

CITY UNIVERSITY LONDON

**Inform to Perform: Using Domain Analysis to Explore
Amateur Athlete Information Resources and Behaviour**

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Abstract

Sporting information has been relatively unexamined in library and information science (LIS) literature with most research concentrating on collection management or archival functions. User studies in LIS have covered some aspects of outdoor recreation and hobbies, but only one study has been found explicitly researching amateur athletes. This project builds contributes a definition of sport as an information domain and an exploratory user study of amateur athletes. The research takes a socio-cognitive approach and uses domain analysis linked to serious leisure, information communication chain and information behaviour theories to provide the research context. These foundational theories are used to define sport as an information domain more formally, noting both degrees of specialisation within it and intersections with related disciplines. Four domain analysis approaches are then used to illustrate the potential of the approach for researching different dimensions within the domain.

Three of these approaches involve desk research into different aspects of amateur sport information. By discussing the role of documents, computer science and discourses in sport these approaches show that sport is a multi-faceted and interdisciplinary domain with many topics of interest for the information researcher and practitioner. The fourth approach is a user study of athlete information behaviour that collected data on information sources, tasks and attitudes via an online questionnaire. The survey focused on amateur athletes in selected sports (running, cycling, triathlon, swimming and rowing). The results showed that athletes were confident information consumers, producers and record keepers who used a variety of sources and systems to seek and share information related to their athletic activity. They relied mostly on freely available sources via informal channels drawing on the Internet and their reference groups for much of their information. Athletes were interested in reading journals but did not make significant use of the library. With other disciplines leading research on sport information, management, governance and data, questions remain about the current and future role of LIS in the sport information domain.

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1. Introduction

Despite popular participation in sport, as athletes or fans, and the diverse and growing volume of sporting information and data generated there is little evidence that library and information science (LIS) has given sport much consideration as an information domain. This study conducts some exploratory research in this area. Adopting a socio-cognitive perspective on the information communication chain, the study uses domain analysis to start to map out sport as an information domain then combines this with information behaviour conceptual models in an empirical user study of serious leisure activity.

Following a literature review covering foundational concepts, theories and previous studies the research examines the theoretical basis for defining sport as an information domain before illustrating how domain analysis provides a methodological framework for researching this domain. Three domain analysis approaches: documents and genres; cognition, expert systems and artificial intelligence; and terminology and discourse studies are used to examine different aspects of sport documentation from the historical to the cutting edge.

Drawing on this conceptual research foundation and related empirical studies the second half of this project surveys amateur runners, cyclists, swimmers, rowers and triathletes to collect evidence on the type of information resources used by amateur athletes and how these relate to common sporting tasks and goals.

The purpose of the research is exploratory so no firm conclusions are drawn. However, some initial themes are offered reflecting on the nature of sport as an information domain, amateur athlete information behaviour and LIS involvement in the sport information domain. The impression received is that amateur athletes are confident users and producers of information, selecting and adapting information from a diverse range of sources and channels to fulfil their tasks and to a lesser extent maintain social worlds. Most of these sources are freely available, found online or via peers, so whilst the athletes feel they are getting the information they need they may not be receiving the best information and may be exposed to contradictory information and even misinformation. The athletes are also dedicated record keepers: archival practice plays an important role in the keeping of sporting records in modern sport. Overall, the LIS discipline is not a significant contributor to developments in sport information though there are plenty of areas of interest for LIS researchers and practitioners and many areas emerging where their skills and knowledge would make valuable contributions.

Aims and Objectives

This research uses domain analysis to explore sport as an information domain, a subject relatively unexamined so far in the LIS literature. Domain analysis is a theory that argues information should be approached as a social collectivist, rather than individual cognitive science (Hjørland and Albrechtsen, 1995). In this case, it provides a theory for considering whether sports and their associated communities can be considered information domains. Hjørland (2002) provides an architecture for analysing domains via eleven approaches, some of which underpin this research. A complete analysis of sport as an information domain is beyond the scope of this project. As Hartel (2003) puts it, this research will proceed in “general domain analytic spirit” in order to explore some information features of sporting participation and consider how applicable the domain analysis approach is to sport.

The motivating research questions are:

- **how can we understand sport as an information domain?**
- **how do committed amateur athletes use information to help them achieve sporting goals?**

This raises numerous supplementary research questions such as:

- what information resources do athletes use, what information areas do they cover and who provides them?
- how does the information communication chain apply to athletes?
- how does information use change at different points in the development, training and exercise cycle?
- what is the role of the training diary in supporting athletic achievement and progression?
- why do athletes seek information? Are motivations primarily task-related, educational, social or motivational?
- what does the library and information science perspective contribute to understanding sport information and analytics?
- how well do libraries and information centres support athlete?
- how satisfied are these athletes with the information they access?
- how has/is digital technology changing athlete information resources and behaviour?

