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Sports Digitalization: A Review and A Research Agenda

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Completed Research Paper

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Abstract

Ever since its first manifesto in Greece around 3000 years ago, sports as a field has accumulated a long history with strong traditions while at the same time, gone through tremendous changes toward professionalization and commercialization. The current waves of digitalization have intensified its evolution, as digital technologies are increasingly entrenched in a wide range of sporting activities and for applications beyond mere performance enhancement. Despite such trends, research on sports digitalization in the IS discipline is surprisingly still nascent. This paper aims at establishing a discourse on sports digitalization within the discipline. Toward this, we first provide an understanding of the institutional

characteristics of the sports industry, establishing its theoretical importance and relevance in our discipline; second, we reveal the latest trends of digitalization in the sports industry and unpack its implications for sports organizations; last, we propose an agenda for sports digitalization research in IS.

Keywords: Sport, Digitalization, e-sport, Sports digitalization, Research agenda

Introduction

Ever since the first Olympic Games was held at Olympia, Greece in 776 BC, sports as a field has accumulated a strong tradition, filled with glory and heroism. At that time, there were only seven sports: running, long jump, shot put, javelin, boxing, pankration, and equestrian events. Today, there are over 8,000 indigenous sports (Lipoński 2003). Although there is no general consensus of how sports should be defined in the academia, a common definition typically entails characteristics of competitiveness, ‘non-hostility’ nature, physicality (no matter to what extent), and also conformance of predefined rules (Wright 2009). The long history of sports has exemplified its evolution from an activity of game to an activity of organization that has been codified, strategized, professionalized, and in many cases, commercialized (Baca 2014).

Analogously, sports science emerged as a research field in Germany in 1960s (Link and Lames 2014). It comprises a collection of knowledge, theories, and research methods that deal with issues and phenomenon related to sports (Röthig et al. 2003). Sports science is not one ‘unified science of sport’; instead, it is an interdisciplinary field (Höner 2001) with several sub-disciplines, such as sports psychology, sports management, sports economics, sports health, and sports informatics (Baca 2014). The common theme is the recognition of sports as a unique context with distinctive characteristics that calls for special attention rather than being treated as just another type of organization (Loy 1968).

Recent years have witnessed another major development in sports – widespread digitalization (Davenport 2014a, 2014b), which can be traced all the way back to Michael Lewis’ work on how Billy Beane, the head coach of Oakland Athletics, deployed analytics to make evidence-based decisions regarding the composition of the team (Lewis 2004). Nowadays, the deployment of digital technologies in sports is even more pervasive. On one hand, the trend of harnessing analytical technologies to support performance enhancement (for the sake of winning) continues and intensifies. For instance, during the 2014 FIFA World Cup, the heroic journey of German National Football Team was supported by SAP, a Germany-based software vendor, who utilized a ‘march insight’ software to help the team improve performance and learn about their rivals (McKenna 2014). On the other hand, the utilization of digital technologies in sports also expands to areas such as organizing and managing sports teams and their stakeholders, accessing and interpreting sports information, inventing new instruments and strategies that would not be possible otherwise (Caya and Bourdon 2016). Finally, digitalization led to the creation of new sports – e-Sports (Boyle et al. 2003; Hamari and Sjöblom 2017; Hilvoorde and Pot 2016), which poses profound implications for the very nature of the sporting field. In Sweden, this is clear after the Swedish e-Sport Association applied for membership in the Swedish Sport Confederation. Despite declining the request, the Swedish Sport Confederation concluded that they need to re-think what sports is [www.rf.se]. To sum up, it is said that information technology and by extension, the increasing digitization in sports, will forever change the ways sports operate (Krzanich 2016).

In spite of the massive transformation of sports triggered by digitalization, academic research on the topic is still limited within the IS discipline. Though recent events (such as the special panel on “How technology is transforming the sports industry” at the 2015 International Conference on Information systems, and the mini-track on Sports Analytics at 2017 Americas Conference on Information Systems) suggest emerging interests of the field, we argue that research on IT related issues in sports is still in its nascent stage. For instance, a preliminary search of sport related studies in IS returned a dozen conference and journal articles that touch on topics including sports analytics (Lee 2016; Schrader et al. 2016; Shah et al. 2015; Wilkerson and Gupta 2016), social media in sports marketing (Holland 2015), IT-enabled injury management (Hanisch and Hanisch 2007; Lam et al. 2016; Wilkerson and Gupta 2016), e-monitoring (Varriale and Tarufi 2014), web site adoption by sports clubs (Bingley et al. 2011), e-ticketing

(Bedeley et al. 2016; Mignerat and Audebrand 2010), large-scale sports event management (Dodd and Sathasivam 2010; Loucopoulos and Kavakli 2016), and data integration issues for sport organizations (McCubbrey and Bloom 2005). For a majority of the abovementioned studies, sports is treated as the empirical context to illustrate other concepts, rather than as a phenomenon of study with its own theoretical underpinnings.

We maintain that such broad brushing approach is problematic, considering how sports organizations *differ* from conventional business entities from an institutional standpoint (Loy 1968). From the structure of the organization to the nature of organizational activities (Loy 1968) to the composition of the stakeholder groups (Junghagen 2016) and to the nature of the consumption product and consumers (Bee and Havitz 2010; Hunt et al. 1999), sports organizations deal with a higher level of complexity that is not often seen in other industries (Davenport 2014a). Additionally, changes brought about by the intertwining relationship between digitalization and commercialization poses further challenges to sport organizations as such complexities (and in some cases tensions) further heighten. Consequently, dismissing sport organizations as just another empirical context will translate into missed opportunities for comprehending an IT-driven phenomenon that might display interesting dynamics due to the uniqueness of the context at a theoretical level.

Against a backdrop of the changing landscape of sports and the advancement of digital technologies, our paper directly addresses the topic of sports digitalization. Broadly, we pose the research question: ***why and how should we study sports digitalization in the IS discipline?*** We would like to start off by conceiving sports as an ***organizing activity*** driven by institutional logics, following the seminal work by Loy (1968). We further define sports organization as “a social entity involved in the sport industry; it is goal oriented, with a consciously structured activity system and relatively identifiable boundary” (Slack and Parent 2006, pg. 5). Though our primary focus is on sports and sports organization, our efforts in proffering a *comprehensive* overview of the sports digitalization phenomenon imply that the ensuing implications and research agenda extend beyond the organizational level to also take into account forces at both individual and industrial levels.

To begin, we first establish sports as a distinctive context that is of theoretical importance. To this end, we choose the institutional lens and build upon Loy’s (1968) characterization of sports as an institution encompassing four main components: the organizational component, the technological component, the symbolic component, and the educational component. Doing so allows us to: (1) decipher the nature of sports, and; (2) highlight the *distinctiveness of the context*, whose study we believe will enrich IS research on digitalization.

