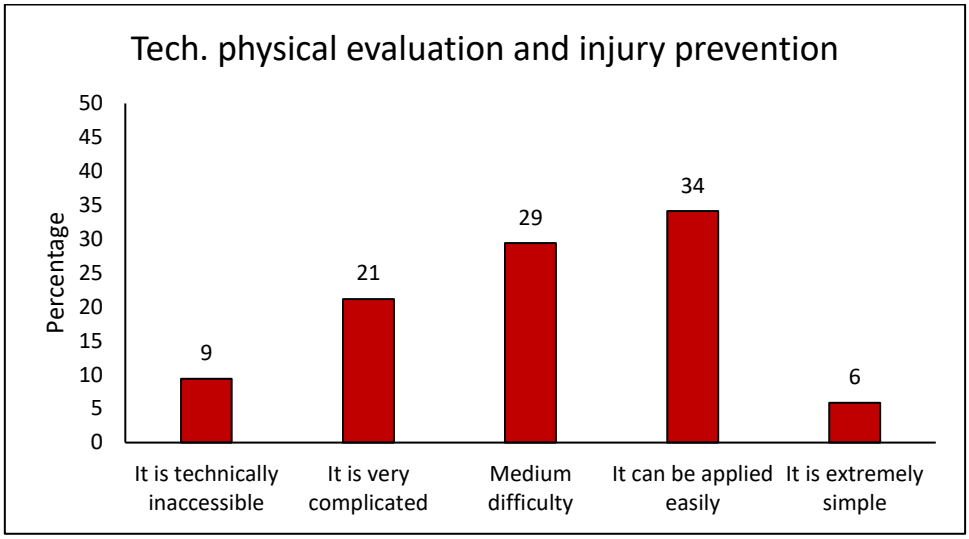
5. What is the level of difficulty that you associate with the use of each technology effectively in your club or sport entity?

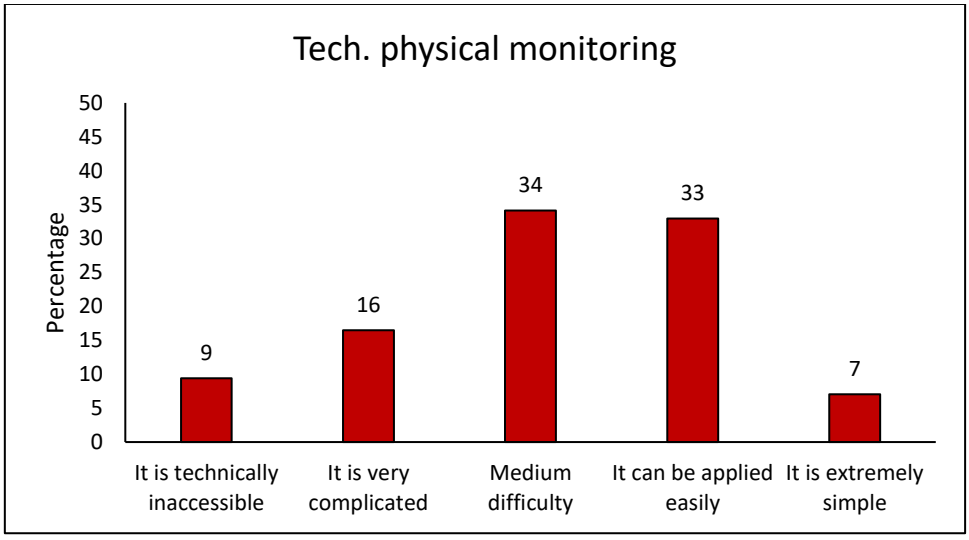
The results obtained provide us that around 32-52% consider that technology can be applied easily. Otherwise, between 18-35% believe that applied technology is medium difficulty, except data analysis and reporting and visualization, where most of respondents think that is easily applicable. While for 5-13% the application of these technologies is technically inaccessible.

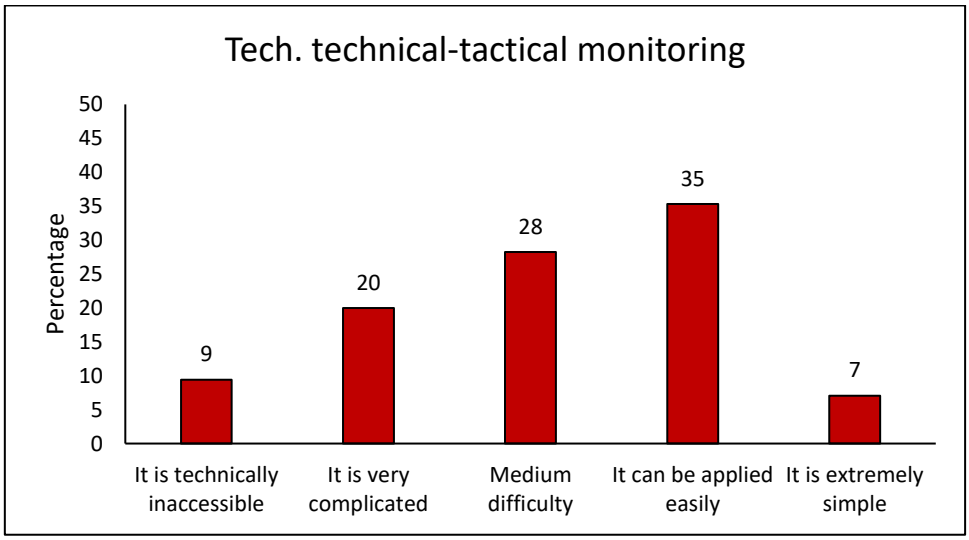

Tech. club or entity management
Percentage
75
60
45
30
15
0
7
8
25
52
8
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple

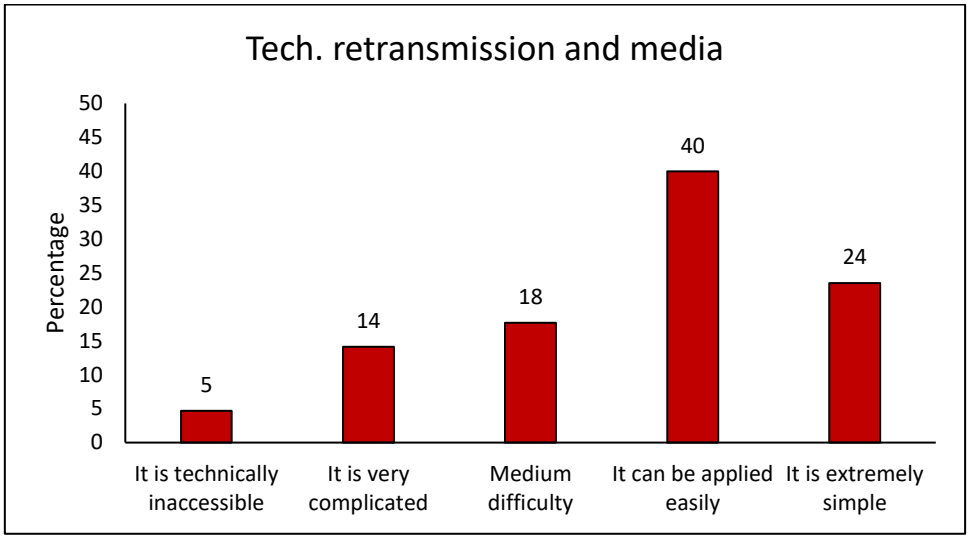

Tech. data analysis
Percentage
50
45
40
35
30
25
20
15
10
5
0
13
27
26
32
2
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple


Tech. reporting and visualization
Percentage
50
45
40
35
30
25
20
15
10
5
0
13
14
35
35
2
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple


Tech. physical evaluation and injury prevention
Percentage
50
45
40
35
30
25
20
15
10
5
0
9
21
29
34
6
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple

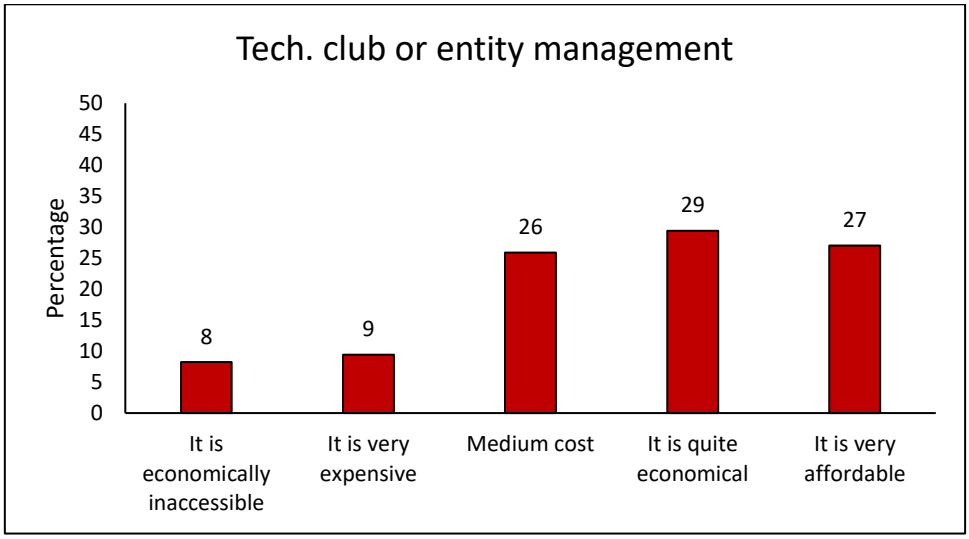

Tech. physical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
9
16
34
33
7
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple

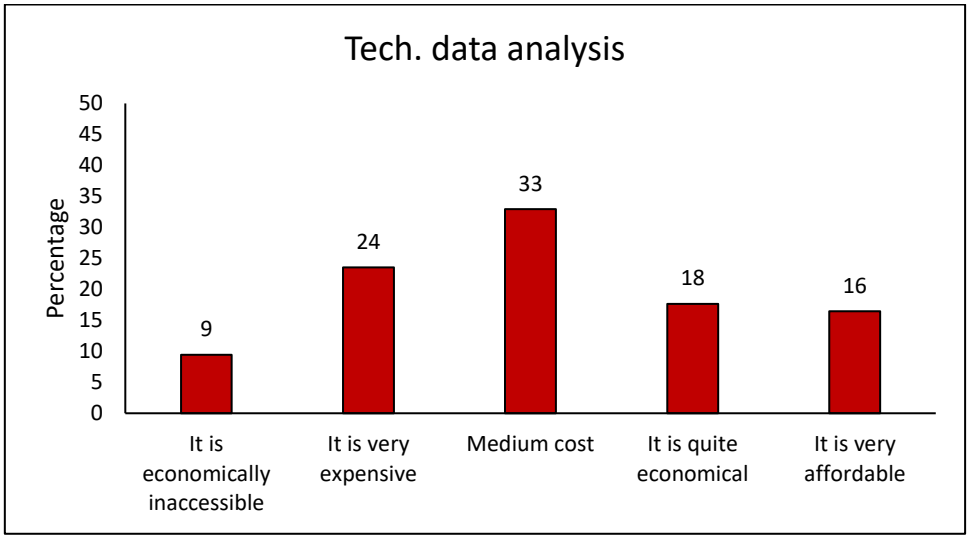

Tech. technical-tactical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
9
20
28
35
7
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple

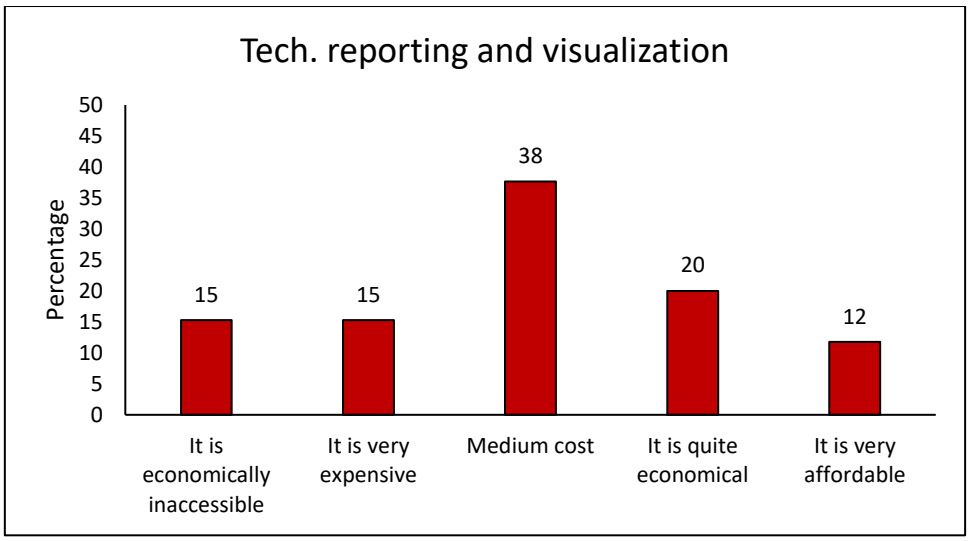


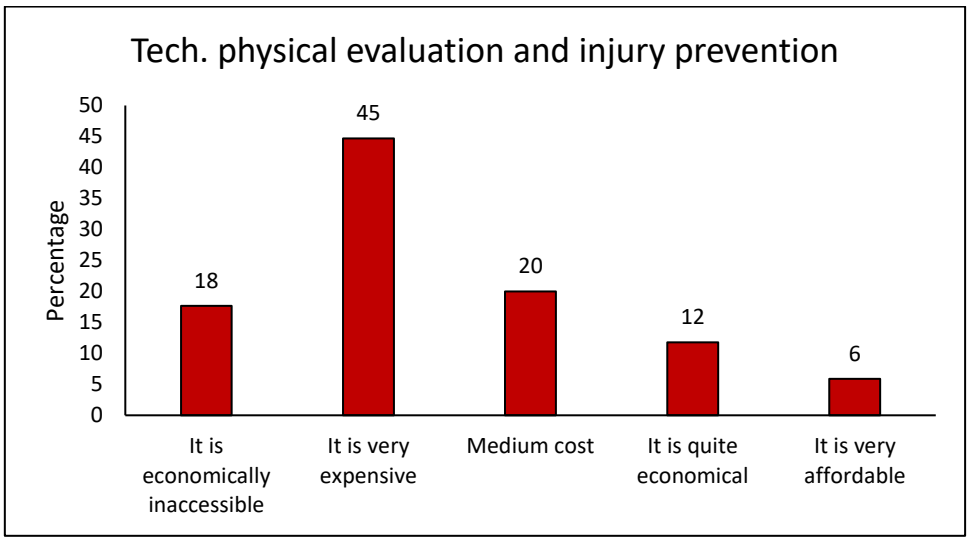
6. Based on your knowledge. How accessible is each technology, economically speaking, for your club or sport entity?

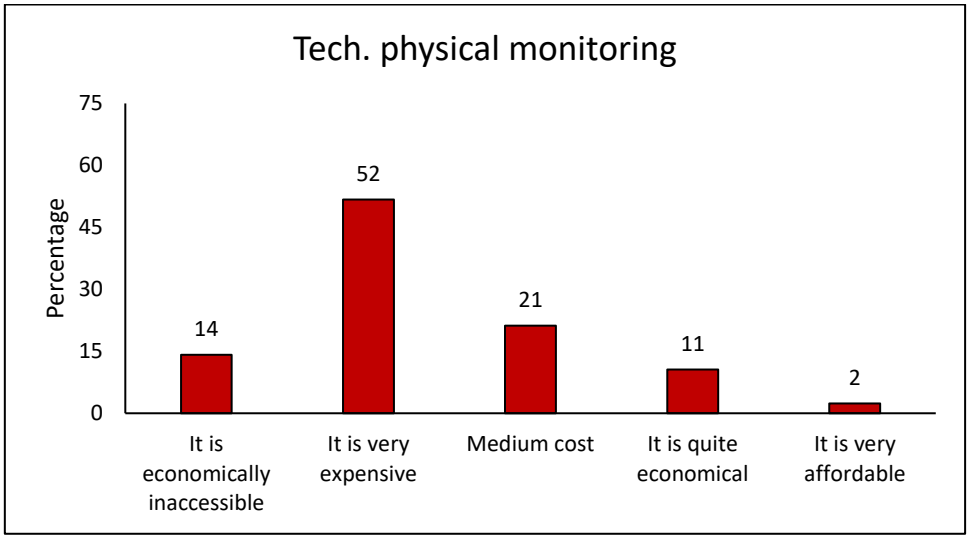
There is a great diversity regarding the cost of technology implementing. The results obtained show that physical evaluation and injury prevention, physical monitoring and technical-tactical monitoring consider applying technology very expensive (39-52%). However, for data analysis, reporting and visualization and retransmission and media to apply technology is medium cost (31-38%). Reporting club or entity management technology do not show any irregularity between their sections.

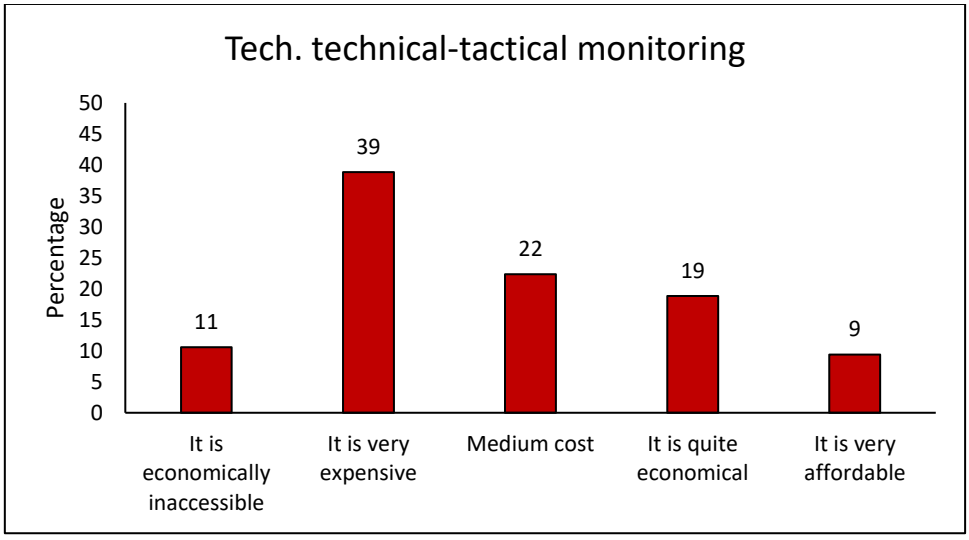


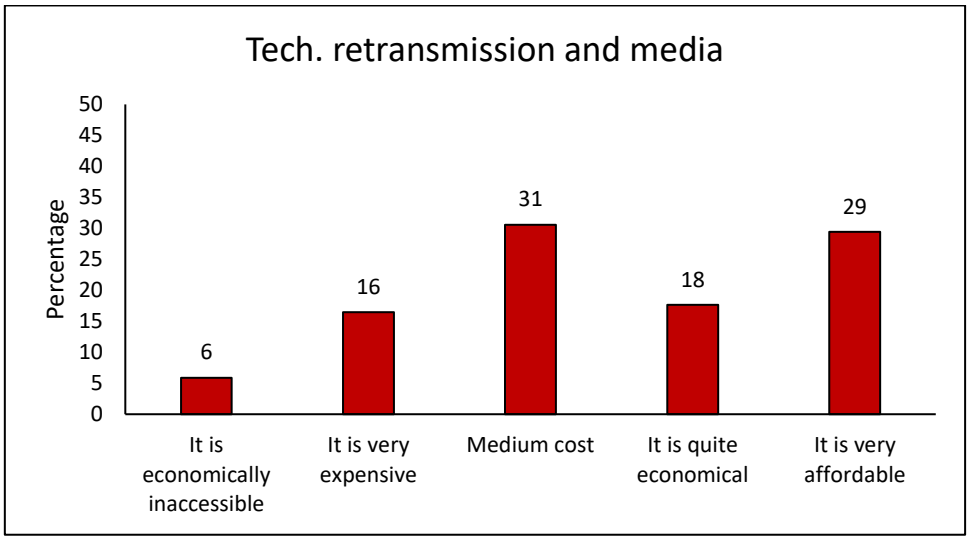

Tech. data analysis
Percentage
50
45
40
35
30
25
20
15
10
5
0
9
24
33
18
16
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very affordable


Tech. reporting and visualization
Percentage
50
45
40
35
30
25
20
15
10
5
0
15
15
38
20
12
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very affordable


Tech. physical evaluation and injury prevention
Percentage
50
45
40
35
30
25
20
15
10
5
0
18
45
20
12
6
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very affordable

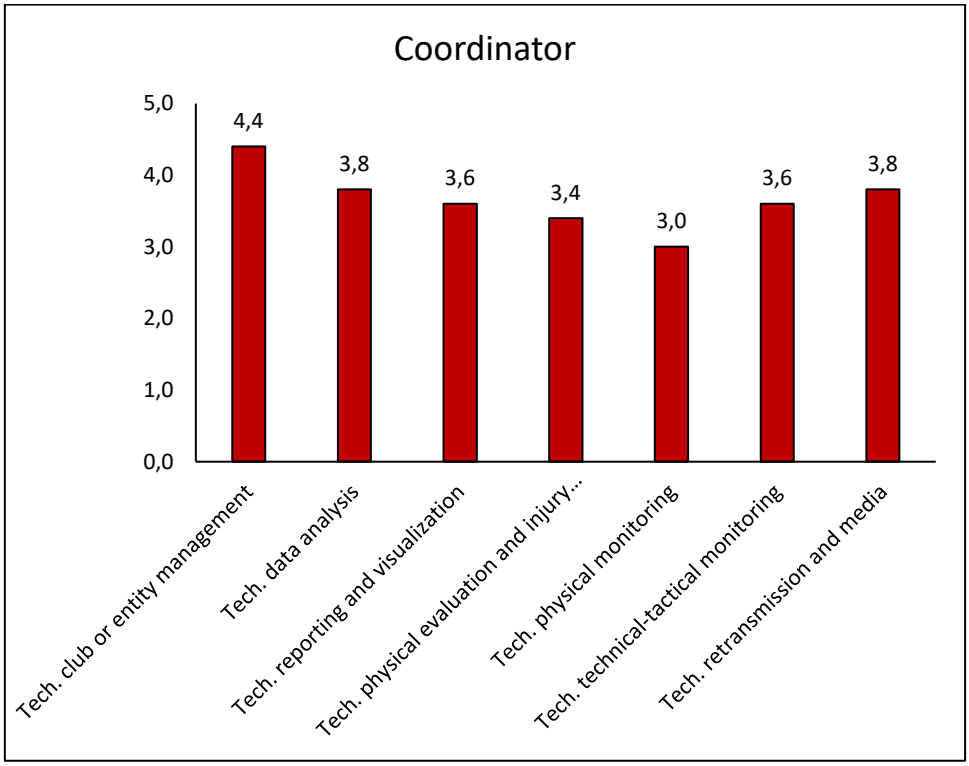

Tech. physical monitoring
Percentage
75
60
45
30
15
0
14
52
21
11
2
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very affordable

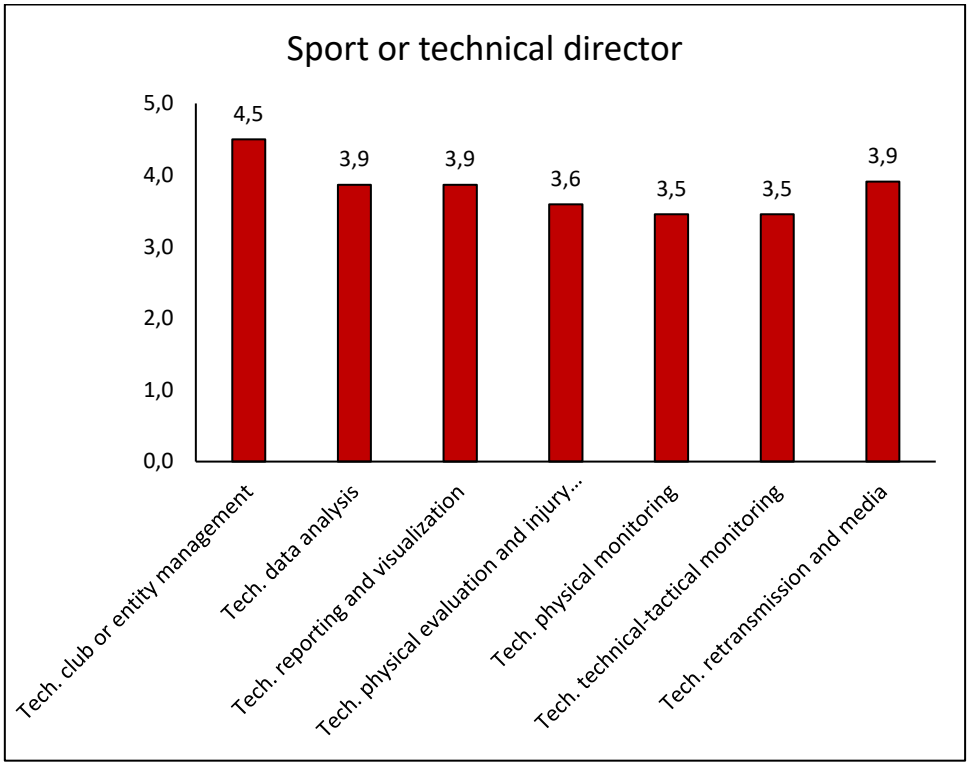

Tech. technical-tactical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
11
39
22
19
9
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very affordable

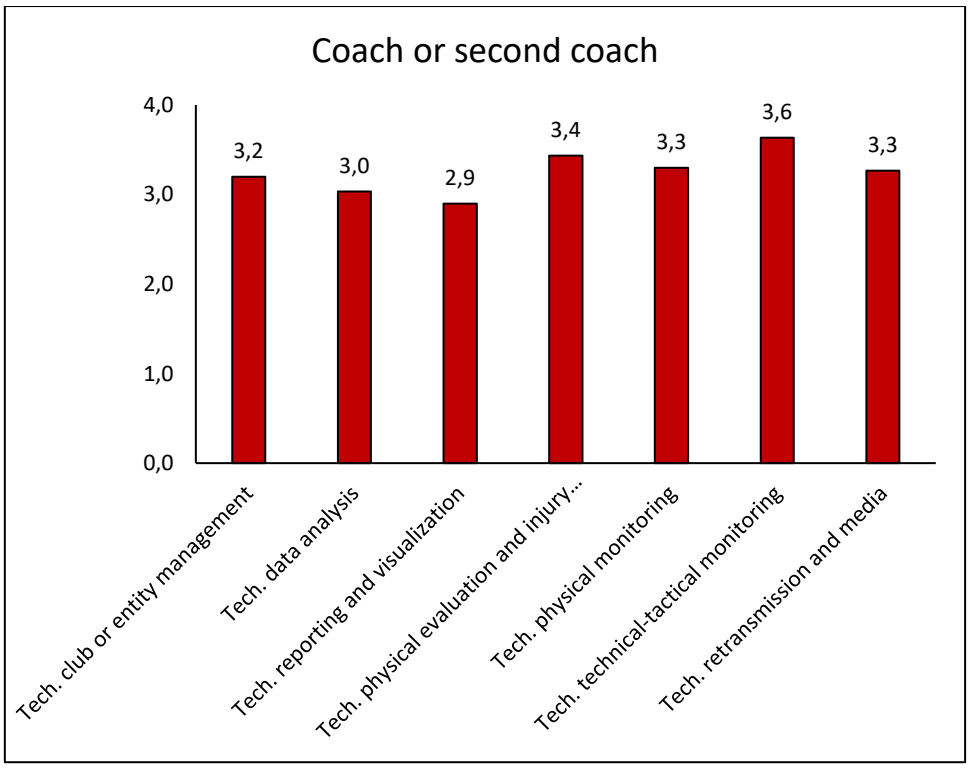

Tech. retransmission and media
Percentage
50
45
40
35
30
25
20
15
10
5
0
6
16
31
18
29
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very affordable

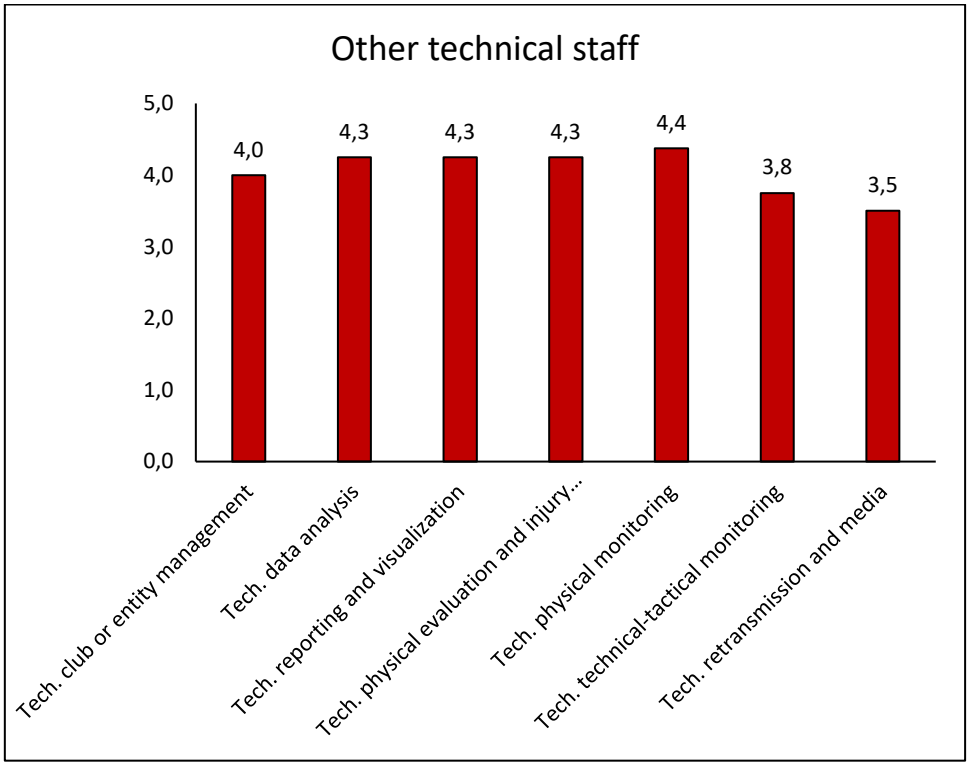
7. How important is each of these technologies for your current position within the club or sport entity?

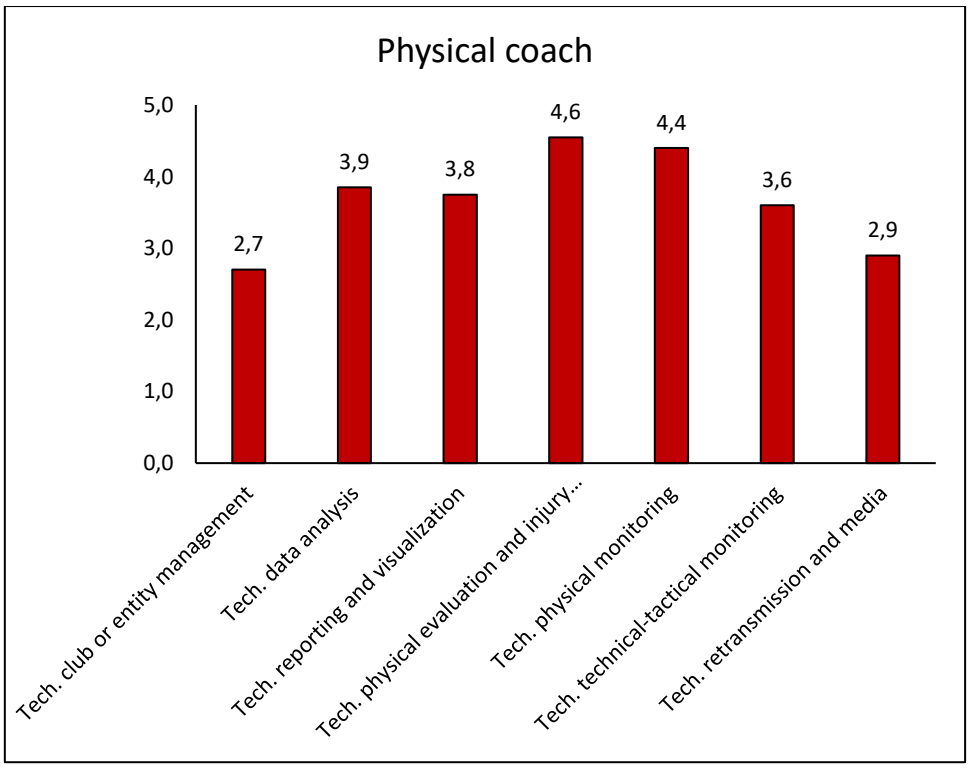
The graphs above show the importance of the use of technologies depending on the current position in a club or sports entity. For the coordinator and sport or technical director of Spain, tech. club or entity management is the most important for their current position. The coach or second coach, however, the tech. technical-tactical monitoring stands out above the other technologies. Like for the physical coach, who determine the tech. physical monitoring and evaluation and injury prevention as the most important. In turn, other technical staff value techs. do not show any irregularity between their sections which the tech. retransmission and media are the least important.




Sport or technical director
5,0
4,0
3,0
2,0
1,0
0,0
4,5
3,9
3,9
3,6
3,5
3,5
3,9
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media

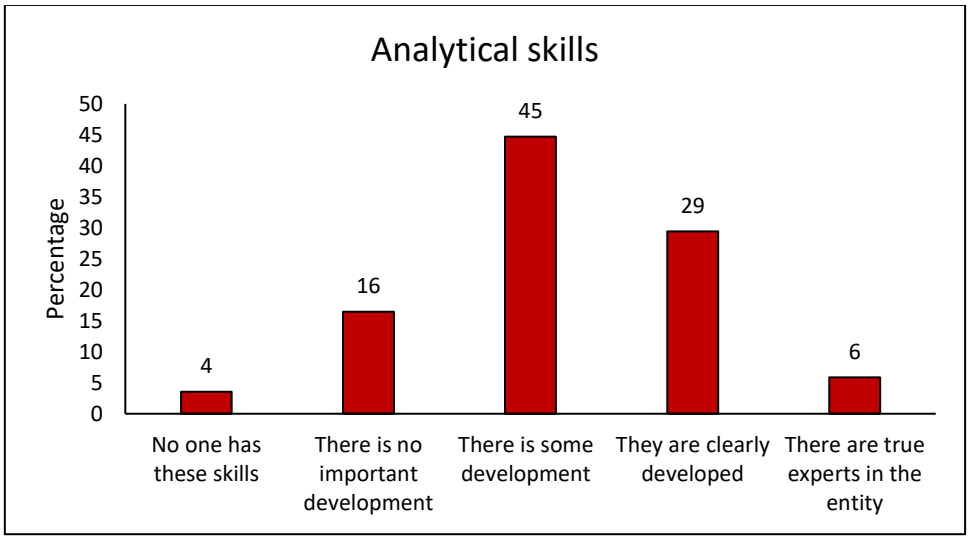

Coach or second coach
4,0
3,0
2,0
1,0
0,0
3,2
3,0
2,9
3,4
3,3
3,6
3,3
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media

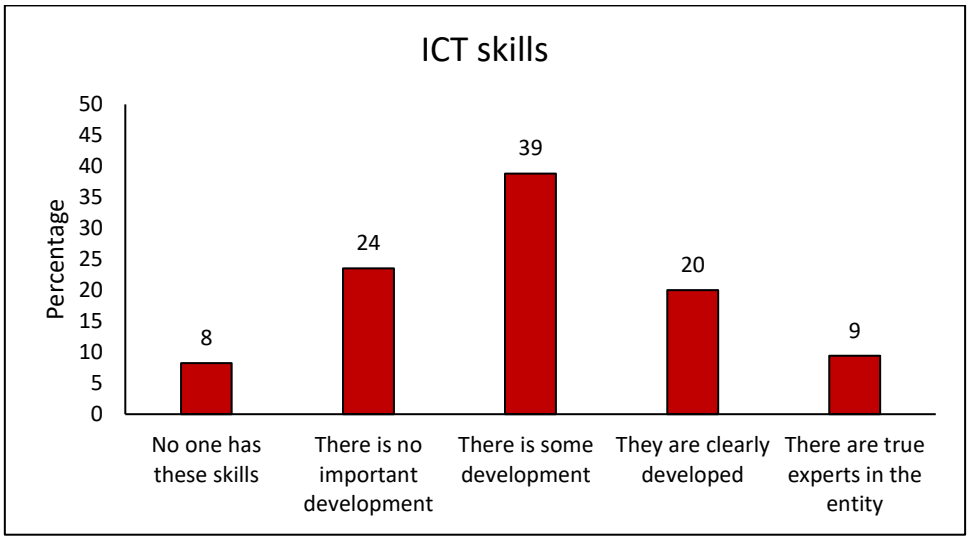

Other technical staff
5,0
4,0
3,0
2,0
1,0
0,0
4,0
4,3
4,3
4,3
4,4
3,8
3,5
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media

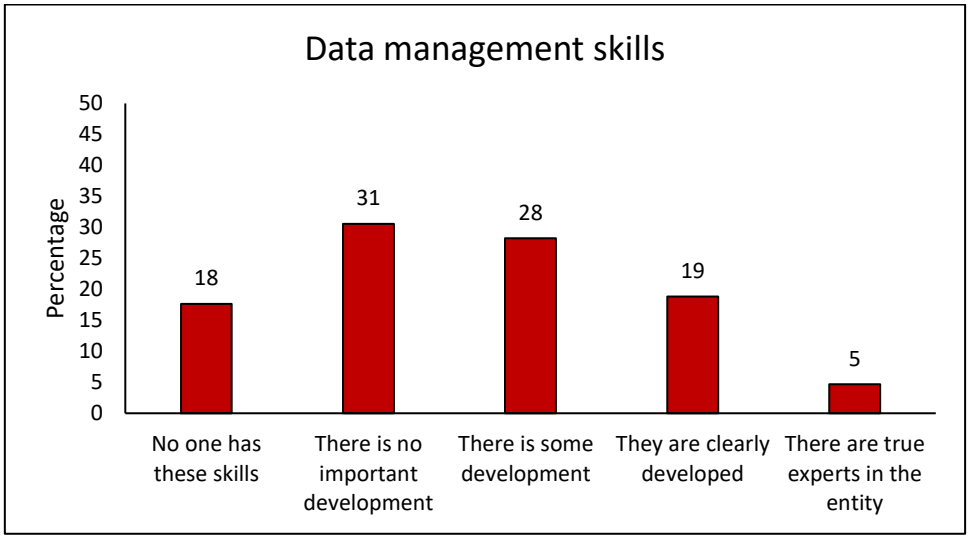

Physical coach
5,0
4,0
3,0
2,0
1,0
0,0
2,7
3,9
3,8
4,6
4,4
3,6
2,9
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media

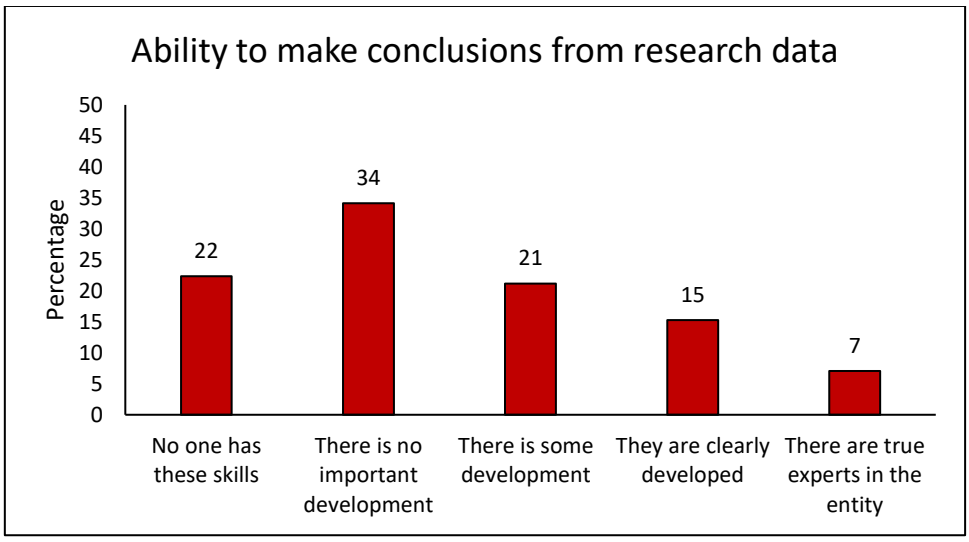
8. How developed are these competencies in your club or sport entity?

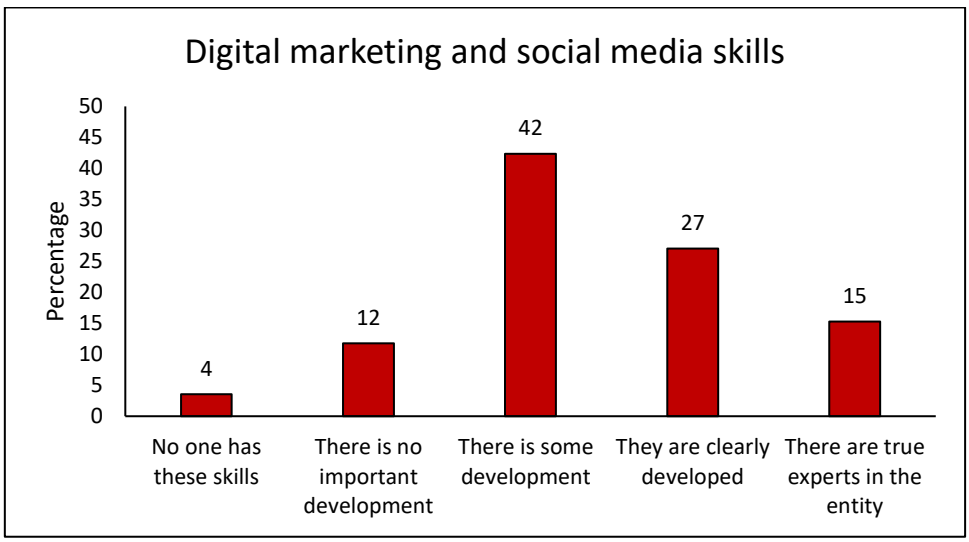
The graphics show that around 39-45% believe that competences in their entities are some developed. Except the ability to make conclusions from research data and data management skills that consider it is no important development (31-34%). In addition, only 39% show no one has skills in digital management of Big data and only 5-15% believe that there are true experts in the entity.

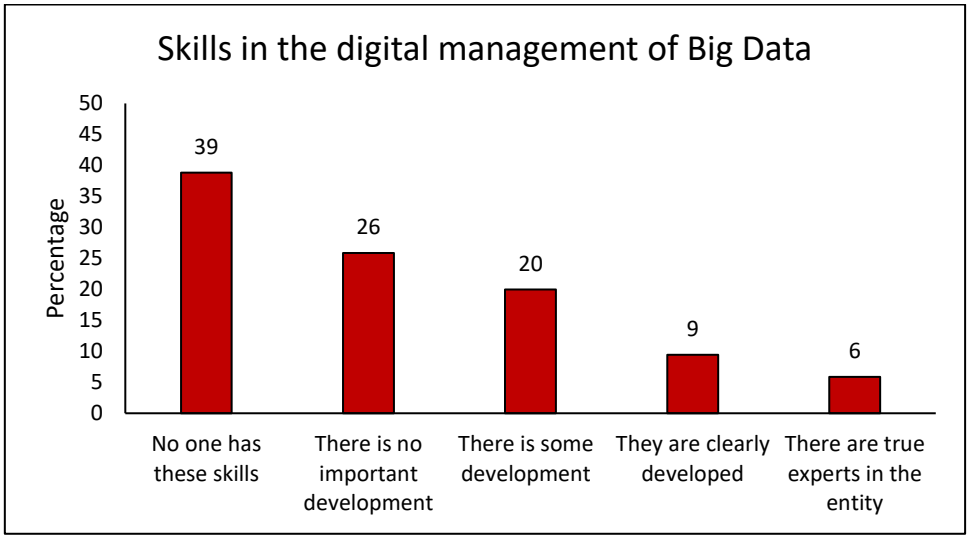





Data management skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
18
31
28
19
5
No one has these skills
There is no important development
There is some development
They are clearly developed
There are true experts in the entity

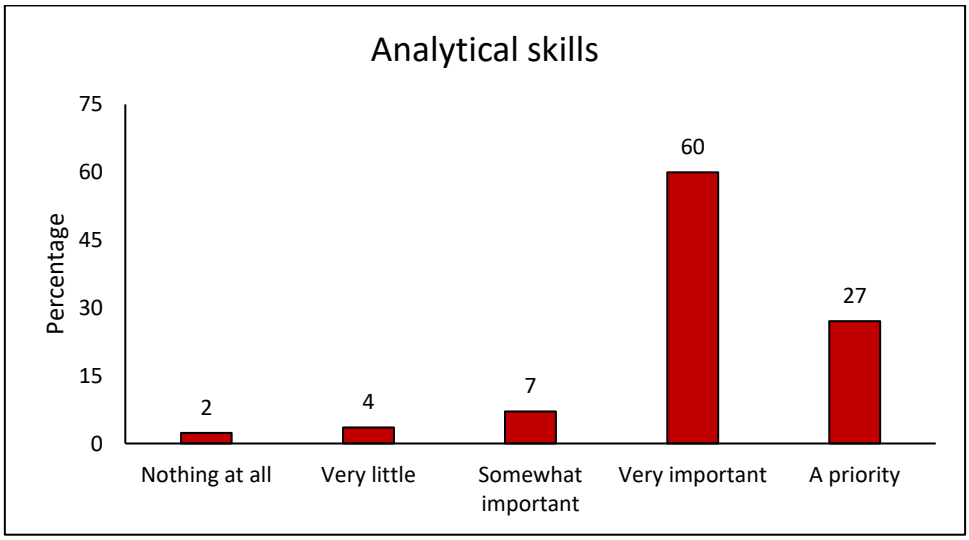

Ability to make conclusions from research data
Percentage
50
45
40
35
30
25
20
15
10
5
0
22
34
21
15
7
No one has these skills
There is no important development
There is some development
They are clearly developed
There are true experts in the entity

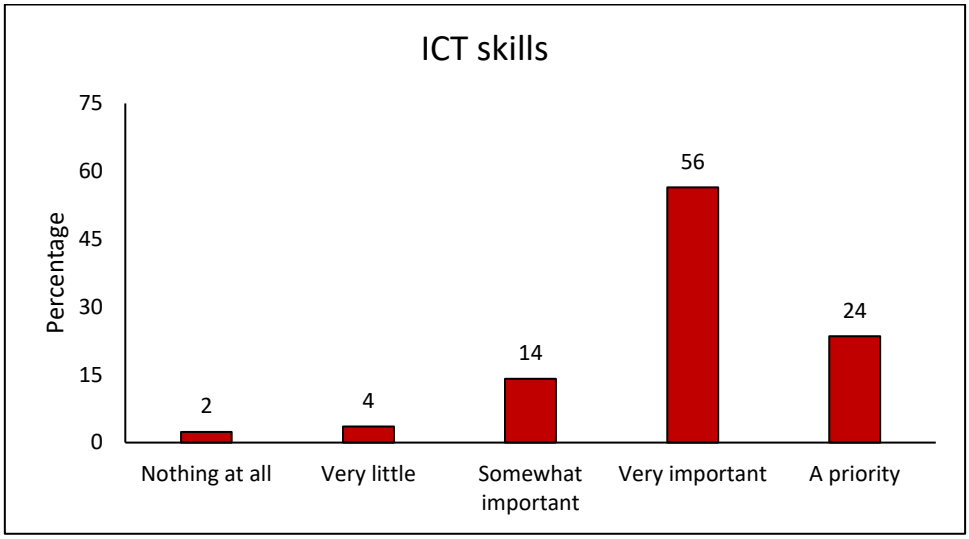

Digital marketing and social media skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
4
12
42
27
15
No one has these skills
There is no important development
There is some development
They are clearly developed
There are true experts in the entity

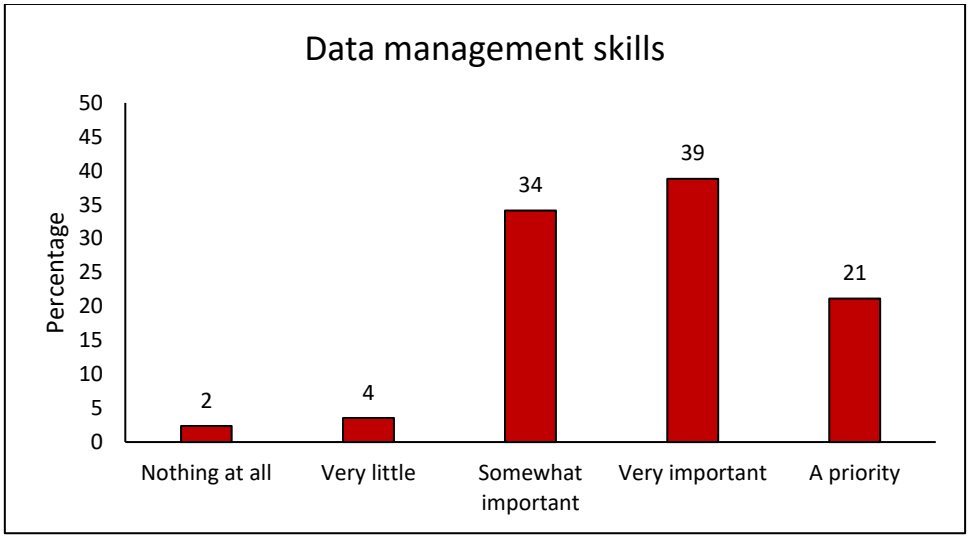


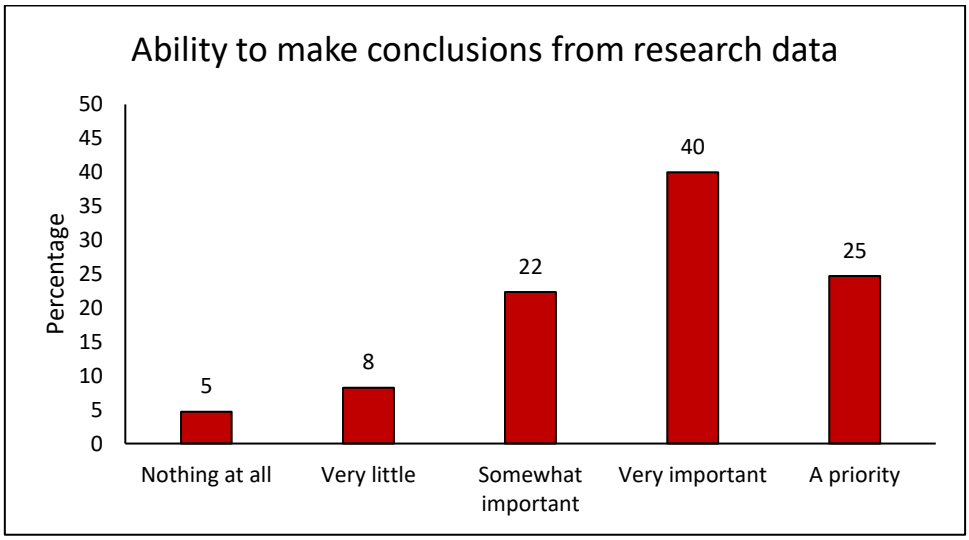
9. How important do you think these professional skills are in your club or sport entity?

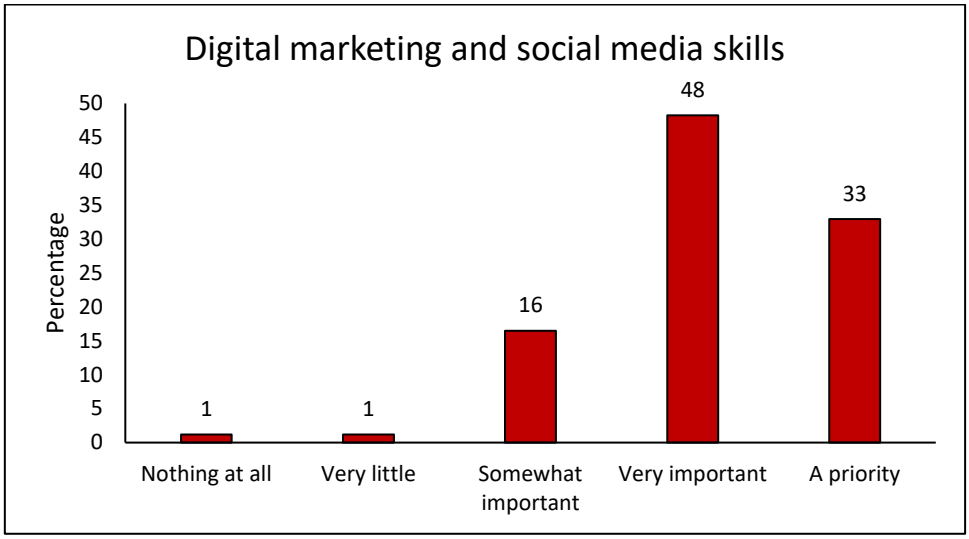
The charts show that between 27-60% believe that the use of these professional skills is very important. In addition, between 2-9% consider that Skills in general are not important at all. Generally, sports clubs or entities believe it is very important or a priority to acquire these skills from their staff.

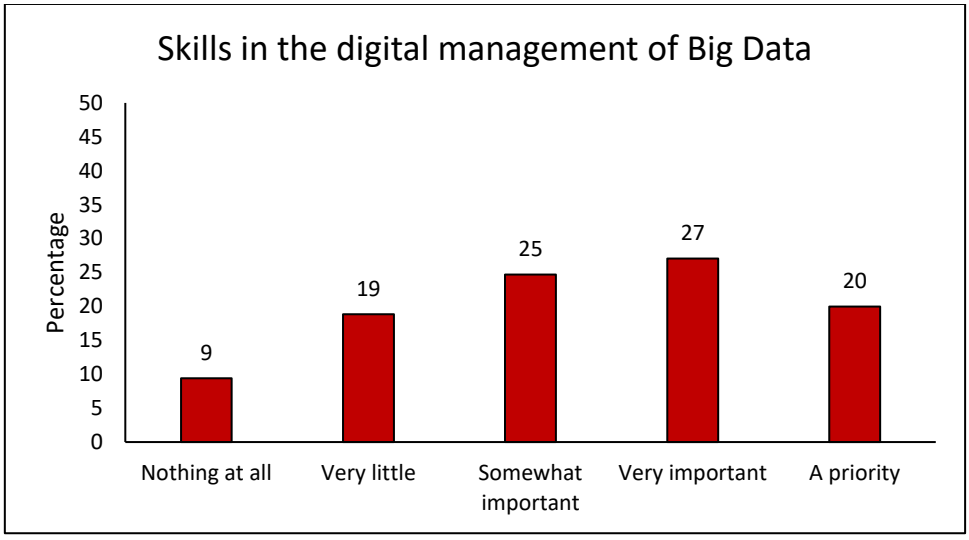



ICT skills
Percentage
75
60
45
30
15
0
2
4
14
56
24
Nothing at all
Very little
Somewhat important
Very important
A priority


Data management skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
2
4
34
39
21
Nothing at all
Very little
Somewhat important
Very important
A priority

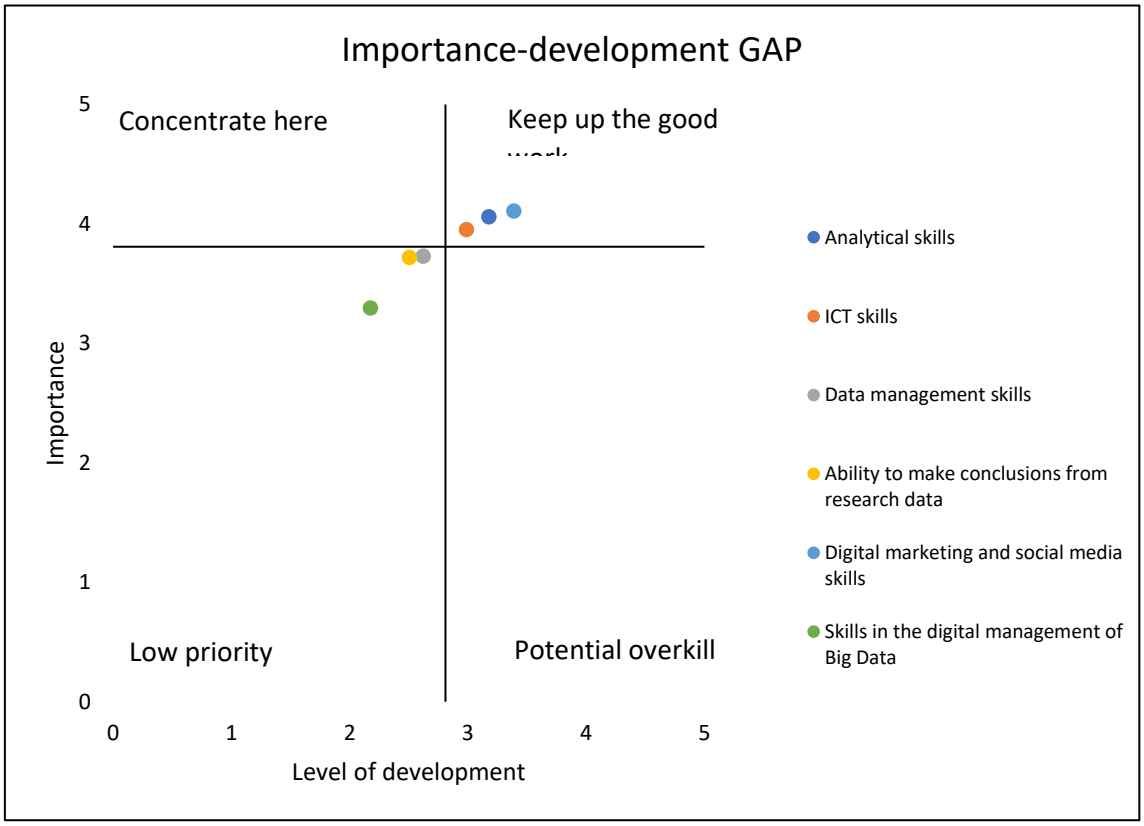

Ability to make conclusions from research data
Percentage
50
45
40
35
30
25
20
15
10
5
0
5
8
22
40
25
Nothing at all
Very little
Somewhat important
Very important
A priority





10. GAP analysis between development and importance of technological competences

In this graph that we observe based on the responses of sports managers in Spain, it follows that analytical skills, ICT skills and digital marketing and social media skills have a high degree of importance and level of development, therefore, they must be maintained. The skills in the data management skills and ability to make conclusions from research data are of low importance, but little use, so they require further development. Finally, the skill in digital management of big data has little use and low importance, therefore they are not a priority for managers in Spain.



11. Discussion of results

Most of the technicians surveyed work in sports clubs. In this regard, Spain has a centuries-old tradition of greater sports clubs with respect to sports associations, with the clubs being highly integrated into society. Sports clubs and associations have offered more comprehensive services than training and competition, such as recreation and leisure, and in some cases the fitness area. For this reason, it is not surprising that the highest percentage of responses came from principal and assistant coaches.

Regarding data on the use of technologies (Q2), it appears that there is constantly use of technologies. This fact may be due to the fact that each time, the different technical staff of clubs and associations use more and more new technologies in a way that makes their work easier and increases the athlete's performance.

In fact, about the importance of using technologies (Q3) by the institution, responses ranged between 35 and 44% (very important / a priority). However, somewhat important responses varied between 2 and 5%, which is not possible to ignore. The data indicate that there is no more dense use of technologies due to the economic

part (Q6), although the respondents have shown availability, if any, to use it. If we look closely, the technicians indicated that most technology is expensive, ranging from medium cost to inaccessible. These responses ranged from 39 to 52%, indicating that the democratization of technology depends mainly on the cost of acquisition/use.

Highlighting this fact is the indication that the use of technology is easy to apply (Q5), varying between 32 and 52%. This response reinforces the idea that the use of technology is not possible, for the most part, because it is not economically accessible. Some technicians replied that its use is difficult, varying from 18 to 35%, which is not negligible, thus requiring periods of preparation and training.

The answers about the importance of using technologies for the current position were specific (Q7). It appears that the specificity and higher responses in certain areas, we could see that the responses are frankly positive (above 3.5), indicating that, regardless of position, everyone considers the use of technology important.

Interestingly, concerning the skills for using technology (Q8), most of the answers focused on intermediate values. However, moving towards the importance attributed to these competencies (Q9), the curve shifts to the right, with the highest percentage of response in the somewhat important / a priority (27-60%), indicating a GAP between reality and the desirable.

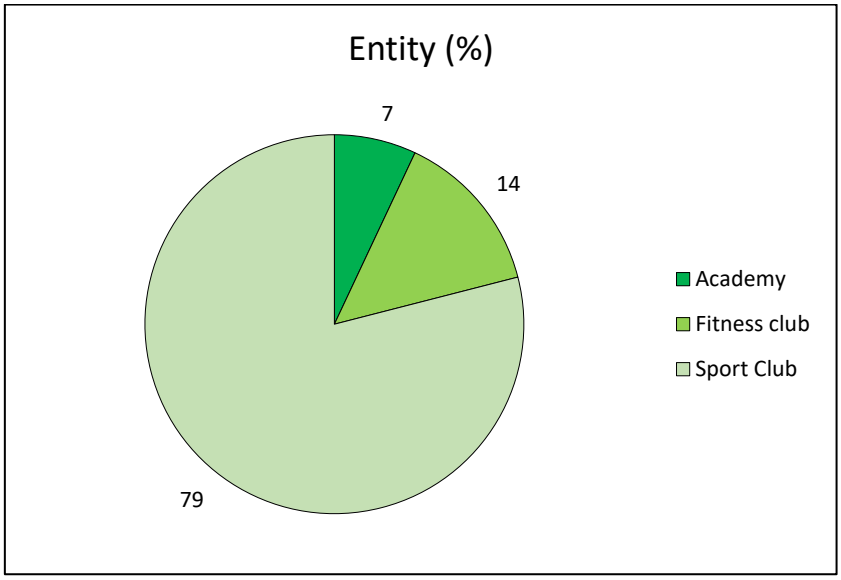
12. Conclusions

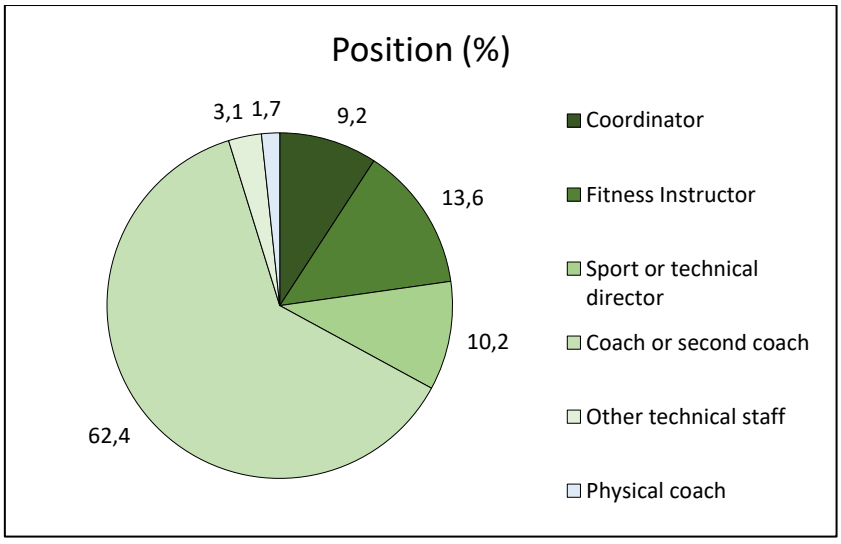
Most technicians do not have the technology available in their clubs or institutions, although they consider its use important or even a priority for the specific position they occupy. The economic value of technologies appears to be the biggest obstacle to their extensive use. However, technicians consider that the use of technologies is not difficult and place a high value on the skills necessary for their use, despite considering that the skills are not developed to the same degree of importance. Therefore, sports institutions must make an effort to acquire technologies and, above all, to provide technicians with the necessary skills for its full and effective use and in this way, improve sports performance, club management, among many other actions.

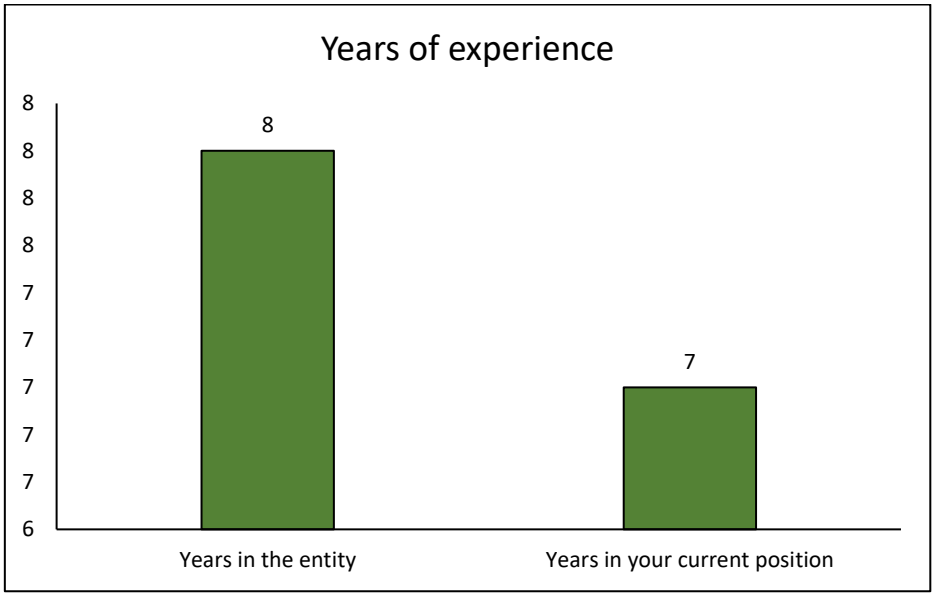
ANEX II. INDIVIDUAL REPORT. QUESTIONARIE PORTUGUESE VERSION, PORTUGAL

1. Sample

The figures show the general characteristics of the sample, depending on the type of entity, position in it and years of experience in the entity and in your current position in %. Sports clubs are the entity that has received the most responses with almost 80%, with coaches and second coaches and the fitness instructor being the positions with the highest number of forms answered. The years of experience in the entities show an average of 8 years, while the years in their current position are less than 7 years.

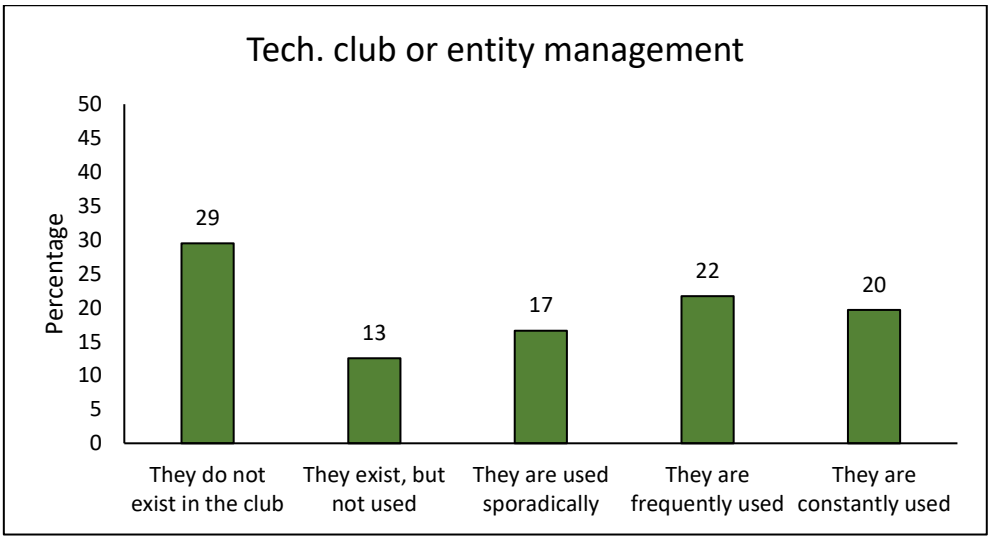


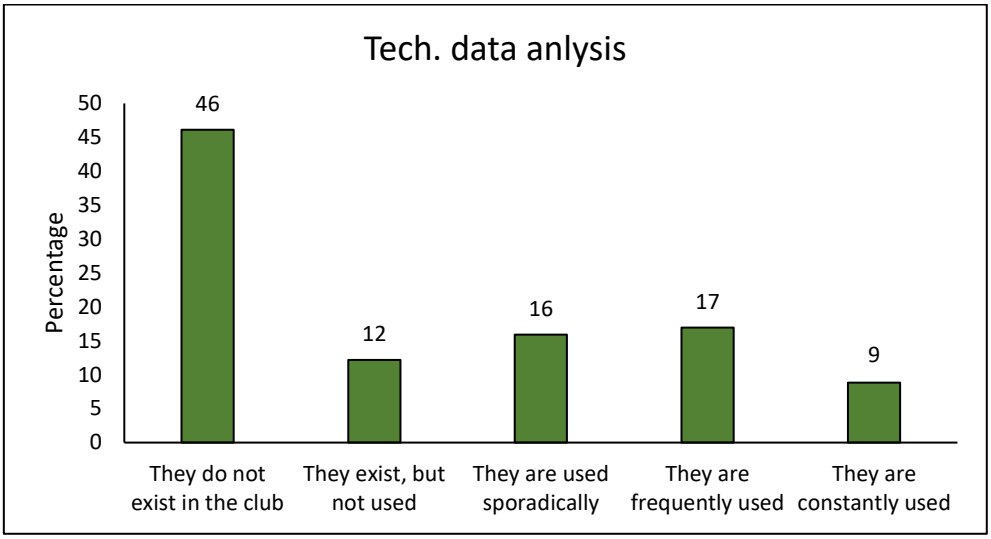


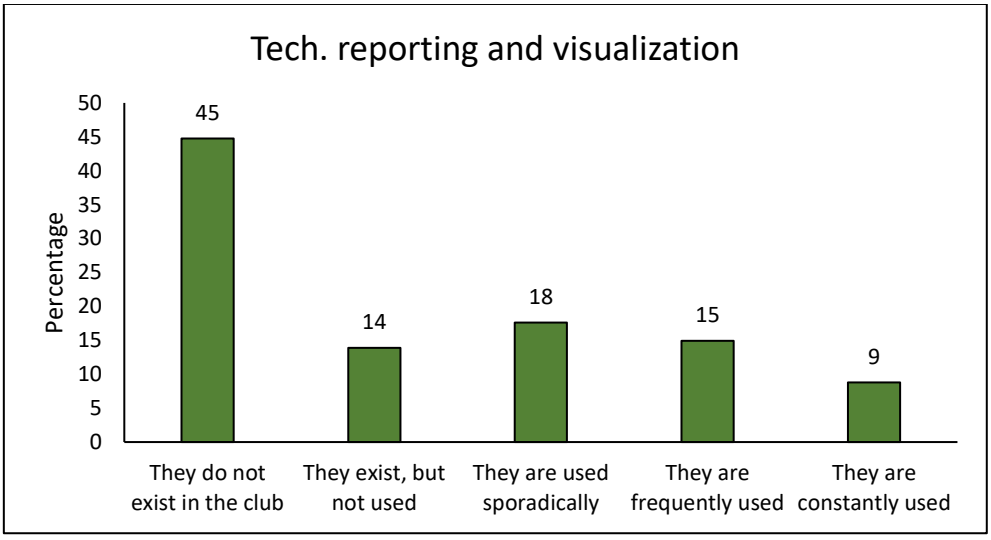


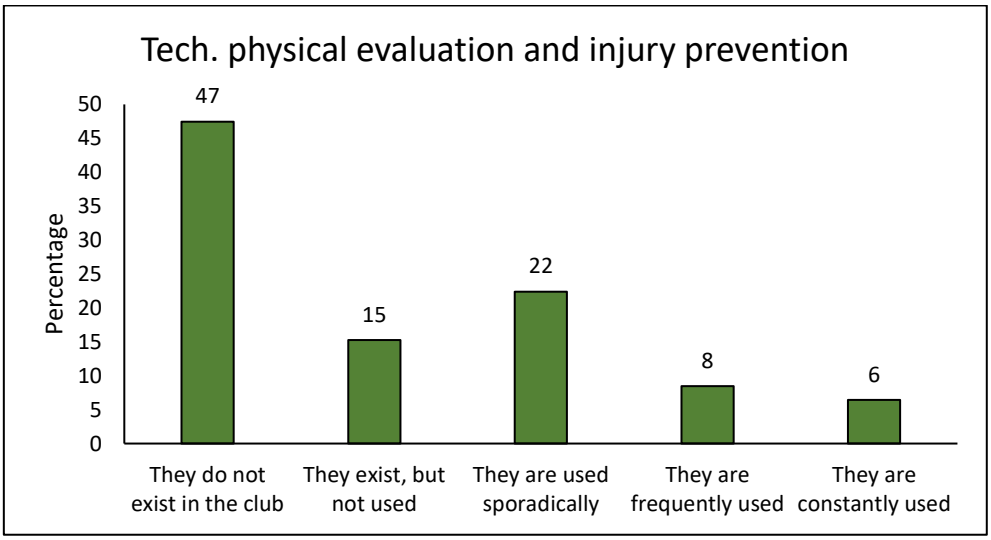
2. To what extent are you currently using these technologies in your club or sport entity?

