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The Future of Sportstech – A Taxonomy and Findings from Delphi-based Prospective Studies

Dissertation for obtaining the degree of Doctor of Business and Economics (Doctor rerum politicarum - Dr. rer. pol.)

at WHU – Otto Beisheim School of Management

16 August 2022

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Acknowledgements

When I embarked on my dissertation journey, I was not too much concerned with what would lie ahead for me personally. While my professional intentions were clear, private matters or the people I would work with hardly played a role in my considerations, for no particular reason. Looking back now on my time as a doctoral student, this has turned entirely. What I will remember is one of the best times of my life, not for the academic stimulation, but for the encounters I was privileged to make and for the friendships that were formed. To express my most sincere and heartfelt appreciation and gratitude, I want to take a moment to thank you¹:

- My friends Daniel, Flo, Harry, and Sebi for your companionship and friendship. I am deeply grateful for having had the pleasure of spending my dissertation years with you and could not have wished for any better. For me, winning you as friends is the most valuable result of my dissertation.
- My family for always being there for me, for listening to my complaints, and for reminding me to actually work on my thesis when there were too many distractions.
- My friends from the Nolle, from school, from sports, from studies, from work, and from everywhere else the best times I have is with you thank you! A special thanks to Fabi for a lifetime of friendship and for being the best roommate throughout my doctoral studies that I could have ever wished for thanks Brudi!
- My first supervisor Prof. Dr. Sascha L. Schmidt, for your help and patience on this research journey, for trusting me with the MIT Bootcamp, and for providing guidance on my thesis when I needed it.

¹ The full names of those mentioned are: Daniel Beiderbeck, Dr. Florian Holzmayer, Harry Krüger, Dr. Sebastian Koppers, Fabian Bernnat, Dennis Gottschlich, Jun.-Prof. Dr. Dominik Schreyer, Kerstin Forword, Maria Dahl, Sigrid Dethloff, Ben Shields, Brian Subirana, Erdin Beshimov, Vimala Palaniswamy, Mariah Rawding, Sanjay Sarma

- My second supervisor Prof. Dr. Christoph Hienerth, for providing feedback and guidance on my research and for the difficult questions that pushed me to better results.
- My CSM colleagues Dennis, Dominik, Kerstin, Maria, and Sigrid for fun during lunch and coffee breaks and for taking care of many things.
- My friends, colleagues, and co-authors from MIT Ben, Brian, Erdin, Vimala, Mariah, Sanjay, and the entire team – thank you for the many incredible experiences we shared and the great things we created together.
- My co-author Benjamin Penkert for providing expert knowledge on sportstech, for many fruitful discussions, and for making sure our research has relevance in practice.
- Prof. Eric von Hippel (PhD) for his kindness of inviting me to MIT as a visiting scholar, which unfortunately was cancelled (for now) due to the pandemic.
- My McKinsey colleagues who are the most values-driven and integer people I have ever experienced in a professional environment, with whom I was able to have an incredible amount of fun, and without whose variety I would have gone stir-crazy during my doctoral studies.

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List of Abbreviations

5G	Fifth generation technology standard for broadband cellular networks
AI	Artificial intelligence
AR	Augmented Reality
ASTN	Australian Sports Technologies Network
ATI	Affinity for technology interaction
ATT	Attitudes towards using technology
AVE	Average variance extracted
B2B	Business-to-Business
B2C	Business-to-Consumer
B2B2C	Business-to-Business-to-Consumer
CDO	Chief Digital Officer
cf.	Compare (Latin: 'confer')
CFA	Confirmatory factor analysis
COVID-19	Coronavirus disease
CR	Composite reliability
CSM	Center for Sports and Management
СТО	Chief Technology Officer
D	Desirability
DFB	German Football Association (German: 'Deutsche Fußball-Bund')
DFL	German Football League (German: 'Deutsche Fußball Liga')
e.g.	For example (Latin: 'exempli gratia')
EP	Expected Probability
et al.	And others (Latin: 'et alii/aliae')
etc.	And so on (Latin: 'et cetera')

EU	European Union
FCM	Fuzzy c-means clustering
GDP	Gross domestic product
GPS	Global positioning systems
GSIC	Global Sports Innovation Center
Ι	Impact
i.e.	That is (Latin: 'id est')
IoT	Internet of things
IQR	Interquartile range
ITT	Intention to use technology
MR	Mixed Reality
No.	Number
OTT	Over-the-top
p.	Page
p. POSDCORB	Page Planning, Organizing, Staffing, Directing, Coordinating, Reporting, and Budgeting
p. POSDCORB RQ	Page Planning, Organizing, Staffing, Directing, Coordinating, Reporting, and Budgeting Research question
p. POSDCORB RQ SaaS	Page Planning, Organizing, Staffing, Directing, Coordinating, Reporting, and Budgeting Research question Software as a Service
p. POSDCORB RQ SaaS TAM	Page Planning, Organizing, Staffing, Directing, Coordinating, Reporting, and Budgeting Research question Software as a Service Technology acceptance model
p. POSDCORB RQ SaaS TAM TI	Page Planning, Organizing, Staffing, Directing, Coordinating, Reporting, and Budgeting Research question Software as a Service Technology acceptance model Technological innovativeness
p. POSDCORB RQ SaaS TAM TI TRUST	Page Planning, Organizing, Staffing, Directing, Coordinating, Reporting, and Budgeting Research question Software as a Service Technology acceptance model Technological innovativeness Trust in technology
p. POSDCORB RQ SaaS TAM TI TRUST UEFA	Page Planning, Organizing, Staffing, Directing, Coordinating, Reporting, and Budgeting Research question Software as a Service Technology acceptance model Technological innovativeness Trust in technology
p. POSDCORB RQ SaaS TAM TI TRUST UEFA VR	Page Planning, Organizing, Staffing, Directing, Coordinating, Reporting, and Budgeting Research question Software as a Service Software as a Service Technology acceptance model Technological innovativeness Trust in technology Union of European Football Associations
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List of Symbols

df	Degrees of freedom
М	Mean
N, n	Sample size (N = total sample size; $n = size$ of a particular group)
р	Probability (the probability value, p-value or significance of a test)
r	Effect size in planned contrasts
R	Pearson's correlation coefficient
\mathbb{R}^2	Coefficient of determination
SD	Standard deviation
SE	Standard error
Sig.	Significance
U	Mann-Whitney U statistic
z-score	Standard scores
λ	Factor loading
θ	Variance of measurement error
Σ	Sum
%	Percent

1 Introduction

"Skate to where the puck is going, not where it has been."

Wayne Gretzky

1.1 Background and Motivation

Sport is a fundamental part of our global society. Its enormous importance is reflected not only in economic indicators, but also in positive effects on healthcare (Khan et al., 2012), in education (European Union, 2012), in media (Kennedy & Hills, 2009), or for simply "bringing people together and contributing to social cohesion" (Lefever, 2012, p. 31). It plays a vital role in interculturality and inclusiveness (Beutler, 2008) and can serve important social functions, including those of religion (Price, 2001). The importance of sports is evident in the European Union's (EU) classification of many sports events as "events of major importance for society" (Katsarova, 2017), ensuring the public the right of access to these events through free information. The promotion of sport due to its nature and social function is also anchored in the Treaty on the Functioning of the European Union (European Union, 2012).

From an economic perspective, the sports industry has evolved into a meaningful entity. Defining the exact size of the industry is complex and has not been done in full yet (Gammelsæter, 2020), however, the current estimates imply a very relevant size. In the EU, the sports industry is assumed to represent almost 3% of gross value added and 3.5% of total employment (Katsarova & Halleux, 2019). Globally, it is assumed to represent about one percent of gross domestic product (Schmidt, 2020b). Beyond its immediate economic impact, the sports industry creates significant value for many other industries such as tourism, media, security services, catering, betting, or consumer goods (Borovcanin et al., 2020; Kokolakakis & Gratton, 2019; McKinsey, 2020; Siegfried & Zimbalist, 2006). The sports industry has

experienced several decades of exceptional growth and is expected to continue its growth trajectory (Schmidt, 2020b).

While sports has always been intertwined with technology, this relationship has seen significant changes in recent years as sports has been disrupted and transformed by technology and digitalization like many other industries (Verhoef et al., 2019). Initially, technology had played a constitutive function for many sports to exist in the first place (Loland, 2009). Over time, this evolved into other functions, including health and safety (Waddington & Smith, 2000), athletic performance (Balmer et al., 2012; Lippi et al., 2008), and ultimately functions for fans, for example, in the consumption of sports (Chan-Olmsted & Xiao, 2019; Ratten, 2011). Today, technology has become indispensable in the way we experience and perceive sports, driven by various technological advancements and digitalization, particularly with the emergence of the Internet and mobile technologies (Ratten, 2019). It is expected that "future limits to athletic performance will be determined less and less by innate physiology of the athlete, and more and more by scientific and technological advances" (Lippi et al., 2008, p. 14). Fans and consumers will be able to follow sports live or on-demand through digital technology anywhere and anytime (Ratten, 2011). Sports managers will increasingly have to rely on technology to do their jobs (cf. Schmidt, 2020b). Overall, this means that almost all stakeholders and all aspects of sports are – and will continue to be – affected by technology.

Given the high relevance in both social and economic terms, there is surprisingly little research in many of these areas. For example, sportstech has received relatively little attention (Ratten, 2017). Most of the existing work is somewhat fragmented with very focused topics (e.g., Ringuet-Riot et al., 2013; Tjønndal, 2017) or it originates in adjacent research disciplines such as biomechanics, brand management, or ethics (e.g., Evans et al., 2017; Magalhaes et al., 2015; Pradhan et al., 2020). Similarly, sports management research is still in its infancy (Peachey et al., 2015). There is a lack of connections between the different works and only a few structured areas such as marketing or organization theory received focused attention

(Ciomaga, 2015). A disparate understanding of what belongs to sports management in terms of economic, social, political, or cultural factors and what does not poses additional challenges (Newman, 2014; Stewart, 2014). Overall, scholars challenge the lack of debate within the field, which could result from multi-disciplinarity and scarce resources (Gammelsæter, 2020). Similarly, there is criticism about the lack of knowledge *about* sports managers as most research is focused on producing knowledge *for* sports managers (Andrews & Silk, 2018; Klikauer, 2018).

The motivation of this dissertation is to address these research gaps, thereby extending our understanding of the relationship between sports and technology and the associated role of sports managers. In view of the relevance, it is surprising how little is known about the intersection of sports and technology as well as sports management in general. In the spirit of one of the greatest athletes of all time, Wayne Gretzky, I decided to direct my research to where the puck is going, not where it has been. That is, I intentionally future-oriented most of my research to help both academia and practice with the challenges that lie ahead instead of explaining what has already happened. Therefore, I conducted two Delphi-based prospective studies that examine the impact of technology on sports and sports management, respectively. As a structure-giving basis, I first developed a taxonomy of sportstech that consists of a definition of sportstech and the SportsTech Matrix. The latter is intended as a valuable tool for scholars and practitioners to establish a shared understanding and to provide an all-encompassing structure for the field. For example, this can be used to examine how different technologies provide different solutions to different user groups in sports.

All in all, through my research, I hope to contribute to the overarching guiding question of my dissertation: *What is the impact of technology on sports and sports management in the future?*

1.2 Research Questions and Theoretical Contribution

The overarching guiding research question (RQ) is divided into three pieces of research, of which the first is conceptual and lays the foundation for the subsequent two empirical papers. First, I will address the fundamental gap of missing structure in the research field by proposing a definition of sportstech and the SportsTech Matrix that intends to provide an all-encompassing structure for the field. Second, I will systematically examine future developments in sportstech along the dimensions of the SportsTech Matrix. Third, I will deep dive into one specific dimension of the matrix and investigate the future impact of technology on sports management which is the leading group of interest in our research. Accordingly, the following three research questions are addressed by one paper each:

- *RQ I:* How should sportstech be defined based on existing literature and what is an overarching structure that both researchers and practitioners can use?
- *RQ II:* How will different technologies impact the main user groups in sports in the future and what are relevant future scenarios?
- *RQ III:* How will the role of sports managers change in the future given the influence of technology and what are relevant future scenarios?

RQ I contributes to both academia and practice as it aims to provide a structure that is able to inform and guide all relevant stakeholders including researchers, sports managers, athletes, and fans but also owners, investors, and other affiliates. Existing definitions and structures tended to be incomplete and limited to partial areas, resulting in a lack of overarching taxonomies, frameworks, models, and guidelines for sportstech (cf. Ratten, 2017). Sportstech and the overall relationship of sports and technology is no new phenomenon, however, it has gained significant momentum in recent years that was accompanied by exceptional advancements and increasing complexity, for example, in terms of varied needs from a broadened stakeholder group (Fuss et al., 2008). Despite the existing lack of sportstech research, a growing amount of research in isolated areas of sportstech illustrates the importance of this research field and its potential as a research stream in its own right (cf. Ratten, 2018). With the first paper of my dissertation, I aim to contribute to advancements in this newly developing field of research by contributing to a shared understanding of the term sportstech and by providing a structure that may guide future investigations of the field.

RQ II contributes to a better understanding of the continued impact of technology on sports (Schmidt, 2020b). This is important given its significant social and economic relevance and the lack of systematic academic attention on the future of sports, particularly in terms of rigorous foresight studies (cf. Merkel et al., 2016). Therefore, a well-established approach of a Delphibased prospective study, including a scenario analysis (Nowack et al., 2011), is used to address this gap. Naturally, this does not allow a prediction of the future, however, it enables anticipation and a thus better understanding of future developments, even in environments that are subject to significant external change (Van der Heijden, 2011), which in turn will help researchers, policymakers, decision-makers, and other relevant stakeholders. Following a rigorous research approach, this also provides a valuable contribution to the scenario planning literature that is relatively young and has seen a substantial increase in publications over the last two decades (cf. Varum & Melo, 2010). In addition, RQ II also contributes to the growing research body of futures and foresight studies (Chermack, 2018; Fergnani & Chermack, 2021; Gary & von der Gracht, 2015; Münch & von der Gracht, 2021). This body of research is still at the crossroads of "becoming part of the social scientific establishment" (Fergnani & Chermack, 2021, p. 1). Future and foresight scholars have had difficulties explaining their field of research to others (Fergnani & Chermack, 2021). One of the reasons for this was the limited use of theoretical grounding common in the field (Hideg, 2007; Mermet et al., 2009; Münch & von der Gracht, 2021; Öner, 2010; Piirainen & Gonzalez, 2015).

RQ III makes valuable contributions to the field of sports management, which is lacking academic attention (Peachey et al., 2015). Existing work is challenging the own field for lack of debate (Gammelsæter, 2020), which shall in part be addressed by the Delphi-based prospective study in Paper III. It has also been criticized that existing research often only looks at subfields (Ciomaga, 2015; Newman, 2014; Stewart, 2014), so I decided to examine sports management as a whole. At the same time, I aim to develop insights for the body of research interested in gaining knowledge *about* sports managers instead of only producing knowledge *for* sports managers (Andrews & Silk, 2018; Klikauer, 2018). In doing so, I also respond to a call from Misener and Misener (2017, p. 130) for "more 'risky' research endeavours" in sports management that shall help to "embrace the complexity of contemporary sport management." They see the role of sport management scholars as "agents of change in providing theoretical and empirical insights that can enable sports organizations to survive and thrive in such a turbulent and evolutionary environment" (Misener & Misener, 2017, p. 130). In terms of contributions to the field of futures and foresight studies and the Delphi method, RQ III is comparable to RQ II and makes complementary contributions.

Overall, research papers II and III of this dissertation not only intend to answer RQs II and III, but they also aim to make methodological contributions to the Delphi method, which will be outlined in more detail in the following.

1.3 Research Methodologies and Datasets

Three papers address the present research questions. All of them contribute to answering the overarching guiding research question – the impact of technology on sports and sports management in the future – but are unique in their way and need to be examined separately.

Paper I is conceptual and proposes a taxonomy of sportstech consisting of a definition of sportstech and the SportsTech Matrix. For Paper I to address RQ I, a taxonomy provides a valuable tool that allows classifying multifaceted phenomena into a posteriori categories,

resulting inductively from analysis (Rich, 1992). These categories ideally center on the properties of the specific objects or topics they represent, respectively, "so the categories are both exhaustive and mutually exclusive" (Fiedler et al., 1996, p. 12). A taxonomy is particularly valuable in emerging and developing research fields as the nature and number of categories are not predetermined and it can start from experience and expertise (Fiedler et al., 1996). Most importantly, the taxonomy needs to "mirror the real world" (Rich, 1992, p. 777) and not only function under controlled conditions, which requires compatibility with the views of both researchers and practitioners. Paper I builds on a review of relevant literature in sportstech (Balmer et al., 2012; Dyer, 2015; Fuss et al., 2008; Ratten, 2016, 2017, 2019; Schmidt, 2020b), an assessment of existing frameworks from both academia and practice (Agarwal & Sanon, 2016; Australian Sports Technologies Network, 2020; Colosseum, 2019; HYPE, 2020; leAD, 2020; Malhotra, 2019; MarketsandMarkets, 2019; Penkert, 2017; SportsTechIreland, 2020; Wylab, 2020), and current developments in the sportstech ecosystem (Agarwal & Sanon, 2016; Bertram & Mabbott, 2019; Fuss et al., 2008; Penkert & Malhotra, 2019a, 2019b). It also builds on existing definitions for sports (Council of Europe, 2001; Guttmann, 1978; Jenny et al., 2017; Sportaccord, 2011; Suits, 2007) and technology (Bain, 1937; Khalil, 2000; Rogers, 2003; Van De Ven & Rogers, 1988) as well as sportstech (Loland, 2009) to derive a proposal for an allencompassing definition of sportstech. To provide a comprehensive understanding, Paper I also sheds light on the characteristics, developments, and dynamics of the sportstech industry. Paper I lays the foundation for the subsequent two empirical papers.

For papers II and III, Delphi-based prospective studies were conducted to gather data, as Delphi is a proven and appropriate method for examining future developments of entire industries (Förster, 2015; Kluge et al., 2020; Merkel et al., 2016; Schuckmann et al., 2012; von Briel, 2018). Delphi is a well-established and powerful research method for the investigation of complex topics that can benefit significantly from qualitative insights that complement quantitative data "to unearth richness in tacit knowledge to help the research understand subtle expert opinion" (Grisham, 2009). The method enables effective group discussions among subject matter experts (Belton et al., 2019; Linstone & Turoff, 2011). I used a real-time format of Delphi (Gnatzy et al., 2011; Gordon & Pease, 2006) and followed the latest methodological and technical papers, including Beiderbeck et al. (2021b) and Schmalz et al. (2021), to ensure a rigorous application of the research method. For Paper II, 92 subject matter experts from 30 different countries and heterogeneous backgrounds responded to six Delphi projections and 35 non-Delphi prospective survey items. For Paper III, 117 subject matter experts from 27 countries and heterogeneous backgrounds responded to five Delphi projections and 50 non-Delphi prospective survey items. Data were collected in 13 weeks between November 2020 and February 2021 for Paper II and eight weeks in September and October 2020 for Paper III, which corresponds to regular Delphi survey durations (Kluge et al., 2020). For the execution of the Delphi surveys, Surveylet software was used as recommended by Aengenheyster et al. (2017).

The results of both Delphi-based prospective studies were assessed with a large variety of statistical methods and analyses, including descriptive analysis (Förster & von der Gracht, 2014; Häder, 2009), dissent analysis (Warth et al., 2013), and sentiment analysis (Beiderbeck et al., 2021b; Loye, 1980; Spickermann et al., 2014). In addition, for both papers, a scenario analysis was conducted based on the Delphi results (Nowack et al., 2011) to structure the evaluation of results (Tapio et al., 2011). Structure in the data was detected with two distinct cluster algorithms: Hierarchical clustering using Euclidean distance and ward method (Kaufman & Rousseeuw, 2009; Murtagh & Legendre, 2014; Ward, 1963) and fuzzy c-means clustering (FCM) (Roßmann et al., 2018). In addition, confirmatory factor analysis (CFA) following Homburg and Giering (1998) with established threshold values (Anderson & Gerbing, 1988; Bagozzi & Yi, 1988; Homburg & Giering, 1998) was used to assess measurement reliability and construct validity of the constructs that were used in the sentiment analyses. The statistics software R Studio was used for all analyses.

1.4 Outline and Abstracts

1.4.1 Outline

The structure of this dissertation is visualized in Figure 1.1 and builds on three stand-alone research papers. Section 1 introduces the dissertation project, including the abstracts of the three papers. These papers are then individually presented in sections 2 to 4. Finally, Section 5 offers an overarching conclusion of this dissertation project, building on the findings of all three papers, addressing implications for both academia and practice, and suggesting directions for future research.

Figure 1.1 Structure of the Dissertation.

	Introduction
Section 1	Background and Motivation Research Questions and Theoretical Contribution Research Methodologies and Datasets Outline and Abstracts
Section 2	Paper I Taxonomy of Sportstech
Section 3	Paper II The Impact of Technology on Sports – A Prospective Study
Section 4	Paper III The Impact of Technology on Sports Management – A Prospective Study
Section 5	Conclusion Summary of Findings Research Contributions Future Research Directions

The Future of Sportstech

1.4.2 Paper I: Taxonomy of sportstech

In this paper, the authors provide a snapshot of the opportunities, challenges, and development of the sportstech industry and propose a sportstech taxonomy comprised of the definition of sportstech and the SportsTech Matrix. Their goal is to provide a common understanding and a useful tool for researchers and practitioners alike. In so doing, they define sportstech based on an established understanding of sports and technology, introduce the SportsTech Matrix, and exemplify how to apply it with use cases for a variety of stakeholders. The SportsTech Matrix provides an all-encompassing structure for the field of sportstech along two angles: the user and tech. Together, the two angles capture how different types of technologies provide solutions to different user groups.

This paper is co-authored by Prof. Dr. Sascha L. Schmidt, Daniel Beiderbeck, Benjamin Penkert, and Prof. Brian Subirana and has been published as a book chapter in 21st century sports (Frevel, Schmidt, et al., 2020). The SportsTech Matrix has been further explained and applied in a paper focusing on information technology in the journal 'Wirtschaftsinformatik & Management' (Frevel, Beiderbeck, et al., 2020). This latter paper is co-authored by Daniel Beiderbeck, Prof. Dr. Sascha L. Schmidt, and Benjamin Penkert; it is not part of this document.

1.4.3 Paper II: The Impact of Technology on Sports – A Prospective Study

Rapid technological progress and digitalization have considerably changed the role of technology in sports in the past two decades. As the human limits of performance have been reached in many disciplines, reaching future limits will increasingly depend on technology. While this represents progress in how athletes train and compete, similar developments await sports managers in the way they lead sports organizations and sports consumers in the way they consume and engage with sports. Using the SportsTech Matrix to guide our research, we examine how technology will impact sports in the future. We present a Delphi-based prospective study with quantitative and qualitative assessments from 92 subject matter experts for six future projections and 35 non-Delphi prospective survey items. We find that, by 2030, technology will significantly impact all three user groups in sports: athletes, consumers, and managers. To provide meaningful insights, we derive and discuss two possible future scenarios:

(1) a probable future and (2) a game changer. Our findings should provide relevant insights for decision-makers and other stakeholders in sports and raise promising directions for future research.

This paper is co-authored by Daniel Beiderbeck and Prof. Dr. Sascha L. Schmidt and has been published as an article in the peer-reviewed journal Technological Forecasting and Social Change (Frevel et al., 2022).

1.4.4 Paper III: The Impact of Technology on Sports Management – A Prospective Study

Today, essentially all aspects of sports are influenced by technology. So far, most scientific investigations have focused on how technology affects the way athletes compete and train or how fans consume and engage. Existing work has mostly neglected the role of sports managers - decision makers in an often-underestimated industry with millions of jobs and billions of followers. Building on management theory, we systematically examine how technology will impact the roles and functions of sports managers in the future. We present a Delphi-based prospective study asking 117 subject matter experts for a quantitative as well as qualitative assessment of five future projections. To gain additional and broader insights, we retrieved the experts' input on 50 prospective survey items. We find that the role of sports managers will significantly change and that many of their tasks will be altered by technology in the future. Sports managers will not be replaced. Managerial functions such as leading, inspiring, and empowering are yet too complex for technology to perform, at least for the foreseeable future. To maintain a competitive edge in the future, sports managers need to increasingly shift their attention to tasks that require human skills and rely more heavily on technology for other tasks. We identify various potential future developments to contribute to the scientific discussion and to provide guidance for decision-makers.

This unpublished working paper is co-authored by Prof. Dr. Sascha L. Schmidt and Ben Shields, PhD, and has been submitted to Harvard Business Review (Frevel et al., n.d.).

2 Paper I: Taxonomy of Sportstech²

2.1 Introduction

The sports industry at large has seen exceptional growth over the past decades, and it continues this development at a remarkable pace. According to the European Parliament, sports' impact on the economy and society amounts to almost 3% of EU gross value added and over seven million people have sports-related jobs – 3.5% of total EU employment (Katsarova & Halleux, 2019). As it grew, the sports industry matured and professionalized in an unprecedented way. Throughout development, innovation in sports technique and equipment has always played a decisive role: In sports, a fraction of a second can make the difference between winning and losing; and innovation and technology can often be the distinguishing factor. Examples of the innovations that have sustainably altered their sport in a disruptive way are manifold – some can even be described as Schumpeterian³. For example, the invention of the Fosbury flop allowed a mediocre athlete, Richard Fosbury, to clinch an Olympic gold medal (van Hilvoorde et al., 2007); the introduction of the forward pass made American Football a much safer sport (Oriard, 2011); and Jan Boklöv's transformation of ski jumping from skis held in a V-shape instead of in parallel allowed for both longer and safer jumps (Virmavirta & Kivekäs, 2019).

Today, many athletes have perfected their technique to an extent that leaves little room for improvement from an athletic point of view. If we look at the 100 meters, it is hard to imagine that anyone will ever sprint much faster than Usain Bolt's astonishing 9.58 seconds, given the natural limitations of the human body (Nevill & Whyte, 2005). In most professional sports, the

² Frevel, N., Schmidt, S. L., Beiderbeck, D., Penkert, B., & Subirana, B. (2020). Taxonomy of Sportstech. In S. L. Schmidt (Ed.), 21st Century Sports. Springer.

³ A "Schumpeterian innovation is primarily radical and disruptive in nature" (Galunic & Rodan, 1998, p. 1194). According to Schumpeter, "developments [= innovations] are new combinations of new or existing knowledge, resources, equipment and the alike" (Schumpeter, 1934, p.65).

rate of performance improvement has stagnated and we see a plateauing of performance and records (Berthelot et al., 2008, 2010; Nevill et al., 2007). Linear performance improvements in the 20th century, as discussed by Whipp and Ward (1992)⁴, are a thing of the past; "sport performance may cease to improve during the 21st century" (Berthelot et al., 2010). Lippi et al. (2008, p. 14) found that "future limits to athletic performance will be determined less and less by innate physiology of the athlete and more and more by scientific and technological advances and by the still evolving judgment on where to draw the line between what is 'natural' and what is artificially enhanced." In their paper, Balmer et al. (2012) discussed the various mechanisms⁵ that have historically led to better performance and argued that technology will be necessary for any significant gain in the future.

In their perpetual pursuit of records and better performance – Citius, Altius, Fortius⁶ as the Olympic motto proclaims – athletes will increasingly depend on advances in sportstech (Dyer, 2015). While technology-driven progress in performance could already be observed in the past, it will be of paramount importance in the future. Performance in many sports has seen improvements through technology, for example, cycling, the 100 meters, the javelin, and the pole vault (Balmer et al., 2012; Haake, 2009), long jump, high jump, triple jump (Balmer et al., 2012), amputee sprinting (Dyer, 2015), and swimming (Foster et al., 2012; Stefani, 2012), to name but a few. As these examples suggest, application of technology was limited to only a few aspects of sport such as improving athletes' immediate performance. However, we have seen a significant change in recent years. Technology now affects nearly all aspects of sports: how athletes compete and train, how fans consume and engage, and how managers run their organizations. Advanced materials, data-driven solutions, and information and communication

⁴ Whipp and Ward (1992) demonstrate that the world record progression in standard Olympic events ranging from 200 meters to marathon is linear throughout the 20th century.

⁵ These mechanisms include "increased participation, professionalization (of participants and coaches), natural selection, improved training, nutrition and psychological preparation, advances in technique, and technological innovation in the design of equipment and ergonomic aids" (Balmer et al., 2012, p. 1075).

⁶ Latin for faster, higher, stronger.

technologies such as augmented reality are the new sources of competitive advantage. Sportstech has evolved from a niche topic to a key component in sports. As a consequence, the sports ecosystem is ever more complex and increasingly reliant on advanced technologies (Fuss et al., 2008).

Sportstech embraces a lot more than elite athletes' pursuit of sportive perfection. It is an emerging industry that is taking shape. No longer limited to the aspects discussed above, sportstech today is a creative force that has spawned a host of new: new sports like drone racing and esports, new ways of fan engagement like betting and fantasy sports, new ways of sports consumption through augmented reality, and new ways to manage sports organizations through big data analytics. Sportstech is not restricted to the elite athlete; the wider or mass audience is the target of tracking devices and fitness applications, for example.

Meanwhile, the sportstech venture scene has gained significant momentum. Investors have realized the potential of sportstech as a promising market for venture investing; cumulatively, more than 12 billion USD were invested in sportstech between 2014 and 2019 (Penkert & Malhotra, 2019b). Simultaneously, the number of startups operating in this area has increased rapidly and established corporates such as Intel or Comcast have also heavily invested into sportstech solutions (cf. Ogus, 2020). An entire sportstech ecosystem has developed with numerous accelerators, hubs, and venture funds. In 2018, the sportstech market was valued at 8.9 billion USD and estimated to reach 31.1 billion USD by 2024 (MarketsandMarkets, 2019).

Developments in the sportstech industry have caught the attention of scholars as well. The increase in analyses of individual areas of sportstech highlights the relevance of this field of research and the potential as its own stream of research⁷ (cf. Ratten, 2018). However, there is a lack of overarching taxonomies, frameworks, models, and guidelines for sportstech (cf. Ratten,

⁷ The number of publications on Google Scholar for the keyword "sportstech" has increased from 25 in 2010 to 114 in 2019, an increase of more than 450% (see Scholar PLOTr; https://www.csullender.com/scholar/).

2017). Such structuring elements are needed to foster research that can inform the relevant stakeholders – from researchers to athletes, fans, and management as well as owners and investors. To fill this gap, we propose a sportstech taxonomy⁸ (see Figure 2.1), which includes the definition of sportstech and a SportsTech Matrix; the overarching goal is to establish a shared understanding of the term sportstech and to guide the investigation of the intersection between sports and technology.





Note. Frevel, Schmidt, et al. (2020).

In the next section, we develop a definition that captures the meaning, use, function and essence of the term 'sportstech', building on commonly used definitions for sports and technology. We will then review the characteristics and developments of the sportstech industry, before introducing the SportsTech Matrix and providing examples of how it can be used by both researchers and practitioners. Finally, we will conclude this chapter.

⁸ A taxonomy is an approach to classification that groups subjects into a posteriori categories that inductively result from analysis (Rich, 1992). That is, a taxonomy's categories are based on the characteristics of their respective subjects, "so the categories are both exhaustive and mutually exclusive" (Fiedler, Grover, & Teng, 1996, p. 12). In contrast, in a typology, categories are defined a priori and subjects are deductively assigned to these categories. Thus, "typologies and taxonomies represent two fundamentally different approaches to classification" (Fiedler et al., 1996). Taxonomies are particularly useful for unexplored fields of study as both the number and nature of categories are not preordained. Developing a taxonomy typically includes multiple steps from defining classification criteria and categorizing items to evaluating the resulting categories. For new phenomena, a taxonomy may start from experience and expertise, while at some point it needs to result in emergent theory (Fiedler et al., 1996). In addition, it is very important that the taxonomy "mirror[s] the real world" (Rich, 1992, p. 777), that is, its categories and subjects must be identifiable by researchers and practitioners and it must be compatible with their views. As a result, our suggested taxonomy is predominantly based on experience and expertise, however, we largely built on the pre-existing and tested SportsTech Framework and evaluated the resulting categories against the current largest sportstech database, SportsTechDB (Penkert & Malhotra, 2019).