Second, we strive to unravel the latest trends of increasing digitalization in the sports industry and unpack its implications for sports organizations. To do so, we have systematically gathered a wide range of material on how digital technologies have been (and will be) deployed in various sports contexts. Such material include: research articles in the sports area involving digital technologies, existing case studies, news articles, and industrial reports. Our goal is to offer a relatively comprehensive review of how digitalization transforms each of the four institutional components of sports.

Finally, in light of the preceding points, we aim to put forth a research agenda that covers a wide range of topics regarding the four components of sports, in order to guide future studies in the field of sports digitalization. Our overall approach is consistent with existing agenda-setting studies (e.g., de Reuver et al. 2017; Tilson et al. 2010; Yoo et al. 2010). The rest of the paper is organized into three sections, corresponding to the above three objectives.

Sports Organizations: A Distinct Institutional Context

Competition in Games and Sports

Though numerous efforts to reach a conclusive definition of sports have proven to be futile, scholars in the area have endeavored to provide insights into the nature of sports given its long and rich history. In an attempt to define sports, Loy (1968) compared sports to a game occurrence, and concluded that sport is similar to game in many aspects (e.g., a private game of tennis versus a tennis match at a tournament). For instance, just like games, sport is “playful” or a type of play (Caillois 1961; Huizinga 1955), in the sense that it is “spatially and temporally limited” and its occurrence demands a specific space and time (Loy

1968); its outcome and course of play is “uncertain” (a feature that is much desired for the sake of excitement); it is “unproductive” and “non-utilitarian”; it is “governed by rules” that were agreed upon (sport is even more so than game) to guide the process and also the outcome (i.e., who wins); and finally, it happens outside of “real life” and demonstrates the characteristics of “make-belief” (Loy 1968; Veblen 2009). Further, sports and games are both competitive, or based on competition between two or more parties. In other words, without competition, there will be no sports or games. Finally, both sports and games require “physical skill, strategy, and chance” (Loy 1968, p. 2). However, as Loy (1968) pointed out, one significant distinction between sports and games is the demand to demonstrate “physical prowess” in sports, which often requires systematic training at a high level. Due to the aforementioned commonalities, we therefore argue that sport is rooted in game (Weiss 1969). In other words, a “game is an occurrence [whereas] a sport is a pattern” (Weiss 1969, p. 82).

Sports as Institutionalized Game

Despite the comparison to games, Loy (1968) went on to argue that a fundamental distinction between the two is that sports is often considered as an “institutionalized game” for its “distinctive, enduring patterns of culture and social structure” (Loy 1968, p. 7). The institutionalization of sports stems from the accumulation of tradition and development in the past, but can also serve as guidelines for the future (Loy 1968). According to Loy (1968), the institutionalized patterns associated with sports include organizational, technological, symbolic, and educational components.

First, the ***organizational*** component concerns the organization of sport in terms of teams, sponsorship, and government. Unlike games, sports is often carried out by carefully selected “teams” which can be seen as “stable social organization[s]”, often established as a legal entity and sometimes even traded on the stock market. Sport organizations consist of players with specialized roles (Loy 1968) (e.g., a quarter back and a line back in American football). For these organizations, players are their assets, being directly responsible for producing the sport situations (e.g., the game occurrences)¹. But a wide range of indirect producers are also involved, such as coaches, trainers, and medical staff. As sports get increasingly commercialized, these organizations often need to be gauged by both its sport performance and also its financial performance (Caya and Bourdon 2016). For instance, Forbes ranks Dallas Cowboys as the most valuable (\$4 Billion) and profitable (\$ 270 Million) sports team (Badenhausen 2016) and the CNN estimates the financial value of the Olympics at \$47.5 Billion (Morley 2012). Therefore, organizational activities not only encompass activities in direct relation to sports production, but they also include business activities that ensure targeted outcomes (e.g., customer satisfaction and revenue).

Sports is tightly entangled with commercial agents, for instance owners of sportsclubs like Emirates and RedBull and sporting goods manufacturers like Nike and Addidas. An illustration of how much commercial agents invest in spoets is General Electric, who reportedly paid \$200 million for sponsorship rights covering London and Vancouver Olympics (Morley 2012). Such entanglement has become ever more important in sports due to increasing commercialization of the field. Finally, the institutionalization is also reflected in the various governing bodies at the local, national, and international levels that enforce codified rules – like the World Anti-Doping Agency (Wada). In this regard, we can argue that sports organizations deal with a higher level of complexity when it comes to the composition of stakeholders. For instance, when investigating the different stakeholders of a professional football club in Sweden, Junghagen (2016) discovered that such complexity led to tensions among multiple stakeholders (e.g., sponsors versus governing bodies; sponsors versus fans) with conflicting interests.

Second, the ***technological*** component of sports emphasizes “the material equipment, physical skills, and body of knowledge which are necessary for the conduct of competition and... technical improvements” (Loy 1968, p. 8). To be more specific, technology in sport includes physical equipment (e.g., field, stadium, ball, racket, car engine, boat, training facilities), physical skills (e.g. strengths, ball control ability, endurance and resilience), knowledge possessed by players and the teams (e.g. team spirit, cooperative capability and team play), and skills and knowledge possessed by coaches, team physicians, and other indirect producers (Loy 1968) to improve the technological components. Many of

¹ It is worth noting that for individual-based sports (e.g., tennis), sports organizations revolve around one individual player, rather than a team of players. However, we argue the organizing activities are similar and the organizing logic is similar across different sports scenarios (either individual-based or group-based).

the organizational activities are organized around the technological component, or around the goal of continuous technical improvement to the physical equipment, the physical skills, and the knowledge.

Third, the **symbolic** component of sports contains elements of “secrecy, display, and rituals” (Loy 1968). Similar to other business context, secrets related to game strategies and other technical aspects are often treated with great priority, which Loy (1968) referred to as “approved clandestine behavior” (e.g., a starting line-up of a soccer match will not be released by both teams until right before the match). However, what is different in sport in terms of its symbolic dimension is the embeddedness of display in the course of a sports occurrence (Goffman 1961). Such display is manifested through numerous sport events (or even tournaments) (e.g., from a soccer game that lasts 2 hours to an Olympic game that lasts 16 days), which requires involvement from even more indirect sport producers, such as mainstream media, broadcasting companies, event sponsors and voluntaries. The last element of the symbolic component of sports is ritual, though not contributing to the technical components of sports, but is crucial in creating “solemnity” among people who directly or indirectly engaged in the sport occurrence (Loy 1968). Such rituals could be the gesture of hand shaking between opponents before the game, the singing and chanting of fans during the game (Serazio 2013), and even certain superstitious behaviors performed by players (Bleak et al. 1998).