It is clear that even this narrow focus on a particular aspect of the sporting information domain prompts many questions. Such a small study cannot answer all of these but this research aims to make an initial contribution to surveying this terrain and suggest ideas for more detailed research.

Scope and Definition

Sport is a broad and diverse domain, so this study concentrates on **committed amateur athletes** in **selected sports** to narrow the target population and resources to a scope feasible for a project of this size.

The **sports** included in the study are running, cycling, swimming, rowing and triathlon.

Athletes are defined as those those actively participating in the above sports.

Committed amateurs means that the athletes should be training and/or competing at a higher level than entry-level, casual participants who are undertaking physical exercise simply for health and fitness, but not full time athletes, either elite amateurs or professionals, as these groups often have highly developed support and coaching frameworks to guide their development. The target athletes are self-supported but motivated by a developmental or competitive goal.

This scope is more formally defined, with reference to supporting theory, in Chapter 3. *Sport as an Information Domain*. Before attempting this definition, the literature is reviewed to outline some foundational theories and earlier studies that provide the general research context for this study.

2. Literature Review

Sport and exercise is a significant leisure activity. In the UK, Sport England's Active People Survey (APS9 Q2) suggests 15.5 million adults, about 35% of the population, play sport at least once per week (Sport England, 2015b). This includes 54.8% of 16-25 year olds. Around 17% of the population participate in sport at least three times per week and 57.4% of the population say they would like to do more sport (Sport England, 2015c). There are around 2 million regular runners, swimmers and cyclists (Sport England, 2015a). Despite this level of activity and demand, there is not much research on the role of library and information science (LIS) in sport recreation.

2.1 LIS and Sport

There is some general LIS literature relating to sport collection management and archival functions. Periodic reviews and bibliometric studies in the literature provide selection advice for both scientific literature (academic libraries) and general literature (public libraries). For example, Delwiche and Hall (2007) conducted a bibliometric analysis of athletic training literature for academic libraries. Allen provides a public library guide to sport reference and information sources (2005) and collection selection advice (2004). Allen also notes the difficulties involved: whilst sport is a relevant and accessible topic its interdisciplinary nature makes selection a complex task for libraries. Spahr and Wiegand (2012) also make this point in their annotated bibliography of sport management literature: an area that relates to business, entertainment and law more than sport science and medicine. Sport is a domain where information is fragmented across disciplines, databases and collections. Typical sources include publishers, such as Human Kinetics; databases, such as SPORTDiscus; abstracting and indexing services; and specialist organisations. One comprehensive guide to these is *The Reference Handbook for World Sports* covering not just key issues in sport but also chapters on various print and non-print resources (Hanold 2012).

Wilson (2015) writes eloquently about the practice of sports history in relation to the future of the library. He notes the symbiotic relationship between sport information and the Internet and also the changing role of librarianship to envisage how sports librarianship may look in the future and the contribution of librarianship to keeping sporting knowledge and memory given sport's enthusiastic adoption of new media technologies. Library roles may include the retrospective digitisation of sport's vast paper collections and also the curation of born-digital collections from Internet sources. Some countries such as Canada and Australia have dedicated sport information centres. Canada has the Sport Information Resource Centre (SIRC)¹ and

¹ Available at <http://sirc.ca/> (Accessed: 5 September 2015)

Australia has the Clearinghouse for Sport², the knowledge sharing initiative of the Australian Sports Commission. This features a knowledge base, library and publications archive. It's not evident that the UK has any similar consolidated information centre for sport. Neither the UK Sport and Recreation Information Group (SPRIG) or the North American Sport Library Network (NASLIN) referred to in Ghent (2008) seem to still be in existence. Globally the International Association for Sport Information (IASI)³ co-ordinates sport information bodies though they seem to be an opaque organisation and accessing information about them, their activities and meetings is difficult.

The archival and record keeping functions discussed by Wilson are important for preserving the sporting record. This is most noticeable for large-scale, global events such as the Olympic Games. The International Olympic Committee (IOC) provides research and resources via the Olympic Studies Centre⁴ and Olympic Museum⁵. In addition specific events may be archived by host nations; for example, the London 2012 games are archived by the National Archives⁶ who also provided a guide to accessing these, and other sporting history records⁷. Additionally the National Sports Museum Online⁸ provides a portal to sport heritage collections across the UK.