2.2 Defining Sports, Technology, and Sportstech

Before diving into the characteristics of the sportstech industry, we provide clear definitions of sports and technology, respectively, and a definition of sportstech.

2.2.1 The Definition of Sports

Defining sports in a way that everyone would agree on is far from easy and anything but trivial.⁹ If you agree with Nike Co-Founder Bill Bowerman, then "if you have a body, you are an athlete" (cf. Nike, 2020). However, to separate sports from other leisure or professional activities varies by source and largely depends on the perspective. That is, answering what qualifies and what does not qualify as a sport may differ significantly among medical, societal, ethical, and other considerations¹⁰. Two definitions that have been seminal in this field stem from sport sociology (Guttmann, 1978) and sport philosophy (Suits, 2007). Jenny et al. (2017), for example, have received much attention for their work on esports and the definition of sports. Building on the definitions of Guttmann and Suits, they provide an overview of the characteristics of sport, according to which a sport must (i) "include play (voluntary, intrinsically motivated activity)," (ii) "be organized (governed by rules)," (iii) "include competition (outcome of a winner and loser)," (iv) "be comprised of skill (not chance)," (v) "include physical skills (skillful and strategic use of one's body)," (vi) "have a broad following (beyond a local fad)," and (vii) "have achieved institutional stability where social institutions have rules which regulate it, stabilizing it as an important social practice" (p. 5).

Outside of academia, a clear definition of sports is relevant in many regards. Beyond the interest of billions of people as a popular pastime, sport has strongly grown in societal and economic significance. As a result, increased importance has been given to sports policy and

⁹ The definition of sports can, however, have severe consequences for certain stakeholders, for example, when it comes to federation's qualification as a sport federation (e.g., consider drone racing) or access to funding available to sports (e.g., consider esports). Given technological, societal, etc. advancements today, the need for a refinement of the definition of sports might become necessary.

¹⁰ For example, esports might not be considered a sport given its potential lack of physicality; and some forms of martial arts might not be considered a sport given their potentially harmful nature (cf. Sportaccord, 2011).

the matter has been pushed higher up the European Union (EU) agenda (Katsarova & Halleux, 2019). The EU follows a definition of sport developed by the Sports Charter of the Council of Europe where "sport means all forms of physical activity which, through casual or organized participation, aim at expressing or improving physical fitness and mental well-being, forming social relationships or obtaining results in competition at all levels" (*Recommendation No. R (92) 13 Rev of the Committee of Ministers to Member States on the Revised European Sports Charter*, 2001). Another interesting perspective to this discussion comes from the Global Association of International Sports Federations which aims at providing a "pragmatic description of activities which could be considered as a sport" (Sportaccord, 2011). Following their definition, sport "should have an element of competition, [...] in no way be harmful to any living creatures, [...] not rely on equipment that is provided by a single supplier, [... and] not rely on any 'luck' element specifically designed into the sport" (Sportaccord, 2011). While some elements of this definition overlap with Jenny et al. (2017), other elements such as the explicit mentioning of no harm to living creatures differ.

For the purpose of deriving a sportstech taxonomy, we follow the definition of Jenny et al. (2017) as it is based on widely accepted definitions from scholars like Guttman (1978) and Suits (2007) and, in our view, captures the most comprehensive and succinct meaning of sports.

2.2.2 The Definition of Technology

The term technology is widely used, however, there are different levels of understanding among scholars, practitioners, and even philosophers. Earlier definitions of technology focused much more on physical tools, machines, and devices as well as the required skills to use them (Bain, 1937). Over time, less tangible facets such as knowledge, methods, and procedures were included; and definitions focused on the application of that knowledge in the provision of goods and services (Khalil, 2000). Similarly, Van De Ven and Rogers (1988) defined technology as "knowledge that is contained within a tool for accomplishing some function; the tool may be a

mental model or a machine" (p. 634). For the purpose of developing a taxonomy of sportstech, we build on the commonly used definition from Rogers' Diffusion of Innovation Theory (Rogers, 2003):

"A technology is a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome. A technology usually has two components: (1) a hardware aspect, consisting of the tool that embodies the technology as a material or physical aspect, and (2) a software aspect, consisting of the information base for the tool."

This definition embodies all relevant facets of technology. It is not too narrow as to exclude certain types of technology and at the same time it clearly states the purpose of technology in achieving a desired outcome and its instrumental role in that process. It also addresses hardware and software, which can be technology independent, but are usually both part of a given technology.

2.2.3 The Definition of Sportstech

Sports and technology have been intertwined for hundreds of years, but the term sportstech reached its current prominence only in the past few years. Previously, technology in sports had a mostly constitutive function; for many sports (e.g., skiing, cycling, ice skating¹¹), technology is a necessary condition to exist at all (Loland, 2009). As health and safety concerns gained increasing attention, technology played a significant role in protecting athletes against harm and injuries (Waddington & Smith, 2000). These technologies range from the obvious, helmets and protective gear, to the more imperceptible, like shock-absorbing soles. Over time, technology was increasingly used to improve athletic performance, both during competition and in training. Examples include training machines such as treadmills, wind tunnels to improve

¹¹ For example, ice skating may have been a sport for as long as people have inhabited Finland. There is evidence of bone skates 5,000 years ago and of bone implants as far back as 10,000 years ago (Choyke & Bartosiewicz, 2006; Hines, 2006).

aerodynamics, biochemical means of performance-enhancement, or drag-reducing, high-tech swimwear fabrics that resulted in the setting of over 130 swimming world records in 2008 and 2009 (Crouse, 2009; Tang, 2008).¹²

A broad definition—that we agree with—comes from Loland (2009, p. 153); he defines sport technology as "human-made means to reach human interests and goals in or related to sport." Similarly, we understand sportstech as the intersection of sports and technology. When technology provides a solution in the larger sphere of sports, we consider it sportstech. Therefore, beyond the athlete-focused aspects discussed above, sportstech also includes areas such as broadcasting, ticketing, sponsoring, digital media, smart venues, and fan engagement. It has also significantly aided adherence to the rules and officiating of sports through, for example, the shot clock in basketball, the hawk eye in tennis, the video assisted referee and goal line technology in football, and the photo finish in many sports (cf. Kolbinger & Lames, 2017).

As the sector could benefit from a consistent use of terminology, we would also like to provide our view on the spelling of sportstech. Multiple versions still exist including sportstech, sports tech, sporttech, sport tech, sportstechnology, sports technology, sporttechnology, and sport technology. We advocate for the universal use of 'sportstech'. We chose 'sports' over 'sport' as it better reflects the notion of all sorts of sports instead of an individual sport. And, we chose the spelling 'sportstech' rather than 'sports tech' following other tech industries such as fintech, medtech, biotech, edtech, agritech, foodtech, cleantech, greentech, etc.

Finally, we wish to emphasize that sportstech is by no means a new phenomenon, it has been around for centuries. However, the term gained significant attention and popularity over the

¹² Technology as it is applied in sports often operates on a fine line between what is considered fair competition and doping. For example, high-tech swimwear fabrics have been banned from the sport while goggles are still allowed, even though when used for the first time during the 1976 Olympics they resulted in a similar waterfall of broken world records (Tang, 2008).

past couple of years and has diversified to accommodate the different needs and wants of a broadened stakeholder base (Fuss et al., 2008).¹³

2.3 The Sportstech Industry

The sportstech industry has experienced and is expected to experience exceptional growth with a compound annual growth rate of more than 20% between 2018 and 2024; this means growth from 8.9 billion USD in 2018 to 31.1 billion USD in 2024 (MarketsandMarkets, 2019). Some forecasts are even more optimistic, valuating the sportstech industry at 27.5 billion USD in 2018 with estimates as high as 93.8 billion USD by 2027 (Bertram & Mabbott, 2019). The industry's growth is also reflected in venture investing whereby more than 12 billion USD were invested between 2014 and 2019 (Penkert & Malhotra, 2019b). While the world's largest companies were not very active in sportstech as recently as a decade ago, they are now entering the space at an increasing pace. For example, the Global Sports Innovation Center powered by Microsoft (GSIC) connects the sports industry to innovation through networking, research, showcasing, and supporting startups (Global Sports Innovation Center, 2020). SAP built its own sports and entertainment unit that supports clients to "transform traditional methods in athlete management, scouting, health, fitness, training, development, game execution, and compliance through digital transformation" (SAP, 2020). There is an ongoing paradigm shift as corporates start to realize that sportstech holds great potential for them (cf. Ogus, 2020).¹⁴

One of the key contributors to this paradigm shift is digitalization. Many industries and markets have been disrupted by technologies and digital transformation (Verhoef et al., 2019). These changes occur on various levels from changing consumer demands (cf. Lemon &

¹³ When Adi Dassler upgraded football boots with studs, that was an early form of sportstech. Of course, the nature of most sportstech solutions has changed over time; when we talk about sportstech today, we are more likely to think of a machine learning algorithm that helps Formula 1 teams predict race strategy outcomes than of football boots.

¹⁴ This paradigm shift is intensified as the increasing combinations and intersections of business models create new and highly complex environments. Just as automotive industry incumbents fear Google or Apple as market entrants, many broadcasting incumbents in the sports industry fear Amazon or Facebook as potential entrants.

Verhoef, 2016) to digital attackers that disrupt less digitally-advanced companies (Goran et al., 2017). Some examples, such as Spotify (cf. Wlömert & Papies, 2016) or Netflix (cf. Ansari et al., 2016), are well known. Like any other industry, the sports industry is not immune to these developments, despite its rather traditional characteristics. Sportstech could particularly benefit from these developments; many sportstech companies build their ventures on digitalization and are thereby more likely to be the driver of change in sports rather than the object of change.

Despite the variety of opportunities for sportstech, there are still many challenges that need to be overcome as they are potential barriers to growth. The sportstech industry is still very fragmented in many regards—geography, talent and skills, access to funding, and so on (cf. Proman, 2019b). In addition, the adoption of technology in the sports industry remains an issue and is often rather ad hoc than strategic¹⁵; thus, technology does not contribute to competitive advantage as much as it could. One of the main reasons for low technology adoption rates is the lack of (access to) talent and skills (Bertram & Mabbott, 2019). According to a survey among more than 100 sportstech experts¹⁶, the main factors holding back the adoption of sportstech are "unqualified decision makers, risk aversion, and cost" (Proman, 2019a). With respect to sportstech venturing, many startups and ventures experience difficulties with funding, as access to funding is very limited particularly for early stage startups (Bertram & Mabbott, 2019). In addition, startups often lack access to other resources (e.g., talent) and relationships or networking opportunities with the right people in the industry (Ogus, 2020). Finally, sportstech protagonists could benefit from an intensified collaboration with universities and other research institutes. So far, it is to navigate industry-leading research in sportstech (Bertram & Mabbott, 2019).

¹⁵ For example, many professional football clubs still consider technology as "nice to have" rather than a strategic imperative (Raveh & McCumber, 2019). According to a survey conducted by PwC among more than 500 sports leaders across 49 countries about the role of innovation in sports organizations, the majority of sports organizations do not have concrete innovation strategies in place (PwC, 2019).

¹⁶ Experts included founders, investors, and industry professionals in sportstech (Proman, 2019a).

The developments in sportstech also present associations, leagues, and clubs with major challenges. They are responding in multiple ways. Many of them have already set up centers of expertise to make rapid progress in sportstech and to make the best possible use of the opportunities that arise. Examples of such centers include UEFA Innovation Hub, DFB Academy with its recently established Tech Lab, Barca Innovation Hub, or Real Madrid Next. An alternative way to engage with sportstech is through startup competitions such as LaLiga Startup Competition, Werder Lab, City Startup Challenge, and EuroLeague Basketball's Fan Experience Challenge and through accelerator programs such as the 1. FC Köln HYPE Spin Accelerator. There are also approaches that focus more on strategic partnerships and investments in sportstech startups such as DFL for Equity.

Regarding investors, several interesting trends can be identified. First, there is an increasing emergence of sportstech-specific investors such as Sapphire Sport (with City Football Group as anchor investor), Courtside Ventures, Elysian Park Ventures, Causeway Media Partners, and SeventySix Capital. They are mostly equipped with smaller funds¹⁷ and tend to participate in earlier rounds of funding. Despite increasing activity from sportstech-specific investors and their notable investments including unicorn candidates Strava, Tonal, and Zwift, the sportstech industry could benefit from more dedicated funds to generate even more growth from within the industry (Penkert & Malhotra, 2019b). Second, more and more industry-agnostic investors have gained interest in sportstech, including some of the world's leading investors such as Accel, Andreessen Horowitz, Sequoia, Softbank, and Tencent. So far, their activity has proven to be successful with unicorn startups such as Peloton, DraftKings, FanDuel, Hupu, and Dream11 (Penkert & Malhotra, 2019b). A continued influx of such high-profile investment companies is needed to develop the industry further and increase the overall funding. Third, athletes are taking stakes in the space with their own funds or investment companies (cf.

¹⁷ For example, Sapphire Sport launched a 115 million USD venture fund to invest in sports and technology in early 2019 (Ogus, 2019) and Courtside Ventures initiated a 35 million USD fund in 2016 (Heitner, 2016).
Bloomberg, 2019). Examples include Serena Williams' Serena Ventures, Kevin Durant's 35 Ventures, and Aaron Rodgers' RX3 Ventures (Abraham, 2019). Athletes pursue different strategies to grow their wealth to prepare for life after sports. Next to their financial investment, athletes typically bring additional benefits to the cap table such as their network and their social media following (Rooney, 2020).

Although sportstech has gained significant relevance in business practice, there is surprisingly little research on sportstech in the academic literature (Ratten, 2017). Most of the existent scientific work is fragmented and has a very specific focus like sports innovation (Ratten, 2016; Ringuet-Riot et al., 2013; Tjønndal, 2017) or comes from adjacent disciplines such as brand management (cf. Pradhan et al., 2020), biomechanics (cf. Magalhaes, Vannozzi, Gatta, & Fantozzi, 2015), and ethics (cf. Evans, McNamee, & Guy, 2017). A systematic review that examines sportstech in its entirety is certainly missing. Existing literature reviews focus on individual aspects such as ethics of sportstech (e.g., Dyer, 2015), statistical analysis in sports (e.g., Sidhu, 2011), integrated technology¹⁸ and microtechnology sensors in team sports (e.g., Cummins et al., 2013; Dellaserra et al., 2014), machine and deep learning for sport-specific movement recognition (e.g., Cust et al., 2019), human motion capture and tracking systems for sport applications (e.g., Barris & Button, 2008; van der Kruk & Reijne, 2018), augmented reality and feedback strategies in motion learning (e.g., Sigrist et al., 2013), ubiquitous computing in sports (e.g., Baca et al., 2009), artificial intelligence in the analysis of sports performance (e.g., Lapham & Bartlett, 1995), or practice-enhancing and human enhancement technologies (e.g., Farrow, 2013; Miah, 2006).¹⁹ In addition, many reviews focus more on practically relevant themes such as illustrating the latest technological developments. Exemplary works of this type look at virtual environments for training in ball sports (e.g., Miles et al., 2012) and data collection and processing technologies (Giblin et al., 2016).

 ¹⁸ Integrated technology refers to accelerometers, global positioning systems (GPSs), and heart rate monitors.
 ¹⁹ These are a few exemplary reviews from different fields of research; the enumeration is not exhaustive.

2.4 The SportsTech Matrix

We develop the SportsTech Matrix as part of our taxonomy to provide an all-encompassing structure and a common understanding for the field of sportstech. It is intended to help both researchers and practitioners alike, even though their respective use of the matrix might differ. At its core, the SportsTech Matrix consists of two angles: a user angle and a tech angle. For the user angle, we rely on a framework from Penkert (2017, 2019) and Malhotra (2019). It involves three different user groups that are relevant in sports: athletes, consumers, and management. For the tech angle, we developed a categorization of technologies suitable for capturing sportstech. Together, these two angles capture how different types of technologies provide solutions to different user groups in the realm of sports. Please refer to Figure 2.2 for an overview of the SportsTech Matrix.

User angle			
Tech angle	Athletes	Consumers	Management
Advanced materials, sensors, devices, internet of things, and biotech			
Data, artificial intelligence, and machine learning			
Information, communication, and extended reality			



Note. Frevel, Schmidt, et al. (2020).

2.4.1 User Angle

The user angle of our SportsTech Matrix builds on the SportsTech Framework (see Figure 2.3) by Malhotra (2019) and Penkert (2017, 2019), which is based on the review of thousands

of sportstech startups.²⁰ The framework is structured along the main user groups in sports and has the following three dimensions: activity and performance, fans and content, and management and organization. Analogously, we consider three different user groups in our SportsTech Matrix: (i) athletes, (ii) consumers, and (iii) management. These user groups are both exhaustive and mutually exclusive, that is, any user in sports belongs to one of these three user groups. The user angle captures the group of users that benefits from a certain sportstech solution²¹. It is important to note that these users are mutually exclusive even though one and the same person can be an athlete and a consumer and a manager in the realm of sports. However, in our matrix logic, a person can only represent one of these user groups at a time. At the same time, a sportstech solution will typically only address that user in one of the three user group roles. There are certainly solutions that target, for example, both athletes and consumers, however, they typically have different features for each group. We describe the three user groups below.

Figure 2.3	SportsTech	Framework.
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Nearables & Equipment	Performance Tracking & Coaching	Preparation	Organisations & Venues
Wearables	Activity Data	Tutorials & Training	Team / Club Management
Game Equipment	Video Analytics	Injury Prevention & Rehabilitation	Scouting & Recruitment
Infrastructure	Coaching	Booking & Matchmaking	Stadium Management
			League / Tournament / Event Manage
& Content			
& Content	Fan Experiences & Social Platforms	Fantasy Sports & Betting	Media & Commercial Partner:
& Content News & Content	Fan Experiences & Social Platforms	Fantasy Sports & Betting	Media & Commercial Partner
& Content News & Content News Aggregator	Fan Experiences & Social Platforms Fan Engagement	Fantasy Sports & Betting Betting	Media & Commercial Partner
& Content News & Content News Aggregator Original Content	Fan Experiences & Social Platforms Fan Engagement Ticketing & Merchandise	Fantasy Sports & Betting Betting Betting Enablement	Media & Commercial Partner Media Production Sponsorship
& Content News & Content News Aggregator Original Content OTT Platforms	Fan Experiences & Social Platforms Fan Engagement Ticketing & Marchandise Social Platforms	Fantasy Sports & Betting Betting Betting Enablement Fantasy Sports	Media & Commercial Partner Media Production Sponsorship Crowdfunding

Note. Malhotra (2019).

²⁰ The framework has been continuously refined over the past three years; it received notable revision in 2019 based on feedback and insights from SportsTechDB, a global sportstech database that provides market intelligence on the sportstech industry. In a similar approach, Agarwal and Sanon (2016, p. 1), suggest "a taxonomy of 12 different categories of companies that collectively constitute "sportstech," based on the clustering of 400 private companies in this field. Reverence# is missing

²¹ A solution can be any product, service, etc.

Athletes. This user group includes anyone who performs sports, no matter if it is on a professional, amateur, or even purely recreational level. It is not limited to any time period (e.g., one could differentiate before, during, or after an activity), but basically spans the entire life of an athlete. Typical applications where sportstech can provide value to athletes include training, preparation, skills, performance, recovery, injury (prevention), motivation, etc. Typical offerings include equipment, data trackers and (advanced) analytics, wearables, software applications, etc., but also solutions to find other players or venues and coordinate joint activities (cf. Malhotra, 2019).

Consumers. This user group includes anyone who consumes sports, which encompasses all possible ways of engaging with a sport without performing the sport oneself. Basically, it is about how fans interact with sports. For sportstech, the core proposition for this user group is the provision of access to sports content (e.g., broadcasting and media), which requires capturing, processing, and presenting the required information. It is not limited to the pure provision of content as it also includes data, analytics, and insights. Further, it includes means of fan engagement such as (social) platforms and networks that allow sports consumers to engage with athletes, teams, brands, etc. to build and manage relations (cf. Penkert, 2017).

Management. This user group comprises anyone who has any management or organizational role in the realm of sports. It ranges from sports executives who lead professional clubs to managers of much smaller sports facilities or any other sort of institution. This may include the management of associations, leagues, clubs, and teams. It may also include the management of events, venues, facilities, ticketing platforms, marketplaces, etc. (cf. Penkert, 2019). Beyond these more organizationally focused aspects, the management user group also contains all aspects of sport governance that relate to defining rules and regulation or any other boundary condition in the context of sports. In our SportsTech Matrix, any sportstech solution that is not focused on the athlete or the consumer, addresses this user group.

2.4.2 Tech Angle

The tech angle considers three different categories of technology in sportstech: (i) Advanced materials, sensors, devices, Internet of things, and biotech, (ii) data, artificial intelligence, and machine learning, and (iii) information, communication, and extended reality.²²

Our categorization results from a thorough evaluation of existing technology classifications. It is important to note that classifications, categorizations, and taxonomies for technologies are generally scarce, particularly from an industry-agnostic point of view. There appears to be no universal or generally accepted approach to divide technologies into different categories (Ellis et al., 2016). Existing classifications are typically limited to specific areas of technology such as information technology (cf. Fiedler et al., 1996; Zigurs & Buckland, 1998). By comparison, a rather technical classification comes from an European Commission-funded research project that identified systems, sensors, devices, and actuators as relevant technology types in a medical setting (Farseeing, 2013). Ho and Lee (2015) developed a typology of technological change with four different innovation types: incremental, modular, architectural, and discontinuous. Khalil (2000) has defined six categories to structure technology: new, old, medium, high, low, and appropriate. Similarly, technologies and innovation can be grouped in different levels such as incremental vs. radical (cf. Norman & Verganti, 2014) or exploitative vs. explorative (cf. O'Reilly & Tushman, 2013).

In the context of sports, exhaustive technology classifications are also scarce. MarketsandMarkets (2019) consider four technology categories in the sportstech market: device, smart stadium, esports, and sports analytics. The Australian Sports Technologies Network (ASTN) follows another set of four technology categories: (i) Advanced materials

²² Providing an exhaustive and mutually exclusive tech angle is difficult given the constant trade-off between increasing the number of categories (which would render the matrix less useful) and maintaining mutual exclusiveness. We consider these three categories reasonably exhaustive; that is, they allow for a classification of the technologies that are relevant in sportstech. We acknowledge that some sportstech solutions may belong to more than one technology category (e.g., a sportstech solution could consist of data capturing sensors and machine learning algorithms for data processing) in our SportsTech Matrix. In such cases, we would classify the solution in one category based on its core technology.

(e.g., fibers/textiles; composites; coatings, adhesives, elastomers), (ii) sensors and devices (e.g., advanced manufacturing; industry 4.0; IoT electronics), (iii) medical, health and biotech (e.g., biomechanics; sleep & recovery; nutrition/ethical/nutraceuticals), and (iv) information and communication (e.g., mobile/online; big data/analytics; VR/AR/betting/e-Sports) (Australian Sports Technologies Network, 2020). In addition, there are many similar structures of technology categorizations developed by various institutions such as sportstech accelerator and incubator programs. They often reflect similar technology categories like AR/VR, IoT, data analytics, wearable tech, and/or categories like fan engagement, sports performance and coaching, smart stadium, esports, or fantasy sports (cf. Colosseum, 2019; HYPE, 2020; leAD, 2020; SportsTechIreland, 2020; Wylab, 2020).

We find that all these classifications, typologies, categorizations, etc. have their merits, however, none of them is necessarily suitable to structure technologies in the realm of sports. Generalizable technology classifications appear to be rather difficult, if not impossible, to apply. This is partly because they do not rely on a set of general criteria defined in the realm of technology. Therefore, we contribute to closing this gap by providing a categorization of technologies that is useful in the context of sports. The consideration of technology categories is mostly focused on emerging and frontier technologies. However, it also includes other technologies that have the potential to play a major role in the future of sportstech (see Figure 2.4).

Advanced materials, sensors, devices, Internet of things, and biotech. This technology category is mostly about physical technologies (e.g., hardware). It includes technologies such as robotics, sensors, fibers, textiles, coatings, composites, etc. Many of these technologies play a key role in capturing data.

Data, artificial intelligence, and machine learning. This technology category is concerned with data handling and processing. It includes technologies in the realm of big data, advanced analytics, artificial intelligence, machine learning, etc.

Information, communication and extended reality. This technology category is about human interaction. It plays a particularly important role in sportstech (e.g., fan engagement) with technologies such as AR/VR/MR, voice, or mobile technologies in general.

Figure 2.4 Tech Angle Categories and Exemplary Technologies.

Advanced materials, sensors, devices, internet of things, and biotech	 Advanced/New materials Composites Coatings/ Adhesives/ Sealants/ Elastomers Fibers/ Textiles Wearables 	 Advanced manufacturing Digital fabrication 3D printing Robotics Automation Internet of things 	 Sensors Smart dust Chips Near-field communication Drones Biotech
Data, artificial intelligence, and machine learning	 Big data Synthetic data Cloud (Advanced) Analytics Artificial intelligence Machine learning 	 Blockchain Decentralized web Quantum computing Cognitive computing Computer vision 	
Information, communication, and extended reality	 Augmented reality Virtual reality Mixed reality Mobile 5G Applications 	VoiceAudioBots	

Note. Frevel, Schmidt, et al. (2020).

2.4.3 How to Use the SportsTech Matrix

The SportsTech Matrix can be used by both researchers and practitioners. Researchers can use the SportsTech Matrix to guide their investigation of the intersection between sports and technology. For example, the SportsTech Matrix can help to structure thinking and to identify potential 'white spots' that require examination. One potential white spot could be a lack of research on management. While athletes and consumers have received at least some academic attention in sportstech research, the management user group has mostly been neglected. A promising next step in research would be to map existent research on the SportsTech Matrix and explain any research areas that might emerge. This would reveal untreated or less researched phenomena and it would help to navigate industry-leading research in sportstech, which is still a challenge (Bertram & Mabbott, 2019). Further, researchers could use the SportsTech Matrix to identify promising ways to further integrate "theories from related disciplines including economics, engineering, and medicine" (Ratten, 2019, p. 2). This could be particularly useful along the tech angle categories of the matrix, as the application of research from other disciplines could lead to additional advancements in the use of technology in sports (cf. Ratten, 2019).

Practitioners can use the SportsTech Matrix in many ways, too; we will outline a few use cases here. First, the individual groups of the user angle themselves can use the matrix. Athletes could systematically assess which technologies they are already using and in which areas they could benefit from additional use of technology. For example, considering the three categories of the tech angle, an athlete might already use sensors to capture biometrical data, but they might lack the technological solutions in terms of data processing to make the best use of that data. Similarly, management could think about how to connect the individual categories of the tech angle to maximize value. For example, how can the technologies in use be best leveraged to improve performance: by capturing the most relevant data, providing valuable insights to coaching staff through improved data processing, or communicating interesting information to consumers to improve the fan experience? Consumers, in turn, are the least likely group to actively use the matrix; however, they could theoretically consider how they want to engage with athletes and sports and chose technology-enabled sports content accordingly.

Second, the SportsTech Matrix can be used by sportstech ventures and startups to develop a better understanding of the sportstech landscape and derive what need is addressed by their solution. To start, the SportsTech Matrix can serve as a reflection tool to choose the right business model. A wide range of viable business models can be observed in sportstech: B2B, B2C, B2B2C, peer-to-peer, SaaS, marketplaces, platforms, eCommerce, data licensing, and so

on. It is important to carefully consider different business models as they might significantly affect the scalability of the venture (cf. Lorenzo et al., 2018). Thus, sportstech ventures should carefully ask themselves which users they are targeting, and which technologies can best help them in that endeavor.²³ Another important use case for sportstech ventures and startups is examining the sportstech ecosystem. It consists of startups, accelerator and incubator programs, investors, events and awards, innovation hubs and labs, and many other initiatives and representatives. Looking at sportstech from an ecosystem perspective has many benefits including, but not limited to, the following: adapting strategies and business functions to opportunities and threats of emerging trends; gaining access to networks, identifying new customers, and exploiting new data sources by plugging into the ecosystem and the existing external capabilities; and benefiting from integration with the ecosystem through open, dynamic, and real-time interfaces (e.g., integrate payment or advertising solutions) to improve own products and services (Desmet et al., 2017). In addition, ecosystem perspectives can be used to represent "resource flows within, in and out of a given system" (Despeisse et al., 2013, p. 565). The SportsTech Matrix can facilitate the identification of relevant ecosystems in sportstech. For example, startups could identify technology ecosystems along the tech angle such as the blockchain ecosystem (e.g., Dhillon et al., 2017).

Third, investors could use the SportsTech Matrix to strategically invest and build a well thought out and better balanced sportstech portfolio. So far, if we consider the user angle, the majority of funding has gone into solutions for the consumer. Between 2014 and 2019, "51% of invested dollars went to [the] 'fans & content' sector'' (Penkert & Malhotra, 2019b, p. 11). The SportsTech Matrix will not answer the question on where to invest money, but it helps to get a better overview and identify opportunities for investments. For example, investors could analyze funding activity along the tech angle of the SportsTech Matrix and consider an

²³ It is worth mentioning that this not only applies to startups as business models are "essential to every successful organization, whether it's a new venture or an established player" (Magretta, 2002, p. 87).

investment portfolio that focuses on a certain type of technology that might benefit all three user groups in sportstech.

2.5 Summary and Conclusion

The sportstech industry has grown rapidly and is expected to continue this growth for the foreseeable future. This should not only lead to improved conditions for the different user groups in sports and sportstech (athletes, consumers, and management), but also attract large corporates, startups, and institutional investors to become more active in the field (Bertram & Mabbott, 2019, Penkert & Malhotra, 2019). However, as this emerging industry is taking shape it could benefit from more structure. This is why we have proposed a sportstech taxonomy consisting of a general definition of sportstech and the SportsTech Matrix – a 3x3 grid along the user angle and the tech angle. Our SportsTech Matrix shows how different types of technologies provide solutions to different user groups in the realm of sports.

The taxonomy should provide structure for the field and a common understanding. We aim to support both researchers and practitioners in the realm of sportstech to better handle the complexity of the sportstech industry and guide their activities at the intersection between sports business and technology going forward. Stronger ties between industrial and academic research could combine economics and engineering in the interest of sport. Therefore, it would be promising to initiate more research that is transdisciplinary and holistic in its approach.

True to the motto 'all models are wrong, but some are useful,' we hope that you find our taxonomy useful and a good starting point for any endeavors in sportstech.

3 Paper II: The Impact of Technology on Sports – A Prospective Study²⁴

3.1 Introduction

The role of technology in sports has drastically changed since the turn of the century in lockstep with technological advancements and digitalization across industries. Driven by the emergence of the Internet and mobile technologies, technology has become indispensable in many sports (Ratten, 2019). By playing "a vital role in becoming the best – on and off the pitch" (Schmidt, 2020a, p. ix), technology has contributed to making sport potentially more exciting and challenging than ever before. While sports was considered a leisure time activity for most of its history, the technology-driven internationalization and professionalization have led to enormous changes: fans and consumers can follow sports events and their favourite teams and athletes across the globe live or on-demand through digital technology or social media basically at any time (Ratten, 2011). Athletes have more sports than ever to choose from and are much less dependent on other players or restrictions. In their quest for better performance, they have also benefitted from technology. Human limits seem to be reached in many sports (Berthelot et al., 2008, 2010; Nevill et al., 2007; Nevill & Whyte, 2005), and "future limits to athletic performance will be determined less and less by innate physiology of the athlete, and more and more by scientific and technological advances" (Lippi et al., 2008, p. 14). In most professional sports, it is assumed that any significant gains in the future will depend on technology to some degree (Balmer et al., 2012). Of course, such developments and prospects raise a variety of ethical questions that have been addressed in the literature as well (Dyer, 2015; Evans et al., 2017; Karkazis & Fishman, 2017; Loland, 2005; Miah, 2005).

²⁴ Frevel, N., Beiderbeck, D., & Schmidt, S. L. (2022). The impact of technology on sports – A prospective study. Technological Forecasting and Social Change.