Distinct from organizations in other contexts, sports consumers or co-called fans (Hunt et al. 1999) are a major part of the symbolic component of sport, both as observers and as participants, depending on their roles and level of engagement. Sport fans are mainly driven by emotions and social values, whereas consumers in more traditional business context evaluate primarily the utility of the product or service they consume (Biscaia et al. 2012; Underwood et al. 2001). This distinction is further exemplified through the complexity related to how and why sport consumers engage with or participate in sports occurrences (Bee and Kahie 2006). Studies from the marketing discipline have indeed identified different types of sport consumers (fans) according to the level of attachment to and identification to the particular sport (or sport organizations) (Hunt et al. 1999; Stewart et al. 2003).

Finally, the **educational** component of sports deals with the activities of acquiring the above-mentioned skills and knowledge when we discussed the technological component (Huizinga 1955; Loy 1968). Unlike in games, such knowledge and skills in sports need to be gained through formal instruction, often in the form of training. Such education and formal training are not limited to direct producers of sport – players, but also apply to indirect producers such as coaching staff, managers, physicians, and referees (Loy 1968). This is especially true for the latter, as certifications are often a prerequisite to enter the field. Moreover, the educational component of sport is embedded in the routines of sports organizations, as we see training constituting a major portion of what players and teams do on a daily basis. In this sense, the education component is closely related to its technological counterpart: high demand of technological excellence (both in intellectual knowledge and physical skills) in competition and hence the requirement of continuous technical improvements has attested to the importance of formal education.

Table 1. Distinct Institutional Context of Sports Organizations	
Organizational component	<ul style="list-style-type: none"> • Sports performed by carefully selected individuals or teams that compose of players with different specialization. • Sports produced directly by teams and players; indirectly by coaches, physicians, etc. • Sports organizations concern with both sports performance and business performance, separating organizational activities into sports activities and business activities. • Sports are entangled with sponsorship. • Sports are governed by different governing bodies at various levels. • Sports organizations deal with stakeholder complexities (various stakeholders with different interests).

Technological component	<ul style="list-style-type: none"> • Sports and competition in sports demand physical equipments, physical skills and sports knowledge. • Physical skills and knowledge are required for sports producers such as players and teams. • Physical skills and knowledge and/or certifications are required for indirect sport producer such as coaches, physicians, and referees. • Sports demand continuous improvements of the technological components.
Symbolic component	<ul style="list-style-type: none"> • Secrecy or “approved clandestine behavior” are considered an important part of sports. • Display is embedded in sports. • Rituals are important elements of sports, both among sport producers and also among sport observers. • Sport consumers participate in the symbolic component of sports. • Sport consumers show diversity and complexity in motivations and hence needs when it comes to their engagement in sports occurrences.
Educational component	<ul style="list-style-type: none"> • Formal instructions are required to obtain the physical skills and knowledge in sports, for both direct producer (players) and indirect producers (coaches, referees). • Training makes up majority of organizational activities (in order to meet the demand of continuous improvements of the technological components).

Table 1 summarizes the four components of sports from an institutional point of view. Based on the patterns we have highlighted across the organizational, technological, symbolic, and educational components, we argue that the distinctiveness of the sport organizations lie in the complexity embedded in their organizational structure and activities, the criticality of technologies in the choice of equipment, the importance of symbolic elements in product consumption, the complexity of customer composition and relationship, as well as the formalized acquisition and continuous improvement of skills and knowledge. Conceivably, it is imperative to not dismiss sports organizations as just another empirical context, but rather, to recognize the *contextual distinctiveness* at the theoretical level. Our arguments resonate with those of Chiasson and Davidson (2005), who call for viewing industries in IS research as institutional context by explaining how structures of certain industries, including schemas, rules, norms, and routines, become entrenched as authoritative guidelines for social behavior. In the next section, we will discuss how the latest trends of digitalization in the sports industry further shape these four components of the institutional context for sports organizations, which in turn lends credibility to the relevance of sports in the IS field.

The Digitalization of the Sports Industry

The preceding discussion on the institutional context of sport organizations has painted a picture of how sports organizations operate in a distinctive environment of structure, norms, routines, and schemas. Similar to other industries with longstanding traditions (e.g., financial or food industry), the sports industry is also going through the waves of digitalization. Recent advances in digital technologies have prompted massive change to the sports industry, one which has traditionally been labelled as conservative (Smith and Stewart 1999). This in turn has ushered in a new era where an in-depth appreciation of digitalization and sports has become ever more pertinent. Table 2 summarizes the implications of digitalization for the sports industry across the four institutional components, which we will elaborate further in the remainder of this section.

Table 2. Implications of Digitalization on the Sports Industry	
Organizational component	<ul style="list-style-type: none"> • Administration of sports is supported by digital technologies eliminating manual processes and creating real time access to game results as well as historical data. • Live broadcasting and the separation between TV and digital rights of sports events provide new value to teams, viewers and sponsors.

	<ul style="list-style-type: none"> • Business intelligent and analytics are increasingly utilized in sport organizations to pursue both business outcomes and sports outcomes. • Emergence of digitally born sports, such as e-Sports, the organization of which demonstrates different dynamics, creates new types of competitions for traditional sports. • Utilization of digital touch points, such as websites, mobile applications, and social media, enable new ways to interact and engage with various stakeholders, (e.g., sponsors, advertisers, players, club management, national association employees and management). • New specialized stakeholders, such as data providers, software developers, and data analysts, emerge with capabilities addressing the digital technologies.
Technological component	<ul style="list-style-type: none"> • Commercialization of the technological component of sports (physical skills and knowledge) results in producing new digital products, such as e-Sports. • Increasing accessibility, traceability, and visibility of the technological component of sports (physical skills and knowledge) driven by the use of IoT and data analytics technologies, as well as emerging digital platforms that enable data production and data aggregation. • Technological component of sports is increasingly integrated in live broadcasting (consumption) of sports event, which creates new revenue streams. • The increasing importance of technological component that is enabled by digital technologies in creating competitive advantages. • Players play a more active role in the production and distribution of their own technological data, and hence democratizing the recruitment process (from top-down to bottom-up).
Symbolic component	<ul style="list-style-type: none"> • Pluralization of channels for sport organizations and its members to identify and brand themselves. • Digital presence of sports increases the accessibility of sports events and related content to potentially more stakeholders than before. • Display and rituals are extended to online sphere with digital means • Boundaries between online display and offline (physical) display are blurred. • Visibility to actions (goals, fouls committed, inappropriate behavior) increases.
Educational component	<ul style="list-style-type: none"> • Increasing utilization of data analytics in training, preparation and post-match analysis, challenges the traditional way of coaching, and demands new skill sets for sports producers. • Technological advancement in HCI, IoT, VR, and AR create more individualized/tailored training opportunities, or in some cases, replaces physical training with virtual training (digital simulator). • ‘Democratization’ of sports as information asymmetries (“training secrets”) reduced when novel practices spread viral.