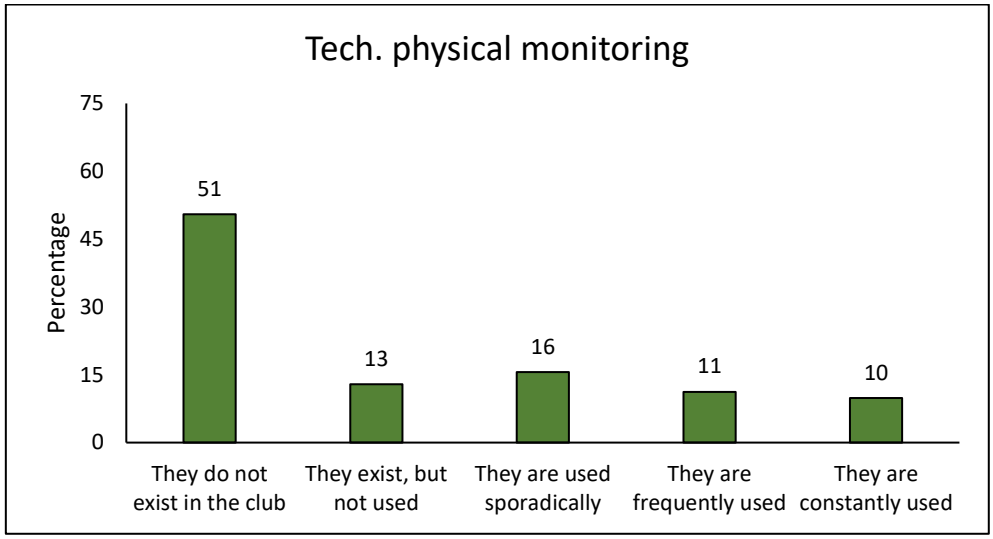
The results of technology utility in different aspects within a club or entity, indicate a greater use of club or entity management technology, still considered low. Regarding the use of data analysis, reporting and visualization technologies, physical evaluation and injury prevention, physical monitoring, technical-tactical monitoring and retransmission and media between 45-50% indicate that they do not exist in your sports club or entity. Very high values that show the lack of technology in sports entities and clubs.

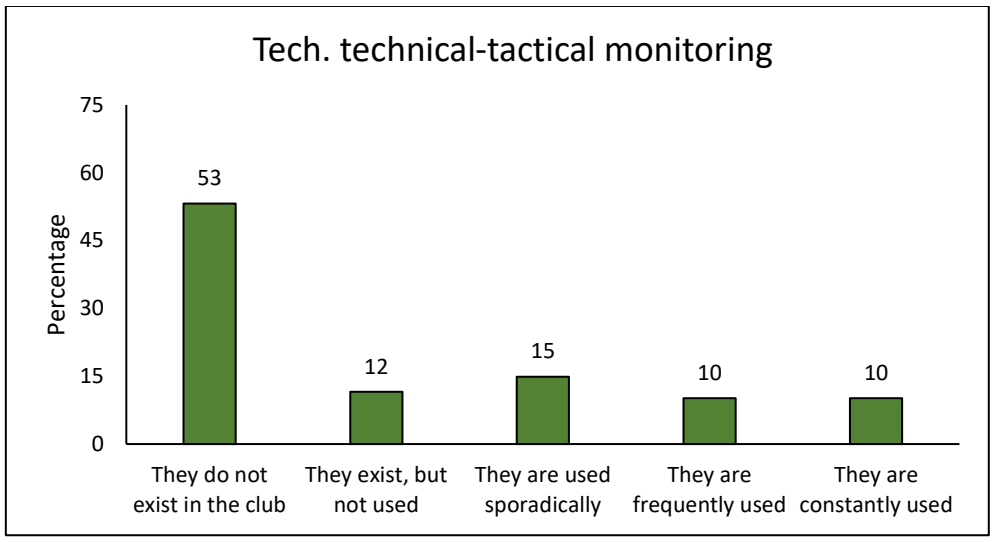


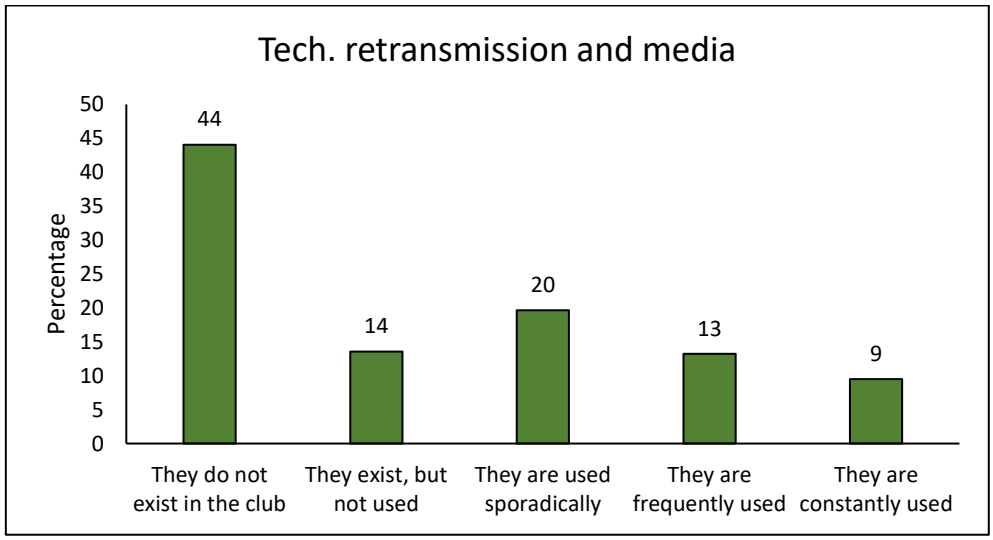

Tech. data anlysis
Percentage
50
45
40
35
30
25
20
15
10
5
0
46
12
16
17
9
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used


Tech. reporting and visualization
Percentage
50
45
40
35
30
25
20
15
10
5
0
45
14
18
15
9
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used


Tech. physical evaluation and injury prevention
Percentage
50
45
40
35
30
25
20
15
10
5
0
47
15
22
8
6
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

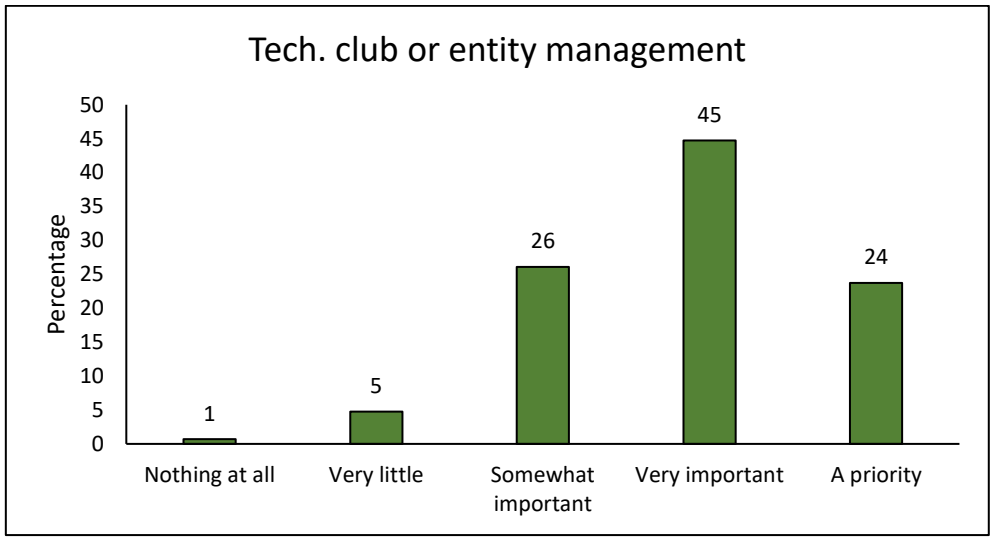

Tech. physical monitoring
Percentage
75
60
45
30
15
0
51
13
16
11
10
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

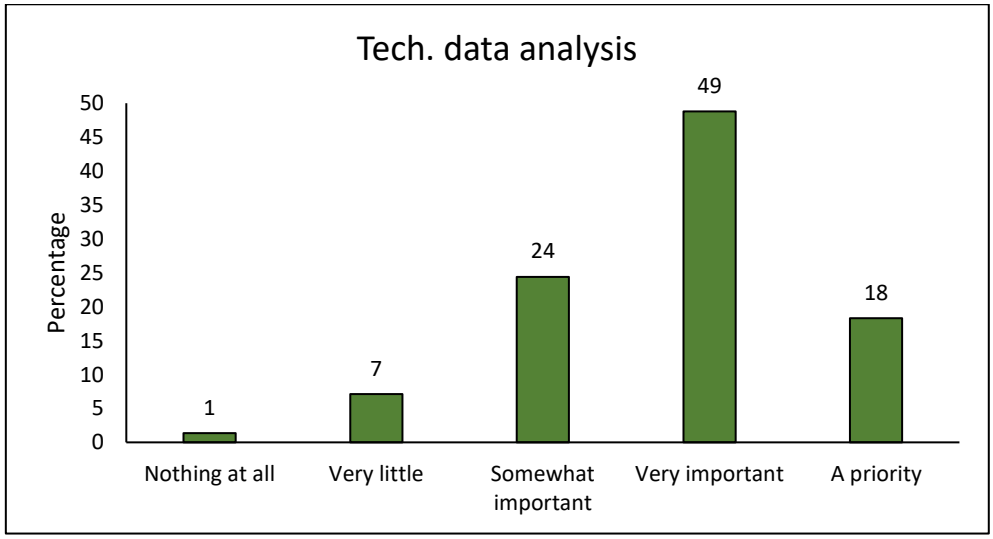

Tech. technical-tactical monitoring
Percentage
75
60
45
30
15
0
53
12
15
10
10
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

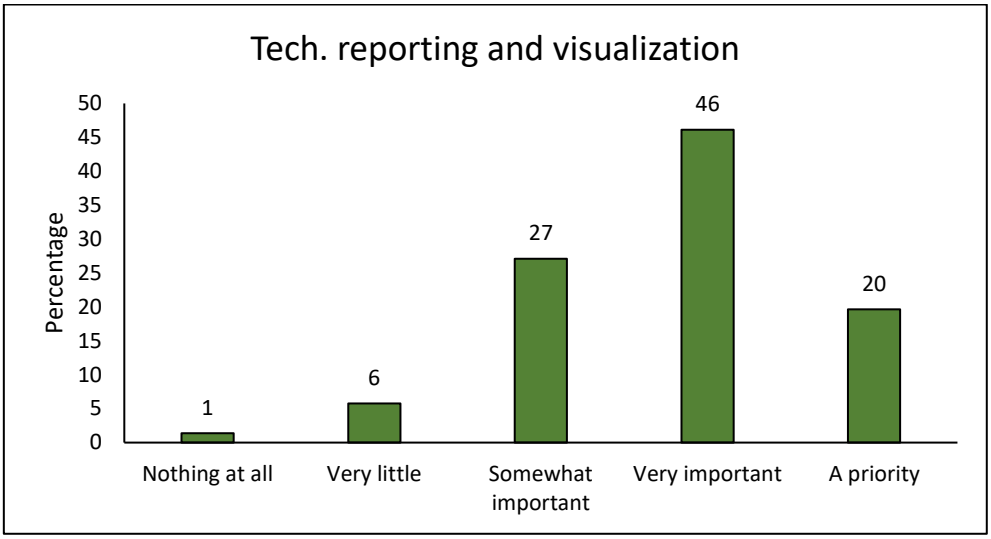

Tech. retransmission and media
Percentage
50
45
40
35
30
25
20
15
10
5
0
44
14
20
13
9
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

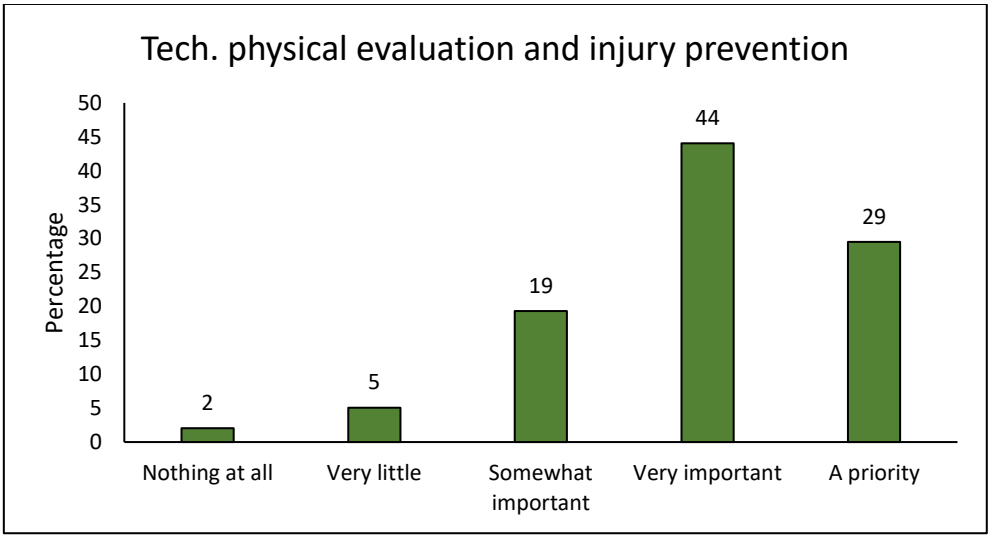
3. How important do you think using these technologies are or would be for your club or sport entity?

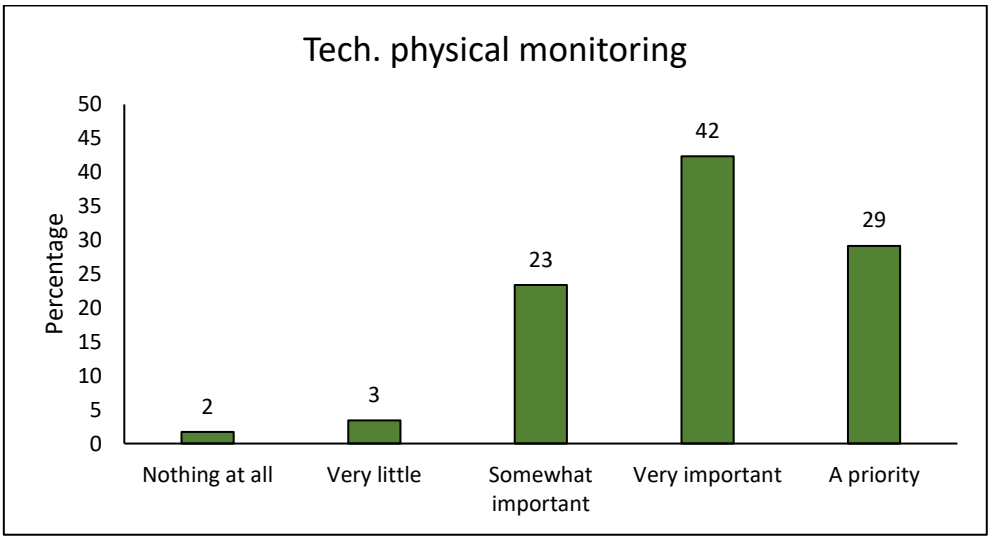
The graphs show us how important they think the use of different technologies is in sports clubs or entities. As can be clearly seen, between 39 - 49% believe that it is very important to have these technologies in their entities or sports clubs. Even 20-30% believe that they should be a priority for the proper development of the activities of the entity or sports club. In general, they believe that the use of these technologies is important or very important in their sports entities or clubs.

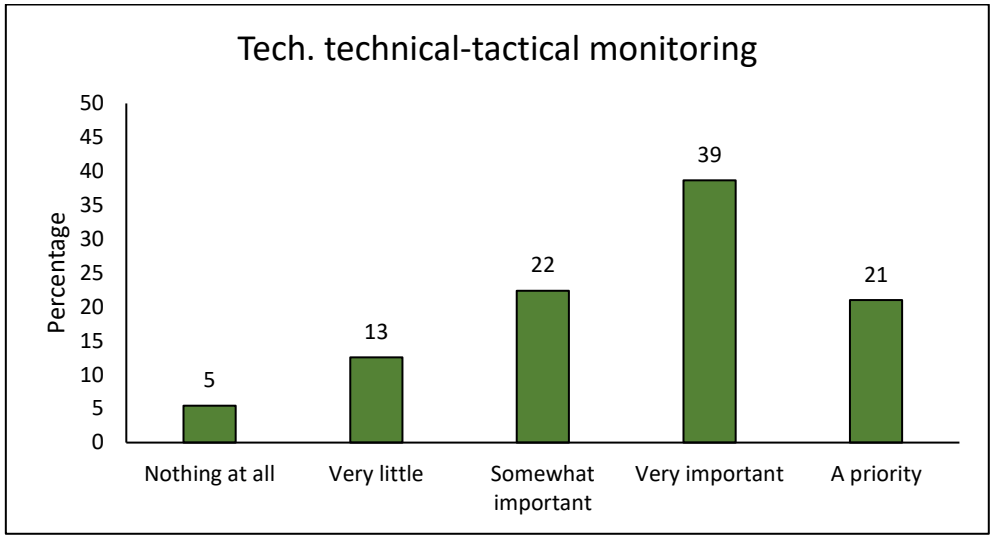


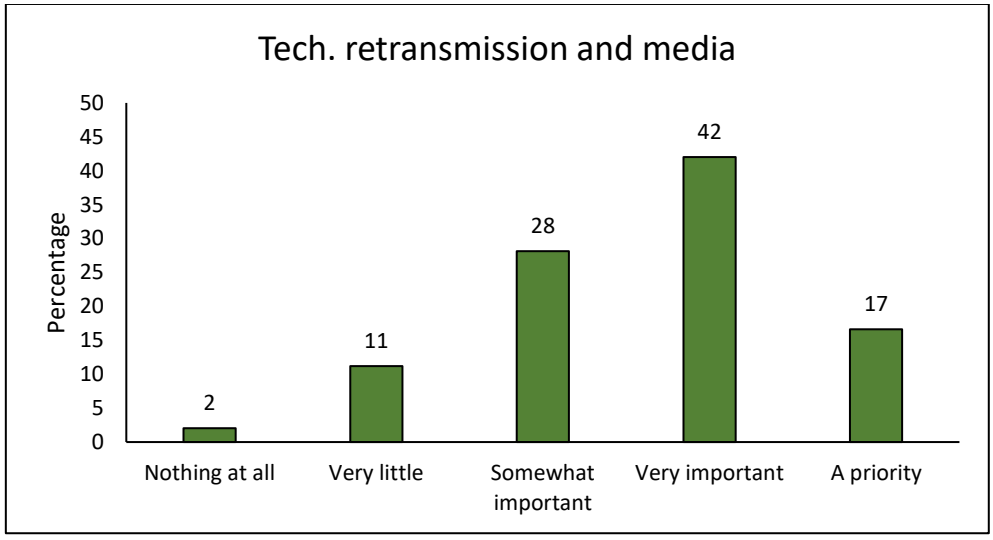



Tech. reporting and visualization
Percentage
50
45
40
35
30
25
20
15
10
5
0
1
6
27
46
20
Nothing at all
Very little
Somewhat important
Very important
A priority


Tech. physical evaluation and injury prevention
Percentage
50
45
40
35
30
25
20
15
10
5
0
2
5
19
44
29
Nothing at all
Very little
Somewhat important
Very important
A priority

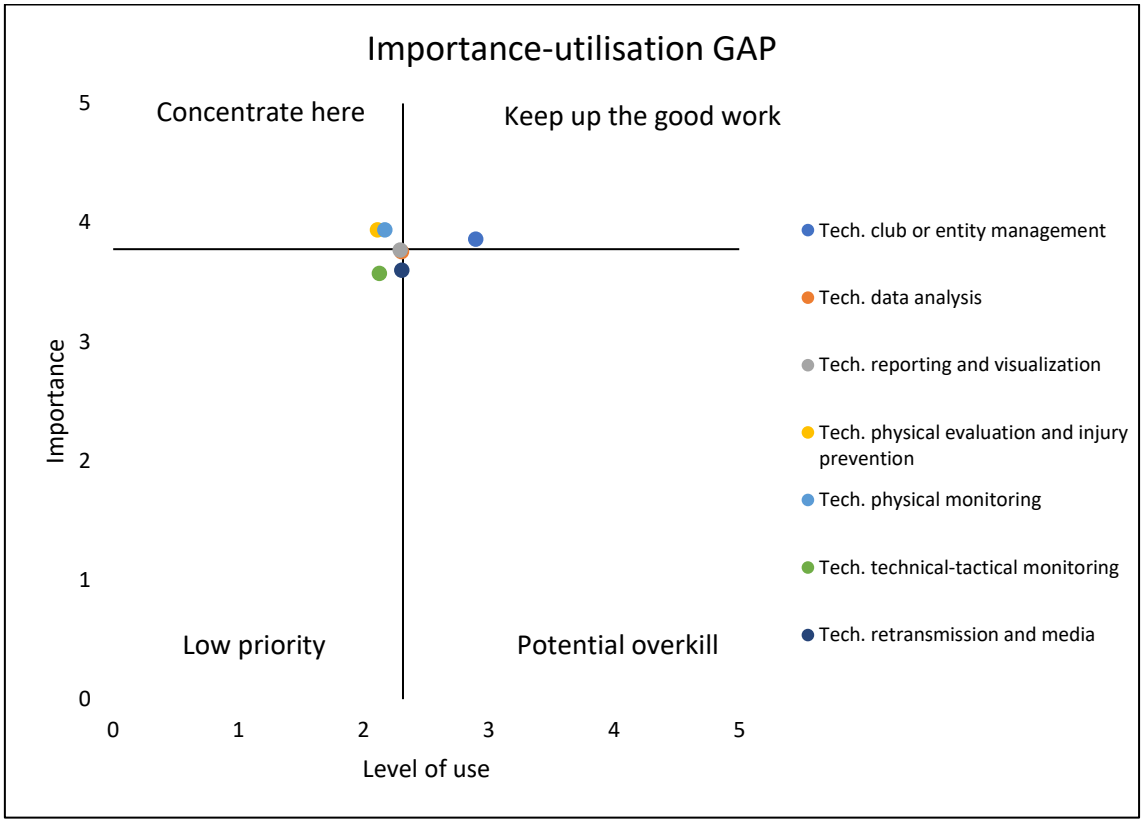

Tech. physical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
2
3
23
42
29
Nothing at all
Very little
Somewhat important
Very important
A priority





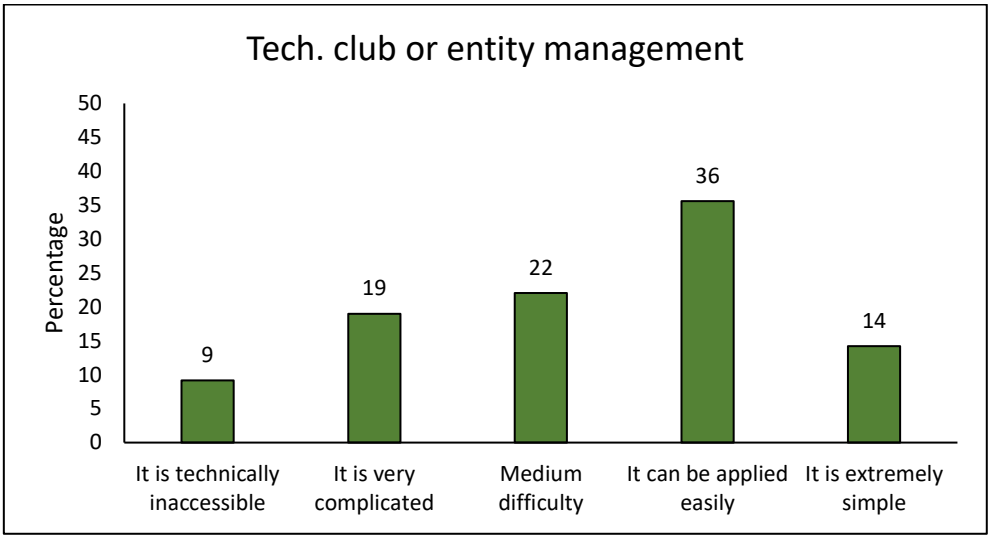
4. GAP analysis between use and importance of technological areas

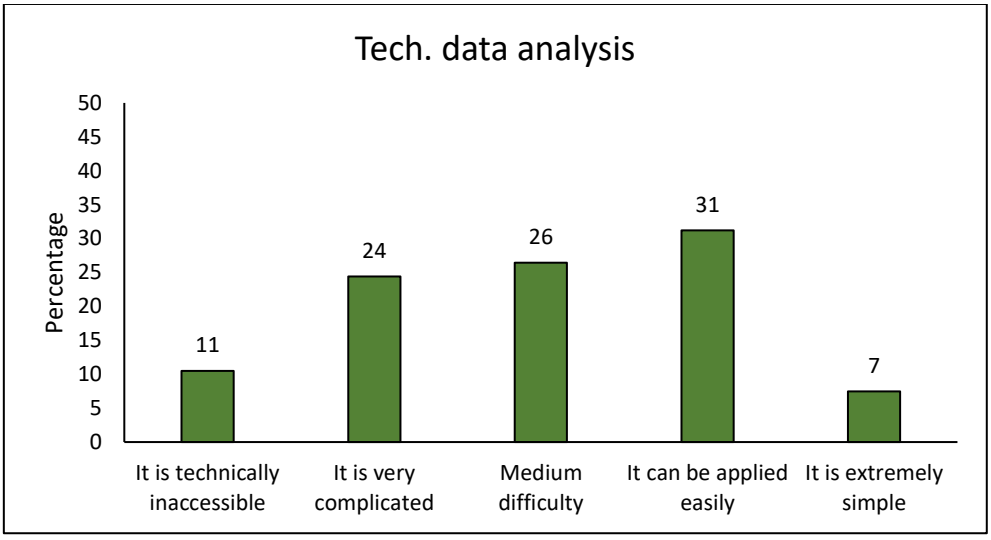
In this graph we observe based on the responses of the sports managers of Portugal, it follows that the Tech. Club or entity management have a high importance and a high use, therefore, it should be maintained. However, Tech. Physicial monitoring and physical evaluation and injury prevention are of high importance, but little use, so they require further development. Finally, the Tech. Technical -tactical monitoring and retransmission and media have little use and little importance, therefore they are not a priority for managers in Portugal.

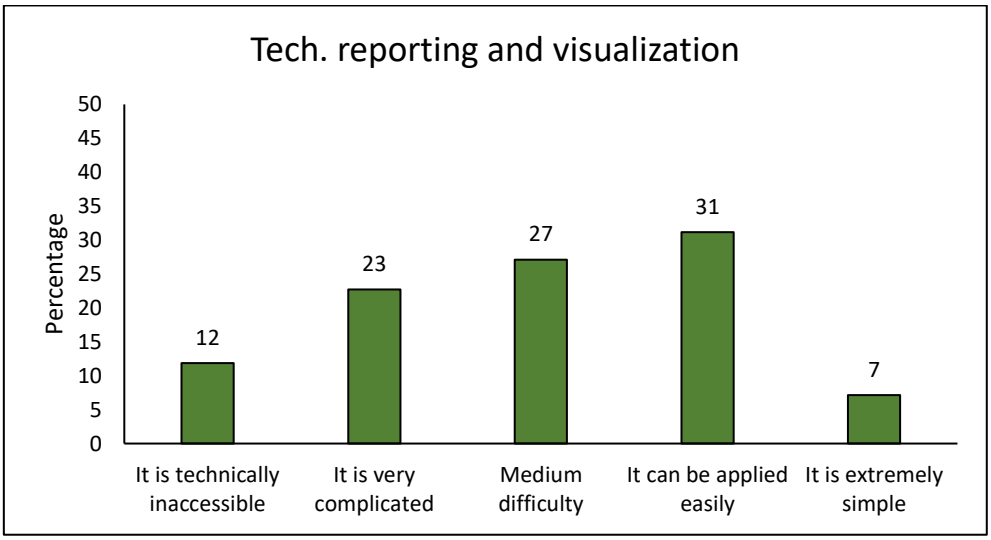


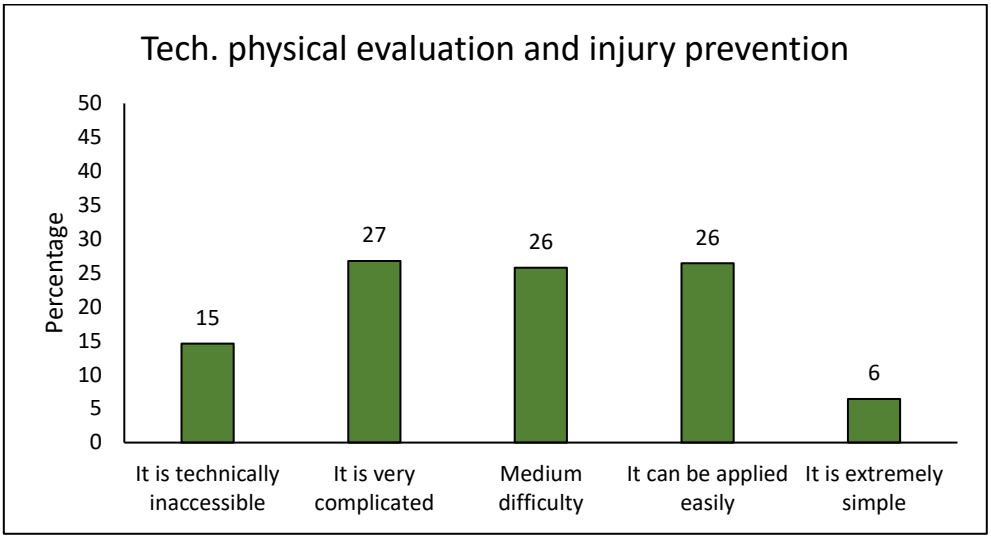
5. What is the level of difficulty that you associate with the use of each technology effectively in your club or sport entity?

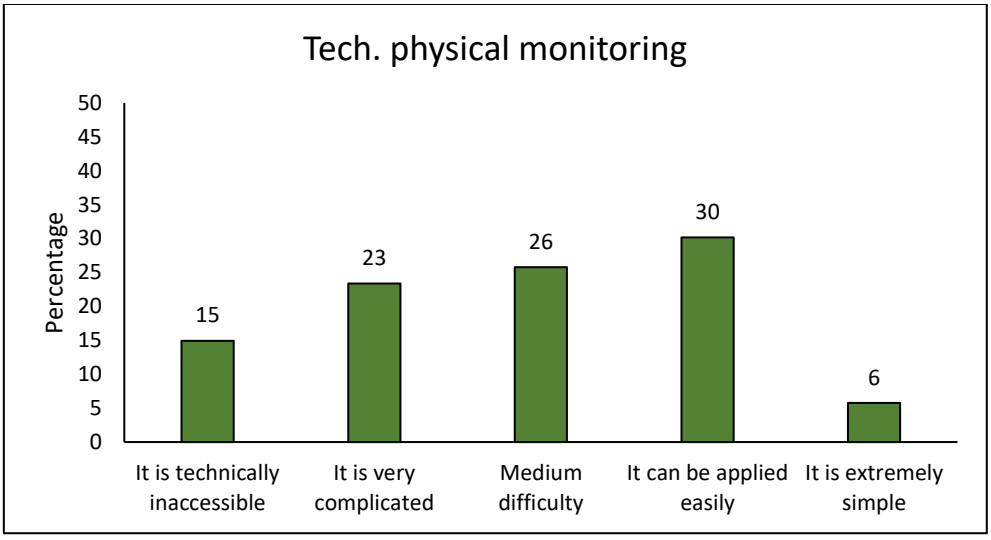
The results obtained regarding the level of difficulty associated with the effective use of each technology in your sports club or entity, provide us that around 20-35% see the use of technologies as easily applicable or of medium difficulty. Around 19-27% consider it very difficult to apply them. While for 11-15% the application of these technologies is technically innacesible. There is a great diversity of difficulty regarding the application in deprived entities or clubs.

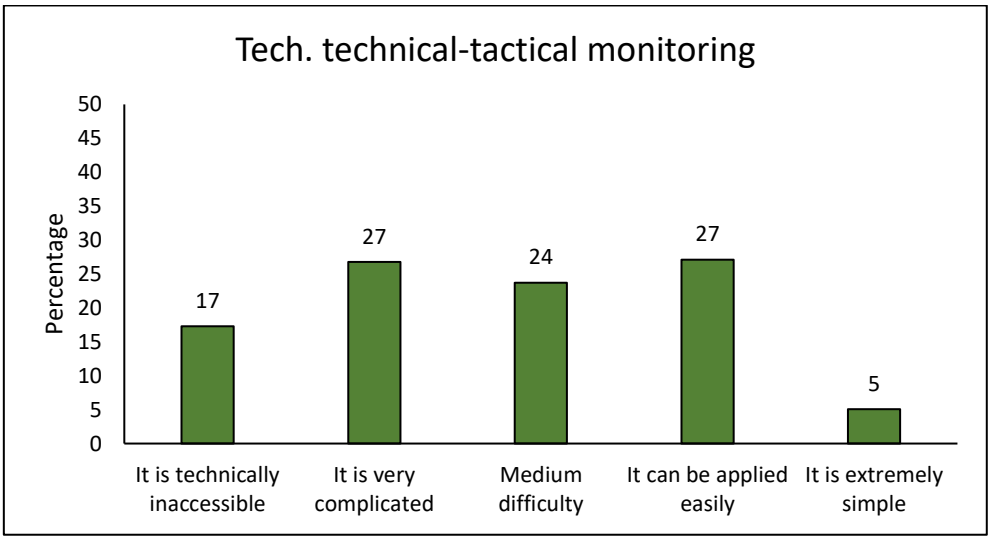

Tech. club or entity management
Percentage
50
45
40
35
30
25
20
15
10
5
0
9
19
22
36
14
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple

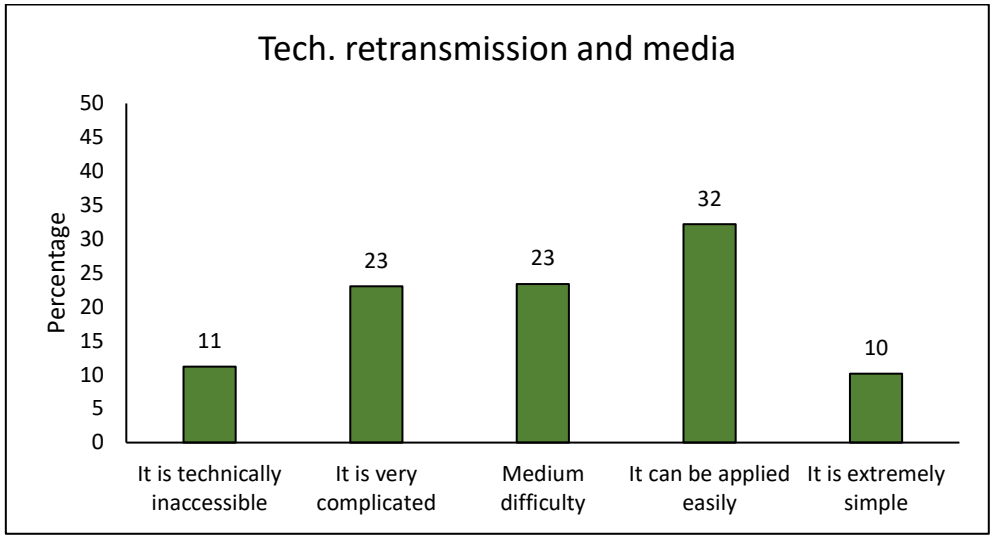

Tech. data analysis
Percentage
50
45
40
35
30
25
20
15
10
5
0
11
24
26
31
7
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple


Tech. reporting and visualization
Percentage
50
45
40
35
30
25
20
15
10
5
0
12
23
27
31
7
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple


Tech. physical evaluation and injury prevention
Percentage
50
45
40
35
30
25
20
15
10
5
0
15
27
26
26
6
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple

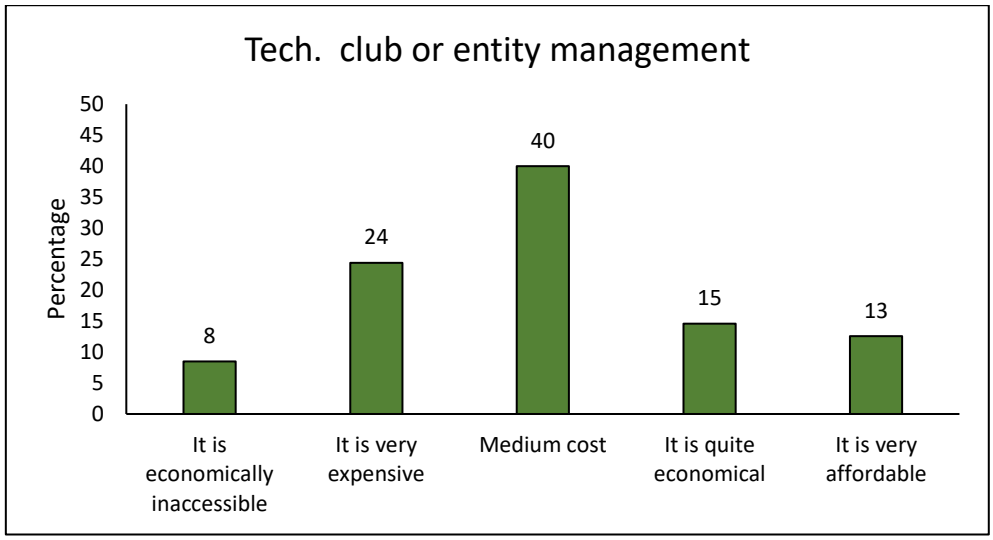

Tech. physical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
15
23
26
30
6
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple

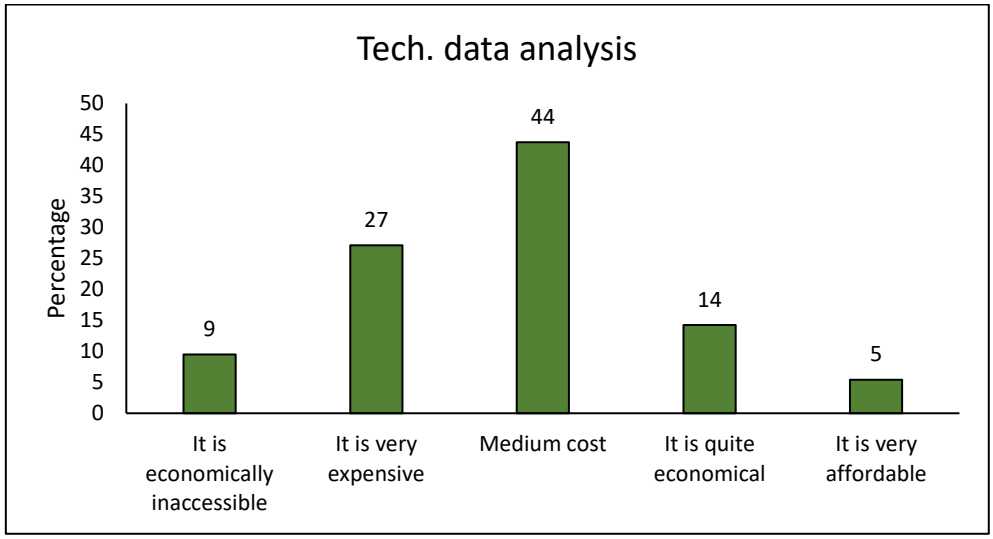

Tech. technical-tactical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
17
27
24
27
5
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple

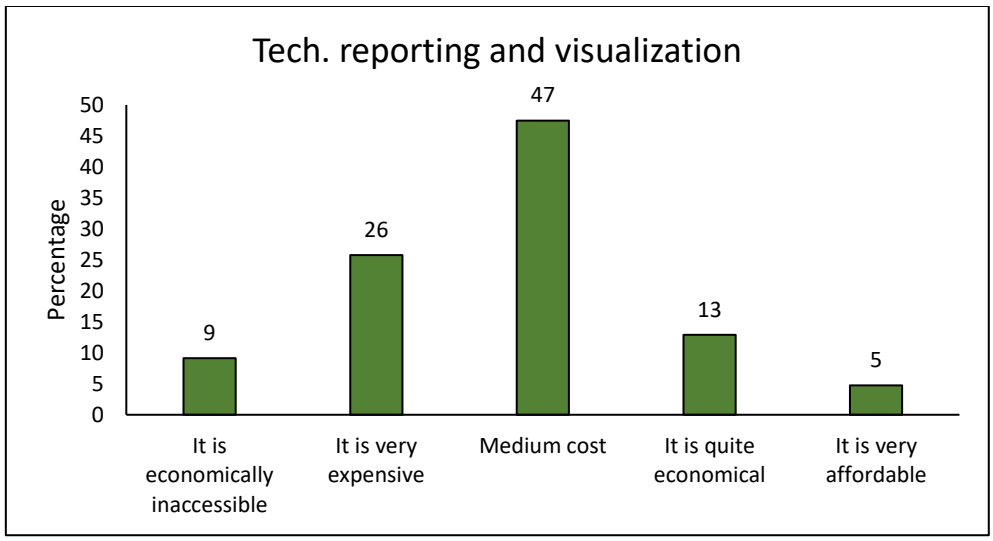


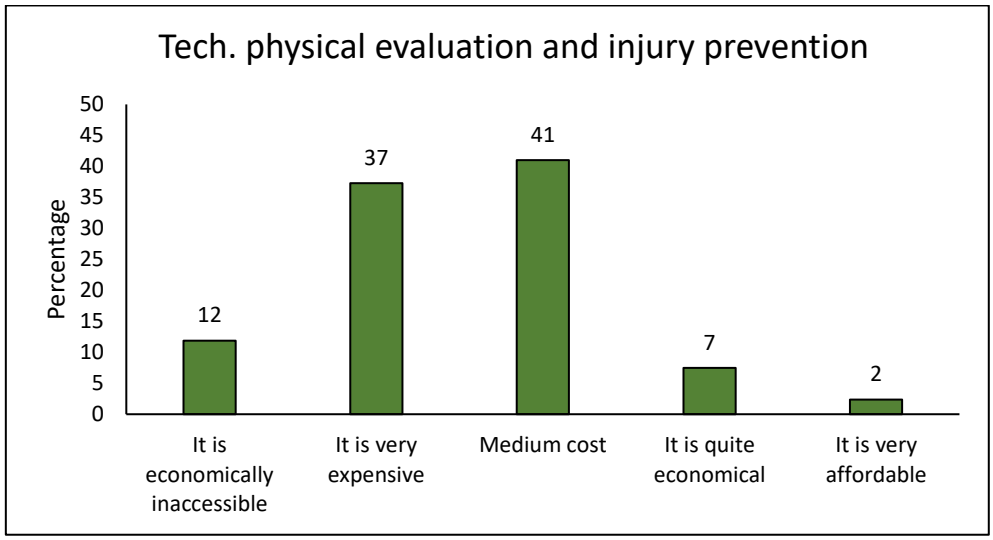
6. Based on your knowledge. How accessible is each technology, economically speaking, for your club or sport entity?

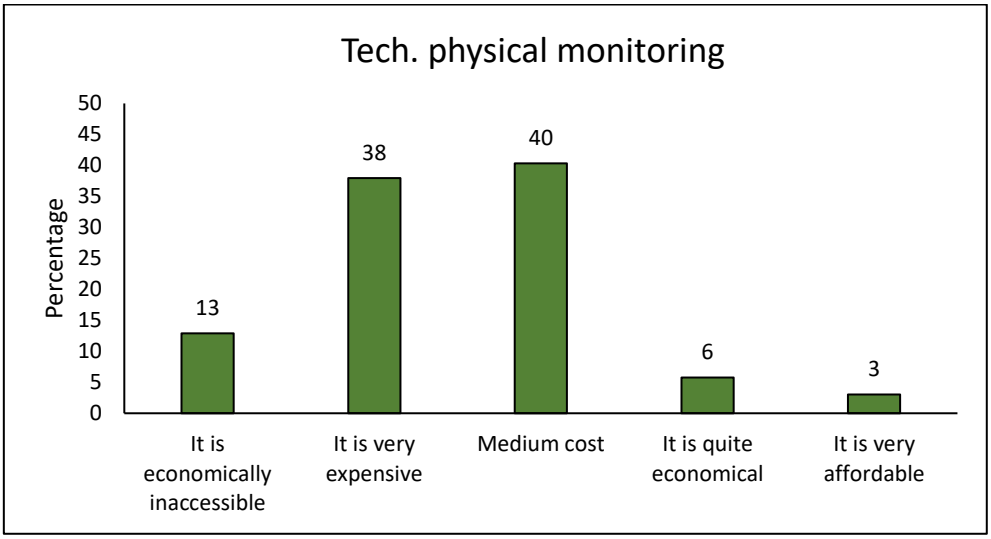
The results obtained regarding the economic accessibility of the sports club or entity to obtain these technologies, show that for 40-50% of sports entities or clubs it is a medium cost to be able to acquire these technologies. Between 30-40% believe that technical-tactical monitoring, physical monitoring and physical evaluation and injury prevention technologies would be very expensive to use. While a very small% of 5-14% believe that it is very affordable to have them. In general, clubs and entities see implementing technologies as a medium cost or very expensive.

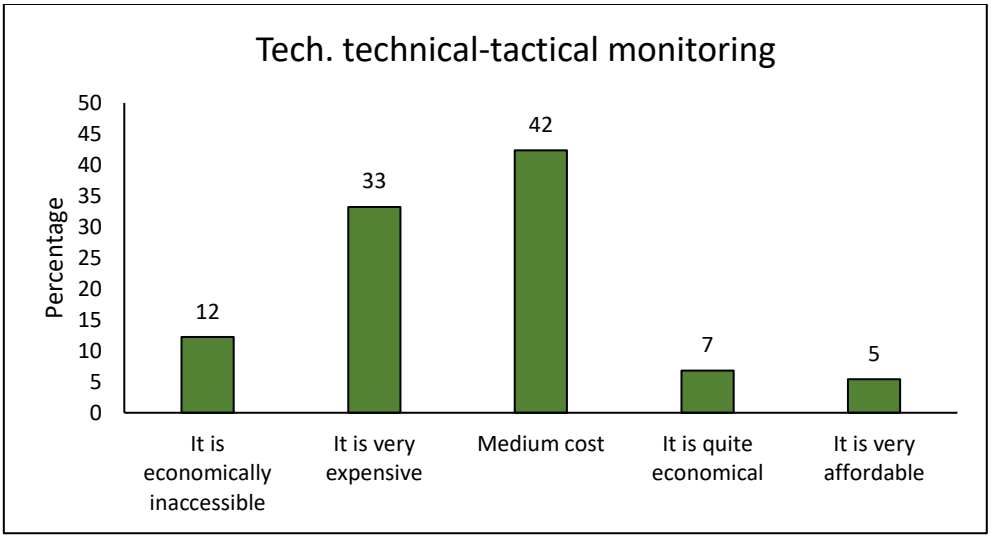


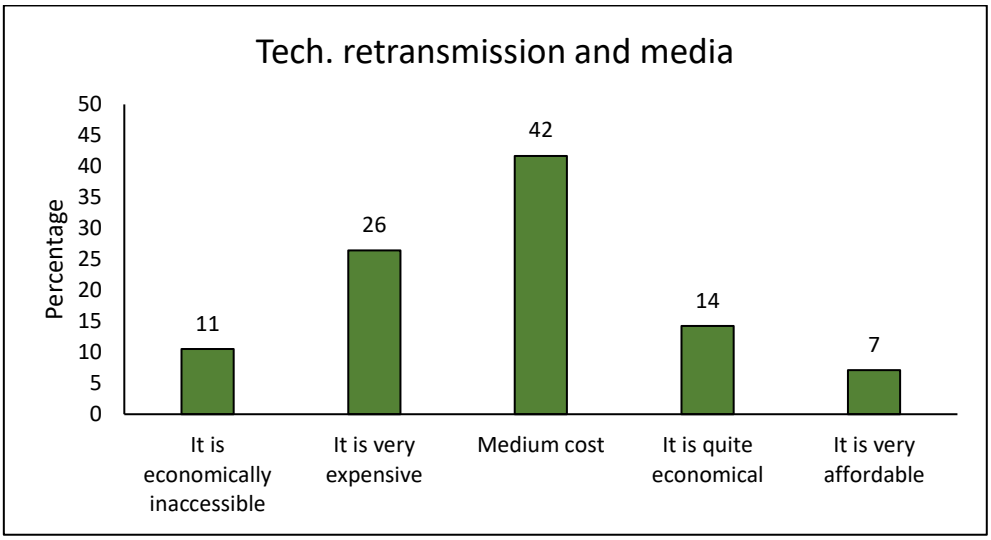

Tech. data analysis
Percentage
50
45
40
35
30
25
20
15
10
5
0
9
27
44
14
5
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very affordable


Tech. reporting and visualization
Percentage
50
45
40
35
30
25
20
15
10
5
0
9
26
47
13
5
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very affordable


Tech. physical evaluation and injury prevention
Percentage
50
45
40
35
30
25
20
15
10
5
0
12
37
41
7
2
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very affordable

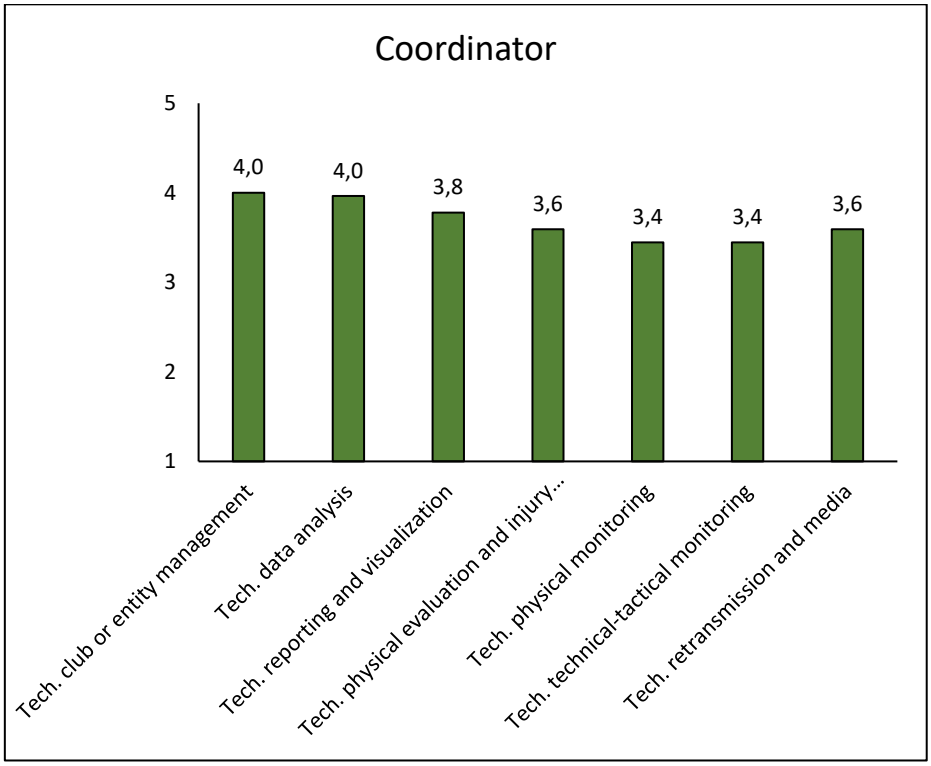

Tech. physical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
13
38
40
6
3
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very affordable

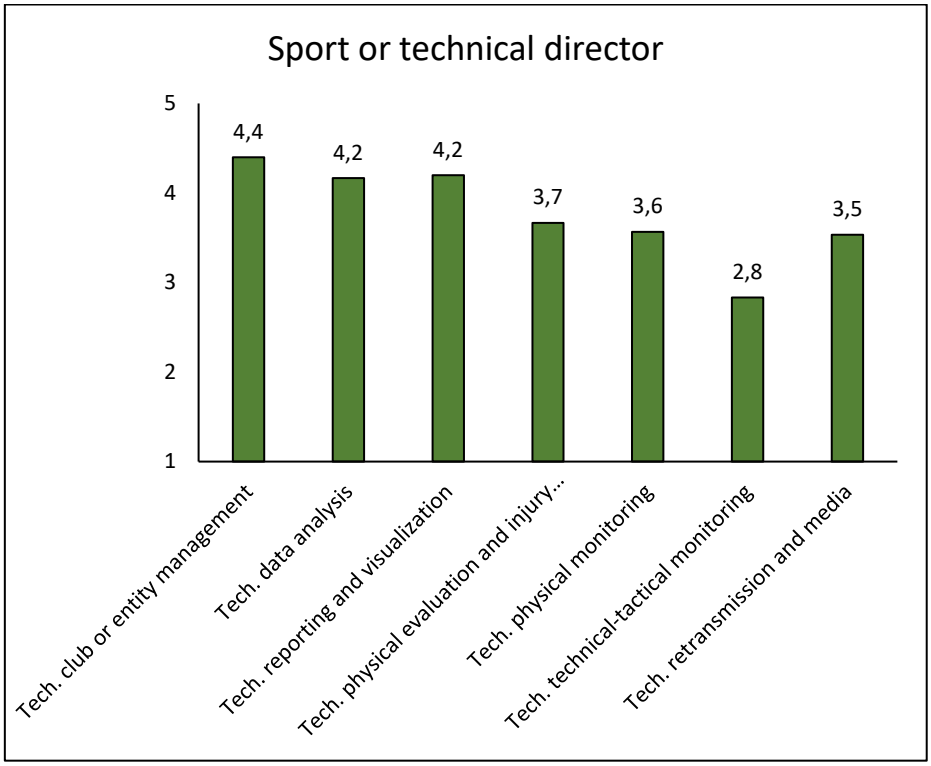

Tech. technical-tactical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
12
33
42
7
5
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very affordable

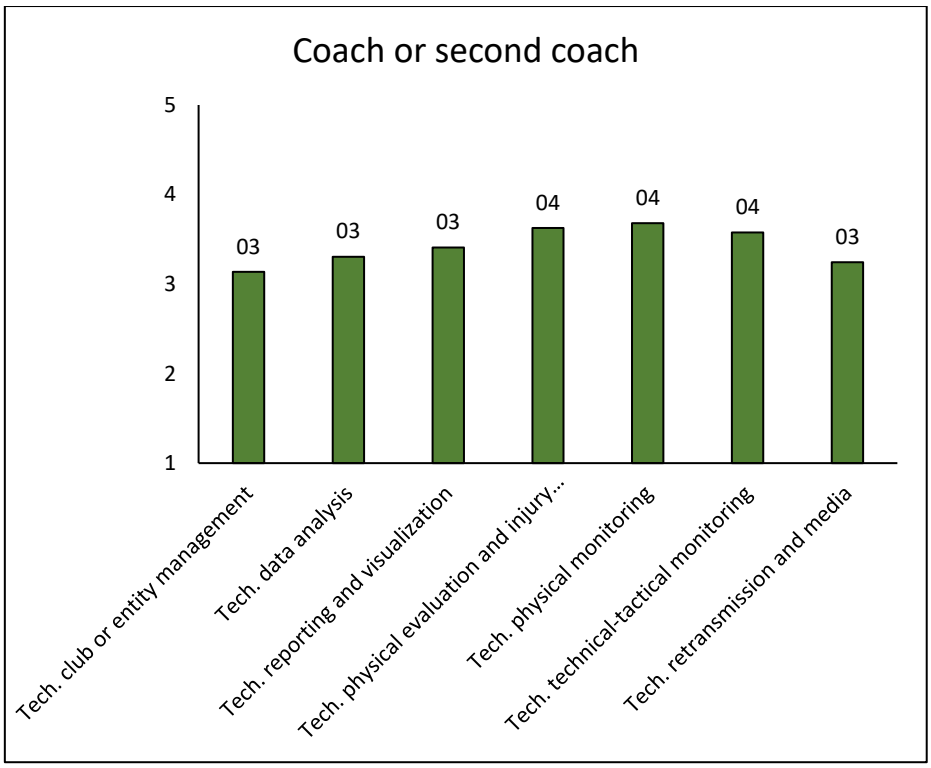

Tech. retransmission and media
Percentage
50
45
40
35
30
25
20
15
10
5
0
11
26
42
14
7
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very affordable

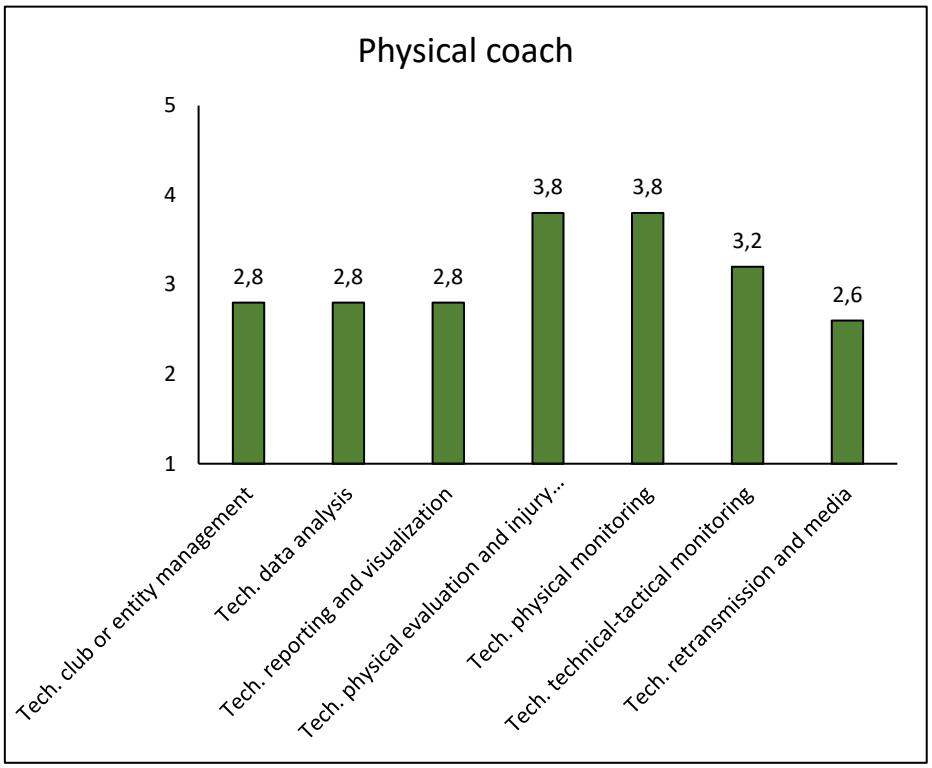
7. How important is each of these technologies for your current position within the club or sport entity?

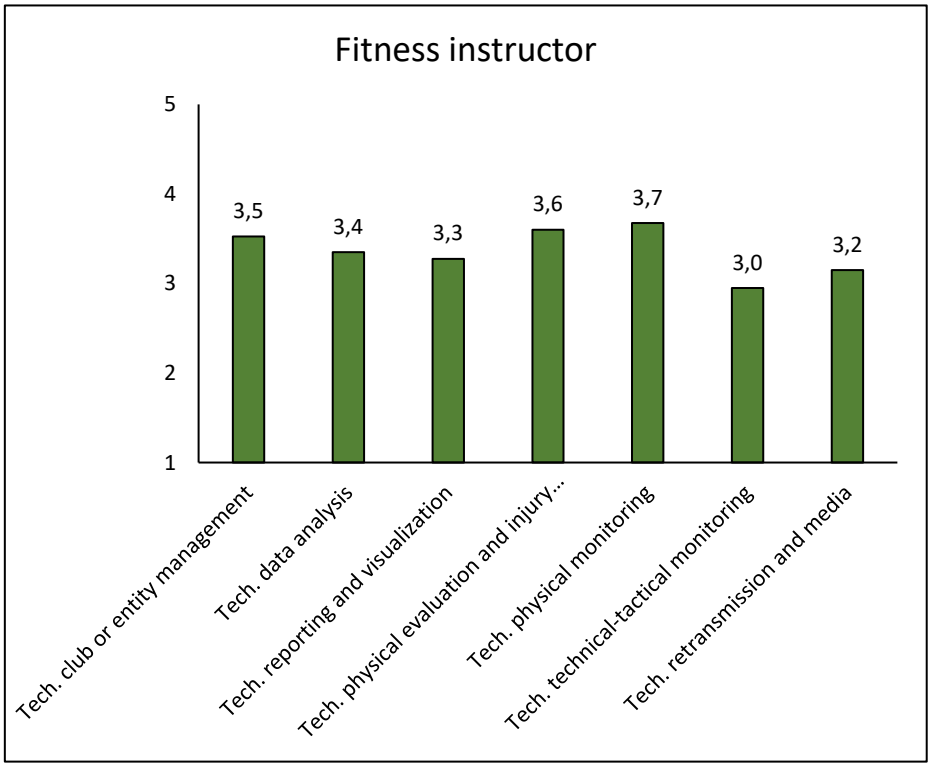
The graphs above show the importance of the use of technologies depending on the current position in a club or sports entity. The Coordinators believe that club or entity management and data analysis technologies are most important to them, while physical monitoring and technical-tactical monitoring technologies would be less important. The Sport or technical directors consider that management, data analysis and reporting and visualization technologies are the most important. While technical-tactical monitoring technologies are less important, coinciding with coordinators. However, for the coach or second coach and physical coach, the technologies physical evalaution and injury prevention, physical monitoring and technical-tactical monitoring are the most important, and they consider that they would help more in their current position. On the other hand, fitness instructor and other technical staf believe that all technologies would be equally important without obtaining great differences between them.

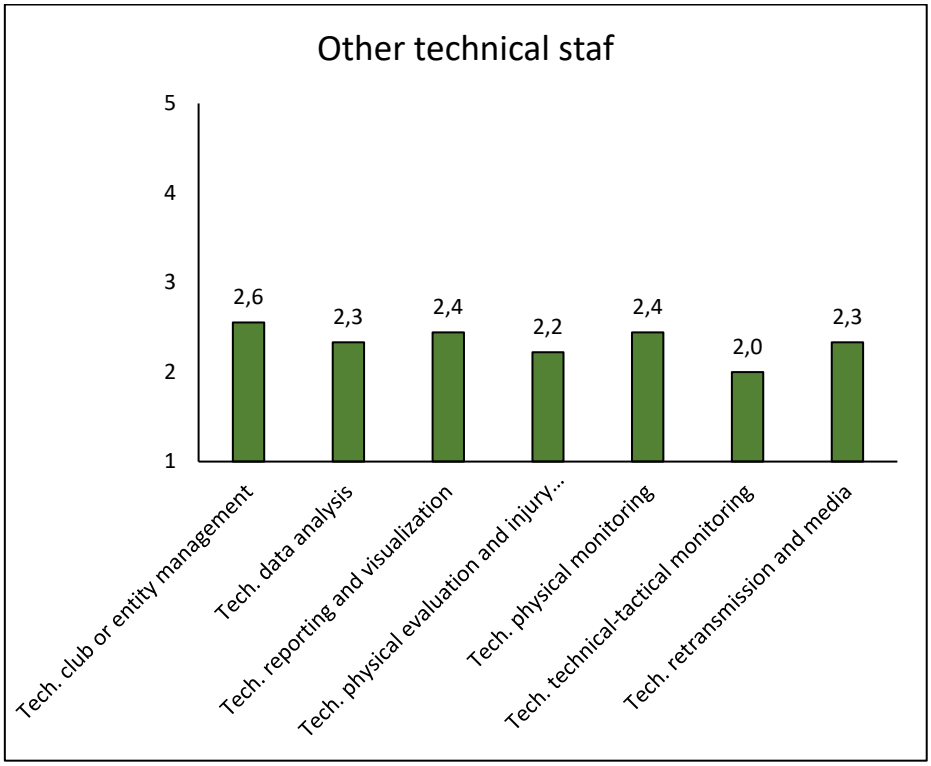



Sport or technical director
5
4
3
2
1
4,4
4,2
4,2
3,7
3,6
2,8
3,5
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media


Coach or second coach
5
4
3
2
1
03
03
03
04
04
04
03
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media

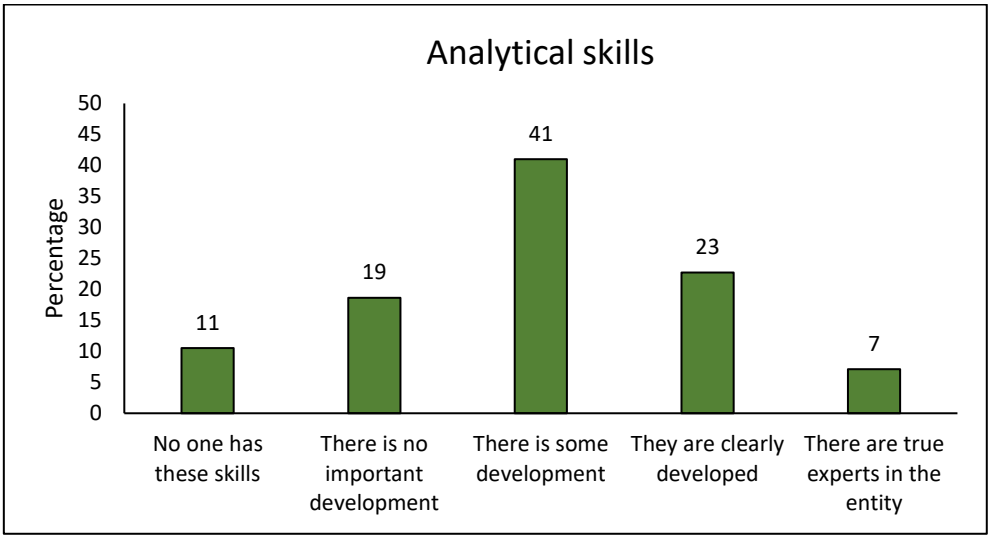

Physical coach
5
4
3
2
1
2,8
2,8
2,8
3,8
3,8
3,2
2,6
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media

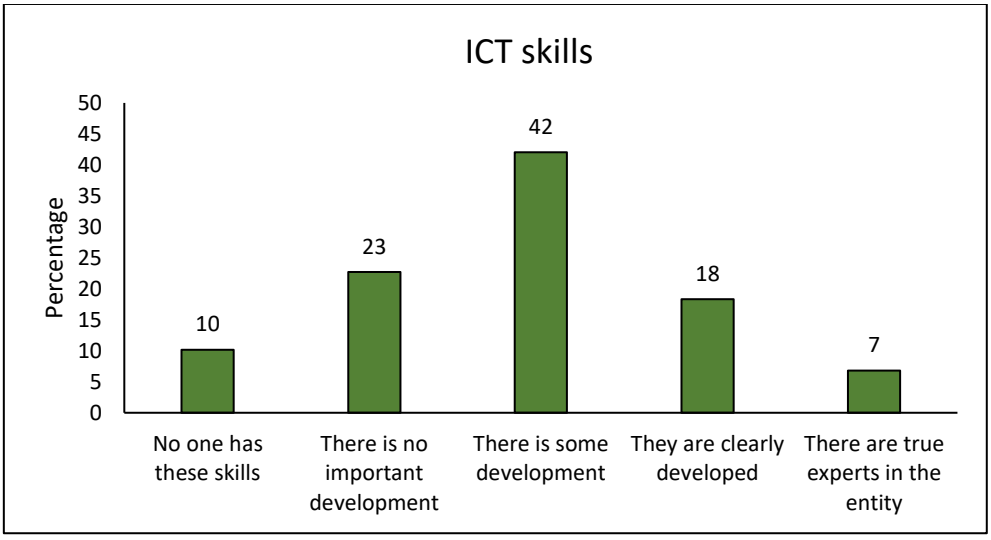

Fitness instructor
5
4
3
2
1
3,5
3,4
3,3
3,6
3,7
3,0
3,2
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media

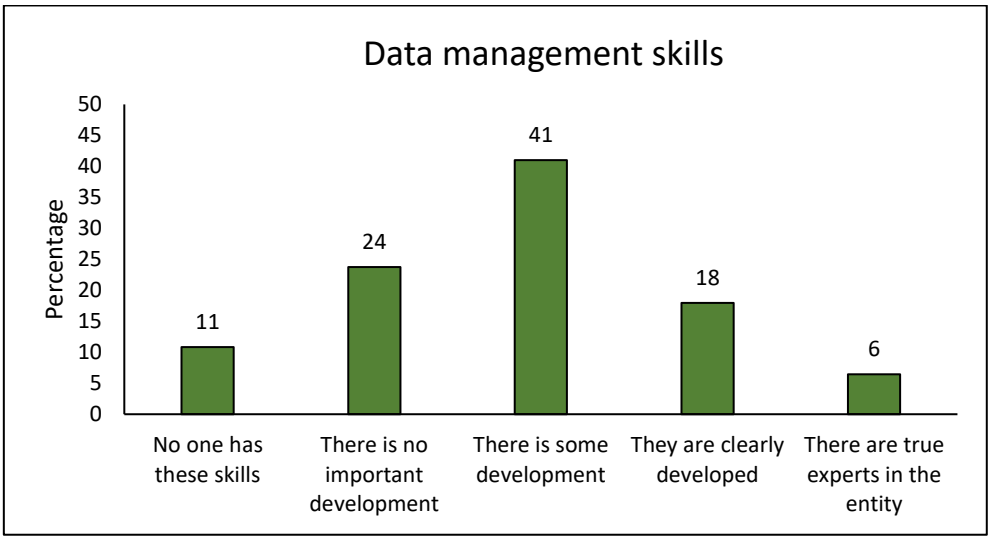


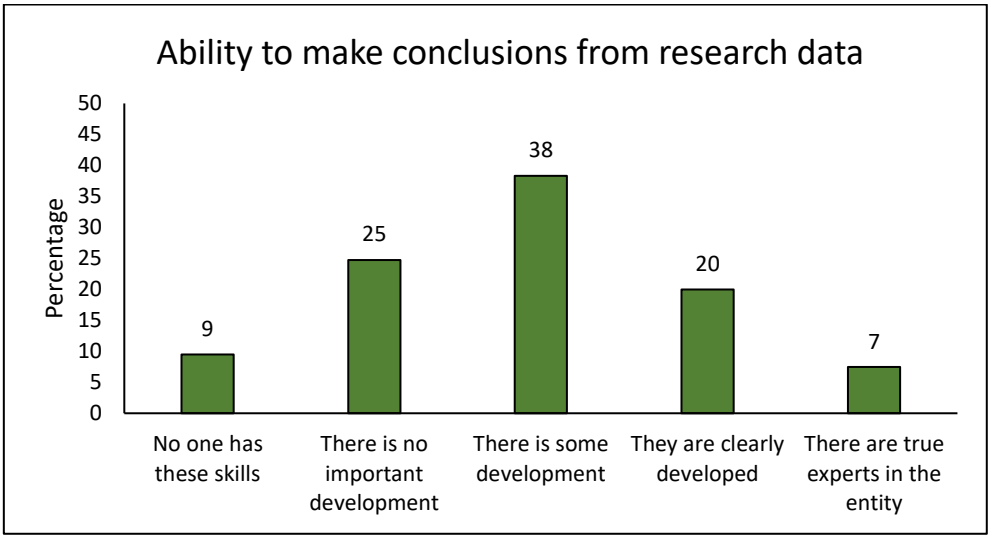
8. How developed are these competencies in your club or sport entity?