Technologization in sports affects not only athletes and consumers but also sport managers who face an increasingly complex industry to manage and compete in. Historically, sports had been governed and managed through a variety of primarily public or voluntary organizations with a limited number of professional or commercial institutions. Given the rapid advancements and growth in the sports industry over the past decades, the pressure to adopt market mechanisms has constantly increased (Misener & Misener, 2017). Earlier non-profit organizations now have to be managed like profit organizations and establish professional organizational structures and processes (Kikulis et al., 1995; Skirstad & Chelladurai, 2011). In this complex development process, a variety of additional difficulties and limitations associated with non-profit organizations have to be addressed, such as resource insufficiencies, paternalism (i.e., decisions and resource allocation follow the interests of those responsible or most influential), or amateurism (i.e., managerial roles and tasks are taken over by wellmeaning amateurs instead of qualified professionals) (Salamon, 1987). In addition, the globalization of sports poses challenges to sports managers ranging from a global flow of athletes to environmental impact and an increasing influence of international media corporates (Thibault, 2009). To manage this progress effectively, sports managers will continue to increasingly rely on technology (cf. Schmidt, 2020a), and their work will need to be guided by innovation and entrepreneurship (González-Serrano et al., 2017).

In sum, almost all aspects of sports and all its stakeholders have been affected by technology in the recent past. Given the high relevance in both social and economic terms, the purpose of this study is to understand better the possible role of technology in sports going forward. In summary, the research question can be expressed quite simply: How will technology impact sports in the short, medium, and long term? Looking at this in detail, we are trying to answer several questions: Will the influence of technology decrease, remain constant, or increase? Will all players in the industry be affected in the same way? Will certain categories of technology play a more significant role than others? What opportunities are emerging and how can they be realized? What are the risks and how can they be mitigated?

Given this broad research question, we use the SportsTech Matrix developed by Frevel et al. (2020) to structure our thinking and research. The SportsTech Matrix provides an allencompassing framework that captures the combination of technology and sports. For this purpose, all technologies relevant in sports are divided into three categories and all possible users of technologies in the sports context are divided into three groups. When put together, this allows to "capture how different types of technologies provide solutions to different user groups in the realm of sports" (Frevel, Schmidt, et al., 2020, p. 25).

In this research, we conducted a real-time Delphi study among 92 subject matter experts from 30 different countries and heterogeneous backgrounds. Given the prospective nature of our study, Delphi represents an ideal research method as it allows examining a rather broad and complex issue both quantitatively and qualitatively. The latter is essential as it allows to tap relevant but tacit knowledge that is difficult to achieve in other research methods (Grisham, 2009). Delphi is a proven method in examining prospective developments of entire industries (Förster, 2015; Kluge et al., 2020; Merkel et al., 2016; Schuckmann et al., 2012; von Briel, 2018). To facilitate an effective group discussion among the experts (Belton et al., 2019; Linstone & Turoff, 2011), we decided to use the real-time variant of the Delphi method (Gnatzy et al., 2011; Gordon & Pease, 2006). To ensure a rigorous application of the research method with the highest standards, we have followed state-of-the-art methodological and technical papers, including Beiderbeck et al. (2021b) and Schmalz et al. (2021).

3.2 Background

Depending on how it is defined, technology has always been of great importance in many sports. If technology is defined as "a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome" (Rogers, 2003, p.

13), then technology is at the root of most sports as a requirement for existence given its constitutive function (Loland, 2009). Over time, technology has evolved from a constitutive function to a differentiating factor in performance improvements (Balmer et al., 2012; Foster et al., 2012; Haake, 2009; Stefani, 2012) as well as health and safety (Beiderbeck et al., 2020; Bjerklie, 1993; Miah, 2006; Schlegel & Hill, 2020; Waddington & Smith, 2000). Similarly, it has constantly gained relevance in the officiating of sports and adherence to the rules in many sports (Kolbinger & Lames, 2017) with inventions such as video-assisted refereeing (Tamir & Bar-Eli, 2021), the hawk eye in cricket or tennis (Collins & Evans, 2011), goal-line technology in football (Winand & Fergusson, 2018), or instant replay (Vannatta, 2011). Some of these technologies not only serve better officiating and fairer competition, but they also represent exciting elements of sports consumption which has also been strongly affected by technology.

Overall, television was one of the most significant technological innovations for sports. With the maturation of television in the 1970s, an enormous dependency of sports on television (and vice versa) has emerged (Miah et al., 2020; Rowe, 1996; Whannel, 2014). Due to innovations such as mobile technologies, including smartphones and tablets, (mobile) Internet, or immersive technologies such as augmented reality and virtual reality, sports consumption has once again developed significantly in recent years and is expected to continue along this trajectory (Chan-Olmsted & Xiao, 2019; Hutchins, 2012, 2018; Miah et al., 2020; Pirker, 2020). Mobile and digital technologies are also among the most relevant technologies for sports managers as they may use them in almost all relevant business areas, including sponsorships (Dees, 2011), ticketing (Popp et al., 2021), or scouting (Mataruna-Dos-Santos et al., 2020).

Finally, it is worth mentioning that the impact of technology on sports is no unidirectional relationship but rather a reciprocal one. That is, sports also have an impact on technology, typically by posing new challenges that are then being addressed with technology. For example, motorsports have produced a whole series of technological advances such as turbocharging, all-wheel drive, or traction control that are nowadays used in our everyday vehicles (Siegel &

Morris, 2020). In machine learning and artificial intelligence, Chess has inhibited an important role as a natural testbed for innovations ever since Alan Turing created a chess computer program in 1948 (Hassabis, 2017; Heath et al., 1997).

3.3 Research Methodology

For this study, we used a mixed methods approach, including a Delphi study and 35 additional prospective survey items. For the Delphi study, we used a real-time format following approaches from Roßmann et al. (2018) and Beiderbeck et al. (2021b). To apply the Delphi method rigorously, we have been guided by numerous best practice papers in terms of methodical advice, including Beiderbeck et al. (Beiderbeck et al., 2021a), Hasson and Keeney (2011), Markmann et al. (2020), and Schmalz et al. (2021). The 35 additional survey items were grouped into six questions and served to generate additional insights. The study can be divided into three major phases (Figure 3.1): 1) study preparation, 2) study execution, and 3) study analysis (Beiderbeck et al., 2021a). For data collection, we had a relatively long 13-week period between November 2020 and February 2021.

3.3.1 Study Preparation

Since Delphi surveys are usually very time-consuming for participants, they are limited in scope and can therefore only include a limited number of projections, making thorough preparation all the more critical (Beiderbeck et al., 2021a; Schmalz et al., 2021). Clearly defined research objectives should be at the core of such preparation – with this study we have pursued three objectives: 1) Gain valuable insights on the future developments in the field of sportstech, 2) facilitate an expert discussion in a yet unstructured field, including a variety of stakeholders to create added value for everyone involved, and 3) add to the growing body of high-quality Delphi method literature by testing relatively new approaches of enriching Delphi studies. To achieve these objectives, we placed a high value on a careful composition of the (extended)

research team, including non-authoring supporters in terms of subject expertise (sports industry and technology) and methodical expertise (Delphi method).



Figure 3.1 Study Phases – Projection Development, Expert Selection, and Analyses.

Note. Based on Beiderbeck et al. (2021b) and Roßmann et al. (2018).

3.3.1.1 Initial Conceptualization and Creative Workshops

The initial conceptualization of this research project began in 2018 with two members of the research team. Based on findings from initial desk research, we conducted a first creative workshop to narrow down the research scope. The creative workshops were mainly used to refine research scope, underlying theory or frameworks, and Delphi methodology specifics (Beiderbeck et al., 2021a). Concerning scope, we started very broadly with interest in understanding what the future of sportstech might look like and which insights could be derived for academics and practitioners today. As we wanted to get a global perspective, we did not limit ourselves from a geographical perspective. We tried to include global perspectives in the study preparation and in the study execution and analysis. If a Delphi study addresses a very

broad field of interest, it is advisable to use a framework to guide the development of projections in a structured way (Beiderbeck et al., 2021b; Merkel et al., 2016). Therefore, we used the SportsTech Matrix developed by Frevel et al. (2020), which allowed us to systematically consider all user groups (user angle of the matrix) and the different types of technologies (tech angle) that are relevant in sports.

Regarding the Delphi methodology, we decided to use the real-time format of the research method (Gnatzy et al., 2011; Gordon & Pease, 2006), which is a variation of the traditional Delphi approach (Linstone & Turoff, 1975). It lets participants proceed with the questionnaire at their convenience with immediate access to other respondents' responses after completing the survey, thus permitting an effective online group communication process (Belton et al., 2019; Linstone & Turoff, 2011). Our main goal with this choice was to increase survey convenience, avoid research fatigue (Clark, 2008, 2010), and limit dropout rates between rounds as the real-time format does not have pre-defined rounds but allows experts to revisit and review the survey at their convenience to adjust their assessments as needed. To execute the survey, we have chosen a proven software (Surveylet) as recommended in the literature (Aengenheyster et al., 2017).

3.3.1.2 Desk Research and Expert Interviews

The development of the specific content of this study is primarily based on an iterative process of extensive desk research and numerous workshops and interviews with subject matter experts (Schmalz et al., 2021). First, we synthesized existing insights from academic literature as well as industry reports and edited books. As proposed by Beiderbeck et al. (Beiderbeck et al., 2021a), to consult other sources in future studies where academic literature is scarce, we also closely followed a series of industry newsletters that cover the most relevant topics in this sphere. Second, we tested, iterated, and supplemented the insights from our desk research with subject matter experts to make sure we focus on the essentials, do not miss anything important,

and cover a broad range of topics with a minimal number of projections. Thus, we used expert input for both exploratory and confirmatory purposes (Bogner et al., 2014). To avoid biased perspectives, we ensured that the experts we engaged in interviews and workshops during the study preparation phase (some of them were engaged multiple times at different stages of our preparation) had diverse backgrounds and represented different stakeholder groups (Bonaccorsi et al., 2020).

In sum, this iterative process provided us with 205 factors or potential Delphi projections to consider. As suggested by Merkel et al. (2016), we used the chosen framework (SportsTech Matrix) to structure the factors and condense the long list of factors, thus allowing for an unbiased and balanced survey design (Nowack et al., 2011).

3.3.1.3 Formulation of Delphi Projections

The formulation of the projections is one of the most crucial steps of a Delphi study and should be guided by state-of-the-art methodological research (Hasson & Keeney, 2011; Markmann et al., 2020; Schmalz et al., 2021). All projections in our study were formulated positively as recommended by Schmalz et al. (2021) and as concrete statements with simple and unambiguous wording in a single sentence (Markmann et al., 2020). To ensure and support this, we have placed great emphasis on sentence comprehensibility and concreteness. Keeping sentences short is essential as it promotes comprehensibility (Flesch, 1950), while longer sentences are typically more complex, making them more challenging to process and more time-consuming to absorb (Salancik et al., 1971; Stone & Parker, 2013). Longer sentences in Delphi studies often reduce the information value of the results as they were found to "lead to a dispersion around 'undecided'" Markmann et al. (2020, p. 11). In contrast, experts tend to be clearer in their assessments and responses towards shorter projections. In line with the generally recommended sentence length of 15–20 words (Cutts, 2020), we kept the core of all of our projections at less than 20 words.

For the time horizon of our study, we considered 2030 as not too far away to be unimaginable for participants but sufficiently far away to go beyond what might be only incremental developments. This ten-year time horizon goes beyond decisions that have already been made, thus stimulating outside-the-box thinking (von der Gracht & Darkow, 2010) and providing the possibility to take measures based on the findings. Similar Delphi studies have chosen similar time horizons (Merkel et al., 2016). To make sure participants consistently considered the right time horizon, each projection started with "By 2030, …" (Markmann et al., 2020).

The number of projections was intentionally limited to six as Delphi studies often tend to be overly time-consuming for respondents (Schmalz et al., 2021; e.g., Trevelyan & Robinson, 2015) and have to trade-off between gathering enough data and keeping it short (Schmalz et al., 2021). The less time-consuming and easier to answer a Delphi questionnaire is, the more likely respondents are to complete and revisit it (Hsu & Sandford, 2007). This challenge of panel attrition and participant dropout is one of the main threats to the validity of Delphi results (Hasson & Keeney, 2011). It should be addressed with Delphi study designs that promote continuous participation of experts (cf. Bardecki, 1984). With our study, we are confident about having achieved this goal of developing a compact and engaging survey with both the Delphi projections as well as the additional prospective survey items.

The approach of iterative desk research and expert involvement described earlier resulted in the final set of six projections, with three projections each for the two respective angles of the SportsTech Matrix: User angle and tech angle. Together, both angles "provide an allencompassing structure and a common understanding for the field of sportstech" by depicting the various types of technologies that offer solutions in sports and the different types of user groups that will use these solutions (Frevel, Schmidt, et al., 2020, p. 24).

The user angle of the SportsTech Matrix was developed based on a framework (Malhotra, 2019; Penkert, 2017, 2019) that relied on a review of thousands of sportstech institutions to derive an exhaustive but mutually exclusive structure of user groups in sports. As a result, they

have been defined in the SportsTech Matrix as athletes, consumers, and management. To generate representative results with the study, we decided to address all three user groups with one projection, respectively. From our desk research and the expert input, we concluded that performance would be the most important topic for athletes, rather than focussing on any of the many potential sub-elements. Ultimately, all individual elements such as training and preparation, psychology, nutrition, or equipment advancements contribute to the athletes' performance which at the highest level is measured by world records (Lippi et al., 2008). For consumers, we aimed to focus on the most significant dimensions of all possible ways in which fans and consumers engage with a sport without performing (excluding the own performance of sports for this purpose). At the core of this idea is access to sports content which is why we developed a projection that allows for a fruitful discussion around how the consumption of sports content may change in the future. This could include not only a trend towards shorter sequences and more highlight-focused content (Hutchins et al., 2019) but also a development towards more personalized content using machine learning and AI (Chase, 2020) or dataenriched content, including live statistics (Van Gisbergen et al., 2020). With respect to sports managers, our expert discussions and desk research showed that one of the most interesting areas of investigation would not necessarily be the changes that sports managers need to manage as part of their jobs in the future, but how their own profiles might change (e.g., Duclos-Bastías et al., 2021). As a result, we derived the following three projections for the user angle:

Projection 1. By 2030, most of the current world records in Olympic disciplines will be broken due to technological advancements (*short: world records*).

Projection 2. By 2030, consumption of sports content will continue to change significantly, for example, towards shorter sequences (highlights) and data-enriched content (live statistics, etc.) *(short: content formats)*.

Projection 3. By 2030, technological progress has led to new types of manager profiles in sports organizations (backgrounds, skill sets, etc.) (*short: manager profiles*).

The tech angle of the SportsTech Matrix was developed to categorize technologies in a way that is suitable to provide structure in the sports context (Frevel, Schmidt, et al., 2020). Each of the resulting categories has a different focus, which we aimed to address with our projections. The first category is advanced materials, sensors, devices, Internet of things, and biotech and includes primarily physical technologies that are highly important in capturing data. Technology-based solutions for capturing data in sports have proliferated in recent years (Stein et al., 2017). Based on our desk research and the expert input, a focal question is whether the amount of data being collected is nearing a saturation point or whether it will continue to grow and, if so, how much. For the second technology category – data, artificial intelligence, and machine learning - our main area of interest was to understand better how automated data processing will develop over the next ten years. While the amount of data might be increasing, it is questionable whether it will be possible or feasible for athletes to use that data for relevant insights (Luczak et al., 2019). Advancements in automated data processing could be among the most considerable impact factors, for that matter. The third category is called information, communication, and extended reality and is mostly about human interaction. Our desk research and expert discussions have shown that AR/VR/XR and how frequently fans will use them to consume sports in ten years would be among the most interesting subjects for investigation (Miah et al., 2020). Overall, we concluded the following three projections for the tech angle:

Projection 4. By 2030, at least ten times as much data will be collected in professional sports compared to today (*short: data collection*).

Projection 5. By 2030, automated data processing has significantly improved, allowing athletes to make better data-driven decisions around their sport (e.g., AI-generated training plans or optimization of technique) *(short: data processing)*.

Projection 6. By 2030, most consumers/fans will frequently follow (live) sports in AR/VR/XR (*short: consumers/fans*).

Before finalizing these six projections, we subjected them to rigorous testing by researchers, experts, and a student sample (Hasson & Keeney, 2011). First, in addition to prior expert input, we made a final check with one leading industry expert who is highly familiar with the global sportstech ecosystem. Second, we pre-tested the projections with two senior researchers and three junior researchers from our research network. Third, we had two Delphi expert members of our research team once again test all projections against all known quality criteria. Finally, we pre-tested the complete survey with a student sample from a sports strategy class of our MBA program. Twenty-five students were invited to participate, 18 started the survey, and ten fully completed it. This pre-test yielded good results and did not indicate any required changes.

3.3.1.4 Development of Additional Prospective Survey Items

Following the Delphi section of our survey, respondents had to reply to 35 additional prospective survey items grouped in six questions. In contrast to the Delphi projections, however, these questions had to be answered only once and were not asked again or displayed at all in subsequent revisits. This rather unique approach to Delphi-based prospective studies allowed us to address a very broad range of relevant topics without having to pose a full-fledged Delphi projection to experts for every single area of interest. For example, we were very eager to get the experts' assessment for individual technologies and individual user groups. We could do this with a matrix-like Likert scale based question instead of surveying 18 additional Delphi projections (three user groups times six technologies). This allowed us to keep the survey relatively short, as recommended by Schmalz et al. (2021), while at the same time avoiding the collection of unnecessarily large amounts of both quantitative and qualitative data, which can be a risk with Delphi projections. With this approach of relatively few Delphi projections combined with onetime prospective survey items, we aimed at avoiding research fatigue (Clark,

2008, 2010) and reducing dropout rates, which may threaten the validity of results (Hasson & Keeney, 2011).

The six additional questions that we posed focused on different topics identified as relevant following the same process that we used to develop the Delphi projections. Apart from the 18item technology-centred question mentioned above, one 3-item question focused on the expected benefits from tech solutions for the three different user groups (athletes, consumers, managers). Another 3-item question assessed how much different players or institutions in sports would be impacted by technology in the next ten years. The next 3-item question about specific technology-enabled innovations or alterations. Finally, we asked respondents to rate their agreement on four items regarding possible developments by 2030 (e.g., "By 2030, investments (venture capital or private equity) into sportsech will have more than tripled compared to today").

3.3.2 Study Execution and Expert Selection

In order to execute the study successfully, we mainly had to identify and include suitable experts and we had to make some additional design choices beyond the earlier-mentioned decision between the real-time and the traditional Delphi format (Gnatzy et al., 2011). Given some respondents' unfamiliarity with the Delphi method, we carefully created the survey's landing page to ensure a proper survey process understanding among participants as recommended by Beiderbeck et al. (Beiderbeck et al., 2021a). This included a brief explanation of the Delphi method, including a link to a short video and a brief explanation of common cognitive biases to sensitize participants to avoid them (Bonaccorsi et al., 2020). After the landing page, participants first had to respond to the six Delphi projections and then the 35 additional prospective survey items, which were again divided into six questions. After that,

two sentiment constructs with a total of seven items were surveyed. Finally, participants were asked for demographics and three short self-assessments in terms of experience and expertise.

For the Delphi projections, respondents had to provide three quantitative assessments with expected probability of occurrence on an eleven-point scale from 0 to 100% as well as desirability of occurrence and impact in case of occurrence on seven-point Likert scales anchored at "very low" (1) and "very high" (7). Like some other Delphi studies (Kluge et al., 2020), we chose seven-point Likert scales over more commonly used five-point scales given the seven-point scale's superiority in terms of reliability (Allen & Seaman, 2007; Nunnally, 1994). Following advice from Trevelyan and Robinson (2015), we required respondents to provide only one qualitative assessment at the end of each projection to provide reasoning for their assessment. We purposely limited ourselves to one qualitative input per projection (compared to having multiple mandatory comments, e.g., for each Delphi dimension separately) to improve survey convenience and reduce research fatigue (Bardecki, 1984; Clark, 2008; Thiebes et al., 2018).

Delphi results' quality depends largely on the quality of experts (Förster & von der Gracht, 2014; Hasson et al., 2000; Nowack et al., 2011). A range of factors must be considered for expert selection, including the level of expertise, panel size, heterogeneity, and access to the panel (Beiderbeck et al., 2021a). Given our study's broad area of investigation, we aimed for a relatively large panel as suggested by Beiderbeck et al. (Beiderbeck et al., 2021a). We ensured a heterogeneous composition in terms of backgrounds that help bring in diverse perspectives and improve the reliability of results and mitigate the risk of potential biases (Bonaccorsi et al., 2020). The diversity of backgrounds in our panel referred to different dimensions, including age, geography, job position, occupation, or stakeholder group (Mauksch et al., 2020). To identify experts, we followed recommendations from Kluge et al. (2020) and primarily relied on the research team's extended personal network of more than 30,000 contacts, including

LinkedIn and direct contacts as well as desk research, including screening relevant interest groups or conference participation lists.

In total, 650 experts were identified and contacted individually via email or LinkedIn. 171 (26.3%) started the survey and 92 (14.2%) fully completed it, i.e., a response rate in line with similar Delphi studies (Beiderbeck et al., 2021b; Keller & von der Gracht, 2014). For an overview of panel composition, see Figure 3.1. Experts were 39 years old on average and had slightly less than ten years of work experience. One expert preferred not to indicate their gender. From the remaining experts, 18% were female, which seems to be a representative share given the low share of women in the sports industry (Burton, 2015) and the low share of women in the tech workforce which, for example, is below 20% in 29 OECD countries included in the 2018 Women in Tech Index (Honeypot, 2018). Experts from 30 different countries and all five continents participated in the study, with 56% from Europe, 20% from Asia, 19% from America, 4% from Oceania, and 1% from Africa. Occupational backgrounds were diverse and resulted in five larger groups: Academia (22%), startup (22%), consulting (21%), adjacencies (20%;, including agencies, media, broadcasters, and others), and sports-centric (16%;, including sports associations, leagues, clubs, and athletes). All in all, we rate the panel as wellbalanced and well-suited for the present study, especially given the typical reliance on convenience samples in such studies and the common array of difficulties in expert selection (Belton et al., 2019; Devaney & Henchion, 2018).

3.3.3 Study Analysis

To derive multifaceted valuable insights from our study, we have performed a range of analyses (primarily using the open-source software R) that will be described in detail in the results and scenario section. The analyses can be categorized as descriptive statistics, dissent, sentiment, and scenarios. The descriptive statistics included qualitative analyses that contribute significantly to the interpretation of results such as a syntax and content analysis as well as

quantitative analyses, including arithmetic mean value and interquartile range evaluations for the Delphi projections. While many Delphi studies in the past were focused on consensus, particularly prospective studies may benefit significantly from dissent analyses for valuable insights (von der Gracht, 2012; Warth et al., 2013). Consequently, we performed four different analyses for the dissent analysis: desirability bias analysis, outlier analysis, bipolarity analysis, and stakeholder group analysis. In addition to the dissent analysis, we evaluated experts' deeplevel information to gain additional insights from our data, which had been recommended as early as in the 1980s (Loye, 1980) but was not commonly applied in Delphi studies (Spickermann et al., 2014). Given the context of our study, we include more common deeplevel information such as experience and expertise, but also context-specific technology-related sentiments. Finally, we conducted a scenario analysis which is often a core feature of Delphibased prospective studies (Nowack et al., 2011). All of the above analyses will be described in more detail in the following.

3.4 Results

3.4.1 Descriptive Statistics

Before our analyses, we cleaned our data and checked it for errors (Häder, 2009). A test for non-response bias following Roßmann et al. (2018) was performed to ensure the generalizability of the results. To do so, we assumed late respondents and non-respondents to be similar (Armstrong & Overton, 1977) and applied Mann-Whitney U tests for comparisons between the first 20 (early) and last 20 (late) respondents across all dimensions of our six projections. There was no non-response bias present, based on the absence of significant differences between early and late respondents (p < 0.05).

For qualitative results, the respondents provided a total of 549 from 552 possible comments, i.e., an exceptional comment rate (99.5%), indicating that our experts were very involved in the survey (Kluge et al., 2020). Syntax and content analyses (see Table 3.1) were conducted to

evaluate the quality of comments (Förster & von der Gracht, 2014). Like the overall comment rate, the share of whole sentences was particularly high at 93.3%, suggesting in-depth consideration and high involvement. From a content analysis perspective, beliefs (39.1%) were most dominant, with cause and effect (27.5%) and differentiation (18.5%) as the next most frequent types of arguments and comments.

Statement type	Total amount	Percentage share
Syntax analysis		
Whole sentences	512	93.3%
Catchphrases	29	5.3%
Catchwords	8	1.5%
Blank	3	0.5%
Content analysis		
Belief	216	39.1%
Cause and Effect	152	27.5%
Differentiation	102	18.5%
Trend	57	10.3%
Example	13	2.4%
No information	12	2.2%

 Table 3.1 Syntax and Content Analysis of Written Statements.

All six projections of our study achieved an impact rating between five ("somewhat high") and six ("high") on a seven-point scale, underlining the high relevance of the selected Delphi projections (Kluge et al., 2020). With an average of 5.85, projection 3 *(manager profiles)* yielded the highest impact in case of occurrence, whereas projection 1 *(world records)* had the lowest average impact at 5.21. Consensus on impact was reached for projections 1 *(world records)* and 2 *(content formats)*; the IQR threshold was 1.75 (25% of seven-point Likert scale) (Warth et al., 2013). See Table 3.2 for descriptive statistics of the Delphi projections.

	-	-										
	EP				D				Ι			
Projection	Mean	SD	Median	IQR	Mean	SD	Median	IQR	Mean	SD	Median	IQR
1: World records	0.60	0.24	0.60	0.40	4.77	1.39	5	2	5.21	1.17	5	1
2: Content formats	0.83	0.20	0.90	0.20	5.10	1.65	5	2	5.51	1.10	6	1
3: Manager profiles	0.79	0.22	0.80	0.30	5.70	1.24	6	1.25	5.85	1.09	6	2
4: Data collection	0.88	0.18	1.00	0.20	5.36	1.48	5.5	2	5.60	1.23	6	2
5: Data processing	0.81	0.20	0.85	0.30	5.75	1.24	6	2	5.84	1.14	6	2
6: Consumers/Fans	0.64	0.25	0.70	0.33	4.86	1.56	5	2	5.15	1.39	5	2

Table 3.2 Delphi Results – Descriptive Statistics.

Note. EP = expected probability of occurrence (0-100%); D = desirability of occurrence (7 pt. Likert scale; 7 = very high); I = impact in case of occurrence (7 pt. Likert scale; 7 = very high); SD = standard deviation; IQR = interquartile range; Consensus (IQR for EP \leq 0.25, IQR for D and I \leq 1.75) is marked in bold.

Four out of six projections achieved a desirability rating between five ("somewhat high") and six ("high") on a seven-point scale and may thus be considered opportunities (Schweizer et al., 2020). Projection 1 (*world records*) – the least desirable projection with an average score of 4.77 and projection 6 (*consumers/fans*) had a desirability rating of slightly below five, which is still "somewhat high" and therefore desirable from the experts' point of view. The highest desirability was assigned to projection 5 (*data processing*), with an average desirability score of 5.75. Consensus was only reached for projection 3 (*manager profiles*) at the same 1.75 IQR threshold as for the impact assessment. Finding consensus on desirability for only one of six projections is an interesting insight and may be interpreted as a selection of somewhat controversial projections. To address this in more detail and better understand potential underlying reasons, a rigorous dissent analysis was performed, as suggested by Warth et al. (2013).

All projections achieved an expected probability of occurrence (EP) of 60% or higher, with projection 4 (*data collection*) being the highest (M = 88%) and projection 1 (*world records*) being the lowest (M = 60%). Hence, the experts evaluated the projections as realistic future developments, which is a good result and underlines the relevance of the chosen projections. Consensus was reached for projections 2 (*content formats*) and 4 (*data collection*) at an IQR consensus threshold of 0.25 (i.e., 25%) for EP estimates (Warth et al., 2013). Delphi projections with EP estimates at this level usually reach consensus (von der Gracht & Darkow, 2010). It is therefore all the more interesting that projections 3 (*manager profiles*) and 5 (*data processing*) have only almost reached consensus despite the high EP estimates of 79% and 81%, respectively. The lack of consensus for projections 1 (*world records*) and 6 (*consumers/fans*) with somewhat lower EP estimates is consistent with earlier Delphi research (Ogden et al., 2005; von der Gracht & Darkow, 2010); projections that are less likely to occur are typically more difficult to evaluate and often involve higher levels of dissent. These insights serve as a relevant basis for our dissent and sentiment analyses.

Upon the first completion of the Delphi projections, our respondents evaluated six additional prospective questions that included 35 Likert-type items. Comparing the results of early to late respondents, we found no non-response bias. The descriptive results for the additional prospective survey items can be found in Table 3.3 and they provide valuable input and insights for our analyses and discussions.

Question	Item	Mean	Median	Mode	SD
Please indicate how much the	Advanced Materials	4.36	5	5	0.79
following technologies will	IoT/Sensors	4.38	5	5	0.78
vears.	AI/Machine Learning	4.26	4	5	0.83
(1 = No impact at all,	Advanced Analytics	4.41	5	5	0.89
5 = Full impact)	AR/VR/XR	3.18	3	2	1.16
	5G	3.29	3	3	1.16
Please indicate how much the	Advanced Materials	2.71	3	3	1.00
following technologies will	IoT/Sensors	3.27	3	3	1.04
next 10 years.	AI/Machine Learning	3.63	4	4	1.18
(1 = No impact at all,	Advanced Analytics	3.66	4	4	1.07
5 = Full impact)	AR/VR/XR	4.17	5	5	1.04
	5G	4.43	5	5	0.94
Please indicate how much the	Advanced Materials	3.30	3	3	1.09
following technologies will	IoT/Sensors	3.73	4	4	0.99
the next 10 years.	AI/Machine Learning	4.27	5	5	0.91
(1 = No impact at all.)	Advanced Analytics	4.64	5	5	0.69
5 = Full impact)	AR/VR/XR	3.15	3	4	1.13
	5G	3.63	4	4	1.16
Please indicate how much you	Athletes	6.00	6	6	0.97
think the following types of	Sports associations/leagues/clubs	6.04	6	6	0.97
will be impacted by technology	Media and agencies (Sales, PR, etc.)	6.34	7	7	0.86
in the next 10 years.					
(1 = Not at all impacted,					
5 = Fully impacted)					
By 2030, the benefits from	athletes	5.90	6	6	1.19
significantly increase compared	consumers/fans	6.13	6	7	0.87
to today for	sports managers	5.90	6	7	1.12
(1 = Strongly disagree,					
7 = Strongly agree)					
By 2030, most organizations in the world of sport will	have a Chief Digital Officer (CDO) or Chief Technology Officer (CTO)	6.08	6	7	1.20
(1 = Strongly disagree,7 = Strongly agree)	have hired/employed new skills to manage technological advancements	6.34	7	7	0.94
	be considered as leading-edge in terms of technology and innovation when compared to other industries	4.46	4.5	4	1.55
By 2030, new technology- enabled	competition formats will have become normal (e.g., pro-level virtual indoor cycling races)	4.93	5	6	1.43
(1 = Strongly disagree,	sports will have been established (cf. drone racing)	5.16	5	5	1.32
7 = Strongly agree)	sports (e.g., drone racing or eSports) enjoy similar popularity as traditional sports	4.61	5	5	1.59
	ways of fan engagement will have become normal (e.g., fans can virtually race against Formula 1 drivers)	5.51	6	6	1.26

 Table 3.3 Prospective Survey Items Results – Descriptive Statistics.