Organizational Component of Sports Digitalization

Changes brought about by digitalization to sport organizations are multi-faceted. First, the most direct impact is that new digital means translate into touchpoints that allow for integration of various stakeholders of sports organizations. In other words, sports digitalization integrates lots of administrative functions such as player registration, ranking lists, tournament (single event and seasonal) management including registration of results, and more, into a comprehensive ICT system/service with multiple channels such as websites and mobile applications. The structural complexity related to the organizational component of sports organizations and its stakeholder groups is in full manifestation through digital displays. For instance, in individual-based sports, such as badminton, it is clear that the organizing has changed as the individual players today relate to both the national association and their own club,

whereas in the past, recreational players related to their own club, and only elite players related to the national association. Within the sports of badminton today, the national association is important for players to administer their ranking (if they have such one), obtain and review player license, register for tournaments, monitor tournament results, etc.. At the same time, the players' local badminton club often has a website that supports local club life, which may mirror many of the same functions that are on the national association website, including tournament management, sponsorship, game statistics, and more.

Second, digitalization extends the ecosystem of sport organizations, as new IT stakeholders, such as software providers and data providers, enter the picture. For instance, in the above-mentioned example, the success of the German national soccer team in utilizing data analytics in the World Cup tournament was largely supported by software provider SAP. Indeed, Davenport (2014a) pointed out that for sports organizations to successfully ride the digitalization trend, they will have to rely on a larger ecosystem, due to the size of such organizations (comparable to small-and-medium size enterprises) and the associated resource constraints. Therefore, with the entrance of new players, we are likely to witness the expansion and increasing complexity of sports ecosystems, as well as the growing importance of IT players.

Third, increasing digitalization also implies that administration (governance) of sport can be supported by digital technologies through the elimination of manual processes and creating real time access to game results as well as historical data. For instance, Stats.swehockey.se is the official statistics website of the Swedish Ice Hockey Association. The site provides current and historical data from all sanctioned official games and leagues, from youth leagues to the highest national division, by the Swedish Ice Hockey Association. Besides displaying information on leagues, teams and players, the system has also digitalized most of the administration surrounding ice hockey, including game reports, league management, player register and coach register. For instance, the system helps game organizers to prepare and publish official line-ups and team rosters before the game, real time game progress reports including goals and penalties, and post-game official game reports. The system also supports the allocation of referees to the individual games. All these reports and tasks were historically carried out manually and on paper and often submitted to the Swedish Ice Hockey Association for archiving.

Fourth, digital technologies provide new means for sports organizations to interact with both its own team members and also other stakeholder groups such as sponsors and fans. In other words, the digitalization of sports consumption product through various online channels renders opportunities for sport organizations, especially the ones with limited resources, to configure and deliver sport content/service/product in customized ways (Hoye et al. 2015). Sports consumption products are not limited to only match-day events any more. Instead, they have been extended to the whole organizational process such as training, scouting, and recruitment of player, thanks to various online channels, such as social media sites that allow sport organizations to stay connected with the fans and other stakeholders on a daily (if not hourly) basis across the globe. Further, such distribution of content is also democratized in the sense that every member of the sport organization as well as fans themselves can be part of the process (DiMoro 2015). Finally, even for the traditional broadcasting of events, digital technologies provide new means that would allow enhanced accessibility and interactivity. Take extreme skiing for example, a free ride skiing competition taking place on a mountain with a decent of 500-800 meters with its steepest inclination being as far as 60 degrees (e.g. in Haines, Alaska). It is, therefore, difficult for the sports fans to get to the actual location of the event and watch the competition. So instead, the Free Ride World Tour is broadcasting all events over the web, which overcomes the space and time constraints, provides the audience an opportunity to follow the skiers and their performance, as well as gives the sponsors wider exposure. Moreover, the live web broadcast offers the re-play function of the individual runs, often enabled by digital cameras mounted on players' helmets, which further increases the visual experience of the event.

Fifth, the increasing use of business intelligence and analytical tools in the sports industry also presents new means to improve how sports organizations conduct their business and sport activities (Caya and Bourdon 2016; Davenport 2014a, 2014b; Troilo et al. 2016). However, it should be noted that, due to the complexity inherent in the organizational component of sport organizations, the utilization of BI and analytical tools also renders different dynamics. For instance, a recent study by Tan et al. (2017) on Bayern Munich, a German football club revealed that analytics in the sports context span different areas, which could include performance and health analytics (for sports activities), business analytics (for

business activities; often consumer facing), and event management (for game-day activities that concern with the organization of the event).

Finally, digitalization has enabled the emergence of e-Sports. Though it is still debatable whether e-sports should be considered sports to begin with (Hilvoorde and Pot 2016), its success is likely to introduce more competition to traditional sports, especially considering its different structural and organizational features that are likely to fit with the digital world we live in. For instance, for eSports, power is vested predominantly in game developers (and not governing bodies) because they hold the intellectual property rights for game software. Also, gaming rules are either imposed by game developers (through game mechanics and therefore more universal) or emerged from social consensus (through negotiation and thus more game-specific). Finally, gaming events do not necessarily generate revenue (oftentimes losses are incurred); rather, value creation and capturing stem from the conversion of audience into players (through sales of game software and/or in-game micro-transactions). These organizational characteristics of eSports could provide some reference points for traditional sports in better coping with the digital environment (Hilvoorde and Pot 2016).

Technological Component of Sports Digitalization

The most direct impact of digitalization on the technological component of sports is on the physical equipment, in the sense that IT hardware and software are now included as essential parts of many of these equipment. Drastically different from the picture painted by Loy (1968) half a century ago, competition in sports now heavily involves competition on the digital assets. For instance, in Formula One, digitalization combined with the new formula of hybrid power units with internal combustion engines paired with energy recovery systems has led to a software competitiveness era. Accordingly, team composition has changed from predominantly mechanical and aerodynamics engineers and technicians to include software programmers and data analysts.