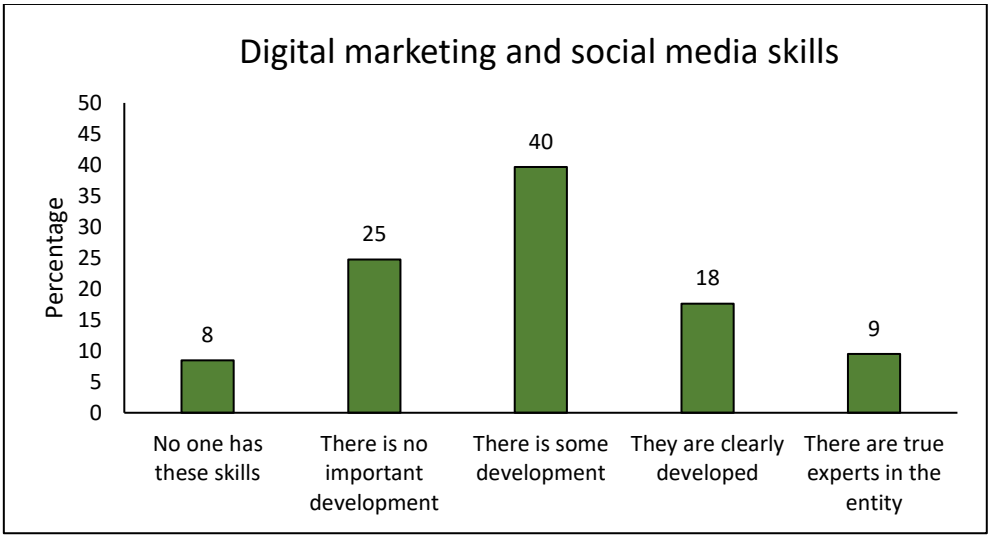
The graphics show how developed each of the competitions in your sports club or entity is. In general, around 40% believe that they are somewhat developed. Except the skills in the digital management of big data competition that 34% believe is not important development. Also, around 20% of the clubs or entities there is no important development in all competitions. In addition, sports clubs or entities, only 5-9% have experts in these competitions.

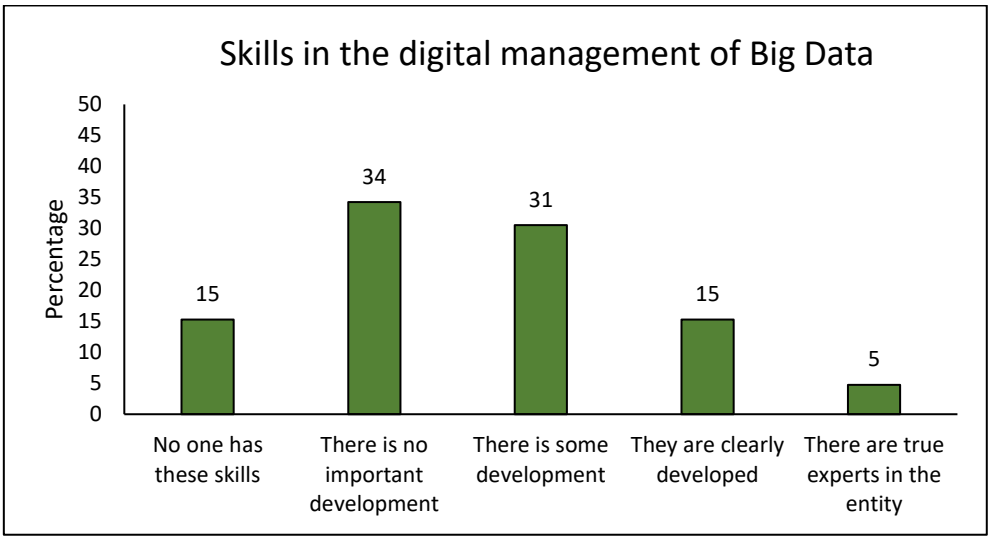

Analytical skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
11
19
41
23
7
No one has these skills
There is no important development
There is some development
They are clearly developed
There are true experts in the entity


ICT skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
10
23
42
18
7
No one has these skills
There is no important development
There is some development
They are clearly developed
There are true experts in the entity


Data management skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
11
24
41
18
6
No one has these skills
There is no important development
There is some development
They are clearly developed
There are true experts in the entity

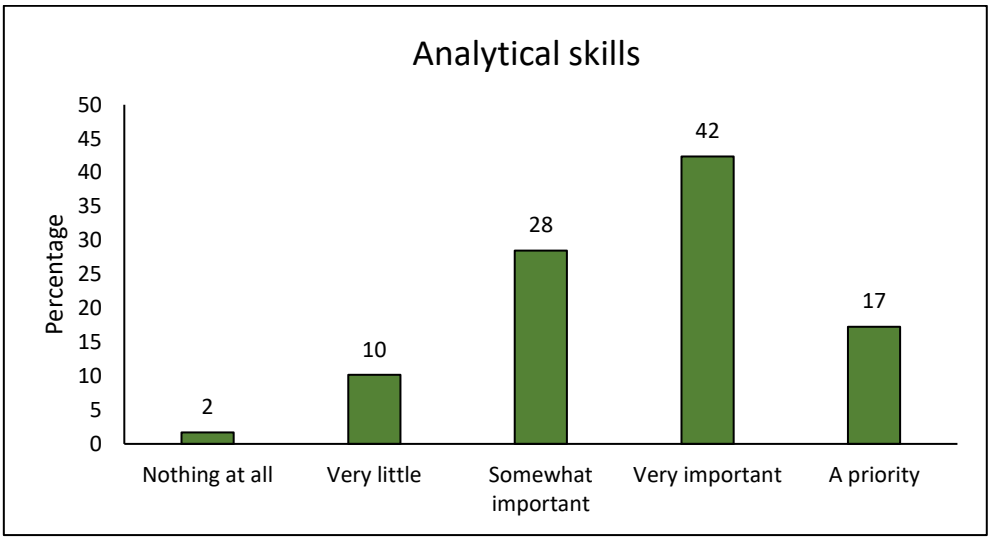

Ability to make conclusions from research data
Percentage
50
45
40
35
30
25
20
15
10
5
0
9
25
38
20
7
No one has these skills
There is no important development
There is some development
They are clearly developed
There are true experts in the entity

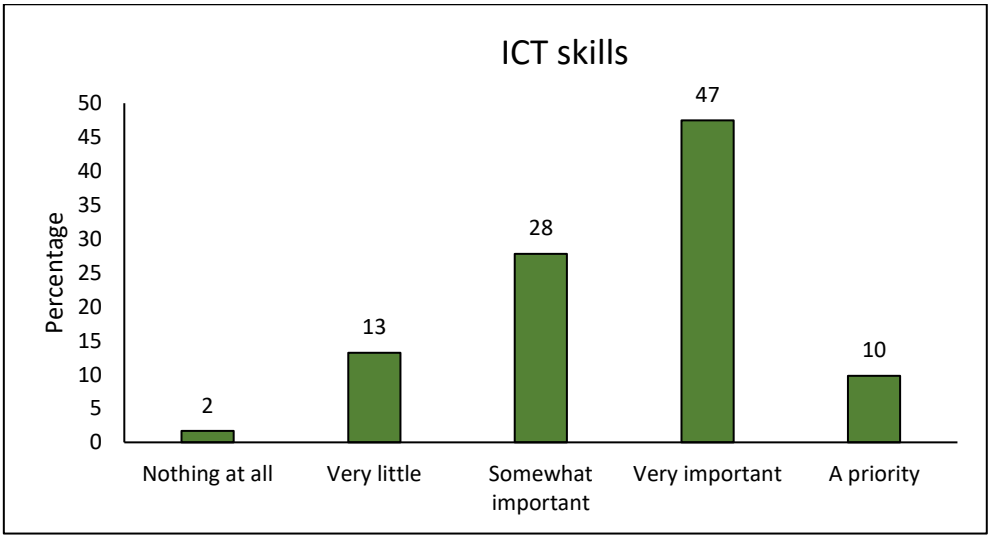

Digital marketing and social media skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
8
25
40
18
9
No one has these skills
There is no important development
There is some development
They are clearly developed
There are true experts in the entity

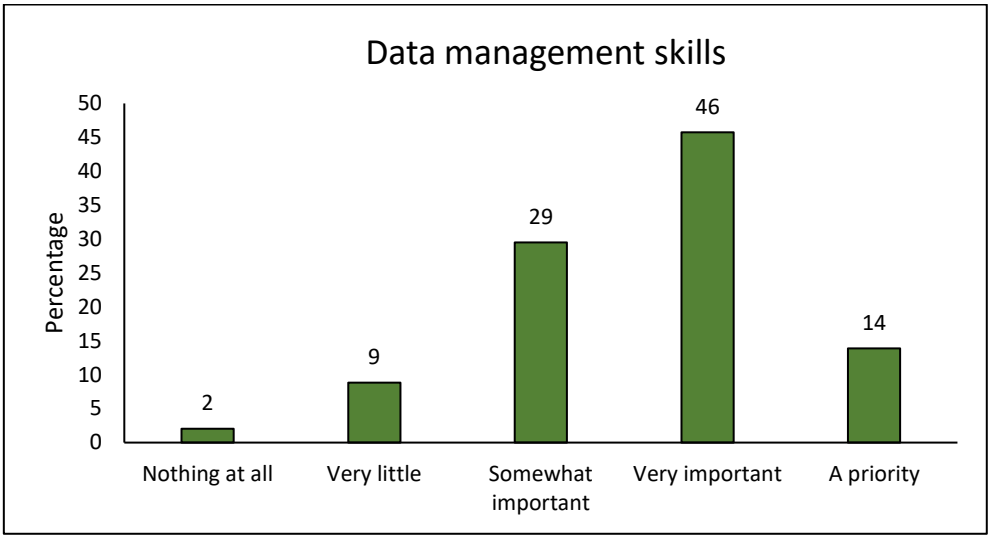

Skills in the digital management of Big Data
Percentage
50
45
40
35
30
25
20
15
10
5
0
15
34
31
15
5
No one has these skills
There is no important development
There is some development
They are clearly developed
There are true experts in the entity

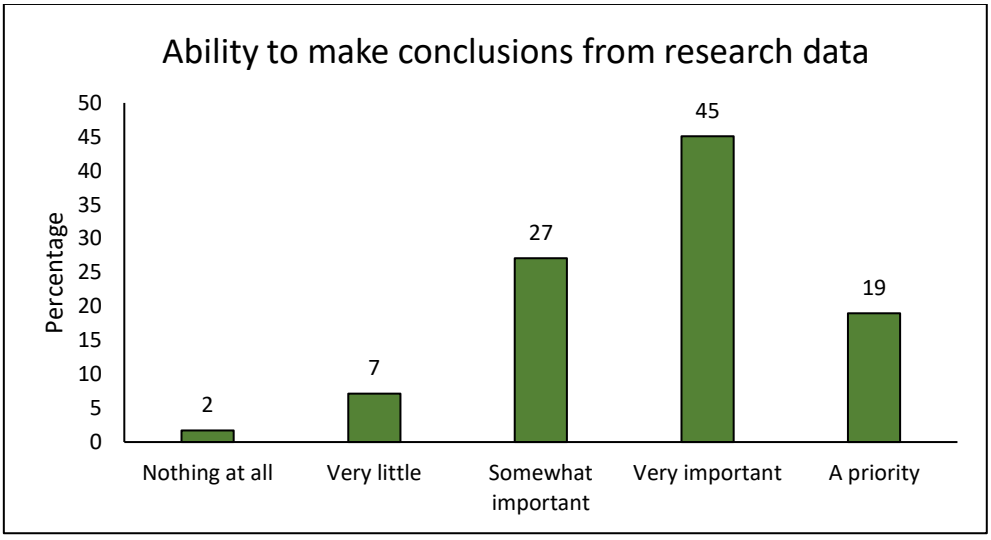
9. How important do you think these professional skills are in your club or sport entity?

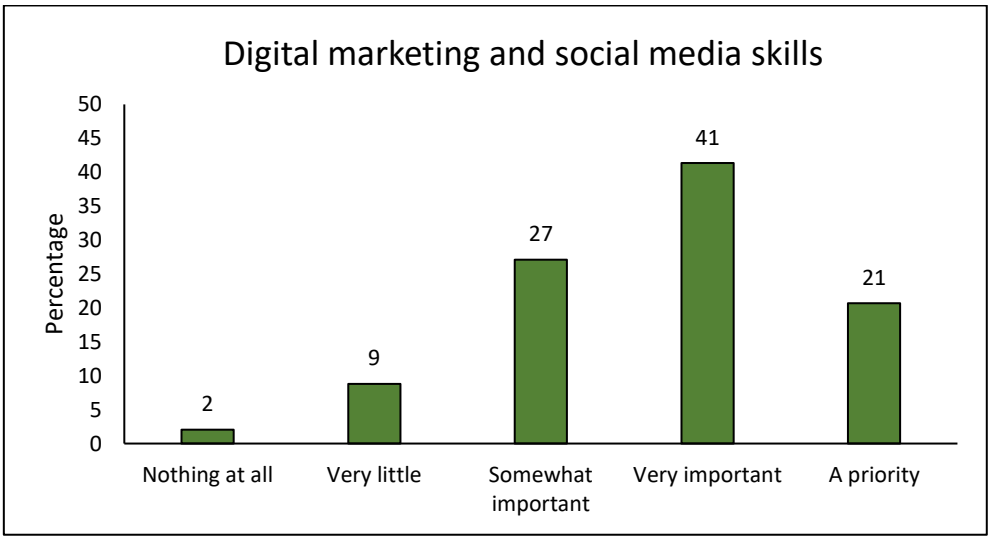
The graphs show how important these competitions are for a club or sports entity. Around 45% believe that the use of these professional skills is very important. Between 10-21% believe the use of these skills is essential. While approximately 10% believe their use is of little importance. Sports clubs or entities believe it is very important to acquire these skills from their workers.

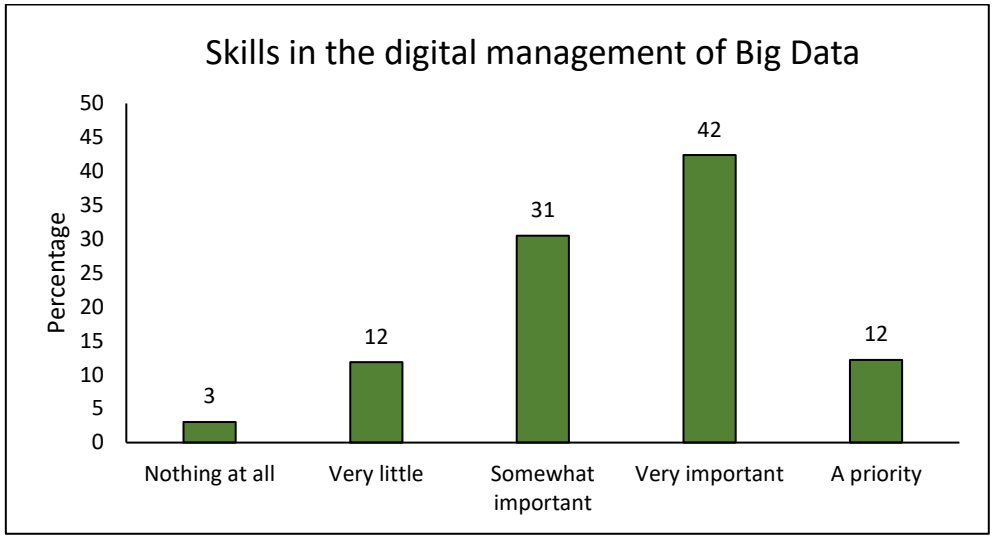





Data management skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
2
9
29
46
14
Nothing at all
Very little
Somewhat important
Very important
A priority

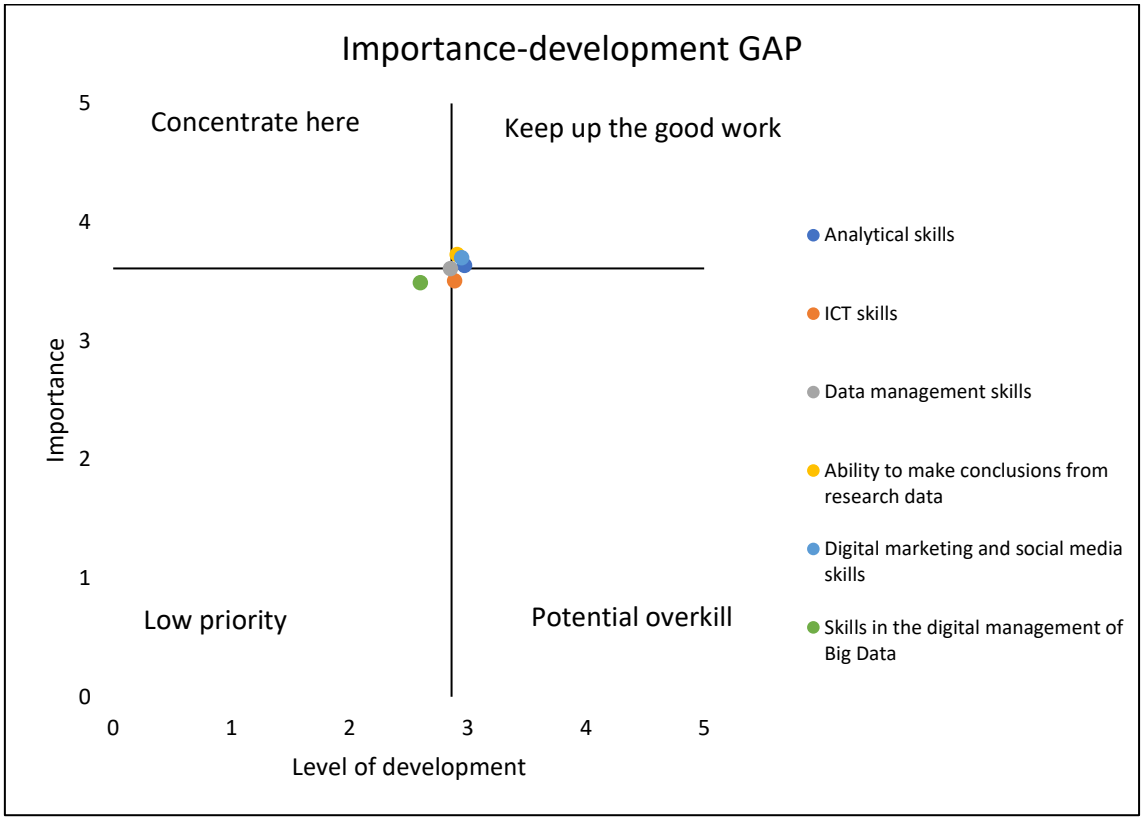

Ability to make conclusions from research data
Percentage
50
45
40
35
30
25
20
15
10
5
0
2
7
27
45
19
Nothing at all
Very little
Somewhat important
Very important
A priority


Digital marketing and social media skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
2
9
27
41
21
Nothing at all
Very little
Somewhat important
Very important
A priority



10. GAP analysis between development and importance of technological competences

In this graph that we observe based on the responses of the sports managers in Portugal, it follows that the skills of analytical skills, ability to make conclusions from research data and digital marketing and social media skills have a high degree of importance and level of development. therefore, they must be maintained. The skills in the digital management of Big Data competition is of little importance and little development, therefore it is not a priority for sports managers in Portugal. However, ICT skills competition is less important and more developed for these sports managers.



11. Discussion of results

Most of the technicians surveyed work in sports clubs. Portugal has, in this respect, a centuries-old tradition concerning sports associations, with clubs having a high integration into society and increasingly with more valency than those exclusively sporting. Sports clubs and associations have offered more comprehensive services than training and competition, such as recreation and leisure, and in some cases the fitness area. For this reason, it is not surprising that the highest percentage of responses came from principal and assistant coaches.

Regarding data on the use of technologies (Q2), it is essential to reflect on them. The values varied between 60 and 80% in the set of responses. It appears that there is little use of technologies. This fact may be due to more conservative practices by technicians, where direct and *in situ* observation prevail, or, on the other hand, the lack of economic means to purchase and maintain the Technological devices.

In fact, about the importance of using technologies (Q3) by the institution, responses ranged between 59 and 73% (very important / a priority). However, somewhat important responses varied between 19 and 28%, which is not possible to ignore. The

data indicate that there is no more dense use of technologies due to the economic part (Q6), although the respondents have shown availability, if any, to use it. If we look closely, the technicians indicated that technology is expensive, ranging from medium cost to inaccessible. These responses ranged from 72 to 91%, indicating that the democratization of technology depends mainly on the cost of acquisition/use.

Highlighting this fact is the indication that the use of technology is easy to apply (Q5), varying between 56 and 72%. This response reinforces the idea that the use of technology is not possible, for the most part, because it is not economically accessible. Some technicians replied that its use is difficult, varying from 28 to 44%, which is not negligible, thus requiring periods of preparation and training.

The answers about the importance of using technologies for the current position were specific. It appears from the outset that the other technical staff did not attribute any emphasis to any of the responses. However, despite the specificity and higher responses in certain areas, we could see that the responses are frankly positive (above 2.5), indicating that, regardless of position, everyone considers the use of technology important.

Interestingly, concerning the skills for using technology (Q8), most of the answers focused on intermediate values, as if it were a Gaussian curve. However, moving towards the importance attributed to these competencies (Q9), the curve shifts to the right, with the highest percentage of response in the somewhat important / a priority (85-91%), indicating a GAP between reality and the desirable.

12. Conclusions

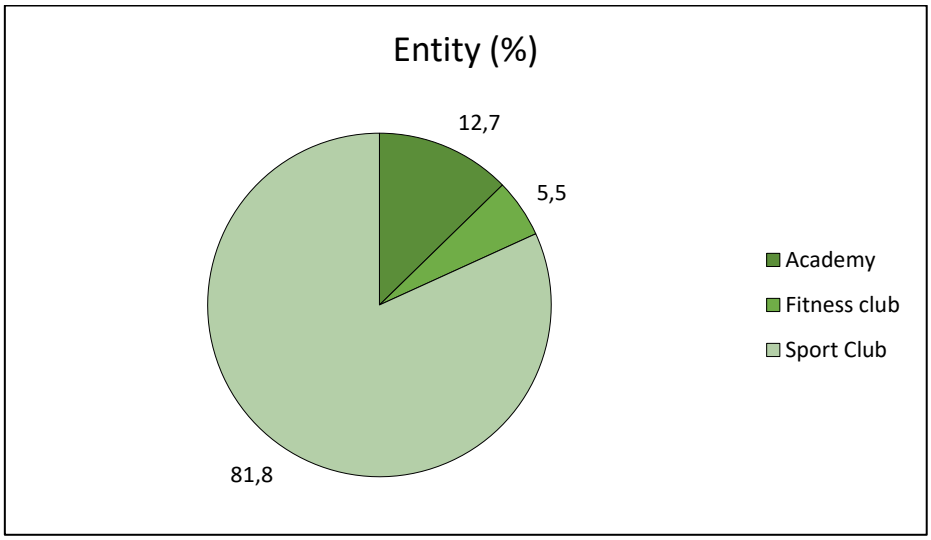
Most technicians do not have the technology available in their institutions, although they consider its use important for the specific position they occupy. The commercial value of technologies appears to be the biggest obstacle to their extensive use. However, technicians consider that the use of technologies is not difficult and place a high value on the skills necessary for their use, despite considering that the skills are not developed to the same degree of importance.

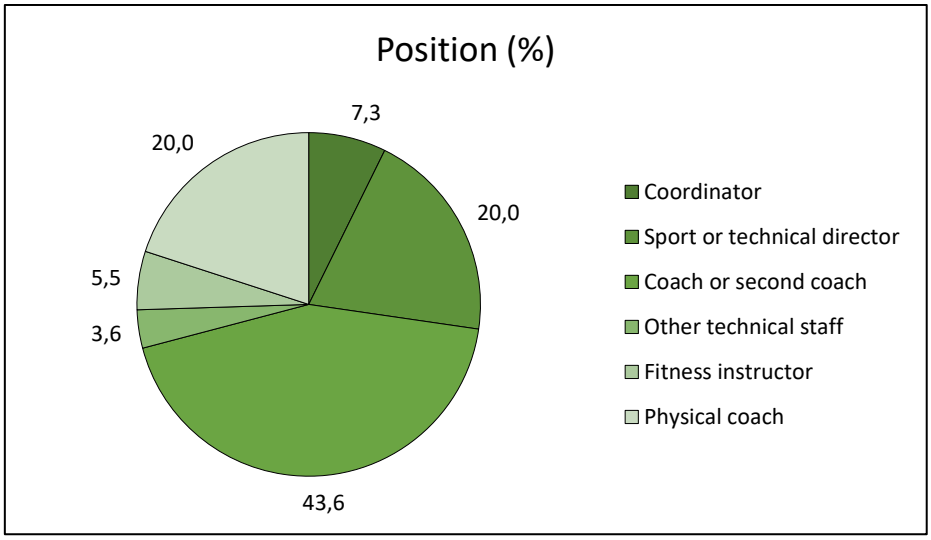
An effort should be made to acquire technology and, above all, to provide technicians with the necessary skills for its full and effective use.

ANEX III. INDIVIDUAL REPORT. QUESTIONARIE ITALIAN VERSION, ITALY

1. Sample

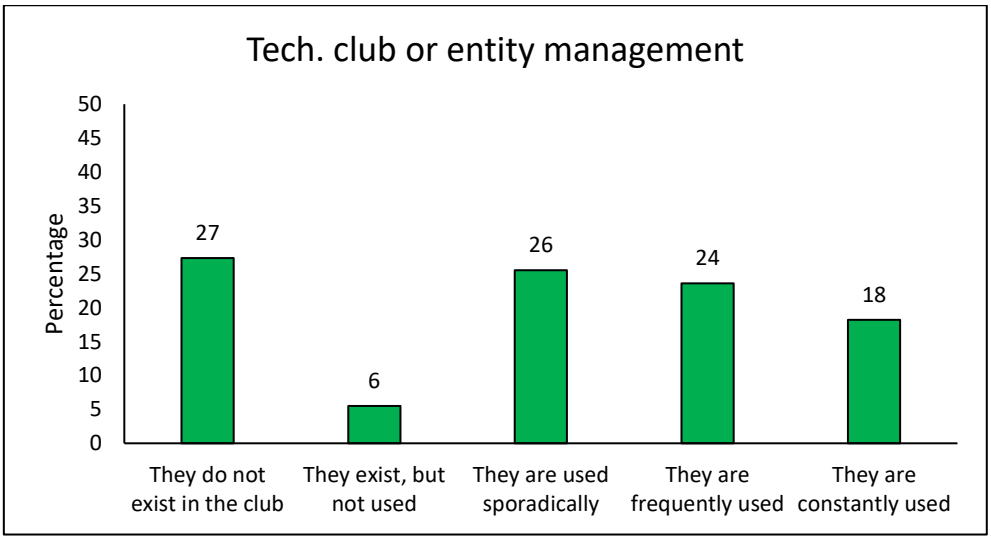
The figures show the general characteristics of the sample, depending on the type of entity, position in it and years of experience in the entity and in your current position in %. Most of the respondents work in Sport Clubs. The percentage of responses per position is widely distributed. 27% are managerial positions (Coordinator and Sport or the technical director), 44% coaches (Coach or second coach) and 29% technical and physical preparation positions (Fitness instructor, physical coach, and other technical staff). The years of experience in the entities show an average of 13 years, while the years in their current position are 7 years.

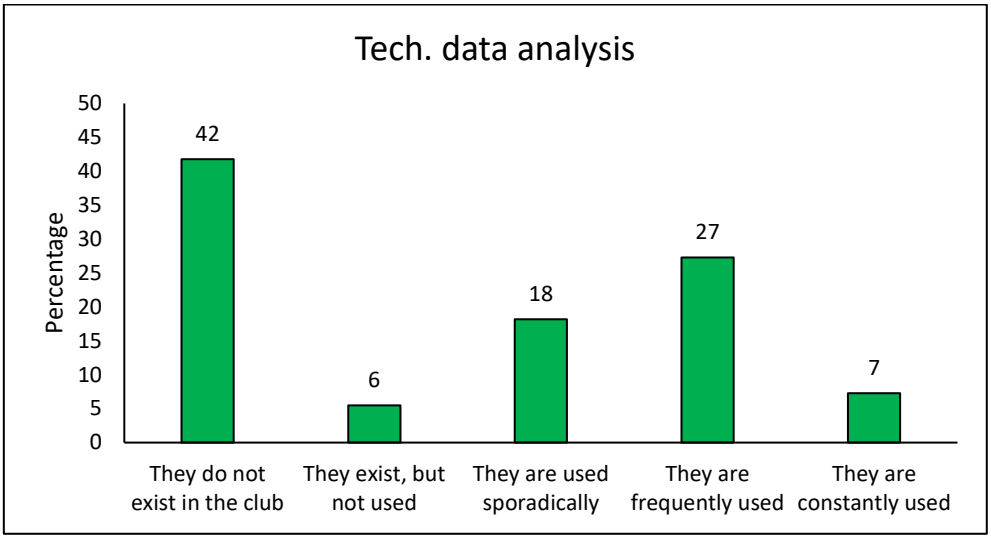


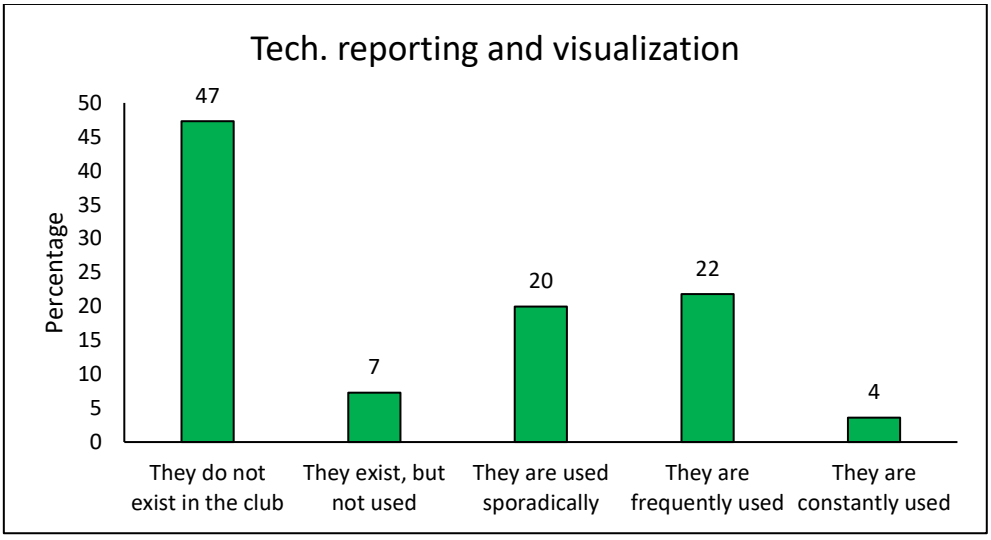


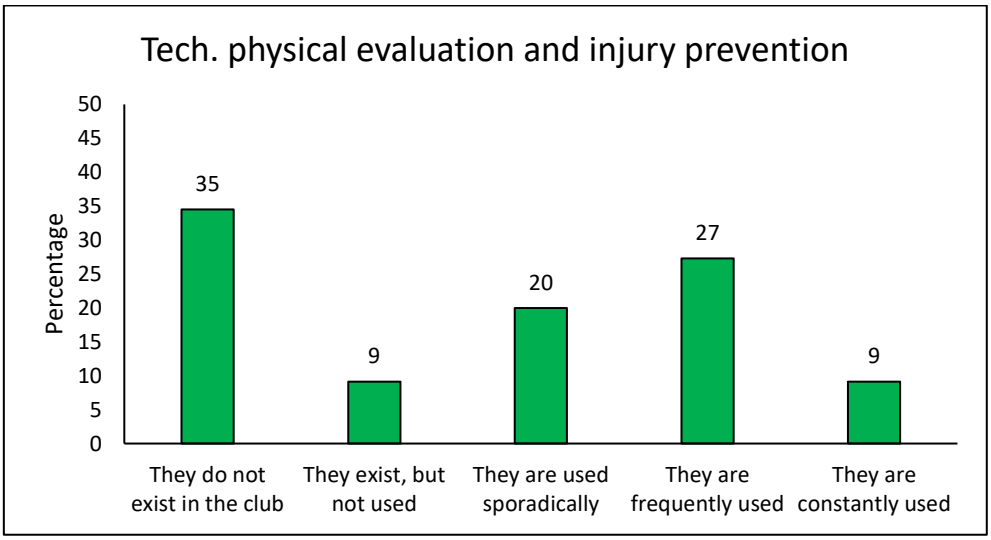
2. To what extent are you currently using these technologies in your club or sport entity?

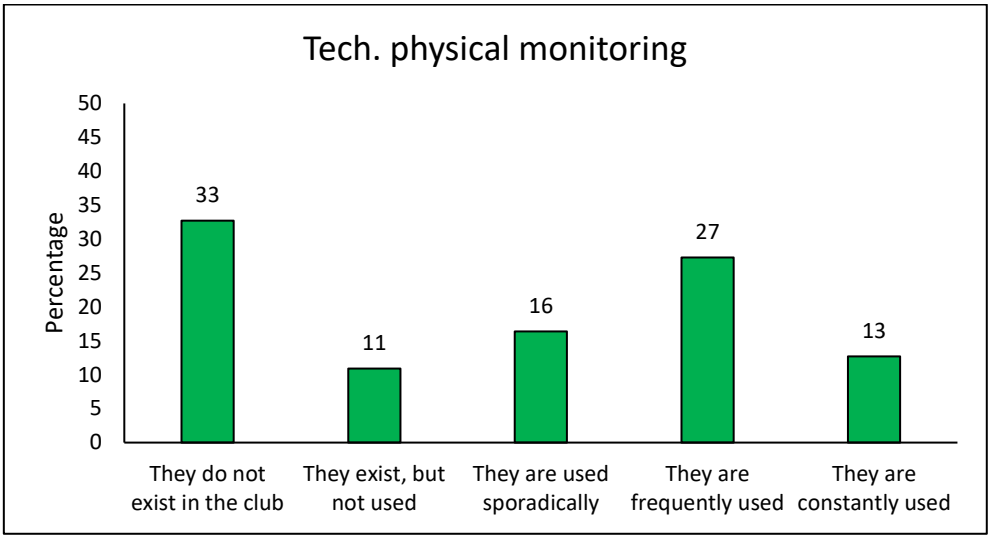
The results of the use of technology in different aspects within a club or entity indicate that technologies used for reporting and visualization, and also those related to data analysis are the least present technologies in the sector, with 47% and 42% of the respondents indicating that they do not exist in the entity at all, respectively. On the other hand, technologies related to retransmission and media are clearly the ones with the most presence, with 58% of respondents indicating that they are frequently used or constantly used.

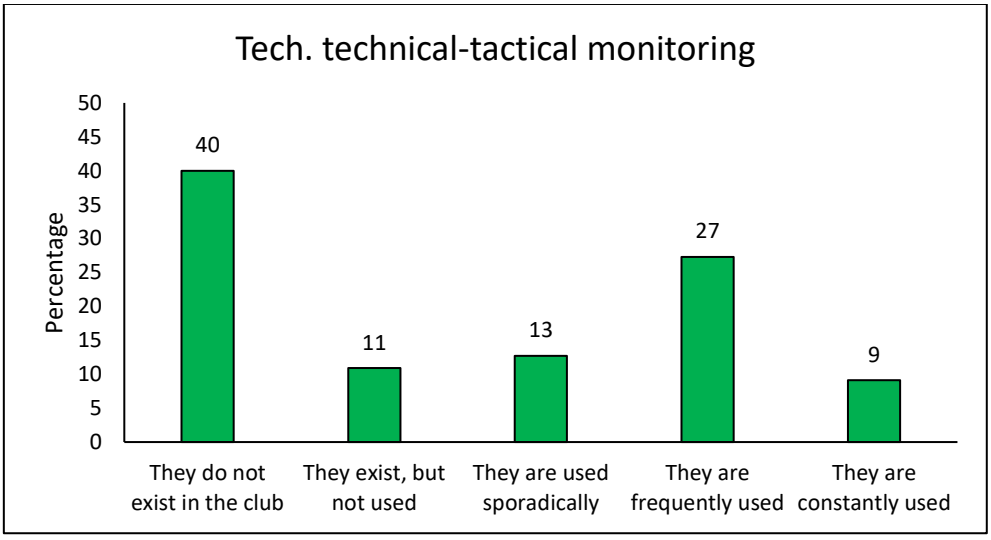


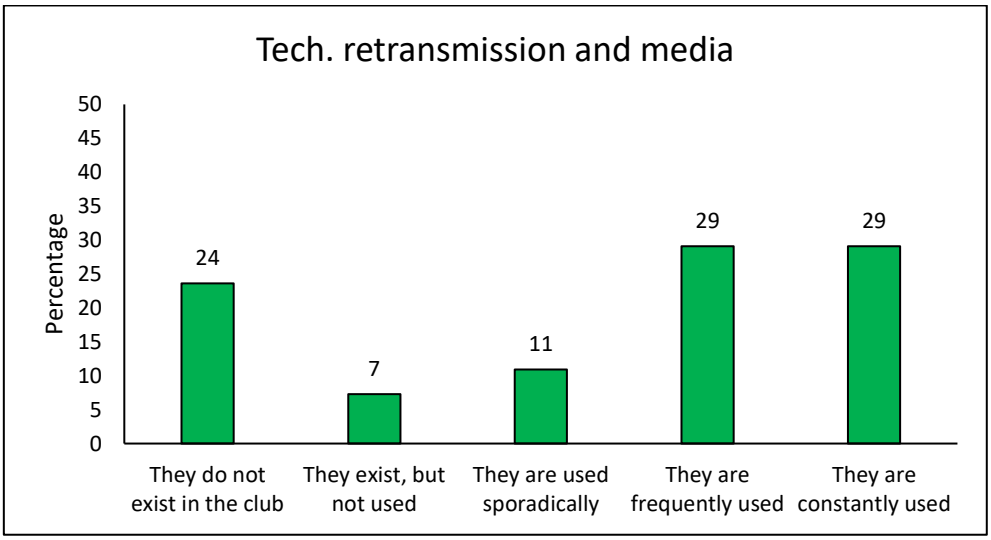

Tech. data analysis
Percentage
50
45
40
35
30
25
20
15
10
5
0
42
6
18
27
7
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used


Tech. reporting and visualization
Percentage
50
45
40
35
30
25
20
15
10
5
0
47
7
20
22
4
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used


Tech. physical evaluation and injury prevention
Percentage
50
45
40
35
30
25
20
15
10
5
0
35
9
20
27
9
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

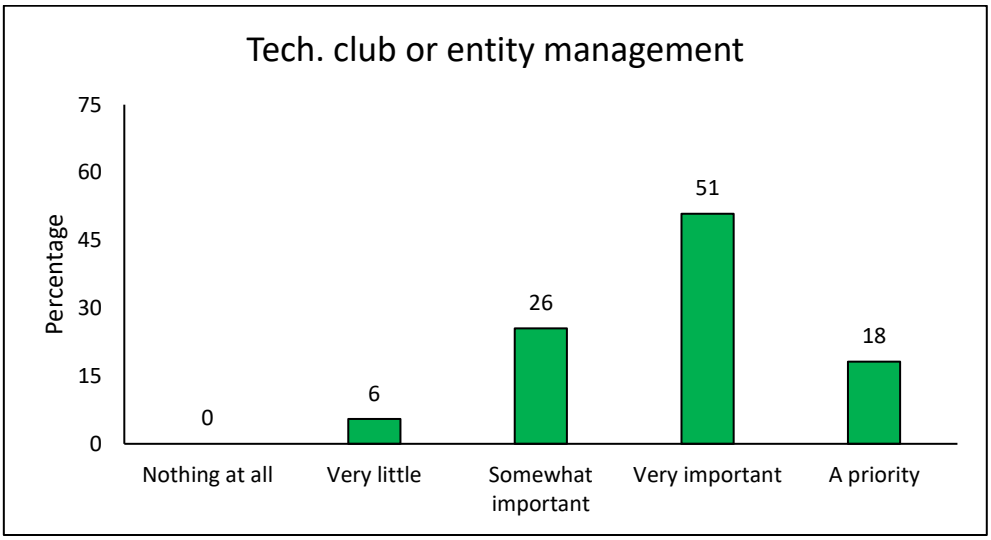

Tech. physical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
33
11
16
27
13
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

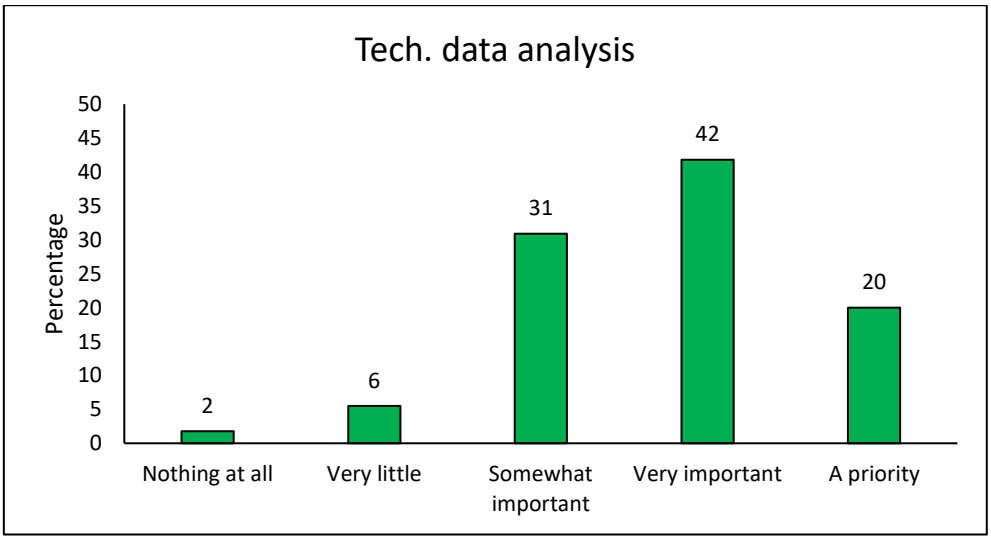

Tech. technical-tactical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
40
11
13
27
9
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

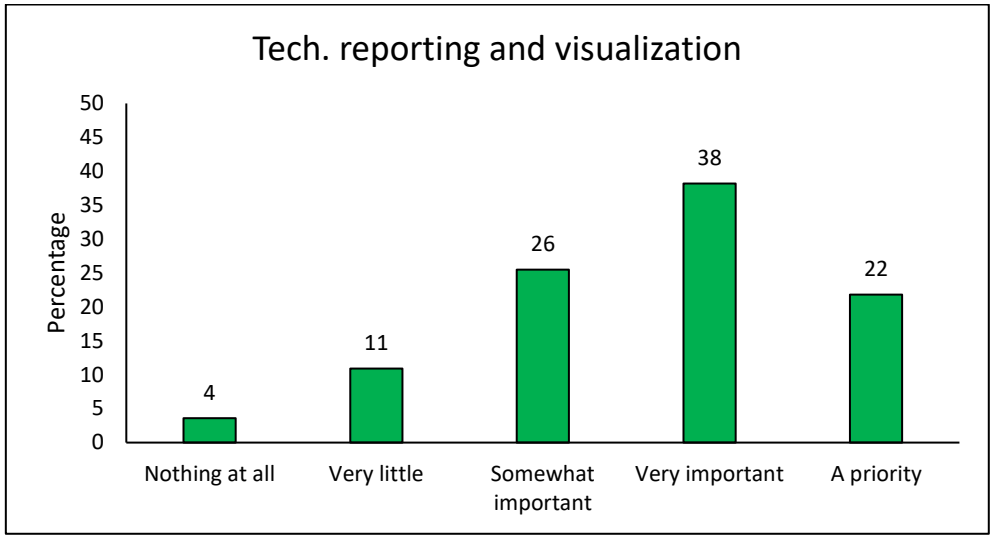

Tech. retransmission and media
Percentage
50
45
40
35
30
25
20
15
10
5
0
24
7
11
29
29
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

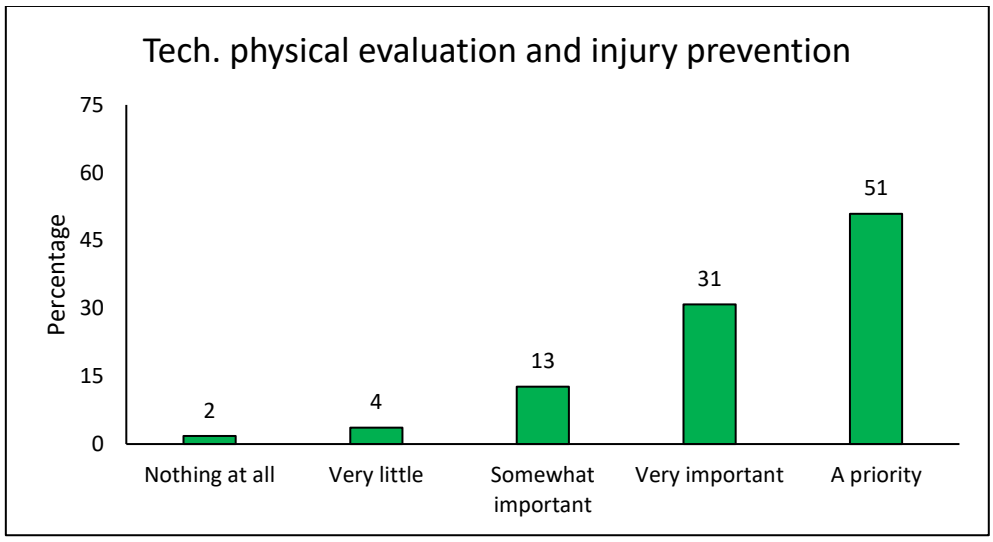
3. How important do you think using these technologies are or would be for your club or sport entity?

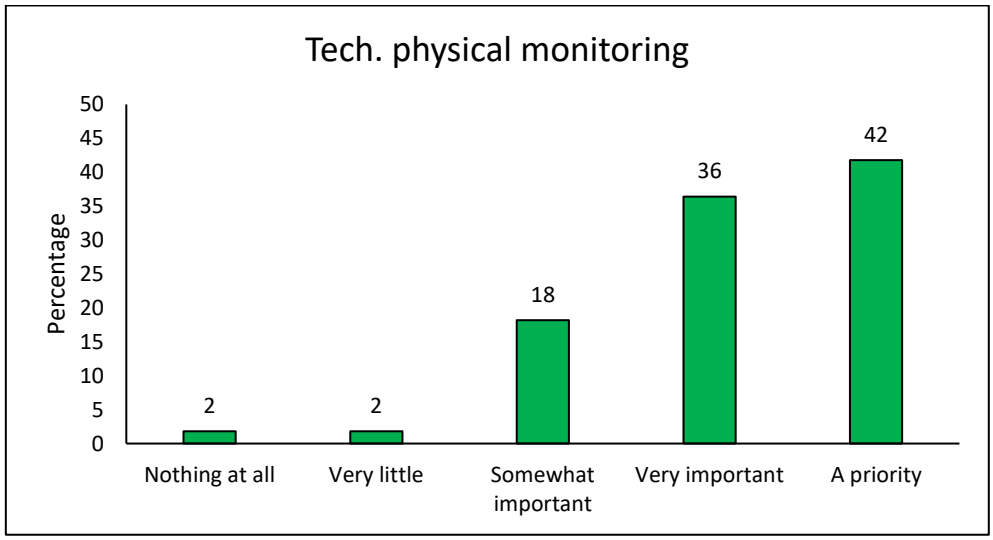
The following graphs show how important participants think the use of different technologies is in sports clubs and entities. Around 15% of the respondents consider that technologies used for reporting and visualization are not important at all or very little, being this the least valued technology in the sport clubs and sport entities. On the other hand, the most important technologies are those related to physical evaluation and injury prevention, and also those used for physical monitoring, being these very important or a priority for 82% and 78% of the respondents, respectively.

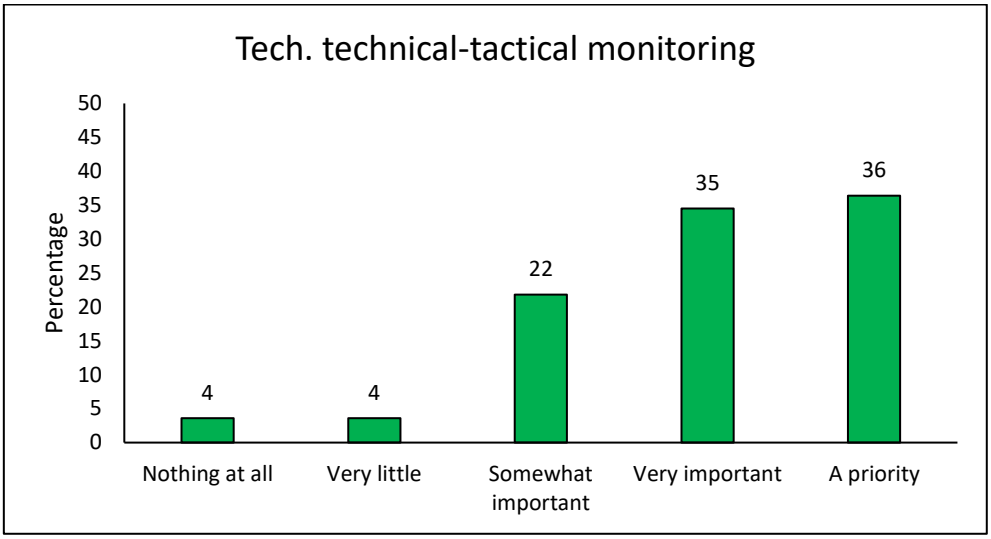


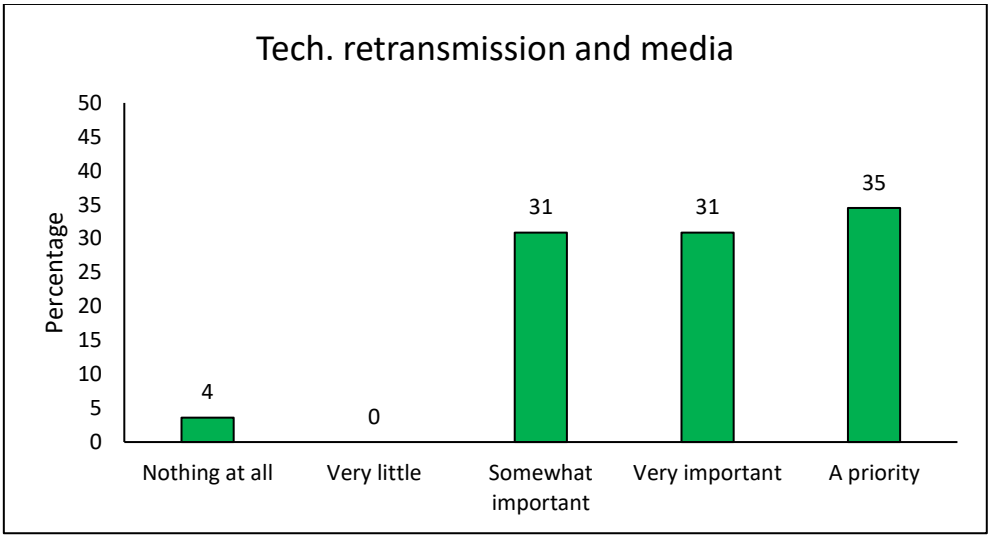



Tech. reporting and visualization
Percentage
50
45
40
35
30
25
20
15
10
5
0
4
11
26
38
22
Nothing at all
Very little
Somewhat important
Very important
A priority


Tech. physical evaluation and injury prevention
Percentage
75
60
45
30
15
0
2
4
13
31
51
Nothing at all
Very little
Somewhat important
Very important
A priority

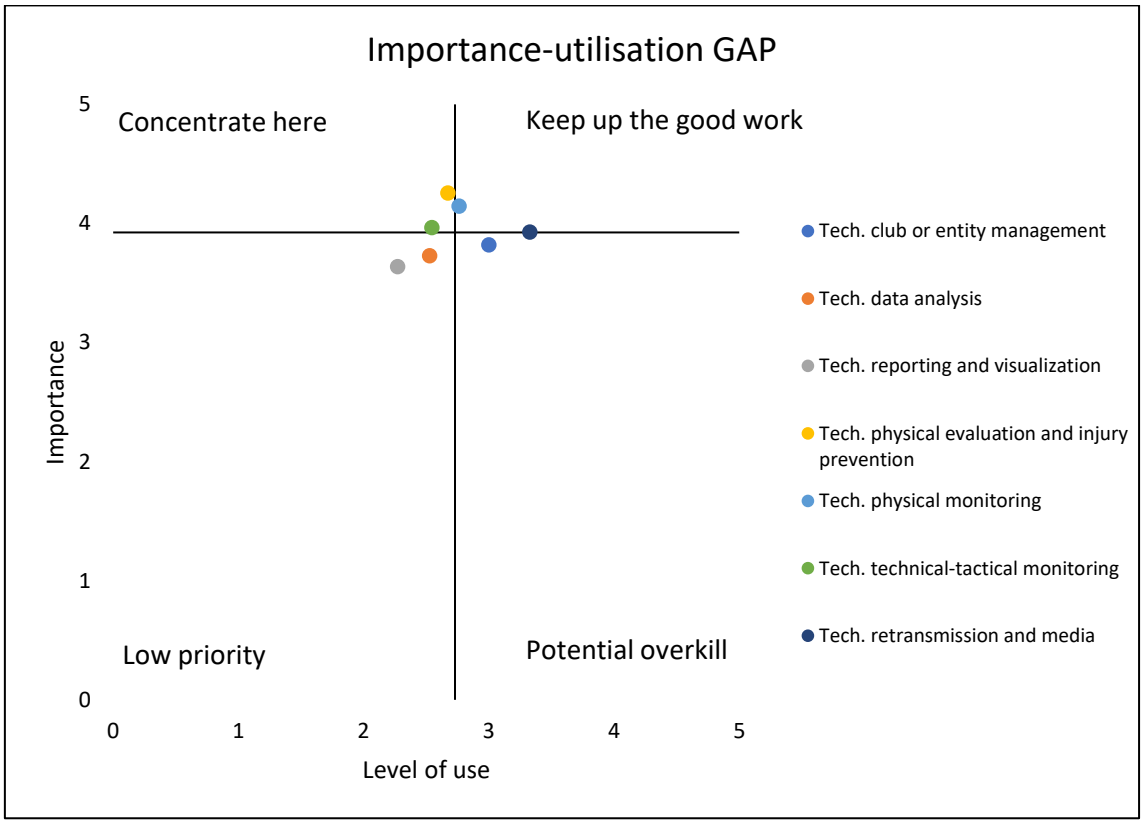

Tech. physical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
2
2
18
36
42
Nothing at all
Very little
Somewhat important
Very important
A priority





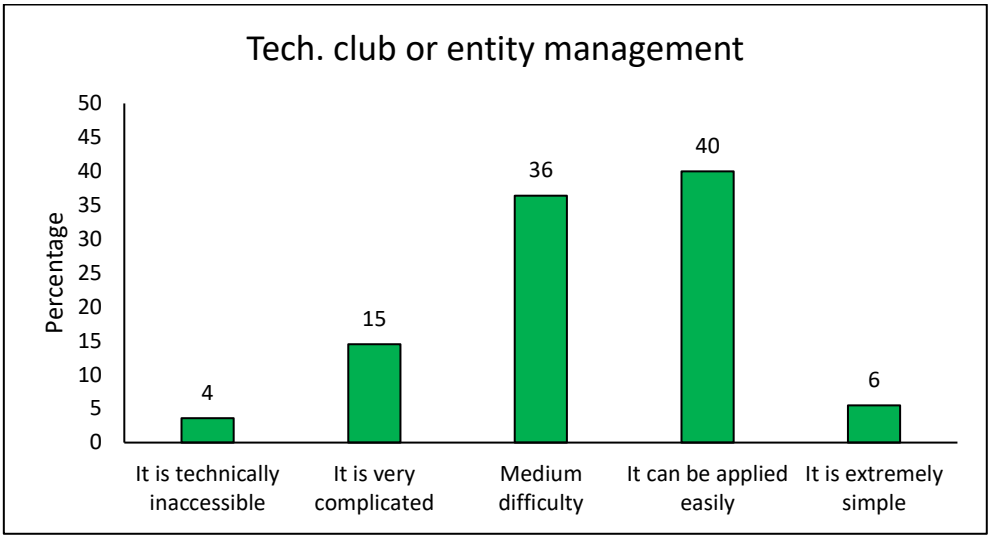
4. GAP analysis between use and importance of technological areas

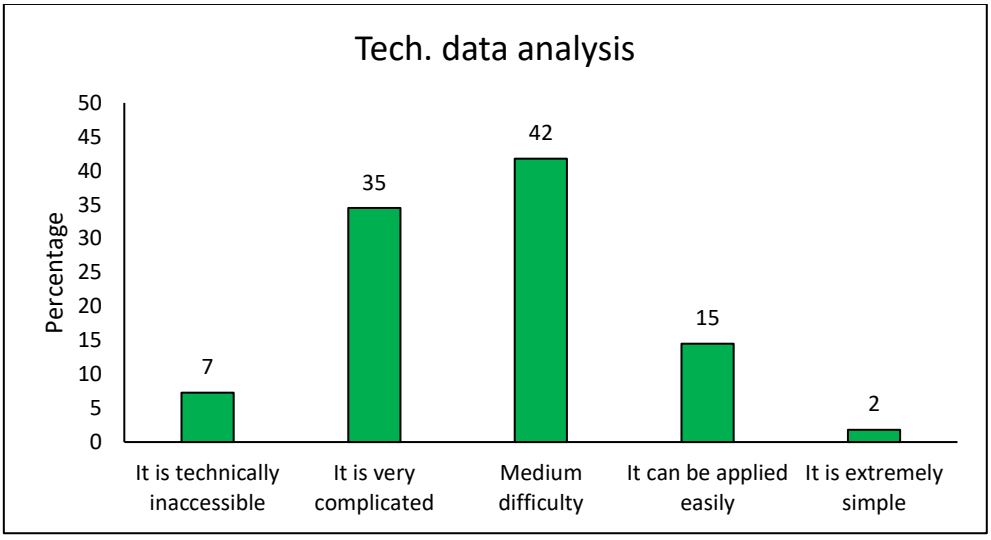
The following graph shows the relation between importance and utilisation of the different technologies, based on the responses of the sports managers in Italy. According to this, technologies related to physical evaluation and injury prevention, and technologies related to technical-tactical monitoring, should gain presence in the sector due to the importance they have; therefore, they could potentially be more widely used. On the other hand, low priority should be given to other technologies used for reporting and visualization and for data analysis, since they are poorly used but they also have little importance compared to the other technologies. Also, the use of technologies related to club or entity management might be widely spread but they do not seem to have a level of importance according to their use.

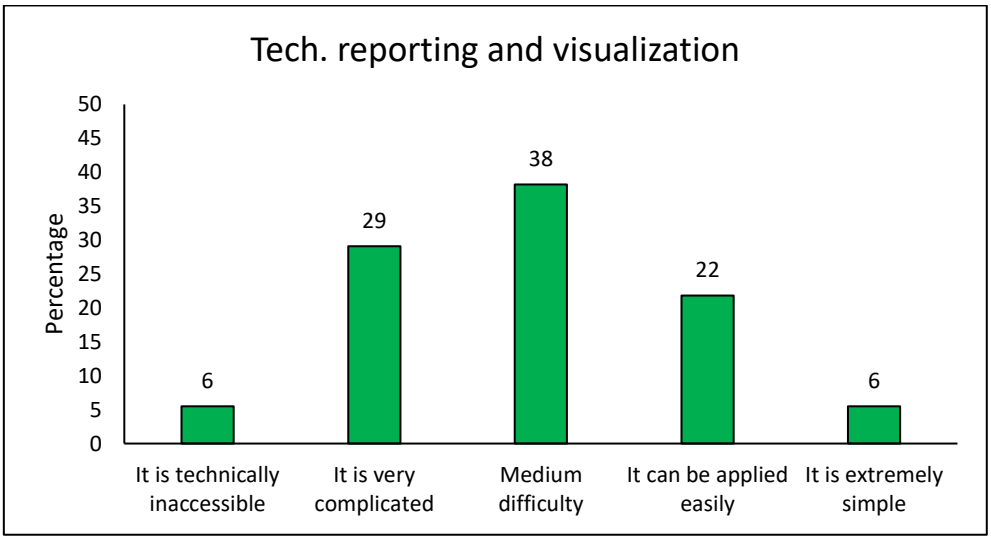


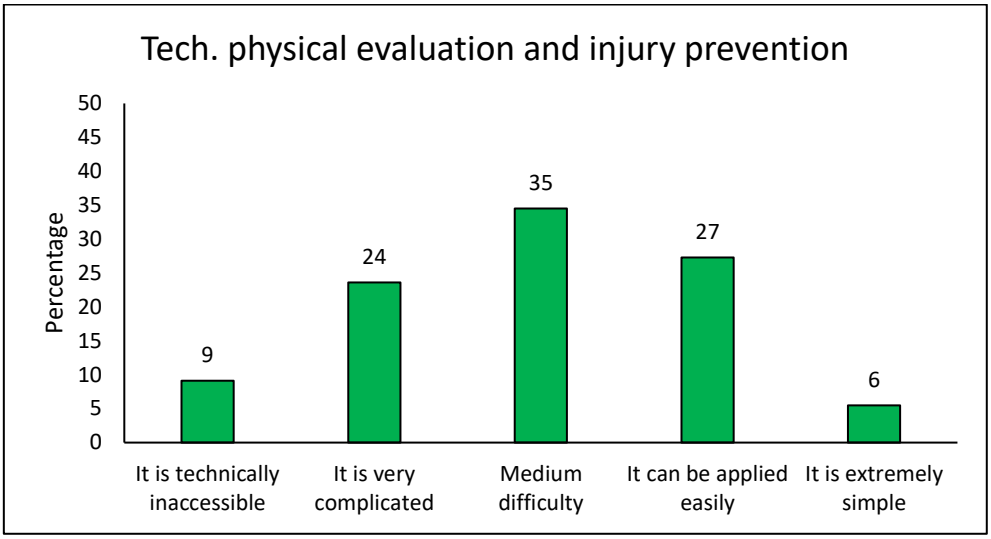
5. What is the level of difficulty that you associate with the use of each technology effectively in your club or sport entity?

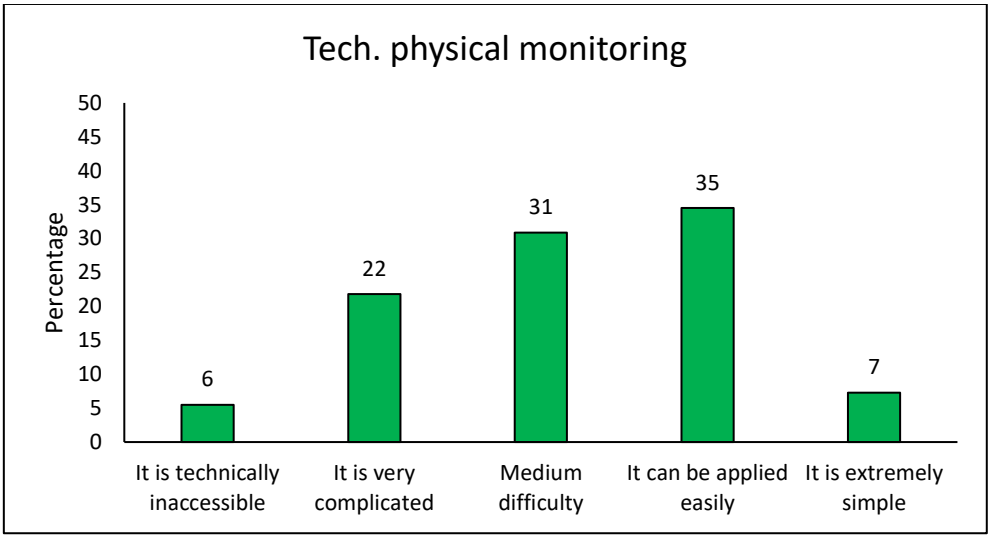
These results show that technologies related to data analysis and technologies used for reporting and visualization are the most difficult ones to implement, with 42% and 35% of the respondents indicating that they are technically inaccessible or very complicated. On the other hand, technology for retransmission and media are the easiest technology to be used effectively in clubs and sport entities, with 20% of respondents indicating that its use is extremely simple.

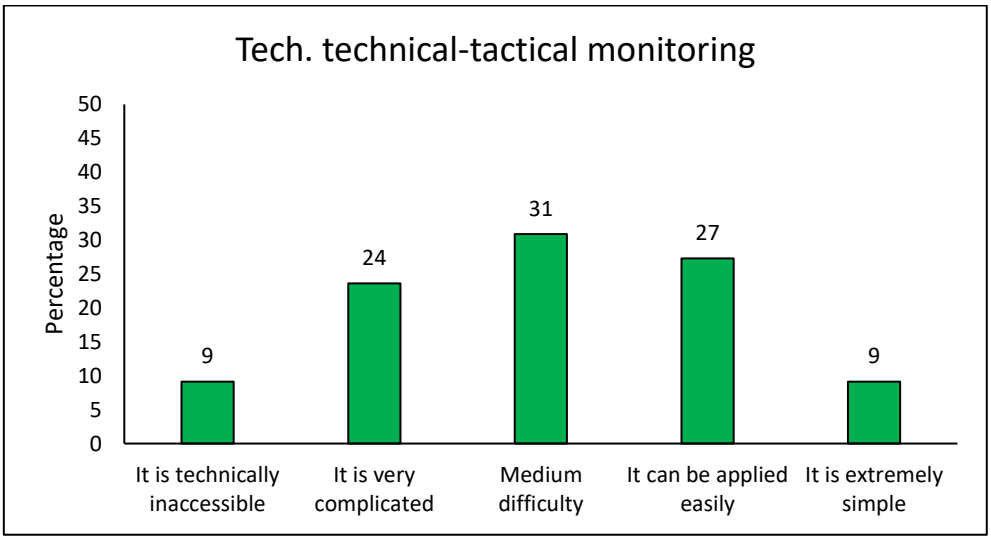

Tech. club or entity management
Percentage
50
45
40
35
30
25
20
15
10
5
0
4
15
36
40
6
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple

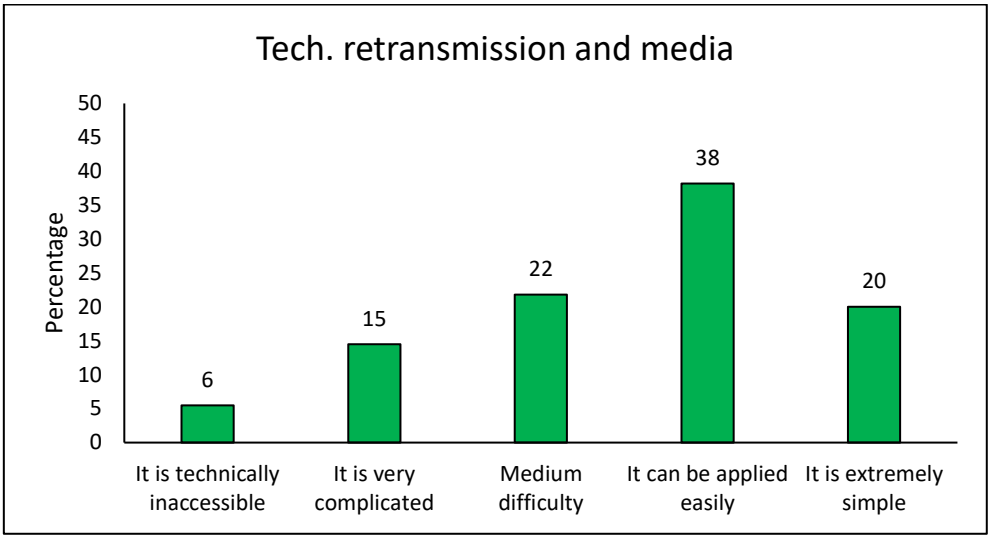

Tech. data analysis
Percentage
50
45
40
35
30
25
20
15
10
5
0
7
35
42
15
2
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple


Tech. reporting and visualization
Percentage
50
45
40
35
30
25
20
15
10
5
0
6
29
38
22
6
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple


Tech. physical evaluation and injury prevention
Percentage
50
45
40
35
30
25
20
15
10
5
0
9
24
35
27
6
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple

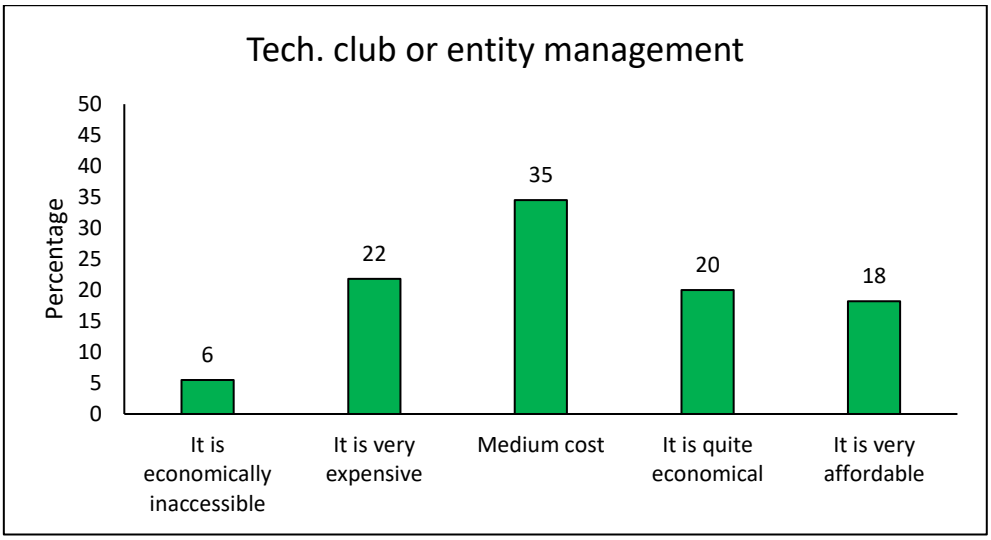

Tech. physical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
6
22
31
35
7
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple

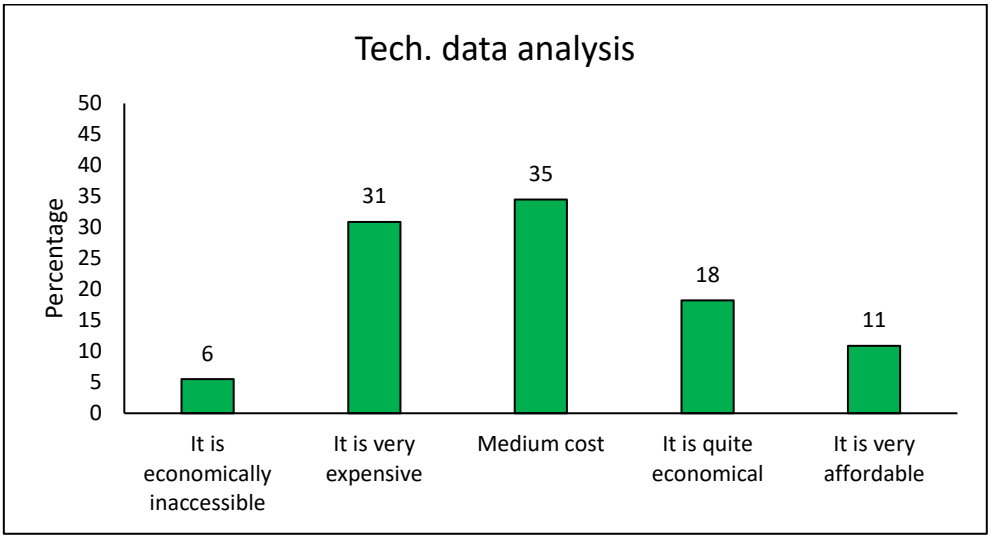

Tech. technical-tactical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
9
24
31
27
9
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple

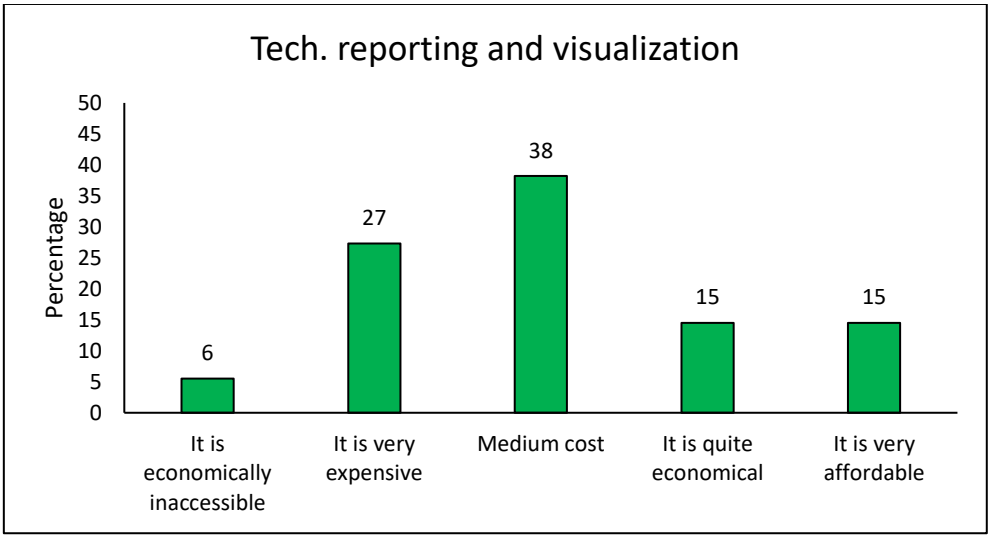


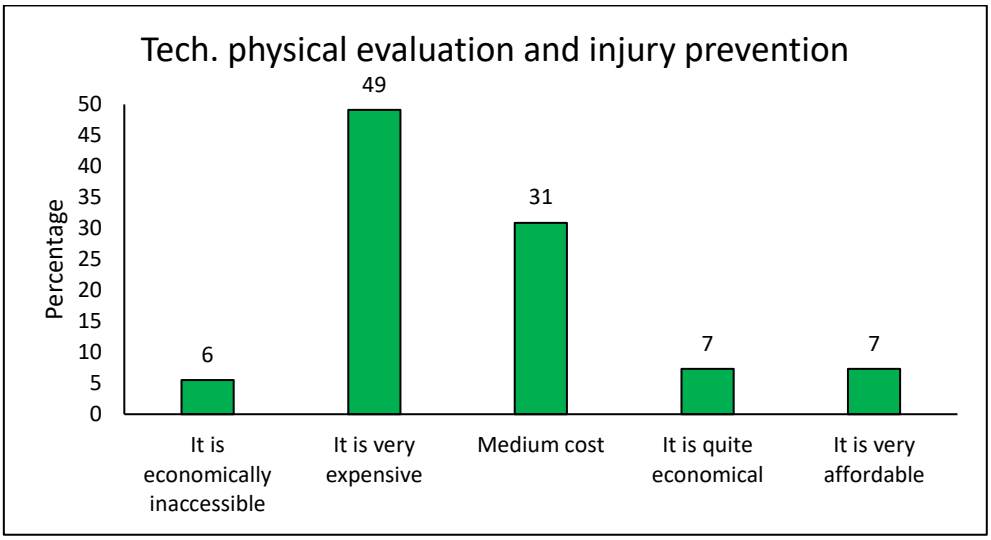
6. Based on your knowledge. How accessible is each technology, economically speaking, for your club or sport entity?