Question	Item	Mean	Median	Mode	SD
By 2030, (1 = Strongly disagree,	even more extreme versions of extreme sports will have emerged through technological advancements	5.09	5	5	1.28
7 = Strongly agree)	sports tech will have significantly driven the development of new methods of training (e.g., cognitive training)	5.89	6	6	1.15
	investments (venture capital or private equity) into sportstech will have more than tripled compared to today	5.97	6	7	1.13
	new regulatory/governance measures will have been put in place in many sports organizations to regulate the use of technological advancements in sports	5.86	6	7	1.26

 Table 3.3 Quantitative Prospective Survey Items Results. (Continued)

3.4.2 Dissent Analysis

3.4.2.1 Desirability Bias Analysis

Desirability bias is a phenomenon that describes how the probability judgment of an event's occurrence may be influenced by the subjective opinion on the desirability (undesirability) of that event (Ecken et al., 2011; Krizan & Windschitl, 2007). The presence of desirability bias may skew probability judgments and consensus/dissent distributions, thus threatening the reliability of Delphi results and limiting their explanatory power (Ecken et al., 2011). To test for desirability bias, we followed the procedure suggested by Beiderbeck et al. (Beiderbeck et al., 2021a) and evaluated Pearson's product-moment correlation coefficients between expected probability of occurrence and desirability for all six projections. The test showed correlations at the 5% significance level for projection 1 (world records) and the 1% significance level for all other projections (see Table 3.4). As our study used a rather distant time horizon, the presence of a desirability bias is not necessarily surprising and in line with previous Delphi research (Beiderbeck et al., 2021b; Winkler & Moser, 2016). It is also worth mentioning that the potential existence of desirability bias in Delphi studies is mostly offset by Delphi's averaging process (Ecken et al., 2011). The bias is negligible if experts do not "share a pronounced and common desirability" (Ecken et al., 2011, p. 1666). Given that only one of our projections reached consensus on desirability and the average desirability scores of all projections were in a perfectly usual range, we concluded that the bias was negligible in our study. However, we still treat the results of this analysis as a relevant insight to keep in mind throughout our analyses and discussion.

Projection	r	df	t	р
1: World records	.25	90	2.49	.014
2: Content formats	.46	90	4.96	.000
3: Manager profiles	.43	90	4.55	.000
4: Data collection	.39	90	4.02	.000
5: Data processing	.58	90	6.70	.000
6: Consumers/Fans	.68	90	8.47	.000

Table 3.4 Dissent Analysis – Desirability Bias.

Note. Statistics describe correlation between expected probability and desirability of each respective projection.

3.4.2.2 Outlier Analysis

To better understand the dissent in some of our projections and to test whether the mean values of our projections were biased or had inflated standard deviations due to outliers (Field, 2005), we conducted an outlier analysis by standardising the projections' EP values and testing whether they exceeded the threshold z-score of 2.58 (Warth et al., 2013). Only projections 1 (*world records*) and 6 (*consumers/fans*) had no outliers. For all other projections, we recalculated EP mean values and the IQR after excluding the outliers from the data. The IQR remained unchanged in all four instances. The EP mean values, however, decreased by three percentage points for projection 2 (*content formats*), two percentage points for projection 5 (*data processing*). Thus, while outliers may potentially explain some of the dissent in our results, the differences caused by these outliers are minor and can mostly be ignored, leading to the conclusion that no significant effect of outliers on our results is present. Our content analysis of the qualitative input further confirms this conclusion as no significant differences between outliers and other experts were found.

3.4.2.3 Bipolarity Analysis

Another contributing factor to indications of dissent can be a bipolar distribution of data (Dajani et al., 1979). Thus, we evaluated whether the mean estimates for the projections' expected probability, desirability, and impact might stem from bipolar response distribution (i.e., one group providing high estimates and one group providing low estimates) (Warth et al., 2013). Following Linstone and Turoff (1975), we tested all dimensions of all projections for bimodal distribution and found two modes for the desirability assessments of projections 2 (*content formats*), 4 (*data collection*), and 6 (*consumers/fans*). However, in all three cases, both modes were very close together (maximum distance of two on a seven-point Likert scale), i.e., no indication of bipolarity. For expected probability and impact, there were no instances of bimodal distribution. A critical inspection of the histograms for all projections and all dimensions did not yield any visual cues that would suggest bipolar data distribution, leading us to conclude that bipolarity is not present in our data and does not help explain dissent in our projections.

3.4.2.4 Stakeholder-group Analysis

Dissent in Delphi studies can be caused by diverging backgrounds from participating experts (Warth et al., 2013). To test for potential differences in assessments between different backgrounds, we conducted a stakeholder-group analysis for five distinct groups in our study: Academia (n = 20), startup (n = 20), consulting (n = 19), adjacencies (n = 18), and sports-centric (n = 15); the results are presented in Table 3.5.

To identify significant differences between stakeholder groups in the non-normally distributed data, the nonparametric Mann-Whitney U test was applied (see Table 3.6). For groups *academia* and *startup*, we each found significant differences between their assessments of the projections and those of all other groups, respectively. Group *startup* had, on average across all six projections, the highest estimates for all three dimensions EP, D, and I as well as the highest EP and D estimates for five out of six projections and the highest I estimate for half

of the projections (2: *content formats,* 4: *data collection,* 6: *consumers/fans*). Only for projection 3 (*manager profiles*) were the EP and D estimates of group *startup* lower than that of another group. A potential explanation for this outcome could be that entrepreneurs often tend to be more optimistic and confident about the future (Koudstaal et al., 2015). Group *adjacencies* also provided relatively high estimates across almost all projections and dimensions, with the highest I estimate for projections 1 (*world records*), 3 (*manager profiles*), and 5 (*data processing*).

At the lower end of the spectrum, for half of the projections, group *sports-centric* had the lowest EP (1: *world records*, 3: *manager profiles*) estimates; this group also had the lowest estimate for I of projection 3. Group *adjacencies* also had several "lowest estimates," namely for EP of projection 2 (*content formats*), for D of projections 4 (*data collection*) and 6 (*consumers/fans*), and for I of projections 2 (*content formats*) and 6 (*consumers/fans*). Interestingly, group *adjacencies* had both a significant number of "highest estimates" and "lowest estimates," suggesting that this group felt somewhat stronger about the individual projections than other groups. A possible reason could be the diverse composition of the group *adjacencies* that is not necessarily united by a set of shared interests or disinterests. Group *academia* had the lowest estimates for EP of projections 5 (*data processing*) and 6 (*consumers/fans*), for D of projection 5 (*data processing*) and 6 (*consumers/fans*), for D of projection 5 (*data processing*) and 6 (*consumers/fans*), for D of projection 5 (*data processing*) and 6 (*consumers/fans*), for D of projection 5 (*data processing*) and 6 (*consumers/fans*), for D of projection 5 (*data processing*) and 6 (*consumers/fans*), for D of projection 5 (*data processing*) and 6 (*consumers/fans*), for D of projection 5 (*data processing*) and 6 (*consumers/fans*), for D of projection 5 (*data processing*) and 6 (*consumers/fans*), for D of projection 5 (*data processing*) and 6 (*consumers/fans*), for D of projection 5 (*data processing*) and 6 (*consumers/fans*), for D of projection 5 (*data processing*), and for I of projection 4 (*data collection*). Group *consulting* had the lowest I estimates for projections 1 (*world records*), 3 (*manager profiles*), and 5 (*data processing*).

Comparing individual groups bilaterally reveals additional interesting insights. For example, the largest difference in average EP estimates between any two groups was between group *startup* (EP = 0.73) and group *academia* (EP = 0.57) for projection 6 (*consumers/fans*), which is not too far apart. Similarly, the largest difference in average D and I estimates is in both cases between group *startup* (D = 5.60; I = 5.55) and group *adjacencies* (D = 4.39; I = 4.83). These are interesting insights to bear in mind for subsequent analyses, results, and their discussion.

	Acader	nia		Startup)		Consul	ting		Adjace	ncies		Sports-	centric	
Projection	EP	D	Ι	EP	D	Ι	EP	D	Ι	EP	D	Ι	EP	D	Ι
1: World records	0.62	4.45	5.15	0.62	5.35	5.35	0.62	4.53	5.00	0.59	5.17	5.39	0.52	4.27	5.13
2: Content formats	0.88	4.85	5.50	0.89	5.80	5.75	0.80	4.84	5.37	0.76	5.17	5.33	0.81	4.73	5.60
3: Manager profiles	0.82	5.90	5.95	0.78	5.80	6.05	0.76	5.47	5.53	0.83	6.11	6.11	0.74	5.07	5.53
4: Data collection	0.92	5.15	5.40	0.92	6.00	5.85	0.83	5.37	5.68	0.89	5.06	5.50	0.79	5.13	5.53
5: Data processing	0.76	5.50	6.00	0.88	6.10	5.70	0.82	5.74	5.68	0.82	5.67	6.00	0.78	5.73	5.80
6: Consumers/Fans	0.57	4.45	5.25	0.73	5.60	5.55	0.63	5.00	5.05	0.59	4.39	4.83	0.71	4.80	5.00
Average	0.76	5.05	5.54	0.80	5.78	5.71	0.74	5.16	5.39	0.75	5.26	5.53	0.73	4.96	5.43

 Table 3.5 Stakeholder Group Analysis – Descriptive Statistics.

Note. EP = mean expected probability of occurrence (0-100%); D = mean desirability of occurrence (7 pt. Likert scale; 7 = very high); I = mean impact in case of occurrence (7 pt. Likert scale; 7 = very high); Consensus (IQR for EP \leq 0.25, IQR for D and I \leq 1.75) is marked in bold.

Group comparison	Projection	Dimension	U	р
Academia / Startup	1: World records	D	117.5	.022
	2: Content formats	D	126	.040
	5: Data processing	EP	133	.063
	6: Consumers/Fans	EP	134	.074
	6: Consumers/Fans	D	120	.026
Academia / Consulting	4: Data collection	EP	248.5	.078
Academia / Adjacencies	1: World records	D	123.5	.090
Academia / Sports-centric	3: Manager profiles	D	201	.072
	4: Data collection	EP	196	.097
	6: Consumers/Fans	EP	100	.095
Startup / Consulting	2: Content formats	D	256.5	.057
	4: Data collection	EP	248	.078
Startup / Adjacencies	2: Content formats	EP	241.5	.065
	4: Data collection	D	243	.059
	6: Consumers/Fans	EP	240	.079
	6: Consumers/Fans	D	253	.031
Startup / Sports-centric	1: World records	D	212.5	.034
	4: Data collection	EP	200	.067
	4: Data collection	EP	207.5	.049
Consulting / Adjacencies	3: Manager profiles	D	116	.077
Adjacencies / Sports-centric	1: World records	D	181	.090
	3: Manager profiles	D	200.5	.013

Table 3.6 Stakeholder Group Analysis – Results of the Mann-Whitney U Test.

Note. EP = expected probability of occurrence; D = desirability of occurrence; I = impact in case of occurrence.

Since we found a substantial number of in some cases significant differences between groups, we did an in-depth examination of intra-group consensus for all stakeholder groups, all projections, and all dimensions (EP, D, I); see Table 3.7 for an overview. Intra-group consensus was reached in almost two-thirds of all possible instances. IQR scores were partially very low, indicating a very high level of consensus within groups in those cases. For example, group *sports-centric* had an IQR of 10% for EP of projection 2 (*content format*) and group *academia* had an IQR of 0.5 for D of projection 3 (*manager profiles*).
Stakeholder group	EP	D	Ι
Academia	1, 2, 3, 4, 5	1, 3, 4, 5, 6	1, 2, 3, 4
Startup	2, 3, 4, 5	1, 5	2
Consulting	1, 2, 4, 5, 6	3, 5	2, 3, 5, 6
Adjacencies	4, 6	1, 2, 3, 5	1, 2, 3, 4, 5
Sports-centric	2, 5, 6	1, 3, 4, 5, 6	1, 2, 3, 4, 5, 6

 Table 3.7 Stakeholder Group Analysis – Intra-group Consensus Across Projections.

Note. Numbers indicate the projections for which intra-group consensus was reached; EP = expected probability of occurrence; D = desirability of occurrence; I = impact in case of occurrence. Numbers indicate respective projections.

3.4.3 Sentiment Analysis

Following approaches from Beiderbeck et al. (2021b), Loye (1980), and Spickermann et al. (2014), we evaluated experts' deep-level information to gain additional insights from our data. In addition to the typical deep-level information variables of experience and expertise, we examined specific technology-related sentiments using established constructs for experts' attitude toward using technology (Teo & Zhou, 2014) and trust in technology (McKnight et al., 2011).

3.4.3.1 Experience and Expertise

To assess our experts' experience and expertise, we relied on a multi-perspective approach (Nowack et al., 2011) that included years of work experience, job level, and stakeholder status as well as a self-assessment of expertise in closed-ended questions with the possible choices novice, beginner, intermediate, advanced, and expert. In addition, we ensured a certain level of expertise through the individual pre-selection of experts for our study (Förster, 2015). Finally, another valuable confirmation of our respondents' expertise was the critical review of comments (Bolger et al., 2011; Bolger & Wright, 2011; Bonaccio & Dalal, 2006). The sample may be considered quite experienced, with more than nine years of work experience on average. To check whether years of work experience influenced experts' assessments, we performed Mann-Whitney U tests for all relevant comparisons (see Table 3.8).

Expertise	Draisstian	Dimen-	Group 1		Group 2					
area	Projection	sion	Expert level	n	mean	Expert level	п	mean	U	р
Years of	5: Data processing	D	> 5yrs	59	5.98	< 5yrs	33	5.33	1217	.038
work	2: Content formats	Ι	> 5yrs	59	5.76	< 5yrs	33	5.06	1322	.003
experience	3: Manager profiles	Ι	> 5yrs	59	5.92	< 5yrs	33	5.72	1168.5	.097
	2: Content formats	EP	0-3yrs	15	80%	> 3yrs	77	84%	409.5	.067
	2: Content formats	Ι	0-3yrs	15	4.93	> 3yrs	77	5.62	380.5	.028
	3: Manager profiles	EP	0-3yrs	15	71%	> 3yrs	77	80%	419	.089
	6: Consumers/Fans	Ι	0-3yrs	15	5.73	> 3yrs	77	5.04	751.5	.060
	1: World records	Ι	3-10yrs	32	4.88	< 3 or > 10yrs	60	5.38	687.5	.020
	2: Content formats	Ι	3-10yrs	32	5.28	< 3 or > 10yrs	60	5.63	757	.079
	6: Consumers/Fans	EP	3-10yrs	32	55%	< 3 or > 10yrs	60	69%	660	.013
	6: Consumers/Fans	D	3-10yrs	32	4.34	< 3 or > 10yrs	60	5.13	723.5	.048
	2: Content formats	Ι	> 10yrs	45	5.87	< 10yrs	47	5.17	1457.5	.000
	3: Manager profiles	Ι	> 10yrs	45	5.98	< 10yrs	47	5.72	1298	.049
	5: Data processing	D	> 10yrs	45	6.04	< 10yrs	47	5.47	1267.5	.087

Table 3.8 Sentiment Analysis – Mann-Whitney U Test Results for all Relevant Comparisons for Years of Work Experience.

Note. EP = expected probability of occurrence; D = desirability of occurrence; I = impact in case of occurrence.

We started by comparing only two groups with different levels of work experience in the sports industry: *moderate work experience* (less than five years; n = 33) and *significant work experience* (more than five years; n = 59). Experts with *significant work experience* group had rated the desirability of projection 5 (*data processing*) and the impact of projections 2 (*content formats*) and 3 (*manager profiles*) significantly higher than experts with only *moderate work experience*.

To get a more nuanced understanding, we then further divided the experts and tested for differences in three distinct groups: low work experience (0 to 3 years; n = 15), medium work experience (3 to 10 years; n = 32), and high work experience (more than ten years; n = 45). A series of interesting findings came to light, for example, the more work experience experts had, the higher their impact estimate for projection 2 (content formats). In particular, experts with high work experience assigned a significantly higher (M = 5.87) impact to projection 2 (content *formats*) than others (M = 5.17). One possible explanation could be that experts with less work experience tend to be younger and thus tend to be more digitally savvy, which may make new content formats more natural for them, leading to a low impact assessment. Another interesting finding is that experts with *medium work experience* assigned lower scores than other experts for the impact of projection 1 (world records) and the expected probability and desirability of projection 6 (consumers/fans). That is, there was no tendency of correlation for these projections (e.g., impact assessment of the world records projection increases in work experience), but rather it is a u-shaped relationship. However, we did find three instances of significant positive correlation between work experience and our experts' assessments, namely for impact of projection 2 (content formats) as well as expected probability and desirability of projection 5 (data processing) (see Table 3.9).

Parameter	Projection	Dimension	r	t	р
Years of work experience	2: Content formats	Ι	. 33	3.64	.001
	5: Data processing	EP	.18	1.70	.092
	5: Data processing	D	.25	2.42	.018
Job level	1: World records	D	.24	2.33	.022
	2: Content formats	Ι	.20	1.96	.053
	4: Data collection	Ι	.26	2.51	.014
	5: Data processing	D	.23	2.22	.029
Technology	1: World records	D	.18	1.73	.087
experience/expertise	2: Content formats	Ι	.26	2.50	.014
	4: Data collection	EP	.24	2.39	.019
	5: Data processing	EP	.25	2.48	.015
	5: Data processing	D	.19	1.80	.076
Sports industry	2: Content formats	Ι	.24	2.35	.021
experience/expertise	5: Data processing	D	.19	1.91	.060

Table 3.9 Sentiment Analysis – Results of the Correlation Analysis forExperience/Expertise Sentiments.

Note. Statistics describe statistically significant correlations between sentiment parameters and EP, D, and I of each respective projection. EP = expected probability of occurrence; D = desirability of occurrence; I = impact in case of occurrence.

Job level may serve as another proxy for experience and expertise besides years of work experience. Looking at the four distinct groups of executives, senior management, middle management, and juniors, we checked for differences between these groups using Mann-Whitney *U* tests and found 13 instances of significant differences (see Table 3.10). For example, executives estimated the desirability of projections 1 (*world records*) and 5 (*data processing*) as well as the impact of projections 3 (*manager profiles*) and 4 (*data collection*) significantly higher than non-executives. A possible explanation could be that they better understand certain industry dynamics or possess certain information that leads them to assign higher estimates to these projections 2 (*content formats*) and 3 (*manager profiles*), which could be due to a lack of experience in evaluating such developments. They also had significantly lower estimates for the desirability of projection 3 (*manager profiles*) and the expected probability of projection 5 (*data processing*).

Expertise	Ducidation	Dimen-	Group 1			Group 2				
area	Projection	sion	Expert level	<i>n</i> mean		Expert level	n	mean	U	р
Joblevel	1: World records	D	High	53	5.13	Low	33	4.33	1151	.012
	2: Content formats	Ι	High	53	5.70	Low	33	5.09	1131	.017
	3: Manager profiles	D	High	53	5.77	Low	33	5.45	1081	.053
	3: Manager profiles	Ι	High	53	5.98	Low	33	5.61	1122	.022
	4: Data collection	EP	High	53	89%	Low	33	85%	1080	.045
	4: Data collection	Ι	High	53	5.87	Low	33	5.15	1140.5	.012
	5: Data processing	D	High	53	6.04	Low	33	5.36	1153	.010
	1: World records	D	Executive	35	5.17	Non-executive	51	4.59	1103.5	.058
	3: Manager profiles	Ι	Executive	35	6.00	Non-executive	51	5.73	1078	.089
	4: Data collection	Ι	Executive	35	5.91	Non-executive	51	5.37	1098.5	.061
	5: Data processing	D	Executive	35	6.11	Non-executive	51	5.55	1106	.050
	2: Content formats	D	Senior	18	4.22	Non-senior	68	5.26	396.5	.012
	3: Manager profiles	EP	Senior	18	85%	Non-senior	68	76%	772	.084
	4: Data collection	EP	Senior	18	96%	Non-senior	68	86%	824.5	.013
	1: World records	D	Middle	18	4.22	Non-middle	68	4.99	449.5	.078
	5: Data processing	D	Middle	18	5.17	Non-middle	68	5.94	411.5	.026
	2: Content formats	Ι	Junior	15	4.87	Non-junior	71	5.59	307	.007
	3: Manager profiles	D	Junior	15	5.27	Non-junior	71	5.73	387.5	.082
	3: Manager profiles	Ι	Junior	15	5.47	Non-junior	71	5.92	307	.007
	5: Data processing	EP	Junior	15	73%	Non-junior	71	83%	362	.043

Table 3.10 Sentiment Analysis – Mann-Whitney U Test Results for all Relevant Comparisons for Job Level.

Note. EP = expected probability of occurrence; D = desirability of occurrence; I = impact in case of occurrence.

Table 3.11 Sentiment Analysis – Mann-Whitney U Test Results for all Relevant Comparisons for Technology and Sports Industry Experience/Expertise.

Expertise	Drojaction	Dimen-	n- Group 1		Group 2					
area	Projection	sion	Expert level	n	mean	Expert level	n	mean	U	p
Technology	5: Data processing	EP	High expertise	59	83%	Low expertise	33	78%	1185.5	.077
	5: Data processing	D	Advanced	41	5.51	Non-advanced	51	5.94	811	.054
	1: World records	D	Expert	18	5.50	Non-expert	74	4.59	908.5	.015
	2: Content formats	EP	Expert	18	88%	Non-expert	74	82%	854.5	.056
	2: Content formats	Ι	Expert	18	6.17	Non-expert	74	5.35	943	.004
	4: Data collection	EP	Expert	18	98%	Non-expert	74	85%	969.5	.001
	5: Data processing	EP	Expert	18	92%	Non-expert	74	79%	922	.010
	5: Data processing	D	Expert	18	6.44	Non-expert	74	5.58	982.5	.001
Sports	2: Content formats	Ι	High expertise	71	5.66	Low expertise	21	5.00	999.5	.013
industry	4: Data collection	EP	High expertise	71	89%	Low expertise	21	81%	939.5	.049
	2: Content formats	Ι	Intermediate	18	5.06	Non-intermed.	74	5.62	488.5	.066
	4: Data collection	EP	Advanced	29	92%	Non-advanced	63	86%	1124.5	.053
	2: Content formats	Ι	Expert	42	5.71	Non-expert	50	5.34	1263	.078

Note. EP = expected probability of occurrence; D = desirability of occurrence; I = impact in case of occurrence.

To look at more general results, we aggregated the existing four groups into only two groups (N = 86 as six experts indicated their job level as "Other" and were thus excluded from this analysis): *high job level* (executives and senior management; n = 53) and *low job level* (middle management and junior; n = 33). For all seven instances of significant differences that we found (see Table 3.10), the estimates of experts with a *high job level* were higher than those of the experts with lower job levels. It is particularly interesting to see that they provided significantly higher desirability (projections 1, 3, and 4) and impact (projections 2, 3, and 4) ratings for half of the projections, respectively. This is an interesting finding which could indicate that experts with higher job levels are more optimistic, more experienced, or more informed than their lower-level colleagues. In line with these results, we have also found four significant positive correlations between job level and expert assessments (see Table 3.9), namely for the desirability of projections 1 (*world records*) and 5 (*data processing*), as well as the impact of projections 2 (*content formats*) and 4 (*data collection*). That is, the higher the experts' job level, the higher their estimates for these projections.

To test for expertise in the sports industry and the field of technology, we asked participants for self-assessments along five-point Likert scales, anchored at "novice" (1) and "expert" (5). For technology, more almost two thirds of experts had advanced (n = 41) or expert (n = 18) expertise, followed by intermediates (n = 30) and beginners (n = 3); there were no novices. Significant differences in the Mann-Whitney *U* tests were only found for groups expert and advanced in a total of seven instances (see Table 3.11). Similar to our findings on job level, participants with expert technology knowledge gave consistently higher estimates for the projections in all instances of significant differences. Particularly large were the differences for projection 5 (*data processing*), where technology experts assessed the probability of occurrence (M = 92%) and the desirability (M = 6.44) significantly higher than others (expected probability M = 79%; desirability M = 5.58). Given the complexity of today's and future technologies, less tech-savvy experts might not yet grasp the full potential of technology or more tech-savvy experts might overestimate the application of technology in sports. Based on these insights, it is no surprise that the probability of occurrence and desirability of projection 5 (*data processing*) are significantly positively correlated with technology expertise and so is the probability of occurrence of projection 4 (*data collection*) (see Table 3.9).

With respect to the sports industry, our participants had even more expertise, with almost half of them categorizing themselves as expert (n = 42), followed by advanced (n = 29), intermediate (n = 18), beginner (n = 2), and novice (n = 1). We found three instances of significant differences between these groups and aggregated participants into only two groups for a more conclusive comparison (see Table 3.11): *high expertise* (n = 71) and *low expertise* (n = 21). Again, higher levels of expertise led to higher estimates and we found that participants with high sports industry expertise expected the probability of occurrence of projection 4 (*data collection*) significantly higher (M = 89%) than participants with low expertise (M = 81%). Likewise, they projected the impact of projection 2 (*content formats*) significantly higher (M = 5.66) than others (M = 5.00). Overall, the impact of projection 5 (*data processing*) (see Table 3.9).

3.4.3.2 Technology-related Sentiments

For the examination of our experts' technology-related sentiments for additional insights (Beiderbeck et al., 2021a), we relied on two established constructs for attitude toward using technology (ATT) (Teo & Zhou, 2014) and trust in technology (TRUST) (McKnight et al., 2011) along seven-point Likert scales anchored at "strongly disagree" (1) and "strongly agree" (7). Both constructs were intentionally very short to limit assessment time and achieve high response rates as well as high face validity through lower perceived redundancy by respondents (Rammstedt & Beierlein, 2014; Wessel et al., 2019). A confirmatory factor analysis (CFA) was performed to confirm the constructs' measurement reliability and construct validity (Homburg

& Giering, 1998). As threshold values served \geq .6 for composite reliability (CR) and \geq .5 for average variance extracted (AVE), according to the corresponding literature (Anderson & Gerbing, 1988; Bagozzi & Yi, 1988; Homburg & Giering, 1998). CR exceeded the .6 threshold proposed by Bagozzi and Yi (1988) for both constructs. Likewise, AVE not only exceeded the pre-defined .5 threshold but even exceeded the preferred .7 threshold recommended by Nunnally (1994) for both constructs (see Table 3.12).

Table 3.12 Confirmatory Factor Analysis.

Construct	Mean	SD	CR	AVE
Attitude toward using technology (ATT)	5.86	1.03	0.91	0.71
Trust in technology (TRUST)	4.70	1.45	0.92	0.79
			_	

Note. SD = Standard deviation; CR = Composite Reliability; AVE = Average Variance Extracted; CR = $(\sum \lambda_i)^2 / ((\sum \lambda_i)^2 + \sum \theta_i)$; AVE = $\sum \lambda_i^2 / (\sum \lambda_i^2 + \sum \theta_i)$.

First, to assess participants' attitude toward using technology (ATT), we adapted a construct from Teo and Zhou (2014) that builds on the technology acceptance model (TAM) (Davis, 1989) and measures "the degree to which a user likes or dislikes using technology" (Teo & Zhou, 2014, p. 126). A reasonable hypothesis was to assume that experts with higher ATT scores provided higher estimates for the assessment dimensions EP, D, and I of our projections. When testing this hypothesis using Pearson's product-moment correlation coefficients between ATT for all dimensions of all projections, we found 13 (out of 18) statistically significant correlations (see Table 3.13). For all six projections, desirability was positively correlated with ATT. Concerning expected probability, all except projection 6 (*consumers/fans*) were positively correlated. For impact, projections 2 (*content formats*) and 3 (*manager profiles*) were positively correlated. As all experts indicated fairly high levels of ATT, we could not assess differences between low ATT and high ATT groups but limited our analyses to correlations.

Second, to assess participants' trust in technology (TRUST), we adapted a construct from McKnight et al. (2011) that measures "the belief that the specific technology has the capability, functionality, or features to do for one what one needs to be done" and "the general tendency to be willing to depend on technology across a broad spectrum of situations" (McKnight et al.,

2011, p. 7). Pearson's product-moment correlation coefficients between trust and all dimensions

of all projections yielded statistically significant correlations for 13 out of 18 tests (see Table

3.13).

Parameter	Projection	Dimension	r	t	р
Attitude toward using	1: World records	EP	.28	2.82	.006
technology (ATT); Davis,	1: World records	D	.35	3.49	.001
1989; Teo & Zhou, 2014	2: Content formats	EP	.19	1.87	.065
	2: Content formats	D	.33	3.28	.001
	2: Content formats	Ι	.30	2.98	.004
	3: Manager profiles	EP	.28	2.73	.008
	3: Manager profiles	D	.26	2.60	.011
	3: Manager profiles	Ι	.22	2.16	.033
	4: Data collection	EP	.30	3.00	.003
	4: Data collection	D	.37	3.81	.000
	5: Data processing	EP	.26	2.59	.011
	5: Data processing	D	.28	2.80	.006
	6: Consumers/fans	D	.22	2.13	.036
Trust in technology	1: World records	EP	.25	2.50	.014
(TRUST); McKnight et al.,	1: World records	D	.44	4.60	.000
2002; McKnight et al.,	2: Content formats	D	.21	2.08	.040
2011	2: Content formats	Ι	.35	3.60	.001
	3: Manager profiles	D	.22	2.13	.036
	3: Manager profiles	Ι	.36	3.65	.000
	4: Data collection	EP	.36	3.69	.000
	4: Data collection	D	.32	3.17	.002
	4: Data collection	Ι	.17	1.68	.096
	5: Data processing	EP	.30	3.02	.003
	5: Data processing	D	.32	3.25	.002
	5: Data processing	Ι	.28	2.73	.008
	6: Consumers/fans	D	.20	1.95	.054

Table 3.13 Sentiment	Analysis –	Results	of the	Correlation	Analysis	for	Technology-
related Sentiments.							

Note. Statistics describe statistically significant correlations between sentiment parameters and EP, D, and I of each respective projection. EP = expected probability of occurrence; D = desirability of occurrence; I = impact in case of occurrence.

Interestingly, desirability was positively correlated with trust for all six projections; that is, the higher the higher the desirability. This is likely a consequence of the phenomenon that high-trust individuals typically expect better results from using technology (McKnight et al., 1998). Expected probability was positively correlated with trust for half of the projections (1, 4, and 5) and impact was positively correlated with trust for four out of six projections (2,

3, 4, and 5). To gain more nuanced insights, we performed Mann-Whitney U tests to compare *high-trust* (n = 36) and *low-trust* (n = 25) groups, where high trust was defined as a score larger than five and low trust was defined as a score smaller than four on a seven-point Likert scale. Consistently across all 12 instances of statistically significant differences between the two groups, the *high-trust* group gave higher estimates in their assessments, indicating trust in technology as a key factor in the belief in and openness towards technology. In particular, we found significant differences between the two groups in projections 1 (*world records*), 4 (*data collection*), and 5 (*data processing*) for expected probability, in projections 1, 4, 5, and 6 (*consumers/fans*) for desirability, and in all except projection 1 for impact. These findings could allow the conclusion that *low-trust* individuals would typically prefer less technological progress and perceive the impact of technology to be lower compared to their *high-trust* counterparts.

3.5 Scenarios and Discussion

Scenarios are among the most useful tools for exploring possible and plausible future states of any given object of study. A scenario typically builds on several influencing factors to form an internally consistent and plausible narrative about possible future states (Van der Heijden, 2011; von der Gracht & Darkow, 2010). It is an anticipation of the future rather than a prediction. Scenarios are very useful in strategy-making, especially in environments influenced by external change (Van der Heijden, 2011). Scenario planning is rather new to the business environment (Bradfield et al., 2005) and to academia, with a substantial increase in publications after 2000 (Varum & Melo, 2010). Scenario analysis in prospective studies often builds on quantitative data for scenario formation and is then enriched by qualitative data. Therefore, scenario analysis is also very powerful in eliciting understandable insights from different types of research (Schmalz et al., 2021). For Delphi studies, this approach is well-established (Nowack et al., 2011) as it helps structure the discussion of results and the evaluation of qualitative data (Tapio et al., 2011).