Besides the technological advancement of physical equipment and the inclusion of IT components, what is also relevant for IS researchers is the ever-increasing importance of data and information generated, integrated, and analyzed through various digital tools, both software and hardware. Admittedly, such trend is not recent and has been accumulating since the seminal work by Michael Lewis (2004) on the legendary story of Oakland A Baseball Team and how robust technical analysis based on performance data outperformed intuition and old-school wisdom when it came to decision making related to recruitment of players as well as team composition. However, latest development in digital technologies that led to increasing capacity in producing data has further stimulated interests in the area (Ferguson 2013; Travassos et al. 2013). First, due to the increasing use of IoT (Internet of Things) technologies such as sensors and wearables and analytical tools, what used to be “hidden” information on the technological component of sports (e.g., the level of physical skills of certain players, performance data of players and teams) has become increasingly accessible, traceable, and visible to the public (Davenport 2014a). For instance, in 2014, MLBAM (Major League Baseball Advanced Media) in U.S. rolled out a “camera-and-radar-based system” in all the baseball stadiums for MLB teams, which allows the tracking of live data related to not only the baseball (e.g., travelling speed) but also performance of each player with great details (Neyer 2014). Similarly, NBA (National Basketball Association) teams have started to use the so called “Player Tracking” technology which would allow them to track movements of each player “25 times per second,” the data of which will then be aggregated and analyzed to generate innovative statistics on player performance (Steinberg 2015).

The 2014-15 edition of the Volvo Ocean Sailing race tested the world's best professional sailing teams to the limit in a race around the world. For the first time, the race adopted a “one-design” boat (all teams sailed with an identical boat) with the latest technology on board. The boat is equipped with 160 sensors that offer new opportunities to understand the behavior of the boat in various conditions. More data is available than ever before and this data can be stored, aggregated and analyzed to facilitate understanding and learning and ultimately support both small operational decisions (such as trimming of sails or setting keel angle) and eventually more strategic decisions (such as deciding to take an alternative route seeking wind and current conditions that fit the boat best). As sailing teams had little experience with the application of data analytics on large data sets, external expertise was called for. Van Hillegersberg et al. (2017) describe how a university research team supported the Dutch Volvo Ocean sailing team by developing a race evaluation dashboard and architecture. The dashboard offered the sailing team various

visualizations and analytics of the sensor data to analyze performance over each route leg and investigate the impact of the use of sail configurations under changing wind conditions. The sailing team confirmed that the use of data analytics greatly enhanced their understanding of the boat and supported on-board decision making. It can be expected that in future races the importance of the use of data analytics to improve sailing performance will further increase.

The implications of the wide-spread use of data technologies are three-fold. First, the technological component that is essential for the competitiveness of sport is now influenced by digital means. In other words, it is not only important for players and teams to gain physical skills, but it is also increasingly indispensable to codify such skills into data/information that can be used to evaluate performance and prepare for future events. For instance, as the example of German soccer team at the beginning of the paper illustrated, it is both the players' physical skills and the national team's way of collecting and analyzing data on the players' physical skills that lead them to the final success in winning the World Cup. Second, the scouting or discovery of talents has also been revolutionized. As Lewis (2004) recounted, scouting and recruitment are no longer old-school game based on intuition and experience. With the availability (and abundance) of statistics generated by the digital means such as above mentioned systems, it can be expected that scouting and recruitment of players will be less reliant on "eyes" and more dependent on data (Steinberg 2015). It could also be expected that the skill requirement for scouting experts will be different under the new operations: shifting from the ability to read the talent to the ability to identify relevant information sifting through a sea of data. Finally, the increasing availability and visibility of live performance data can then be used for fan engagement and commercial opportunities, especially in enhancing match-day experiences (Klug 2015).

Further, we argue that players are playing a more active role in the production and distribution of their own technological data, thanks to emerging digital platforms that enable user-generated content and leverage the interactive/participatory nature of web 2.0 (O'Reilly 2007). For instance, Tonsser (www.tonsser.com) is a Danish tech startup that has created 'Facebook for football' - a social network site for youth football players. The Tonsser app was first launched in Denmark in March 2015. Within a year, the app was released also in Sweden, Norway, Italy, France and Spain. Two years later, the app was actively used by 250,000 youth players. At its core, the Tonsser platform provides functionality for register about players, teams and matches. The content is crowdsourced and dependent on that players provide the data themselves, which they to a large extent do. For the players, Tonsser has become the window to display achievements and for spying on opponents' performance and the pin board for team management. Two types of actors have shown a particular interest in accessing the Tonsser platform: agents and club scouts. Having data specialists analyzing the individual contributions of players have become core components of the recruitment process in football. For agents and scouts, Tonsser's detailed and longitudinal data consists an opportunity for talent management. Currently, the data allows for identification of top performance in a certain season. As data is aggregated, it will allow for specific inquiries into the relative contribution of individual players across teams and squads, in different positions, and even by controlling for game time, weather and season. In short, what this example has showcased is not only how scouting in sports has been increasingly relying on data analytics, but more so, how players have now become active producer of their own data profiles to demonstrate their physical skills. In other words, digitalization in a way has *democratized* the recruitment process of sport – young players are not passively waiting to be discovered any more.

Finally, as discussed above, digitalization of sports is also driving the rise and popularity of e-sports, which, from the technological point of view, represents commercialization of physical skills and knowledge possessed by sports producers in creating digital products (often in the format of digital games). For instance, the popularity of FIFA Football can be attributed to its simulation of the real world, where gamers reside in and control players whose skills are duplicated from the data gathered on their live counter parts (Hilvoorde and Pot 2016). This area will gather further attention considering the great potential of VR (virtual reality) and AR (augmented reality) technologies in creating simulated gaming scenarios that are close to real-life experience (Hamdhaidari 2016).

Symbolic Component of Sports Digitalization

Digitalization of the symbolic component of sport can refer to the pluralization of channels through which sports organizations and their members can (and need to) utilize in constructing display and building

their identity and brand. However, such digitalization of identities can sometimes change the symbolic attributes of a certain sport, especially the ones carrying long traditions. For instance, Badminton is historically labelled as a “white sport” by middleclass people to show off their cultural capital (Warde 2006). Such identity is evident through symbolic products such as photos of well-fed and well-dressed kids and grown-ups in white clothes who listen respectfully to instructions or clearly collaborate with good manners. In other words, the image was created under certain social context. While increasing digitalization of sports can certainly reinforce such image, it also bears the question of whether the symbols of badminton will be challenged given the different social and cultural contexts associated with digitalization (Deuze 2006). Another example to demonstrate such dynamic is a recent move by one of the oldest Italian football club Juventus F.C. in changing their old-school, badge-style logo that has been in place for decades to a modern logo that embodies minimalistic design (“Black and White and More” 2017). The change has stirred great controversies among the fans, overseeing a clash between the old value, associated with heritage and history, and the new one that is tailored for the modern world dominated by commercialization and digitalization (it was argued that the new logo suits the future as its design is much easier to be reproduced and optimal for digital channels) (Guardian Sport 2017).