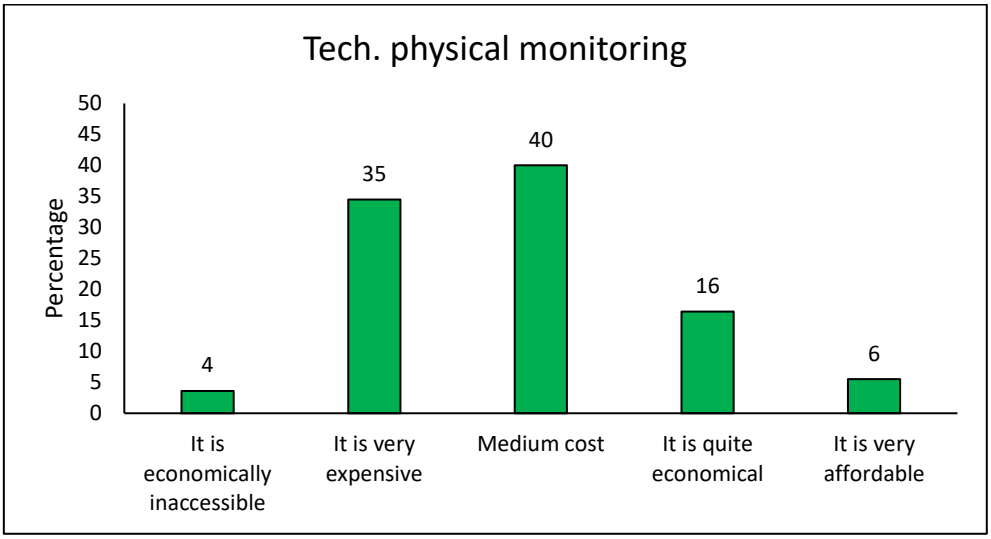
Great diversity is appreciated regarding the cost of implementing the different technologies. Overall, results show that the least accessible technology in economic terms are technologies used for physical evaluation and injury prevention, with 55% of the respondents indicating that they are very expensive or economically inaccessible. On the other hand, the most affordable technologies are those used for retransmission and media, with around 57% reporting that they are quite economical or very affordable.

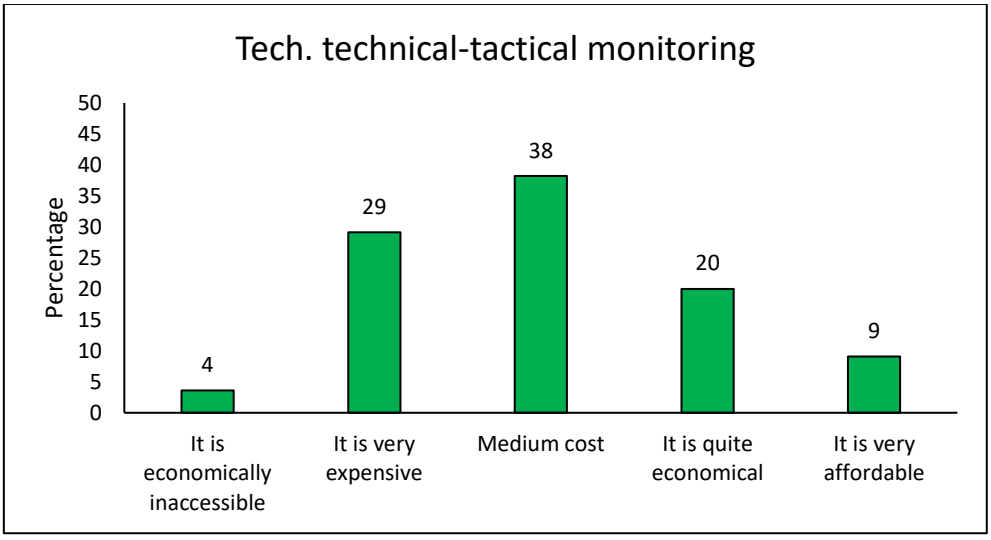


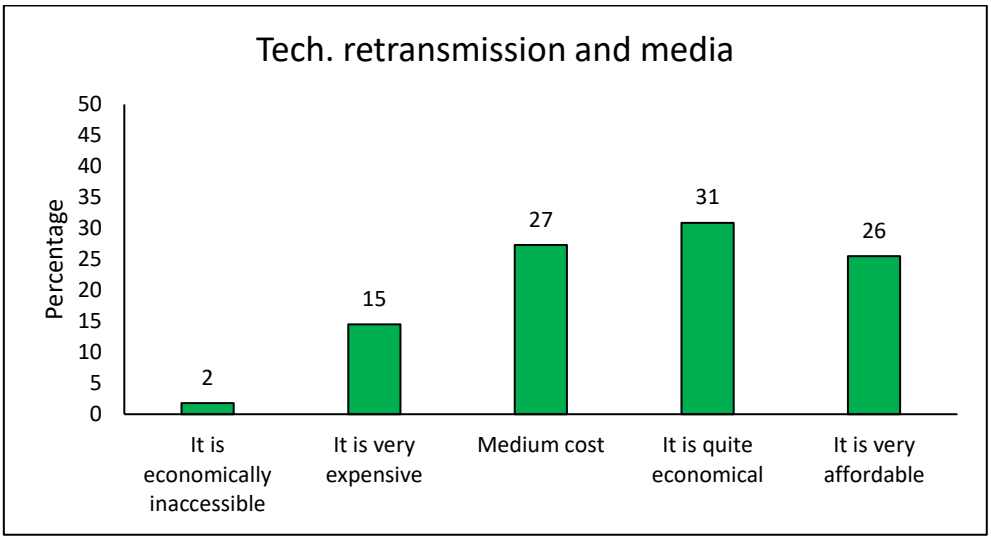

Tech. data analysis
Percentage
50
45
40
35
30
25
20
15
10
5
0
6
31
35
18
11
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very affordable


Tech. reporting and visualization
Percentage
50
45
40
35
30
25
20
15
10
5
0
6
27
38
15
15
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very affordable


Tech. physical evaluation and injury prevention
Percentage
50
45
40
35
30
25
20
15
10
5
0
6
49
31
7
7
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very affordable

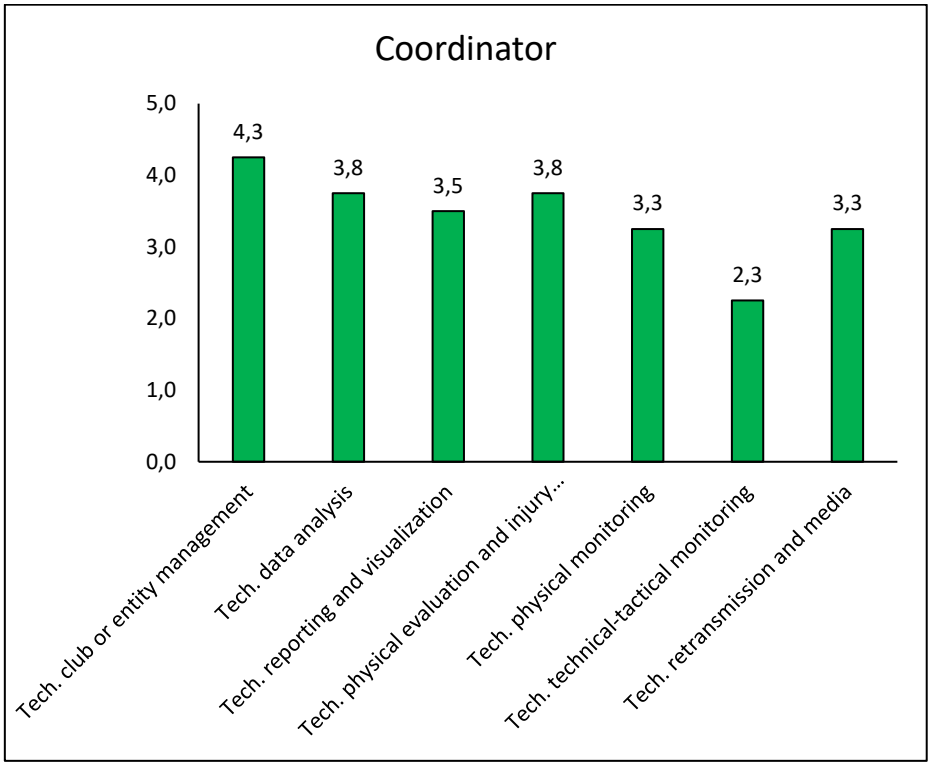

Tech. physical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
4
35
40
16
6
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very affordable

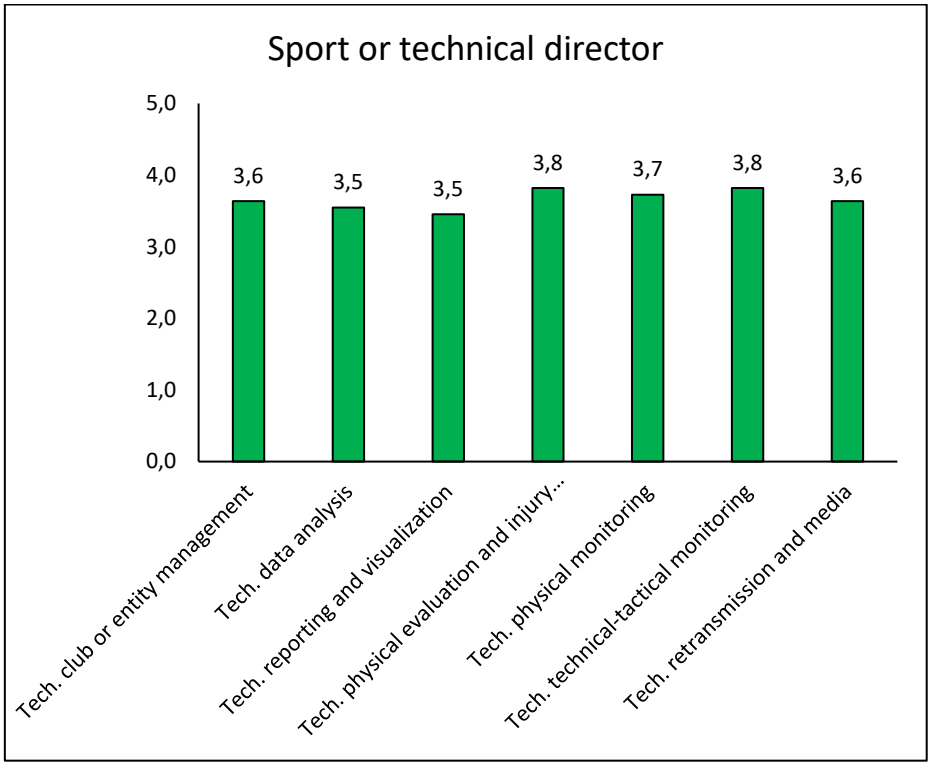

Tech. technical-tactical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
4
29
38
20
9
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very affordable

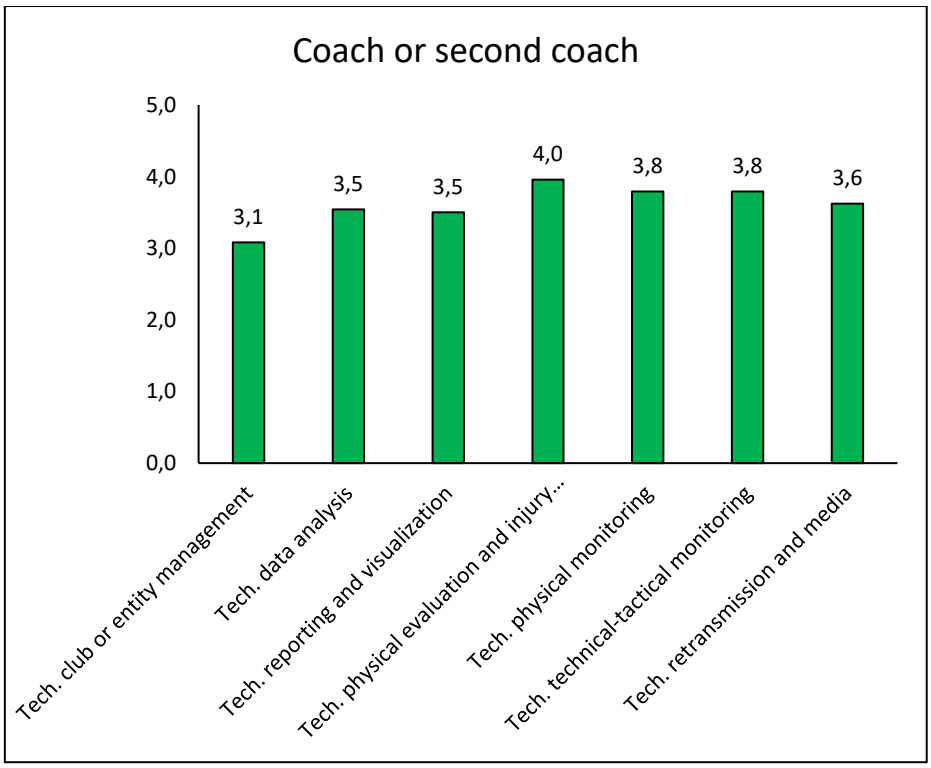

Tech. retransmission and media
Percentage
50
45
40
35
30
25
20
15
10
5
0
2
15
27
31
26
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very affordable

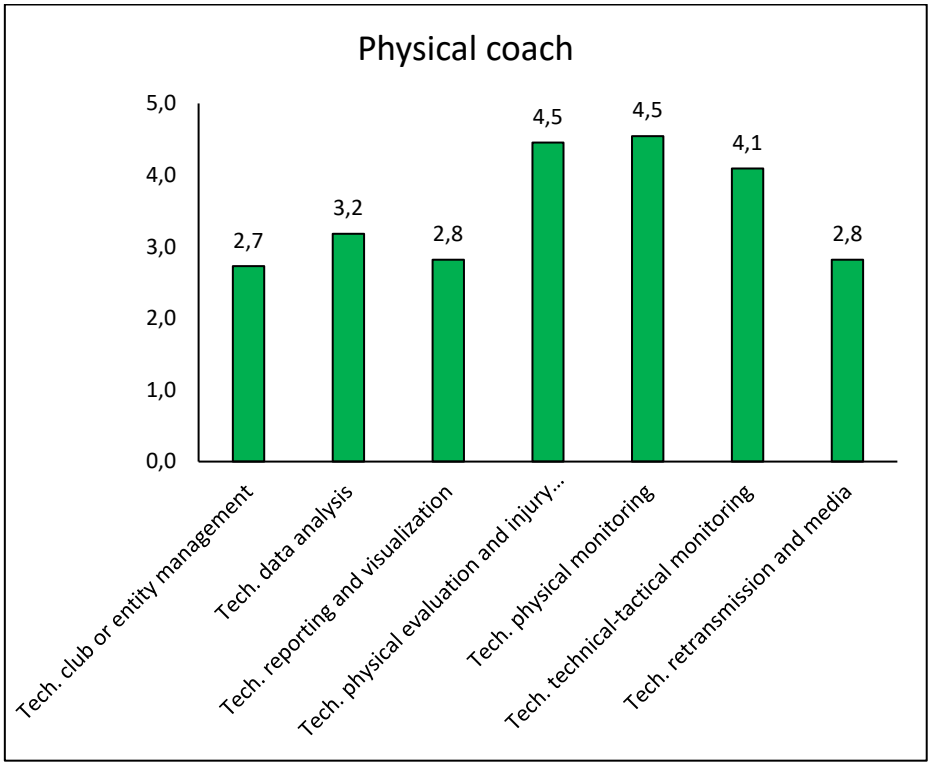
7. How important is each of these technologies for your current position within the club or sport entity?

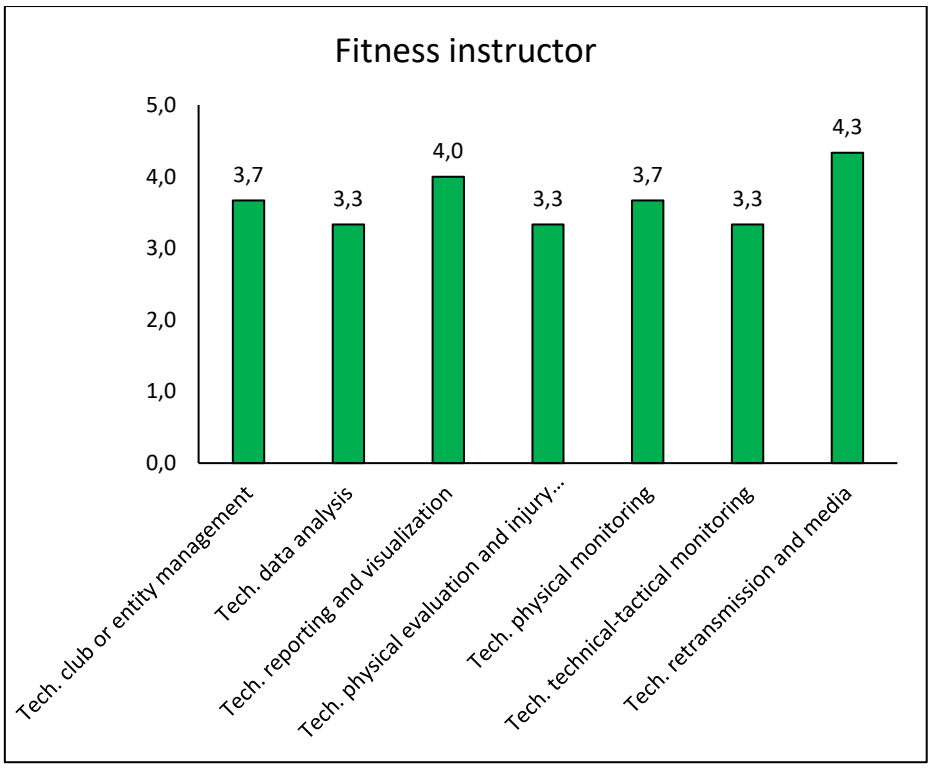
The graphs below show the importance of the use of technologies depending on the current position in a club or sports entity in Italy. The valuation of the different technologies is usually balanced across position, and all of them are of a similar level of importance for most profiles. The greatest differences are seen in Physical coaches, Coordinators and Other technical staff, with differences around 1.8, 2.0, and 2.5 over 5 points, respectively. The importance of the technologies varies greatly across positions, with no current consensus about which of them are the most and least valued.

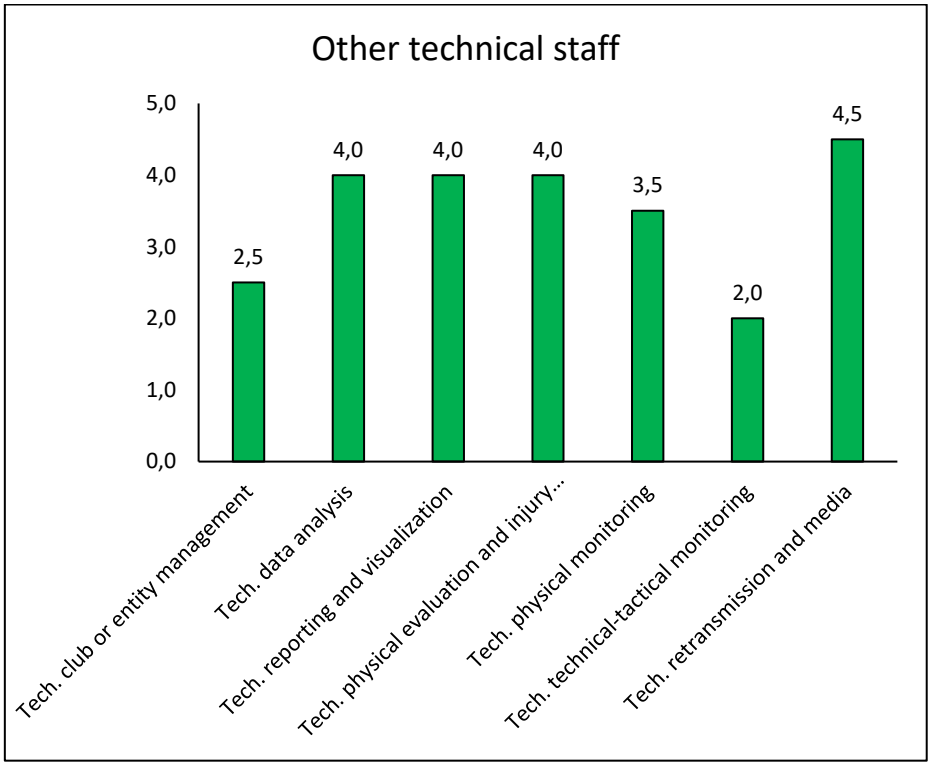



Sport or technical director
5,0
4,0
3,0
2,0
1,0
0,0
3,6
3,5
3,5
3,8
3,7
3,8
3,6
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media


Coach or second coach
5,0
4,0
3,0
2,0
1,0
0,0
3,1
3,5
3,5
4,0
3,8
3,8
3,6
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media

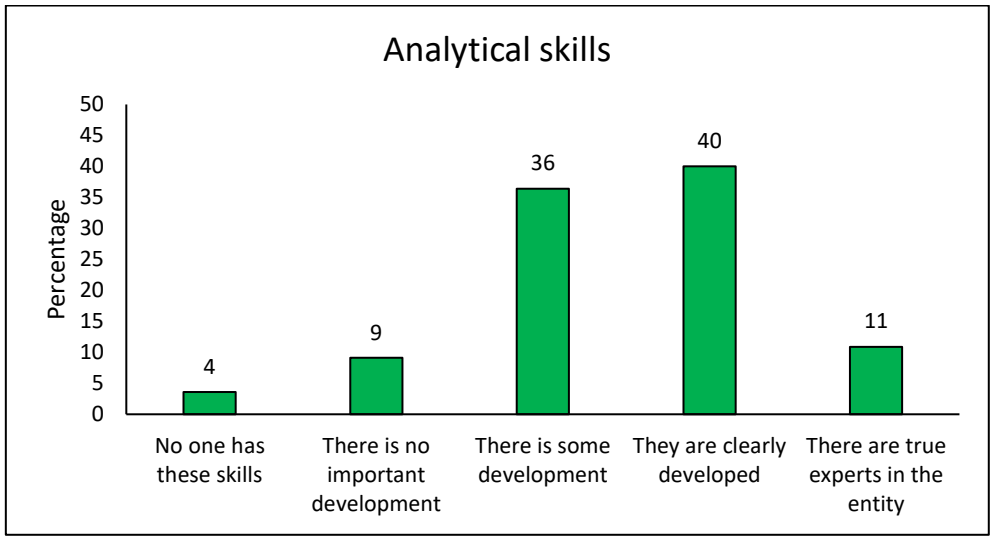

Physical coach
5,0
4,0
3,0
2,0
1,0
0,0
2,7
3,2
2,8
4,5
4,5
4,1
2,8
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media

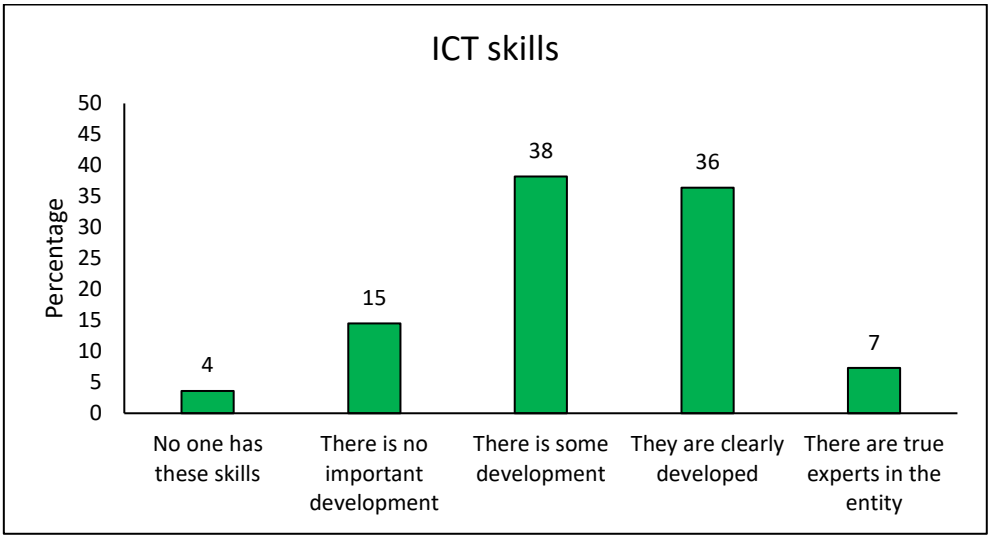

Fitness instructor
5,0
4,0
3,0
2,0
1,0
0,0
3,7
3,3
4,0
3,3
3,7
3,3
4,3
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media

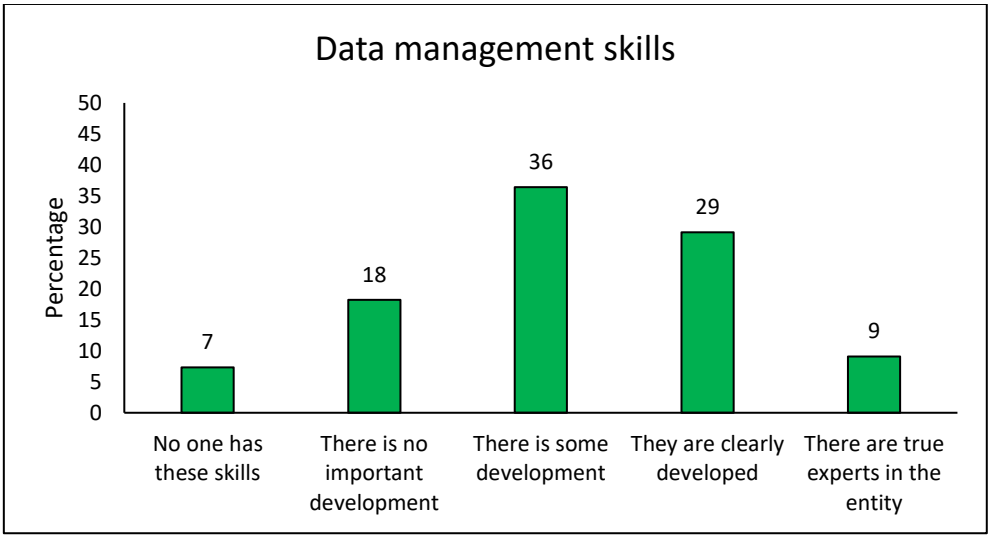


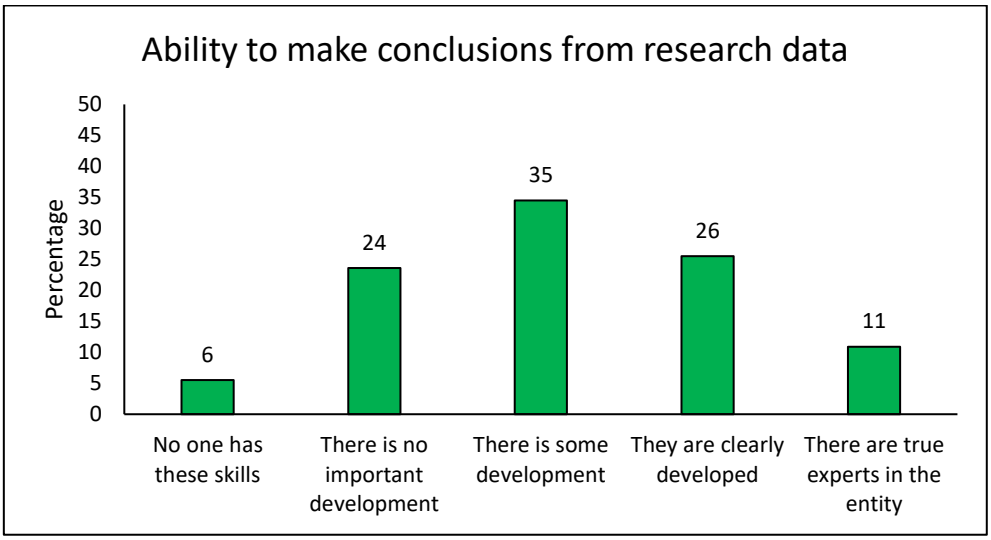
8. How developed are these competencies in your club or sport entity?

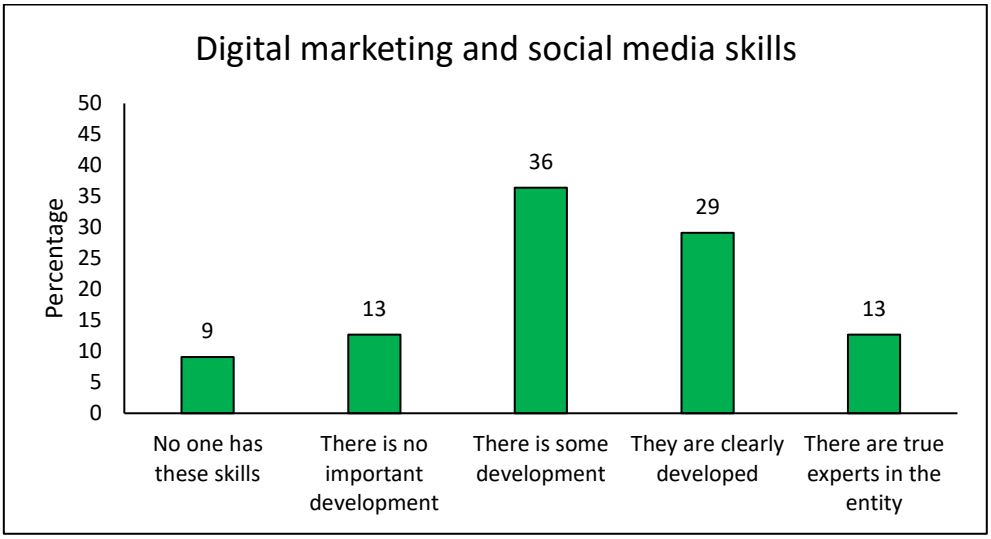
The graphics below show that skills related to digital management of Big Data are clearly the least present in the sector, with 51% of the respondents indicating that no one has these skills or that they are not significantly developed. On the other hand, analytical skills are the ones with the most presence, with 51% reporting that they are clearly developed, at least.

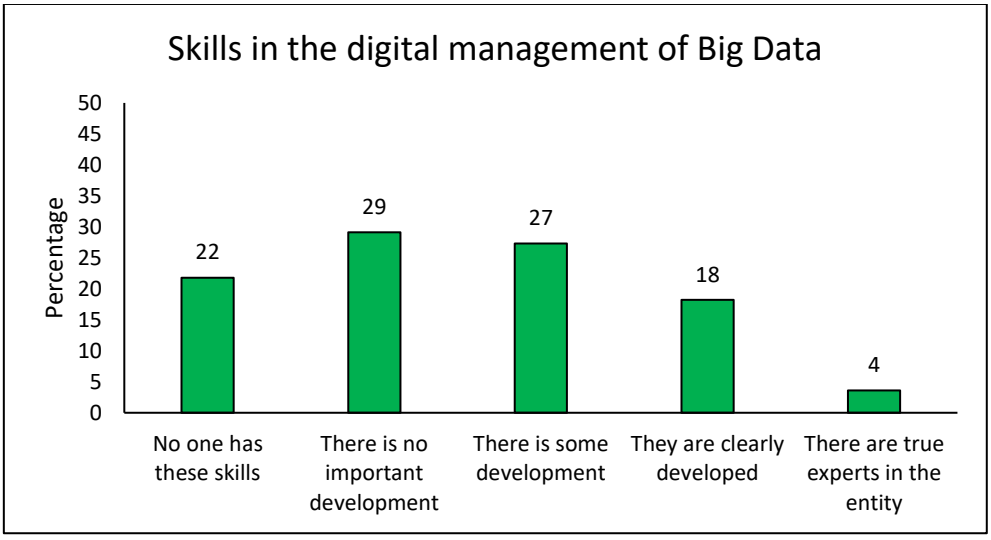



ICT skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
4
15
38
36
7
No one has these skills
There is no important development
There is some development
They are clearly developed
There are true experts in the entity


Data management skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
7
18
36
29
9
No one has these skills
There is no important development
There is some development
They are clearly developed
There are true experts in the entity

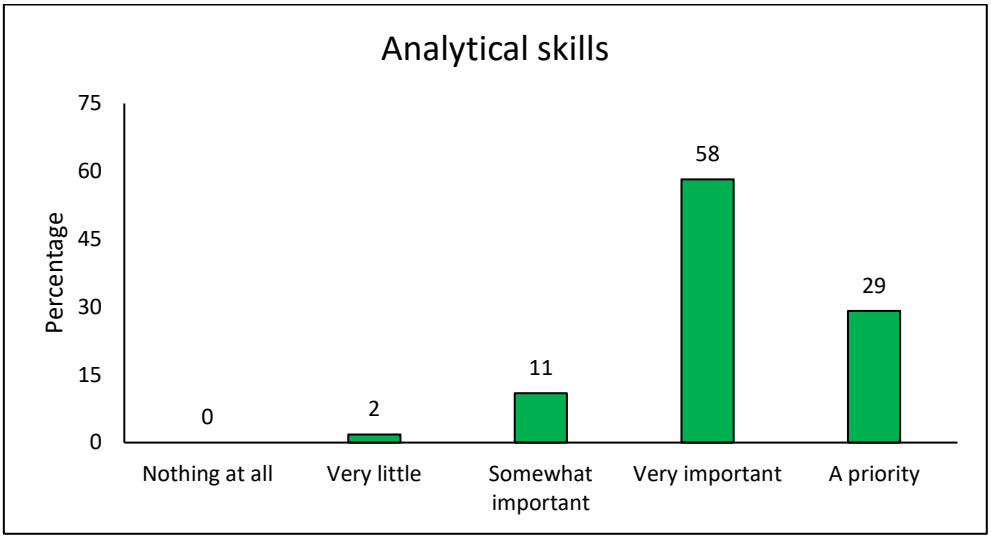

Ability to make conclusions from research data
Percentage
50
45
40
35
30
25
20
15
10
5
0
6
24
35
26
11
No one has these skills
There is no important development
There is some development
They are clearly developed
There are true experts in the entity

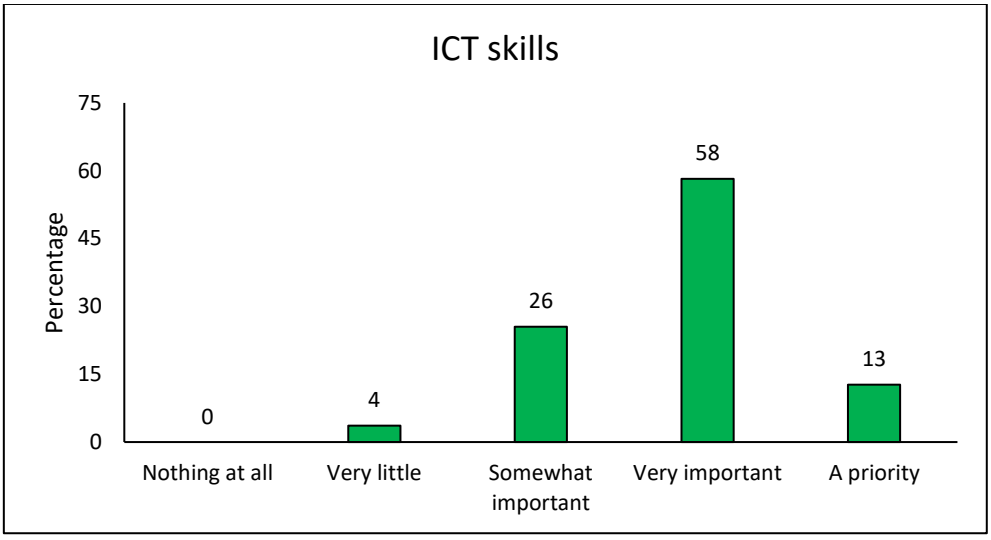


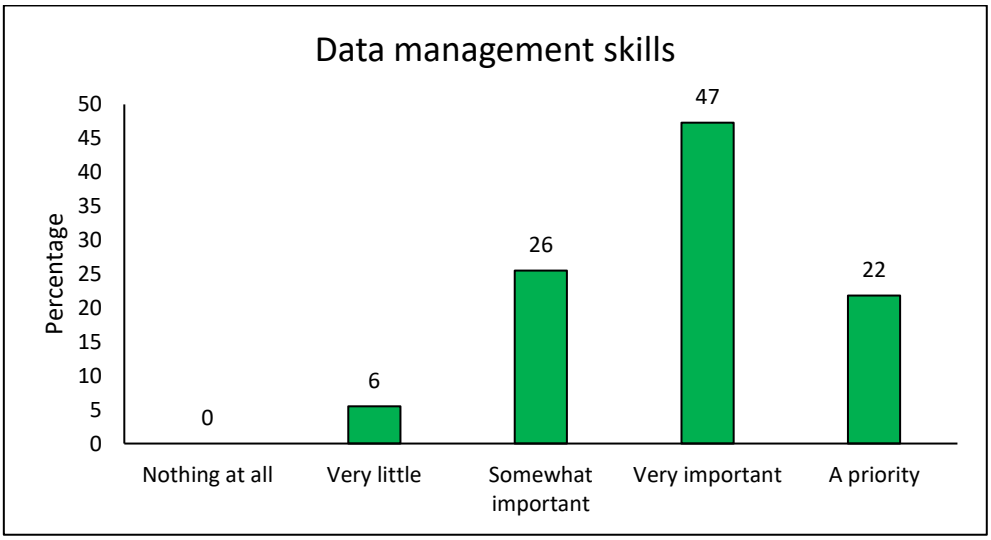


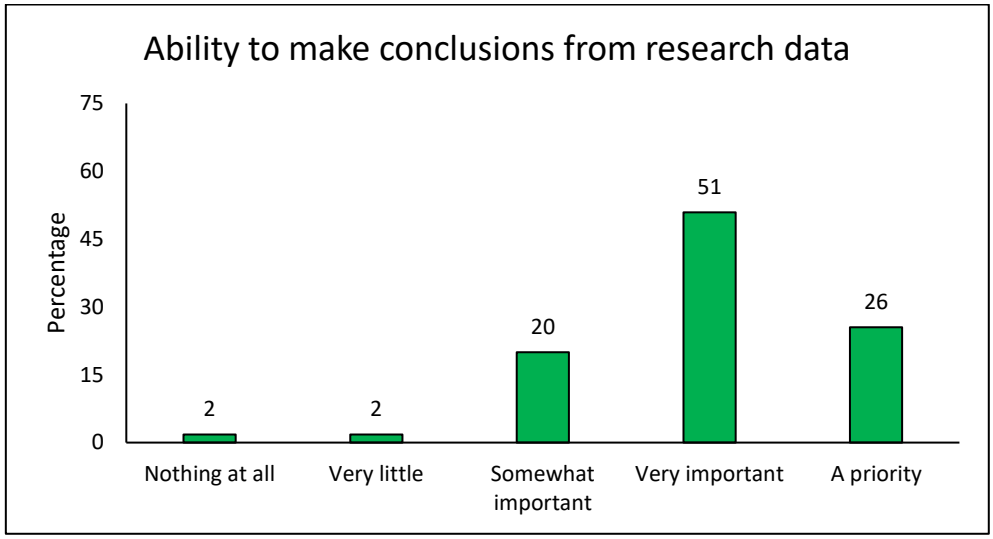
9. How important do you think these professional skills are in your club or sport entity?

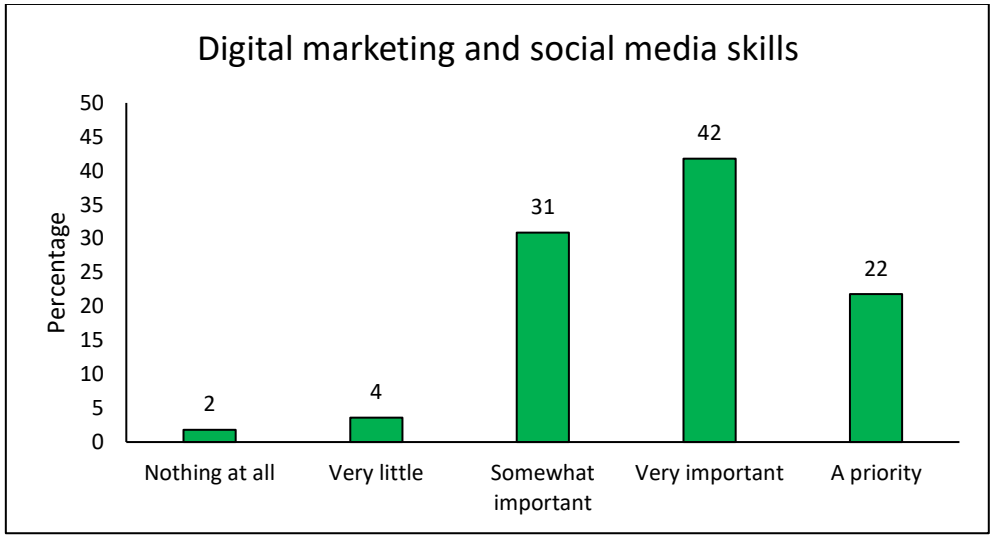
The results show that around 22% of the respondents consider that skills related to digital management of Big Data are not important at all or very little, these being the least important skills in clubs or sport entities in Italy. On the other hand, the most important skills are Analytical skills and Ability to make conclusions from research data, being these very important or a priority for 87% and 77% of the respondents, respectively.

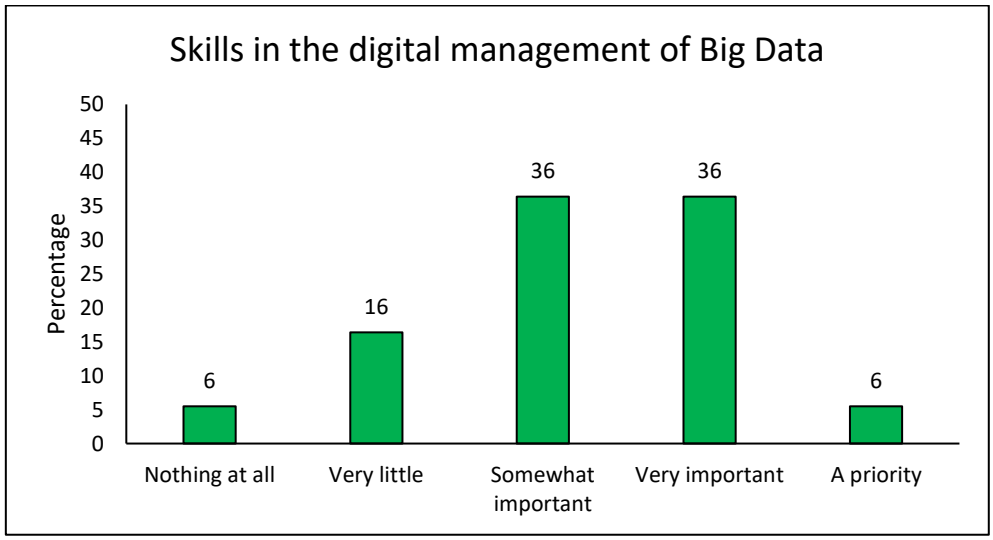

Analytical skills
Percentage
75
60
45
30
15
0
0
2
11
58
29
Nothing at all
Very little
Somewhat important
Very important
A priority


ICT skills
Percentage
75
60
45
30
15
0
0
4
26
58
13
Nothing at all
Very little
Somewhat important
Very important
A priority


Data management skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
0
6
26
47
22
Nothing at all
Very little
Somewhat important
Very important
A priority

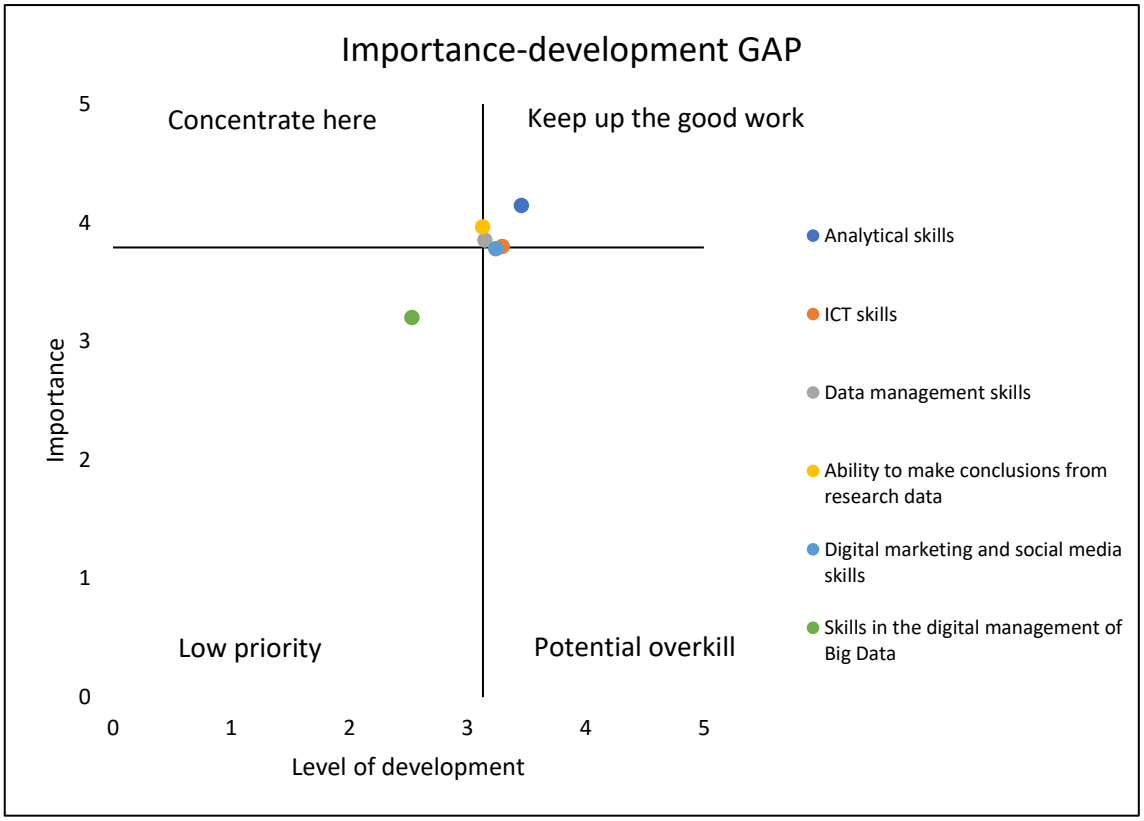

Ability to make conclusions from research data
Percentage
75
60
45
30
15
0
2
2
20
51
26
Nothing at all
Very little
Somewhat important
Very important
A priority


Digital marketing and social media skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
2
4
31
42
22
Nothing at all
Very little
Somewhat important
Very important
A priority


Skills in the digital management of Big Data
Percentage
50
45
40
35
30
25
20
15
10
5
0
6
16
36
36
6
Nothing at all
Very little
Somewhat important
Very important
A priority

10. GAP analysis between development and importance of technological competences

The following graph shows the relation between the importance and the degree of development of the different skills in Italy, based on the responses of the sports managers. According to this,
skills related to digital management of Big Data are clearly the skills that have a lower priority, since they are poorly developed but also have very little importance compared to other skills. No great needs have been identified in terms of improving other skills, since all of them have a level of development commensurate with their relevance in the sector.



11. Discussion of results

In Italy the entire sports movement falls under the leadership of CONI, which is the National Olympic Committee affiliated to the IOC, the confederation of national sports federations and associated sports disciplines, and the national governing body responsible for the development and management of sport in Italy.

CONI is an umbrella organization reuniting 45 National Sport Federations (FSN), 19 Associated Disciplines (DSA), 15 organizations for sports promotion and 19 further cultural associations active in the sports field. An overall number of 95,000 sport clubs fall under CONI's jurisdiction, counting up to 4.7 million members[1].

Within this vast world, the figures object of the present study were the following:
a). Coach or second coach
b). Physical coach
c). Fitness instructor
d). Coordinator
e). Sport or technical director
f). Other technical staff, rehabilitator, analyst, etc.

Except the fitness sector, which does not fall under the competence of CONI, all the other figures are mentioned in the aforementioned survey which reports the following numbers: 247,806 technicians in the FSN plus 9,819 in the DSA, for a total of n. 257,625 technicians.

This term includes those who are regularly registered by the Federation and possess the qualifications of instructor, coach and/or trainer. Sports directors and technical directors are also included in this category.

There are also 118,668 other figures that include among other doctors and parasanitary personnel (masseurs, physiotherapists, athletic trainers, physical coach, etc.).

The members of the governing bodies of clubs and sports organizations and the operators active in daily management exceed well over half a million people.

The results from the sample examined, although in their small size, seem to photograph with sufficient approximation the point of view of qualified representatives of the technical component of the sports world, mostly coaches.

The technologies most closely related to physical assessment, injury prevention, training monitoring and, to a slightly lesser extent, technical-tactical monitoring are considered to be of the utmost importance. Their use is considered of medium difficulty- that is, the participants consider themselves sufficiently in possession of the necessary skills - but they are not very present in the clubs and therefore underused, often due to the significant cost.

[1] I numeri dello sport 2017 – Coni Servizi S.p.A., Centro Studi e Osservatori Statistici per lo Sport, Roma 2018

Probably this is the field in which the most effective improvement interventions are conceivable, aimed at increasing skills and a more in-depth knowledge of the market. Technologies and skills related to communication and the media are also considered extremely important and there is already a widespread use of these technologies, an extensive ability to use them and easy accessibility.

The situation is different for data analysis and reporting technologies, which are not very present in most of the clubs examined, both because they are considered of moderate importance, and because they are technically assessed as being inaccessible based on the available skills and because they are expensive.

Finally, with regard to the management technologies of the club or sports organization, they are considered important and widely used, without encountering particular problems of economic accessibility or difficulties related to technical skills. Still, with regard to skills, the main discovery is the low importance and the degree of development of skills in the digital management of Big Data, which are also considered not very relevant.

Instead, there is a substantial agreement in considering analytical skills, the ability to draw conclusions from research data, ITC skills and data management skills to be very important. For all these skills, there is a use substantially aligned with the importance attributed.

For all the aspects considered, there are obviously great differences between a small club of low competitive level and a large competitive club and future research should further differentiate these areas as well as take into account the wide regional variations. Considering, moreover, the obstacle constituted by the cost of certain technologies, future programs could explore the possibility of interventions that take into consideration the economic aspect, both by improving information on the supply side, and by favoring greater integration between producers and sports organizations.

12. Conclusions

► The use of specific technologies in the sports field is considered to be important or even a priority

► Technologies and skills related to communication and use of the media and, to a slightly lesser extent, technologies for the management of clubs or sports organizations are considered extremely important and in this field there is rather widespread use, good skills and easy accessibility

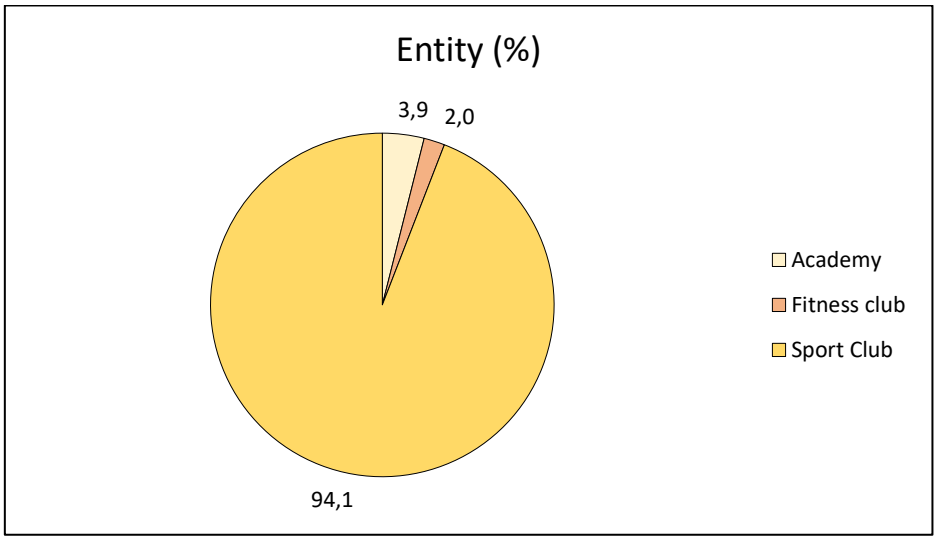
► The technologies considered to be of most interest (technologies for physical evaluation, physical monitoring and technical-tactical monitoring) have an evident underutilization and require development interventions. They are also the ones that face the greatest economic difficulties

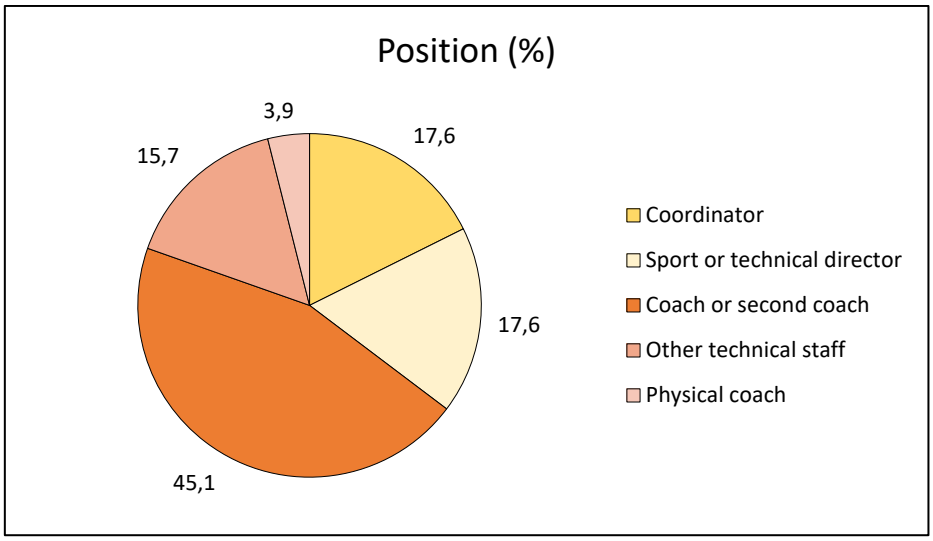
► The technologies relating to data analysis and reporting and presentation are underused, in addition to being expensive, also because they are assessed as being technically inaccessible. Interventions aimed at training specialized figures would be desirable.

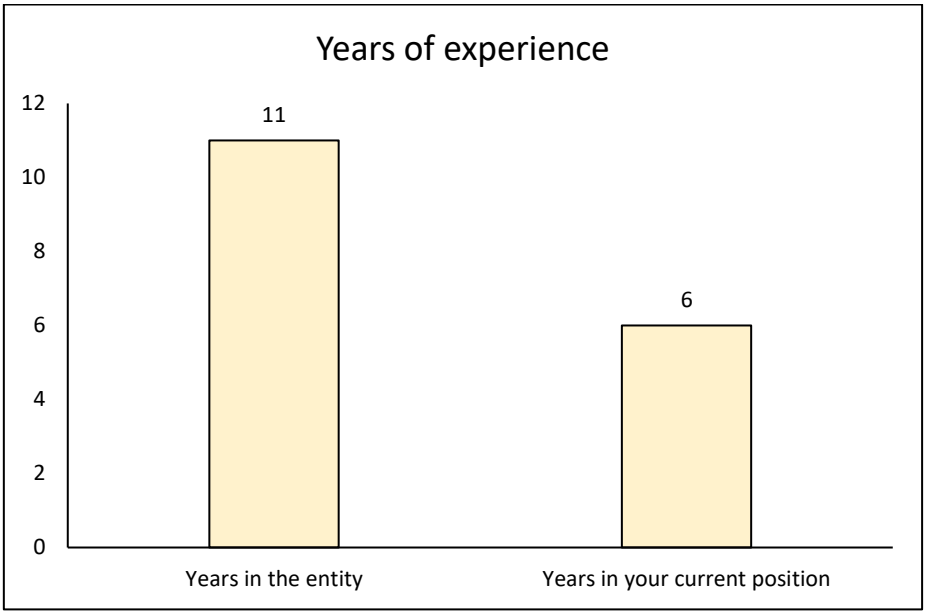
ANEX IV. INDIVIDUAL REPORT. QUESTIONARIE GERMAN VERSION, AUSTRIA

1. Sample

The previous graphs show the general characteristics of the sample. Sports clubs are the entity that has received the most responses (95%). The positions with the highest number of forms answered were physical coach and coordinator and coaches and second coaches. In addition, 10 years was the average of years of experience from those who responded the questionnaire. Finally, an average of 6 years has spent in their current position.

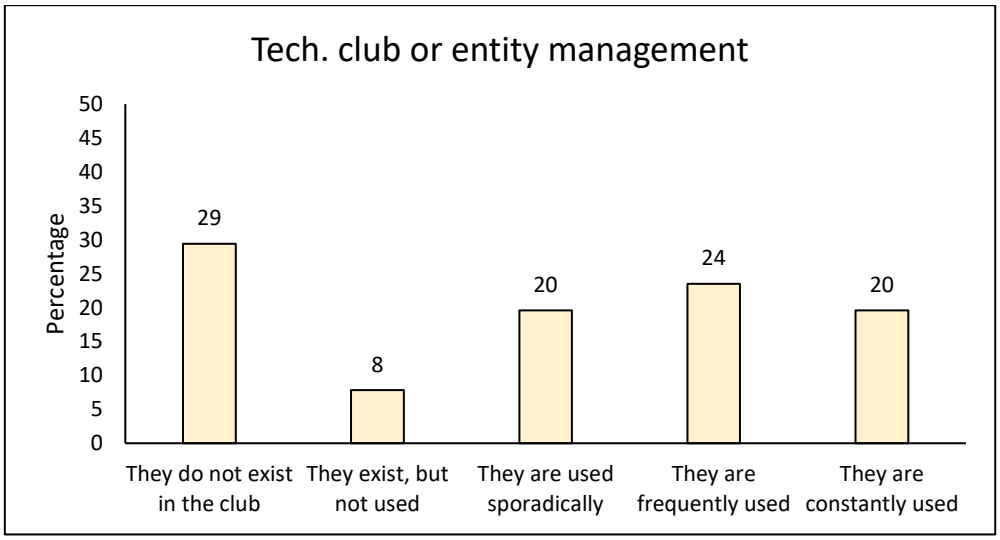


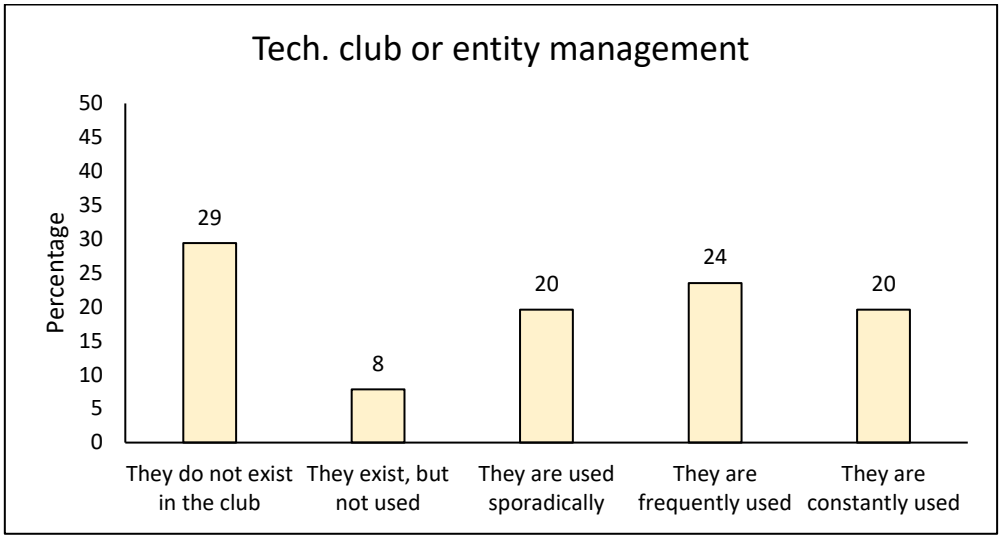


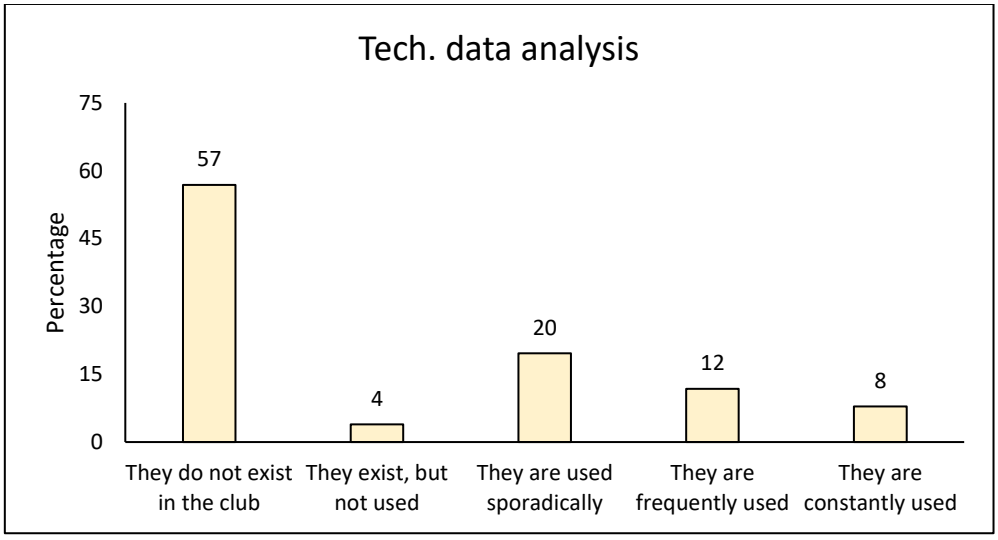


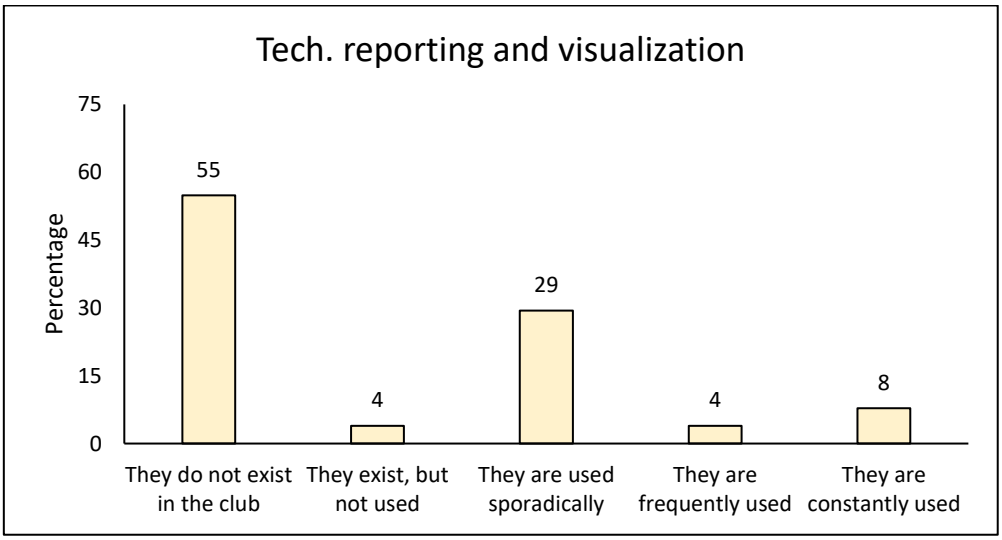
2. To what extent are you currently using these technologies in your club or sport entity?

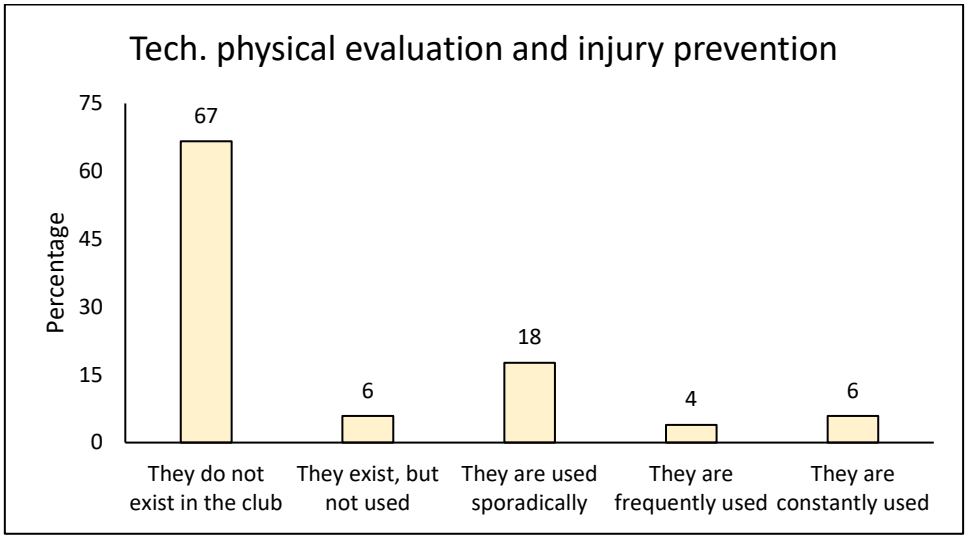
The results of technology utility in different aspects within a club or entity, indicate a greater use of club or entity management technology, still considered low. Regarding the use of data analysis, reporting and visualization technologies, physical evaluation and injury prevention, physical monitoring and technical-tactical monitoring between 55-67% indicate that they do not exist in your sports club or entity. Very high values that show the lack of technology in sports entities and clubs. Finally, the club or entity management and retransmission and media show low values in comparison with others, reflecting the fact that those two areas are getting better.