To develop scenarios, we first identified the optimal number of scenarios by testing thirty validation indices based on the majority rule (Charrad et al., 2014); the result was two scenarios. We then tested two distinct cluster algorithms to detect structure in the data for average expected probability, desirability, and impact. Each resulting cluster would present one scenario. Fuzzy c-means clustering (FCM) (Roßmann et al., 2018) suggested the first scenario to consist of projections 1 (world records), 2 (content formats), and 6 (consumers/fans) and the second scenario to consist of projections 3 (manager profiles), 4 (data collection), and 5 (data processing). Similarly, hierarchical clustering using Euclidean distance and ward method (Kaufman & Rousseeuw, 2009; Murtagh & Legendre, 2014; Ward, 1963) suggested almost the same allocation of projections to scenarios. Only projection 2 was assigned to the other scenario (in FCM, the degree of membership of projection 2 to scenario 2 was also quite substantial at 30%). After comparing the two resulting classifications, including a visual inspection, hierarchical clustering generated the most meaningful results (cf. Schmalz et al., 2021). Based on this analysis, we defined the first scenario, which consisted of four projections as "probable future" and the second scenario consisting of two projections as "game changer"; for an overview, including average assessments for expected probability, desirability, and impact on a scenario level see Table 3.14. An evaluation of these assessments combined with a visual inspection shows that the assignment of projections to scenarios is most strongly supported by expected probability, followed by desirability and impact, which is important to note for subsequent discussions (see Figure 3.2). While both scenarios represent different potential futures, they are not mutually exclusive; thus, we also considered shared links and trends in our analysis of the individual scenarios.

Table 3.14 Scenario Statistics.	
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Scenario name	Included projection(s)	EP (mean)	D (mean)	I (mean)
(1) Probable future	2, 3, 4, 5	83%	5.48	5.70
(2) Game changer	1,6	62%	4.82	5.18

Note. EP = expected probability of occurrence; D = desirability of occurrence; I = impact in case of occurrence.



3.5.1 Scenario One: Probable Future

Scenario one ("probable future") describes a highly probable future for sports with respect to technological developments and is composed of four projections (2: content formats, 3: manager profiles, 4: data collection, 5: data processing). The experts consider these

developments very probable, with projections having an expected probability of 79% or above at an average of 83%. They also consider them very desirable, with average desirability of this scenario's projections of 5.48 and a minimum of 5.10. Impact of this scenario was also assessed as very high at an average of 5.70 and a minimum of 5.51.

With the second-highest expected probability of all six projections (M = 83%), experts reached consensus that the consumption of sports content will continue to change significantly until the year 2030. They also reach consensus that this will have a high impact (M = 5.51), however, they do not reach consensus for desirability, which is somewhat high on average (M = 5.10). These were the lowest impact and desirability assessments of all projections in scenario one. In their discussion, the experts put forth a whole range of reasons for change, including advanced technological opportunities, new media formats, and generational shifts. One of the biggest challenges in the next decade will be finding a way to cater to Generation Z consumers' demands (Yim et al., 2020). While they might not yet be the most financially attractive target group today, they could be in 2030, according to our experts. Sports media right holders will have to compete for consumer's attention and limited screen time with other (entertainment) formats – a development that we can already observe today (Lindholm, 2019). Social media has played a decisive role in this development and is expected to continue its influence. Many experts expect significant changes in the nature of content towards even more data richness, more immersive formats, and shorter sequences such as highlights. The expected increase in demand for exclusive formats, behind-the-scenes content, and similar features was mentioned less uniformly but clearly. An interesting finding in this context was the anticipated influence of video game standards for sports consumption in the future. It is worth mentioning that not all experts expect major changes, one group of experts expects these changes to come but only marginally. Many experts expect full-length games and live events to remain relevant, but their audiences might reduce. A big advantage of on-demand and more digital content is its availability for a truly global audience across time zones as well as other factors that might prevent fans from following sports, including outlier events such as the COVID-19 pandemic.

Besides these more central discussion points, the experts raised several other interesting topics. By 2030, most professional athletes will be digital natives themselves, which might significantly add to how sports content is delivered. They also raised a series of interesting questions, such as at what level consumers' desire for more data and live statistics will be saturated, which leads to several further questions: Will consumers demand more data by 2030 compared to today? Will sports consumers demand more participation and impact on the game by 2030? Will all this data take some of the "art" out of sports? Moreover, if so, will this be a risk in terms of a negative selection bias early on in all youth academies?

The experts also acknowledged that not all of this is entirely new. A lot is already in motion but needs more time for diffusion and adoption. Many sports organizations are already producing their own digital offerings; however, they should be thinking even more like media companies. At the same time, some experts believe that the multitude of opportunities provides much room for disruptive innovations and the emergence of new multi-billion-dollar companies in this market.

With respect to manager profiles, most experts agreed that technological progress will have led to new types of manager profiles in sports organizations in terms of backgrounds, skills, etc., by 2030. The panel did not reach consensus on the expected probability of this projection (M = 79%), however, they did reach consensus on desirability, which had the second-highest assessment among all projections (M = 5.70). This was also the projection with the highest impact assessment (M = 5.85). The debate on this projection was less about whether technological advances and the associated requirements would change but whether this is expected to happen in sports organizations by 2030. The vast majority of experts acknowledged a lack of technology-related skills and a need for new skills towards more tech-savvy and analytical profiles. The drivers of this development include new technologies, more data, competitive advantage, generation Z demands, investor demands, new business models. Possible solutions include replacing managers with new profiles, expanding existing management teams with new profiles, and reskilling and upskilling existing managers. The experts have pointed out that some of these developments are already underway with many positive examples, however, the pace of change will increase over the next decade, according to them. For example, roles such as Chief Data Officer or Chief Innovation Officer are currently a rarity but could be the standard in 2030. On the other hand, traditional hiring frameworks could hinder this progress. This refers to the competencies and profiles that are being searched for and the compensation that is being offered; attracting and retaining employees with relevant backgrounds could be difficult if they are not compensated competitively. Another main hurdle that experts in the debate addressed was that the incumbent decision-makers might have little interest in giving up power to these new types of manager profiles. This is one reason why some experts do not expect such changes to take place on a large scale until 2030, but only later.

With the highest expected probability (M = 88%), the panel reached consensus that, by 2030, at least ten times as much data will be collected in professional sports compared to today. On average, the experts consider this both desirable (M = 5.36) and impactful (M = 5.40). The main drivers they see for more data include easier and more affordable access to required technologies for professionals and amateurs, more technologically advanced sports facilities and venues, and a higher level of granularity, creating significantly more data points (e.g., positional data of athletes during competition and training). About the actual amount of data, opinions differ. Some consider the current amount of data to be already very high and doubt a tenfold increase or see no reason for it, whereas others assume an exponential development of the amount of data. Accordingly, some experts also assume that a tenfold increase will occur well before the year 2030. What was more decisive from the experts' point of view is the relevance of the data. It is not simply a matter of generating more data. It must also have a clear benefit. Sports organizations, athletes, and other users of that data need to be able to make sense

of the data and extract insights; this starts with asking the right questions to solve problems and identify opportunities. A data-related competitive advantage will most likely result from the ability to use the data rather than from the sheer amount of data. Therefore, the experts pointed out how important it will be to have athletes, managers, coaches, and staff who possess the relevant skills and train them. Data overload might become a problem for some stakeholders. The experts' discussion also raised some questions to which answers must be found: Who will own which data? Who will be allowed and able to monetize and how? How to ensure fair competition with different levels of access to technology and data? Do gathering and handling data require more regulation?

According to our panel, the most desirable (M = 5.75) projection was that automated data processing has significantly improved by 2030, allowing athletes to make better data-driven decisions around their sport. The experts also assigned this projection the second-highest impact (M = 5.84) and a high probability (M = 81%). Mostly, the experts expect significant advantages and opportunities for athletes, for example, for injury prevention, prolongation of careers, competitive advantages, or better training overall. According to the experts, this could also significantly reduce athletes' dependence on their coaches, which relates to training management and feedback and the quality and availability of coaches in general. At the same time, this will also place new demands on coaches in tech-savviness and data analytics. A key part of the discussion was which athletes would be affected at all. On the one hand, some experts argued that it would be more for professional athletes, as the application and necessary marketability would be difficult in lower leagues. On the other hand, other experts argue that these solutions could provide opportunities to amateur athletes who could not afford a human coach in the first place, i.e., the democratization of high-quality training, which the experts considered highly desirable.

There was a vivid debate on who should own the data and who should have access to it. Some experts argue that most data belong to the athletes, while others counter that significantly more insights could be derived if data was public and could be combined in larger datasets. Similarly, the question was whether that data could be used to generate accurate and valuable insights as there might still be a lack of coaches and athletes who can use it appropriately. The automation aspect in data processing could partly address this, however, many experts are still sceptical whether this level of automation will be possible by 2030. According to them, AI has not yet fully proven its potential for these purposes and they expect significant advancements to really take off only after 2030. They also pointed out that advancements will come much earlier in some sports than in others; factors may include available (financial) resources and how static versus dynamic the different sports are. The experts raised some other interesting topics for discussion. For example, the speed of progress depends largely on federations and leagues and their adaptation of such technologies and analytics. At the same time, data would have to be more athlete-focused and less for other stakeholders if it is to really add value for athletes. A key point that will play an important role in this development overall is that in 2030 almost all athletes will belong to a generation of digital natives and will have a much greater affinity for relevant technologies.

3.5.2 Scenario Two: Game Changer

In contrast to the first scenario, scenario two ("game changer") describes technology-related developments in the future of sports that could be considered game changers to some extent. It is composed of two projections (1: world records, 6: consumers/fans) that are somewhat less probable, less desirable, and less impactful in the opinion of our experts compared to the projections from scenario one. However, this is not to say that they have a low probability, desirability, and impact. In fact, their expected probabilities of 60% and 64% are still relatively high compared to similar Delphi studies. The experts did not reach consensus on these two projections, which is reasonable given that projections with expected probability assessments of around 60% tend not to reach consensus (Ogden et al., 2005; von der Gracht & Darkow,

2010). Impact and desirability were assessed by the experts to be somewhat high for both projections.

With the lowest expected probability (M = 60%), the lowest desirability (M = 4.77) and the second-lowest impact (M = 5.21), the panel did not appear to be fully convinced that most of the current world records in Olympic disciplines will be broken due to technological advancements by 2030. In the discussion, many topics were addressed, from human limits to regulation as well as positive and negative effects. One group of experts argued that human limits had been reached in many disciplines and there is not much that technology could help without significantly altering the nature of the sport or the like. Other experts counter that it is precisely for this reason that technology can now make the small but subtle difference it needs for marginal record improvements. However, this alone is not a particularly desirable state of affairs for the former group because they lose the desirable comparability of performances and records across generations. With respect to timing, some experts considered significant advancements possible until 2030 as the next generation of athletes are digital natives who could be much better in leveraging data and technology for their training and performance, while other experts do not expect any leaps in performance over the next years, but rather later. Some experts have pointed out the desirable benefits such as positive spill-over effects on amateurs or even society as a whole, for example, in terms of health. On the other hand, several possible negative consequences have also been addressed. For example, consumers and fans could lose interest if success in sports depended too much on technology and if the discrepancy between athletes would become too significant. This could be harmful to the Olympic brand in the eyes of some experts. Some experts expressed concern that too much technological advancement could lead athletes to exceed their limits in ways that could lead to injuries. These concerns, along with others, are part of many experts' advocacy for increased regulation through governing bodies. Depending on the outcome of such regulation (which will most likely differ between different sports), the impact of technology on sports and world records could be more

or less significant. There appeared to be consensus between experts that the impact of technology may differ between different sports for various reasons. For example, some disciplines are already much closer to performance limits than others and some disciplines are, by definition, better suited to using technology to achieve performance advances. Overall, the experts assumed disciplines with more equipment (e.g., cycling) more likely to be impacted by technology than disciplines with less equipment (e.g., running).

The experts assessed the projection that most consumers/fans will frequently follow (live) sports in augmented reality (AR), virtual reality (VR), or extended reality (XR) by 2030, with the second-lowest expected probability (M = 64%) and the second-lowest desirability (M = 4.86) of all projections. If it was to occur, experts believe this projection to have the lowest impact (M = 5.15), which was also reflected in their argumentation. For example, some experts argued that the number of users of such technologies should not be overestimated, especially with a time horizon of only ten years. This would also significantly depend on the diffusion of the required technology among consumers, primarily dependent on other (entertainment) industries. For this debate, experts differentiated between AR, VR, and XR and they were significantly more optimistic about the diffusion and adaptation of AR advancements than VR and XR. A major reason is that AR applications are often smartphone-based, which is already much more widespread than VR devices. Particularly with regards to VR, some experts argued that breakthroughs would depend on significant improvements in the quality, availability, and affordability of technology. Many people still experience negative effects such as dizziness or struggle with the user-friendliness of available devices and applications. In addition, some experts have cited existing VR solutions in sports that have failed to meet expectations, ultimately dampening enthusiasm for such solutions and slowing development. High demands in terms of computer processing capacity were named as an additional hurdle for faster adaptation.

The discussion also involved many advantages of such technologies and applications. Many experts agreed that these technologies had the potential to lift the sports experience to another level. For example, an unlimited number of fans, no matter where they are located, could get into the pleasure of first row experiences that would otherwise only be available to a very small group of physically present and mostly privileged people (Chase, 2020). It could allow fans to almost "live the experience," as one of the experts put it, including taking the perspective of athletes. The current COVID-19 pandemic has made the potential of such remote use cases even clearer. Such technologies can significantly improve he provision of data and information. From a commercial perspective, this may bring new marketing options as well as disruptive applications for ticketing. Further advantages and opportunities mentioned by experts in the discussion include the possibility of competing against (professional) athletes virtually, improving the participatory element for fans, or innovating new sports and competition formats.

Finally, this debate has also raised a couple of questions that could not be answered conclusively. For example, will these technologies ever be able to fully replace the experience of physically going to the stadium? Will it be a generational question of who uses such technology and applications and who might not? Will the next generation of sports consumers demand such offerings, or will they be more traditional than expected in their consumption of sports content?

3.6 Conclusion

3.6.1 Limitations and Future Research

To address the limitations of this study, we started by critically reviewing the composition of our expert panel as recommended by Ecken et al. (2011) and Kluge et al. (2020). This is important to avoid potential biases such as social desirability bias and self-interests of certain experts that could influence study results. From a geographical perspective, it would have been desirable to have an even more balanced panel. We saw an over-representation of experts from Europe who made up 54% of all participants, followed by America and Asia with 20% each. Oceania (4%) and Africa (1%) were under-represented. A likely explanation for this geographic distribution could lie in the composition of the authors' networks (including LinkedIn contacts) that were a key source in selecting participants. It is positive that experts from 30 different countries participated in the study. In sum, while the geographic distribution of participants could have been better, we still believe our results are a legitimate representation of the potential development of technology's impact on sports globally. Looking at their backgrounds, our experts were evenly distributed among the relevant stakeholder groups (academia 22%, consulting 21%, sports-centric 16%, startup 22%, and adjacencies 20%). Nonetheless, individual groups might still have certain self-interests that could bias results by influencing the experts' assessments. Such self-interests or biases could include an overly optimistic reflection of the conditions and progress in one's own industry or one's own business interests that may lead to distorted assessments (cf. Kluge et al., 2020).

Another limitation of our study is the limited number of Delphi projections. Compared to many other Delphi studies, the total number of projections was relatively low. While the study results suggest that relevant and appropriate projections were selected, building on a broader set of projections would have presumably led to additional insights. For example, this could have provided more space to consider more extreme projections that would potentially have a low probability but high impact assessments and are thus important for stakeholders to have in mind. The inherent trade-off between study completion time and breadth of content is one of the most difficult decisions in Delphi research and we encourage future research to further look for ways to best achieve both goals.

This study and the SportsTech Matrix, in general, provide plenty of starting points for future research to investigate the impact of technology on sports. While we have taken a high-level overview in this study, future research could take more focused approaches. For example, it could be interesting not to consider all user groups in one study but focus on the impact of technology on sports separately for athletes, consumers, and management. Alternatively, researchers could approach the topic from a technology perspective, examining what role a particular category of technologies will play for user groups. Ultimately, the research could ideally become granular enough to examine in detail the effect of very specific technologies on very specific user groups. In order to conduct such specific research, using the Delphi method will depend enormously on the selection of experts, which could become increasingly difficult as the granularity increases.

It would be interesting to consider a wider range of time horizons in future research. Replicating our study or conducting similar studies with different time horizons could yield valuable insights. Shorter time horizons of five years or less could allow focusing on the most pressing issues, while much longer time horizons of 15-20 years or beyond could help to identify major threats and opportunities early.

Finally, this research could be used to derive several highly relevant and very concrete research questions for future work. For example, how do governing bodies want to approach the diminishing comparability of world records? Should there be more regulation to limit the influence of technology? Should one accept that some of the future world records will no longer be comparable to earlier world records? Or could there be a dual system that acknowledges technology-enabled world records versus non-technology-enabled world records? It would also be interesting to look at the concrete required skills of sports managers in the future in terms of what will be really important and what could be nice to have; this could inform the training and education of sports managers. Research could also look at the trend of sports consumption shifting towards highlights instead of watching full competitions. Does this carry the risk that at some point it might no longer be economically interesting for broadcasters and media companies to produce full-length sports content? This could be an undesirable negative externality of market dynamics and an interesting area for investigation.

3.6.2 Summary

This study provides multifaceted findings on impact of technology on sports in the future. We presented the results of a Delphi-based prospective study with 92 subject matter experts. They gave their quantitative and qualitative assessment of six future projections in terms of expected probability, desirability and impact and 35 additional prospective survey items grouped in six questions, which only had to be answered once. This allowed us to address a broader range of relevant topics within a reasonable survey scope Schmalz et al. (2021), overcoming a typical drawback of Delphi studies. We also gathered participants' deep level information, including experience and expertise as well as context-specific technology-related sentiments (Loye, 1980; Spickermann et al., 2014)

The Delphi projections selected for this study proved appropriate for the research focus and highly relevant, with an estimated average impact greater than five on a seven-point scale for all six projections (cf. Kluge et al., 2020). As the experts assessed the desirability of all projections as either somewhat high or high, it may be concluded that the addressed topics can be considered opportunities for the sports industry (cf. Schweizer et al., 2020). Looking at the probability assessments, it may be concluded that the posed projections represent realistic and conceivable future developments, given probability assessments between 60 and 88% for all six projections. Despite these high expected probabilities, consensus was only reached for a few projections, which is an interesting finding as consensus projections typically fall within the 60 to 80% expected probability range (Ogden et al., 2005; von der Gracht & Darkow, 2010). The experts reached consensus that consumption of sports content will continue to change significantly (e.g., shorter sequences or data-enriched content) and that at least ten times as much data will be collected in professional sports by 2030 compared to today. There was also consensus that new types of manager profiles in terms of backgrounds and skill sets in sports organizations would be desirable. With respect to impact, consensus was reached that new world records by 2030 in most Olympic disciplines due to technological advancements would have a high impact. The above-mentioned changes in the consumption of sports content would also have a high impact. As consensus on expected probability was only reached on two out of six projections, we performed a comprehensive dissent analysis (Beiderbeck et al., 2021b; Warth et al., 2013), which provided valuable insights. For example, we analyzed five different stakeholder groups and found that intra-group consensus was reached in almost two-thirds of all possible instances. At the same time, IQR scores for intra-group consensus projections were partially very low, indicating a very high level of consensus within groups in those cases.

To derive relevant insights from our results for academia and practice, we developed two scenarios (cf. Schmalz et al., 2021). Scenario one ("probable future") depicts a very high probability, high desirability, and high impact scenario. Probability assessments of all four projections in this scenario ranged from 79 to 88% at an average of 83%. This scenario pictures the future of all user groups in sports as largely technology-driven with significant changes in sports consumption, sports management, and athletes' use of data. Scenario two ("game changer") is a less probable, less desirable, and less impactful scenario compared to scenario one, but still has a relatively high expected probability (60-64%) and impact and somewhat high desirability. While both scenarios describe developments in different areas of sports, they share common underlying themes. For all six projections, the experts acknowledged the impact of technology that is to be expected. For the technological developments under discussion, the question is largely no longer how but when and to what extent.

In conclusion, all user groups in sports – athletes, consumers, and managers – may expect significant technology-driven changes by 2030. Different types of technologies can be differentiated in this development and not all of them will be relevant for all users. According to our experts, this technological progress can mostly be considered an opportunity rather than a threat and it can be a source of competitive advantage for both sports managers and athletes.

4 Paper III: The Impact of Technology on Sports Management – A Prospective Study ²⁵

4.1 Introduction

"Will humans go the way of horses?" is the thought-provoking question raised by Brynjolfsson and McAfee (2015, p. 8) in their article on labour in the digital world. Horses have played an important role in labour throughout a larger part of history. However, with innovations such as steam or combustion engines, horses have become obsolete and their role in and contribution to the world economy is minimal (e.g., Tarr, 1999). Could a similar fate await humans in the digital age?

Almost a hundred years ago, John Maynard Keynes's had predicted widespread technological unemployment "due to our discovery of means of economising the use of labour outrunning the pace at which we can find new uses for labour" (Keynes, 1930, p. 3). In the past century, machines have already largely replaced human labour in many aspects of work to lower costs, accelerate production, or improve quality (Webster & Ivanov, 2020). In particular, easily automated tasks were taken over by machines. However, unlike at the beginning, this is no longer limited to manufacturing. Robotics, artificial intelligence, and automation technologies affect all sorts of industries, tasks, and functions. Significant technological advancements can be observed in most industries, for example, agriculture (Driessen & Heutinck, 2015), automotive (Maurer et al., 2016), education (Ivanov, 2016; Timms, 2016), financial markets (Dunis et al., 2017), medicine (Kaur, 2012; Mirheydar & Parsons, 2013; Schommer et al., 2017), or warfare (Crootof, 2015; Sparrow, 2007). And across industries it affects many roles

²⁵ Frevel, N., Schmidt, S. L., & Shields, B. (n.d.). The impact of technology on sports management – A prospective study. Unpublished working paper.

and functions ranging from bookkeeping to customer interaction (Bresnahan, 1999; Hill et al., 2015; Manyika et al., 2013; Xu et al., 2017).

Today, advanced technologies transform many aspects of life, society and business (Makridakis, 2017; Talwar, 2015; Talwar et al., 2017). The days where technologies have only affected easy-to-automate or so-called blue-collar jobs are counted. Managers' roles and functions have never before evolved as fast as at present. Future of work, reskilling, and upskilling are the order of the day and "managers at all levels will have to adapt to the world of smart machines" (Kolbjørnsrud et al., 2016, p. 2).

The use of technology in the workplace has made significant advances over the past decades and the absence of technology has become unimaginable. A substantial amount of research on the future of work has investigated how our work environments might change in the future. The focal question of interest evolves around which roles and functions may be performed by technology going forward and which roles and functions require human capabilities that are still out of reach for technology. In their mostly dynamic and complex work settings, managers encounter a wide array of roles and constituencies to which they need to respond (Hooijberg et al., 1997; Mintzberg, 1975; Tsui, 1984). High-performing managers display greater abilities across different management roles and are able to diversify their behaviours (Lawrence et al., 2009).

For sports managers, this is particularly relevant as they typically operate in an environment characterized by intense competition. Just as performance improvements on the field will be largely technology-driven in the future (Balmer et al., 2012), sports managers' competitive advantage off the field will also be dependent on technology and innovation (cf. Schmidt, 2020a). Therefore, sports managers will need to be entrepreneurial and innovative in their work (González-Serrano et al., 2017). Technology and its purposeful use will play a crucial role in this endeavour, just like in any other industry (cf. Mamonov & Peterson, 2019). To better

understand the role of technology for sports managers to remain effective and efficient in the future, we pose the following research question: How will technology impact the roles and functions of sports managers in the short, medium and long term?

To find objective answers, we conducted a real-time Delphi study among 117 subject matter experts from 27 countries and heterogeneous backgrounds. Delphi provides a powerful research method to examine this complex issue requiring qualitative insights from subject matter experts beyond quantitative data "to unearth richness in tacit knowledge to help the research understand subtle expert opinion" (Grisham, 2009). We used a real-time format of Delphi (Gnatzy et al., 2011; Gordon & Pease, 2006) to allow for an effective group communication process (Belton et al., 2019; Linstone & Turoff, 2011). To ensure best practices in design, execution and analysis of our Delphi study, we follow the recommendations from methodological insights and technical papers (Beiderbeck et al., 2021b; Schmalz et al., 2021).

4.2 Background

4.2.1 Relevance of Managerial Roles and Functions

Management is "the process of designing and maintaining an environment in which individuals, working together in groups, efficiently accomplish selected aims" (Koontz & Weihrich, 1990, p. 4). Throughout its scientific examination, management has been represented by means of roles, functions, skills and so on. Throughout the last century, the way managers have been viewed has changed many times (Yang et al., 2018). Fayol (1916, p. 6) pioneered the field by examining a set of functions that managers perform: "To manage is to forecast and plan, to organize, to command, and to control." He was also among the first to note the need for education in management (Brodie, 1967). In the 1930s, Gulick (1937) introduced the acronym POSDCORB (planning, organizing, staffing, directing, coordinating, reporting, and budgeting) as a formal description of the management process. Terry (1953) described management as a "distinct process consisting of planning, organizing, actuating and controlling,

performed to determine and accomplish the objectives by the use of people and resources." As the body of research grew, "new theories have been developed and presented as being more appropriate for studying managerial work than previous theories" (Snyder & Wheelen, 1981, p. 249). Most of the work focused on the roles a manager should play and the skills a manager should possess. A series of seminal works have been developed in the second half of the 20th century. Koontz and O'Donnell (1955, 1976) defined five managerial functions: planning, organizing, staffing, directing, and controlling. Similarly, Katz (1955, 1974) tried to capture management as a set of managerial skills, grouping them into the areas of human, conceptual, and technical skills. In his view, managers need to be eclectic and possess skills in all three of these areas to be successful. Unlike these skills-based approaches, Mintzberg (1973) proposed ten roles that are common in every manager's work. He defined a role as "an organized set of behaviors belonging to an identifiable office or position" (Mintzberg, 1973, p. 54) and grouped the roles as interpersonal, informational, and decisional. An overview of Mintzberg's ten managerial roles can be found in Table 4.1. Mintzberg also criticized some of the earlier works including the POSDCORB concept as "a vague and meaningless depiction of managerial work, with no link to the work of real managers" (Mintzberg, 1972, p. 92). It is worth mentioning, that limited attention was paid to real managerial actions (Yang et al., 2018), a stream of research that is gaining momentum more recently.

The influential works from Koontz and O'Donnell (1955), Katz (1955, 1974), and Mintzberg (1973) still build the foundation for our understanding of management today (cf. Shinde, 2018). Over the last 50 years these works have received significant academic attention where their core principles have continuously been reinforced through investigations of the underlying nature of management. A wide array of mostly survey-based studies has developed an extensive understanding of managerial roles (e.g., Grover et al., 1993), managerial functions (e.g., Pavett & Lau, 1983), managerial skills (e.g., McLennan, 1967), managerial activities (e.g., Wu et al., 2004), or managerial behaviors (e.g., van Dun et al., 2017).

It can be concluded that the existing concepts of managerial roles and functions are still applicable. However, given the fast-changing nature of today's society and economy that brings along an unprecedented dynamism and complexity in many work settings, it is of great relevance to better understand how technology will affect managers in the future.

Category	Role	Description
Interpersonal	Figurehead	"Performing ceremonial and social duties as the organization's representative" (Koontz, 1980, p.181)
	Leader	"Establish the work atmosphere within an organization and motivate subordinates to achieve organizational goals" (Shapira & Dunbar, 1980, p. 88)
	Liaison	"Develop and maintain webs of contacts outside the organization to obtain favors and information" (Shapira & Dunbar, 1980, p. 88)
Informational	Monitor	"Collectors of all information relevant to the organization" (Shapira & Dunbar, 1980, p. 88)
	Disseminator	"Passing information to subordinates" (Koontz, 1980, p.181)
	Spokesperson	"Transmitting information outside the organization" (Koontz, 1980, p.181)
Decisional	Entrepreneur	"Initiate controlled change in their organization to adapt to the changing conditions in the environment" (Shapira & Dunbar, 1980, p. 88)
	Disturbance Handler	"Deal with unexpected changes" (Shapira & Dunbar, 1980, p. 88)
	Resource Allocator	"Make decisions concerning resource utilization" (Shapira & Dunbar, 1980, p. 88)
	Negotiator	"Involved in major negotiations with other organizations or individuals" (Shapira & Dunbar, 1980, p. 88)

Table 4.1 Overview of Mintzberg's (1973) Ten Managerial Roles.

4.2.2 Relevance of Technology in Management

The replacement of management functions by technology in the way we perceive it today was discussed as early as 1967 when Peter Drucker elaborated on the impact of the computer on business and management, predicting the computer to take over unskilled jobs and to "radically change the organization structure of business" (Drucker, 1967, p. 25). Koontz (1980, p. 185) was among the first to acknowledge "that technology has an important impact on organizational structure, behavior patterns, and other aspects of managing." Today, the absence of technology is almost unimaginable and its extensive impact is undisputed. In this fourth

industrial revolution (Schwab, 2017), managers increasingly seek benefits from (emerging) technologies for their business, for example, to become more efficient. The ongoing transformation of the global labor market is currently predominantly driven by technological advances in artificial intelligence, big data, cloud technology, and (mobile) Internet (World Economic Forum, 2018). The continued progress makes a crucial question increasingly relevant: Which roles and functions may be performed by technology going forward and which roles and functions require human capabilities that are still out of reach for technology. For example, in many industries there is a lot of speculation as to which jobs can be replaced by technologies going forward (e.g., Davenport & Dreyer, 2018). More often than not, the answer is not the replacement of jobs, but rather the replacement of tasks or even the performance of work that – before – had not really existed in the first place such as big data analytics (Davenport & Ronanki, 2018). With this research, we contribute to a better understanding of what impact technology will have on management in the short, mid, and long-term future.

4.2.3 Relevance of Sports Management

The strong socioeconomic impact of sport across the globe is undisputable given the important role of sport in society, for example, in healthcare (Khan et al., 2012), in education (European Union, 2012), in media (Kennedy & Hills, 2009), or for simply "bringing people together and contributing to social cohesion" (Lefever, 2012, p. 31). In fact, sport is so relevant for our society that many sport events are considered "events of major importance for society" (Katsarova, 2017) by the European Union (EU), ensuring the public the right of access to these events through free information. Similarly, Article 165 of the treaty on the functioning of the European Union emphasizes the promotion of sport given the nature of sport and its social function (European Union, 2012). In addition to its role for society, sport has become a strong economic sector representing close to 3% of EU gross value added and 3.5% of total EU employment (Katsarova & Halleux, 2019). Globally, the sports industry represents about one percent of gross domestic product (Schmidt, 2020b). Beyond the immediate economic impact,

sport additionally creates significant value for many other industries such as tourism, media, security services, catering, betting, consumer goods, etc. (Borovcanin et al., 2020; Kokolakakis & Gratton, 2019; McKinsey, 2020; Siegfried & Zimbalist, 2006).

In view of this relevance, it is surprising that sports management in academic research is still in its infancy (Peachey et al., 2015) and has been questioned by scholars for a lack of debate within the field; possibly the result of scarce resources or multi-disciplinarity (Gammelsæter, 2020). Much of the research on sports management has little in common and only few structured areas of focussed attention such as marketing or organisation theory (Ciomaga, 2015). A fundamental problem is the yet unresolved question of what should be considered integral parts of sports management and what should be neglected by the field with respect to economic, social, political, or cultural questions (cf. Newman, 2014; Stewart, 2014). There has also been criticism among sport management scholars that much of current research produces knowledge for sports managers, not about sports managers (Andrews & Silk, 2018; Klikauer, 2018), a gap that is addressed by our research.

4.3 Research Methodology

We conducted a real-time Delphi study following an approach based on Roßmann et al. (2018) and Beiderbeck et al. (Beiderbeck et al., 2021b). To ensure the quality of our results, we closely followed the methodical advice from Beiderbeck et al. (Beiderbeck et al., 2021a), Hasson and Keeney (Hasson & Keeney, 2011), and Schmalz et al. (2021). To gain additional and broader insights, we retrieved the experts' input on 50 prospective survey items. The main steps in our research approach were: 1) Development of Delphi projections and prospective survey items, 2) expert selection, 3) execution of the Delphi study, and 4) analysis and interpretation of results. Data were collected in September and October 2020, over a total period of eight weeks, i.e., a usual Delphi survey duration (Kluge et al., 2020).