Second, different digital channels make sports event and related content accessible to potentially more stakeholders than before. For instance, livestreaming of eSport, such as Dot2, through Twitch.tv. The implications here are multi-fold. To begin with, the display and ritual of sports have been extended to online sphere, meaning that new opportunities arise for sports organizations and its members to engage in such displays. The previous example on extreme skiing provides an excellent point in how digital means not only remove the constraints of time and space in accessing the sport content, but also intensify the display of the sports through replays facilitated by various camera angles. Another example related to ritual of sports being carried out in digital means can be found in soccer. On January 11th, 2015, when the legendary player Francesco Totti of the Italian soccer club A.S. Roma scored a momentum goal in so-called Roma derby, as part of the celebration, he took a selfie with the emotional, flag-waving supporters in the background, and posted the photo live on his social media site (Bandini 2015). Such moment was later touted by media as historic, as smartphone and social media for the first time became part of the sports ritual – celebration of goals – carried out by players live on the field (Laird 2015). In a way, the seemingly unbreakable boundary between the physical sphere and the online sphere in sport events is getting blurry. Such blurring of boundaries is also demonstrated by the above-mentioned case of Tonsser, where the players have the platform and the capability to document their display on the field and distribute it to the digital world. It can then be asked whether such possibility of extending on-field display to the on-line environment and hence the increased visibility of actions (positive and negative) would then influence players’ performance on the field.

Regardless of whether and how digital channels will influence players’ performance, they have enabled the online sports consumption for sports fans (Seo and Green 2008; Witkemper et al. 2012). For instance, the role of social media in sport and sport culture has become increasingly important (DiMoro 2015). It is even deemed as a necessity for every team, club, and player to maintain a social media presence (Sanderson 2011). For an industry where emotions and attachments are a major part of the consumption product (Bee and Havitz 2010; Hunt et al. 1999), it is reasonable to argue that social media platforms render as powerful tool for sports organizations to enhance the consumption experience through increased interaction possibilities. Additionally, when combining this with the increasing availability of live match and player data (see above), new opportunities arise to further diversify online sports consumption and create new revenue streams. For instance, in cricket, live broadcasting includes data analytics in terms of projected score and predicted winner, and social media engagement in terms of polls, activity counters, and sentiment metrics. As for sport organizations, the afore-mentioned Juventus F.C. provides another example when they created so-called Juventus Pass (<https://pass.juventus.com>), a portal where fans can consume various digital content (comprising mostly of match highlights and historical match videos) based on a subscription model.

Educational Component of Sports Digitalization

The educational component of sports refers to the development and continuous improvement of physical skills and knowledge that are deemed essential to be competitive. As discussed in the technological component, digitalization has made it easier to collect and analyze data related to players and teams’ skills and performance, and hence enabling the widespread utilization of such data in training and game

preparations. Data analytics utilized in the educational component of sports can be separated to two areas: performance analytics and player health and injury prevention analytics (Davenport 2014b). The above-mentioned examples of MLB and NBA illustrate how such data can be gathered live and utilized later in training and preparing for future matches. Similarly, in Europe, the same trend can be found in soccer where we have witnessed data analytics going beyond the descriptive statistics with increasing focus on the diagnostic and prediction components (Davenport 2014a). For instance, F.C. Bayern, a pioneer when it comes to data analytics, in collaboration with software provider SAP and data provider Opta, would collect 80 million pieces of data for one single soccer match, which will then be integrated and utilized in training together with training data gathered from sensors at training centers to monitor/evaluate the performance of each player and the overall team (Tan et al. 2017). However, as Davenport (2014b) pointed out, sport producers (players and coaching staff) will not be able to take full advantage of data analytics until they fully embrace the technology and use them to their advantage. Such observation reflects one of the main issues/implications of digitalization to the sports industry in challenging its traditional mindset (Smith and Stewart 1999). As Lewis (2004) documented, the clash between the old way of doing business – heavy reliance on intuition and tacit knowledge – and the new way of doing business – reliance on technology and evidence – is real and contests the core of the industry. Further, similar to the discussion of scouting, beside mindset change, utilization of data analytics in training and match preparation also requires new skill sets for coaching staff (possibly players as well) that would allow them to interpret and use the data in an effective way.

Second, technological advancement in HCI, IoT, VR, and AR are creating more individualized/tailored training opportunities, which might change the collective nature of sport (Coleman 2012). With again badminton as an example, meeting several times a week with a large group of other people in specialized rooms – badminton clubs – is currently necessary to train the skills that are required to play the game even on a recreational level. In the near future, a diversity of other approaches may become available to the individual player. Already for years, elite players had access to time and trainers in badminton clubs so that they could train, but with instructional technologies, these players will be able to train individually, and not be constrained to a single location (i.e., the club training center). In this sense, the collectiveness of the sports, especially related to the educational part, can be further challenged.

Following up on the previous point, technological advancement and consequently the accessibility of data and information, also further drives the democratization of sports. On one hand, as described in the badminton example, individualized training based on instructional technologies (that are commercialized) could potentially lower the barrier for future sportsman to gain education and training. On the other hand, information asymmetries (e.g., tactical secrets) are reduced due to the public availability of performance data (as discussed above). In fact, even fans and/or individual sport journalist nowadays engage in the interpretation and analysis of performance data on various social media platforms. In other words, what used to be the exclusive domains of experts can now be accessed and interpreted by the general public, i.e., a decrease in the barriers to participate and the declassification of the secret nature of sports.

Finally, in certain sports such as Formula One, digitalization combined with restrictions on testing (both pre-season and in-season) led to increased reliance on race simulators. In this regard, physical training is replaced by full or partial virtual training. In the future, we might witness the spreading of this trend to more sports domain, as technologies in VR and AR continues to develop.

Proposal of a Research Agenda for Sports Digitalization

The previous section demonstrates how digitalization has prompted tremendous changes to the sport industry and sport organizations, marking a new era where studying digitalization and sports has become more relevant and important. This is evident from a broad range of sports, from the ones with long history and tradition, such as badminton, soccer, baseball, cricket, skiing, to newly-emerging, digitally-born sports – eSports. In this section, we aim at providing a research agenda for sports digitalization, by making sense of the implications listed in Table 2 and reviewing relevant areas in IS research. Specifically, we look for different topics that are of theoretical and practical importance across the organizational, technological, symbolic, and educational components of sport organizations, in relation to the digitalization in these areas. Table 3 presents a summary of such agenda.