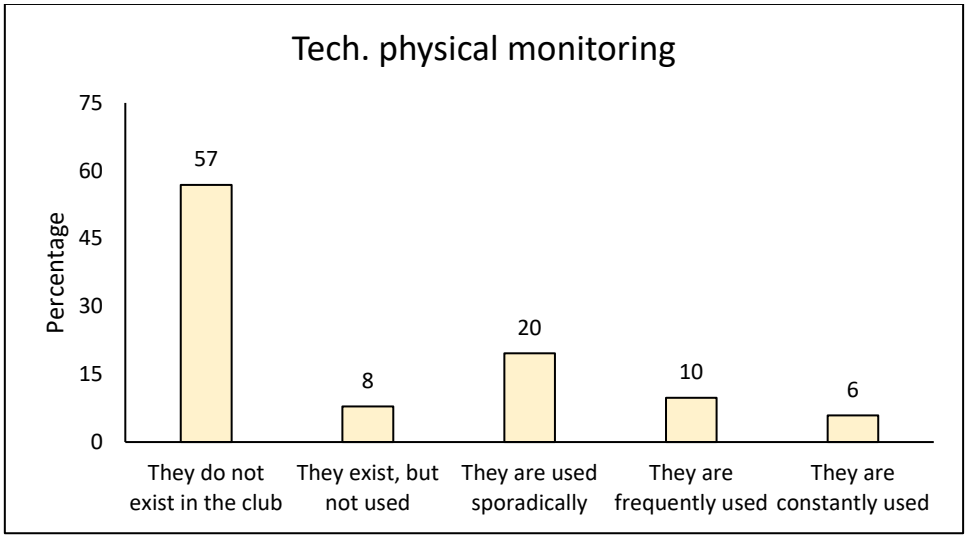


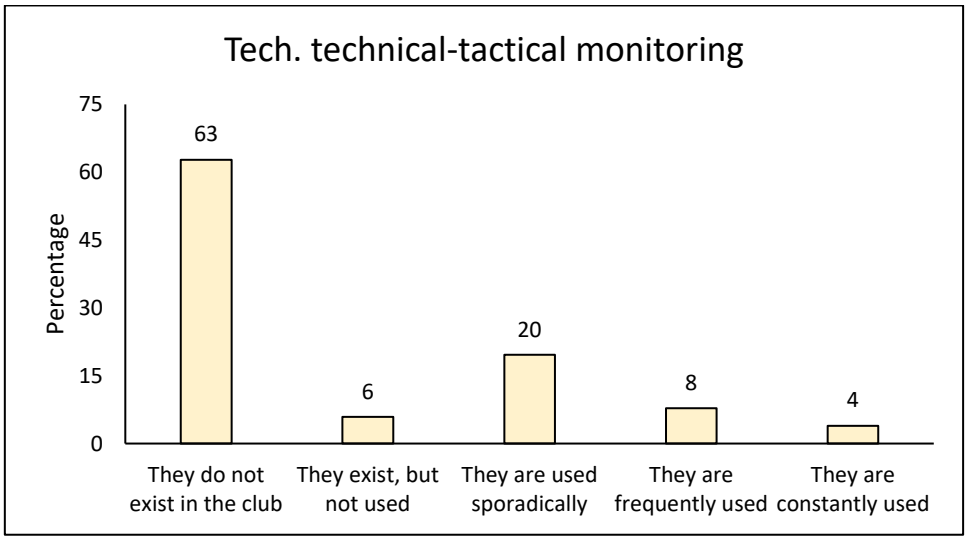

Tech. club or entity management
Percentage
50
45
40
35
30
25
20
15
10
5
0
29
8
20
24
20
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

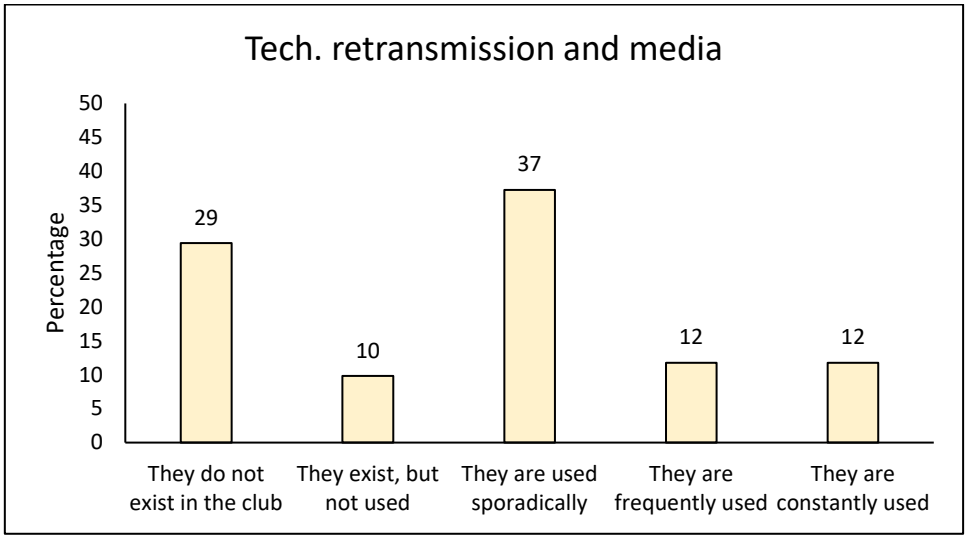

Tech. data analysis
Percentage
75
60
45
30
15
0
57
4
20
12
8
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used


Tech. reporting and visualization
Percentage
75
60
45
30
15
0
55
4
29
4
8
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used


Tech. physical evaluation and injury prevention
Percentage
75
60
45
30
15
0
67
6
18
4
6
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

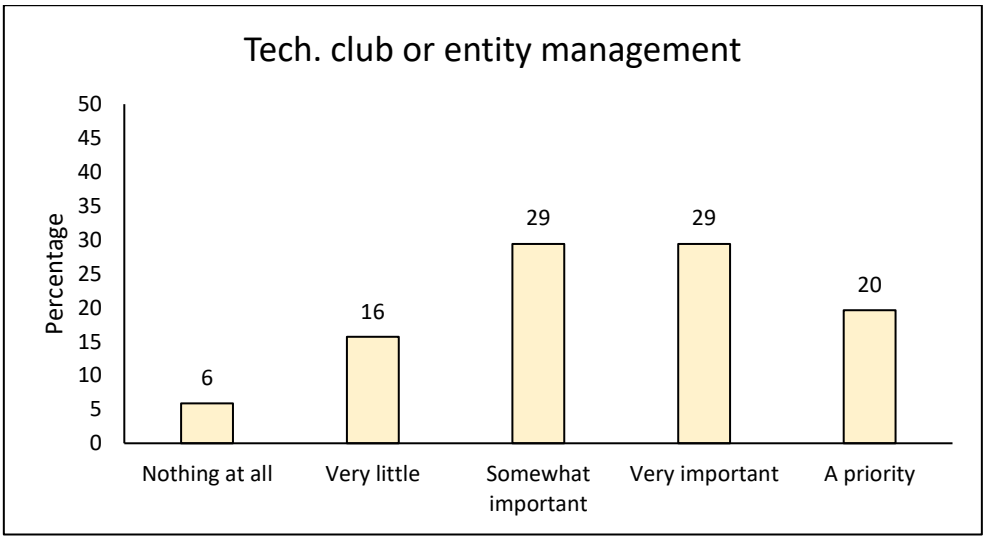

Tech. physical monitoring
Percentage
75
60
45
30
15
0
57
8
20
10
6
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

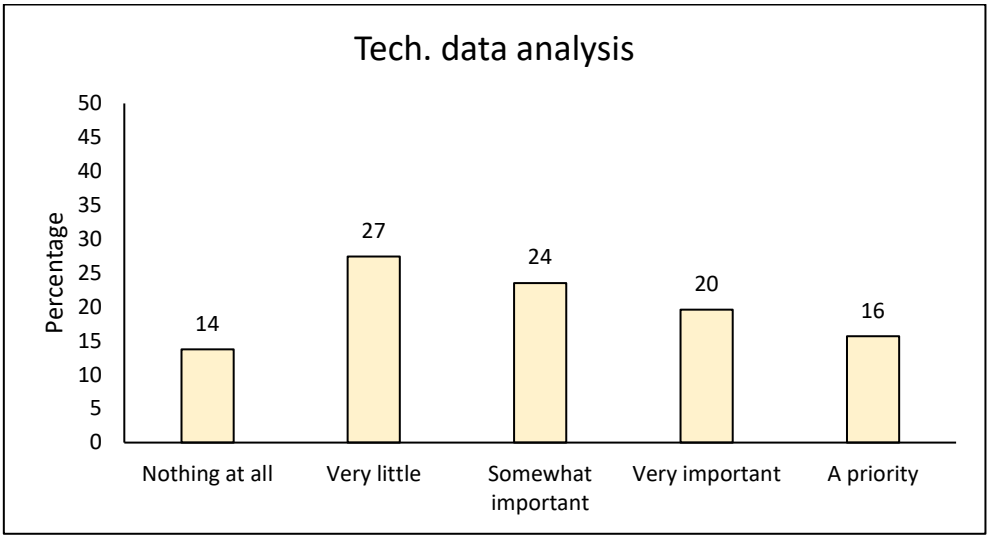

Tech. technical-tactical monitoring
Percentage
75
60
45
30
15
0
63
6
20
8
4
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

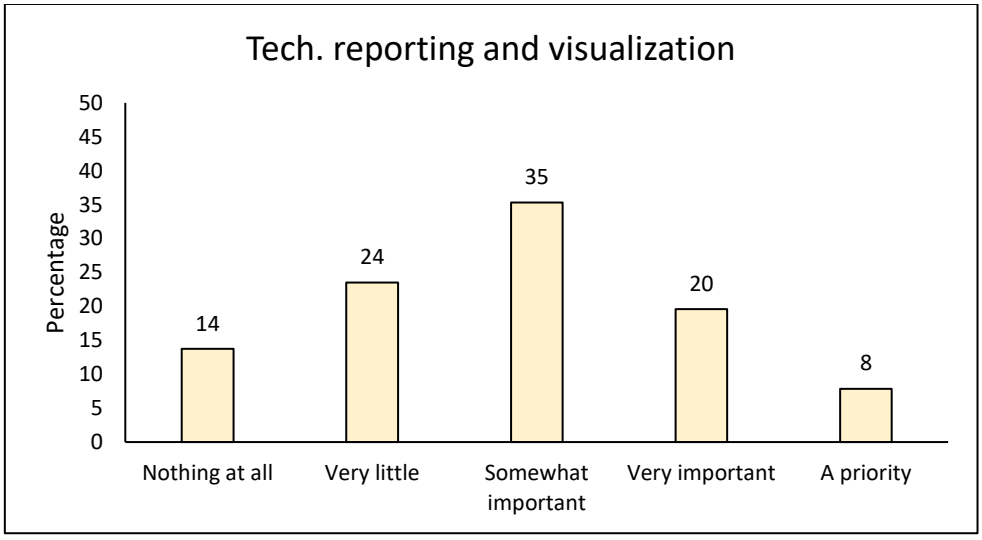


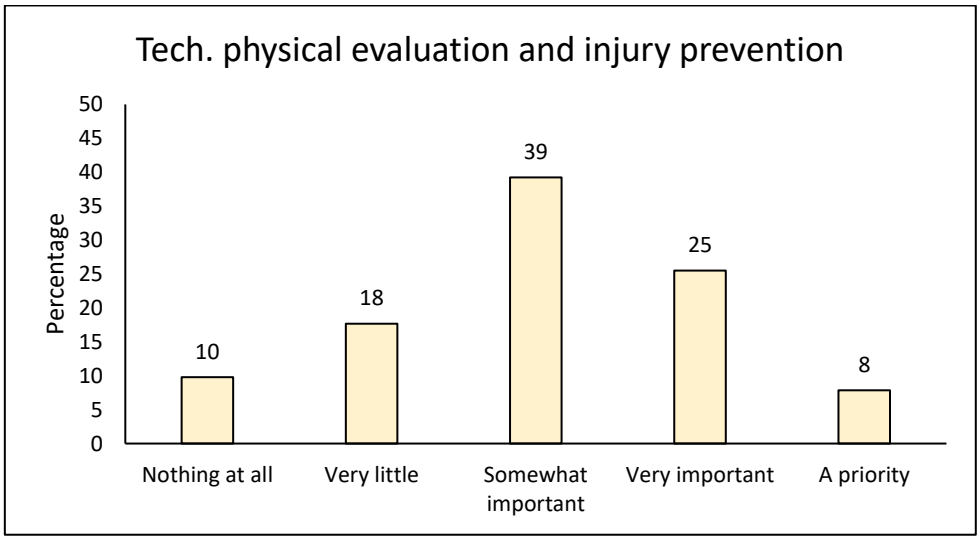
3. How important do you think using these technologies are or would be for your club or sport entity?

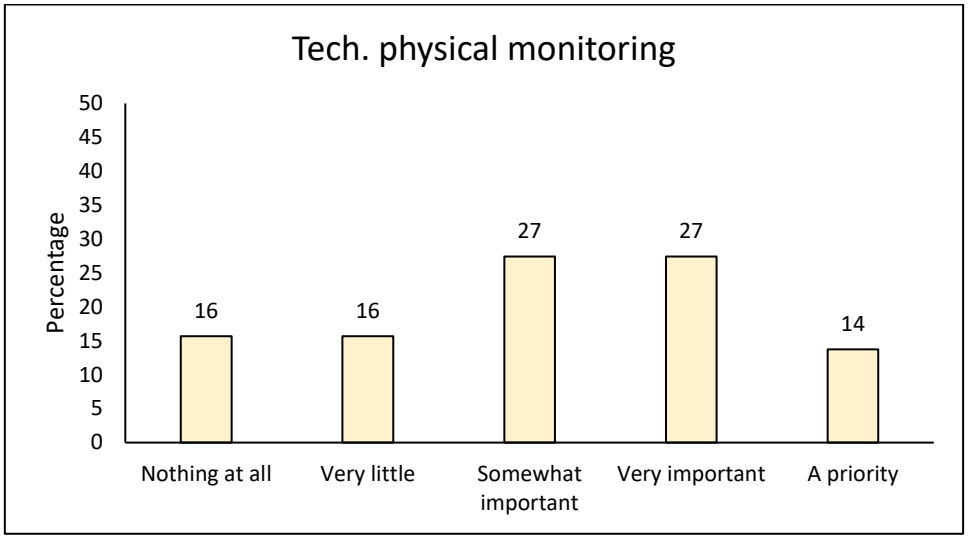
The previous graphs show us how important they think the use of different technologies is in sports clubs or entities. As can be clearly seen, between 24 - 39% believe that it is somewhat important to have these technologies in their entities or sports clubs. Even 20-29% consider that it is very important. Only 8-20% believe that they should be a priority for the proper development of the activities of the entity or sports club. In general, they consider that the use of these technologies is somewhat important or very important in their sports entities or clubs.

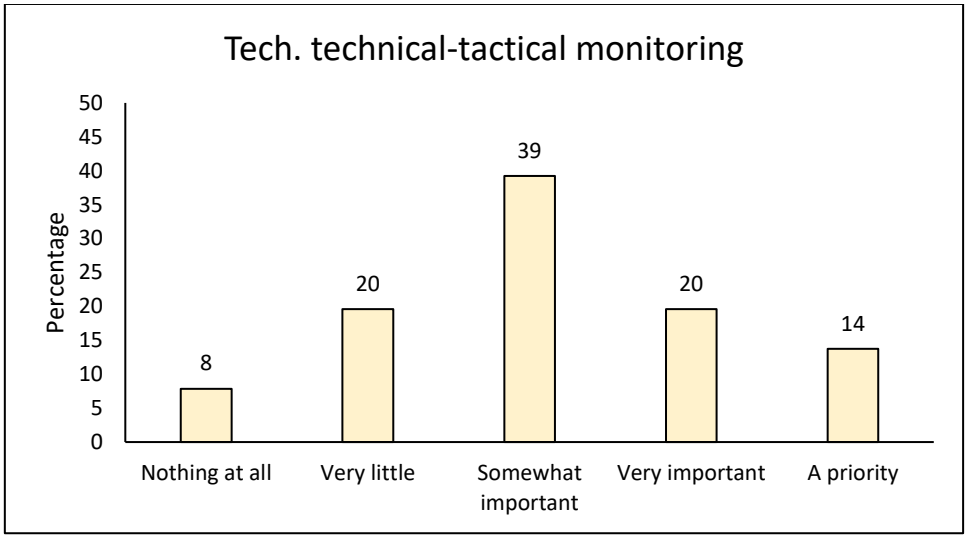


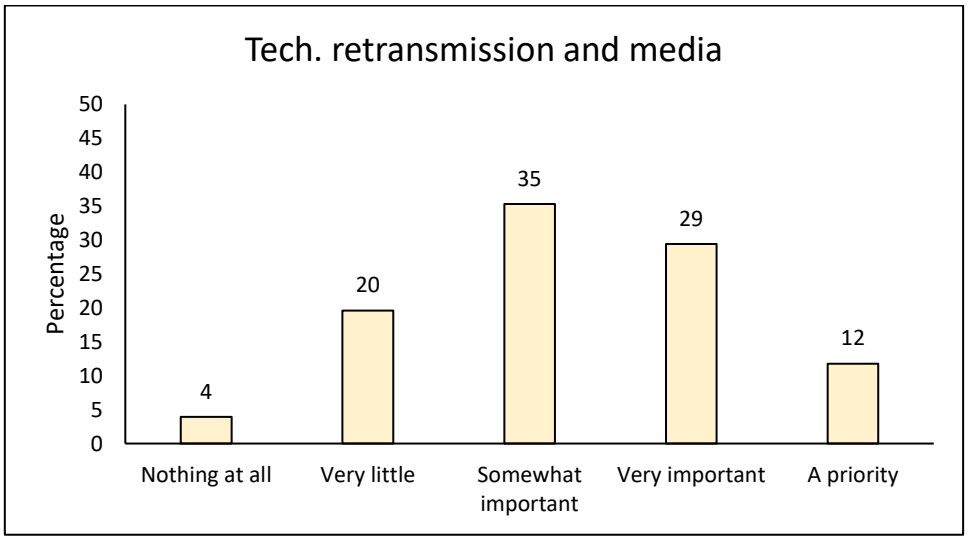

Tech. data analysis
Percentage
50
45
40
35
30
25
20
15
10
5
0
14
27
24
20
16
Nothing at all
Very little
Somewhat important
Very important
A priority


Tech. reporting and visualization
Percentage
50
45
40
35
30
25
20
15
10
5
0
14
24
35
20
8
Nothing at all
Very little
Somewhat important
Very important
A priority


Tech. physical evaluation and injury prevention
Percentage
50
45
40
35
30
25
20
15
10
5
0
10
18
39
25
8
Nothing at all
Very little
Somewhat important
Very important
A priority

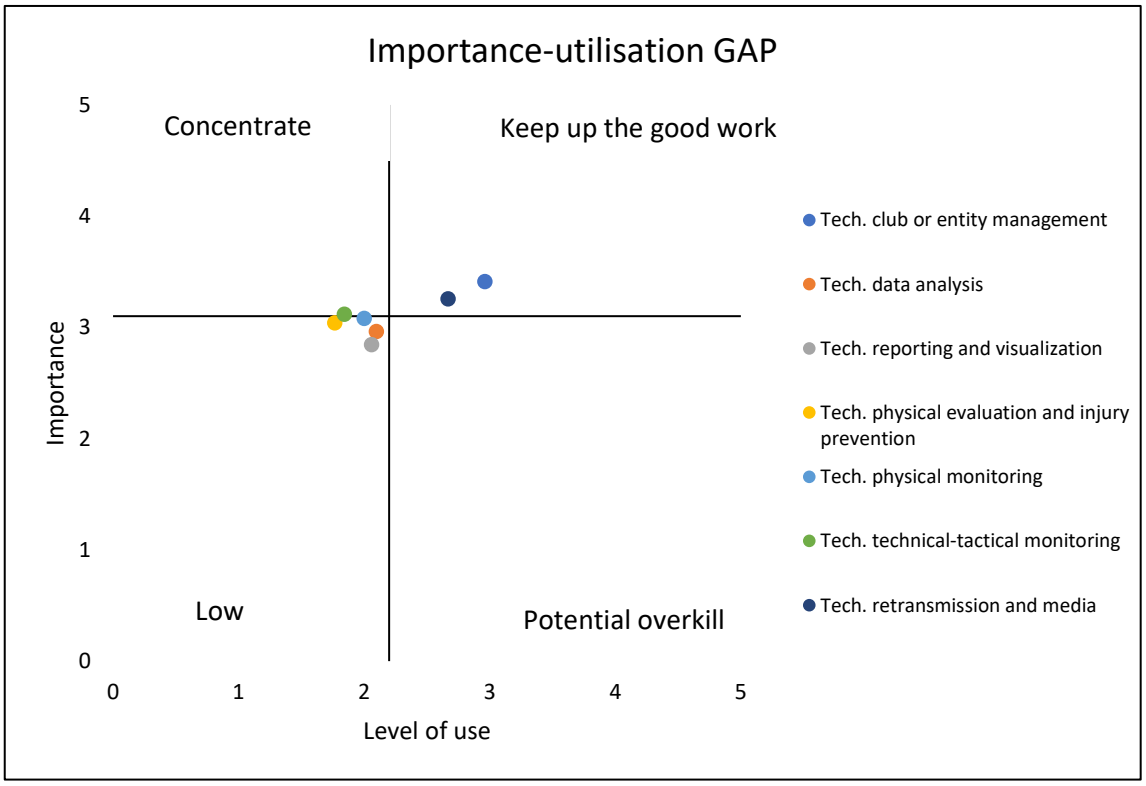

Tech. physical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
16
16
27
27
14
Nothing at all
Very little
Somewhat important
Very important
A priority


Tech. technical-tactical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
8
20
39
20
14
Nothing at all
Very little
Somewhat important
Very important
A priority


Tech. retransmission and media
Percentage
50
45
40
35
30
25
20
15
10
5
0
4
20
35
29
12
Nothing at all
Very little
Somewhat important
Very important
A priority

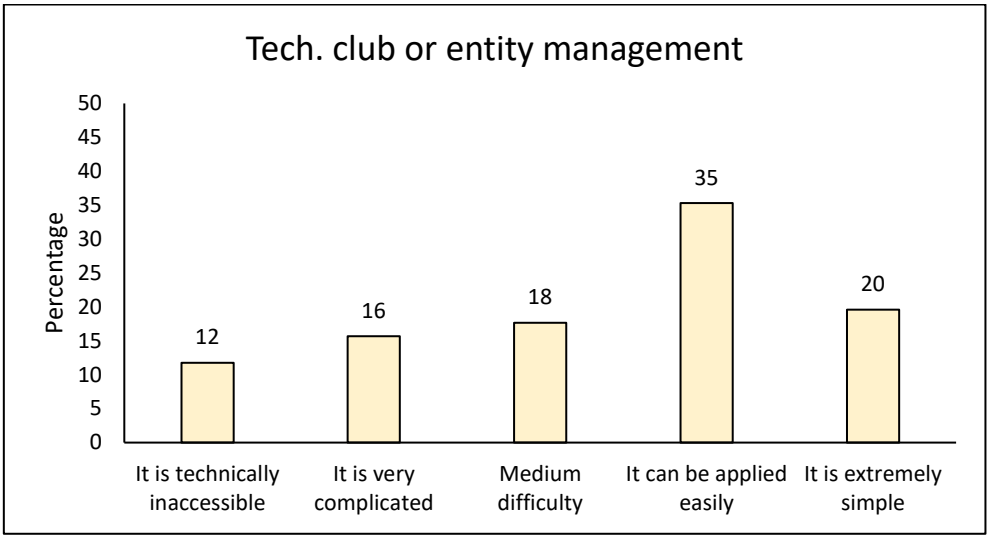
4. GAP analysis between use and importance of technological areas

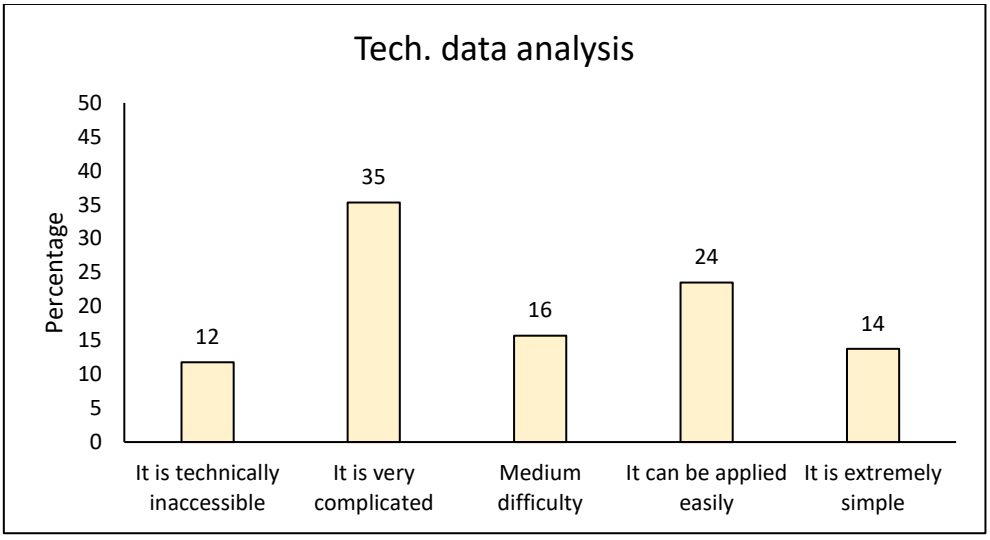
In this graph we observe based on the responses of the sports managers of Austria, it follows that the Tech. Club or entity management and retransmission and media have a high importance and a high use, therefore, it should be maintained. However, Tech. data analysis, tech reporting visualization, tech physical evaluation and injury prevention, tech physical monitoring and tech technical-tactical monitoring have little use and little importance, therefore they are not a priority for managers in Austria.

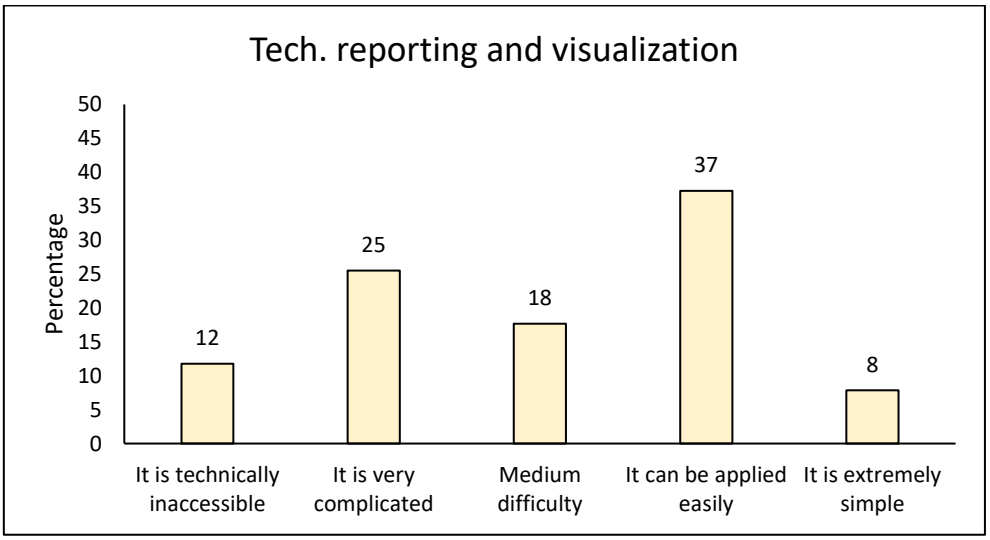


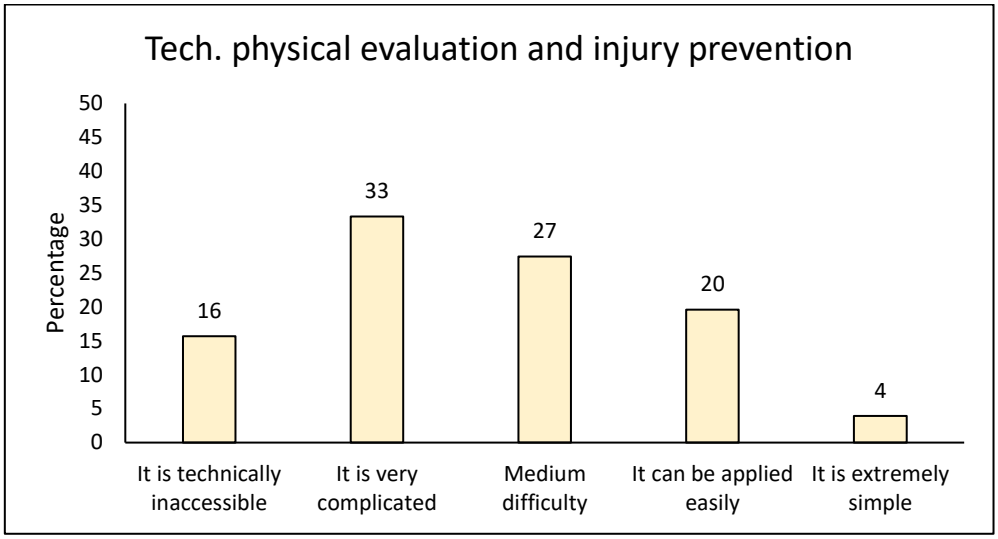
5. What is the level of difficulty that you associate with the use of each technology effectively in your club or sport entity?

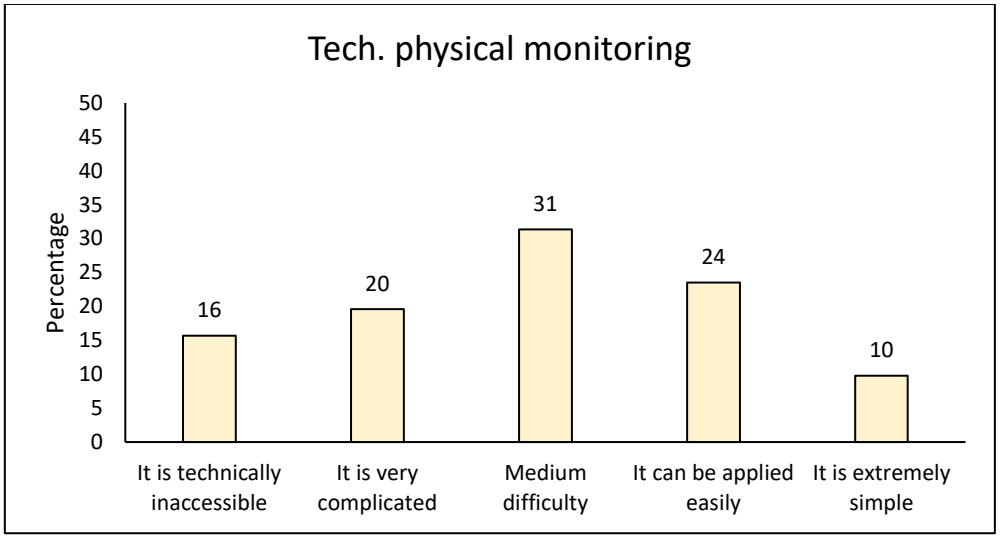
The results obtained provide us that around 18-31% see the use of technologies as medium difficulty. Otherwise, between 16-35% consider it very complicated to apply them. While for 8-18% the application of these technologies is technically inaccessible. Around 20-37% consider the use of technologies as easily applicable. There is a great diversity of difficulty regarding the application in deprived entities or clubs.

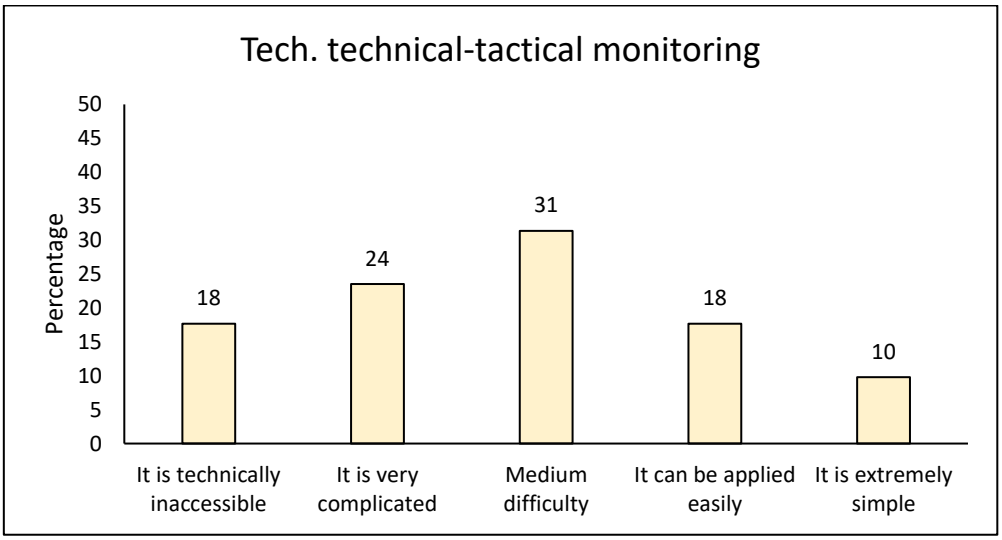

Tech. club or entity management
Percentage
50
45
40
35
30
25
20
15
10
5
0
12
16
18
35
20
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple

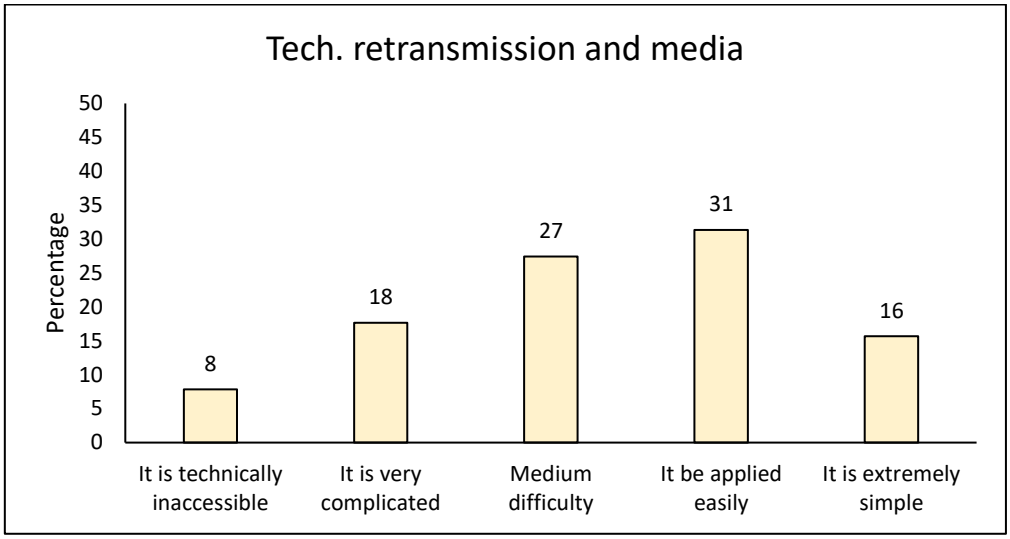

Tech. data analysis
Percentage
50
45
40
35
30
25
20
15
10
5
0
12
35
16
24
14
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple


Tech. reporting and visualization
Percentage
50
45
40
35
30
25
20
15
10
5
0
12
25
18
37
8
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple


Tech. physical evaluation and injury prevention
Percentage
50
45
40
35
30
25
20
15
10
5
0
16
33
27
20
4
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple

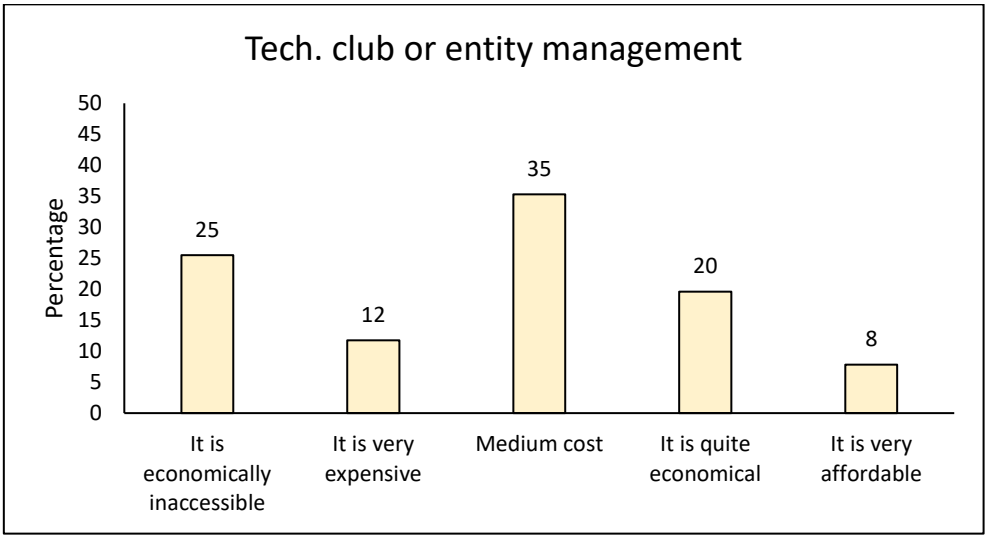

Tech. physical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
16
20
31
24
10
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple

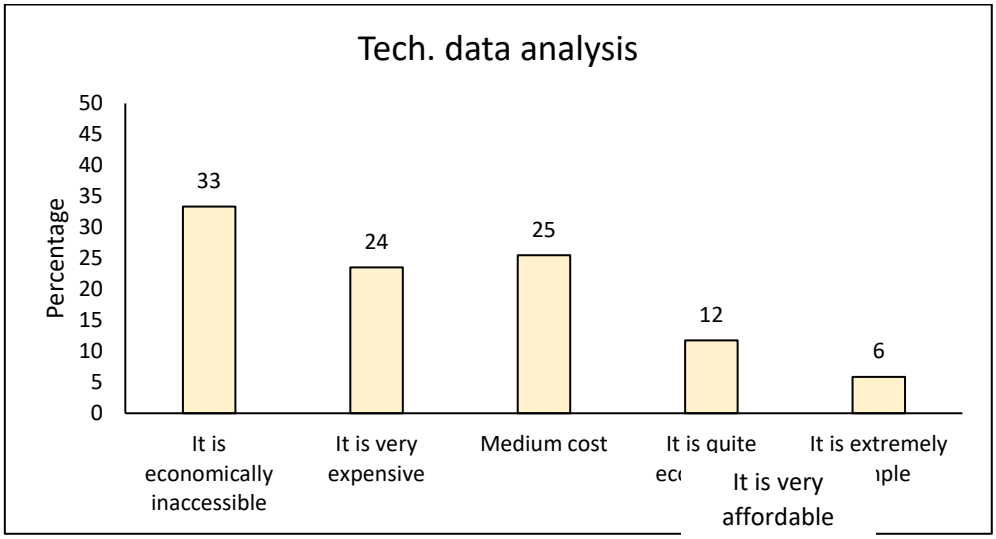

Tech. technical-tactical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
18
24
31
18
10
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple

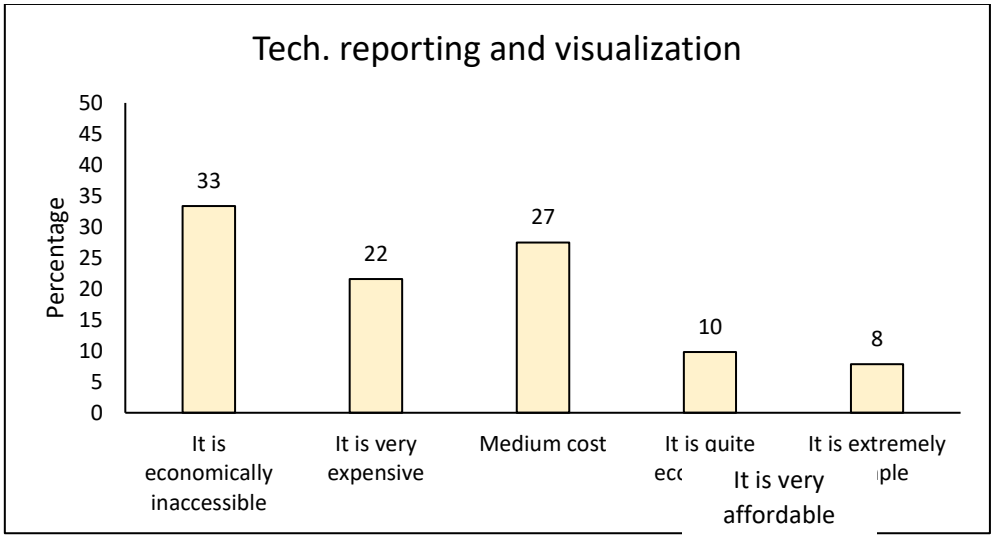


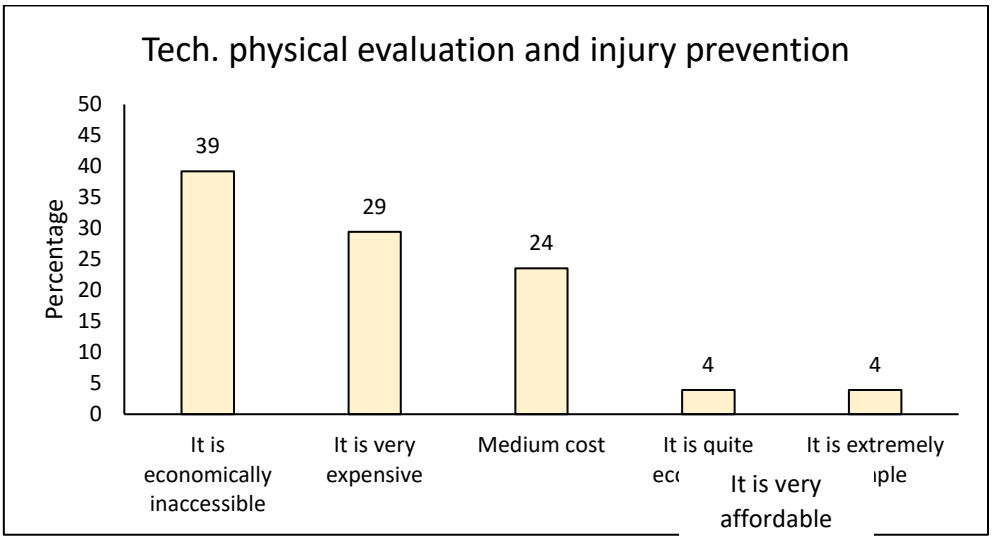
6. Based on your knowledge. How accessible is each technology, economically speaking, for your club or sport entity?

The results obtained show that for 22-39% of sports entities or clubs it is economically inaccessible to be able to acquire these technologies. Between 2-4% believe that technical-tactical monitoring, physical monitoring and retransmission and media technology would be very affordable to use. In general, clubs and entities see implementing technologies as a medium cost or very expensive.




Tech. data analysis
Percentage
50
45
40
35
30
25
20
15
10
5
0
33
24
25
12
6
It is economically inaccessible
It is very expensive
Medium cost
It is quite ecc
It is extremely
ıple
It is very affordable


Tech. reporting and visualization
Percentage
50
45
40
35
30
25
20
15
10
5
0
33
22
27
10
8
It is economically inaccessible
It is very expensive
Medium cost
It is quite ecc
It is extremely
ıple
It is very affordable


Tech. physical evaluation and injury prevention
Percentage
50
45
40
35
30
25
20
15
10
5
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39
29
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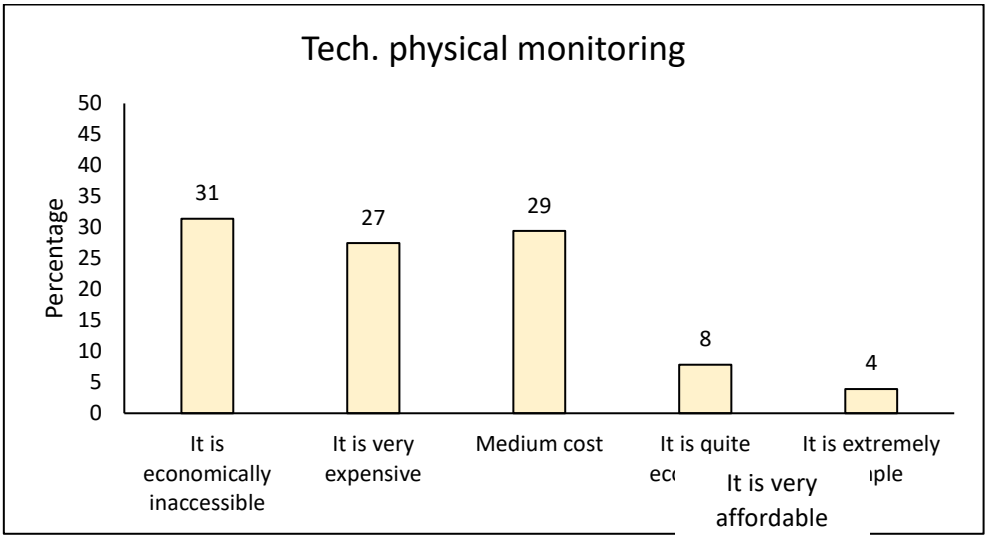
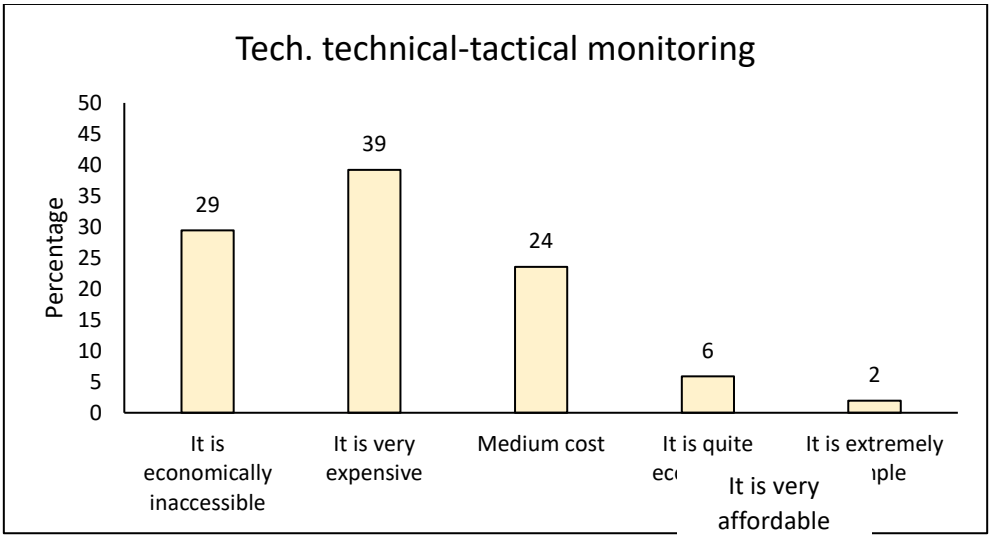
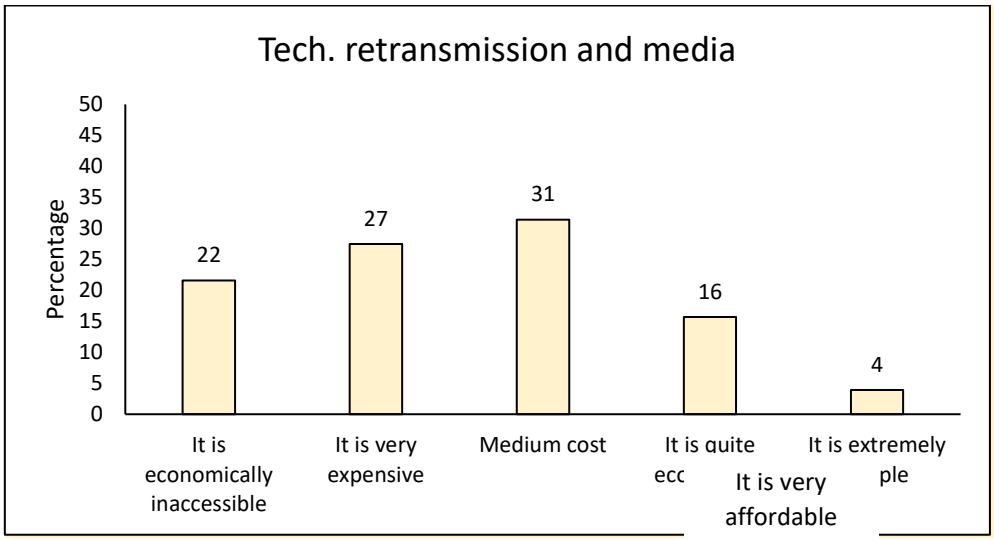
4
4
It is economically inaccessible
It is very expensive
Medium cost
It is quite ecc
It is extremely
ıple
It is very affordable

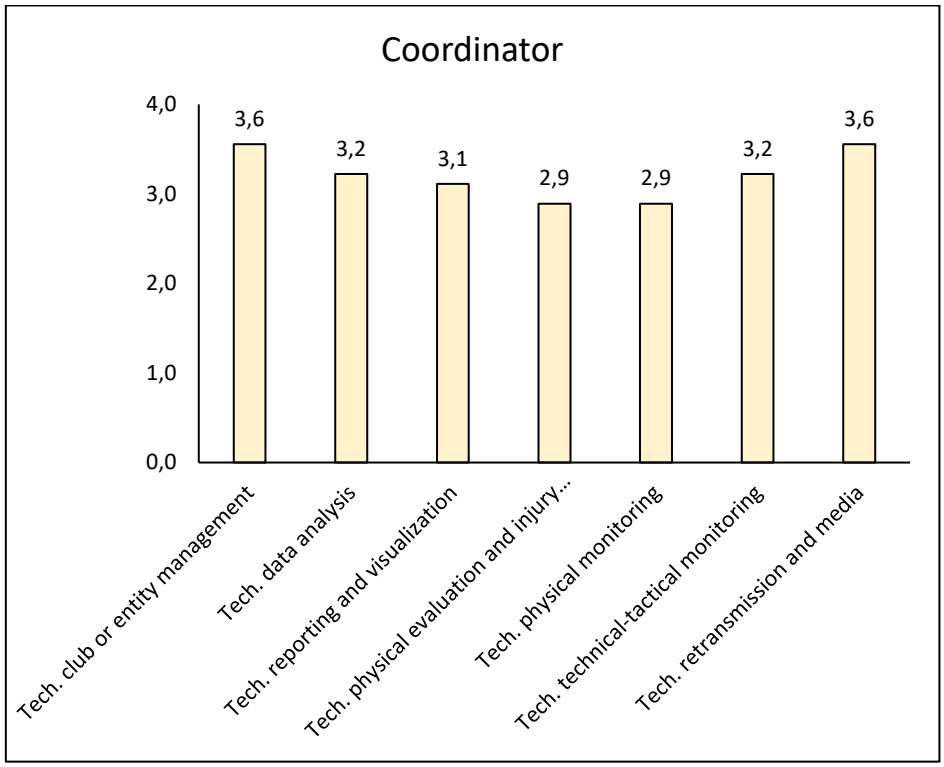

Tech. physical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
31
27
29
8
4
It is economically inaccessible
It is very expensive
Medium cost
It is quite ecc
It is extremely
ıple
It is very affordable

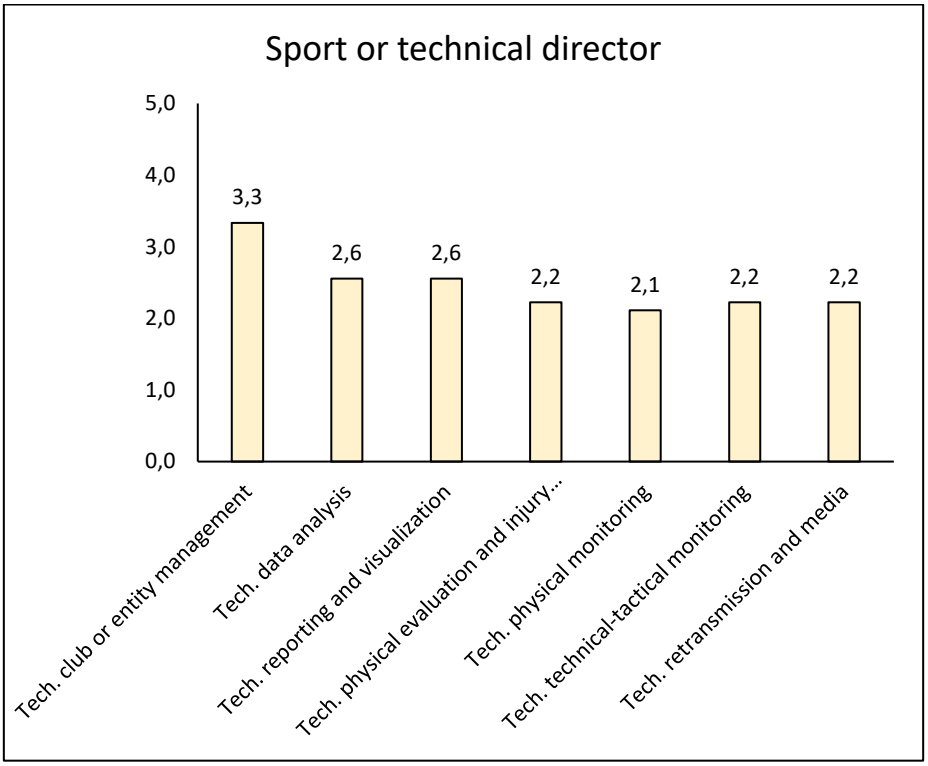

Tech. technical-tactical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
29
39
24
6
2
It is economically inaccessible
It is very expensive
Medium cost
It is quite ecc
It is extremely
ıple
It is very affordable

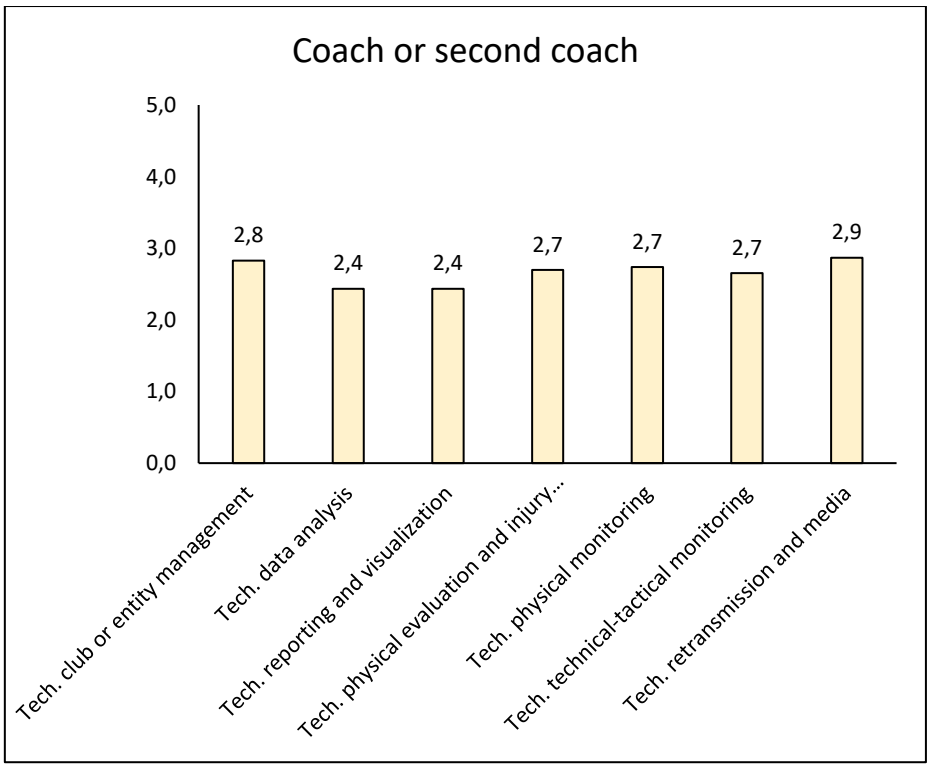

Tech. retransmission and media
Percentage
50
45
40
35
30
25
20
15
10
5
0
22
27
31
16
4
It is economically inaccessible
It is very expensive
Medium cost
It is quite ecc
It is extremely
ple
It is very affordable

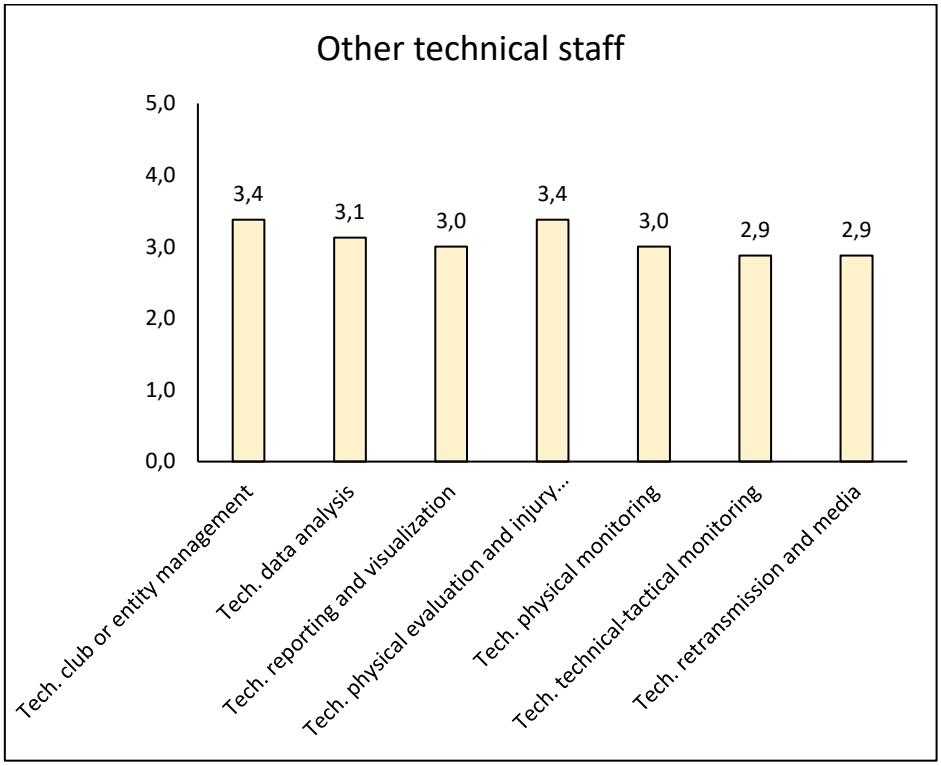
7. How important is each of these technologies for your current position within the club or sport entity?

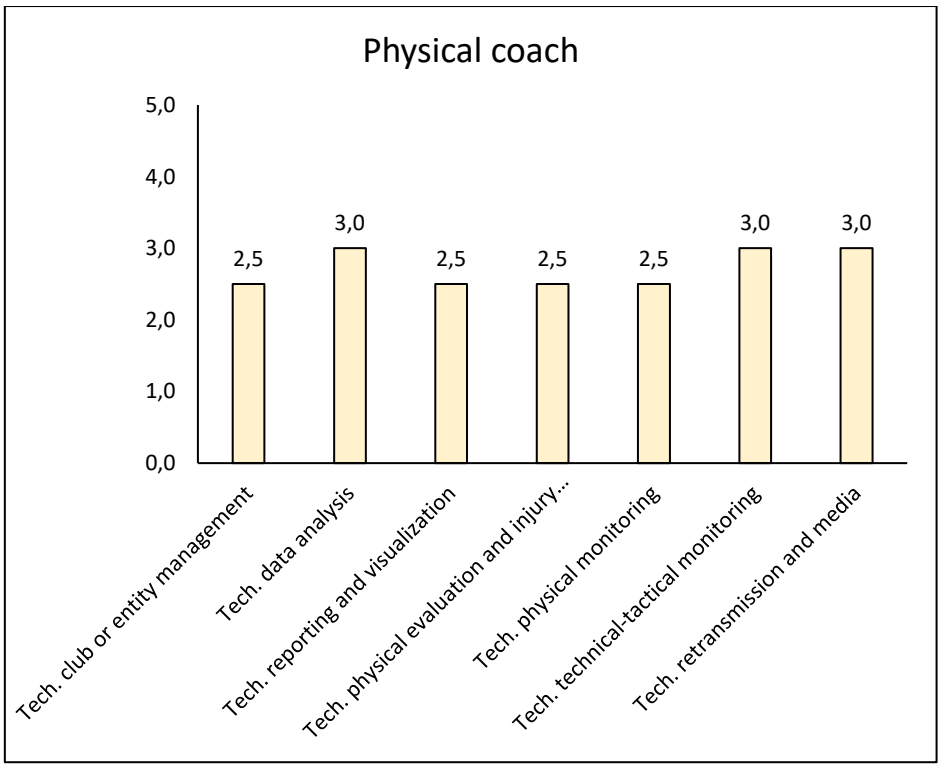
The graphs above show the importance of the use of technologies depending on the current position in a club or sports entity. The Coordinators believe that club or entity management and retransmission and media are most important to them, while physical monitoring and physical evaluation and injure prevention would be less important. The Sport or technical directors consider that club or entity management is the most important. While physical monitoring is the less important coinciding with coordinators. However, for the coach or second coach the retransmission and media is the most important. On the other hand, other technical staff believe that management and physical evaluation and injury prevention are the most important. Finally, Physical coach consider that data analysis, technical-tactical monitoring and retransmission and media need to be develop to have great results.




Sport or technical director
5,0
4,0
3,0
2,0
1,0
0,0
3,3
2,6
2,6
2,2
2,1
2,2
2,2
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media

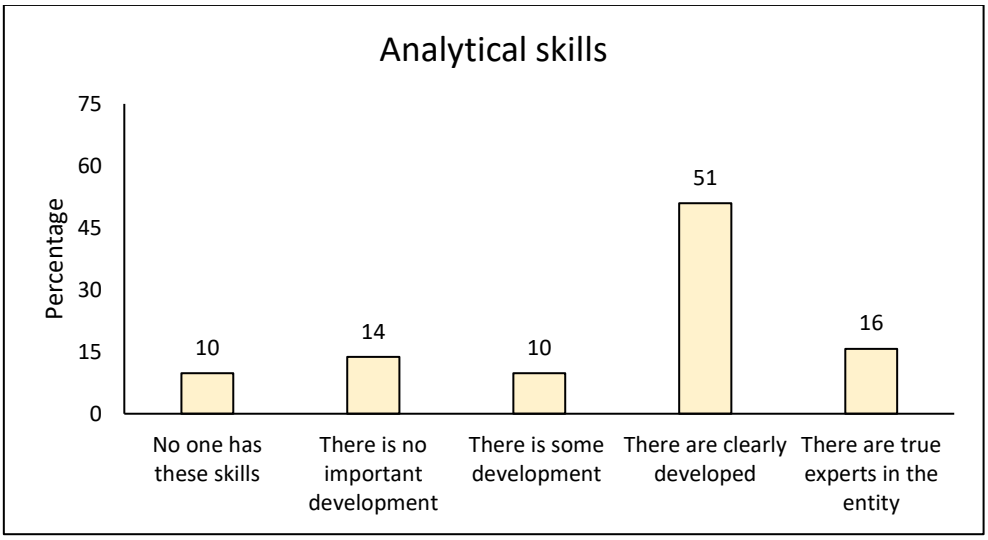

Coach or second coach
5,0
4,0
3,0
2,0
1,0
0,0
2,8
2,4
2,4
2,7
2,7
2,7
2,9
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media

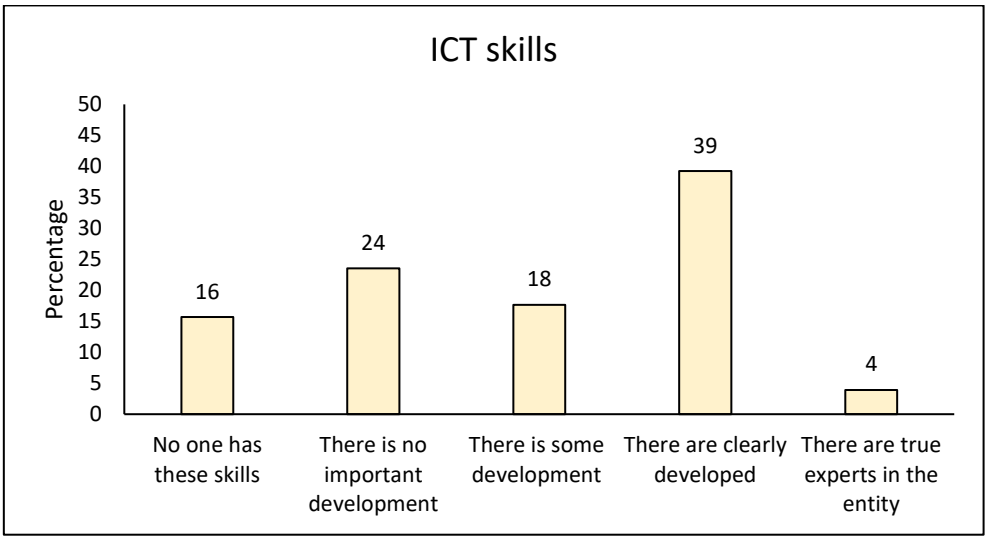

Other technical staff
5,0
4,0
3,0
2,0
1,0
0,0
3,4
3,1
3,0
3,4
3,0
2,9
2,9
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media

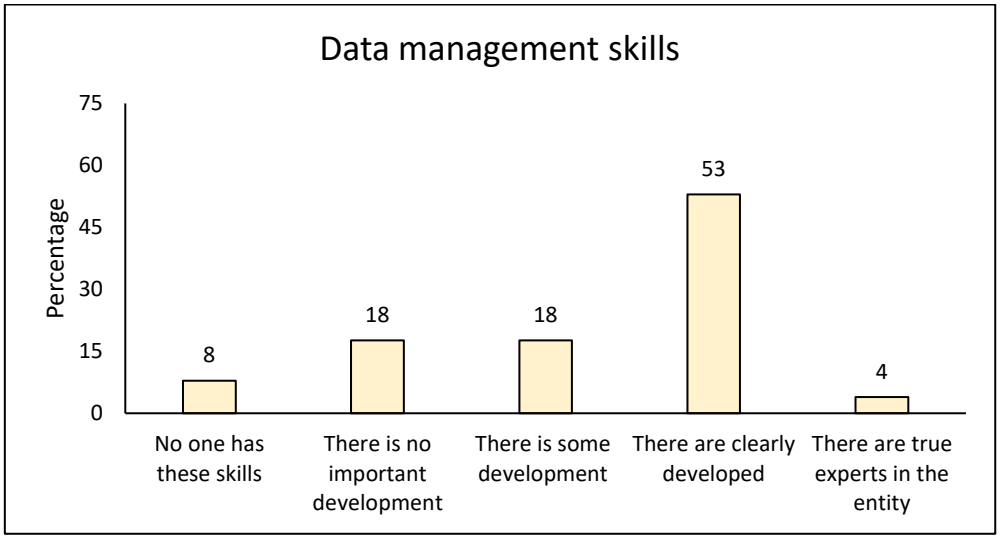

Physical coach
5,0
4,0
3,0
2,0
1,0
0,0
2,5
3,0
2,5
2,5
2,5
3,0
3,0
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media

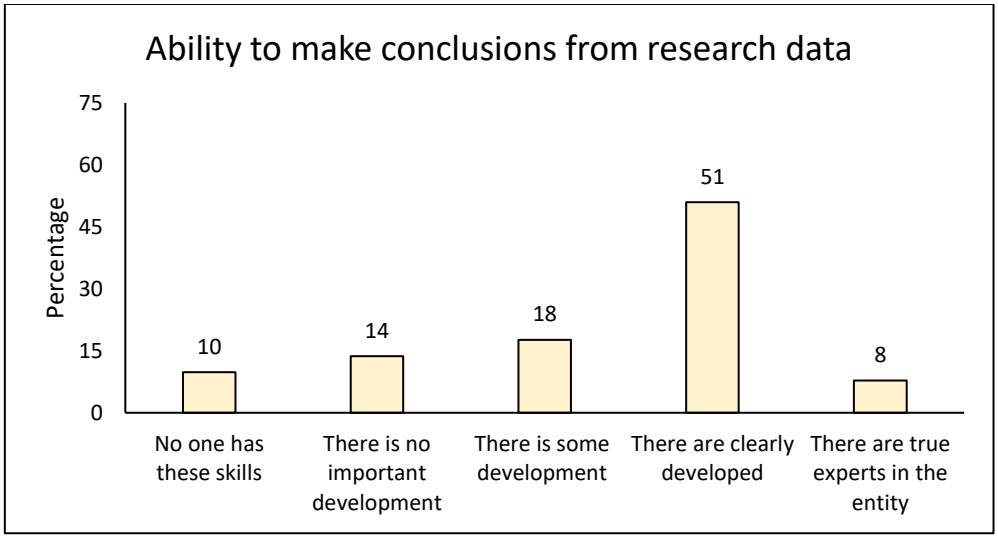
8. How developed are these competencies in your club or sport entity?

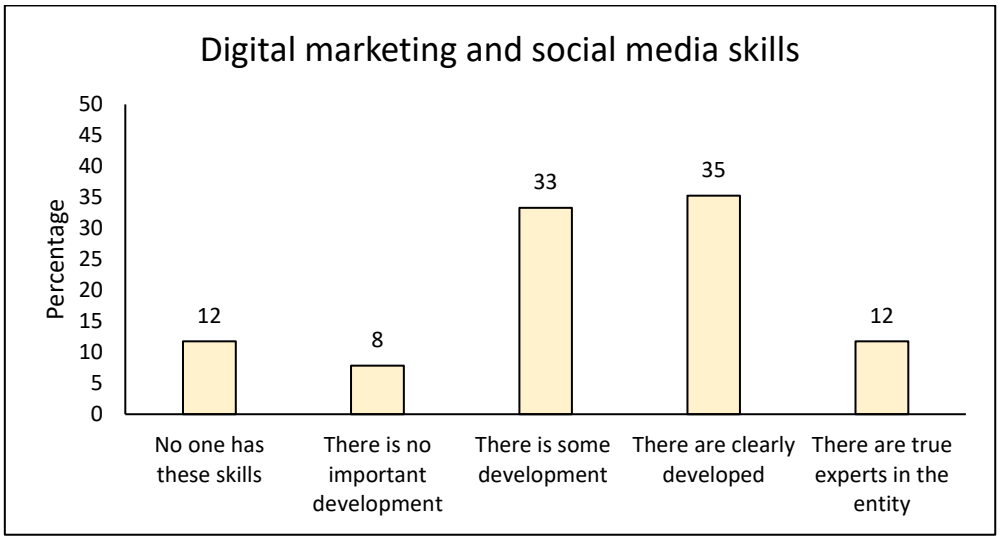
The graphics show that around 35-51% believe that competitions in their sports are clearly developed. Except the skills in marketing and social media and management of big data competition that around 32% believe is some important development. In addition, only 2-4% have experts in skills in the digital management of Big Data, data management skills and ICT skills.