4.3.1 Development of Delphi Projections

To develop relevant and meaningful projections, the inclusion of multiple sources is recommended (Belton et al., 2019; Nowack et al., 2011). After an initial conceptualisation phase, we used three main sources for input: expert workshops, expert interviews, and desk research. We also put particular emphasis on best practices in the formulation of projections (Markmann et al., 2020).

4.3.1.1 Expert Workshops and Expert Interviews

The initial concept for this research was already developed in early 2019 in a conceptualisation phase with four members of the research team. After initial desk research, we conducted an exploratory workshop to identify focal areas of interest. We kept the horizon very broad in this early phase to avoid a premature dismissal of relevant issues. Between March 2019 and August 2020, we had a period of 18 months in which we continuously developed the research content. In retrospect, this time flexibility helped us enormously to ensure a very wellfounded elaboration of our study and survey. For example, we were able to plan and host expert workshops at the experts' and our own convenience which enabled us to get better and more access to experts (e.g., meeting experts at conferences, etc.) than we typically would have had for such a research project. We ran a total of four creative workshops including 1-2 experts and 1-3 members of the research team, respectively. We found that having more workshops, but a small number of experts per workshop very helpful as it helps avoiding issues like groupthink or bandwagon effect (Janis, 1972). We used the workshops mostly to structure our findings (e.g., from desk research), to prioritize, to discuss interdependencies between different topics, and to identify the focus areas of investigation going forward (again, mostly for desk research). The workshops were also ideal to identify and address any problems that might arise once the survey would be under way. For example, concerns arose to whether the majority of experts would be able to provide valuable responses on the different Delphi projections and prospective questions and what level of information (i.e., explanations by the research team to avoid ambiguity) would be required within the survey (Markmann et al., 2020). This represents an important trade-off between clarity and survey completion time and convenience, which is a key driver of dropout rates in Delphi studies (Hsu & Sandford, 2007). We also decided to rephrase and simplify some projections rather than risk misunderstandings or even incomprehension (Markmann et al., 2020).

Expert interviews were used for both exploratory and confirmatory purposes (Bogner et al., 2014). In exploration phases, they helped to improve our understanding of relevant issues and how to prioritize them. In later stages, they helped to confirm (or dispute) our focal issues and associated Delphi projections as well as prospective survey items. We organized interviews with a total of 13 experts, some of whom were interviewed multiple times at different stages of the research project. These experts have diverse backgrounds representing different stakeholder groups including athletes, clubs, leagues, associations, media, consulting, startups, and academia as well as different countries, to avoid biased perspectives (Bonaccorsi et al., 2020).

4.3.1.2 Desk Research

As an indispensable basis for the development of the Delphi projections and prospective items, we conducted extensive desk research in addition to expert interviews and workshops (Schmalz et al., 2021). Our desk research included a literature review to provide a thorough theoretical background as well as a review of popular press and other sources for matters that are not yet addressed in academic literature. As we examined fundamental managerial traits, we focused on seminal works in the field of management research that lay the foundation for the current understanding of management. For sports management and technology in sports, we aimed to provide a good understanding of the overall status quo, given that both research fields are still under researched (Gammelsæter, 2020; Peachey et al., 2015; Ratten, 2017, 2018). For futures studies where the existing literature is scarce, it is recommended to use other sources besides academic literature to develop the projections (Beiderbeck et al., 2021a). For this

reason, we analysed additional sources, such as popular press, online media (news, blogs, etc.), as well as relevant industry conferences that were mostly focused on future trends. Throughout this process, we were able to distil the most relevant issues and high-level trends that formed the basis for developing our projections and prospective items.

4.3.1.3 Formulation of Delphi Projections

To formulate our Delphi projections, we followed best practices from prior Delphi studies. First, to strengthen concreteness and comprehensibility, all projections were limited to one sentence as recommended by Markmann et al. (2020). Sentence length is a key factor in sentence comprehension (Flesch, 1950) and longer sentences increase complexity, reduce reading speed, and require more information processing capacity (Salancik et al., 1971; Stone & Parker, 2013). In a meta-analysis of 587 projections from 33 Delphi studies, Markmann et al. (2020, p. 11) have found that longer sentences (i.e., more words) in projections "will lead to a dispersion around 'undecided'", while shorter sentences typically result in clearer participant responses to probability assessments. In our study, each projection was between 14 and 20 words long, which is consistent with the recommended sentence length of 15–20 words (Cutts, 2020). Second, we formulated our projections as concrete statements and kept the wording as simple and unambiguous as possible (Markmann et al., 2020). In addition, all projections were formulated positively to avoid mixing positive and negative formulations (Schmalz et al., 2021). Third, we chose 2030 as time horizon for our projections. To constantly remind our experts of the year in scope and ensure that they consider the right forecast horizon (Markmann et al., 2020), we started each projection with 'By 2030, ...'. By the time of study execution, 2030 was ten years away, which appeared to be an appropriate time horizon for several reasons. 2030 was not as far away as to become unimaginable for experts, a potential threat of too distant time horizons. At the same time, it was sufficiently far away to really shed light on impactful and potentially disruptive future developments instead of assessing incremental changes. It is distant enough from made decisions and stimulates thinking outside the box (von der Gracht & Darkow, 2010). Ten years also provide enough time to act on findings and implement practical implications such as managerial recommendations. This time frame is also consistent with similar Delphi studies (Merkel et al., 2016).

Based on exploratory expert interviews, creative workshops, and desk research, a total of 203 projections was identified. Through a series of formulation workshops, we reduced the number of projections by grouping, combining, and eliminating them. Given the very time-consuming nature of Delphi studies for participants (Schmalz et al., 2021; e.g., Trevelyan & Robinson, 2015), we limited the number of projections to five and put particular emphasis on having an engaging survey, also in the prospective survey item section. The trade-off between gathering sufficient amounts of data and keeping the survey as short as possible is particularly complex in Delphi studies (Schmalz et al., 2021). "If a questionnaire is easy to respond to and less time-consuming, [participants are] more likely to complete and return the questionnaire" (Hsu & Sandford, 2007, p. 3). Participant dropout and panel attrition require particular attention in Delphi studies to ensure continuous participation throughout the Delphi survey execution period (cf. Bardecki, 1984). High dropout rates typically threaten the validity of Delphi results (Hasson & Keeney, 2011).

Finally, we subjected the five selected projections to a rigorous test with the help of both researchers and experts (Hasson & Keeney, 2011). Two members of our research team checked the projections once again for all known quality criteria. In addition, we asked two researchers who are familiar with the Delphi method to also check our projections for quality. We then tested the projections with three industry experts as a final check. As a result, our study included the following five projections:

Projection 1. By 2030, sports managers will choose among technology-generated decision alternatives instead of planning themselves (*short: decisions*).
Projection 2. By 2030, digital capabilities have become the most important qualification requirement for many jobs in sports organizations (*short: skills*).

Projection 3. By 2030, more than 30% of the tasks in sports organizations currently performed by humans will be performed by technology (*short: tasks*).

Projection 4. By 2030, employees in sports organizations receive feedback and motivation from technology rather than from managers (*short: feedback*).

Projection 5. By 2030, performance monitoring and progress control is automated and managers only interfere when problems emerge (*short: monitoring*).

4.3.2 Development of Prospective Survey Items

In the second part of the survey, participants had to answer six prospective questions with a total of 50 Likert type items. These items only had to be answered once, i.e., when participants revisited the survey they only saw and could only adjust their responses to the five Delphi projections (the survey was programmed to not show the prospective items again once they have been answered; we used the same approach for sentiments and demographics). To the best of our knowledge, this is a novel approach to conducting Delphi studies that addresses some of the typical Delphi drawbacks and provides several advantages.

First, this allowed us to significantly reduce the length and duration of our survey, particularly when experts revisited the questionnaire to review and adjust their own and other participants' assessments. Schmalz et al. (2021, p. 6) "encourage researchers to keep their questionnaires as short as possible," even though this might limit the amount of data that can be collected. This ensures continuous participation throughout the survey execution period (cf. Bardecki, 1984), reduces survey fatigue (Clark, 2008, 2010), and helps to reduce dropout rates that threaten the validity of Delphi results (Hasson & Keeney, 2011). In comparison, some Delphi studies have reduced the number of projections after round one (typically when clear

consensus was reached) (e.g., Mason & Alamdari, 2007), attempting to limit the survey completion time.

Second, it allowed us to address a broader range of issues than would typically be possible in a Delphi study. For example, we wanted to get isolated assessments from the experts on ten managerial roles, nine types of organizations, and nine types of technology (i.e., a total of 28 items). Asking for this through Delphi projections would have a) significantly lengthened the entire survey and b) produced significantly more information than necessary (not all issues are relevant enough to justify a separate Delphi projection, however, they might be important to get a complete picture for certain topics). In addition, we asked the experts for their agreement on 22 additional statements along seven-point Likert scales anchored at 'strongly disagree' (1) and 'strongly agree' (7). These statements have asked the experts' expectations with regard to possible developments by 2030 (e.g., 'By 2030, most sports organizations will have a Chief Digital Officer (CDO) or Chief Technology Officer (CTO)').

4.3.3 Expert Selection

The right selection of experts is a crucial element to ensure validity and quality of the Delphi method (Hasson et al., 2000). Having multi-level perspectives between the experts has shown to improve the reliability of results and avoid biases (Bonaccorsi et al., 2020). To ensure heterogeneity, we included experts from diverse backgrounds in terms of occupation or stakeholder group, job position, geography, and age (Mauksch et al., 2020). For the identification of experts, we used both online and offline networking approaches including desk research (e.g., screening relevant interest groups, conference participation lists, etc.) and the research team's personal networks (e.g., LinkedIn and direct contacts) (Kluge et al., 2020).

A total of 937 experts were invited to participate in the study via email or LinkedIn, each on an individual basis. Of those, 226 started the study and 117 fully completed it (including at least one revisit or review of own responses and those of other participants), leading to an overall response rate of 12.5%, which is consistent with similar online real-time Delphi studies (Beiderbeck et al., 2021b; Keller & von der Gracht, 2014). The composition of the panel is depicted in Figure 4.1. On average, the experts were 39 years old and had slightly more than ten years of work experience. 18% of the experts were female, reflecting an appropriate gender split given the underrepresentation of women in the sports industry (Burton, 2015). With respect to geographical diversity, participants originated from 27 different countries and were distributed as follows: 71% Europe, 17% America, 6% Asia, 3% Oceania, and 3% Africa. From an occupational or stakeholder group perspective, experts could be grouped into sports-centric (27%, including athletes, clubs, leagues, and associations), consulting (26%), agencies and media (19%), academia (15%), and adjacencies (13%, including various backgrounds such as sports medicine, sportstech startups, or sports investors). Overall, we consider this to be a very good expert panel, especially when considering foresight studies' typical dependency on convenience samples and the many common difficulties in expert selection (Belton et al., 2019; Devaney & Henchion, 2018).

To evaluate our experts' overall level of expertise, we used a multi-perspective approach proposed by Nowack et al. (2011), based on years of work experience, job level, and stakeholder status. In addition, we used self-assessment of expertise in closed-ended questions (five-point scale with categories expert, advanced, intermediate, beginner or novice). The combination of multi-perspective and self-assessment of expertise is rare in earlier Delphi studies (e.g., Bijl, 1992), but highly recommendable considering the importance of high quality experts for meaningful Delphi results (Nowack et al., 2011). Moreover, many experts in our study were pre-selected, thus, ensuring a certain level of expertise (Förster, 2015). It is worth mentioning, that a critical review of the qualitative input (i.e., experts' comments) may also serve as a very valuable, albeit laborious, indicator of expertise (Bolger et al., 2011; Bolger & Wright, 2011; Bonaccio & Dalal, 2006). We included this assessment in our syntax and content analysis with two independent researchers, evaluating expertise based on comments on a scale from 1 (very low expertise) to 5 (very high expertise). We assessed 112 out of 117 experts to have a high or very high level of expertise.



Figure 4.1 Study Phases – Projection Development, Expert Selection, and Analyses.

Note. Based on Beiderbeck et al. (2021b) and Roßmann et al. (2018).

4.3.4 Execution of the Delphi Survey

Besides the traditional approach (Linstone & Turoff, 1975), there are several variations of the Delphi method. For the purpose of this study, we chose a real-time format (Gnatzy et al., 2011), to allow participants to answer and proceed with the questionnaire at their convenience and to compare other participants' responses immediately after survey completion. This aimed at increasing survey convenience, avoiding research fatigue (Clark, 2008, 2010), and reducing dropout rates between 'rounds' (technically, there are no defined 'rounds' in real-time Delphis, instead, experts revisit the study as often as possible) to make it as convenient as possible for participants to critically review their own assessments and make adjustments where appropriate. The software used for the execution was Surveylet, as recommended by Aengenheyster et al. (2017).

The survey link was sent as direct message via email or LinkedIn. Given the unfamiliarity of most people with the Delphi method, the beginning of the survey included detailed explanatory information (text and video) on the procedure, to ensure proper participation of all experts. In addition, potential cognitive biases were briefly explained to mitigate their risk as much as possible (Bonaccorsi et al., 2020). Next, participants assessed the five Delphi projections followed by the 50 prospective survey items. For each projection, participants were asked to make three quantitative assessments: probability of occurrence (eleven-point scale from 0 to 100%), desirability of occurrence (seven-point Likert scale), and impact in case of occurrence (seven-point Likert scale). Seven-point Likert scales were chosen instead of the more commonly used five-point version as having more scale points typically yields better and more reliable results (Allen & Seaman, 2007; Nunnally, 1994). This survey design choice is also consistent with other high quality Delphi studies (Kluge et al., 2020). As anchors for the scales we used 'very low' (1) and 'very high' (7). In addition to the quantitative assessments, participants were asked to provide one qualitative assessment per projection where we asked them to explain their assessment and provide a reasoning. To avoid research fatigue and foster survey convenience, we have decided to have only one comment field for each projection, compared to other approaches that use comments for each survey item individually or differentiate between pro and contra argument comment fields. Benefits of using only one comment box include limiting the total number of comments, avoiding duplicate comments from the same respondent, and avoiding overly lengthy qualitative input in general. An excessive amount of qualitative responses in Delphi studies can lead to overly long later Delphi rounds, which in turn often leads to research fatigue and panel attrition (Bardecki, 1984; Clark, 2008; Thiebes et al., 2018). To avoid this, we followed existing Delphi research recommending "fewer, well focused open-ended questions" (Trevelyan & Robinson, 2015, p. 425).

At the survey end, we asked participants for basic socio-demographics such as age, gender, nationality, degree, occupation status, type of organization, and job level. We also asked for

years of experience in the sports industry and the aforementioned self-assessment of expertise with respect to sports management and technology, respectively. This deep-level information about the experts is extremely helpful to understand the experts' knowledge and skills, which may ultimately affect their response behavior and assessments (Spickermann et al., 2014). To obtain more deep-level information, namely with respect to experts' attitudes, we have asked them to respond to the following five established scales along seven-point Likert scales anchored at 'strongly disagree' (1) and 'strongly agree' (7): (1) attitudes towards using technology (ATT) (Teo & Zhou, 2014); (2) intention to use technology (ITT) (Teo & Zhou, 2014); (3) affinity for technology interaction (ATI) (Wessel et al., 2019); (4) trust in technology (McKnight et al., 2002); and (5) technological innovativeness (TI) (Bruner & Kumar, 2007).

4.4 Results

4.4.1 Descriptive Statistics

As recommended by Häder (2009), we checked our complete set of data for errors before our analysis to ensure high data quality and cleaned our data accordingly. To check the generalizability of our results, we tested for non-response bias by following Roßmann et al. (2018). Assuming similarity between late respondents and non-respondents (Armstrong & Overton, 1977), we applied the Mann-Whitney U test for a comparison between early (first 20) and late (last 20) respondents for all five projections in all three dimensions (EP, I, D). Since no significant differences occurred (p < 0.05), we infer the absence of a non-response bias.

The qualitative results build on a total of 559 comments out of 585 possible comments. This very high comment rate (95.6%) suggests a very high level of involvement on the part of the experts (Kluge et al., 2020). We assessed the quality of comments with a syntax and content analysis by following Förster and von der Gracht (2014), see Table 4.2 for the results. The syntax analysis shows that most comments consist of complete sentences, which is an additional indicator for high expert involvement as it signals a thorough consideration of the projections.

The content analysis showed that beliefs (38.6%) were the most common type of qualitative input, followed by cause and effect arguments (19.7%) and differentiations (18.6%).

Statement type	Total amount	Percentage share
Syntax analysis		
Whole sentences	512	91.6%
Catchphrases	45	8.1%
Catchwords	2	0.4%
Content analysis		
Belief	226	38.6%
Cause and Effect	115	19.7%
Differentiation	109	18.6%
Trend	56	9.6%
Example	53	9.1%
No information	26	4.4%

 Table 4.2 Syntax and Content Analysis of Written Statements.

Table 4.3 provides an overview of the quantitative results for the Delphi projections. All five projections had an average impact greater than five. This indicates a 'somewhat high' or 'high' impact, suggesting that the projections addressed in our study are highly relevant (Kluge et al., 2020). Projection 1 (*decision*) is expected to have the highest impact in case of occurrence (M = 5.69) and projection 4 (*feedback*) the lowest (M = 5.02). Except for projection 4 (*feedback*), all projections' impact assessment attained consensus among experts with an IQR threshold of 1.75, i.e., 25% of the seven-point Likert scale (Warth et al., 2013).

	EP				D				Ι			
Projection	Mean	SD	Median	IQR	Mean	SD	Median	IQR	Mean	SD	Median	IQR
1: Decisions	0.65	0.21	0.70	0.30	4.94	1.45	5	2	5.69	1.00	6	1
2: Skills	0.66	0.24	0.70	0.30	4.94	1.53	5	2	5.36	1.23	6	1
3: Traits	0.69	0.24	0.70	0.40	4.78	1.47	5	2	5.50	1.22	6	1
4: Feedback	0.50	0.30	0.50	0.40	3.79	1.91	4	3	5.02	1.57	5	2
5: Monitoring	0.64	0.27	0.70	0.40	4.79	1.70	5	2	5.40	1.23	6	1

 Table 4.3 Delphi Results – Descriptive Statistics.

Note. EP = expected probability of occurrence (0-100%); D = desirability of occurrence (7 pt. Likert scale; 7 = very high); I = impact in case of occurrence (7 pt. Likert scale; 7 = very high); SD = standard deviation; IQR = interquartile range; Consensus (IQR for EP \leq 0.25, IQR for D and I \leq 1.75) is marked in bold.

With respect to desirability, four out of five projections were considered to have an average desirability of close to five, with projections 1 (*decisions*) and 2 (*skills*) being the most desirable (M = 4.94). Thus, following Schweizer et al. (Schweizer et al., 2020), these projections can be seen as opportunities from the experts' point of view. Only projection 4 (*feedback*) had a 'neutral' or 'somewhat low' desirability (M = 3.79) and can thus potentially be seen as a slight threat from the experts' point of view. None of the projections attained expert consensus on desirability. This is a particularly interesting finding, as in most Delphi studies experts do reach consensus for desirability on at least some of the projections; it is an indicator that both relevant and controversial projections for a fruitful discussion have been selected (cf. Warth et al., 2013). To better understand potential reasons for this dissent, we conducted a thorough dissent analysis following Warth et al. (2013).

With respect to the expected probability of occurrence (EP), four out of five projections had an average expected probability between 60-70%; projection 3 (*tasks*) had the highest expected probability of 69%. This shows, again, the relevance of the chosen projections and the realistic possibility of their occurrence. Only projection 4 (*feedback*) had a lower expected probability, but still at 50%. Thus, projection 4 had the lowest scores across all three dimensions EP, D, and I. It is worth mentioning, that the comments on projection 4 suggest that most experts do not necessarily question the technological feasibility of 'receiving feedback and motivation from technology rather than from managers', but they categorically believe that this is something that should continue to be done by humans. This may explain low average mean values for EP and D, whereas the low average mean value for I may be a consequence of the low scores on the EP and D dimensions. It is also interesting to compare that automated feedback is of high interest and relevance in the world of sports (Eyring et al., 2021), however, given our findings there are differences between feedback for athletes and feedback in a managerial context. None of the projections attained consensus with respect to EP, even though four of them had an average expected probability of more than 60% which is within the typical range for consensus projections of 60-80% (von der Gracht & Darkow, 2010). It is worth mentioning, that the experts almost reached consensus on projections 1 and 2 with an IQR of 0.30 (vs. the consensus threshold of IQR \leq 0.25). A common finding in Delphi studies is, that Delphi projections below or at the lower end of the 60-80% EP range are typically less likely to reach consensus (Ogden et al., 2005; von der Gracht & Darkow, 2010). Future developments of projections with relatively low probability are often more difficult to estimate, which in turn usually leads to more dissent. The present consensus/dissensus distribution presents interesting results. Further interpretation will be provided in Section 4.5 and the dissent and sentiment analyses in Sections 4.4.2 and 4.4.3 will provide additional insights as well.

Following the Delphi projections, participants assessed six additional prospective questions with a total of 50 Likert type items. Again, first, we checked for errors in the data as well as for non-response bias. Finding no significant difference between early and late responder groups, we concluded that no non-response bias is present. An overview of the results can be found in Table 4.4 and insights from these questions are included in the discussion.

Question	Item	Mean	Median	Mode	SD
Please indicate how	Figurehead	2.08	2	1	1.37
much you think the	Leader	1.92	2	1	1.25
sports managers could	Liaison	3.18	3	2	1.87
be replaced by	Monitor	5.80	6	6	1.28
technology by 2030.	Disseminator	5.19	5	6	1.29
(1 = Not at all	Spokesperson	2.90	3	1	1.55
7 = Fully replaceable)	Entrepreneur	2.75	2	2	1.51
, <u>, , , , , , , , , , , , , , , , , , </u>	Disturbance Handler	2.91	2	2	1.68
	Resource Allocator	4.89	5	5	1.55
	Negotiator	2.70	2	1	1.54
Please indicate how	Sports associations	5.03	5	5	1.41
much you think sports	Sports leagues	5.78	6	6	1.10
following	Sports clubs	5.85	6	6	1.06
institutions/groups will	Athletes	5.59	6	6	1.13
be impacted by	Broadcaster	6.34	7	7	0.83
next 10 years. (1 = Not at all impacted, 7 = Fully impacted)	Media	6.37	7	7	0.81
	Consulting	5.52	6	5	1.28
	Agency	5.62	6	6	1.18
	Academia	5.31	5	5	1.26

Table 4.4 Prospective Survey Items Results – Descriptive Statistics.

Question	Item	Mean	Median	Mode	SD
Please indicate how	Advanced Materials	5.00	5	5	1.37
much you think the	Robotics	4.21	4	4	1.51
will impact the job of	IoT/Sensors	5.60	6	6	1.28
sports managers over	AI/Machine Learning	5.91	6	7	1.05
the next 10 years.	Advanced Analytics	6.31	6	7	0.82
(1 = No impact at all, 7 = Full impact)	Blockchain	4.36	4	4	1.68
/ = Full impact)	AR/VR/XR	5.32	6	6	1.32
	5G	5.66	6	7	1.28
	Voice	4.86	5	6	1.54
By 2030, (1 = Strongly disagree.	technological progress has led to new types of sports managers (i.e., backgrounds, skill sets, etc.)	5.72	6	6	1.07
7 = Strongly agree)	digital capabilities have become the most important success factor for sports managers	4.31	4	5	1.63
	the number of data scientists (and similar roles) has more than doubled in sports management positions	5.68	6	6	1.17
	data-driven decision-making has replaced intuition-based decision-making	4.56	5	5	1.52
	despite advanced technology, social skills remain the most important element in a sports manager's job	5.85	6	7	1.20
	the majority of tasks of sports managers can be performed by technology such as AI, robots, etc.	3.37	3	4	1.40
	sports managers will spend more than 50% of their time with technology-based tasks they do not perform today		5	5	1.37
	technological equipment has become a key cost driver for sports organizations	5.23	5	5	1.34
	most sports organizations will have a Chief Digital Officer (CDO) or Chief Technology Officer (CTO)	5.98	6	7	1.24
	the sports industry will need to redeploy many of its employees to new tasks given technological advancements	5.41	6	6	1.16
	the sports industry will need to hire/employ new skills to manage technological advancements	6.18	6	6	0.74
	there will be a movement away from technology	2.01	2	1	1.34
By 2030, most sports	will require significant reskilling/upskilling	5.65	6	6	1.15
managers	cannot keep up with the speed of technological advancement	4.36	5	5	1.60
(1 = Strongly disagree,	feel lost in a jungle of technologies and opportunities	4.18	4	3	1.69
/ = Strongry agree)	have managed to become well-informed about technologies and how best to use them	4.80	5	5	1.25
	know which technology is best suited for each of their problems	4.10	4	5	1.55
By 2030, most professional football	will have a Chief Digital Officer (CDO) or Chief Technology Officer (CTO)	5.84	6	7	1.38
clubs (1 = Strongly disagree,	will have a (business) unit dedicated to innovation, technology, or data science	5.77	6	7	1.39
(1 = Strongly disagree, 7 7 = Strongly agree)	will be considered leading-edge in terms of technology and innovation when compared to other industries	3.57	3	3	1.73
	will serve as laboratories for new technologies	4.32	5	5	1.66
	will play a key role in many innovation processes (e.g., as innovators or early adopters)	4.07	4	4	1.72

 Table 4.4 Quantitative Prospective Survey Items Results. (Continued)

Note. SD = standard deviation.

4.4.2 Dissent Analysis

4.4.2.1 Desirability Bias Analysis

The desirability (undesirability) of an event may positively (negatively) influence the judgment of the event's probability to occur, a phenomenon known as desirability bias (Ecken

et al., 2011; Krizan & Windschitl, 2007); it should not be confused with social desirability bias. Desirability bias poses a threat to the reliability of Delphi results as it may distort probability estimates and affect consensus/dissent distributions, thus, limiting the explanatory power of results (Ecken et al., 2011). To assess whether our Delphi results are affected by a potential desirability bias, we followed a procedure proposed by Beiderbeck et al. (Beiderbeck et al., 2021a). Making use of Pearson's product-moment correlation coefficients, we found significant correlations (p < 0.01) between expected probability and desirability for all five projections, indicating the potential existence of a desirability bias (see Table 4.5). This is not surprising, considering the findings of previous Delphi studies (Beiderbeck et al., 2021b) and considering that desirability bias is generally higher in Delphi studies with rather long time horizons (Winkler & Moser, 2016). The potential existence of a desirability bias is a relevant insight to bear in mind for the later results and discussion. However, even if desirability bias was present, the strength of the 'estimated bias' would be negligible in our study as our experts did not "share a pronounced and common desirability" (Ecken et al., 2011, p. 1666) and the desirability bias would mostly be offset by Delphi's averaging process. The relationship between 'estimated bias' and average desirability has been found to be linear (Ecken et al., 2011).

Projection	r	df	t	р
1: Decisions	. 49	115	6.07	0.000
2: Skills	.70	115	10.63	0.000
3: Traits	.64	115	8.92	0.000
4: Feedback	.74	115	11.92	0.000
5: Monitoring	.66	115	9.34	0.000

Table 4.5 Dissent Analysis – Desirability Bias.

Note. Statistics describe correlation between expected probability and desirability of each respective projection.

4.4.2.2 Outlier Analysis

Outliers can distort Delphi results by biasing mean values or inflating standard deviations (Field, 2005). Thus, outliers can potentially explain dissent in Delphi results. To check for

outliers in our data, we standardised the EP values for all projections to see if any of them exceeded the threshold z-score of 2.58, i.e., the 99% confidence level (Warth et al., 2013). Projections 1 (*decisions*) and 3 (*tasks*) had two outliers each, i.e., more than the generally accepted threshold of 1%, meaning that these outliers may have an effect on average scores (Field et al., 2012). Hence, we excluded the outliers in projection 1 and 3 to re-calculate the EP mean and the IQR. For projection 1, the EP mean increased by one percentage point to 66.3% and the IQR remained unchanged at 0.30. For projection 2, the EP mean increased by 1.2 percentage points and the IQR decreased from 0.40 to 0.35, indicating that outliers might explain part of the observed dissent. However, given these very minor differences caused by outliers, we conclude that there is no significant effect of outliers on our results. This is supported by an analysis of the comments provided by the outliers in comparison to other experts, which showed no significant differences.

4.4.2.3 Bipolarity Analysis

Similar to outliers, bipolar data distribution can also function as an explanation for dissent in the assessment of future projections (Dajani et al., 1979). Following Warth et al. (Warth et al., 2013), we tested whether the average EP scores in our data might be the result of a bipolar distribution of responses where one of two opposing groups provided rather high scores for EP, while the other group provided rather low scores. For desirability and impact, we performed the corresponding analyses analogously. In a first step, we tested for bimodal distribution for EP, D, and I values of all five projections (Linstone & Turoff, 1975). None of the variables revealed to have more than one mode. In a second step, 15 histograms (5 projections with 3 dimensions each) were analysed for visual cues of bipolar data distribution. Only projection 4 *(feedback)* showed a tendency towards bipolarity, which might potentially hint at important differences in expert opinions. This is in line with prior work that suggested that particularly EP mean averages between 40 and 60% might be subject to bipolar data distribution (Warth et al., 2013). Projection 4 had an EP mean value average of 50%, the lowest of all projections. It also had the lowest average score for I (5.02) and D (3.79), which is also a value very close to the middle of the 7-point Likert scale. In view of these results, we looked closely at the qualitative results of projection 4 and found diverging opinions: Experts who assessed EP as rather low argued 'this to be quite a dystopian scenario' or 'a disaster for the sports industry'. Experts who assessed EP as rather high considered this to be 'a must' or 'unavoidable', arguing that 'sports managers need to keep up with other employers with regards to tech-friendly work environments' and 'these kinds of work environments are a prerequisite to attract and retain digital talents that will become more and more crucial'. It is worth mentioning, that even though we find a tendency for bipolar distribution in projection 4, this bipolarity is not towards the ends of the scale, but rather to the middle. In addition, projection 4 only showed partial intra-group consensus for 1 out of 15 intra-group comparisons (see intra-group consensus analysis in Section 4.2.4. below) and there were no indications for potentially improved consensus from the desirability bias or outlier analyses. Thus, we conclude that bipolar data distribution is not enough to explain dissent in our Delphi results, while it may partially resolve the dissent in projection 4.

In conclusion, we saw that the tendency towards bipolarity in projection 4 might be the results of opposing opinion groups. Another or an additional explanation could stem from differences in experts' backgrounds which might lead them to diverging assessments; this will be tested in the following section.

4.4.2.4 Stakeholder-group Analysis

Diverging backgrounds and/or interests of experts may function as a cause for dissent in Delphi studies (Warth et al., 2013), particularly on multifaceted and rather complex issues such as socio-technical transitions (Geels, 2002). A socio-technical transition is a shift from one socio-technical system to another, where a socio-technical system is defined as the "interlinked mix of technologies, infrastructures, organizations, markets, regulations, and user practices that

together deliver societal function" (Geels et al., 2017, p. 1242). Socio-technical transitions are typically multi-dimensional and involve both technological and social changes. One of the most impactful socio-technical transitions is the digitalization of our jobs and workforce (cf. Govers & Amelsvoort, 2019), which is the subject of our study as we assess the impact of technology on sports managers. This 'technochange' (technology-driven organizational change) (Markus, 2004) requires a fundamental change in the way sports managers perform their work. Technochange and socio-technical transitions may often lead to group struggles as well as tensions between societal groups (Geels, 2002). Prior work has found that industry experts with long-term work experience in their industry are typically less open to socio-technical transitions than other groups such as academia (Dijk & Yarime, 2010; Dyerson & Pilkington, 2000). Accordingly, one might expect differences in assessments between the different stakeholder groups in our study. To test this assumption, we conducted a stakeholder analysis for the five different groups in our study (sports-centric, consulting, agencies & media, academia, and adjacencies) and present the results in Table 4.6.