Table 3. A Research Agenda for Sports Digitalization

Organizational component	<ul style="list-style-type: none"> • How can we understand the new ecosystem as a result of sport digitalization, with new participants entering the picture? • What are the relationships among the new sports format, business model innovation, and digitalization? • What is the nature of the relationships between different organizational levels of sports in the digital context? • How does digitalization impact the competitive landscape of a certain sports industry (e.g., Formula One)? • How does digitalization (digital infrastructure and digital platform) influence the co-opetitive dynamics among sports organizations within a certain industry?
Technological component	<ul style="list-style-type: none"> • How can we design digital systems/platforms, and integrate sports data across different channels? • In sports scouting and recruitment, how are information and knowledge used to evaluate players' physical skills generated and analyzed through utilization of digital technologies? How have digital technologies changed scouting and recruitment practices? • How do digitalization of sport impact traditional live broadcasting on radio and TV and new digital broadcast platforms? • What are some unique design requirements for digital technologies (e.g., analytical tools, software, digital platforms) in the sports context?
Symbolic component	<ul style="list-style-type: none"> • How to retain and further develop the brand of the sports when the symbols move from offline to online? • How do players manage their own data profiles to attract recruiters' attention? • How do increased measurements and game transparency impact player performance? • What are the ethical concerns and managerial implications of players leaving a 'digital trace' in a club? Who should own the data? • How do new forms of symbolic relationships form due to a combination of innovations in sports formats, business models and digitalization? • How does the increasing utilization of digital technologies in delivering sports events influence both individual experience and collective experience?
Educational component	<ul style="list-style-type: none"> • What kinds of capabilities are required for coaching staff to better utilize data analytics in enhancing performance? What kind of organizational capabilities are required to fully take advantages of data analytics in training players? • Will playing a physical sport - like badminton - against robots change what is learned during training and what is meant by playing the sport? • How can we use IoT technologies and IA (machine learning) to design and develop smart personal trainers/coaches for players?

Developing a Research Agenda in relation to the Organizational Component

Existing IS literature has shown tremendous interests in understanding digital ecosystems that are built upon digital infrastructure or platforms (Tilson et al. 2010; Tiwana et al. 2010; Yoo et al. 2010). In a similar vein, researchers can focus on how digitalization has influenced the existing sports ecosystem and the emerging or changing ecosystem surrounding sports. The pursuit of this agenda can reveal how a number of new specialized actors, such as data providers, data integrators, livestreaming services, and software providers, are becoming critical constituents of a new ecosystem providing the sport industry with new recourses, skills and competences. As traditional IT players such as SAP move into industries like sports, and the emergence of new data provider and data aggregator due to increasing demands for data analytics (e.g. Opta for professional soccer) (Tan et al. 2017), this research agenda is significant: to extend our understanding of how the entrance of IT players changes the ecosystem dynamics or what role

IT players will be playing in such an ecosystem (e.g., commodity player or niche player (Iansiti and Levien 2004)).

Against this backdrop, a broader question can be asked as to how digital technologies transform the sports industry. To answer this question, researchers can focus on either a specific technology or a specific sports area. For instance, as we see the increasing relevance of digital platforms in the sports context (e.g., new business models such as above-mentioned case of Tonsser), one could ask specifically how would digital platforms change the structure of a certain sports industry? We believe the quest of such nature can contribute to the collective dialogue in the area of digital platforms and digital ecosystems (e.g., de Reuver et al. 2017): 1) unlike other industries (e.g., transportation), the sports industry is only beginning to experience influences posed by digital business models, allowing us to witness the unfolding of the impacts; 2) the dynamics of sports industry (e.g., complexity when it comes to the ecosystem composition as well as the relationship among different ecosystem players) will render unique opportunities for us to further our understandings in areas such as platform ecosystems.

Moreover, if we zoom into various organizing activities, we can then look at new business opportunities and their implications on traditional roles in sports. For instance, one area that is affected is the organizational activities related to sports team compositions and competitive advantages. What will the role be for traditional talent scouts – when all data is available online? Furthermore, how will sports transform due to the increased media exposure through live broadcasting and subscription revenue models? From this, we have an opportunity to study how digitalization changes different operational areas of sports organizations, both related to the sports domain and the business domain.

Finally, digitalization poses new competitive dynamics, when considering the digital infrastructure that can be shared across competitors (e.g., the player tracking in NBA). There, sports (with increased digitalization) provide a unique context to explore the co-opetition phenomenon (Brandenburger and Nalebuff 2011), where different sports organizations compete with each other to achieve dominance on one hand, whereas on the other choose to collaborate to improve the standings of the sports itself. It would be interesting to investigate how digitalization influences the co-opetitive dynamics within a certain sports industry.

Developing a Research Agenda in relation to the Technological Aspect

To date, many IS scholars have reported on the capabilities of information technology for organizations particularly through adopting the resource-based view (Bharadwaj 2000; Nevo and Wade 2010). IS research has also identified a comprehensive set of different types of IT capabilities that can be held by a firm, which include outside-in capabilities which deal with responding to the market, inside-out capabilities that deals with internal operations, and spanning capabilities which integrate the previous two (Wade and Hulland 2004). Given that technology has the capability to integrate data between technologies and platforms, a research program on data integration across different sports makes it possible for us to better understand how to compare and learn from other sports and remain competitive (Steinberg 2015). Hence, we can reveal what standards should be developed to enable such integration, extending the knowledge of integrating sports generated data with online content (e.g. social media and user generated content) (O'Reilly 2007). We have an opportunity to reveal how to combine or co-present IT-based resources with other resources and capabilities (Bharadwaj 2000).

In addition, we also call for studies on how digital technologies can be used to build a body of knowledge (expert systems) that can be used to improve the material or the physical skills. For instance, how can 3D models and simulation models (Hamdheidari 2016) be used to test new material. This is significant as we can extend our knowledge of how technological capabilities change practices. For example, when it comes to the recruitment of players, how can digital technology be used to collect knowledge? Furthermore, how can such technologies be used to detect over-performance, i.e. doping, or even incidents related to gambling and betting, to create a fair game? Other relevant research questions in sports scouting and recruitment include, how could the information and knowledge used to evaluate players' physical skills be generated and analyzed through the utilization of digital technologies? How have digital technologies changed scouting and recruitment practices?

Finally, from a design perspective, we can ask what are some of the unique requirements and challenges in designing digital technologies specifically for the sports context (Caya and Bourdon 2016).