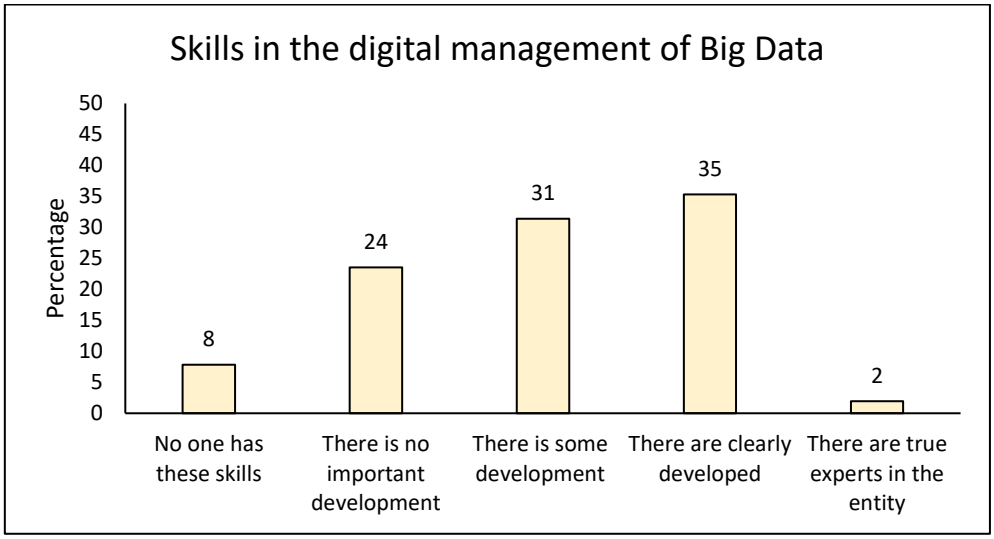





Data management skills
Percentage
75
60
45
30
15
0
8
18
18
53
4
No one has these skills
There is no important development
There is some development
There are clearly developed
There are true experts in the entity

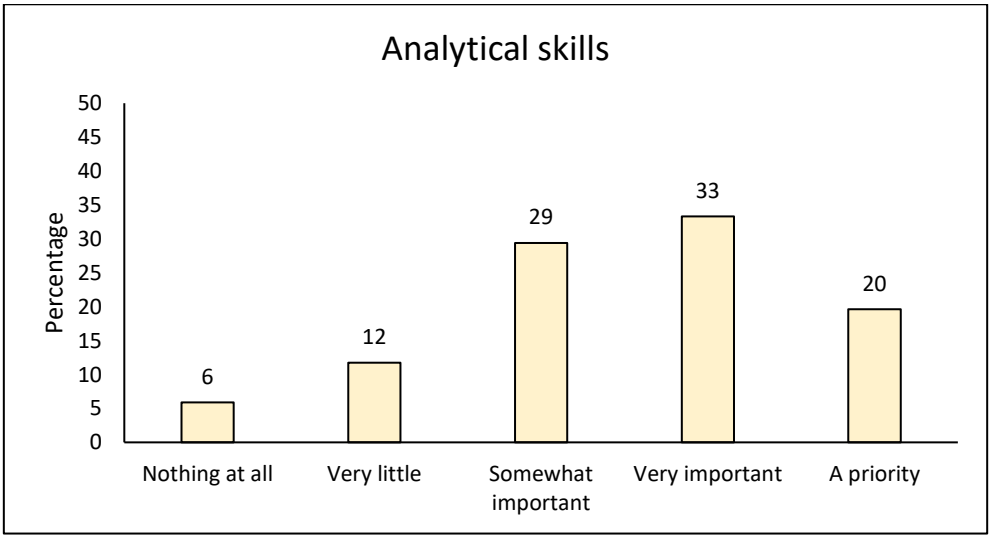

Ability to make conclusions from research data
Percentage
75
60
45
30
15
0
10
14
18
51
8
No one has these skills
There is no important development
There is some development
There are clearly developed
There are true experts in the entity

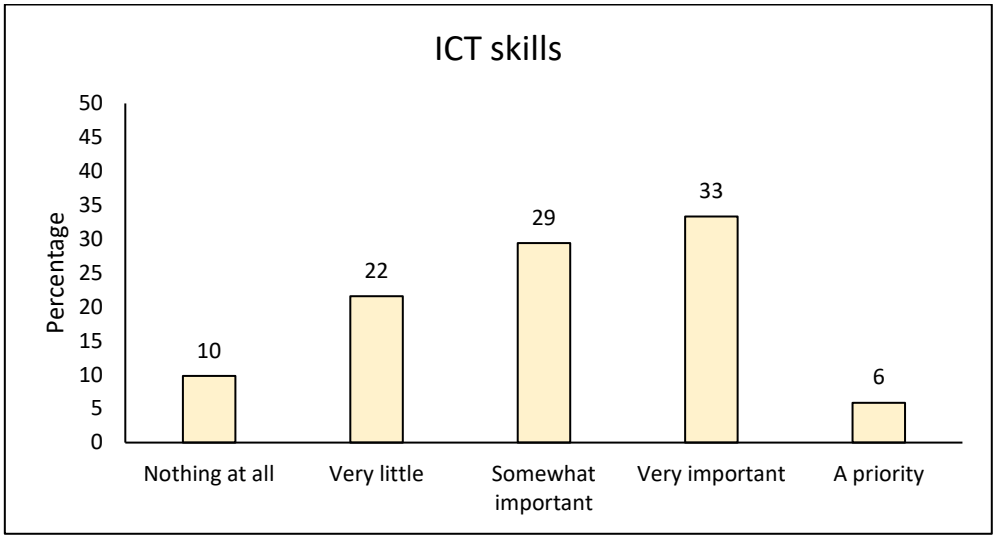

Digital marketing and social media skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
12
8
33
35
12
No one has these skills
There is no important development
There is some development
There are clearly developed
There are true experts in the entity

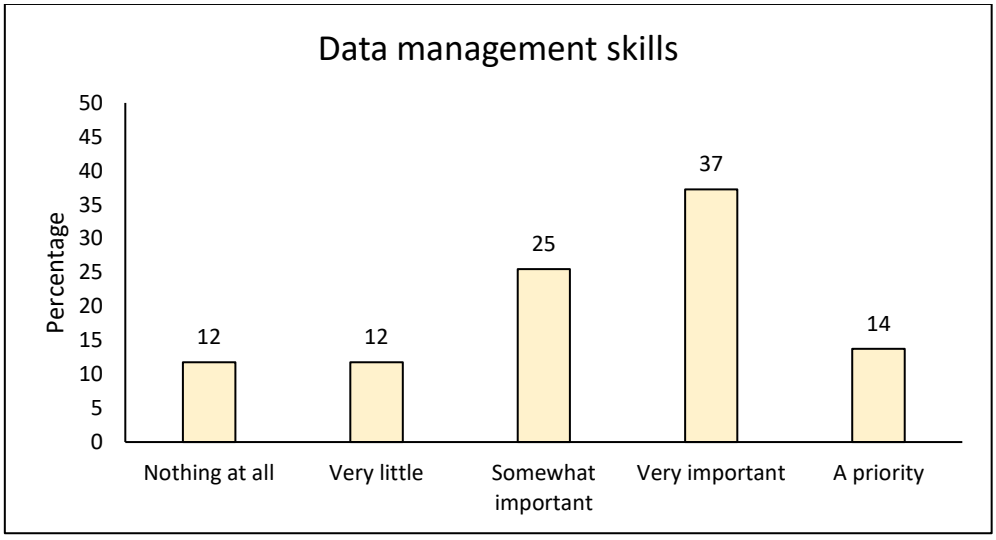


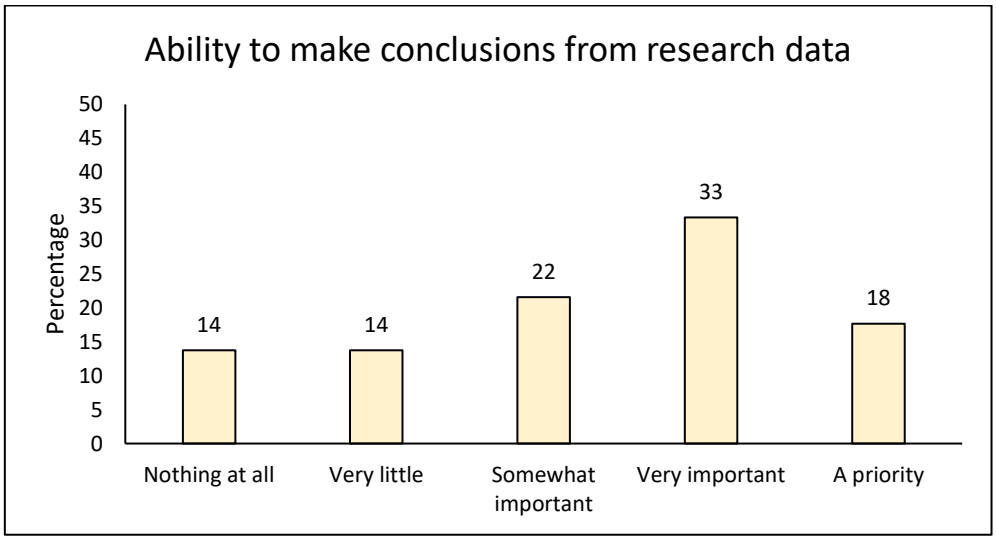
9. How important do you think these professional skills are in your club or sport entity?

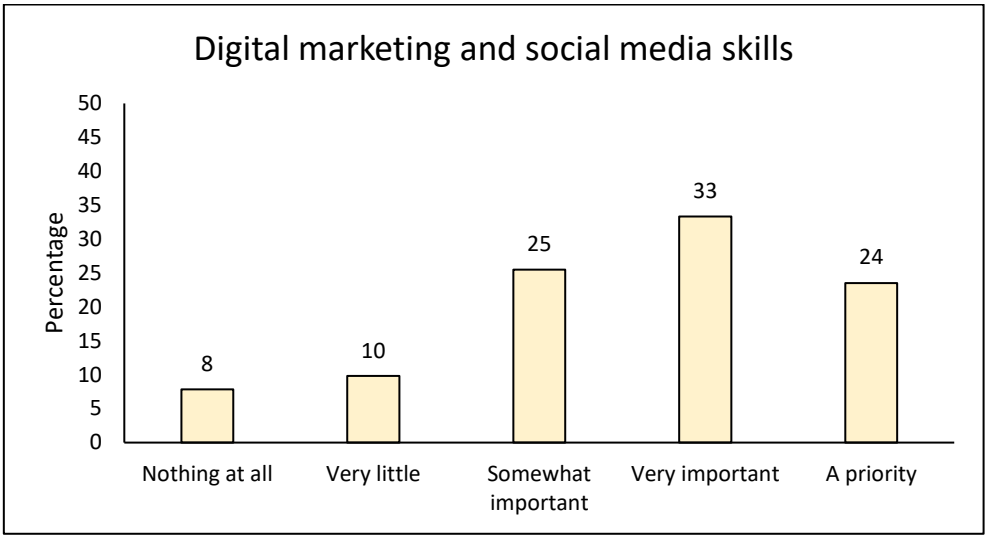
The charts show that between 33-37% believe that the use of these professional skills is very important. Between 29-31% believe the use of these skills is somewhat important. While approximately 14% believe their use is a priority. In addition, between 6 and 10 consider than ICT skills, analytical skills and digital marketing and social media skills are not important. Generally, sports clubs or entities believe it is very important to acquire these skills from their workers.

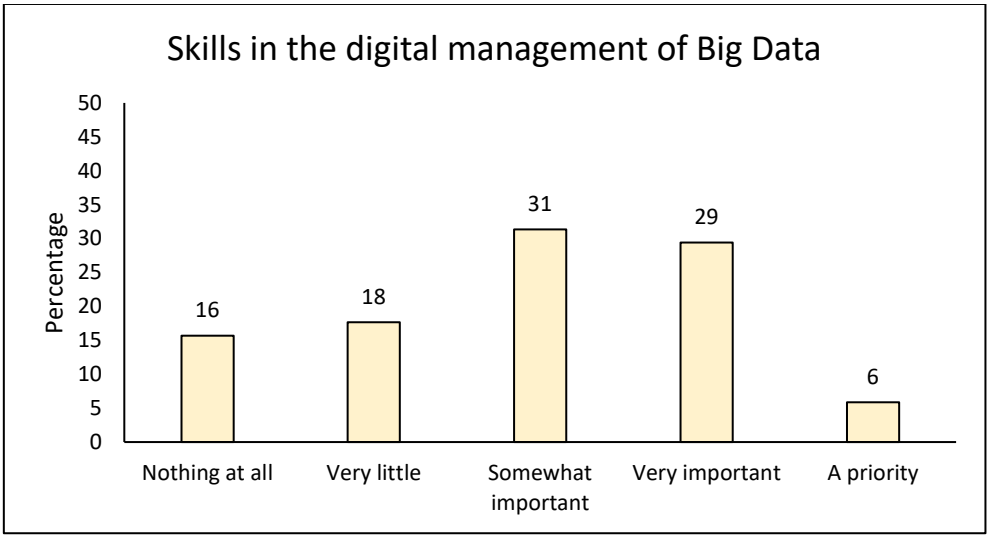



ICT skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
10
22
29
33
6
Nothing at all
Very little
Somewhat important
Very important
A priority


Data management skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
12
12
25
37
14
Nothing at all
Very little
Somewhat important
Very important
A priority

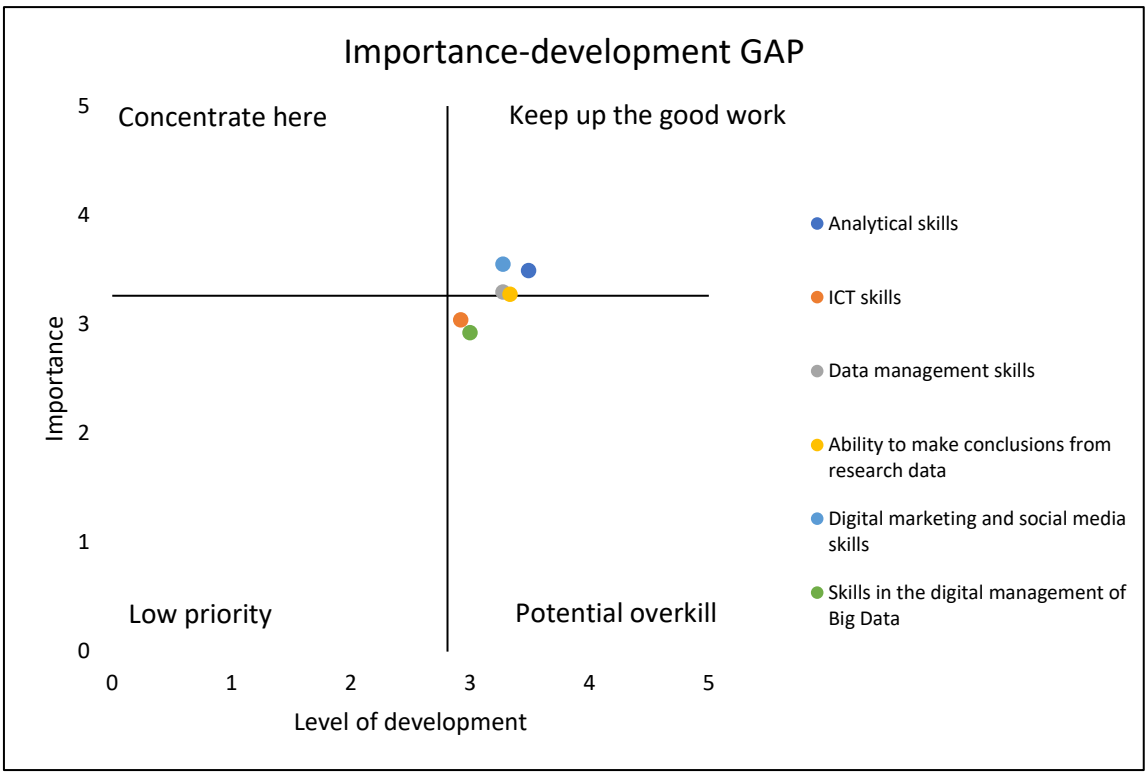

Ability to make conclusions from research data
Percentage
50
45
40
35
30
25
20
15
10
5
0
14
14
22
33
18
Nothing at all
Very little
Somewhat important
Very important
A priority





10. GAP analysis between development and importance of technological competences

In this graph that we observe based on the responses of the sports managers in Austria, it follows that the skills of analytical skills, ability to make conclusions from research data, digital marketing and social media skills and data management skills have a high degree of importance and level of development. Therefore, they must be maintained. The skills in ICT and the digital management of Big Data competition is of little importance and little development, therefore it is not a priority for sports managers in Austria.



11. Discussion of results

As a leitmotif this report about Austria shows, that the knowledge of how important technologies for a club and his entities are, is existing.

The report shows, that if technologies are available, they are used constantly on the level of the management. On the other hand, this report shows, that there is a big lack of accessibility for technical data analysis and the possibility of saving it. To go along with that facts, it shows that if there are people in the club who can use that kind of technologies, the level of performance is high, as the clubs analyse for them self's.

Furthermore, it shows that the understanding of importance of this technology is on a high level. Here you can see a correlation in the costs of buying, staff, and service of that technologies. The big question here is where all the money flows in the clubs or if there is not enough to invest in those technologies.

About the social media and the management skills you can see that clubs and other organisations do not see the importance and possibilities of this technologies, which can be also related to costs and priorities, which are settled.

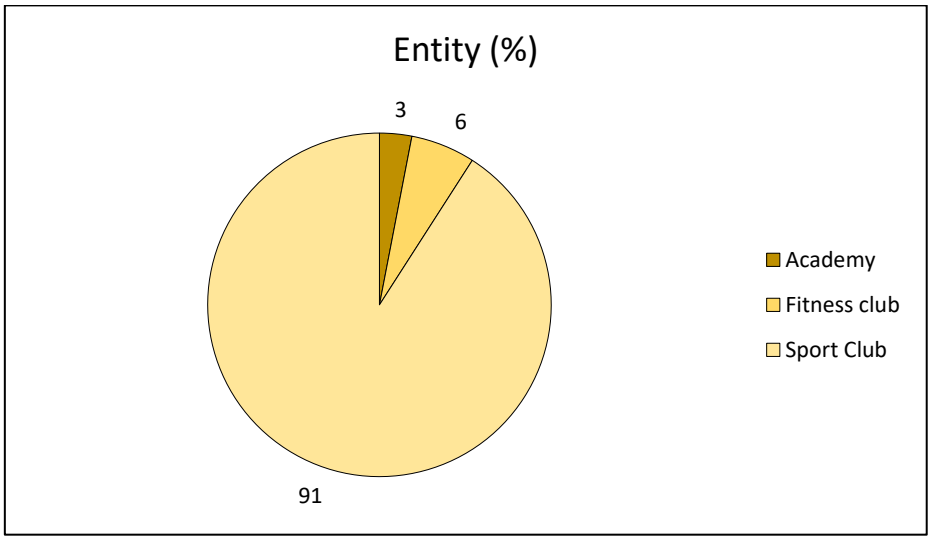
12. Conclusions

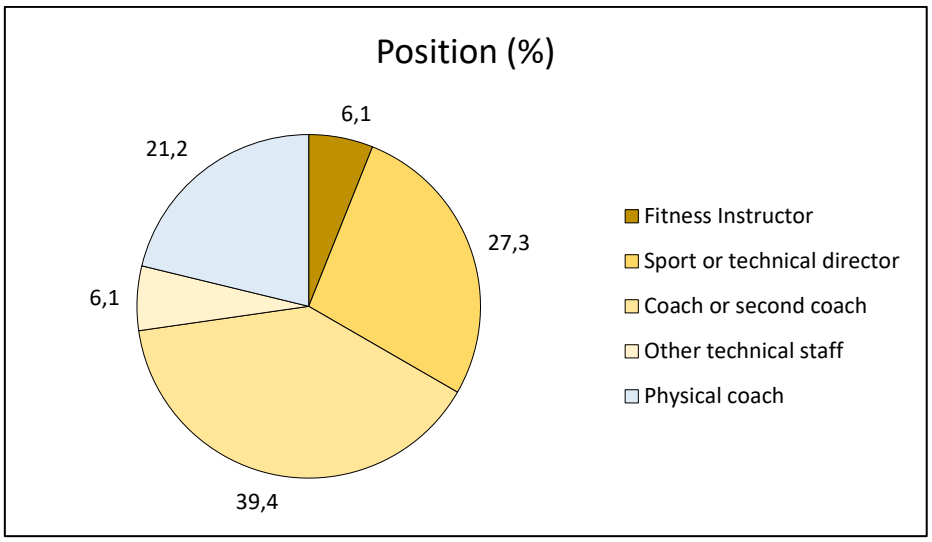
- Necessity of showing the possibilities, which technologies are available
- More training in the clubs in new technologies
- More assistance by the government, according financing and resources, is needed
- Clubs need to understand that this kind of technology can bring them fast forward to achieve their goals

ANEX V. INDIVIDUAL REPORT. QUESTIONNAIRE GREEK VERSION, CYPRUS

1. Sample

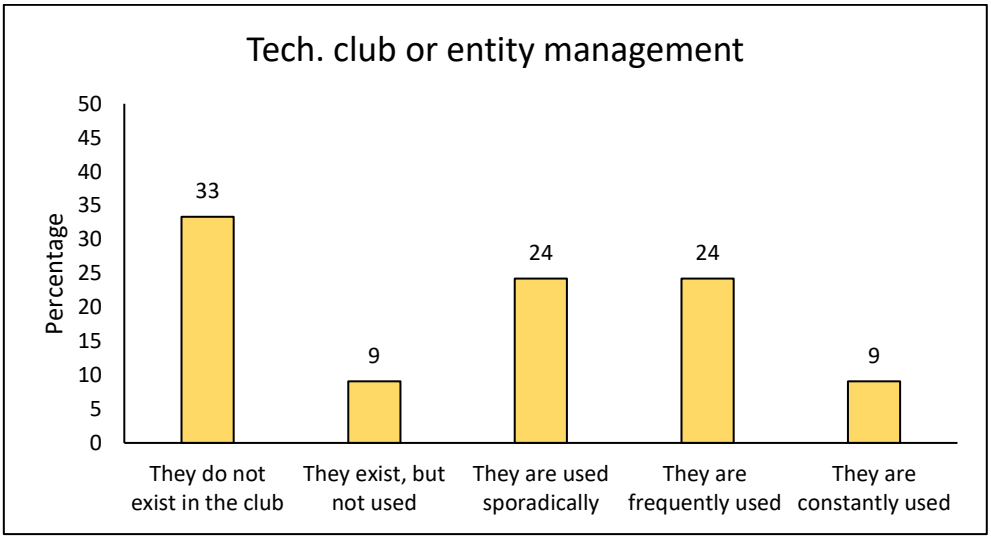
The figures show the general characteristics of the sample, depending on the type of entity, the position in it, the years of experience in the entity, and the current position, in %. Most of the respondents work in Sport Clubs. The percentage of responses per position is widely distributed: 27% are managerial positions (Sport or the technical director), 39% coaches (Coach or second coach) and 33% technical and physical preparation positions (Fitness instructor, physical coach, and other technical staff). The years of experience in the entities show an average of 8-9 years, while the years in their current position are 6 years.

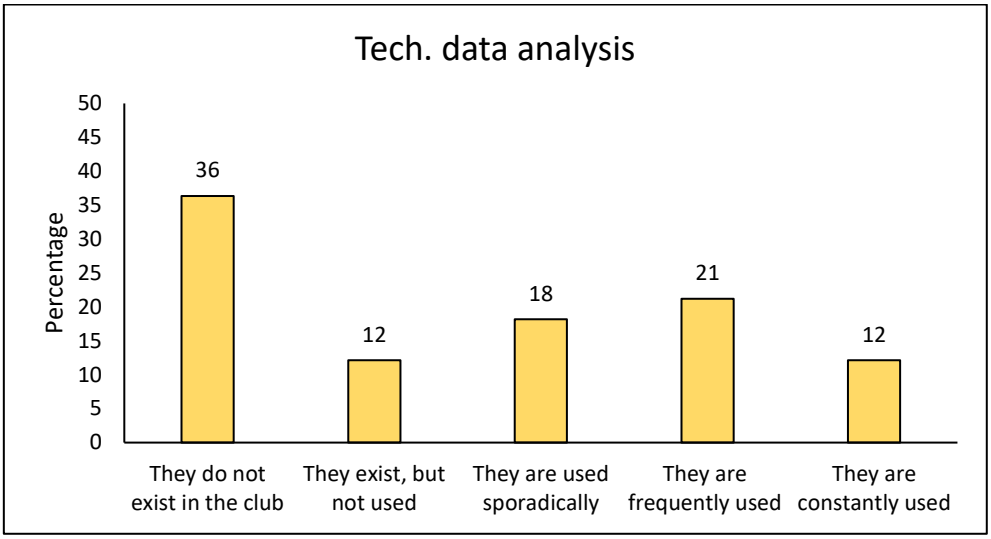


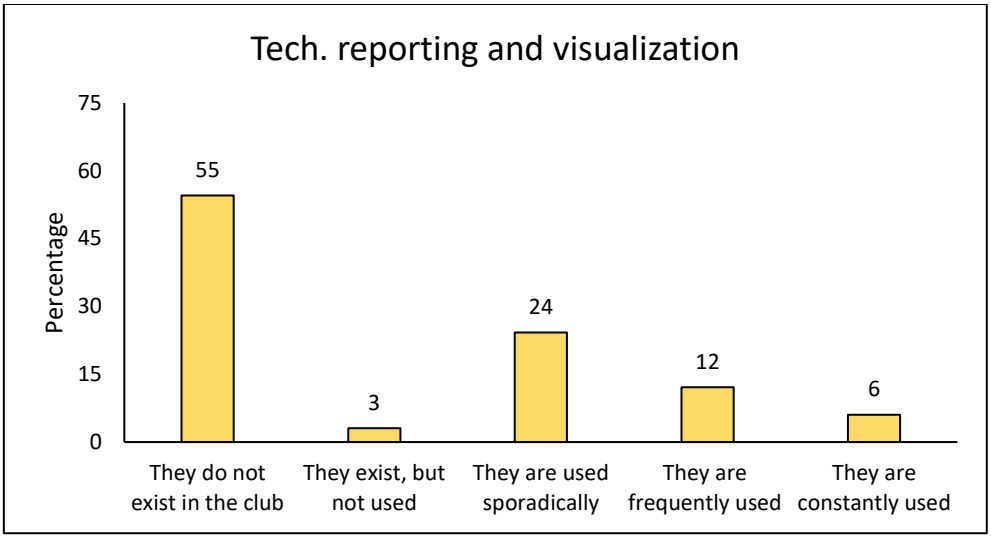


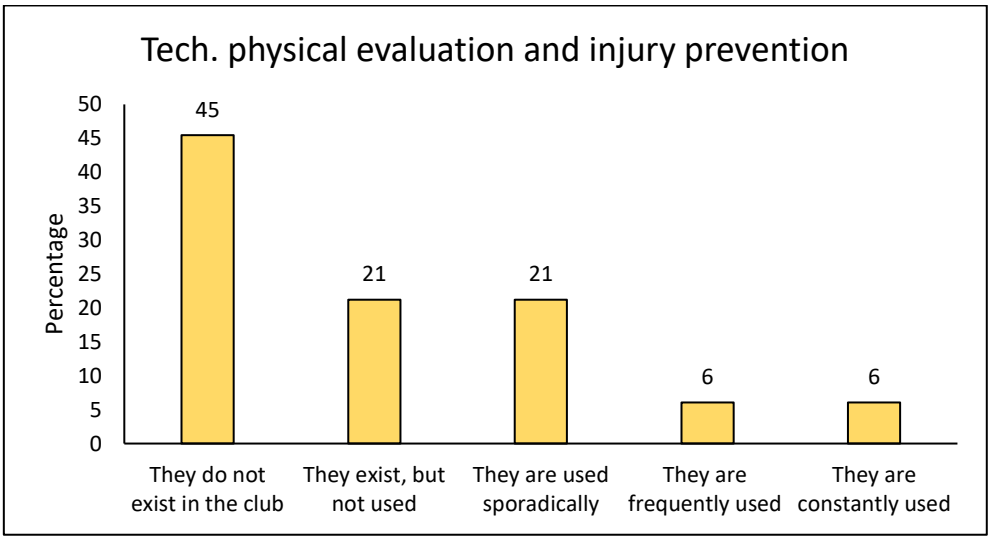
2. To what extent are you currently using these technologies in your club or sport entity?

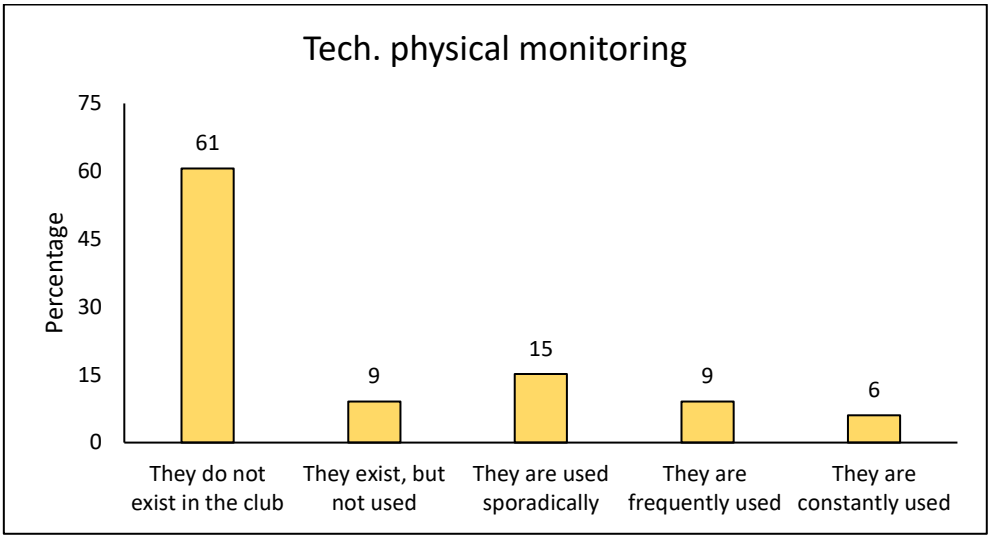
The results of the use of technology in different aspects within a club or entity indicate a greater use of club or entity management technology. Regarding the reporting and visualization technologies, physical evaluation and injury prevention, physical monitoring and technical-tactical monitoring between 45-61% indicate that such technologies do not exist in their sports clubs or entities. These values are very high, showing the lack of technology in sports entities and clubs. Finally, the club or entity management, data analysis and retransmission and media results, show more use in comparison with others, reflecting the fact that these three areas are more developed.

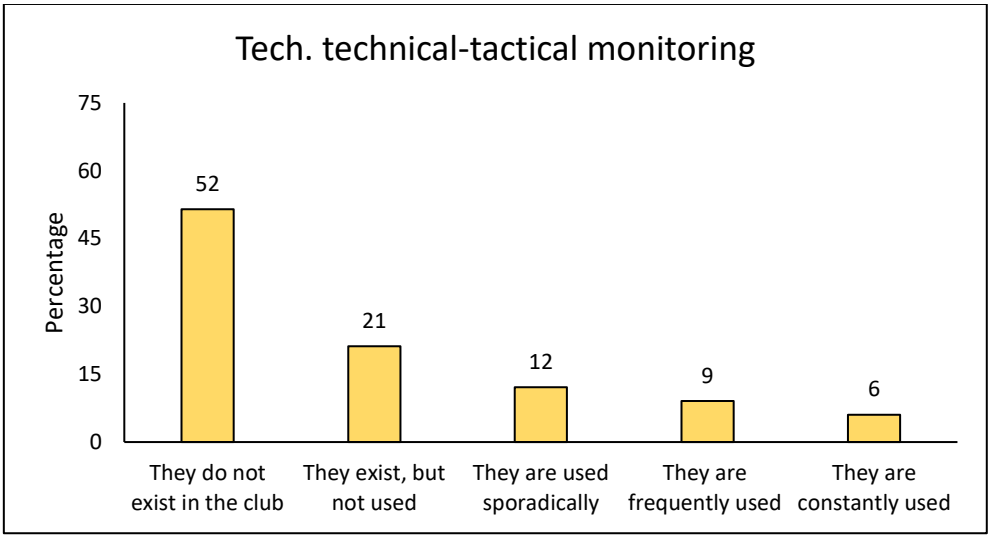


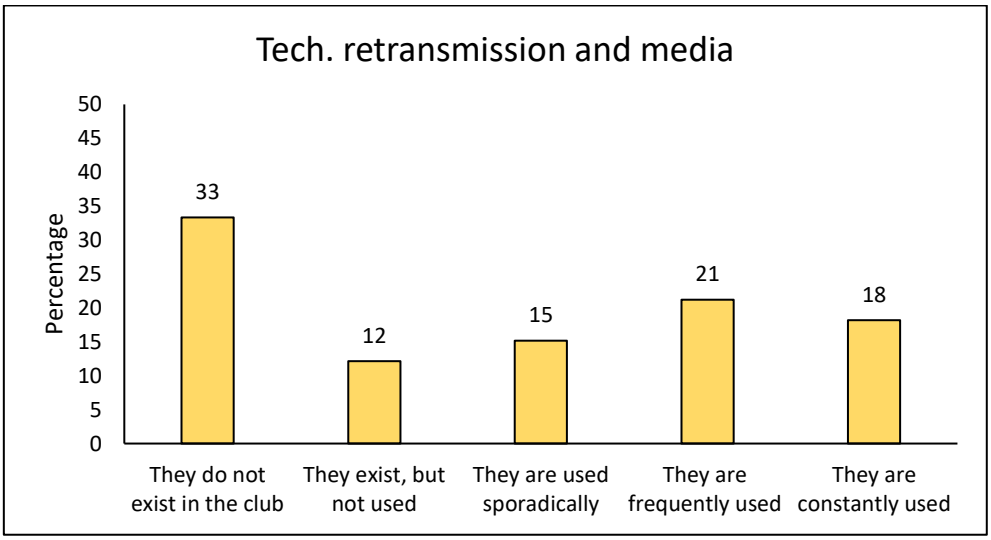

Tech. data analysis
Percentage
50
45
40
35
30
25
20
15
10
5
0
36
12
18
21
12
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used


Tech. reporting and visualization
Percentage
75
60
45
30
15
0
55
3
24
12
6
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used


Tech. physical evaluation and injury prevention
Percentage
50
45
40
35
30
25
20
15
10
5
0
45
21
21
6
6
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

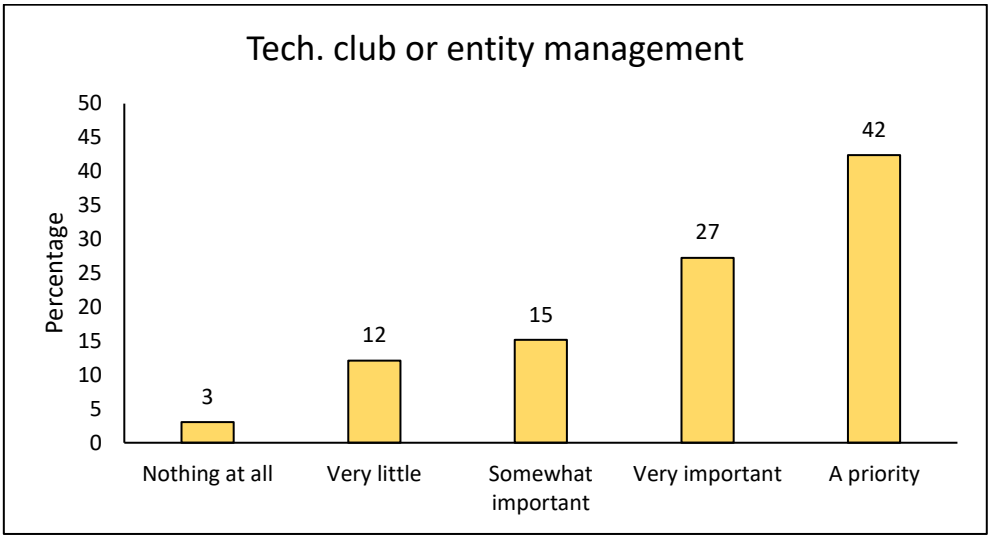

Tech. physical monitoring
Percentage
75
60
45
30
15
0
61
9
15
9
6
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

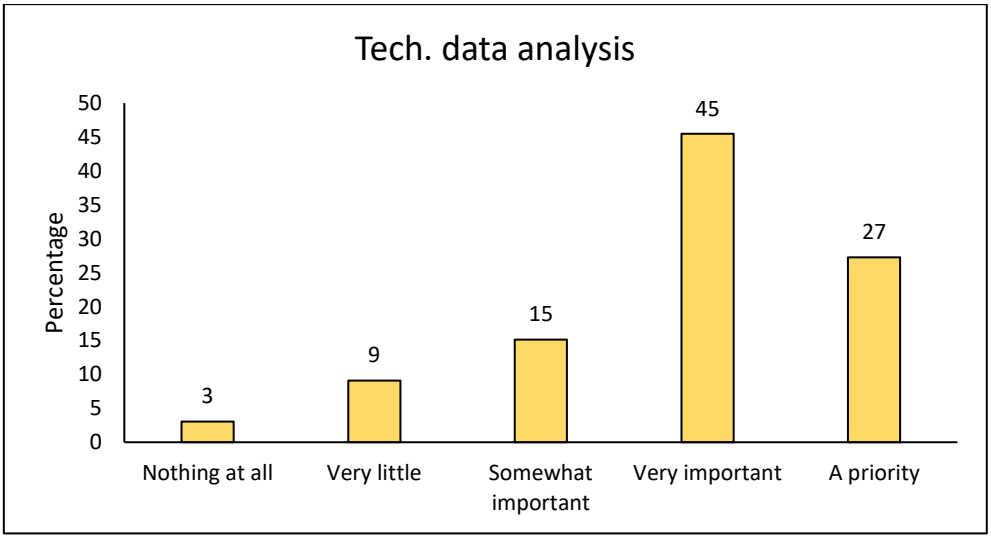

Tech. technical-tactical monitoring
Percentage
75
60
45
30
15
0
52
21
12
9
6
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

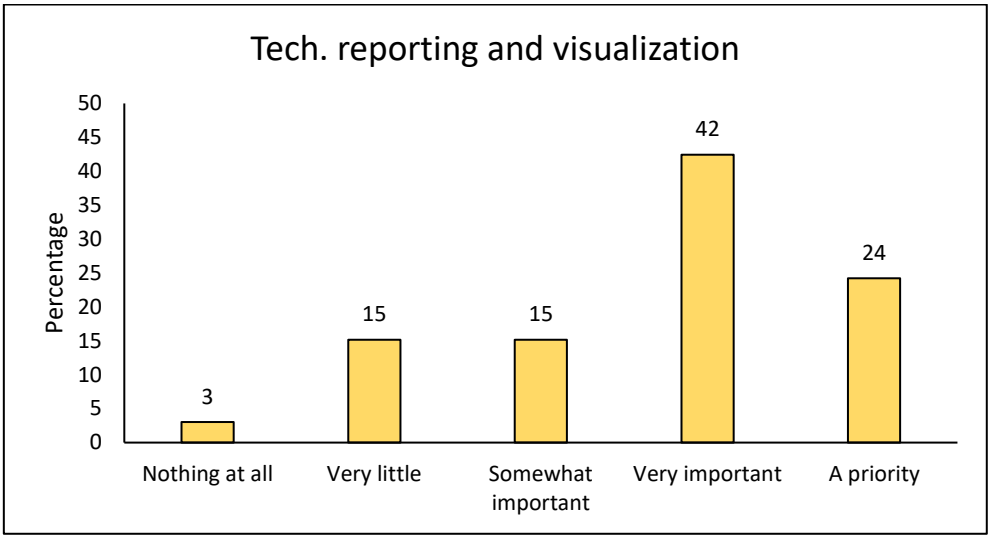

Tech. retransmission and media
Percentage
50
45
40
35
30
25
20
15
10
5
0
33
12
15
21
18
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

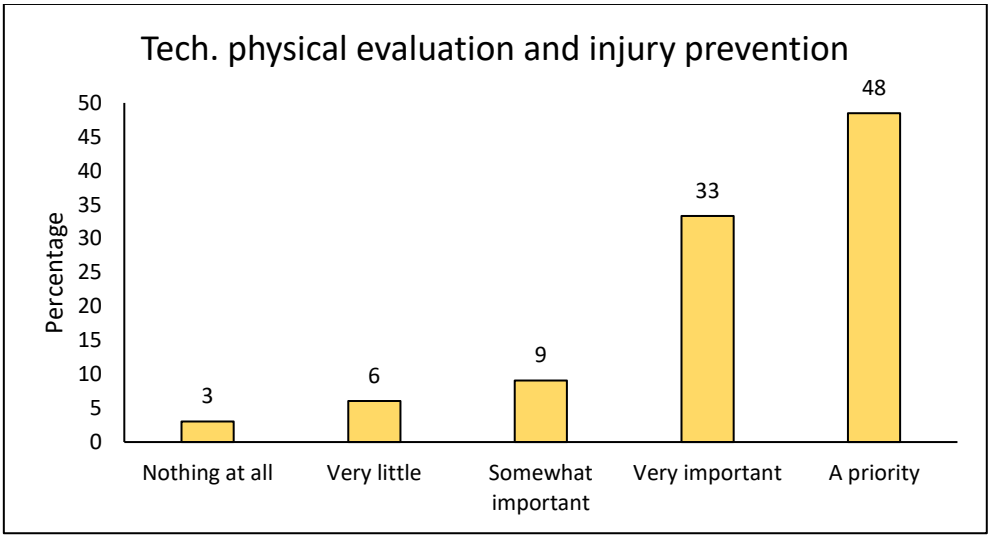
3. How important do you think using these technologies are or would be for your club or sport entity?

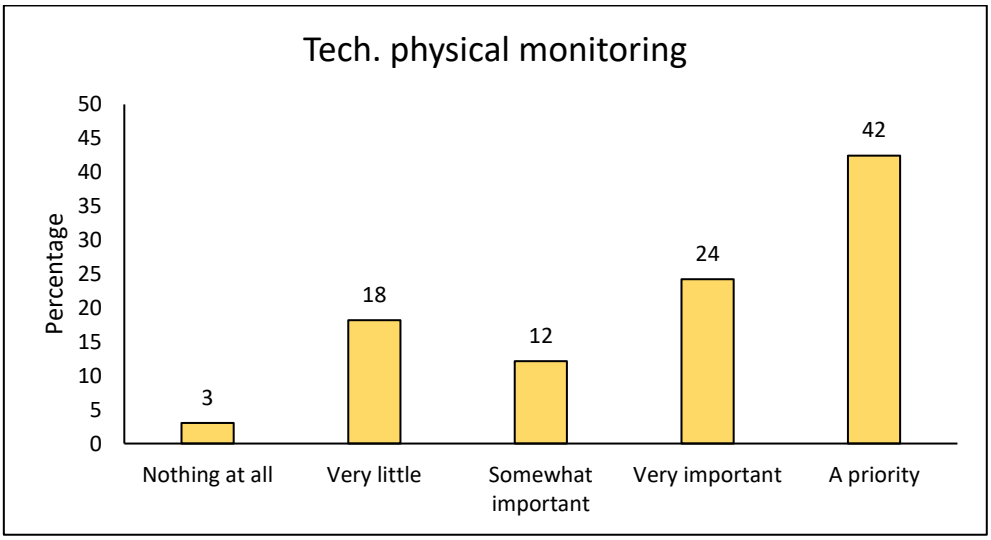
The following graphs show us how important the respondents think that the use of different technologies is in sports clubs or entities. As can be clearly seen, club or entity management, physical evaluation and injury prevention, physical monitoring, technical-tactical monitoring and retransmission and media technologies usage are considered as a priority (39-48%). Furthermore, also data analysis and reporting and visualization are believed to be very important (42-45%). In general, it is shown that the use of these technologies is considered as a priority in the respondents' sports entities or clubs.

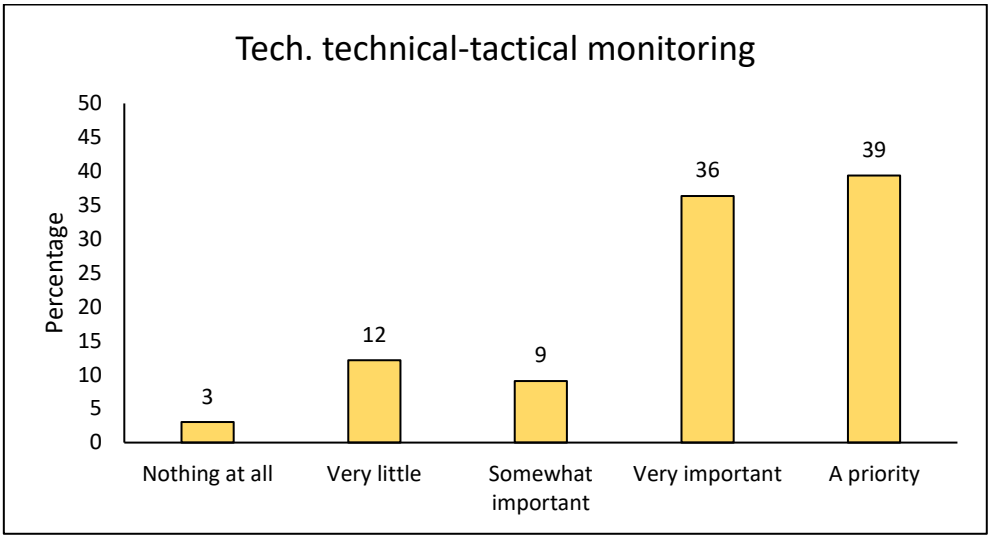


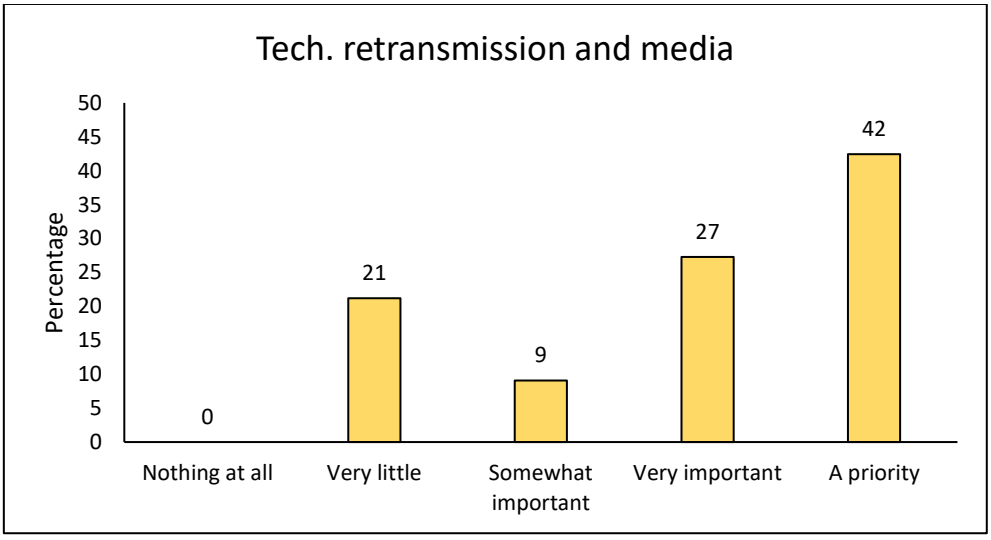



Tech. reporting and visualization
Percentage
50
45
40
35
30
25
20
15
10
5
0
3
15
15
42
24
Nothing at all
Very little
Somewhat important
Very important
A priority


Tech. physical evaluation and injury prevention
Percentage
50
45
40
35
30
25
20
15
10
5
0
3
6
9
33
48
Nothing at all
Very little
Somewhat important
Very important
A priority

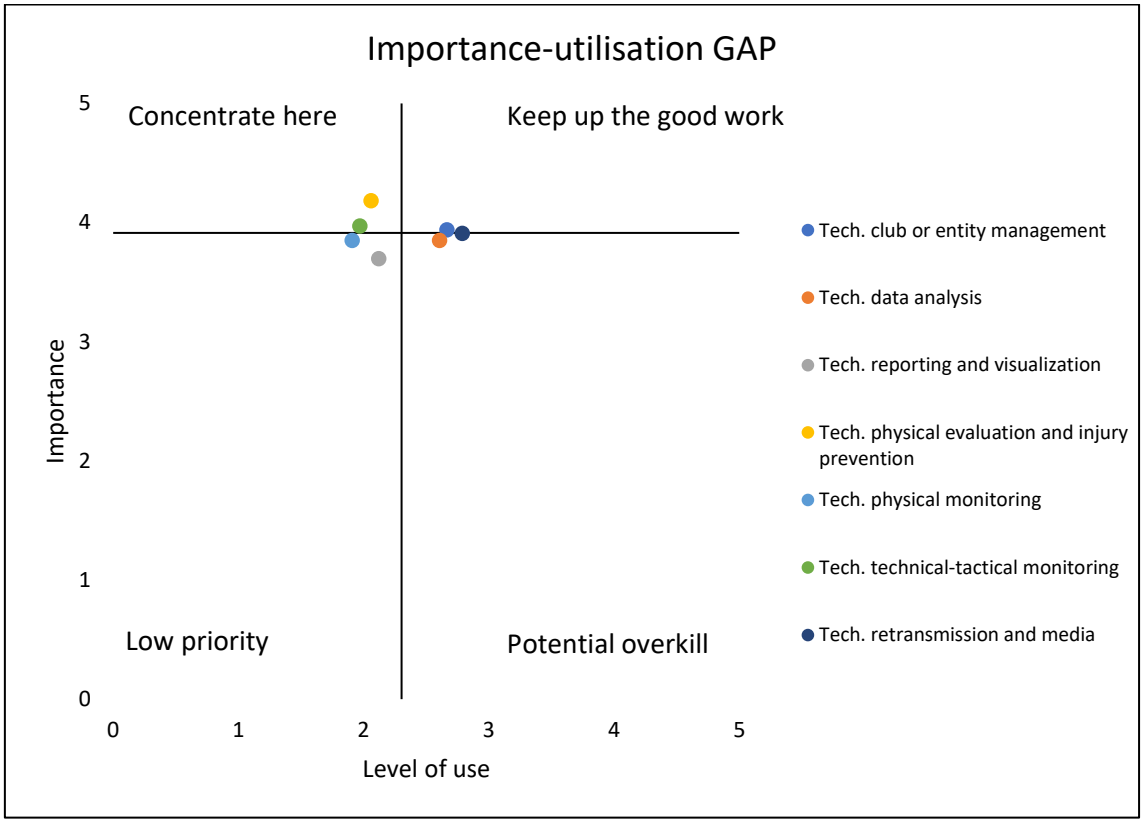

Tech. physical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
3
18
12
24
42
Nothing at all
Very little
Somewhat important
Very important
A priority





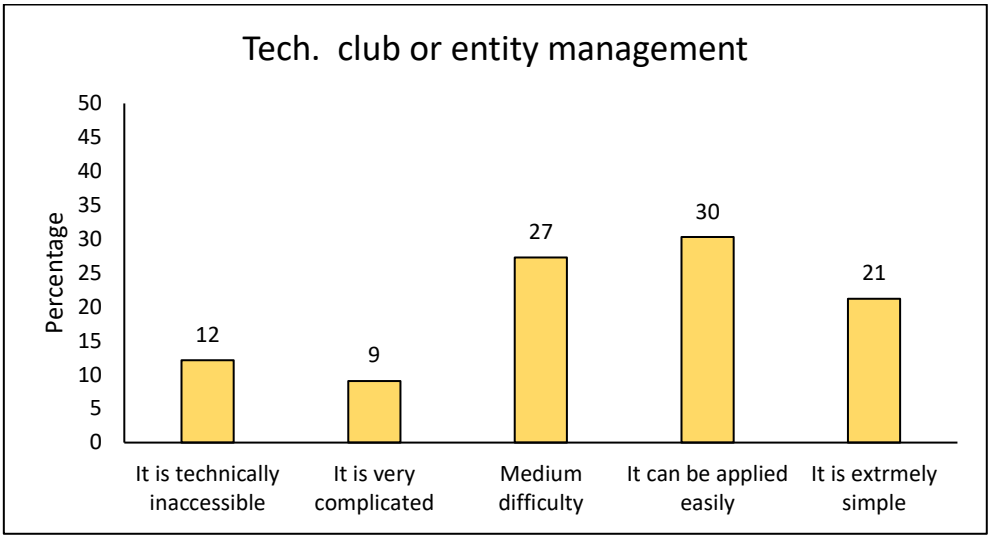
4. GAP analysis between use and importance of technological areas

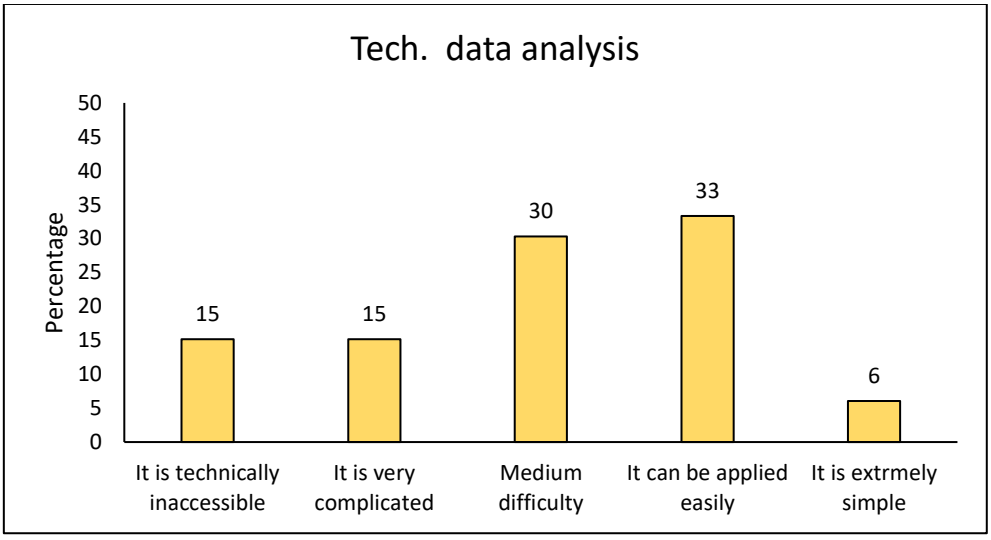
In this graph that we observe based on the responses of the Cypriot sports managers, it follows that the technologies regarding management and retransmission of the club or entity and media are of great importance and high use; therefore, it must be maintained. However, Tech physical evaluation and injury prevention and technical-tactical monitoring are of high importance, but at the same time of little use, so they require further development. Finally, technology regarding Physical monitoring and reporting and visualization have little use and little importance, therefore they are not a priority for managers in Cyprus and Greece .

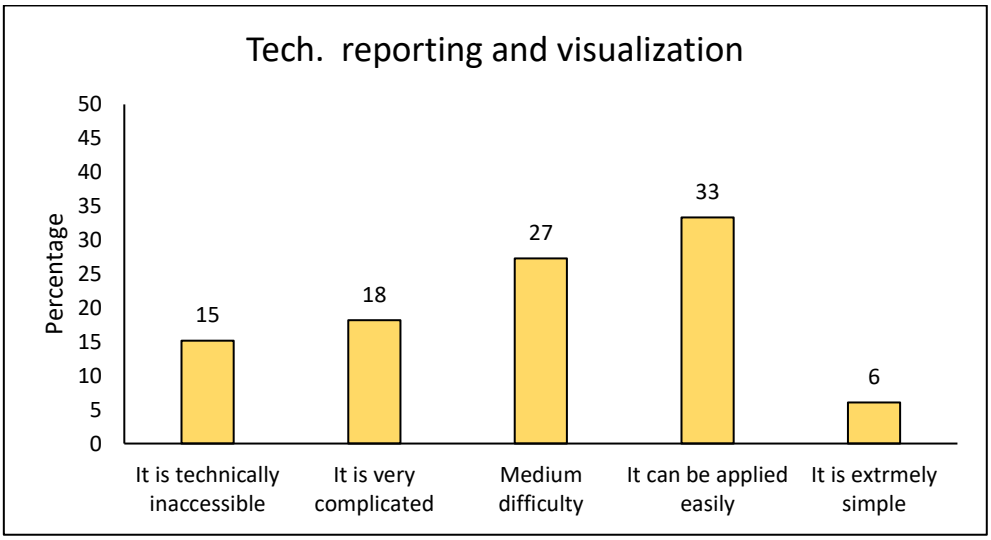


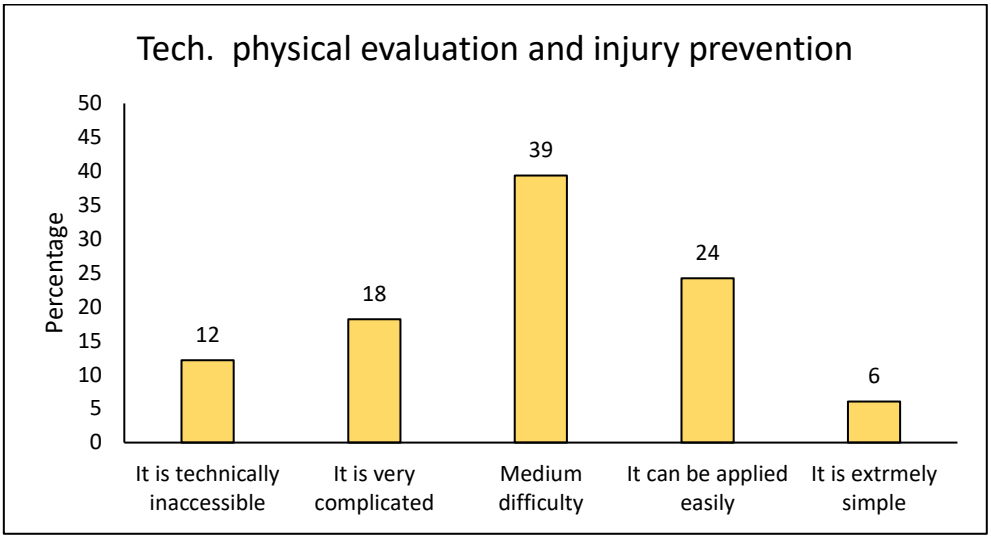
5. What is the level of difficulty that you associate with the use of each technology effectively in your club or sport entity?

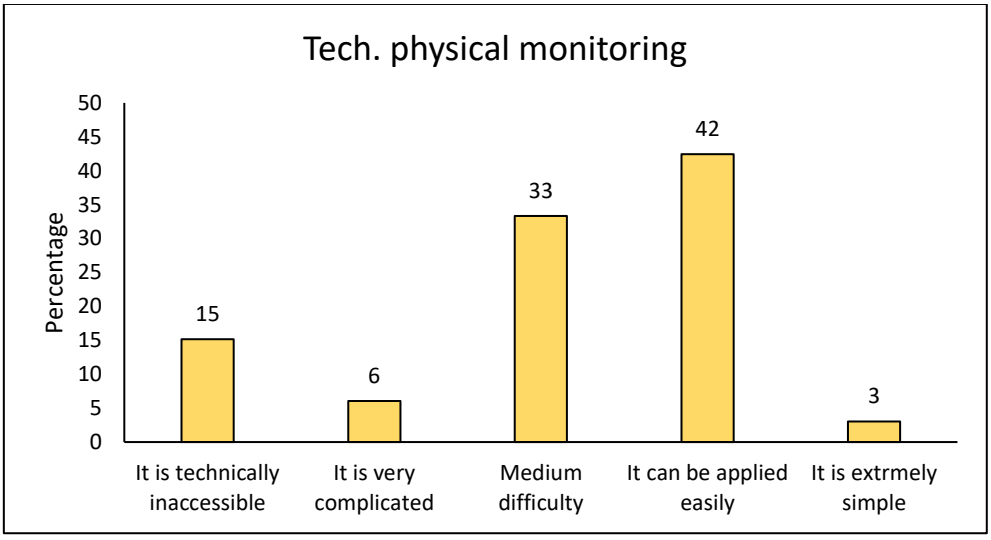
The results obtained provide us that around 24-45% consider that technology can be applied easily. On the other hand , between 27-39% believe that applied technology is medium difficulty, except retransmission and media, where most of respondents think that is easily applicable. While for 6-15% the application of these technologies is considered as technically inaccessible.

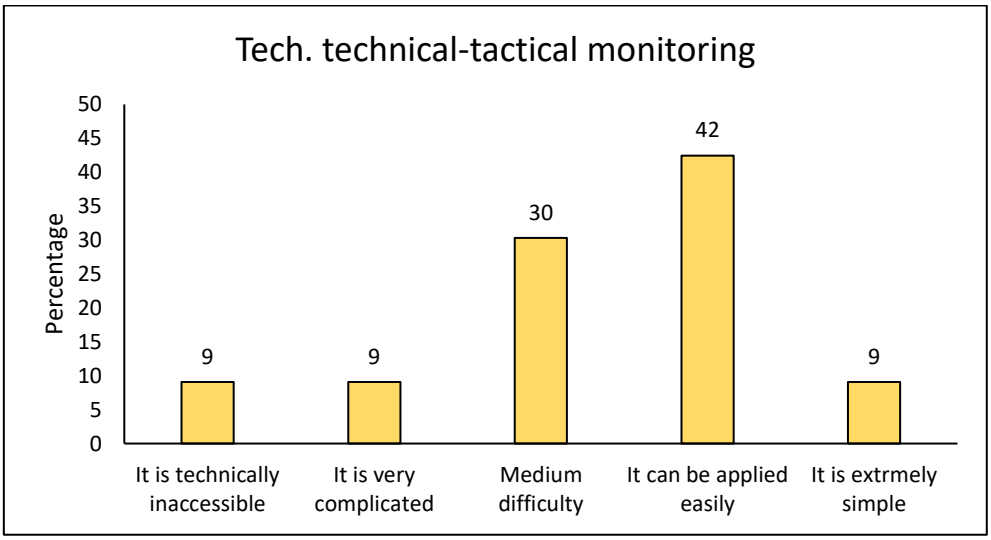

Tech. club or entity management
Percentage
50
45
40
35
30
25
20
15
10
5
0
12
9
27
30
21
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extrmely simple

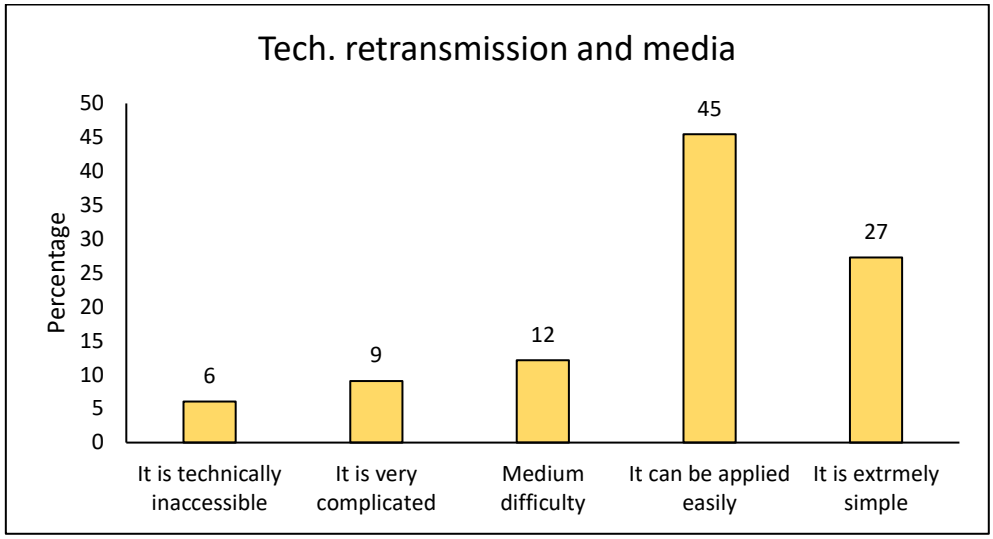

Tech. data analysis
Percentage
50
45
40
35
30
25
20
15
10
5
0
15
15
30
33
6
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extrmely simple


Tech. reporting and visualization
Percentage
50
45
40
35
30
25
20
15
10
5
0
15
18
27
33
6
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extrmely simple


Tech. physical evaluation and injury prevention
Percentage
50
45
40
35
30
25
20
15
10
5
0
12
18
39
24
6
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extrmely simple

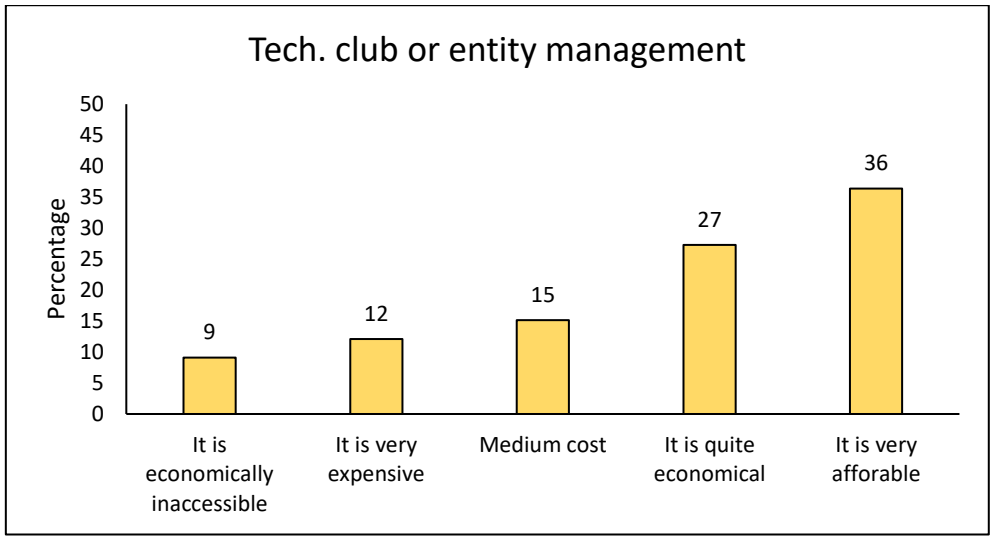

Tech. physical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
15
6
33
42
3
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extrmely simple

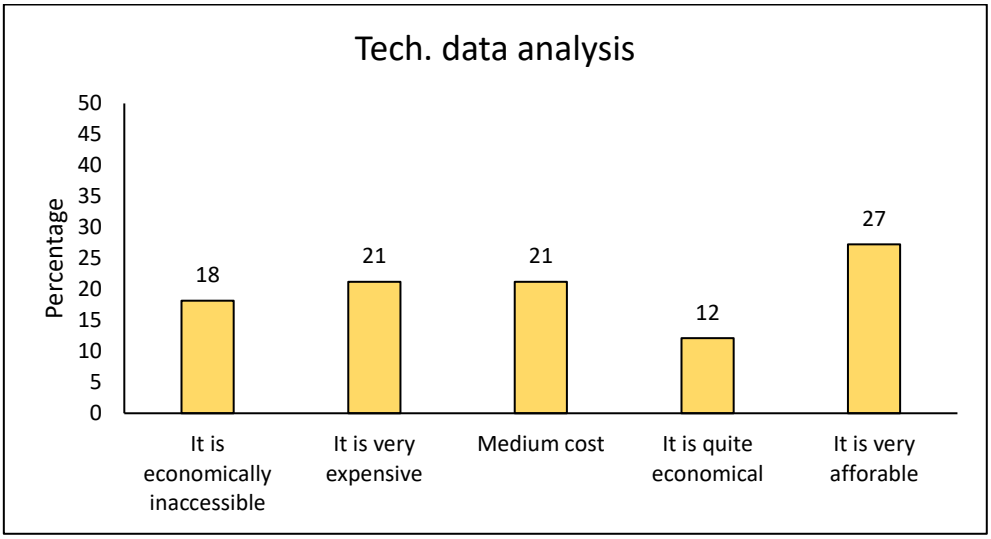

Tech. technical-tactical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
9
9
30
42
9
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extrmely simple

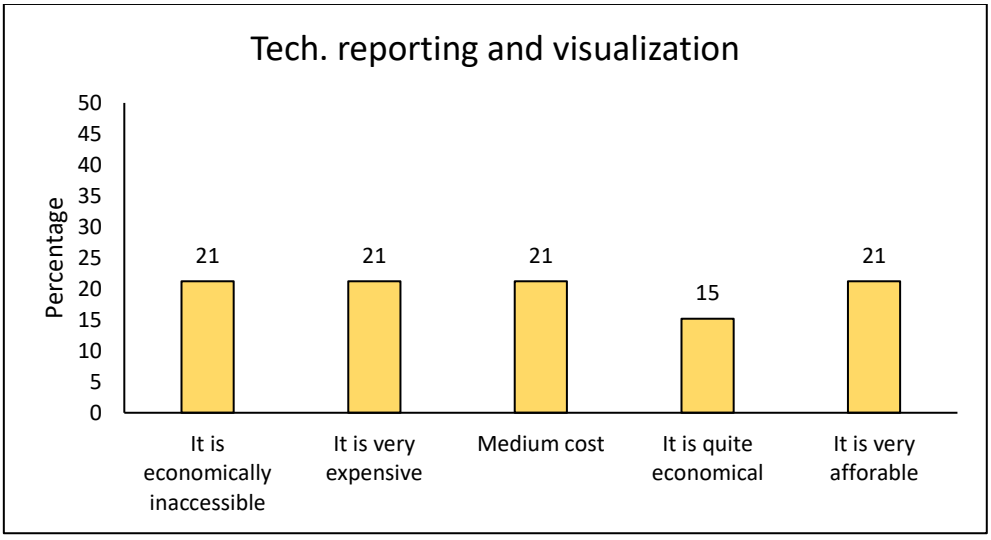


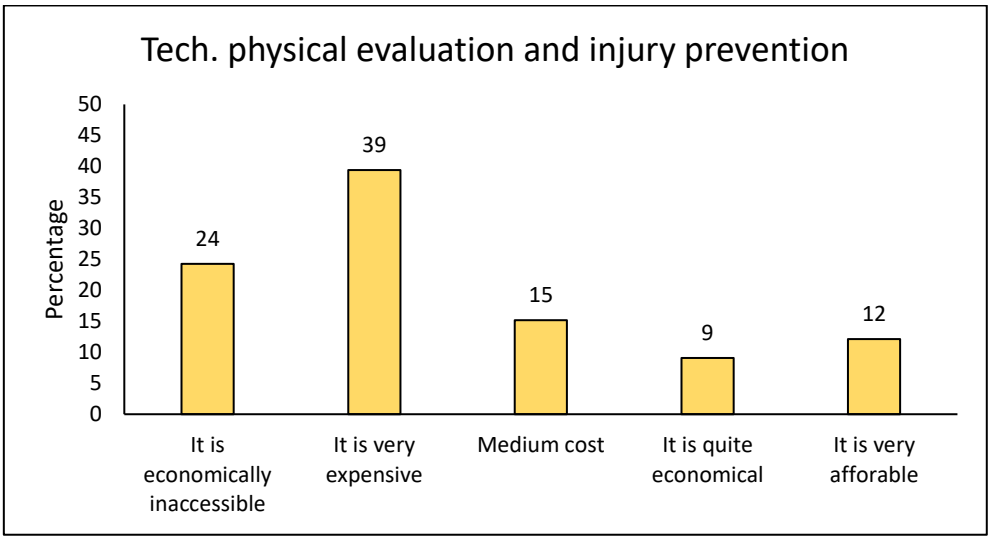
6. Based on your knowledge. How accessible is each technology, economically speaking, for your club or sport entity?

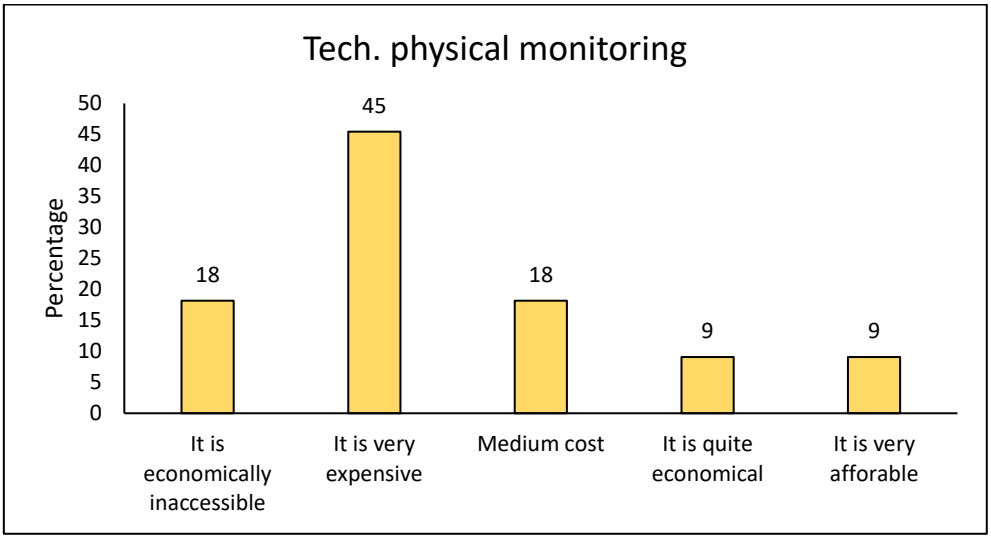
There is a great diversity regarding the cost of technology implementation. The results obtained show that physical evaluation and injury prevention, physical monitoring and technical-tactical monitoring technologies are considered very expensive to be applied (39-45%). However, technologies for retransmission and media, data analysis and club or entity management are considered very affordable to apply (27-36%). Reporting and visualization technology do not show any irregularity between their sections.