Given the non-normal distribution of the data, we used the nonparametric Mann–Whitney U test to analyse significant differences in projection assessments between our stakeholder groups (see Table 4.7). We found significant differences in their assessment between the *sports-centric* group and all other stakeholder groups, respectively. However, as opposed to the indication from prior work, we don't find clear evidence of the group *sports-centric* being less open to socio-technical change. A closer look reveals interesting insights, for example, group *sports-centric* had the highest averages for EP, D, and I for projection 1 (*decisions*). In contrast, for projection 5 (*monitoring*), group *sports-centric* had the lowest averages for EP and D and at the same time the highest average for I. The comparison of EP assessments for projection 5 (*monitoring*) between group *sports-centric* (EP = 0.77) and group *academia* (EP = 0.58) reveals the single largest difference in average EP scores between any two groups. For D, the largest difference is between group *adjacencies* (D = 5.67) and group *academia* (D = 4.06) in

projection 3 (*traits*). For I, the largest difference is between group *sports-centric* (I = 5.75) and group *consulting* (I = 5.10) in projection 5 (*monitoring*). In a comparison across all five projections, on average, group *academia* has the highest EP scores, group *adjacencies* has the highest D scores, and group *sports-centric* has the highest I scores. It is worth mentioning, that similar to group *sports-centric*, group *adjacencies* showed significantly different assessments than other groups in many instances.

Considering the partially significant differences between groups, the intra-group consensus was evaluated. We found instances of intra-group consensus for all stakeholder groups, all projections, and all dimensions (EP, D, I); see Table 4.8 for an overview. The IQR for all five instances of intra-group consensus on EP was 20.

	Sports-	centric		Consul	ting		Agenci	es & mee	dia	Acaden	nia		Adjace	ncies	
Projection	EP	D	Ι	EP	D	Ι	EP	D	Ι	EP	D	Ι	EP	D	Ι
1: Decisions	0.71	5.22	5.94	0.62	4.87	5.48	0.58	4.64	5.64	0.65	4.47	5.65	0.71	5.47	5.73
2: Skills	0.64	5.22	5.53	0.64	4.84	5.32	0.73	5.00	5.18	0.71	4.88	5.59	0.59	4.53	5.07
3: Traits	0.70	4.91	5.72	0.66	4.61	5.26	0.70	4.77	5.23	0.63	4.06	5.65	0.75	5.67	5.80
4: Feedback	0.56	4.31	5.09	0.48	3.42	4.87	0.40	3.36	4.95	0.58	4.24	5.29	0.47	3.60	4.93
5: Monitoring	0.58	4.38	5.75	0.63	4.81	5.10	0.67	4.95	5.36	0.77	5.18	5.59	0.61	4.93	5.13
Average	0.64	4.81	5.61	0.61	4.51	5.21	0.62	4.54	5.27	0.67	4.57	5.55	0.63	4.84	5.33

 Table 4.6 Stakeholder Group Analysis.

Note. EP = mean expected probability of occurrence (0-100%); D = mean desirability of occurrence (7 pt. Likert scale; 7 = very high); I = mean impact in case of occurrence (7 pt. Likert scale; 7 = very high); Consensus (IQR for EP \leq 0.25, IQR for D and I \leq 1.75) is marked in bold.

Group comparison	Projection	Dimension	U	р
Sports-centric / Consulting	1: Decisions	EP	614	.099
	4: Feedback	D	633.5	.056
	5: Monitoring	Ι	644.5	.035
Sports-centric / Agency	1: Decisions	EP	461	.050
	4: Feedback	EP	458	.061
	4: Feedback	D	447.5	.090
Sports-centric / Academia	5: Monitoring	EP	173	.037
	1: Decisions	D	348	.099
	3: Traits	D	353	.086
Sports-centric / Adjacencies	2: Skills	D	318	.070
	5: Monitoring	Ι	310.5	.098
Consulting / Adjacencies	1: Decisions	D	159	.076
	3: Traits	D	126	.01
Agency / Adjacencies	1: Decisions	EP	110	.087
	2: Skills	EP	221.5	.080
	1: Decisions	D	103.5	.051
	3: Traits	D	102.5	.045
Academia / Adjacencies	1: Decisions	D	72.5	.033
	3: Traits	D	54.5	.005

 Table 4.7 Stakeholder Group Analysis – Results of the Mann-Whitney U Test.

Note. EP = expected probability of occurrence; D = desirability of occurrence; I = impact in case of occurrence.

	0 - 0 - r				
Stakeholder group	EP	D	Ι		
Academia	1, 2, 5	2, 5	1, 2, 3, 4, 5		
Adjacencies	-	1, 2, 3	1, 3, 5		
Agency	-	1, 5	1, 2, 3, 5		
Consulting	3	3	1, 2, 3		
Sports-centric	1	1	1, 2		

 Table 4.8 Stakeholder Group Analysis – Intra-Group Consensus Across Projections.

Note. Numbers indicate the projections for which intra-group consensus was reached; EP = expected probability of occurrence; D = desirability of occurrence; I = impact in case of occurrence. Numbers indicate respective projections.

4.4.3 Sentiment Analysis

To gain deeper insights from our study, we followed the approach from Beiderbeck et al. (2021b), Loye (1980), and Spickermann et al. (2014) and included participants' deep-level

information. This information included experience and expertise as well as specific technologyrelated sentiments.

4.4.3.1 Experience and Expertise

As described earlier, we followed a multi-perspective approach (Nowack et al., 2011) to evaluate the expertise of our experts, in combination with experts' self-assessment and an expertise focused syntax and content analysis. First, we tested for differences in responses between different groups with respect to years of work experience in the sports industry; on average, our experts had more than ten years, which indicates a very experienced sample in this regard. The least experienced experts (0 to 3 years of work experience) assessed the impact of projection 4 (*feedback*) significantly lower (M = 4.61) than the more experienced experts (M = 5.16); p = .087. The opposite was the case with the expected impact of projection 1 (*decisions*): The most experienced experts (more than 10 years of work experience) projected a significantly lower average (M = 5.4) than the less experienced experts (M = 5.99); p = .006. The middle group of participants (3 to 10 years of work experience) assigned a significantly higher impact (M = 6.00) to projection 1 (*decisions*) than the rest (M = 5.54); p = .007. Moreover, we found a weak but significant negative correlation between the projected impact of projection 1 (*decisions*) and years of experience (r = -.18, p = .048).

Second, we tested for differences in responses between different groups with respect to their job level. To do so, we grouped experts as (i) junior, (ii) middle management, (iii) senior management, and (iv) executive based on their indicated job level. Executives assigned a significantly lower expected probability of occurrence (M = 58%) to projection 5 (*monitoring*) than experts on 'lower' job levels (M = 68%); p = .044. Senior management considers projection 5 (*monitoring*) significantly less desirable (M = 4.30) than others (M = 4.93); p = .086. This is a very interesting result, indicating that more junior experts consider automated performance monitoring and progress control as significantly more desirable, especially when

we compare the average desirability scores of groups junior (M = 5.18) and middle management (M = 5.19) with those of groups senior management (M = 4.30) and executives (M = 4.62). Middle management expected the probability of occurrence of projection 4 (*feedback*) significantly higher (M = 56%) than others (M = 46%); p = .099. Similarly, they assessed the desirability of projection 5 (*monitoring*) significantly higher (M = 5.19) than others (M = 4.65); p = .090. They also project the impact of projection 1 (*decisions*) significantly higher (M = 6.06) than others (M = 5.59); p = .026. In addition to the significant differences between groups on the desirability of projection 5 (*monitoring*), we tested for correlation and found that projection 5 negatively correlated with job level on all three dimensions: expected probability (r = -.17, p = .071), desirability (r = -.16, p = .079), and impact (r = -.17, p = .063). That is, the higher the experts' job level, the lower their average scores for probability, impact, and desirability of automating performance monitoring and progress control.

To specifically check for expertise in the areas of technology and management, we asked participants to assess their own expertise along five-point Likert scales from 'novice' (1) to 'expert' (5). Most experts indicated to have either intermediate (n = 56), advanced (n = 42) or expert (n = 14) technology expertise, while there were no novices and only five beginners. To test whether assessments were affected by specific expertise, we conducted Mann-Whitney *U* tests for all relevant comparisons (see Table 4.9). To have an even more conclusive comparison, we aggregated participants into only two groups: relatively high technology expertise (n = 56) and relatively low technology expertise (n = 61). Participants with high technology expertise expected the probability of occurrence of projection 5 *(monitoring)* significantly lower (*M* = 59%) than participants with low expertise (*M* = 69%); *p* = .065. For projection 1 *(decisions)*, the high technology expertise group assigned a higher desirability (*M* = 5.27) and anticipated a higher impact (*M* = 5.88) than the low technology expertise group (desirability *M* = 4.64; impact *M* = 5.52); desirability *p* = .017.; impact *p* = .022.

Expertise area	Projection	Dimension	Group 1			Group 2			U	р
			Expert level	n	mean	Expert level	n	mean		
Technology	5: Monitoring	EP	Intermediate	56	69%	Non-intermed.	61	60%	2037.5	.070
	1: Decisions	D	Intermediate	56	4.70	Non-intermed.	61	5.16	1371.5	.058
	1: Decisions	Ι	Intermediate	56	5.46	Non-intermed.	61	5.90	1240	.005
	2: Skills	EP	Advanced	42	60%	Non-advanced	75	70%	1153.5	.016
	3: Traits	EP	Advanced	42	63%	Non-advanced	75	72%	1224.5	.044
	5: Monitoring	EP	Advanced	42	57%	Non-advanced	75	69%	1158	.017
	1: Decisions	D	Advanced	42	5.26	Non-advanced	75	4.76	1871.5	.082
	2: Skills	EP	Expert	14	79%	Non-expert	103	64%	977	.030
	3: Traits	EP	Expert	14	81%	Non-expert	103	67%	958.5	.044
	2: Skills	D	Expert	14	5.57	Non-expert	103	4.85	932.5	.069
	3: Traits	D	Expert	14	5.43	Non-expert	103	4.69	933	.070
	1: Decisions	Ι	Expert	14	6.14	Non-expert	103	5.63	930.5	.053
	2: Skills	Ι	Expert	14	5.86	Non-expert	103	5.29	986.5	.021
	3: Traits	Ι	Expert	14	6.07	Non-expert	103	5.43	939	.056
Management	3: Traits	EP	Beginner	9	54%	Non-beginner	108	70%	288	.041
	4: Feedback	EP	Beginner	9	68%	Non-beginner	108	48%	665.5	.066
	5: Monitoring	EP	Beginner	9	78%	Non-beginner	108	63%	668	.061
	5: Monitoring	D	Beginner	9	5.56	Non-beginner	108	4.72	651	.085
	5: Monitoring	Ι	Beginner	9	6.22	Non-beginner	108	5.33	691	.030
	4: Feedback	EP	Expert	42	43%	Non-expert	75	54%	1254.5	.067
	1: Decisions	Ι	Expert	42	5.36	Non-expert	75	5.88	1164.5	.010

Table 4.9 Sentiment Analysis – Mann-Whitney U Test Results for all Relevant Comparisons for Level of Expertise.

Note. EP = expected probability of occurrence; D = desirability of occurrence; I = impact in case of occurrence.

With respect to management expertise, our sample proofed to be even more proficient as with technology expertise. Most experts indicated to have expert (n = 42), advanced (n = 37), or intermediate (n = 28) management expertise, while there were only one novice and nine beginners. Analogous to our approach with technology expertise, we tested for differences between groups with different levels of expertise (see Table 4.9) and aggregated participants into a relatively high management expertise (n = 79) and a relatively low management expertise (n = 38) group. For these two groups, we found only one significant difference in the evaluation of the projections along all three dimensions EP, D, and I. Participants with high management expertise expected the probability of occurrence of projection 5 (*monitoring*) significantly lower (M = 62%) than participants with low expertise (M = 69%); p = .086.

4.4.3.2 Technology-related Sentiments

In addition to experience and expertise, we evaluated our participants' technology-related sentiments to gain additional insights from our data, following Beiderbeck et al. (Beiderbeck et al., 2021a). We used established constructs, all of which were assessed along seven-point Likert scales anchored at 'strongly disagree' (1) and 'strongly agree' (7). We have mostly selected short scales for their lower costs in terms of assessment time, higher response rates, and higher face validity through lower perceived redundancy by respondents (Rammstedt & Beierlein, 2014; Wessel et al., 2019). To assess the measurement reliability and construct validity of our constructs, we conducted a confirmatory factor analysis (CFA) following Homburg and Giering (1998) and using established threshold values (Anderson & Gerbing, 1988; Bagozzi & Yi, 1988; Homburg & Giering, 1998): Composite reliability (CR) \geq .6 and average variance extracted (AVE) \geq .5. For all constructs, CR exceeded the .6 threshold suggested by Bagozzi and Yi (1988) as well as the .7 threshold suggested by Nunnally (1994). For one construct, AVE was at .47 slightly below the .5 threshold suggested by Fornell and Larcker (1981). We took this into consideration for our further analysis. The results of the CFA are shown in Table 4.10.

Construct	Mean	SD	CR	AVE
Attitude toward using technology (ATT)	5.78	1.02	0.92	0.75
Intention to use technology (ITT)	5.65	1.04	0.85	0.74
Affinity for technology interaction (ATI)	4.54	1.25	0.77	0.47
Trust in technology (TRUST)	4.71	1.35	0.82	0.61
Technological innovativeness (TI)	3.83	1.74	0.95	0.78

Table 4.10 Confirmatory Factor Analysis.

Note. SD = Standard deviation; CR = Composite Reliability; AVE = Average Variance Extracted; CR = $(\sum \lambda_i)^2 / ((\sum \lambda_i)^2 + \sum \theta_i)$; AVE = $\sum \lambda_i^2 / (\sum \lambda_i^2 + \sum \theta_i)$.

First, building on the technology acceptance model (TAM) (Davis, 1989), we adapted two constructs from Teo and Zhou (2014) to measure participants' attitude toward using technology (ATT) and intention to use technology (ITT). An attitude consists of affective, behavioural, and cognitive components (Rosenberg et al., 1960) and is typically either positive or negative (Eagly & Chaiken, 2007). For our purpose, it relates to "the degree to which a user likes or dislikes using technology" (Teo & Zhou, 2014, p. 126). Intention is a subjective probability or a mental state of commitment that an individual will engage in a certain behaviour and typically involves planning and forethought (Bratman, 1987). Attitudes and intention are closely linked in this context as shown in the TAM's belief-attitude-intention relationship (Davis, 1989). It might reasonably be expected that experts with a more positive attitude toward the use of technology and a higher intention to use technology, would also anticipate a higher expected probability, desirability, and impact for our projections. To check this, we calculated Pearson's product-moment correlation coefficients between ATT as well as ITT and all dimensions of all projections. The results showed statistically significant correlations for 9 out of 15 tests for ATT and for 8 out of 15 for ITT (see Table 4.11). As anticipated, experts' desirability assessments were positively correlated with the attitude toward using technology for all five projections and impact was positively correlated for three out of five projections (projections 1, 2, and 5). For ITT, four out of five desirability assessments (projections 1, 2, 3, and 4) and two out of five impact assessments showed a significant positive correlation (projections 1 and

Parameter	Projection	Dimension	r	t	р
Attitude toward using	1: Decisions	EP	. 25	2.76	.007
technology (ATT); Davis,		D	.47	5.69	.000
1989; Teo & Zhou, 2014		Ι	.23	2.57	.011
	2: Skills	D	.28	3.09	.002
		Ι	.24	2.71	.008
	3: Traits	D	.16	1.77	.077
	4: Feedback	D	.23	2.56	.012
	5: Monitoring	D	.21	2.38	.019
		Ι	.37	4.27	.000
Intention to use technology	1: Decisions	EP	.24	2.61	.010
(ITT); Davis, 1989; Teo &		D	.35	4.04	.000
Zhou, 2014		Ι	.15	1.67	.097
	2: Skills	EP	.19	2.08	.040
		D	.18	2.02	.046
	3: Traits	D	.23	2.57	.011
	4: Feedback	D	.25	2.80	.006
	5: Monitoring	Ι	.25	2.75	.007
Affinity for technology	1: Decisions	EP	.19	2.05	.042
interaction (ATI); Franke et		D	.23	2.50	.014
al., 2019; Wessel et al., 2019		Ι	.35	3.97	.000
	5: Monitoring	Ι	.31	3.52	.000
Trust in technology	1: Decisions	EP	.25	2.71	.008
(TRUST); McKnight et al.,		D	.38	4.36	.000
2002; McKnight et al., 2011		Ι	.19	2.09	.038
	2: Skills	D	.24	2.70	.008
		Ι	.19	2.05	.042
	3: Traits	D	.19	2.07	.041
	4: Feedback	D	.19	2.05	.043
	5: Monitoring	D	.18	1.97	.051
Technological innovativeness	1: Decisions	EP	.30	3.32	.001
(TI); Bruner & Kumar, 2007		D	.32	3.63	.000
	2: Skills	EP	.19	2.09	.039
		D	.20	2.23	.027
		Ι	.18	2.01	.047
	3: Traits	Ι	16	-1.76	.082
	4: Feedback	EP	.16	1.73	.086
		D	.27	2.98	.004
	5: Monitoring	EP	.26	2.86	.005
		D	.22	2.39	.019
		Ι	.18	1.94	.055

Table 4.11	Sentiment	Analysis –	Results of the	Correlation	Analysis.

Note. Statistics describe statistically significant correlations between sentiment parameters and EP, D, and I of each respective projection. EP = expected probability of occurrence; D = desirability of occurrence; I = impact in case of occurrence.

Second, to assess participants' affinity for technology interaction (ATI), we used a construct with proven reliability and validity developed by Wessel, Attig, and Franke (2019). Affinity for technology interaction is "the tendency to actively engage in intensive technology interaction" (Franke et al., 2019, p. 456) or to avoid it; it can also be considered a measure of enjoyment. ATI plays an important role in human-technology interaction and addresses an essential facet in technology interaction research. In addition, checking for ATI is particularly important in research settings such as ours to probe whether the study participants are representative for the population under study. There is a risk of self-selection bias as voluntary participants in studies like ours may have a higher affinity for technology interaction than the larger population. Unchecked, this bias may lead to conclusions about potential future developments that miss relevant perspectives or neglect important population groups. Pearson's product-moment correlation coefficients between ATI and all dimensions of all projections showed statistically significant correlations for 4 out of 15 tests (see Table 4.11). For projection 1 (decisions), we find significant positive correlations between ATI and all three dimensions EP, D, and I. This could be an indication of people with high ATI being more likely to enjoy and feel comfortable with 'outsourcing' planning tasks to technology and only choosing from pre-generated decision alternatives. Surprisingly, desirability of occurrence was only significantly positively correlated for one of the five projections. In addition to correlation tests, we conducted Mann-Whitney Utests to compare groups with different levels of ATI. To ensure conclusive comparisons, we aggregated participants into two groups: ATI high (n = 42) and ATI low (n = 13). For all observed significant group differences, the ATI high group had higher average scores than the ATI low group. Particularly worth mentioning here is the very low average value of the ATI low group for projection 4 (*feedback*) expected probability (M = 32%), which is significantly lower than that for the ATI high group (M = 52%); p = .011. This result is of little surprise for a topic like feedback, since a low ATI score indicates the tendency to avoid engaging in technology interaction. An overview of all results is shown in Table 4.11.

Third, we considered participants' trust in technology (TRUST) using a construct from McKnight et al. (2011), that allows us to directly examine trust in technology. This is important as most research so far has focused on trust in people or organizations (even in the context of assessing trust in technology) instead of focusing on trust in the technology itself, i.e., in an technology artifact (McKnight et al., 2011). Consequently, for our purposes, trust in technology is "the belief that the specific technology has the capability, functionality, or features to do for one what one needs to be done" and "the general tendency to be willing to depend on technology across a broad spectrum of situations" (McKnight et al., 2011, p. 7), where one expects to achieve better results with the help of technology irrespective of what one assumes about that technology in general (McKnight et al., 1998). Supporting our earlier hypothesis, we find again significant positive correlations between trust and desirability for all five projections (see Table 4.11), which is most likely the consequence of high-trust individuals' expectations of better results through the use of technology. In addition to examining Pearson's product-moment correlation coefficients, we conducted Mann-Whitney U tests to specifically compare low-trust (n = 10) and high-trust (n = 43) groups in our sample. The low-trust group had significantly lower average scores for 8 out of 15 total comparisons and four out of five desirability comparisons (see Table 4.12). In particular, we find significant differences in projections 1 (decisions), 2 (skills), 4 (feedback), and 5 (monitoring), whereas we find no significant differences in projection 3 (tasks). This could indicate that the low-trust group has a tendency of relying less on technology for those topics that require more typical human skills, whereas they see the benefits of technology in other areas and consider it desirable as well.

Fourth, to assess participants' technological innovativeness (TI), we used a construct developed by Bruner and Kumar (2007), who define TI as the "extent to which a consumer is motivated to be the first to adopt new technology-based goods and services" (Bruner & Kumar, 2007, p. 331). TI is a relevant concept for our study given many people's common tendency to be skeptical of additional benefits from technology as well as a widespread reluctance to

change, both of which may often lead to low acceptance and slow adoption of technological innovation (Bruner & Kumar, 2007). As for attitude, intention, trust, and affinity before, it might reasonably be expected that experts with higher TI would also indicate a higher expected probability, desirability, and impact for the posed projections. Pearson's product-moment correlation coefficients between TI and all dimensions of all projections showed statistically significant correlations for 11 out of 15 tests (see Table 4.11), including all projections with at least one dimension. Interestingly, projection 3 (traits) showed a weak but significant negative correlation between TI and expected impact (r = -.16, p = .082), i.e., the higher participants' technological innovativeness, the lower their assessment of the impact if more than 30% of the tasks in sports organizations currently performed by humans were to be performed by technology in the future. It is worth mentioning, that this was the only negative correlation of all correlation tests across all technology-related sentiments that we assessed. Again, we conducted non-parametric mean value comparisons to identify differences between TI high (n = 34) and TI low (n = 39) groups and found significantly lower average scores for group TI low in 8 out of 15 comparisons (see Table 4.12). As for ATI and TRUST, we find no significant differences for projection 3 (tasks), while we find the single largest difference for projection 5 (monitoring) expected probability where the TI high low is significantly lower (M = 55%) than the TI high group (M = 74%); p = .003.

	-					
Group		Dimen-	N group high /	Mean group high /		
comparison	Projection	sion	N group low	Mean group low	U	р
ATI high / ATI	1: Decisions	Ι	42 / 13	6.07 / 5.08	145	.005
low	4: Feedback	EP	42 / 13	52% / 32%	146	.011
		Ι	42 / 13	3.76 / 2.85	188.5	.092
	5: Monitoring	Ι	42 / 13	5.83 / 4.92	129.5	.003
TRUST high / TRUST low	1: Decisions	EP	43 / 10	71% / 48%	103.5	.010
		D	43 / 10	5.58 / 3.40	92.5	.004
	2: Skills	D	43 / 10	5.21 / 3.70	92	.004
		Ι	43 / 10	5.60 / 4.80	142	.086
	4: Feedback	D	43 / 10	4.26 / 2.80	124.5	.038
		Ι	43 / 10	5.07 / 3.80	139	.078
	5: Monitoring	D	43 / 10	5.23 / 3.90	113.5	.018
		Ι	43 / 10	5.67 / 4.80	126	.036
TI high /	1: Decisions	EP	34 / 39	73% / 57%	379	.001
TI low		D	34 / 39	5.44 / 4.31	394	.002
	2: Skills	EP	34 / 39	70% / 60%	506.5	.082
		Ι	34 / 39	5.59 / 5.08	500	.060
	4: Feedback	EP	34 / 39	58% / 45%	501	.072
		D	34 / 39	4.38 / 3.28	438.5	.012
	5: Monitoring	EP	34 / 39	74% / 55%	392	.003
		D	34 / 39	4.97 / 4.18	505	.076

 Table 4.12 Sentiment Analysis – Results of the Mann-Whitney U Test.

Note. EP = expected probability of occurrence; D = desirability of occurrence; I = impact in case of occurrence.

4.5 Scenarios and Discussion

Scenarios are considered one of the best available tools for strategy making and strategy dialogues, moving away from linear thinking towards a differentiation in views and eventually creating a shared understanding among people in environments typically characterised by external change (Van der Heijden, 2011). Scenarios help in developing a better understanding of what the future might look like and are therefore a useful tool in foresight studies as scholars attempt to elicit insights from their research in an understandable way for academia and practice (Schmalz et al., 2021). Clustering Delphi projections based on their quantitative data is a useful approach to structure the discussion on Delphi results and evaluate qualitative data (Tapio et

al., 2011). The approach and process for scenario development is well proven and widely recognized across disciplines and often builds on Delphi studies (Nowack et al., 2011).

As a first step in developing scenarios, structure in the data was detected by using two distinct cluster algorithms for average expected probability, desirability, and impact hierarchical clustering using Euclidean distance and ward method (Kaufman & Rousseeuw, 2009; Murtagh & Legendre, 2014; Ward, 1963) and fuzzy c-means clustering (FCM) (Roßmann et al., 2018). One cluster corresponded to one scenario. Testing thirty validation indices using the majority rule from Charrad, Ghazzali, Boiteau, and Niknafs (2014), the most appropriate number of scenarios was two. Both hierarchical clustering and FCM clustering produced the same scenarios. Following Roßmann et al.'s (2018) recommendation to use FCM clustering given its benefits for scenario building in Delphi studies, we used the FCM algorithm for all three dimensions of the Delphi projections. This resulted in scenario one ('tech-enabled management') consisting of four projections and scenario two ('tech-led management') consisting of one projection. An overview of the scenarios and their average scores for expected probability, desirability, and impact is shown in Table 4.13. While scenarios often consist of more than one projection, it is not uncommon to have scenarios consisting of only one projection (Kluge et al., 2020). An analysis of the individual degrees of membership (between 0 and 1) of each projection to the respective scenarios, showed high degrees of membership for all five projections (>.97 for each assignment). A visual inspection confirms the clear assignment of the projections to the scenarios and suggests that the assignment is primarily driven by the probability and desirability dimensions (Figure 4.2), a useful insight for the following discussion. The two scenarios depict different perspectives on the possible future; however, they are not mutually exclusive and share certain aspects or trends such as digitalization in general. Building on qualitative input provided by experts via the survey and during interviews and building on additional insights from the prospective part of our survey, both scenarios are described in more detail in the following.

Table 4.13 Scenario Statistic

Scenario name	Included projection(s)	EP (mean)	D (mean)	I (mean)
(1) Tech-enabled management	1, 2, 3, 5	66%	4.86	5.49
(2) Tech-led management	4	50%	3.79	5.02

Note. EP = expected probability of occurrence; D = desirability of occurrence; I = impact in case of occurrence.

Figure 4.2 Clusters Based on Fuzzy C-means Algorithm.



4.5.1 Scenario One: Tech-enabled Management

Scenario one ('tech-enabled management') describes the future of sports management as a highly technology-enabled profession. It contains four projections (1: decisions, 2: skills, 3: tasks, 5: monitoring), all of which were assessed with high average EP values between 64 to 69%; the average EP for scenario one is 66%. Thus, the experts assign a high probability to this scenario. For desirability, all four projections shared relatively close average estimates ranging

from 4.78 to 4.94 with an overall average of 4.86, indicating the scenario to be somewhat desirable from the experts' perspective. The projections' averages for impact were more heterogeneous, ranging from 5.36 to 5.69 with an overall average of 5.49, making it a high impact scenario.

From the above values, it can be deduced that scenario one represents several opportunities for the future of sports management. It could benefit from an increased use of technology in decision making, building relevant capabilities, performing tasks more efficiently, and for monitoring purposes. In other words, sports managers could improve on four out of five managerial functions by relying more on technology. For example, with the highest estimates for desirability (M = 4.94) and impact (M = 5.69), the experts assign a high probability (M = 65%) that, by 2030, sports managers will choose among technology-generated decision alternatives instead of planning themselves. There was a vivid debate about the degree to which technology and AI will interfere in decisions. Despite a relatively persistent belief among many experts that AI can never fully replace human decision making, most experts agree that more data-driven decisions and less intuition and gut feeling are an unstoppable and desirable development in the sports industry. However, the core of the debate is whether decisions are merely supported by data or whether actual artificial intelligence will be employed to develop and weigh up decision options overall. As the amount of available data increases, there will most likely be a need for increased data processing and analysis which is highly resource (mostly labour) intensive without the use of AI. In fact, at some point it might no longer be possible without the use of AI if sports managers want to keep their organizations competitive. In addition, AI support could be a welcome tool in the justification of decisions, especially given high pressure and media attention that managers in sports often face. With respect to sports-related decisions, it could contribute to increased meritocracy – a desirable outcome in competitive environments such as sports.

The expected probability of projection 1 *(decisions)* would have been even higher, had we chosen a longer time horizon, as many experts do believe in this development, but only after 2030. Reasons for that include the lagging nature of the sports industry in terms of technology adoption for business matters, a lack of adequately skilled employees, reluctance to change paired with resistance towards technology, implementation issues, as well as mindsets and organizational cultures that do not foster technological advancements.

To shed even more light on the debate at hand, we would need to differentiate even further on multiple dimensions. For example, highly professionalized sports organizations might be much faster in adoption than smaller less financially strong organizations. Certain types of decisions might be more suitable for AI than others where not all parameters are yet fully understood or captured by AI. Regardless of the extent of AI involvement in decisions, the experts agree that sports managers may expect an extensive change process that requires commitment from decision makers who are currently in charge. Since they themselves are typically not digital natives and could thus lose in this development, this constellation could slow down the change process.

In terms of qualification requirements, most experts agreed that digital capabilities are important, however, many of them did not agree that it would be the most important requirement by 2030 compared to other factors such as personal networks, relationships, leadership skills, or having a background in sports. For the latter, results were mixed: While some experts argued that a background in sports will always be key, others countered that this is losing relevance and will no longer be a requirement for most roles in the sports industry in the medium to long term future. In this debate, it is helpful to distinguish between sporting and commercial areas in sports organizations. For the former, a background in sports is widely seen as useful, but for the latter, no longer necessary. Many experts considered digital capabilities a prerequisite to be successful in 2030. It could allow sports organizations to explore yet untapped potential.

Another interesting perspective on this discussion is that not necessarily all individuals will need to grow their digital capabilities, but on a group or organizational level most teams and business units will need to improve their digital capabilities, for example, with specialists who are brought in for specific roles and tasks. Where these capabilities are used in a targeted and meaningful way, noticeable impact is expected. At the same time, applications could become more user-friendly, reducing the digital capabilities required for at least larger parts of the workforce.

Building better digital capabilities in sports organizations will require significant reskilling, upskilling, and hiring of more digital talent. This will most likely include larger scale training programs and a competition for digital talent among sports organizations as several experts assume it will be difficult for sports organizations to find that talent. Potential hurdles include a lack of understanding of the potential of digital capabilities among some of the decision makers who are still in charge. However, as less digitally savvy managers are increasingly being replaced with digital natives, the speed of digital capability building will also gain momentum. Similarly, sports organizations might not only benefit form an influx of digital talent, but more broadly from talent that is bringing in experience and expertise from other industries and functions.

For a more balanced view, we would again need to differentiate, for example, between large profit-oriented sports organizations in mainstream sports and smaller more community-oriented sports organizations in niche sports. The shift towards digital might be more difficult for sports organizations who still heavily rely on voluntary staff instead of permanent employees. Sports associations, leagues, and clubs could learn from adjacent organizations such as media companies or equipment manufacturers that are typically more advanced and experienced in digital capabilities.