Developing a Research Agenda in relation to the Symbolic Component

IS researchers have a long tradition of studying identity related issues of IT users (Lamb and Kling 2003; Nakamura 2002). The concept of symbolism has also been used as a blueprint for IS research on focus of the IT systems use and their processes (Gopal and Prasad 2000; Ng and Tan 2004). More recently, such efforts have been extended to social media users (Kreps 2010), and users in online communities (Animesh et al. 2011). A central question revolves around how (accurately) users utilize digital means to present themselves in the digital world, and the influence of such virtual representation. Similarly, digitalization leads to several research avenues regarding users and related to displays and rituals. When considering the extension of display to the digital arena, questions can be raised about the virtual identity of both the sports organizations and their producers (especially players) as well as the fans. Hence, we call for initiatives on how stakeholders in sports manage their digital presence. Specifically and from sports players' perspective, it will be interesting to investigate questions such as how players would manage their own data profiles to attract recruiters' attention. How do presence of an online profile (online display) impact a player's performance? Or from a marketing point of view, how could digital technologies be used to further develop the brand of the sport, the team, or the player? Furthermore, with the emerging digital traces (Hamdhaidari 2016) how should teams and players manage their past and who own such traces?

IS researchers have also revealed new forms of symbolic relationships formed as a result of technology intervention for promotion and advertising with consumers (Li et al. 2015). As for the sports consumers, similarly, social media channels have transformed fan bases by diversifying audiences and amplifying subjective aspects such as sentiment. Therefore, the availability of such data that reflects the emotions of sports consumers has rendered new opportunities for examining the connection between online display and offline behavior. For instance, studies from the communication discipline have looked into issues such as how sports fans' online discourses (re)produce their social beliefs offline (Sanderson 2010), and how fans use digital platforms to collectively solve identity issues (Sanderson 2013). On the sport organizations' side, Egebjerg et al. (Forthcoming) addresses the research question of how social data generated by the fans can provide important insights for organizations to understand their fan base. As such, we call on more research on how to retain and further develop the brand of sport.

Finally, we believe studying the digitalization of the symbolic component of sports will provide IS researchers with unique opportunities in areas such as experiential computing (Yoo 2010). The utilization of digital technologies (both software and hardware) in delivering sports consumption products is advancing at two ends: around the physical experience of the live sports event itself and around the virtual event broadcasted through various channels. Thus, on the individual level, we can study how the entanglement of the digital and the physical influences consumer experience, whereas on the group level, we attend to the question of how the introduction of digital channels changes the *collective* experience (Yoo 2010).

Developing a Research Agenda in relation to the Educational Component

Similarly, studying how information systems and technologies facilitate learning in an organizational context has a long standing tradition in IS research. Findings from IS research on technology enabled organizational learning can be used to inform processes, performance and innovation (Alavi and Leidner 2001; Andreu and Ciborra 1996; Scott 2000). As digitalization changes how sports producers improve their physical skills, especially in relation to the increasing utilization of data analytics, we stress the importance of studying how players and coaching staff cloud use digital technologies to gain knowledge and facilitate the training process. Along the same line, one can also examine the types of new skills are required for players and coaching staff to utilize digital means in training. Further, as the new way of training and match preparation challenges the traditional way of learning and education in sports, it is relevant to examine how digitalization influences (or is influenced by) the existing norm systems, or, institutional logics (Scott 2013; Thornton and Ocasio 2008) of certain sports industries. Finally, as we see the advancement and wider use of IoT technologies, such as wearables, we delve into more intrusive and extensive performance monitoring systems that could influence the players' physical performance and psychological well-being.

As increasing knowledge and competence in IT is synonymous with change, in mindset (Smith and Stewart 1999) and in practice (McEwan and Gutwin 2016), a potential avenue of research could be

focusing on the change in the design and development of tools and practices in sports digitalization. For instance, the increasing capabilities of AI and robotics might bring robots to the sports training ground. Whilst researchers have found that learning to play chess with a computer is different from playing chess against a human opponent, it is noteworthy to investigate if playing a physical sport like badminton against shuttlecock robots will change how humans play badminton. This is due to the richer affective and social aspects found in turn-based games like badminton (e.g. waiting some seconds for the tired player to get ready before serving the shuttlecock); where the user experience when playing with robots may be different as flow and immersion are important (IJsselsteijn et al. 2007). Hence communication levels in the robotics should be carefully designed (McEwan and Gutwin 2016).

Concluding Remarks

In this conceptual paper, we focus on the field of sports and the broad phenomenon of sports digitalization. In fulfilling the three research objectives we have presented at the beginning, we aim to make important contributions to both sports related research within the IS discipline. We discuss the research implications of this paper below.

First and foremost, in reviewing the institutional characteristics of sports, a field with long and glorious tradition, we are able to establish the theoretical importance of treating sport organizations as a different context for research. As discussed above, the complexity embedded in the organizational structure and activities, the importance of symbolic elements in the consumption product, the complexity of customer composition and relationship, and the criticality of technologies in the format of equipment, and skills and knowledge which need to be formally acquired and continuously improved, together represent a unique industry. By systematically demonstrating the differences of sport organizations across the organizational, technological, symbolic, and educational components, we contribute to the theoretical understanding of the sports industry. Doing so, we hope more research on the sports context will be conducted by IS scholars to further investigate this distinct field for IT related phenomenon.

Second, in reviewing the latest trends of increasing digitalization in the sports industry, we have also demonstrated the different components of sport organizations that have been changed, challenged, and transformed. This includes how the organizational component changes with new virtual ways of integrating and engaging with various stakeholders, emergence of new specialized stakeholders, and new means for interacting with team players; how the technological component has changed when technological data becomes increasingly accessible, traceable, visible, and data analytics becoming a key component of player recruitment and team formation; how the symbolic component is amplified through the online sphere with digital means; how boundaries between online display and offline (physical) display are blurred; how the educational component changes due to advancement in HCI, IoT, VR, and AR to create more individualized/tailored training opportunities, which might challenge the collective nature of sport; and how match and player performance data is available for analysis before, during, and after the particular match. We believe such a broad overview of sports digitalization, demonstrated by various examples and cases across various types of sports, will further establish the importance and the relevance of conducting IS research in this domain. Additionally, due to the institutional characteristics of the sports industry, many changes we are witnessing in the sports would provide us with unique opportunities to study digitalization related phenomenon which cannot be easily observed in generic business context. As Davenport (2014b) argued that, organizations represent a much more advanced field when it comes to utilization of data analytics tools, from which business should learn from.

Finally, we have proposed a research agenda with a sample of research questions for the IS community to delve deeper into the sports context in general and sports digitalization in specific. We believe this is the first effort in the IS discipline to provide such a blue print that covers a broad range of topics in relation to the organizational, technological, symbolic, and educational components of sports digitalization, and touches upon different IS streams of research. Our hope is that future research in sport digitalization will not be limited to only sports analytics (exemplified by MIT Sloan Sports Analytics Conference), and that our effort will activate more researchers to this field conducting more diversified research.

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