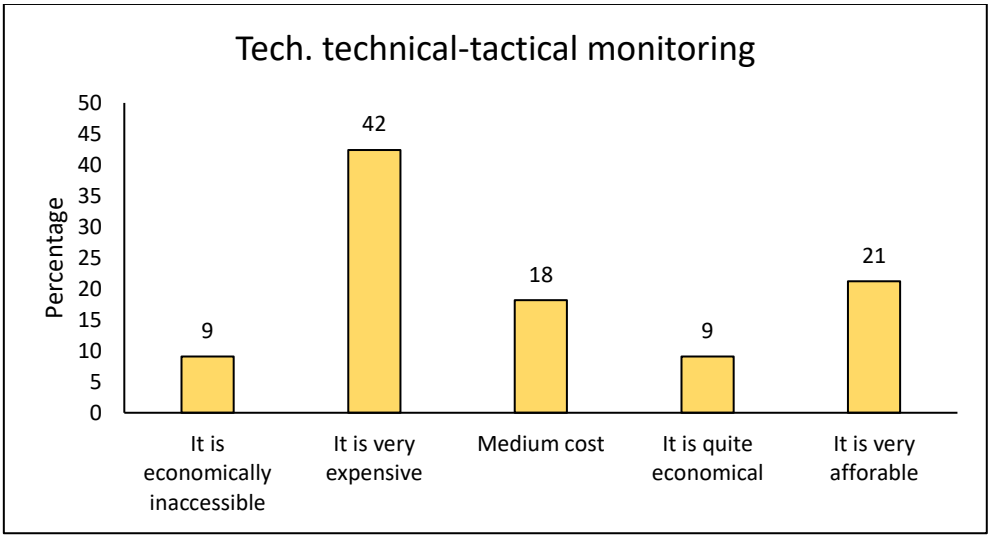


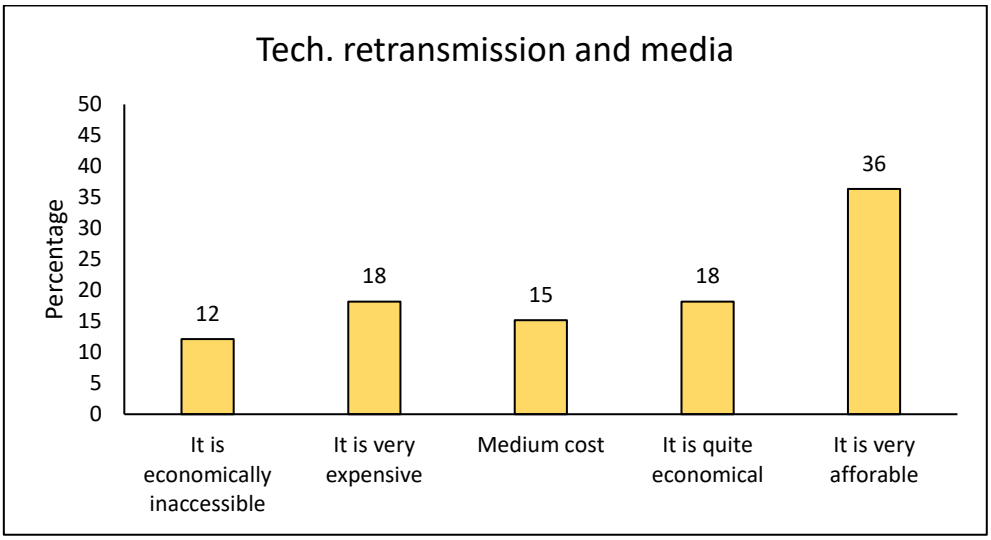

Tech. data analysis
Percentage
50
45
40
35
30
25
20
15
10
5
0
18
21
21
12
27
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very afforable


Tech. reporting and visualization
Percentage
50
45
40
35
30
25
20
15
10
5
0
21
21
21
15
21
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very afforable


Tech. physical evaluation and injury prevention
Percentage
50
45
40
35
30
25
20
15
10
5
0
24
39
15
9
12
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very afforable

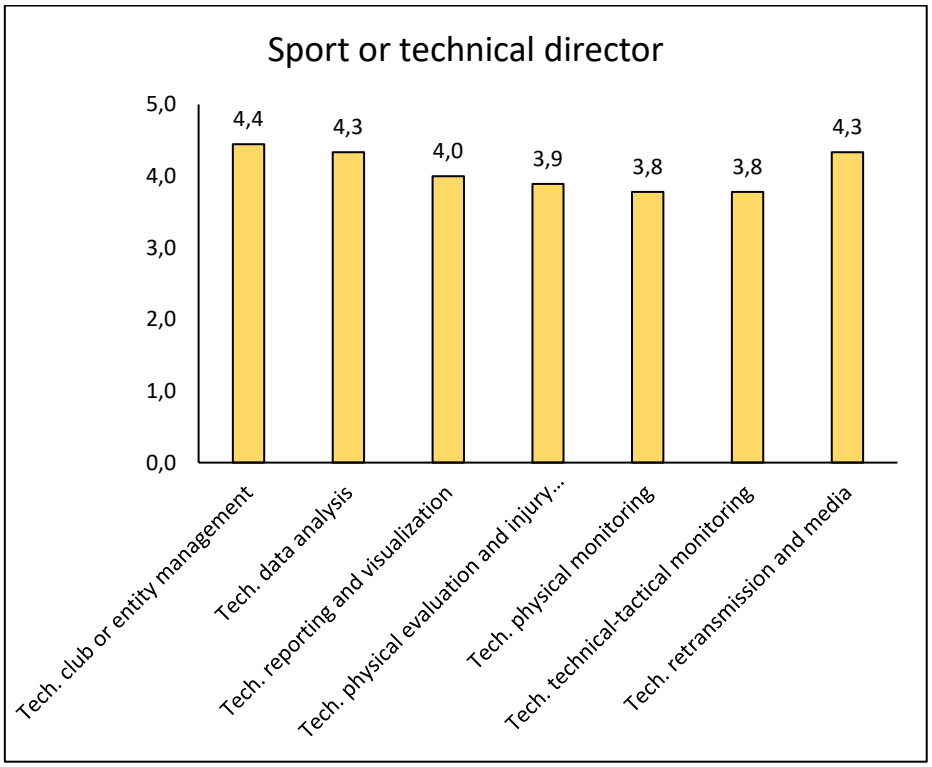

Tech. physical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
18
45
18
9
9
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very afforable

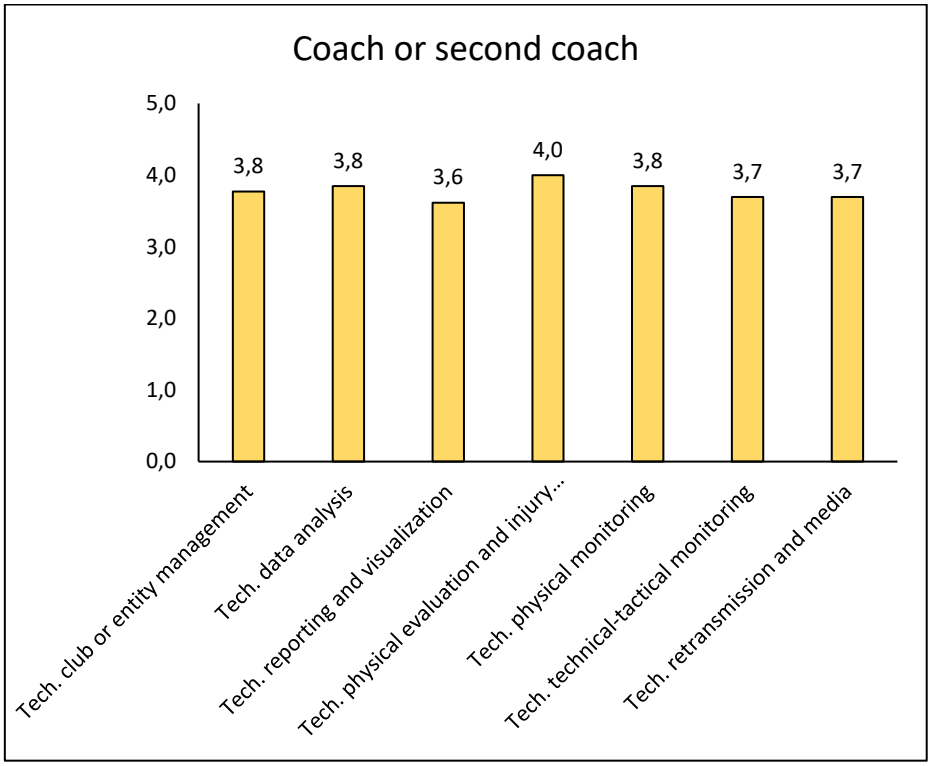

Tech. technical-tactical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
9
42
18
9
21
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very afforable

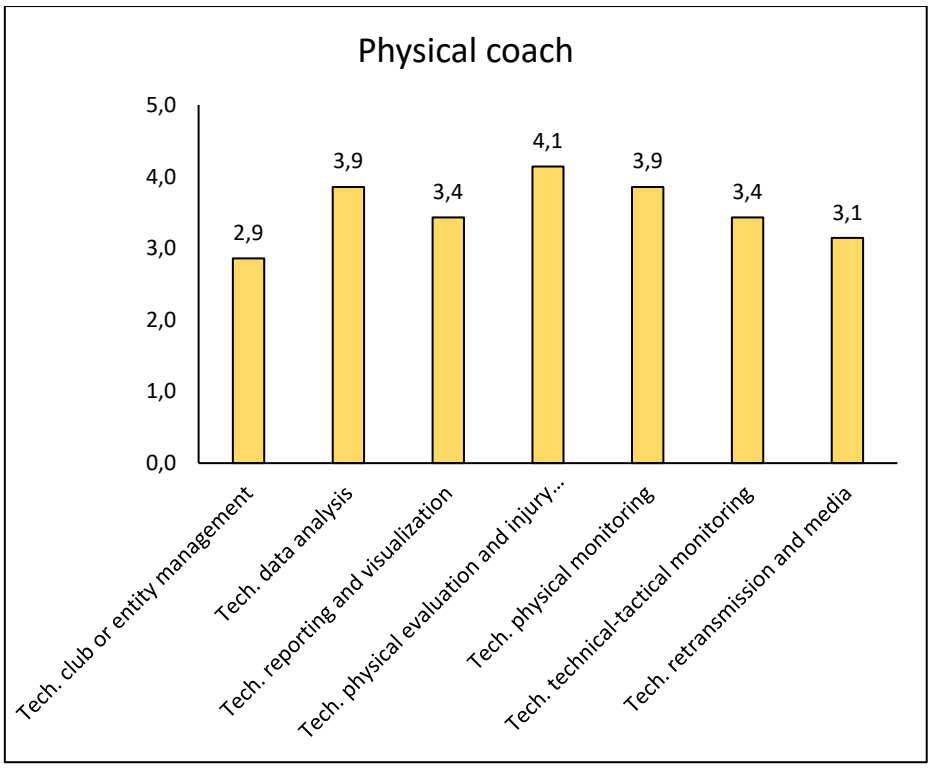

Tech. retransmission and media
Percentage
50
45
40
35
30
25
20
15
10
5
0
12
18
15
18
36
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very afforable

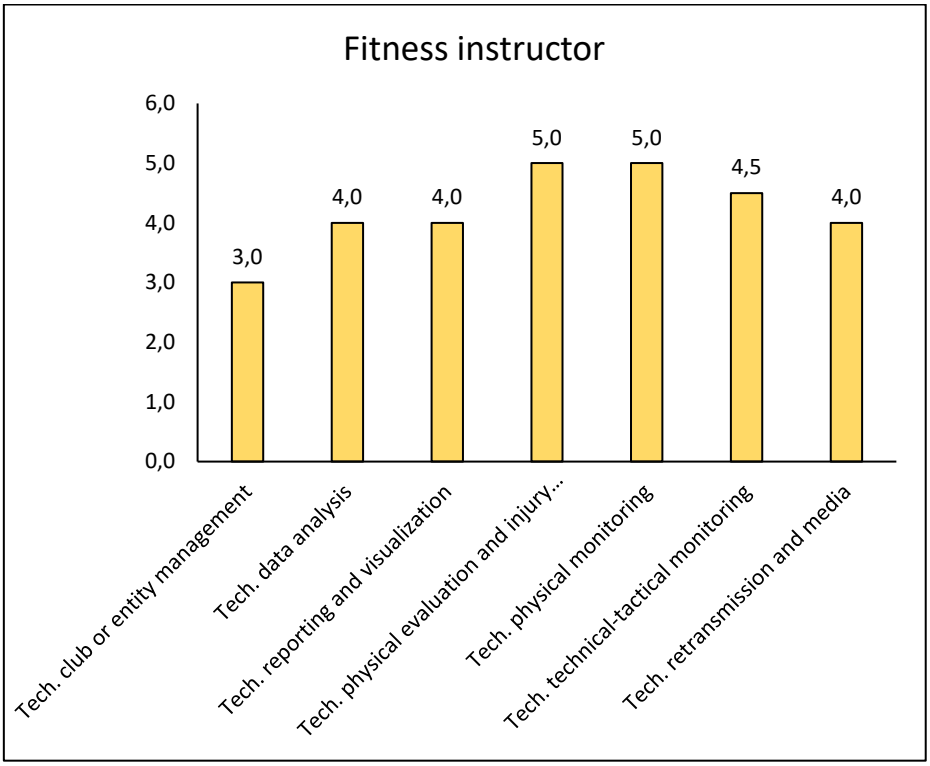
7. How important is each of these technologies for your current position within the club or sport entity?

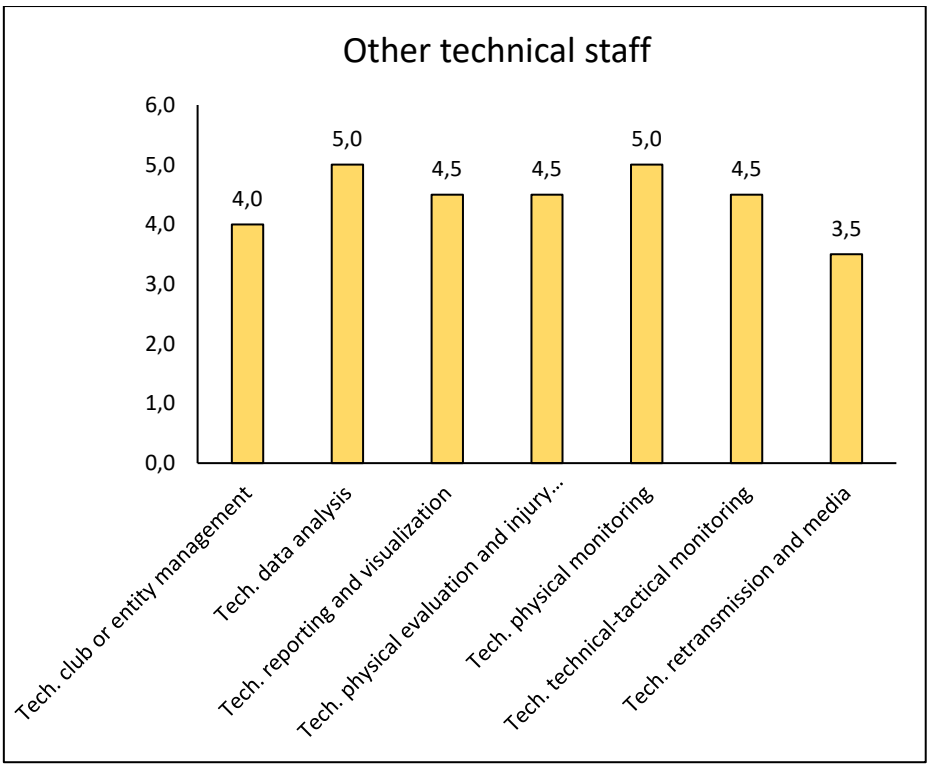
The graphs above show the importance of the use of technologies depending on the current position in a club or sports entity. For sports or technical directors in Cyprus and Greece, tech. club or entity management, data analysis and retransmission and media are the most important for their current position. For coaches or second coaches, however, the tech. Physical evaluation and injury prevention stands out above the other technologies. Likewise for physical coaches and fitness instructors, who determine the tech. physical monitoring and evaluation and injury prevention as the most important. In turn, other technical staff value techs. data analysis together with the physical monitoring the most relevant in their workplace. While the tech. club or entity management is the least important.




Coach or second coach
5,0
4,0
3,0
2,0
1,0
0,0
3,8
3,8
3,6
4,0
3,8
3,7
3,7
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media

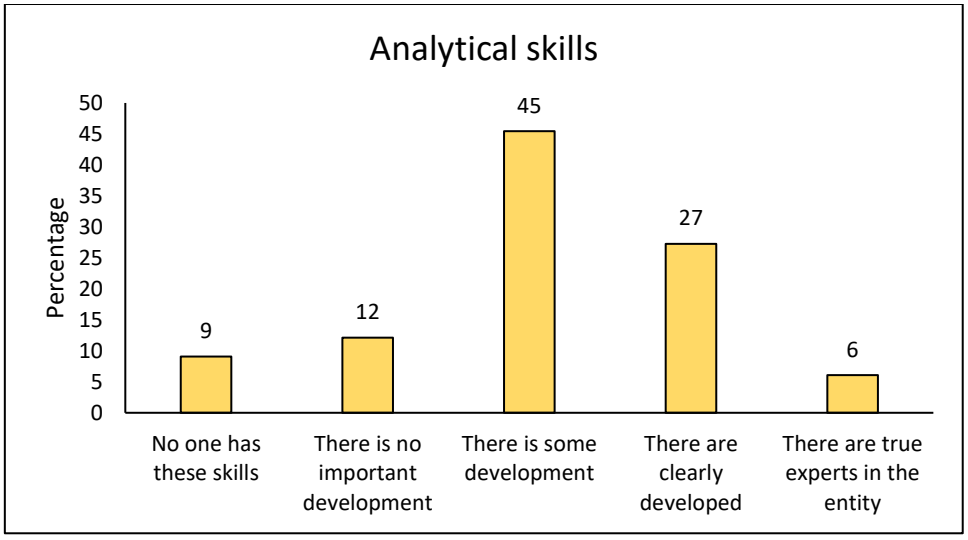

Physical coach
5,0
4,0
3,0
2,0
1,0
0,0
2,9
3,9
3,4
4,1
3,9
3,4
3,1
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media

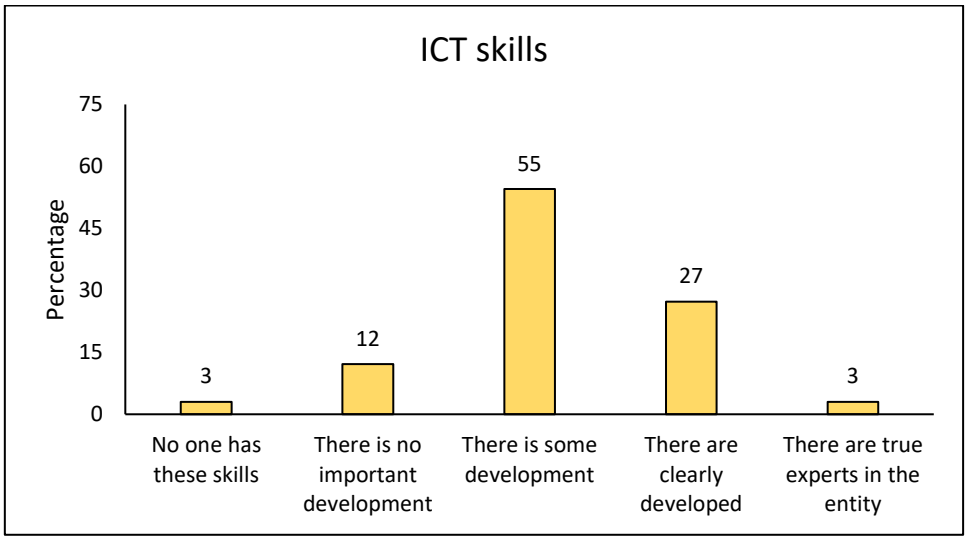

Fitness instructor
6,0
5,0
4,0
3,0
2,0
1,0
0,0
3,0
4,0
4,0
5,0
5,0
4,5
4,0
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media

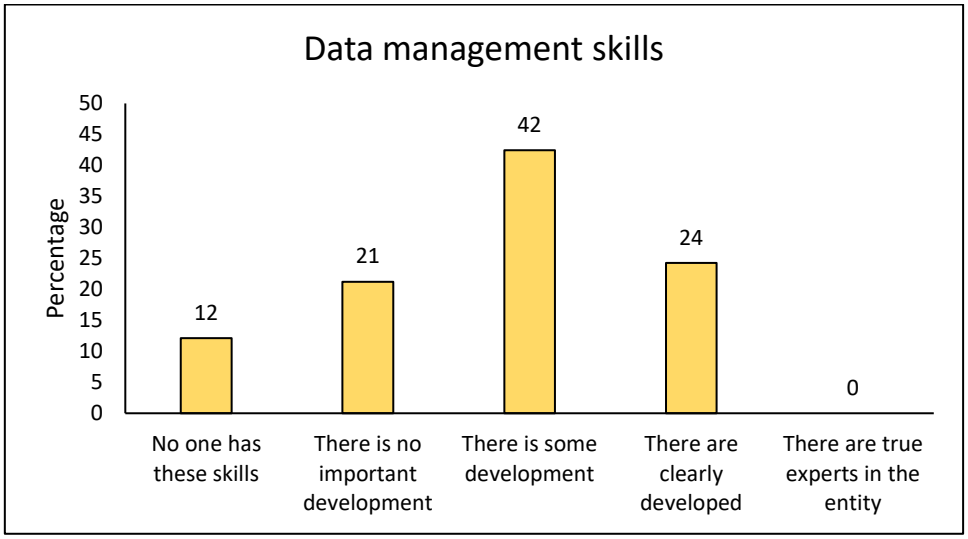

Other technical staff
6,0
5,0
4,0
3,0
2,0
1,0
0,0
4,0
5,0
4,5
4,5
5,0
4,5
3,5
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media

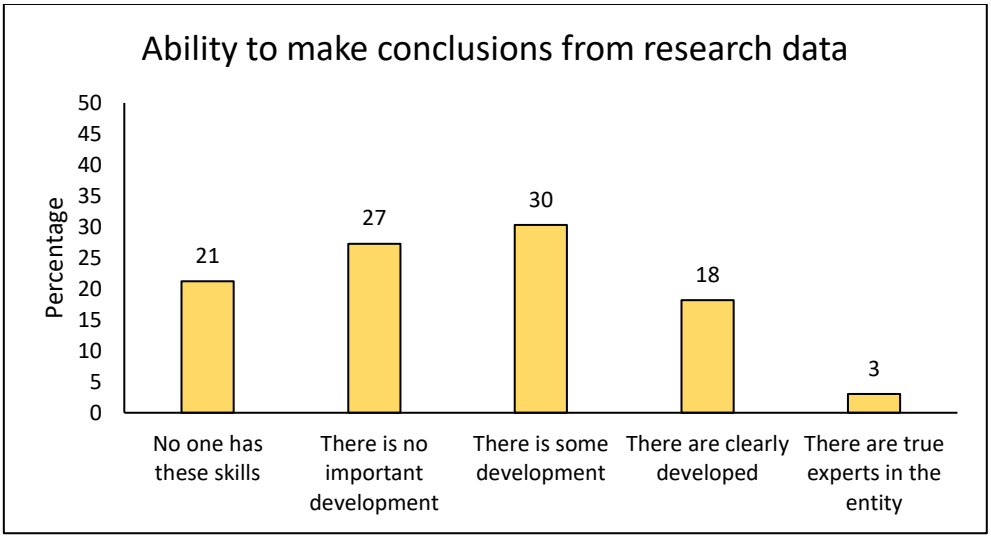
8. How developed are these competencies in your club or sport entity?

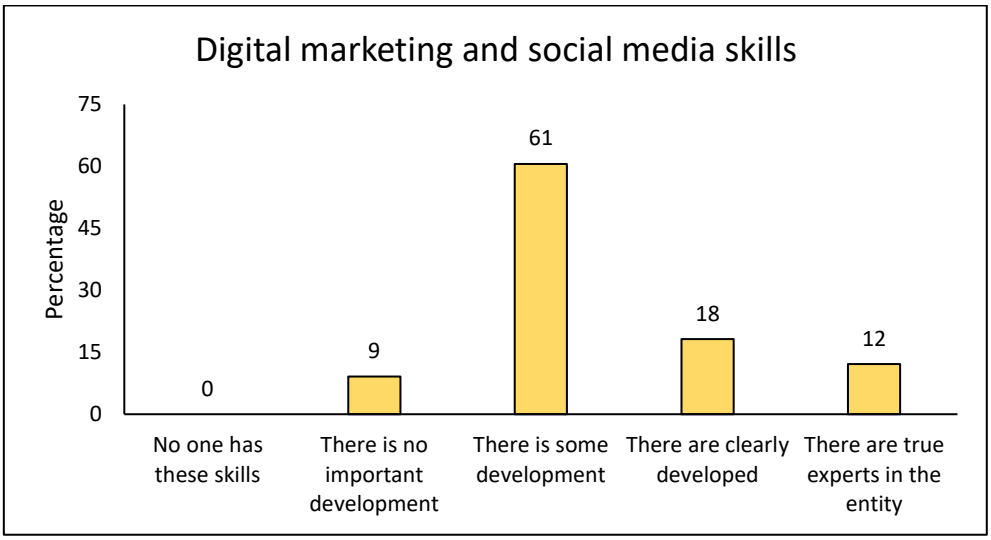
The graphics show that around 42-61% believe that competences in their entities are some developed. Except the ability to make conclusions from research data and skills in digital management of Big Data for which is considered to be no important development (27-36%). In addition, only 0-12% stated that there are true experts in the entity.

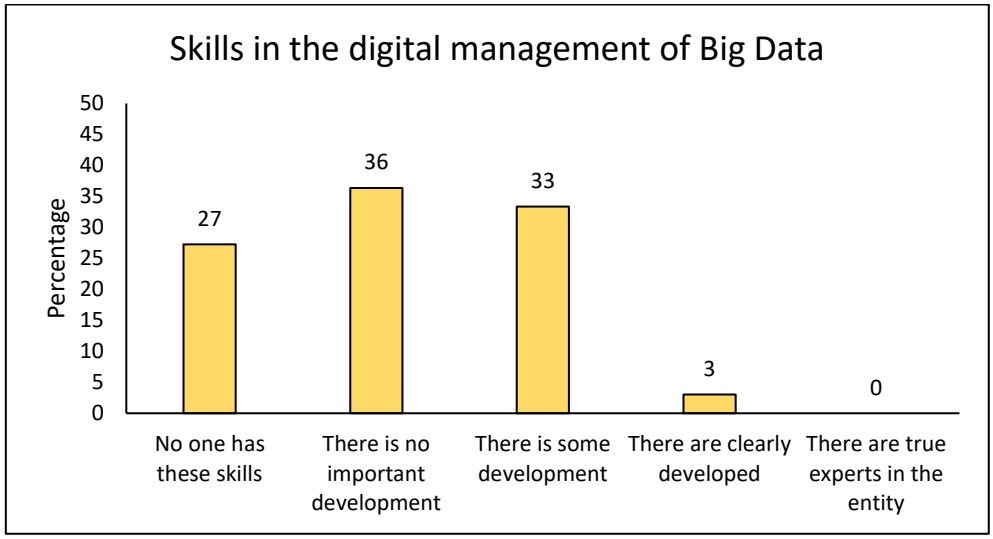





Data management skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
12
21
42
24
0
No one has these skills
There is no important development
There is some development
There are clearly developed
There are true experts in the entity

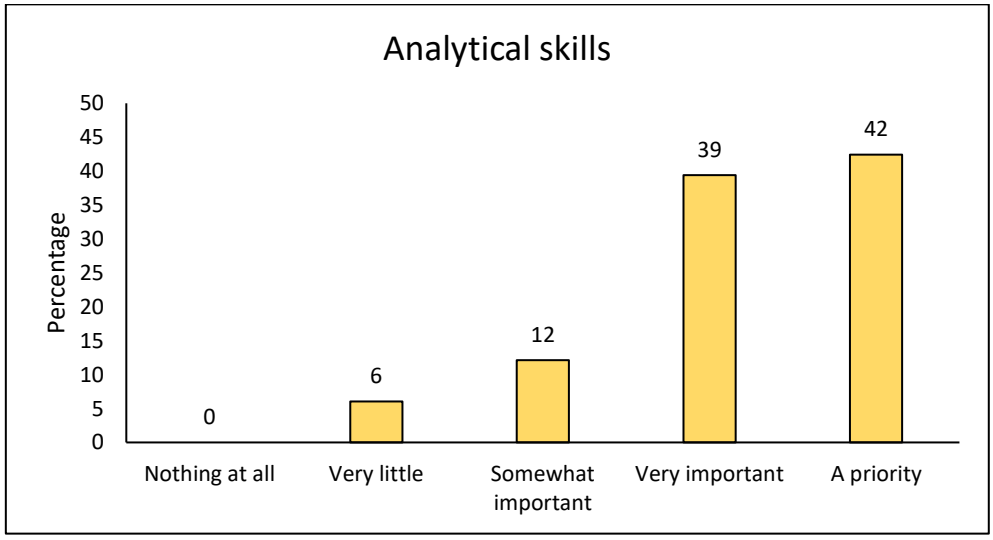

Ability to make conclusions from research data
Percentage
50
45
40
35
30
25
20
15
10
5
0
21
27
30
18
3
No one has these skills
There is no important development
There is some development
There are clearly developed
There are true experts in the entity

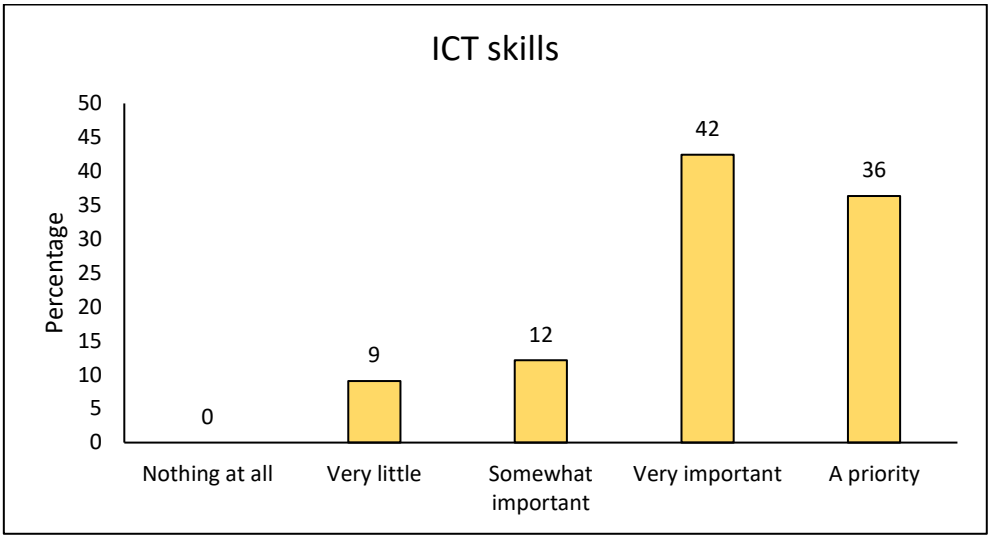

Digital marketing and social media skills
Percentage
75
60
45
30
15
0
0
9
61
18
12
No one has these skills
There is no important development
There is some development
There are clearly developed
There are true experts in the entity

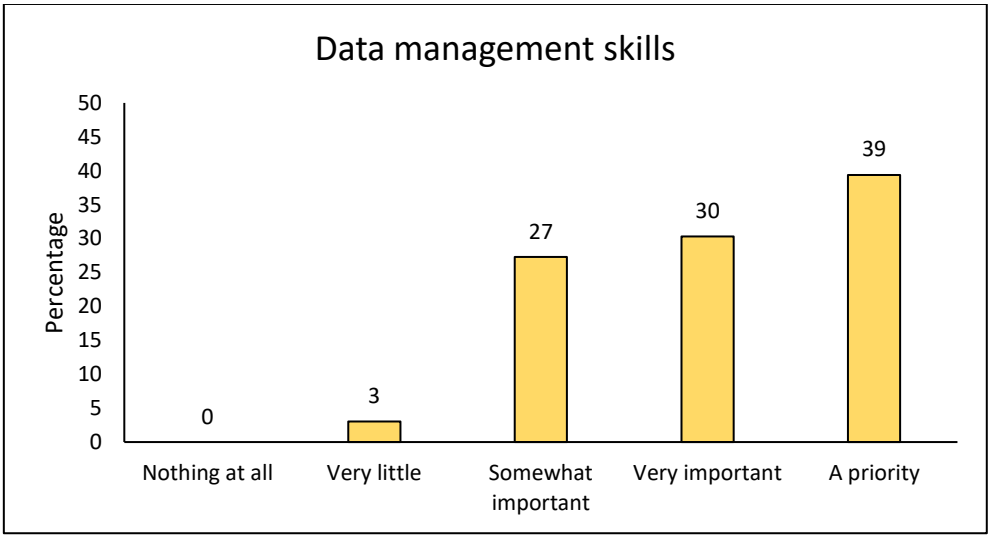


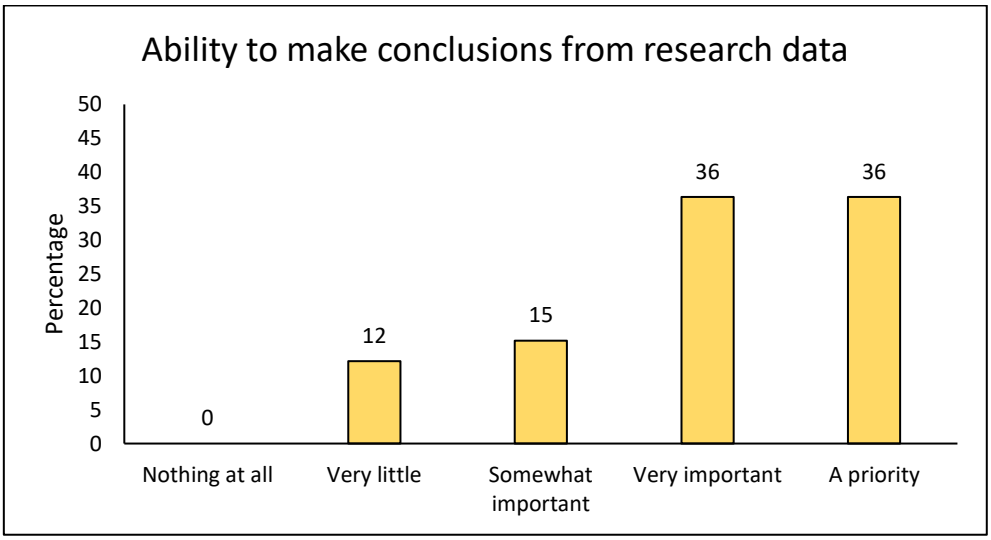
9. How important do you think these professional skills are in your club or sport entity?

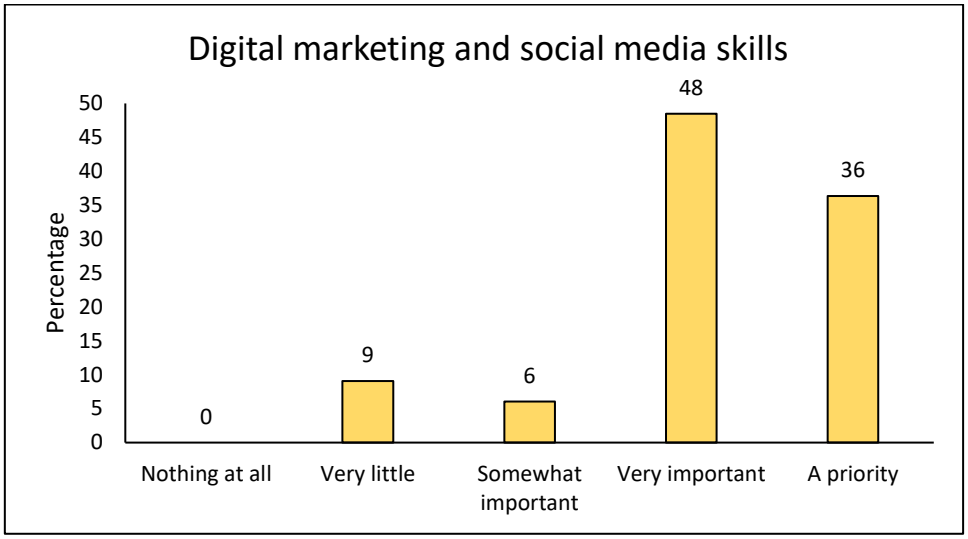
The charts show that between 27-42% believe that the use of these professional skills is a priority. Except skills in the digital management of Big Data, the rest of points are considered to be very important. In addition, between 0-12% consider that Skills in general are not important at all. Generally, sports clubs or entities believe it is very important or a priority to acquire these skills from their staff.

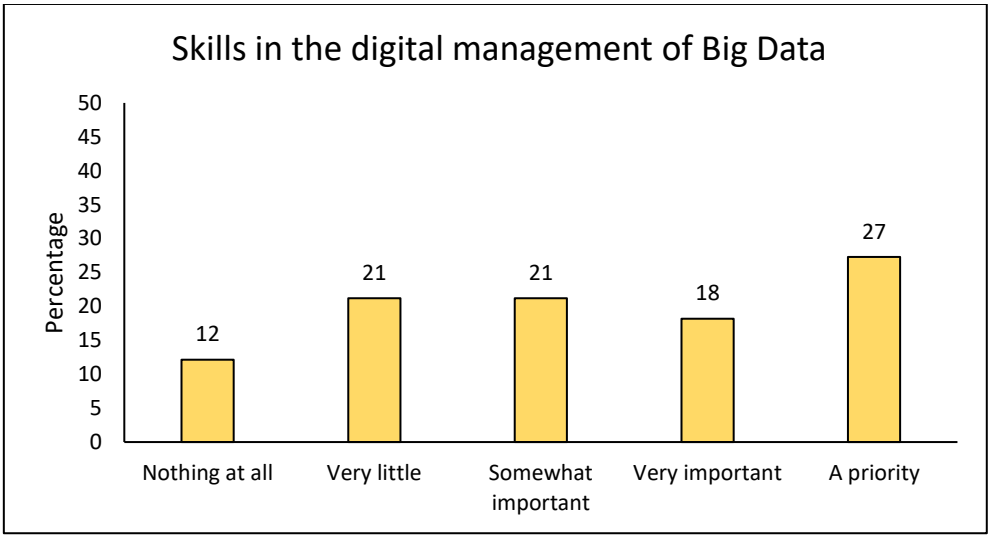



ICT skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
0
9
12
42
36
Nothing at all
Very little
Somewhat important
Very important
A priority


Data management skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
0
3
27
30
39
Nothing at all
Very little
Somewhat important
Very important
A priority

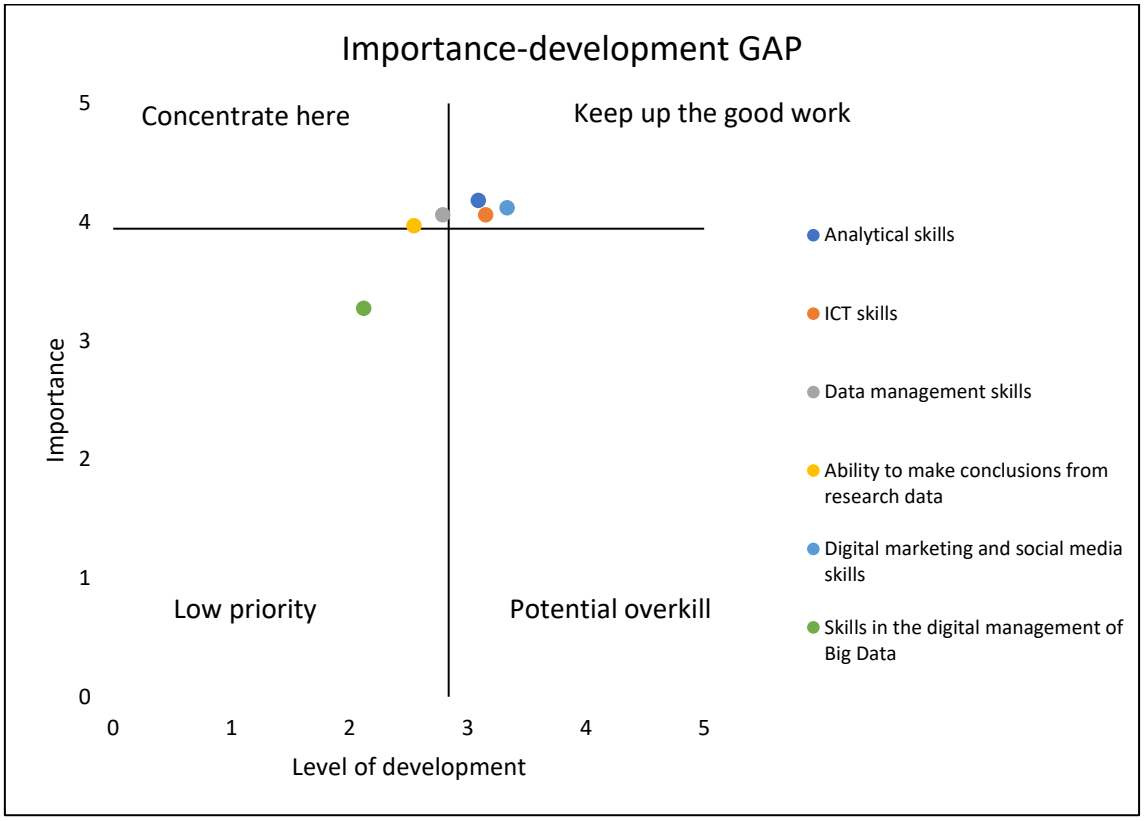

Ability to make conclusions from research data
Percentage
50
45
40
35
30
25
20
15
10
5
0
0
12
15
36
36
Nothing at all
Very little
Somewhat important
Very important
A priority





10. GAP analysis between development and importance of technological competences

In this graph that we observe based on the responses of sports managers in Cyprus and Greece , it follows that analytical skills, ICT skills and digital marketing and social media skills have a high degree of importance and level of development, therefore, they must be maintained. The skills in the data management skills and ability to make conclusions from research data are of high importance, but little use, so they require further development. Finally, the skill in digital big data management has little use and little importance, therefore they are not a priority for managers in Cyprus/Greece .



11. Discussion of results

Cyprus is a country with a population of around 1 million residents, and a corresponding small number of sports entities and clubs. Because of the relatively small sample, clubs in Greece were also contacted to provide feedback to the survey. Sports in Cyprus and Greece, are shaped in a similar manner so the sample would be sound and coherent, thus representative.

In general, even the big and most supported clubs in Cyprus have a more limited budget in comparison to those of other European Countries. Many of the under investigation technologies require a substantial enough, flexible budget in order to be purchased and applied by sports clubs. Moreover, people with the proper knowledge and expertise should be hired or trained in key positions regarding the usage of these technologies. These persons can in turn train the rest of the staff, requiring even more resources. There is no doubt that the use of such technologies would make a remarkably positive difference to sports in Cyprus. For example, a big club in Cyprus may only have the option to use video recordings of matches and training sessions to analyse players' performance in a sport. Since they do not have the required software to do this efficiently and effectively, plenty of hours and

resources need to be consumed to analyse video footage manually. There is also the issue of missing out on crucial data that cannot be analysed in such a manual manner.

Furthermore, not all the big universities and educational institutions in Cyprus offer sports studies, and when they do there does not exist a specialisation in the application and usage of sports technologies. Thus the required knowledge is neither offered nor promoted in national educational institutions.

Additionally, sports technology is not a very common area for research in the Computer Science, and Software Engineering fields. The collaboration of Sports Scientists and Software Engineers could lead to technologies that would help the local clubs in a more cost effective way and also lead to vast developments for the sports community in Cyprus.

In conclusion, the limited budget, as well as the lack of education and research focused on sports technologies in Cyprus are the main factors explaining the not so wide usage and adoption of such technologies in sports entities and clubs in Cyprus, even though they are considered to be very important.

12. Conclusions

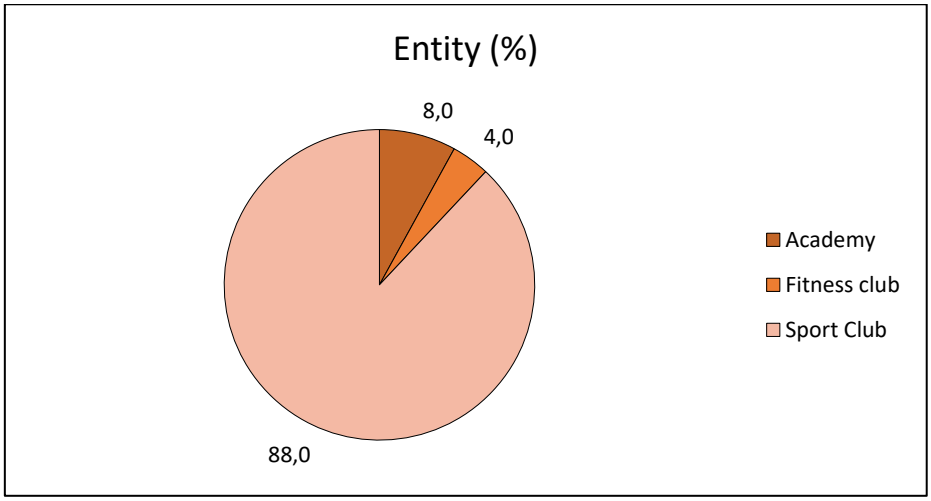
- Most of the Sports Technologies studied in this survey are not widely used in sports clubs and entities in Cyprus (and Greece).
- Sports staff in Cyprus (and Greece) appreciate and consider the usage of such technologies as very important.
- Physical monitoring and reporting and visualization technologies are considered with lesser importance in comparison to the other Sports technologies in Cyprus (and Greece).
- Majority of the respondents do not think that using such technologies would be very difficult.
- Technologies like retransmission and media, data analysis and club or entity management are considered to be very affordable to apply. This is reasonable, considering that such software is in general easily accessible and cost effective. Retransmission and media can even be applied through social media, and free live streaming services.
- On the other hand, it is also stated that applying technologies for physical evaluation and injury prevention, physical monitoring and technical-tactical monitoring, would be expensive for most of the sports clubs and entities. Such technologies would require specialised software and hardware devices.

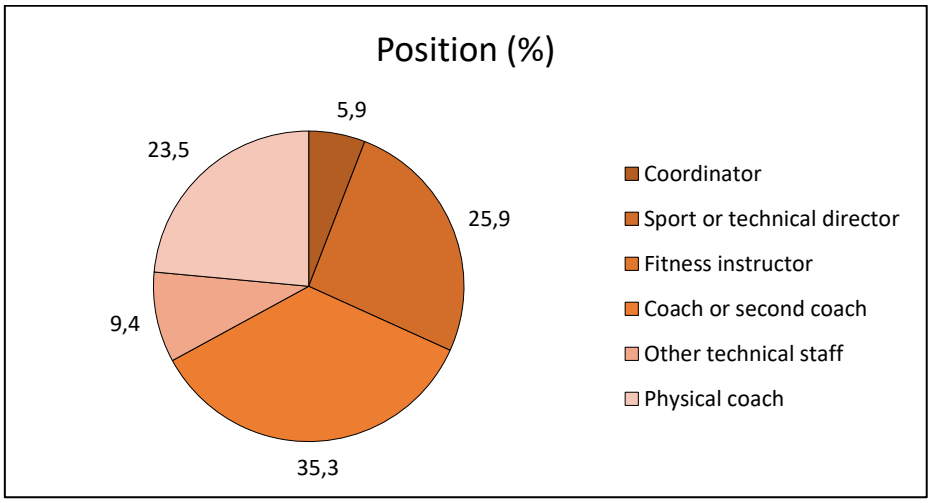
- Certain Sports Technologies would require advanced training to be offered to sports clubs personnel to be able to utilise them properly.
- Concluding from all the above, clubs would proceed in applying such technologies in their everyday operations, if the opportunity was given, or/and if they had the resources.

ANEX VI. INDIVIDUAL REPORT. QUESTIONARIE ENGLISH VERSION, UNITED KINGDOM & IRELAND

1. Sample

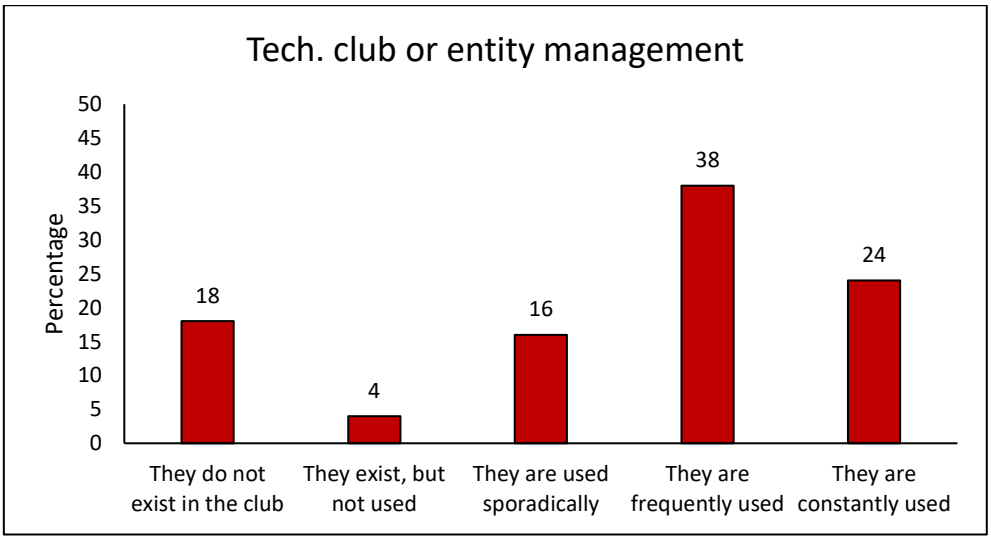
The following graphs show the general characteristics of the sample, depending on the type of entity, position in it and years of experience in the entity and in your current position in %. Sport clubs are the type of entity that provided the most responses (88%), with only 8% and 4% of the respondents coming from academies or fitness clubs, respectively. Accordingly, the most repeated profiles among the participants were coaches (Coach or second coach), with 35,3% of the respondents, and managerial positions (Coordinator and Sport or the technical director), with 32,8%. No fitness instructor answered this questionnaire in the United Kingdom or Ireland. Finally, the years of experience in the entities show an average of 10 years, while the years in their current position averaged 7 years.

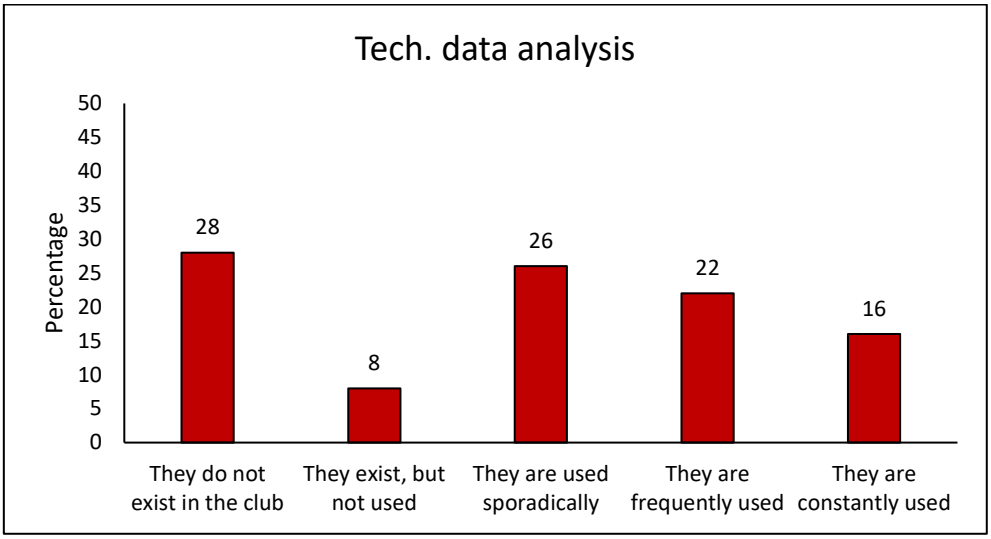


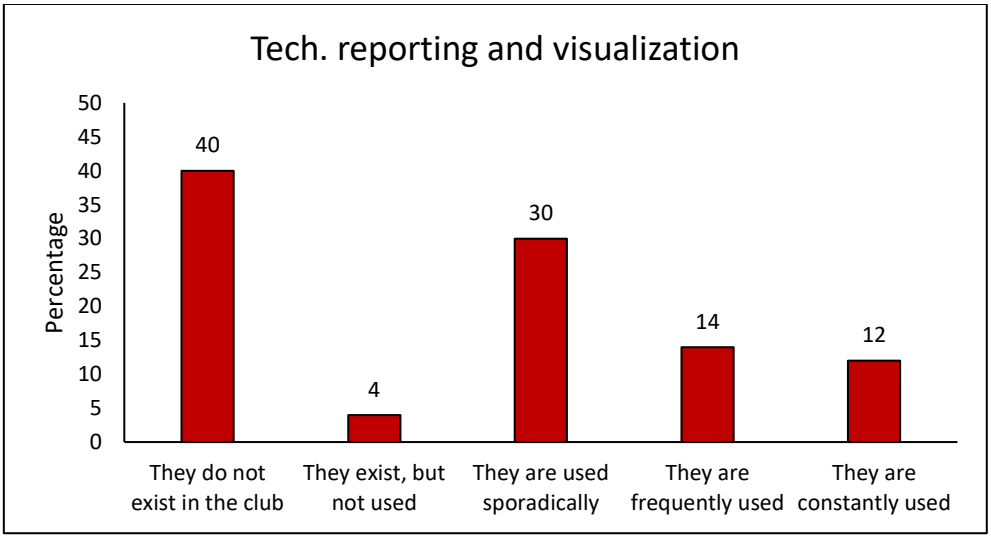


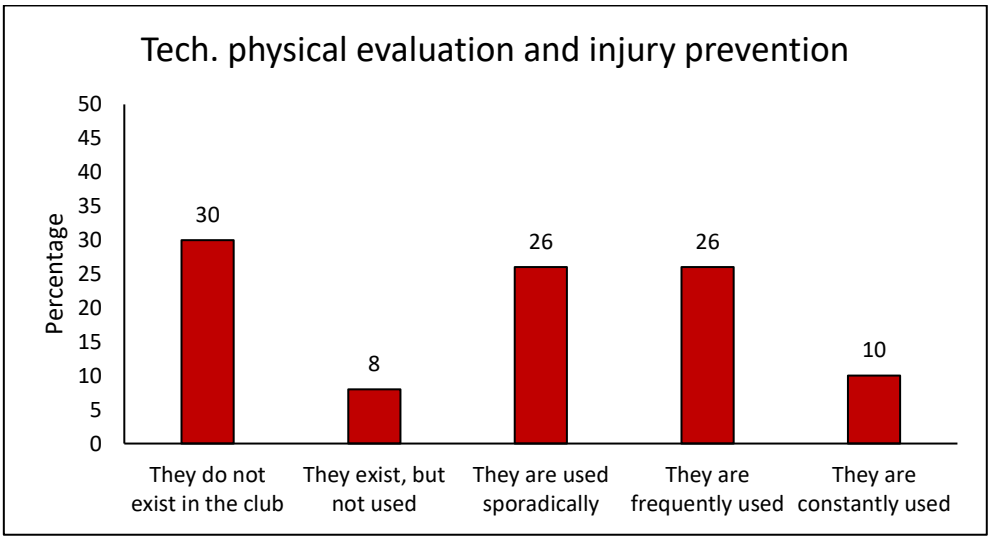
2. To what extent are you currently using these technologies in your club or sport entity?

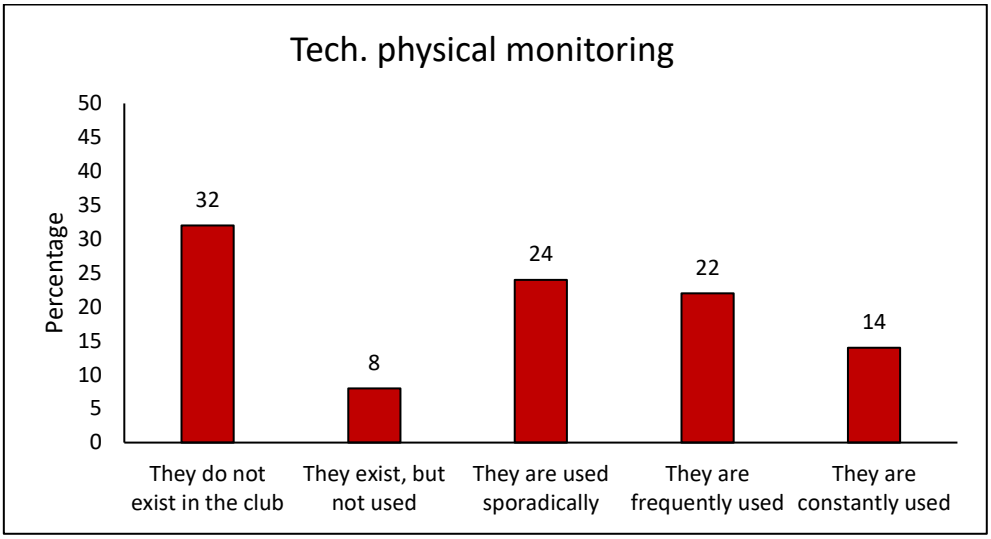
The results of the use of technology within a club or entity indicate that technologies used for reporting and visualization and technologies related to technical-tactical monitoring are the least present technologies in the sector, with 40% of the respondents indicating that they do not exist in the club at all in both cases. On the other hand, technologies related to club or entity management are clearly the ones with the most presence, with 62% of respondents indicating that they are frequently used or constantly used.

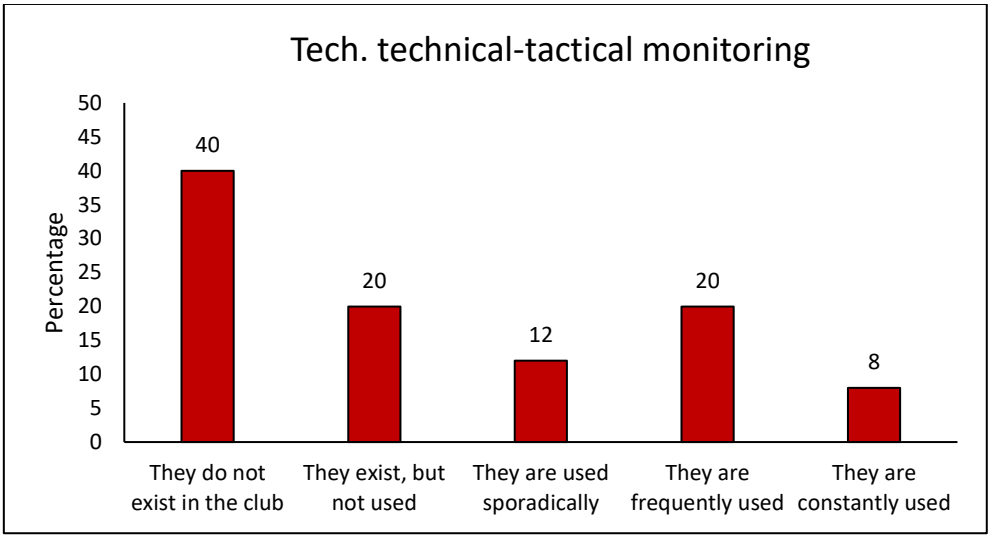


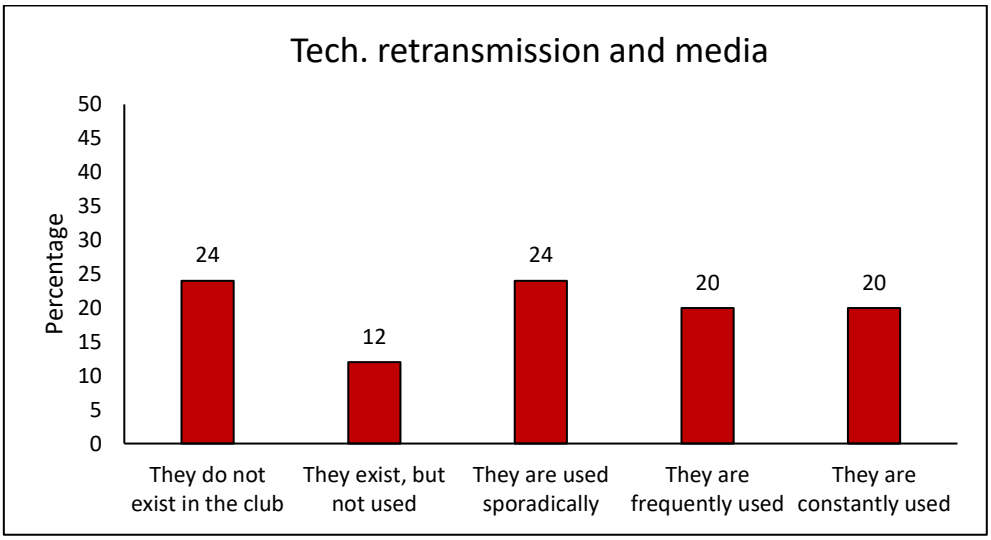

Tech. data analysis
Percentage
50
45
40
35
30
25
20
15
10
5
0
28
8
26
22
16
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used


Tech. reporting and visualization
Percentage
50
45
40
35
30
25
20
15
10
5
0
40
4
30
14
12
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used


Tech. physical evaluation and injury prevention
Percentage
50
45
40
35
30
25
20
15
10
5
0
30
8
26
26
10
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

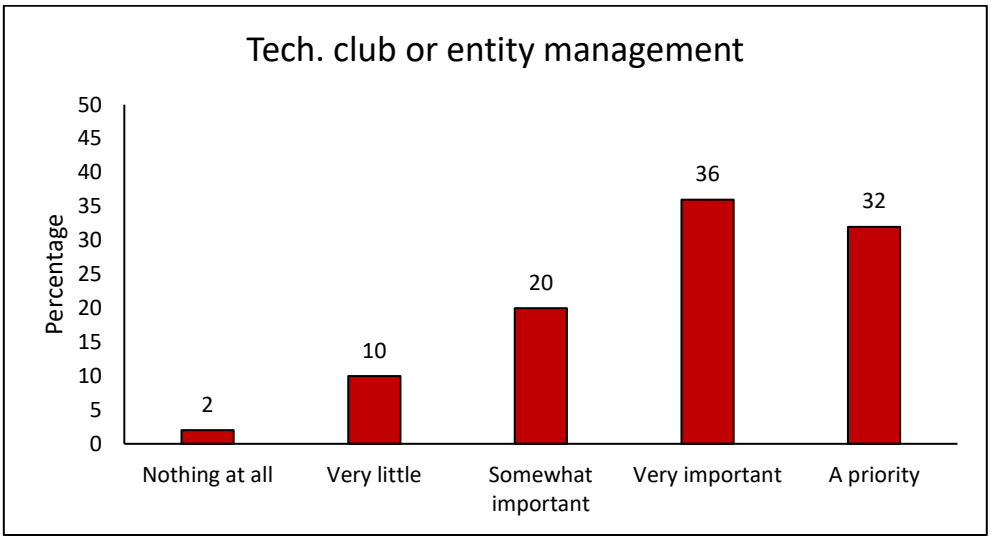

Tech. physical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
32
8
24
22
14
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

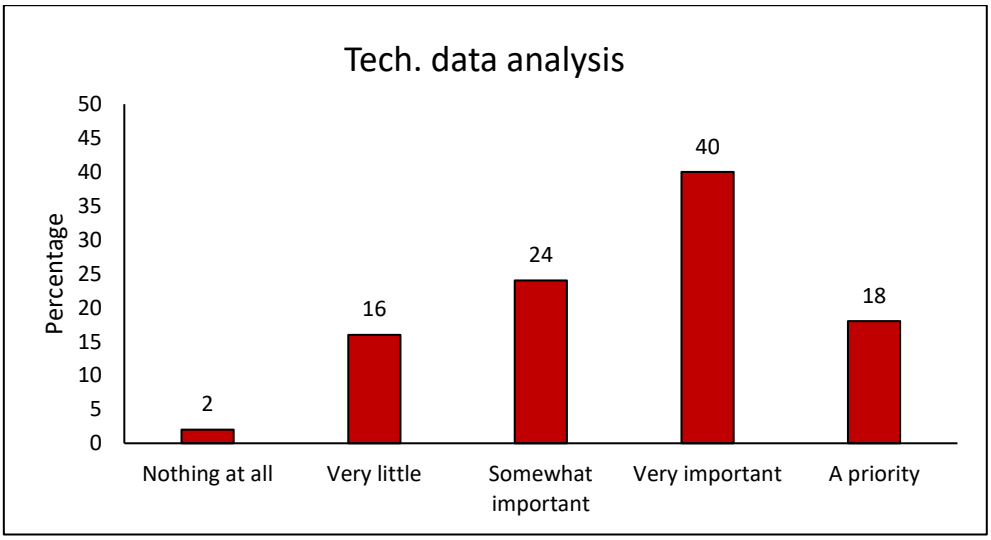

Tech. technical-tactical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
40
20
12
20
8
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

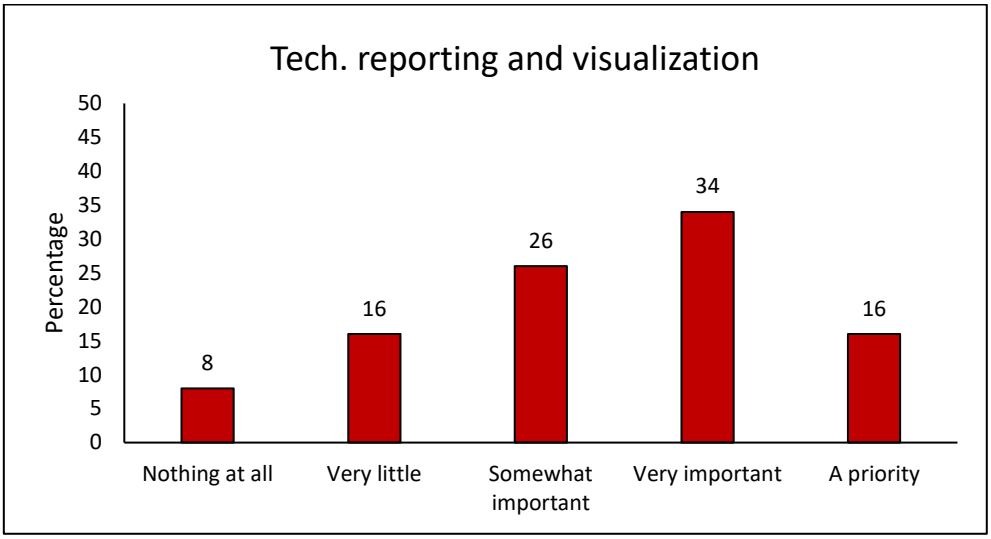

Tech. retransmission and media
Percentage
50
45
40
35
30
25
20
15
10
5
0
24
12
24
20
20
They do not exist in the club
They exist, but not used
They are used sporadically
They are frequently used
They are constantly used

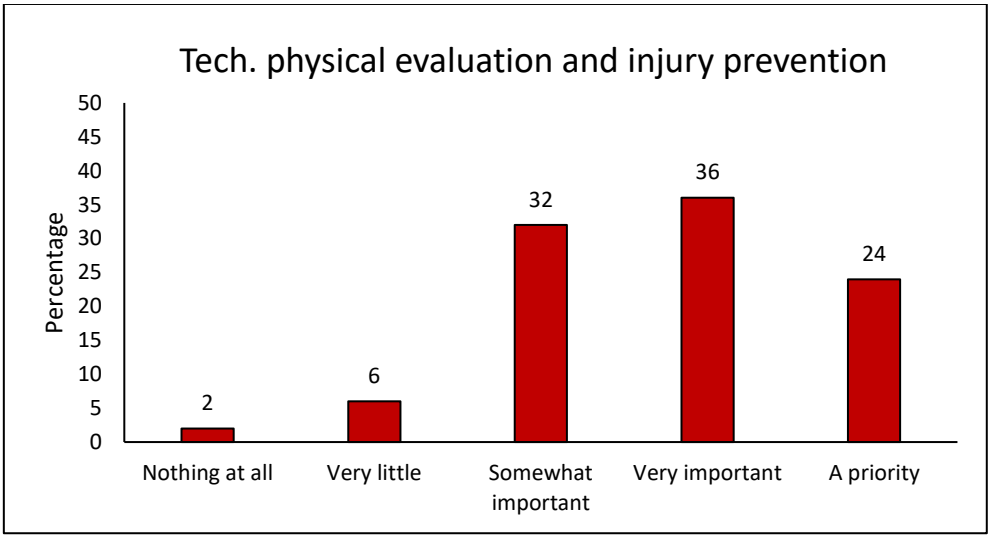
3. How important do you think using these technologies are or would be for your club or sport entity?

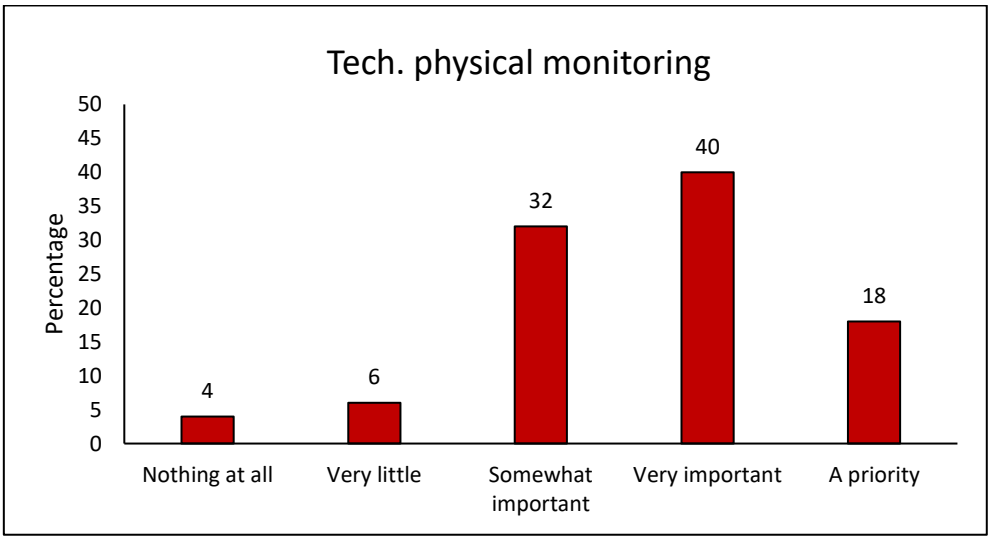
The following graphs show how important participants think the use of different technologies is in sports clubs and entities. Around 24% of the respondents consider that technologies used for reporting and visualization are not important at all or very little, being this the least important technology in the clubs or sport entities, followed by those used for technical-tactical monitoring (20%). On the other hand, the most important technologies are those related to club or entity management, being these very important or a priority for 68% of the respondents.