With the highest expected probability (M = 65%) and second highest expected impact (M = 5.50), the majority of experts believes that, by 2030, more than 30% of the tasks in sports organizations currently performed by humans will be performed by technology. While the desirability of this projection was still somewhat high (M = 4.78), it was the second lowest desirability of all projections. Several interesting topics have been discussed among experts, indicating this to be a multi-faceted and rather complex question. One of the main topics revolved around the question of what kind of jobs and tasks can and will be replaced by technology. Most experts agreed that particularly simple, repetitive, low-expertise, and often more administrative tasks where humans add little value and technology speeds up processes will be first to be replaced by technology, as in most industries. Accordingly, mainly lower level jobs would be affected, but not necessarily those of more senior sports managers, for whom many experts believe human skills such as building personal relationships to remain most important. In addition, the special role of emotions in the sports industry was emphasized several times, which many experts believe to be an area yet too complex for technology and AI to handle. In this context, many experts pointed to the inherent risks of missing certain pieces of information.

A controversial discussion has been whether digitization and technological advancement will lead to fewer jobs or even more jobs. Some experts argued that the consequence would be job losses which they deemed undesirable. What was previously handled by a small team might in future be handled by a single person (e.g., in scouting). This could particularly affect older employees. The opposing side argued that there will not be fewer jobs, but different jobs. Acknowledging the fact that the qualifications for some jobs might (drastically) change, they stress the importance of reskilling and upskilling, as sports organizations should retain their employees in order not to lose important expertise.

The discussion also brought up less obvious but highly interesting arguments. For example, increased use of technology could also lead to more sustainability (e.g., by reducing travel in scouting) which is another topic high up the agenda for many sports organizations. In sum, the sports industry might be lagging behind in many areas in terms of digitalisation, but is expected to catch-up over the next decade – a development that is accelerated, among other things, by the consequences of the COVID-19 crisis (cf. Beiderbeck et al., 2021b).

Projection 5 (*monitoring*) has achieved relatively high averages on expected probability (M = 65%), desirability (M = 4.79), and impact (M = 5.40). Thus, the experts believe in a certain degree of automation in performance monitoring and progress control. One of the biggest benefits they see is the time saved, which can be used elsewhere, for example, to engage in other projects and ideas or to think more strategically. Automated performance monitoring could also lead to fairer and more objective evaluations. For this to work, however, many sports organizations would first need to implement key performance indicators more broadly.

There are a range of hurdles for this projection to materialize. Not all sports organizations might have the financial means for such tools. A part of decision-makers currently in charge are not willing to give up as much control to technology. Others may need training to be able to move in that direction altogether. As a consequence, over the next ten years, it is most likely that some sports managers will choose to make use of the options at hand, while others will choose not to. As before, many experts believe that the sports industry is lagging other industries (e.g., in the use of agile management tools) and that progress in this area would lead to further professionalization. This is expected to gain additional momentum as a new generation of more digitally savvy managers move into key positions.

There was an intense debate on when managers will interfere in the future. Most do not assume that managers will only interfere when problems arise. This is in part because it could render sports managers ineffective by missing out on a lot of information. It could also negatively impact motivation of employees. In addition, some sports managers may want to interfere even if not needed for reasons such as social connections, ego, or politics. They are unlikely to pass that much control to technology. There appears to be consensus among experts that a workplace that is too 'robotic' would not be desirable. Interpersonal relationships such as mentoring and motivating others will prevent excessive automation.

Interestingly, many experts have linked this projection to remote work. They argued that remote working already is and will continue to accelerate the introduction and use of such tools. Once installed and applied, these tools will then further enable remote work, thus, creating a self-reinforcing effect.

4.5.2 Scenario Two: Tech-led Management

Scenario two ('tech-led management') describes the future of sports management as an environment where technology plays a dominant role, that is, not only supporting humans, but in part taking over certain tasks that are traditionally considered inherently human such as motivating others. To some degree, it can be considered a black swan scenario. It only consists of projection 4 (*feedback*): By 2030, employees in sports organizations receive feedback and motivation from technology rather than from managers. This projection received the lowest scores on all dimensions. Expected probability (M = 50%) and desirability (M = 3.79) were much lower than for any other projection. For desirability, it was the only projection that was assessed as somewhat undesirable. The assessment of impact (M = 5.02) was also significantly lower than for all other projections, however, the difference was not as severe as for expected probability and desirability. To derive valuable insights from projection 4, we need to consider two relevant aspects. First, our bipolarity analysis found that projection 4 showed a tendency
towards bipolarity, which is an indicator for differences in expert opinions. Second, the analysis of the qualitative input showed that many experts were themselves divided on this projection. In addition, some experts focused more or sometimes exclusively on the question whether employees should receive feedback and motivation from technology instead of humans, while others considered this topic more broadly, taking into account the notion of sports managers building tech-friendly work environments and relying on technology to lead, inspire, and motivate employees including the use of remote collaboration tools and agile methods for project management.

The most widespread opinion among experts was that tech-friendly work environments would be very desirable and relatively likely to occur, but that feedback and motivation should continue to take place from human to human. Tech-friendly work environments might even be unavoidable if sports organizations want to remain competitive in the war for talent in an increasingly tech-savvy workforce. For feedback and motivation, however, they believe humans cannot be replaced and might become even more relevant in times of accelerated technological progress that some might feel left behind by. One group of experts went even a step further and differentiated between feedback and motivation. They argued that feedback may be taken over by technology in 2030, thus adding to increased transparency and fairness. Or at least, feedback could be strongly supported by technology (e.g., identifying feedback arguments). Motivation, in turn, requires human skills such as recognition, affirmation, or inspiration that technology cannot replace by then.

It was very clear from the qualitative input, that some experts considered this scenario as highly unlikely and highly undesirable, arguing for the irreplaceability of certain human characteristics and traits such as empathy, emotions, or trust. Additional hurdles such as limited resources (e.g., financial) and capabilities in combination with a widespread sense for tradition might slow down technologization (both good and bad) in this regard. As a consequence, the situation by 2030 will probably vary between sport organizations. Some will have adopted truly tech-friendly work environments and embrace technology for all sorts of tasks potentially including feedback and motivation, while others will be more hesitant and resistant, fostering work environments that are not too different from the ones today.

4.6 Conclusion

4.6.1 Limitations and Future Research

As any research project, this study is not without limitations. Despite significant efforts to invite experts globally, a geographically more balanced expert panel would have been desirable. While the participating experts originated from 27 countries from all five continents, 71% of them came from Europe. Even though we believe that our findings represent well-founded perspectives on the global future developments of the impact of technology on sports management roles and functions, the generalizability of our findings beyond the European market – or at least for some global markets – could be questioned. In general, the composition of expert panels in Delphi studies should always be critically reviewed (Ecken et al., 2011; Kluge et al., 2020), for example, to evaluate possible self-interests of the experts, which could lead to biased results (e.g., desirability bias). In our study, we had a large share of experts coming from the stakeholder groups sports-centric and consulting, significantly exceeding other groups such as *academia*. A potential reason for this particular composition of participants could be an increased interest of these two groups in this study and its findings or the structure of the authors' personal networks that were predominantly used for expert selection. While these two groups are very likely to have a comprehensive understanding of the subject matter, an over-representation bears the risk of biases. For example, sports-centric experts may have an interest in portraying themselves and their industry in a certain light, whereas consultants may have business interests that could skew their results (Kluge et al., 2020).

With respect to the experts' level of confidence in responding to projections (cf. Beiderbeck et al., 2021b), we had good reasons not to gather this information for each respective projection; however, in hindsight, we could have benefitted from this information in our analysis. We would like to encourage future research to find ways to assess the level of confidence in a reliable but very efficient way; potentially, this could simply be a five-point Likert scale anchored at 'not confident at all' (1) and 'very confident' (5). However, it is important to take into account the skepticism about confidence assessments that has been expressed by prior literature as respondents may intentionally over- or underestimate their confidence for a variety of reasons (Bolger & Wright, 2011). It could also be interesting to experiment with Delphi designs where participating experts only respond to a pre-defined share of the total number of projections (e.g., 10 out of 15) based on what they feel most knowledgeable about. Not being able to skip projections (e.g., if experts do not feel confident in responding to a certain projection) is another limitation of the study at hand. It is not unusual that experts do not have profound expertise to meaningfully assess all projections they are being presented with in a Delphi study, which is why the option to skip projections was typically a feature in pen and paper Delphi studies (Förster, 2015). In general, the question of how to handle confidence and expertise assessments is a difficult design choice in Delphi studies and there is controversy in the literature on what the most promising approach might be. This discussion is not limited to self-assessments, but is closely related to expert selection (Hasson & Keeney, 2011) and the availability of information (Woudenberg, 1991).

Based on our analyses and results, we may conclude that the selection and formulation of Delphi projections was successful and appropriate for our research. The projections in this Delphi study address a broad field of relevant potential future developments of the impact of technology on sports managers' roles and functions. Even though the Delphi study was deliberately kept shorter than is often customary, it would of course have been interesting to take a closer look at other potential developments. For example, a consideration of low probability high impact projections could have provided additional interesting insights. These, in turn, could be very important for various stakeholders to be prepared for unexpected developments and events. In hindsight, we also would have preferred to formulate all projections in present tense as recommended by Schmalz et al. (2021).

In addition to the starting points already mentioned or implied, future research could replicate this or similar research with varying time horizons. While a ten-year time horizon was a very insightful starting point for this investigation, it would be interesting to also consider shorter time horizons (e.g., five years) or much longer time horizons (e.g., 30-50). This would likely provide additional insight while revealing longer-term trends that could then be appropriately encouraged or discouraged at an early stage, depending on whether they are positive or negative.

Future research could also deliberately try to generate other perspectives via even more diverse or simply other expert panels. While our sample was relatively well-balanced and represented the most relevant stakeholder groups, it would also be interesting to hear from stakeholders who are less immediately affected such as economists, politicians, or sociologists.

Finally, from a methodological and process perspective, we have had very good experiences with the very long study preparation phase and would like to encourage other researchers to do the same. If time allows, we recommend researchers taking as much time as they need for preparing their Delphi study and developing meaningful projections, even if this means significantly prolonged research periods. We know that this is not always practical and feasible, but we would still like to encourage it, especially researchers who have several projects running in parallel and can afford to have a slower maturation process of their research.

4.6.2 Summary

In this research, we conducted a prospective study on the impact of technology on the roles and functions of sports managers. 117 subject matter experts assessed five future projections both quantitatively and qualitatively. All five projections had an average impact greater than five on a seven-point scale, suggesting that the projections addressed in our study are highly relevant (cf. Kluge et al., 2020). Likewise, the relatively high desirability ratings for most projections show that the topics addressed mostly present opportunities and only one projection could be seen as a slight threat from the experts' point of view (cf. Schweizer et al., 2020). With expected probability assessments between 50 and 69%, all projections also proofed to be realistic. Consensus was only reached on the impact dimension, but neither for expected probability nor desirability, which is relatively rare in Delphi studies. This is also an indicator that relevant topics in need of discussion were addressed, which was also evident in the partially controversial discussions among the experts; we addressed this in a comprehensive dissent analysis (cf. Warth et al., 2013). For example, in some cases, we found significant differences between the different stakeholder groups that we evaluated while these in turn have reached high levels of intra-group consensus. For additional and broader insights, we retrieved the experts' input on 50 additional prospective survey items and included the experts' deep-level information including technology-related sentiments (Spickermann et al., 2014).

To provide meaningful results for academia and practice, we derived two scenarios to elicit additional insights from our study (cf. Schmalz et al., 2021). The first scenario ('tech-enabled management') was assessed as highly probable with high impact and mixed desirability. It outlines several technological opportunities in decision making, building relevant capabilities, performing tasks more efficiently, and for monitoring purposes and describes the future of sports management as an increasingly technology-enabled profession. The second scenario ('tech-led management') represents a less probable black swan scenario with low desirability, but medium to high impact. It outlines an environment dominated by technology where even traditionally inherently human tasks such as leading, inspiring, motivating, and giving feedback are performed by technology itself and not only supported by technology. While both scenarios present different and partially contrasting developments, they also share many commonalities such as the importance of being able to use technology in the best possible way for one's own benefit. The extent to which this is taken may then ultimately depend on the context, the requirements, and personal preferences.

To sum up, sports managers and their organizations may expect significant technological change and challenges in the short, mid, and long-term future. They are well advised to engage intensively with this topic and its associated questions as well as any problems that may arise. In doing so, they should not see the issue as problematic or a potential threat, but rather as an opportunity to gain an edge in a highly competitive environment.

5 Conclusion

5.1 Summary of Findings

The objective of this dissertation was to advance our understanding of the intersection between sports and technology and how it will evolve in the future. The overarching guiding research question – *what is the impact of technology on sports and sports management in the future?* – was addressed in this dissertation by dedicating one research paper to each of the following three research questions:

- *RQ I:* How should sportstech be defined based on existing literature and what is an overarching structure that both researchers and practitioners can use?
- *RQ II:* How will different technologies impact the main user groups in sports in the future and what are relevant future scenarios?
- *RQ III:* How will the role of sports managers change in the future given the influence of technology and what are relevant future scenarios?

Paper I addressed the lack of overarching taxonomies, frameworks, models, and guidelines in the field of sportstech (cf. Ratten, 2017) by suggesting a taxonomy of sportstech to provide an all-encompassing structure for all relevant stakeholders, including researchers, sports managers, athletes, and fans as well as owners, investors, and other affiliates. A definition of sportstech is provided based on a selection of definitions for both sports and technology and based on a meaningful definition of sportstech that is exhaustive and allows for a shared understanding between the different stakeholders. As a result, "we understand sportstech as the intersection of sports and technology. When technology provides a solution in the larger sphere of sports, we consider it sportstech" (Frevel, Schmidt, et al., 2020, p. 21). Based on this definition, a structure was developed that would precisely cover this definition of sportstech in a mutually exclusive and collectively exhaustive way by capturing how different types of technologies can be used by or provide solutions and benefits for different user groups in the realm of sports. The resulting SportsTech Matrix consequentially consists of two angles: The user angle based on a framework from Penkert (2017, 2019) and Malhotra (2019) and the tech angle based on a categorization of technologies in the context of sports. It should be mentioned that the focus was rather on high and advanced technology and less on low technology. This taxonomy of sportstech that was developed in Paper I is an essential contribution to both academia and practice as it provides a structure that can inform and guide all relevant stakeholders in a field that has gained significant momentum in recent years, including significant advancements, but also increasing complexity (Fuss et al., 2008). A growing amount of relatively isolated research has shown the potential for sportstech as its own field of research (cf. Ratten, 2018). Therefore, the presented taxonomy – primarily through the SportsTech Matrix – has the potential to contribute to advancements in this evolving field by providing structure for future investigations.

Based on the structuring groundwork of Paper I, Paper II investigated the continued impact of technology on sports (Schmidt, 2020b) by systematically examining future developments in sportstech along the dimensions of the SportsTech Matrix. The paper provides multifaceted findings from a Delphi-based prospective study with 92 subject matter experts and their quantitative and qualitative assessment of six future projections and 35 additional prospective survey items. The time horizon for the projections was the year 2030. All six projections had an estimated average impact greater than five on a seven-point scale, indicating high relevance of the selected topics. Almost equally high desirability assessments lead to the conclusion that the presented topics pose opportunities for the sports industry. Consistently high probability assessments suggest that these future developments are both realistic and conceivable. In terms of probability, the experts reached consensus on two projections: Continued significant changes in the consumption of sports content (e.g., shorter sequences or data-enriched content) and at least a tenfold increase in data collection in professional sports compared to today. In addition, consensus was reached that new types of manager profiles would be desirable in sports organizations with respect to backgrounds and skill sets. The experts also reached consensus on their impact assessment for two projections: Most of the current world records in Olympic disciplines will be broken due to technological advancements and the consumption of sports content will continue to change significantly, as mentioned above.

Given the overall relatively limited degree of consensus, a comprehensive dissent analysis following approaches from Warth et al. (2013) and Beiderbeck et al. (2021b) yielded additional valuable insights such as differences in their assessments between five different stakeholder groups (academia, startup, consulting, adjacencies, and sports-centric). This analysis revealed consensus for almost two-thirds of all possible instances as well as partially very low IQR scores for intra-group consensus projections, which indicates a high level of consensus within the respective stakeholder groups in those instances.

A comprehensive sentiment analysis evaluating experts' deep-level information following approaches from Beiderbeck et al. (2021b), Loye (1980), and Spickermann et al. (2014) provided additional insights concerning experience and expertise as well as for specific technology-related sentiments. For the latter, established constructs for experts' attitude toward using technology (Teo & Zhou, 2014) and trust in technology (McKnight et al., 2011) were used. This analysis yielded a whole range of granular insights such as significant positive correlations between the number of years of work experience in the sports industry and the impact assessments of significant changes in the consumption of sports content as well as expected probability and desirability assessments of significant improvements in automated data processing. The results also showed that while groups with different levels of work experience (low, medium, high) significantly differed in their assessment of some dimensions for some projections, there was also often no tendency of neither correlation nor linear relationships, but sometimes even u-shaped relationships (e.g., impact assessment of the breaking of world records due to technological advancements was higher for the *low work* experience group and the high work experience than for the medium work experience group). Similar findings were found for the variables job level, technology expertise, and sports industry expertise. With respect to technology-related sentiments, the results showed that desirability assessments of all six projections were positively correlated with the attitude toward using technology (ATT). For expected probability and impact assessments, there were five and two projections, respectively, that were positively correlated with ATT. Similarly, desirability assessments of all six projections were also positively correlated with trust in technology. For expected probability and impact assessments, there were three and four projections, respectively, that were positively correlated with the trust in technology. For expected probability and impact assessments, there were three and four projections, respectively, that were positively correlated with the trust in technology. A more nuanced analysis led to the conclusion that low-trust individuals, compared to their high-trust counterparts, tend to prefer less technological progress and perceive the impact of technology to be lower.

Finally, a significant result of Paper II was the two developed scenarios based on the Delphi results. The first scenario ('probable future') had very high expected probability, high desirability, and high impact and describes a largely technology-driven future for all user groups, particularly concerning sports consumption, sports management, and athletes' use of data. The second scenario ('game changer') is less probable and has lower desirability and impact assessments than scenario one. This scenario includes breaking world records due to technological advancements and the projection that most consumers and fans will frequently follow (live) sports in AR/VR/XR by 2030. In both scenarios the experts acknowledged the impact of technology that is to be expected, with the question predominantly being no longer how but when and to what extent the projected developments will occur.

Overall, the results of Paper II suggest technology-driven developments by 2030 will significantly affect all user groups in sports – athletes, consumers, and managers. It is important to differentiate which technologies will be most relevant for which user groups. It is also

important to note that the developments under examination can be considered opportunities rather than threats for the sports industry and its various stakeholders.

Paper III followed a very similar approach to Paper II but took a much narrower approach and focused on sports management exclusively, a research field that has been lacking academic attention (Peachey et al., 2015). The paper presents results from a Delphi-based prospective study with 117 subject matter experts and their quantitative and qualitative assessment of five future projections and 50 additional prospective survey items. The time horizon was again the year 2030. All selected projections can be described as highly relevant and realistic, given average impact assessments greater than five on a seven-point scale and expected probability assessments between 50% and 69%. Desirability was high for four projections. That is, topics are again mostly opportunities, however, one projection may be considered a slight threat given its low desirability assessment. Experts reached almost no consensus across the five projections, which was also evident in some relatively controversial debates among experts on some projections; consensus was only reached on the impact dimension for four out of five projections. The multifaceted and complex character of the topic under investigation serves as a possible explanation for the relatively low degree of consensus.

Again, a dissent analysis was performed following Warth et al. (2013) and Beiderbeck et al. (2021b). The most interesting findings came again from the stakeholder group analysis. There were significant differences in the five different stakeholder groups (sports-centric, consulting, agencies & media, academia, and adjacencies). While the level of intra-group consensus was relatively low for expected probability and only medium for desirability, relatively high levels of intra-group consensus were reached for impact.

The sentiment analysis of Paper III revealed that the experts' assessments in many cases significantly depended on their experience and expertise as well as their technology-related sentiments. Again, granular insights were found for the variables years of work experience and job level as well as for management and technology expertise. For example, experts with high technology expertise assigned higher desirability (M = 5.27) and higher impact (M = 5.88) to the projection that sports managers will choose among technology-generated decision alternatives instead of planning themselves, compared to experts with low technology expertise (desirability M = 4.64; impact M = 5.52).

To assess technology-related sentiments, five established constructs were used, building on existing theory such as the technology acceptance model (TAM) (Davis, 1989): Attitude toward using technology (ATT) (Teo & Zhou, 2014), intention to use technology (ITT) (Teo & Zhou, 2014), affinity for technology interaction (ATI) (Franke et al., 2019; Wessel et al., 2019), trust in technology (TRUST) (McKnight et al., 2002, 2011), and technological innovativeness (TI) (Bruner & Kumar, 2007). Statistically significant correlations were found between the three assessment dimensions of the projections and all of the five technology-sentiment constructs. For example, there was a positive correlation between the experts' assessments of desirability and ATT for all five projections.

The scenario analysis of Paper III revealed a 'tech-enabled management' scenario and a 'tech-dominated management' scenario. In the view of the experts, the former is a somewhat desirable scenario with high probability and high impact that describes the future of sports management as a highly technology-enabled profession. This scenario outlines opportunities and suggests that sports management could significantly benefit from more technology in four out of five managerial functions (planning, organizing, staffing, and controlling). For example, sports managers might choose among technology-generated decision alternatives instead of planning themselves by 2030. The 'tech-dominated management' scenario can in some ways be considered a black swan scenario. It describes a future where technology not only supports sports managers but takes over tasks that have been considered inherently human (e.g., motivating others), which is an undesirable future state in the view of most experts. Accordingly, the assessments of desirability and expected probability of this scenario were low, while the impact in case of occurrence was assessed as somewhat high. The discussion on this

scenario showed that many experts would like to see more tech-friendly environments in sports organizations that better embrace the potential of technology.

All in all, the three papers emphasize the vital role of technology in sports. All relevant stakeholders should consciously elaborate on how to approach technology for themselves and their organizations in the future. Researchers and academia should take away a better understanding of what sportstech is and find more and advanced ways to conduct research that will inform both practitioners and scholars in the future.

5.2 Research Contributions

This dissertation contributes to the growing stream of sportstech research (Ratten, 2018). It addresses several research gaps, including the lack of overarching taxonomies, frameworks, models, and guidelines (Ratten, 2017) and the lack of debate and academic attention in sports management (Gammelsæter, 2020; Peachey et al., 2015). At the same time, it makes methodological contributions by applying and suggesting relatively novel ways of conducting Delphi studies in rigorous research approaches. Thus, the contributions of this dissertation are threefold: Conceptual, empirical, and methodological.

First, this dissertation makes conceptual contributions with both academic and practical relevance in Paper I by proposing a taxonomy of sportstech. A taxonomy is a very useful tool to structure multifaceted phenomena (Rich, 1992) and the starting point for emergent theory (Fiedler et al., 1996), which is hopefully a long-lasting conceptual and theoretical contribution of this dissertation. The proposed taxonomy of sportstech includes a definition of sportstech derived from a thorough understanding of both sports and technology, which is supposed to contribute to a better shared understanding and more consistent use of the term sportstech. The second significant contribution of the taxonomy is developing the SportsTech Matrix as an all-encompassing structure for the field and a valuable tool for researchers and practitioners alike. The two dimensions of the matrix – the user angle and the tech angle – can even be considered

as valuable contributions of their own. For example, given the lack of a universal or generally accepted approach for dividing technologies into different categories (Ellis et al., 2016), this dissertation contributes to closing this gap for the sports industry by providing a categorization of technologies that is useful in the context of sports.

Second, this dissertation makes empirical contributions to sportstech research and sports management research through two Delphi-based prospective studies. This appears to be a valuable contribution, given the profound and continued impact of technology on sports (Schmidt, 2020b), the significant social and economic relevance of sports (e.g., Katsarova & Halleux, 2019; Lefever, 2012), and the lack of systematic academic attention on the future of sports (cf. Merkel et al., 2016). Likewise, this dissertation contributes to the sports management literature by holistically looking at sports management and its future development as a whole instead of focusing on niche elements, which scholars had previously criticized (Ciomaga, 2015; Newman, 2014; Stewart, 2014). This dissertation also produced knowledge not only for sports managers but also about sports managers, thus addressing another issue that had recently been raised in the literature (Andrews & Silk, 2018; Klikauer, 2018). By taking a future-oriented perspective with modern formats of Delphi-based prospective studies, this dissertation also responds to the call for "more 'risky' research endeavors [...] to embrace the complexity of contemporary sport management" from Misener and Misener (2017, p. 130).

Third, this dissertation makes methodological contributions to the Delphi method by rigorously applying and suggesting relatively novel ways of conducting Delphi studies. By designing comparably short and engaging Delphi surveys, this dissertation showed a way that may serve as an example for future Delphi studies to address some of the common drawbacks of the Delphi method, such as its typically very time-consuming nature for participants (Schmalz et al., 2021; Trevelyan & Robinson, 2015), which carries the risk of participant dropout and panel attrition (Bardecki, 1984), thus, threatening the validity of Delphi results (Hasson & Keeney, 2011). Combining traditional Delphi projections with standard non-Delphi

survey items was a suitable approach to address the complex trade-off in Delphi studies between keeping the survey as short as possible while gathering sufficient amounts of data (Schmalz et al., 2021). Another valuable contribution is the gathering of experts' deep-level information and the conduction of sentiment analyses, which has been largely ignored in Delphi research so far (Spickermann et al., 2014), even though Loye (1980) had already pointed out the importance of an expert's personality on his or her assessment of future developments four decades ago. In addition, the two Delphi-based prospective studies in this dissertation make valuable contributions to the growing body of scenario planning literature (Varum & Melo, 2010) as well as to the growing body of futures and foresight literature (Chermack, 2018; Fergnani & Chermack, 2021; Gary & von der Gracht, 2015; Münch & von der Gracht, 2021). An increase in rigorous futures and foresight studies will hopefully contribute to the field's evolution as an established part of the social sciences (Fergnani & Chermack, 2021).

5.3 Future Research Directions

While this dissertation contributes to a better understanding of the future of sportstech and an advancement of the Delphi method, it also reveals promising avenues for future research. The following encouragements for future research are derived from the limitations outlined in each paper of this dissertation and from additional overarching considerations; just like the contributions, they are structured as conceptual, empirical, and methodological.

First, future research on sportstech could benefit from an increased focus on conceptual work, especially in the short term. As the field is still rapidly evolving, the taxonomy of sportstech with the SportsTech Matrix offers a good starting point, but it might not be the answer to everything. It would be desirable if the proposed taxonomy could initiate an increased discussion between researchers and practitioners that leads to an advancement of the field and ultimately to the development of theory. To make sure that this theory "mirror[s] the real world"

(Rich, 1992, p. 777) as much as possible, stronger links between practice and academia would be desirable and future research should be open to emerging opportunities.

Second, future research on sportstech and sportstech management could build on the three papers presented in this dissertation by addressing some of their limitations and by extending the presented research. As with any Delphi study, the expert panel composition should be critically reviewed as recommended by Ecken et al. (2011) and Kluge et al. (2020), which opens up a full range of future research opportunities. For example, the studies presented in this dissertation could be replicated using different expert panels (e.g., different geographies, backgrounds, age structure, work/technology/management/sports industry experience) to investigate the generalizability of the findings. Interesting experts for such research could also include stakeholder groups who are less immediately affected but might have relevant opinions such as economists, politicians, or sociologists. As the two Delphi studies were deliberately limited in their scope, there is, of course, plenty of space for similar research in the same sphere but with a different focus. For example, it would be interesting to examine how the startupdriven sportstech ecosystem will develop in the future or what developments can be expected in terms of investments in the sportstech sector. Alternatively, it could be interesting to focus research on low probability high impact projections which were not included in the research at hand but could deliver valuable insights, for example, to improve the preparedness of different stakeholders for unexpected developments and events such as a global pandemic and its implications (e.g., Beiderbeck et al., 2021b). It would also be interesting to consider both shorter (e.g., five years) and longer time horizons (e.g., 30-50) to gain additional insight or reveal longer-term trends early on. Last but not least, I would like to encourage future research to use the SportsTech Matrix as a starting point for future research. For example, similar to the third paper in this dissertation, the impact of technology on athletes or consumers could be studied. Alternatively, future research could focus on one particular technology or category of technologies to examine how it affects the different user groups today and in the future.

Third, future research should further evolve the Delphi method. Given the many design choices, future research could experiment with different approaches tailored to the specific research context and needs instead of applying standard approaches, as can often be observed so far. For example, it could be worthwhile to conduct a Delphi study where experts only work on a pre-defined share of the total number of projections. The selection of projections to work on could be random or based on the knowledge experts have on respective topics. This might make it possible to address more projections than in the present two Delphi studies without facing the typical drawbacks of excessively long Delphi surveys. Similarly, future research may consider finding suitable solutions to how experts may skip individual projections without threatening the validity of results. This would be a great advantage in situations where experts have no knowledge of individual projections. In general, it would be desirable if future research found ways to assess the experts' level of confidence in a reliable but efficient way (again, a trade-off with survey completion time and convenience). The scholarly debate about this topic is vivid and inconclusive about the best approach. It evolves around self-assessments (Bolger & Wright, 2011), expert selection (Hasson & Keeney, 2011), and the availability of information to experts during their participation (Woudenberg, 1991). For the assessment of projections, future research could also more regularly integrate additional dimensions besides expected probability, desirability, and impact; for example, this could include (technical) feasibility, innovativeness, or urgency. Similarly, besides the Likert type items that are commonly used to assess the above projection dimensions, it could be promising to use a wider variety of question formats, including rating scales or rank-order questions, which has already been applied in Delphi studies in other domains such as medicine (Boulkedid et al., 2011; Sinha et al., 2011).

Overall, future research is faced with a wide range of promising opportunities and I would highly welcome more research on sportstech and sports management. While these fields require more academic attention, they also offer many alleys for future research and the opportunity to work on a subject that I consider truly exciting on a personal level.

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Anlage 1 der Promotionsordnung vom 06.04.2021

Name: Frevel Vorname: Nicolas

Erklärung nach § 12 Absatz 1 Nr. 8

Hiermit erkläre ich, dass ich die bei der Wissenschaftlichen Hochschule für Unternehmensführung (WHU) - Otto-Beisheim-Hochschule-, vorgelegte

Dissertation

selbständig und ohne Benutzung anderer als der angegebenen Hilfsmittel angefertigt habe.

Weder die Arbeit als Ganzes noch Teile der Arbeit wurden bisher in gleicher oder ähnlicher Weise einer anderen Prüfungsbehörde vorgelegt.

Aus fremden Quellen wörtlich oder inhaltlich übernommene Sätze, Textpassagen, Daten oder Konzepte sind unter Angabe der Quelle gekennzeichnet.

Bei der Auswahl und Auswertung folgenden Materials haben mir die nachstehend aufgeführten Personen in der jeweils beschriebenen Weise entgeltlich / unentgeltlich geholfen.

Name	Vorname	Art der Hilfestellung	entgeltlich/ unentgeltlich
Prof. Dr. Schmidt	Sascha L.	Feedback/Review im Rahmen seiner Funktion als Doktorvater und Koautor einzelner Paper	unentgeltlich
Beiderbeck	Daniel	Feedback/Review im Rahmen seiner Koautorenschaft einzelner Paper	unentgeltlich
Penkert	Benjamin	Feedback/Review im Rahmen seiner Koautorenschaft eines Papers	unentgeltlich
Shields, PhD	Ben	Feedback/Review im Rahmen seiner Koautorenschaft eines Papers	unentgeltlich
Prof. Subirana	Brian	Feedback/Review im Rahmen seiner Koautorenschaft eines Papers	unentgeltlich

*Falls an der Erstellung der Dissertation auch Koautoren beteiligt waren, sind diese ebenfalls hier einzufügen

Weitere Personen waren an der inhaltlich-materiellen Erstellung der vorliegenden Arbeit nicht beteiligt. Insbesondere habe ich hierfür nicht die entgeltliche Hilfe von Vermittlungs- bzw. Beratungsdiensten (Promotionsberater oder anderer Personen) in Anspruch genommen. Niemand hat von mir unmittelbar oder mittelbar geldwerte Leistungen für Arbeiten erhalten, die im Zusammenhang mit dem Inhalt der vorgelegten Dissertation stehen.

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