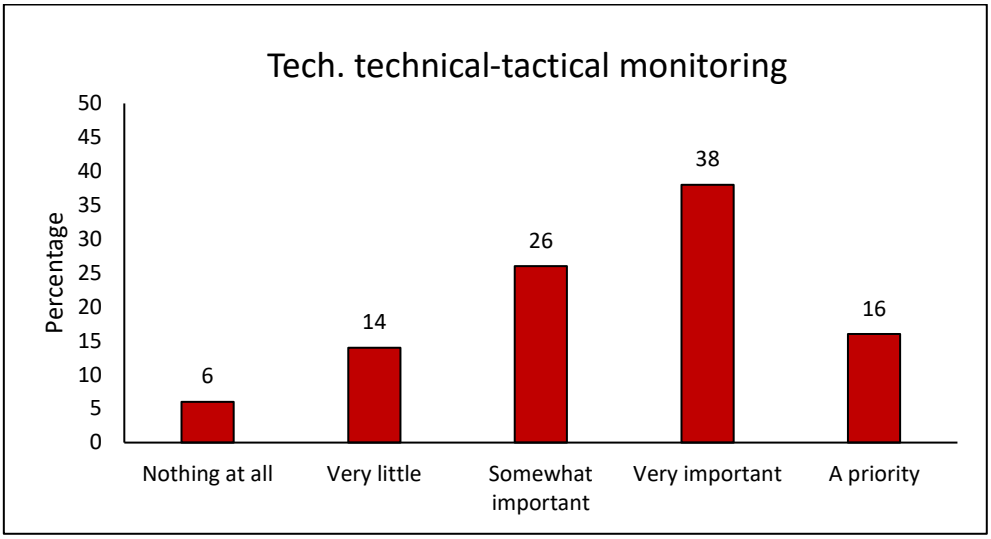


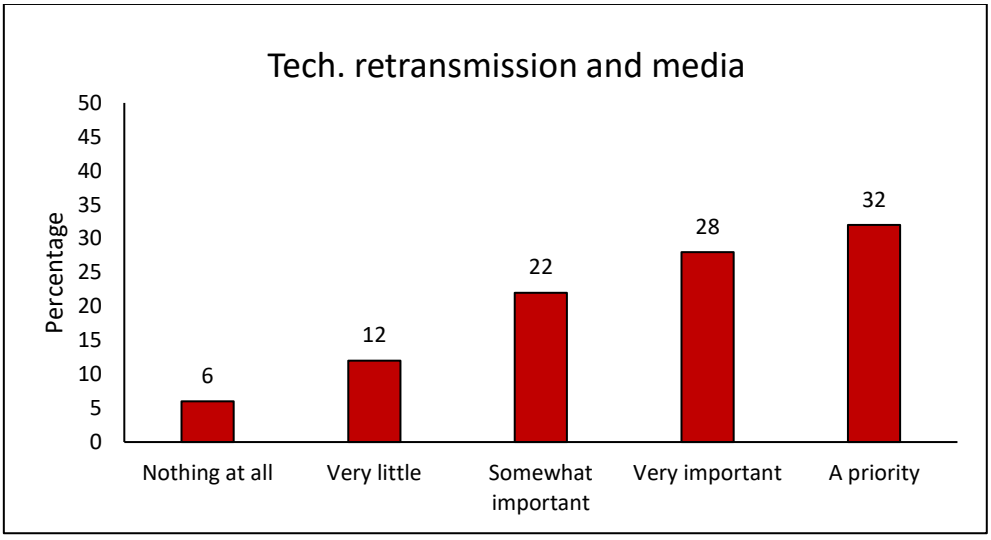



Tech. reporting and visualization
Percentage
50
45
40
35
30
25
20
15
10
5
0
8
16
26
34
16
Nothing at all
Very little
Somewhat important
Very important
A priority


Tech. physical evaluation and injury prevention
Percentage
50
45
40
35
30
25
20
15
10
5
0
2
6
32
36
24
Nothing at all
Very little
Somewhat important
Very important
A priority

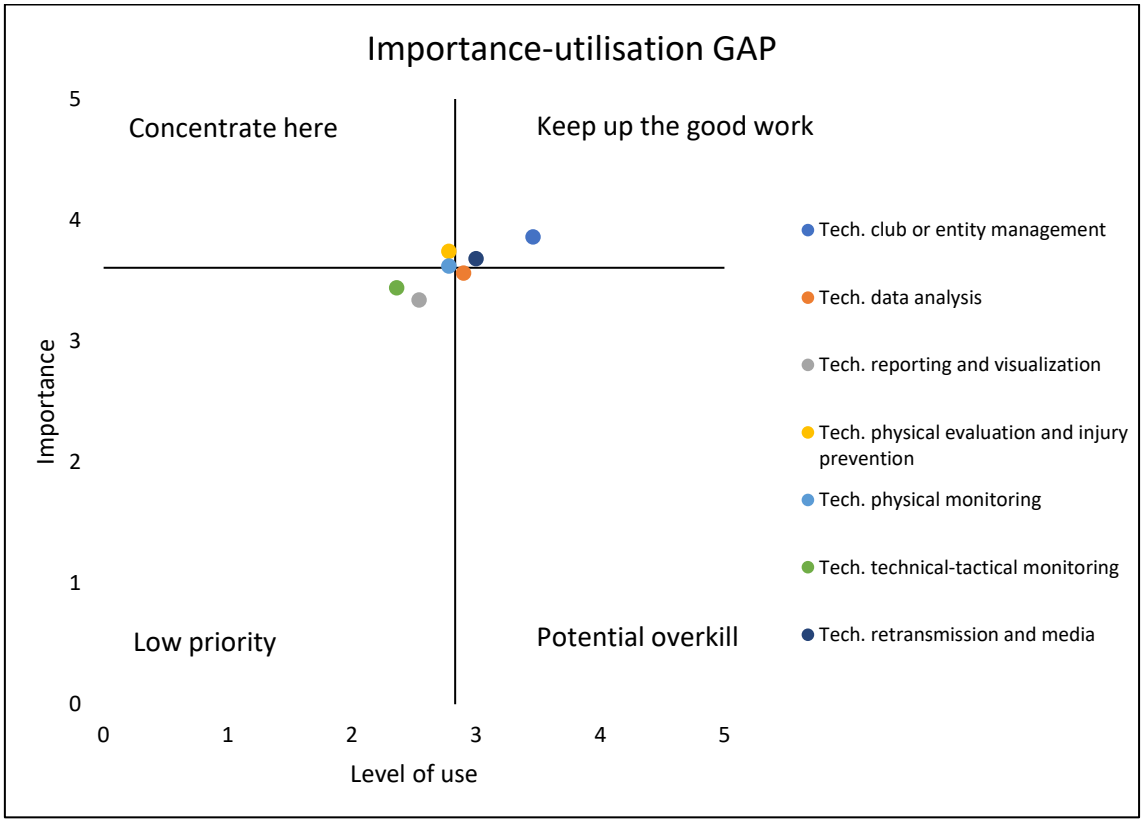

Tech. physical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
4
6
32
40
18
Nothing at all
Very little
Somewhat important
Very important
A priority





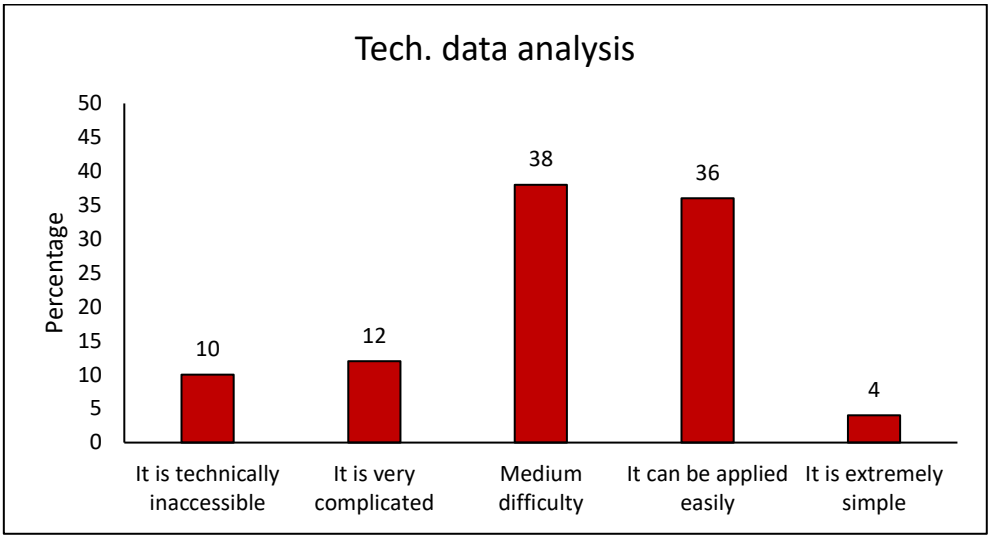
4. GAP analysis between use and importance of technological areas

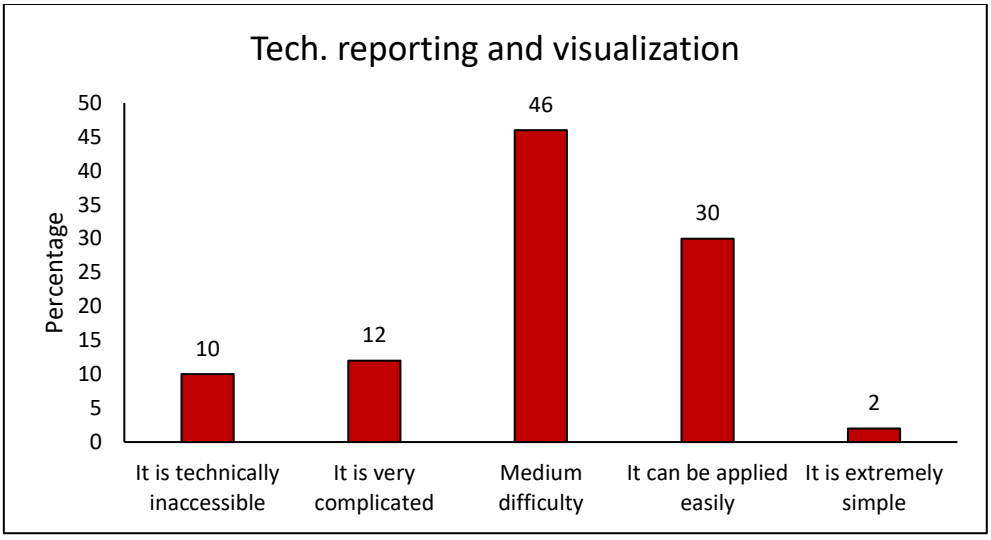
The following graph shows the relation between importance and utilisation of the different technologies, based on the responses of the sports managers in the United Kingdom and Ireland. According to the importance-utilisation analysis, little attention should be paid to technologies used for reporting and visualization and technologies used for technical-tactical monitoring, since they are poorly used but they have also little importance compared to other technologies. On the other hand, technologies related to physical evaluation and injury prevention should gain presence in the sector, since they are poorly used considering the importance they have.

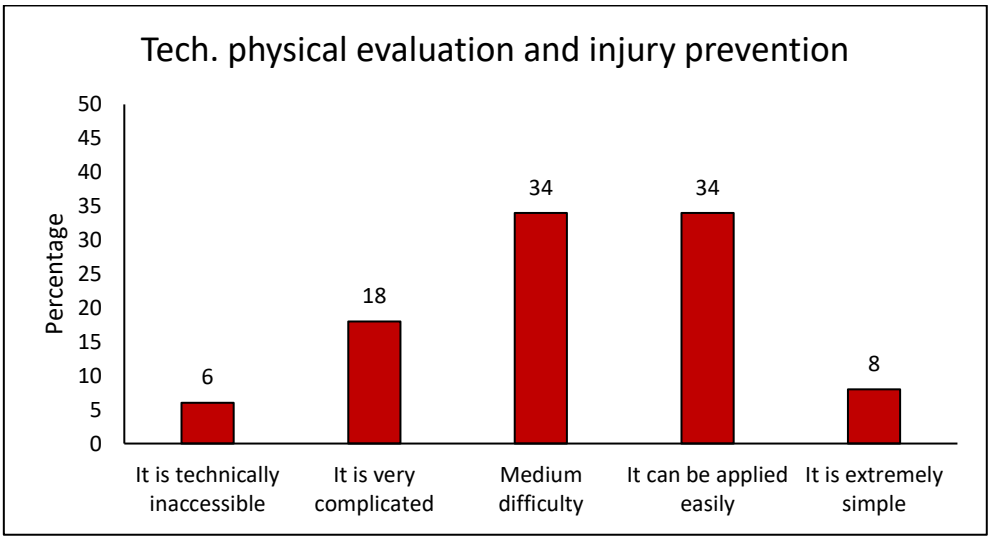


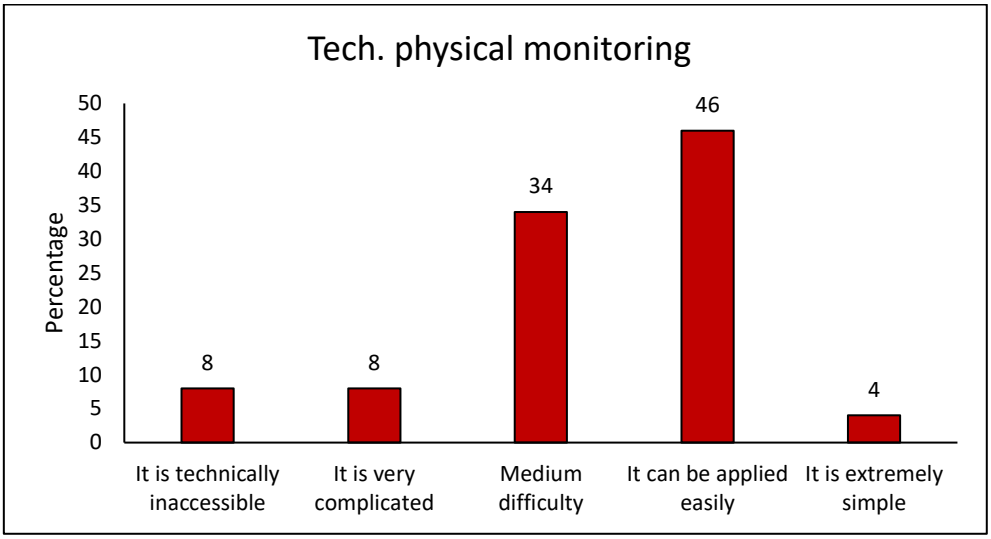
5. What is the level of difficulty that you associate with the use of each technology effectively in your club or sport entity?

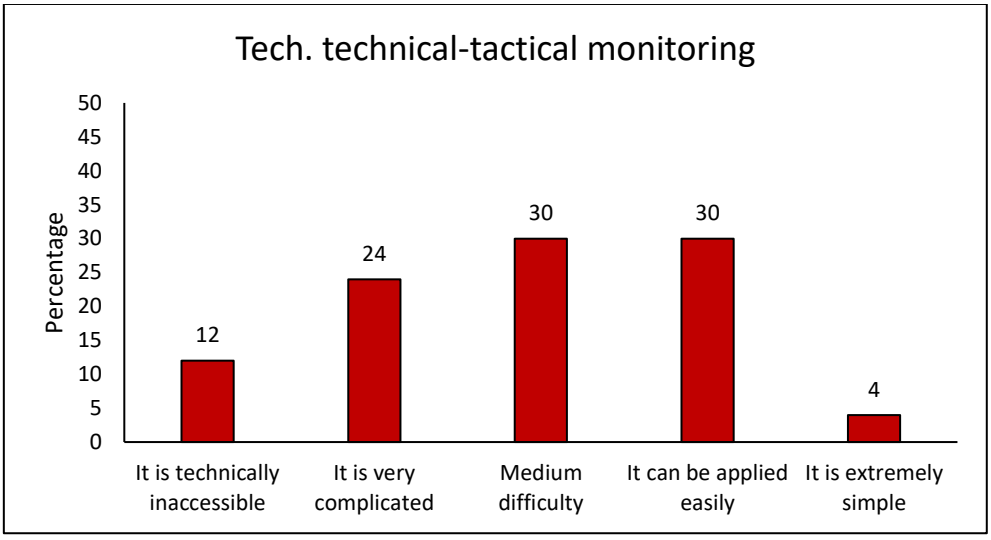
These results show that technologies used for technical-tactical monitoring are the most difficult ones to implement, with 36% of the respondents indicating that they are technically inaccessible or very complicated. On the other hand, technology used for club or entity management is the easiest technology to be used effectively in clubs and sport entities, with 64% of respondents indicating that its use is extremely simple.

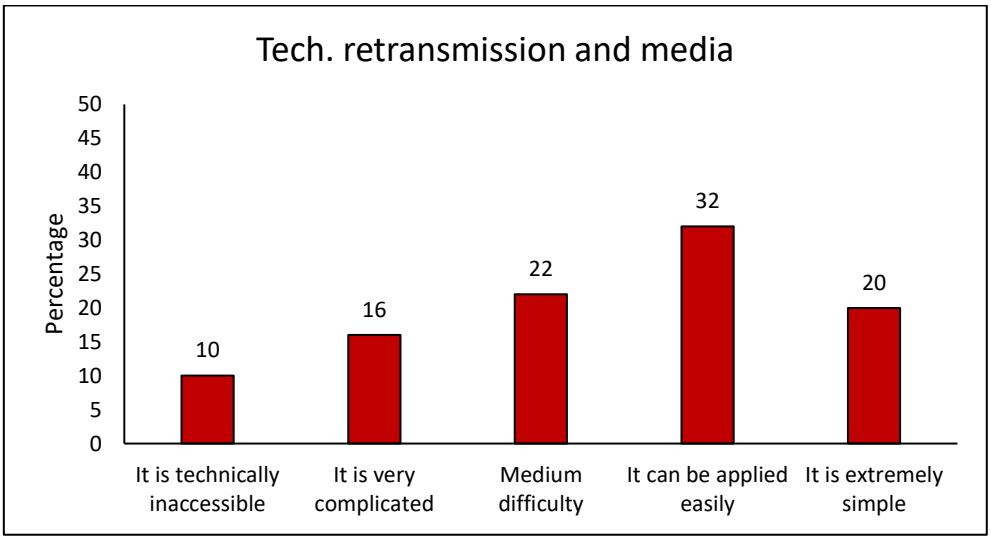

Tech. data analysis
Percentage
50
45
40
35
30
25
20
15
10
5
0
10
12
38
36
4
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple


Tech. reporting and visualization
Percentage
50
45
40
35
30
25
20
15
10
5
0
10
12
46
30
2
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple


Tech. physical evaluation and injury prevention
Percentage
50
45
40
35
30
25
20
15
10
5
0
6
18
34
34
8
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple

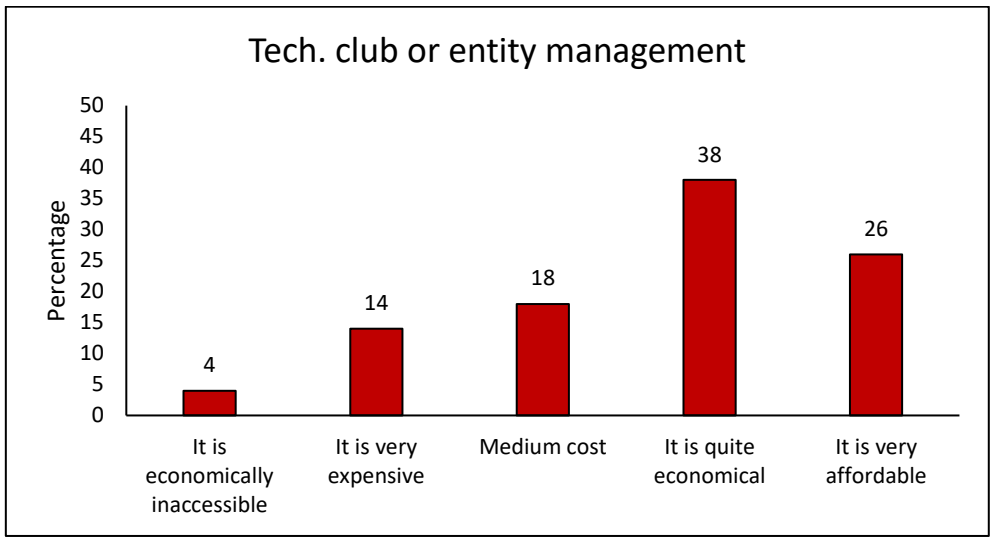

Tech. physical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
8
8
34
46
4
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple

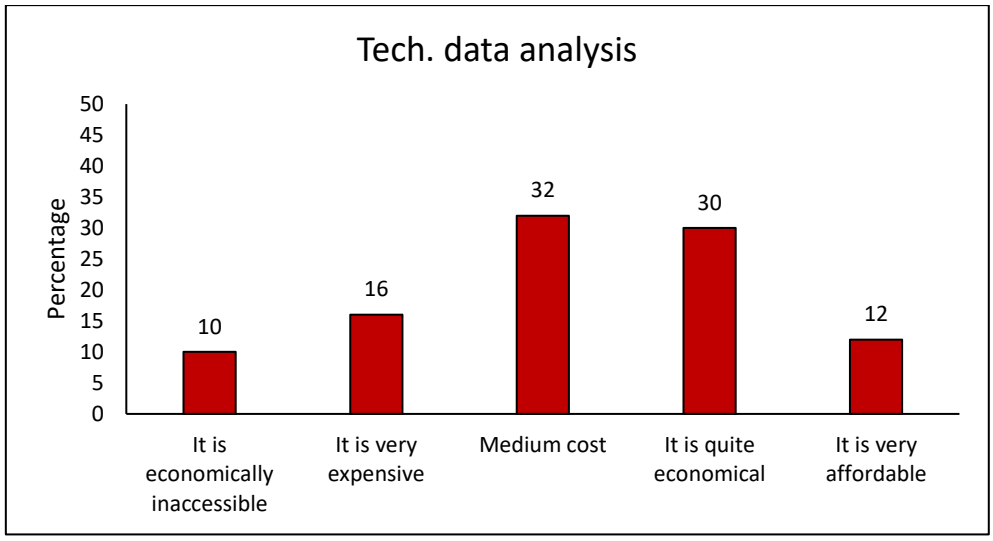

Tech. technical-tactical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
12
24
30
30
4
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple

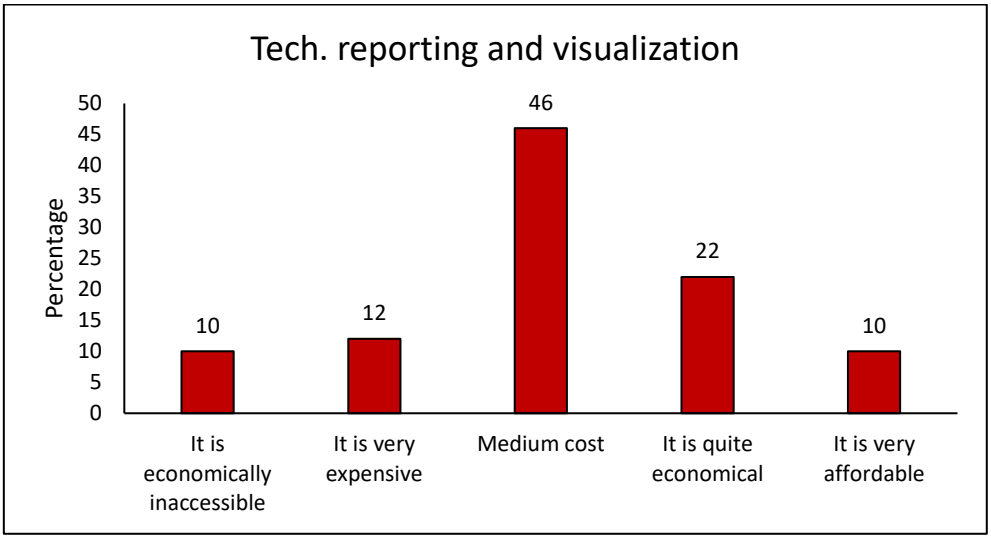

Tech. retransmission and media
Percentage
50
45
40
35
30
25
20
15
10
5
0
10
16
22
32
20
It is technically inaccessible
It is very complicated
Medium difficulty
It can be applied easily
It is extremely simple

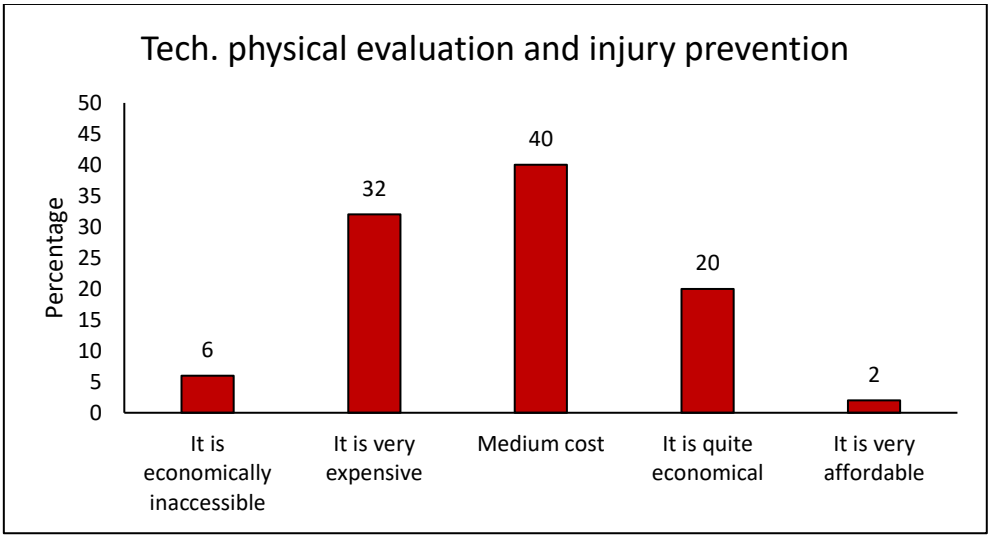
6. Based on your knowledge. How accessible is each technology, economically speaking, for your club or sport entity?

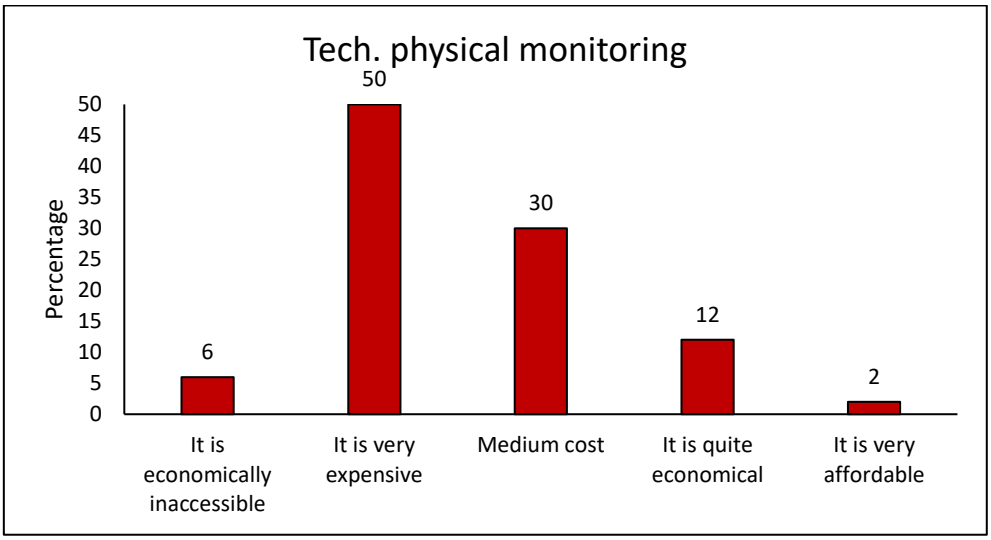
Great diversity is appreciated regarding the cost of implementing the different technologies. Overall, results show that the least accessible technology in economic terms are technologies used for physical monitoring, with 56% of the respondents indicating that they are very expensive or economically inaccessible. They are followed by technologies used for technical-tactical monitoring, with 46% responding the same. On the other hand, the most affordable technologies are those used for club or entity management, with around 64% reporting that they are quite economical or very affordable.

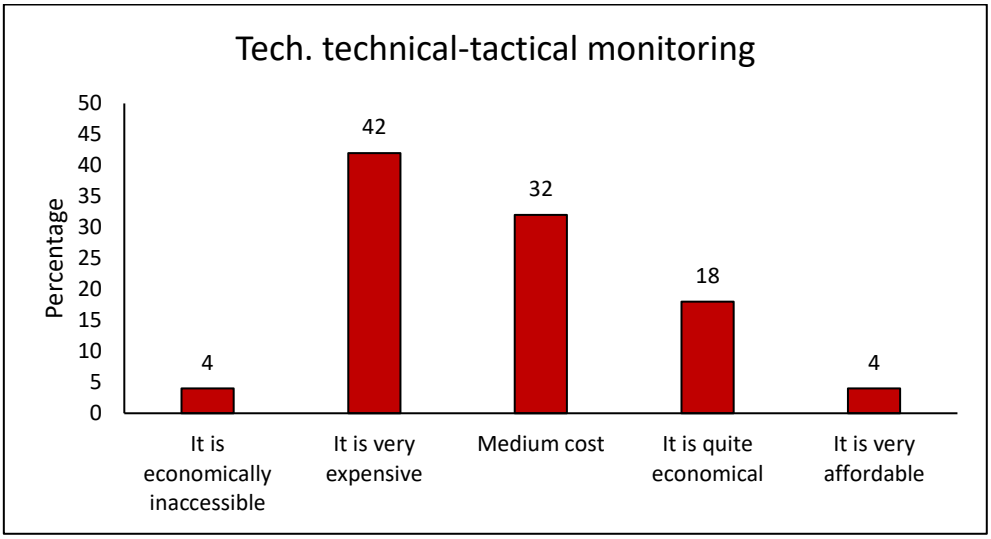


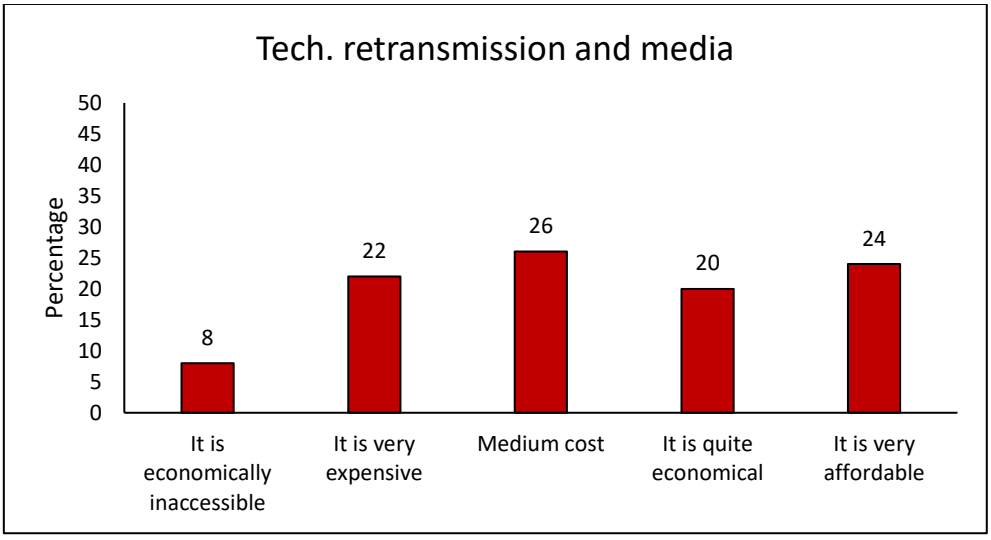



Tech. reporting and visualization
Percentage
50
45
40
35
30
25
20
15
10
5
0
10
12
46
22
10
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very affordable


Tech. physical evaluation and injury prevention
Percentage
50
45
40
35
30
25
20
15
10
5
0
6
32
40
20
2
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very affordable

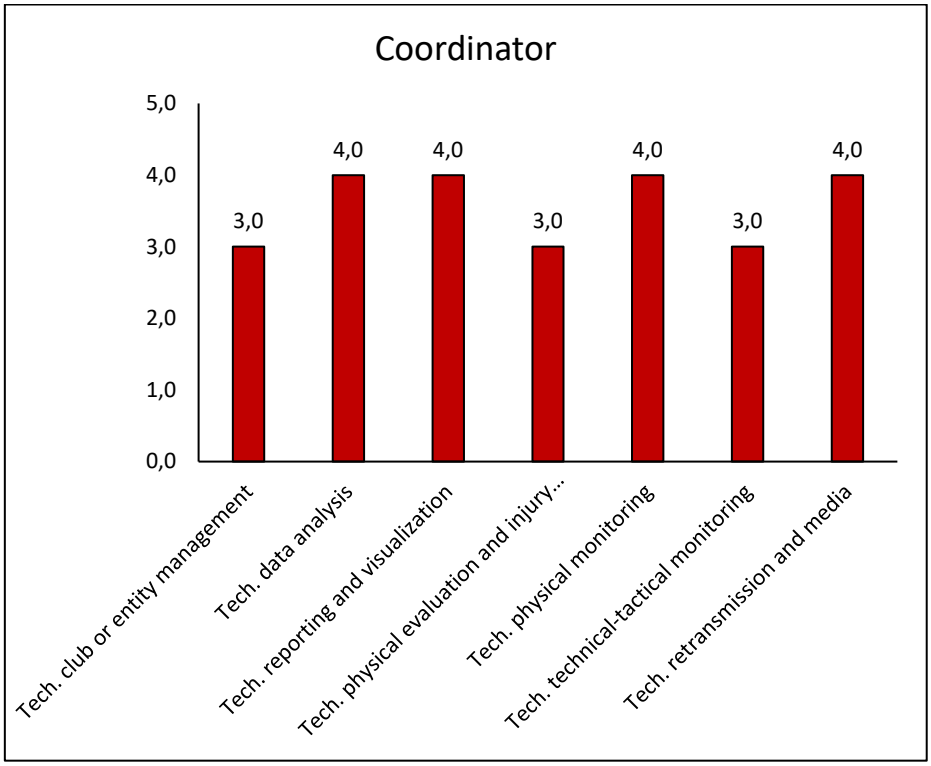

Tech. physical monitoring
Percentage
50
45
40
35
30
25
20
15
10
5
0
6
50
30
12
2
It is economically inaccessible
It is very expensive
Medium cost
It is quite economical
It is very affordable

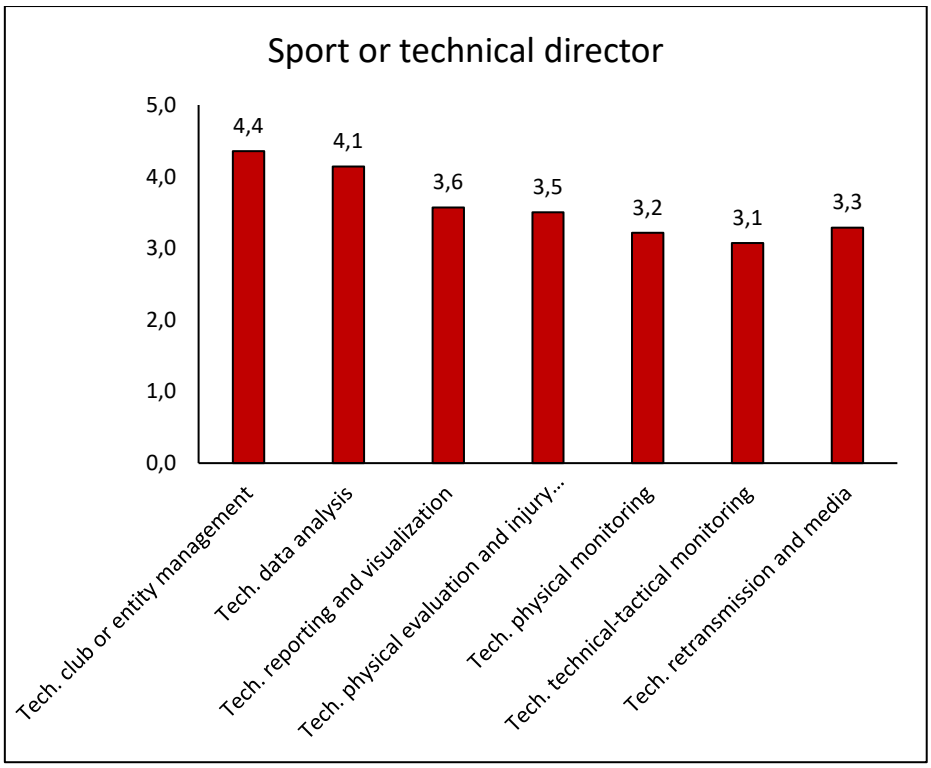


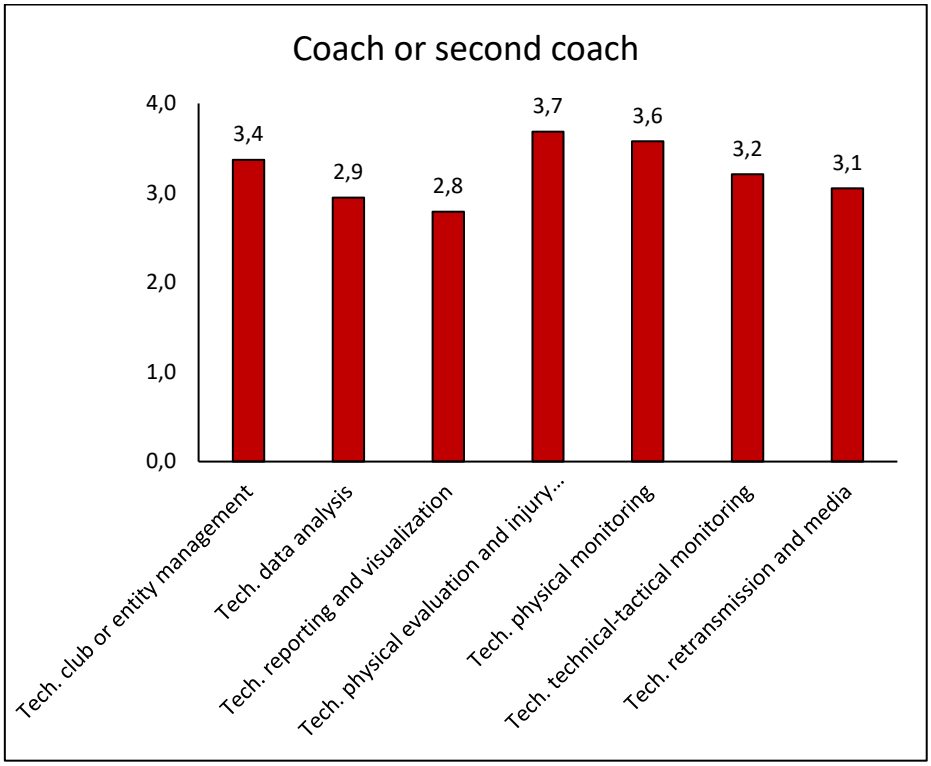


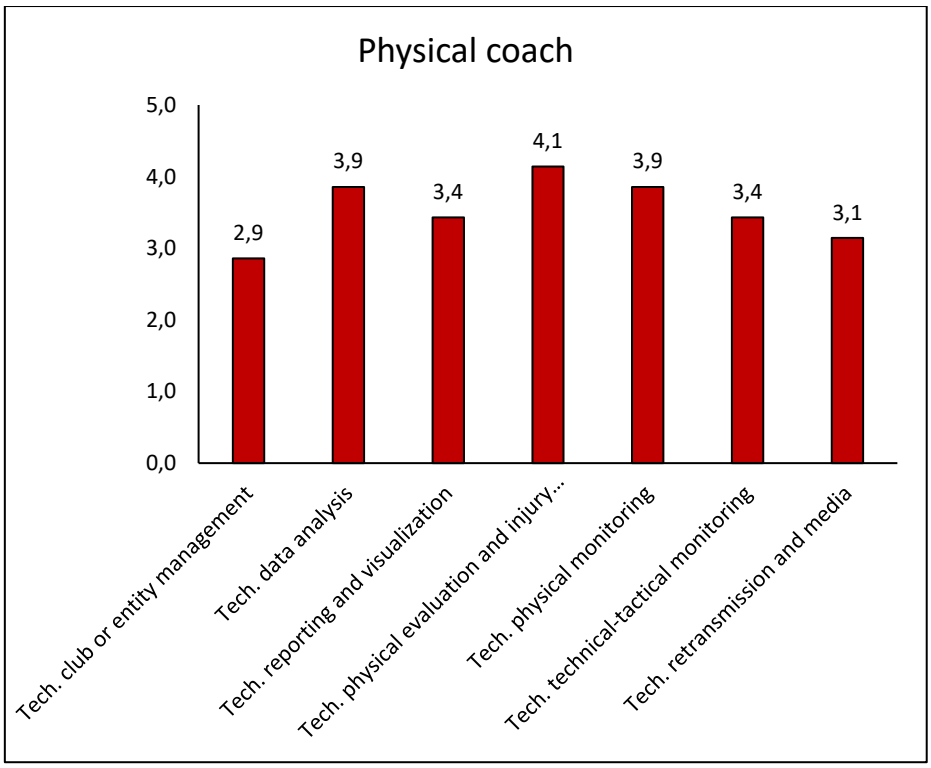
7. How important is each of these technologies for your current position within the club or sport entity?

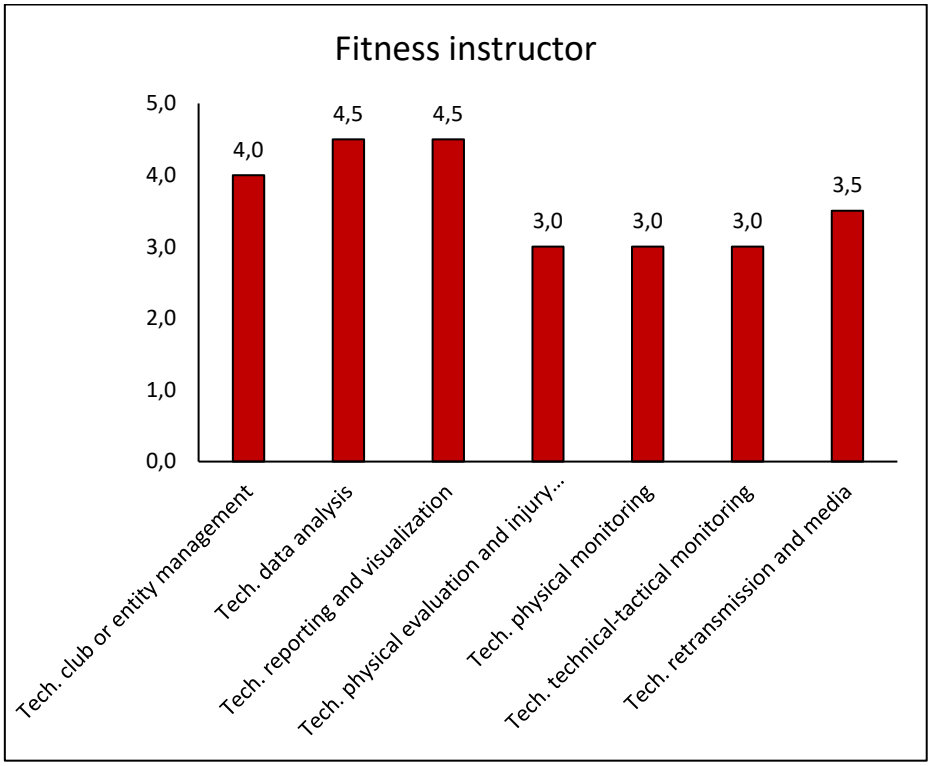
The graphs below show the importance of the use of technologies depending on the current position in a club or sports entity in the United Kingdom and Ireland. The valuation of the different technologies is usually balanced across position, and all of them are of a similar level of importance for most profiles. The greatest differences are seen in Other technical staff and Fitness instructors, with differences around 2.5 and 1.5 over 5 points, respectively. The importance of the technologies varies greatly across positions, with no current consensus about which of them are the most and least valued.

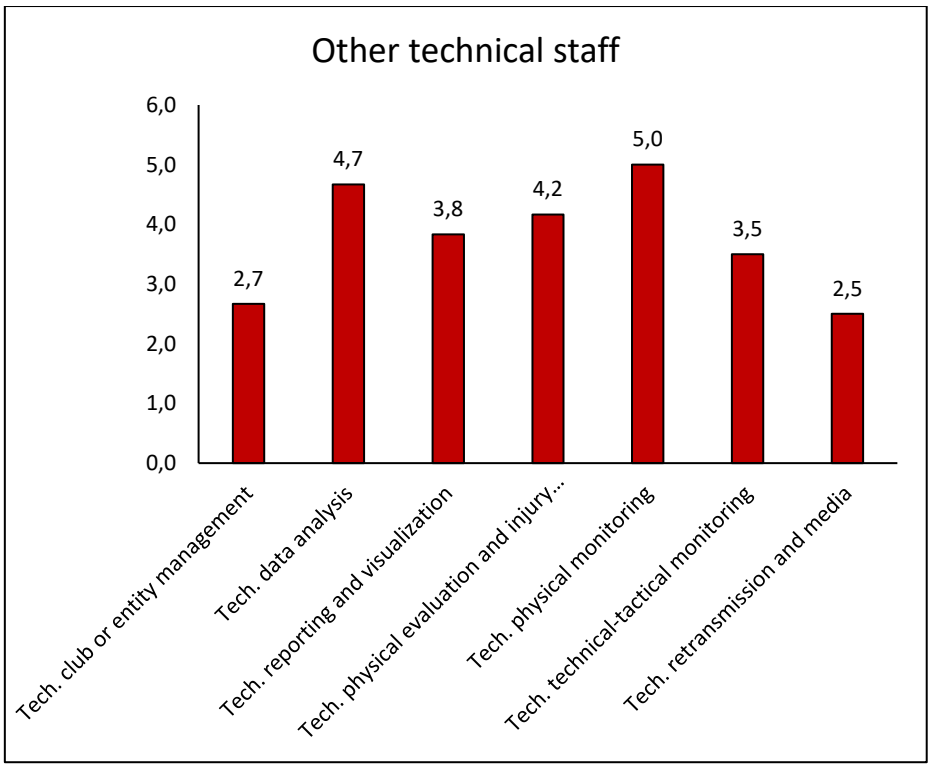

Coordinator
5,0
4,0
3,0
2,0
1,0
0,0
3,0
4,0
4,0
3,0
4,0
3,0
4,0
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media


Sport or technical director
5,0
4,0
3,0
2,0
1,0
0,0
4,4
4,1
3,6
3,5
3,2
3,1
3,3
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media


Coach or second coach
4,0
3,0
2,0
1,0
0,0
3,4
2,9
2,8
3,7
3,6
3,2
3,1
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media

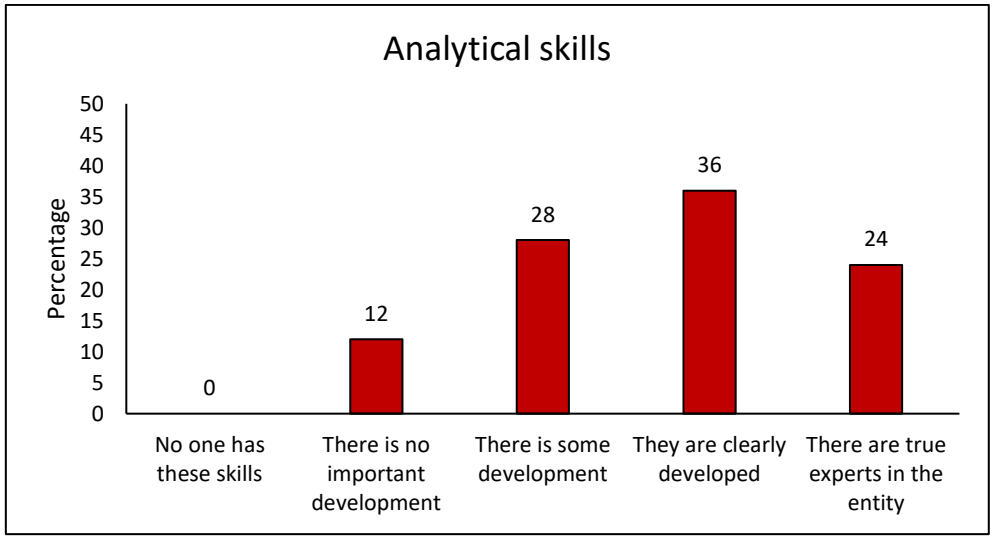

Physical coach
5,0
4,0
3,0
2,0
1,0
0,0
2,9
3,9
3,4
4,1
3,9
3,4
3,1
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media

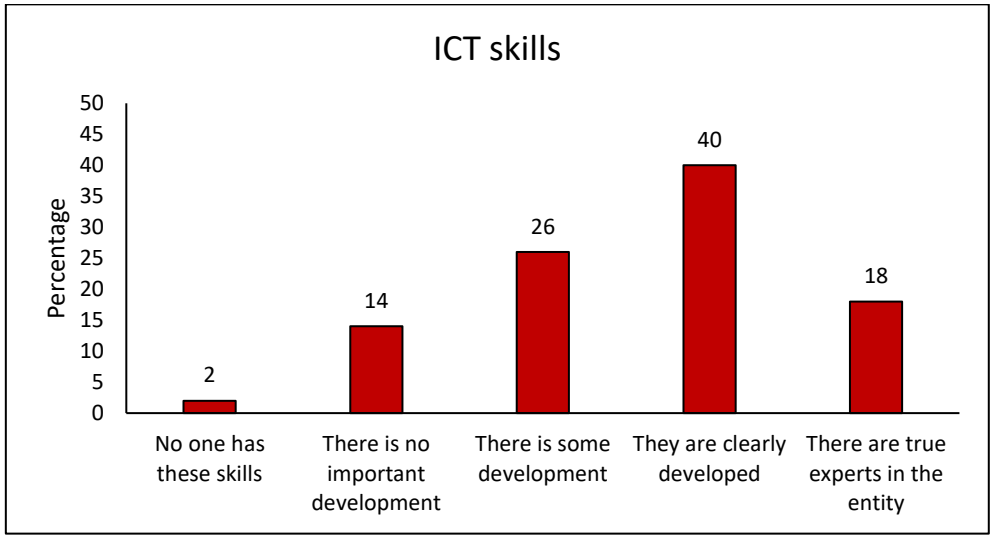

Fitness instructor
5,0
4,0
3,0
2,0
1,0
0,0
4,0
4,5
4,5
3,0
3,0
3,0
3,5
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media

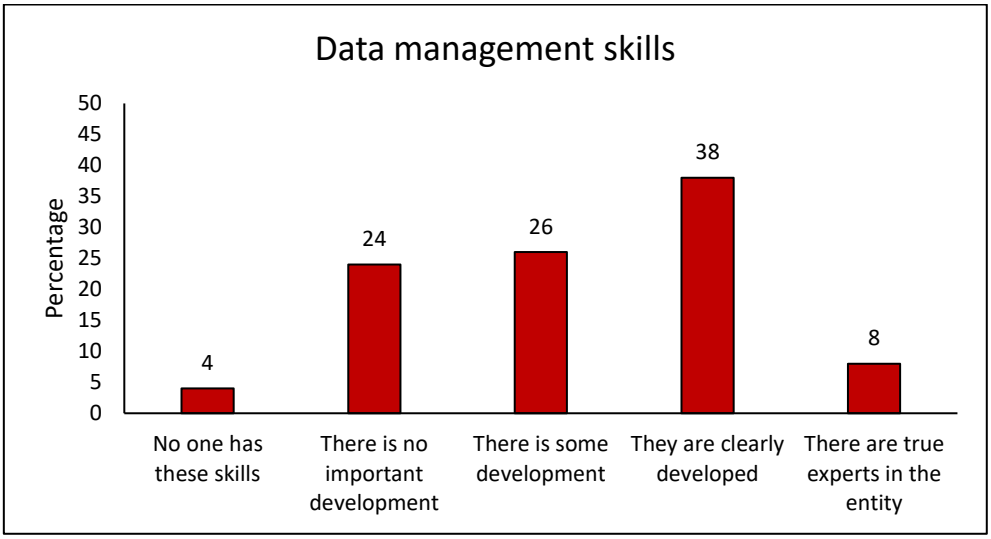

Other technical staff
6,0
5,0
4,0
3,0
2,0
1,0
0,0
2,7
4,7
3,8
4,2
5,0
3,5
2,5
Tech. club or entity management
Tech. data analysis
Tech. reporting and visualization
Tech. physical evaluation and injury...
Tech. physical monitoring
Tech. technical-tactical monitoring
Tech. retransmission and media

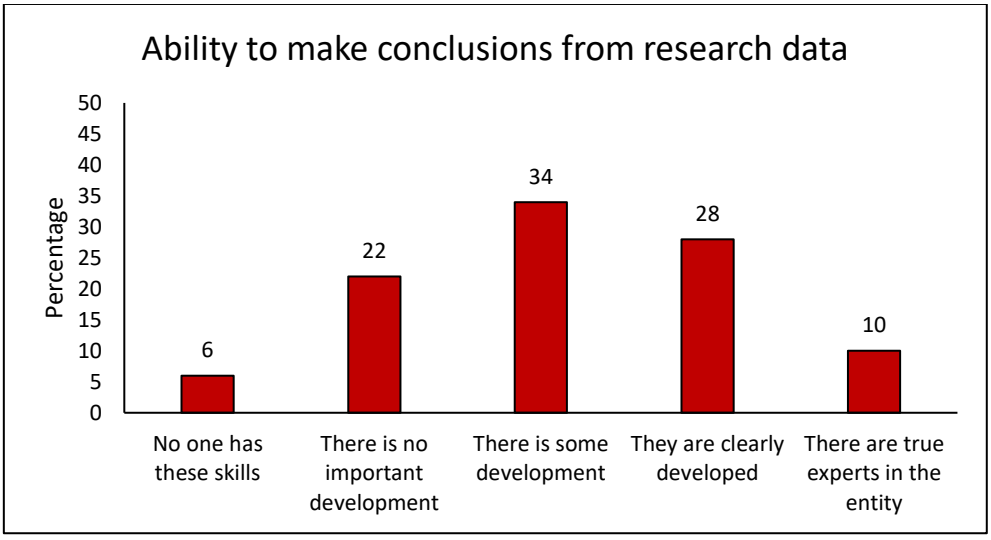
8. How developed are these competencies in your club or sport entity?

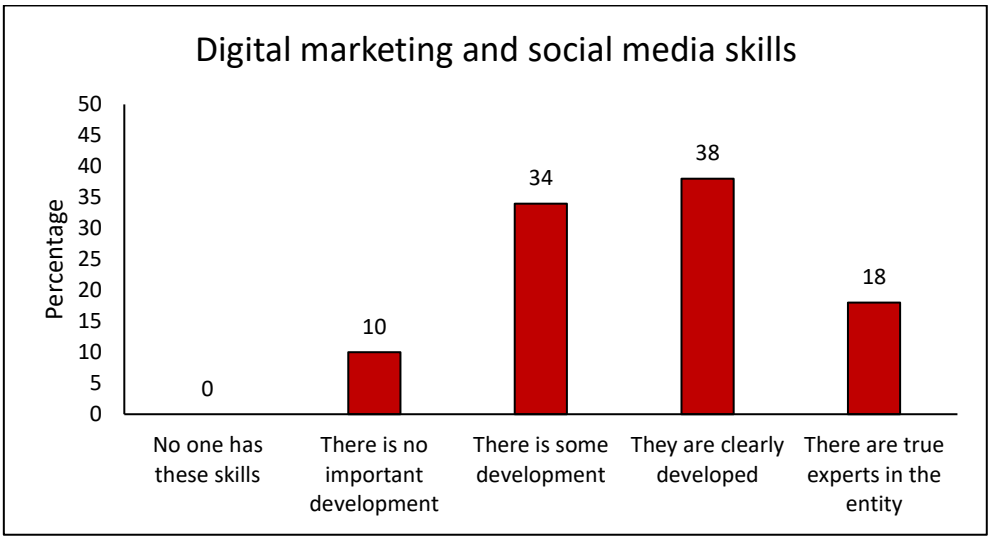
The graphics below show that skills related to digital management of Big Data are clearly the least present in the sector, with 40% of the respondents indicating that no one has these skills or that they are not significantly developed. They were followed by data management skills, and ability to make conclusions from research data, with 28% answering in the same way. On the other hand, analytical skills are the ones with the most presence, with 60% reporting that they are clearly developed, at least.

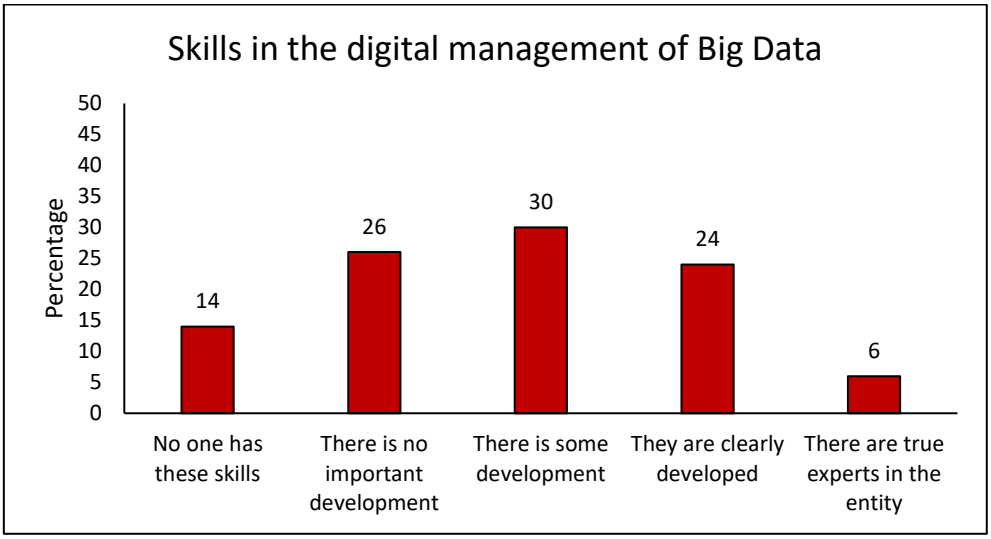





Data management skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
4
24
26
38
8
No one has these skills
There is no important development
There is some development
They are clearly developed
There are true experts in the entity

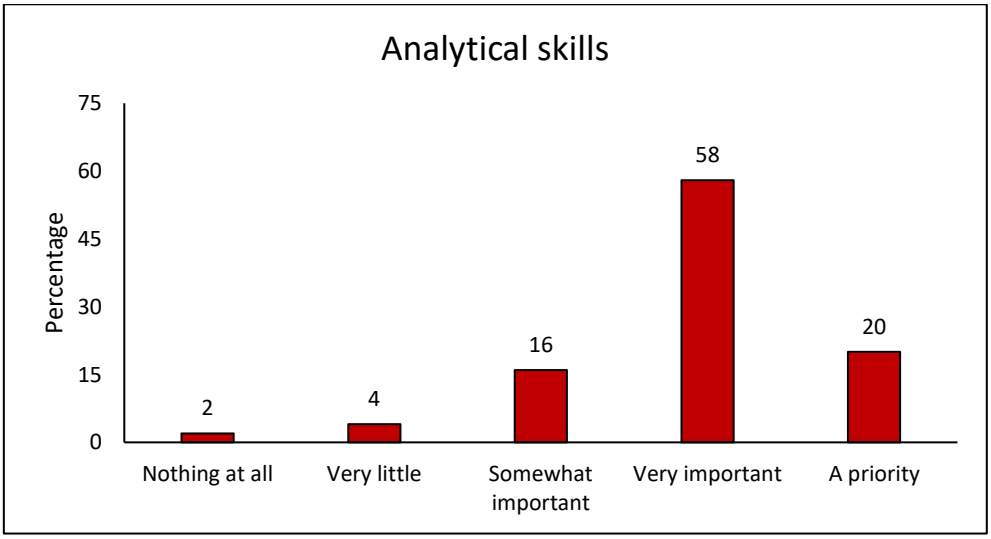

Ability to make conclusions from research data
Percentage
50
45
40
35
30
25
20
15
10
5
0
6
22
34
28
10
No one has these skills
There is no important development
There is some development
They are clearly developed
There are true experts in the entity

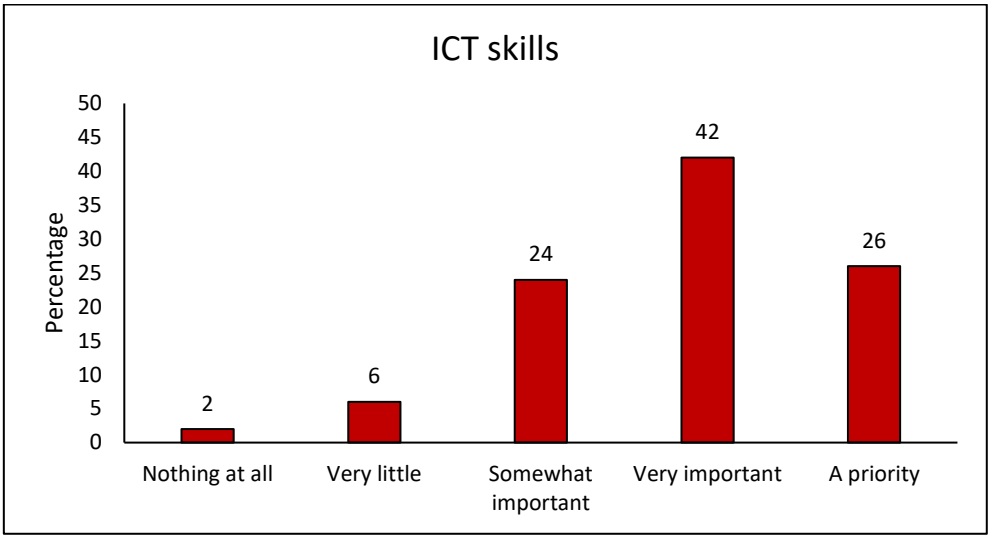

Digital marketing and social media skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
0
10
34
38
18
No one has these skills
There is no important development
There is some development
They are clearly developed
There are true experts in the entity

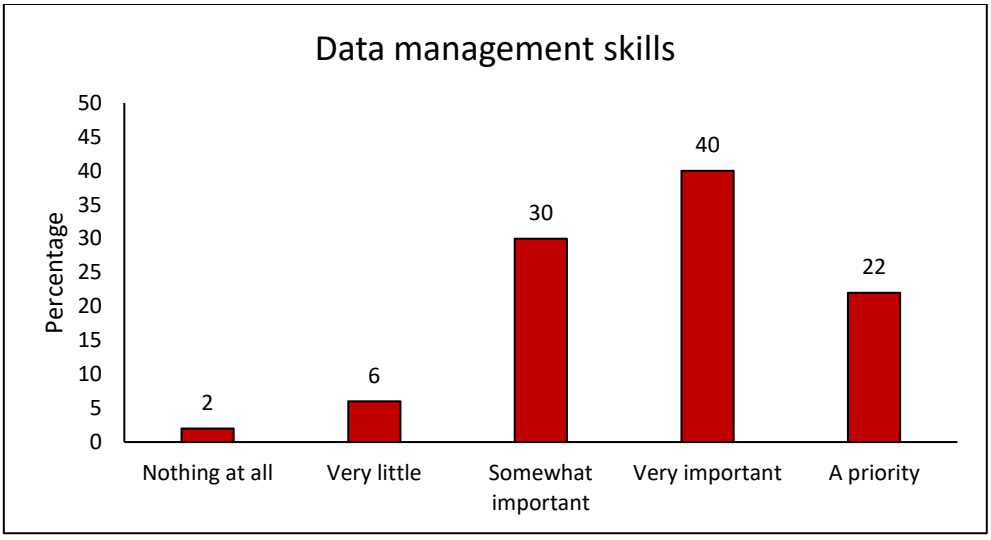


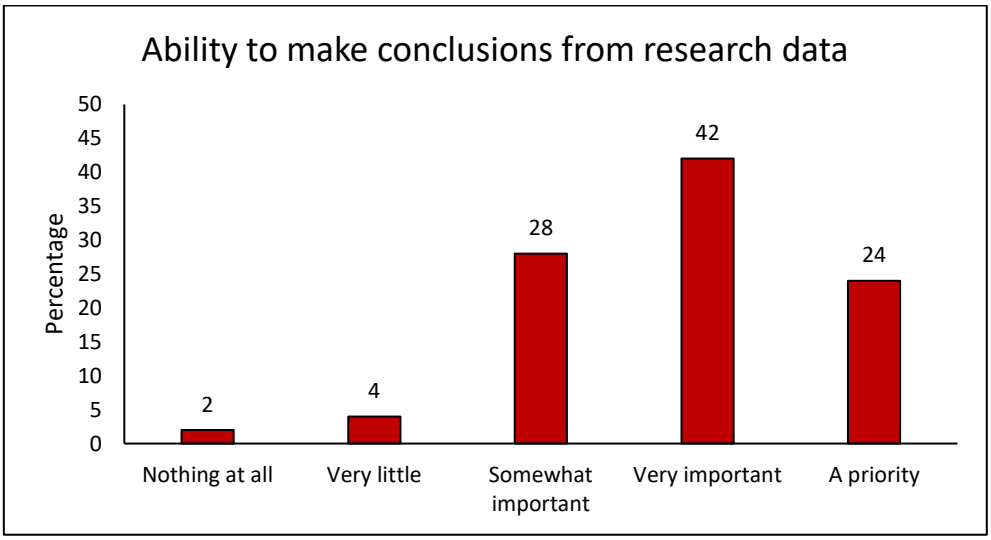
9. How important do you think these professional skills are in your club or sport entity?

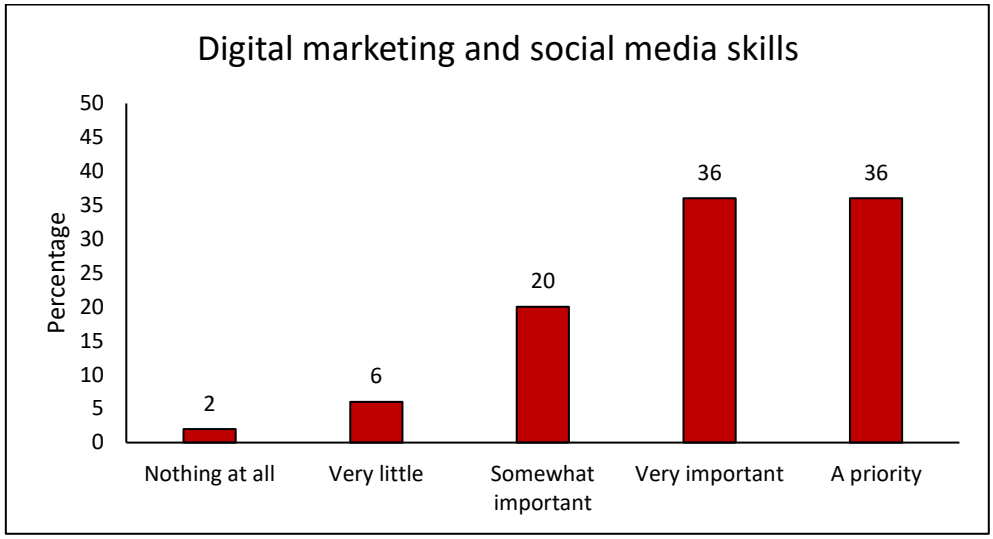
The results show that around 30% of the respondents consider that skills related to digital management of Big Data are not important at all or very little, these being the least important skills in clubs or sport entities in the United Kingdom and Ireland. On the other hand, the most important skills are Analytical skills and Digital marketing and social media skills, being these very important or a priority for 78% and 72% of the respondents, respectively.

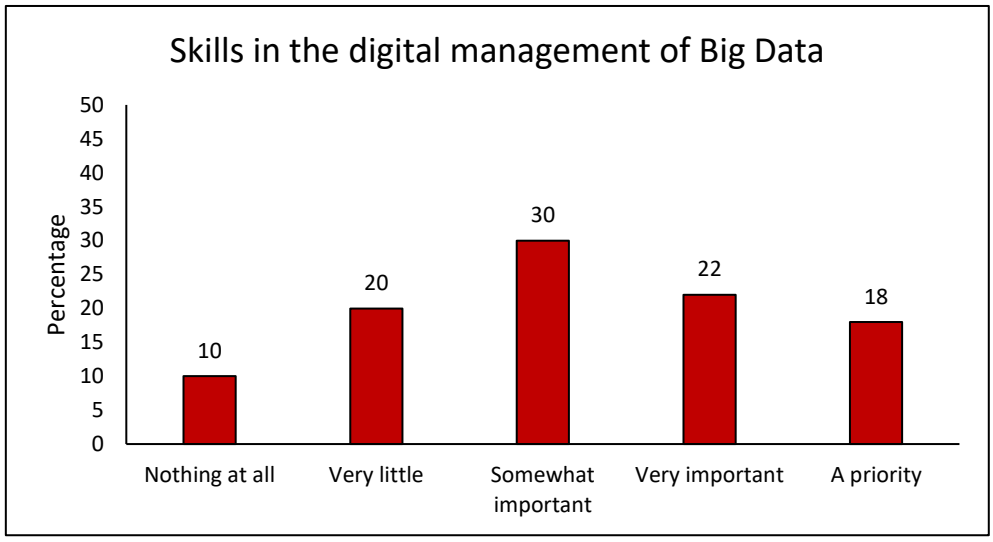



ICT skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
2
6
24
42
26
Nothing at all
Very little
Somewhat important
Very important
A priority


Data management skills
Percentage
50
45
40
35
30
25
20
15
10
5
0
2
6
30
40
22
Nothing at all
Very little
Somewhat important
Very important
A priority

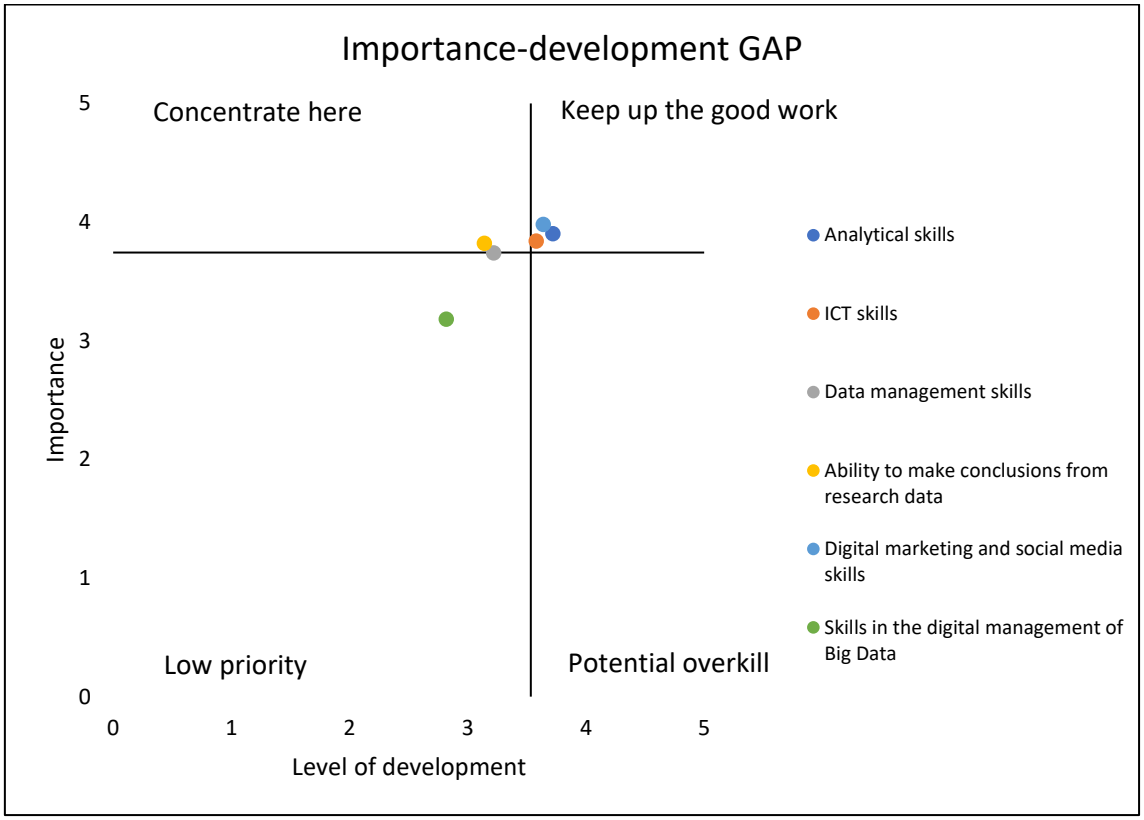

Ability to make conclusions from research data
Percentage
50
45
40
35
30
25
20
15
10
5
0
2
4
28
42
24
Nothing at all
Very little
Somewhat important
Very important
A priority





10. GAP analysis between development and importance of technological competences

The following graph shows the relation between the importance and the degree of development of the different skills in the United Kingdom and Ireland, based on the responses of the sports managers. According to this, skills related to digital management of Big Data are clearly the skills that have a lower priority, since they are poorly developed but also have much less importance compared to other skills. On the other hand, Ability to make conclusions from research data and Data management skills are the ones that should be improved the most, since they are poorly developed considering the relevance they have in the sector.



11. Discussion of results

Although the survey reports the results of two different countries, the application of new technologies has an increasing importance to sport academies and clubs both in UK and Ireland. Some IT tools such as technologies related to club or entity management are clearly an integral part of working activities in UK and Ireland. Yet, this analysis shows that the importance of the technologies varies greatly across positions and job's duties. Future studies are therefore needed to better asses the level of digital competences of professionals, not only in the managerial and coaching positions, but also in the field of fitness.

However, one of the most important result achieved by the survey is to highlight the important need to tackle skills gaps and mismatches. In particular, some data suggest that many existing good practices are quite widespread within the two countries. For instance, it is possible to highlight that analytical skills and digital marketing and social media skills are considered very important by professional of sport sectors. At the same time, the future adoption of new technologies and best practices in sports daily management might a way to further increase the level of digitalization in sports in UK and Ireland

Indeed, the low level of respondents' rate in questions related to management of Big Data and performance analysis illustrates that it is still crucial to offer a wider range of digital opportunities and competences development. This issue can be addressed by promoting interdisciplinary cooperation in technology and sports science, both at the local and national level. Indeed, the strategic cooperation might be a way to increase the offer of services and opportunities in British and Irish sport academies and clubs.

Lastly, it is also important to highlight that sport academies and clubs in UK and Ireland might have significant national differences in terms of digitalisation which are yet to be assessed. While for the scope of Digi-Sporting it is possible to merge all national data into an integrated survey's multinational result, further research might be necessary to develop effective national strategies to unlock the full potential of an effective digital transformation in sports. Therefore, a stronger cooperation between different stakeholders and a clear dissemination strategy of Digi-Sporting's outputs at a large scale will certainly be beneficial in these terms.

12. Conclusiones

- In UK and Ireland, the application of new technologies has an increasing importance within sport academies and clubs.
- Analytical and Marketing skills are widespread among British and Irish coaches and sport managers.
- Big Data and performance analysis skills are lacking in UK and Ireland. Therefore, it would be beneficial in future to increase educational opportunities in these fields.
- The survey has a limited number of respondents in terms of professions and the data are aggregated for two different countries. Therefore, further research is needed to asses of digital skills both in terms of nationality and professional roles.
- Due to its nature, Digi-Sporting's dissemination strategy might be a good way to developing and transferring digital skills in the countries.