2.1.1 Expanding the LIS View of Sport

Whilst these examples suggest a number of possibilities for LIS engagement with sport, the relatively small amount of literature suggest sport is under-represented in LIS both in research and practice. In a 2013 paper on sport information in Australia Crook found that whilst sport entertainment is well represented in public libraries resources on fitness and exercise are less well provided for. Furthermore, he also notes the growing volume of sport-related information that requires professional management and the types of services information professionals could provide to support this in addition to the more traditional collection management or archival roles of the library. These may include services such as the classification, governance and maintenance of document and data repositories. Finally, in a novel example, Waelchli describes how the information tasks associated with fantasy sports can be used to teach information literacy (2008).

This study opens the way to a more extensive and in-depth consideration of sport as

² Available at <https://secure.ausport.gov.au/clearinghouse/home> (Accessed: 5 September 2015)

³ Available at <http://www.iasi.org/> (Accessed: 14 May 2015)

⁴ Available at <http://www.olympic.org/olympic-studies-centre> (Accessed: 5 September 2015)

⁵ Available at <http://www.olympic.org/museum> (Accessed: 5 September 2015)

⁶ Available at: <http://www.nationalarchives.gov.uk/olympics/> (Accessed: 4 August 2015)

⁷ Available at: <http://www.nationalarchives.gov.uk/help-with-your-research/research-guides/olympic-paralympic-games-sporting-history/> (Accessed: 5 September 2015)

⁸ Available at: <http://www.nationalsportsmuseumonline.org.uk/> (Accessed: 5 September 2015)

an important information domain for LIS researchers and practitioners. The remainder of this literature review covers theoretical approaches that help develop a rigorous and grounded perspective on information in sport. LIS theories on domain analysis and information behaviour are covered along with an understanding of sport as a serious leisure domain. To conclude, the rise of computer science in sport is noted and literature on the subsequent growth of an interdisciplinary perspective known as sport informatics is reviewed.

2.2 Domain Analysis

This study takes a domain-analytical approach to sport related information. Domain analysis is paradigm that situates information within domains of knowledge (Hjørland and Albrechtsen, 1995). These information domains are typically academic subjects but may also be professionally, socially or culturally constituted. Bawden and Robinson (2012) define an information domain as:

“the set of information systems, resources, services and processes associated with a group of users with common concerns and a common viewpoint and sharing a common terminology.” p.93

Domain analysis aims to understand the social construction and functional requirements of a particular domain as underlying mechanisms affecting information use within that domain. The agency and subjectivity of individual users is acknowledged, but their information use and access to knowledge is mediated and constrained by the structures of the domain. Hjørland describes this as working “outside-in” instead of “inside-out” (2002a).

This socio-cognitive position is contrasted with other paradigms in information science: object, communication, behavioural and cognitive. The object paradigm is a realist view that considers information exists objectively. Hjørland and Albrechtsen (1995) argue that this type of realism is naive, as it is inaccessible, and prefer a qualified realism that posits information cannot be understood in isolation but can only be accessed within a historical situation and via the scientific knowledge of subject experts.

Hjørland and Albrechtsen recognise objectivism as an attempt to formulate an alternative to subjectivity: the idea the information can only be constructed from user perception or behaviour. This subjective idea of information is reflected in the behavioural paradigm, understanding information by how users interact with it, or the cognitive paradigm, understanding information by how people think about it (1995). These paradigms assert information systems should be based on the views of its users. Hjørland and Albrechtsen’s opposition to this is two-fold: philosophically, they argue that by attempting to isolate and abstract user’s knowledge from their

environments that knowledge become less realistic; practically, it is difficult to extrapolate from a user's knowledge general principles for information systems design as the user perspective is often incomplete or defective. This is not to say that Hjørland and Albrechtsen think that information systems should not be user friendly, or that studying human cognition is not important for information science but they argue that domain-analysis provides a more "socio-cultural, pragmatic, and realistic" theory of cognition (1995).

Domain Analysis and the Information Communication Chain

Hjørland and Albrechtsen view the communication paradigm slightly more favourably as they consider it as the most socially oriented though still too focused on individual concerns. Robinson (2009) reconciled this somewhat by proposing a conceptual model for information science that combines the idea of the information chain, common in accounts of information science, with domain analysis.

The information chain concerns the communication of recorded information through a sequence of processes (Robinson, 2009; Bawden and Robinson, 2012, Chapter 1). These processes typically cover:

- creation;
- dissemination;
- organisation;
- indexing and retrieval;
- storage;
- use;
- archiving and disposal

Robinson's combine model comprises three elements that together provide a way to frame an information situation. One element is the information communication chain process of interest. A second element is the context in which it is applied. There are two aspects to the context: the scale (from individuals to whole societies) and the media of interest. The media may be "any information-bearing entity type expressed specifically or generally" (Robinson, 2009). The final element of the model is the selection of a domain analysis approach for studying the process in context.

Approaches to Domain Analysis

Whilst Hjørland and Albrechtsen (1995) provide the historical context and philosophical basis for domain analysis it is in a subsequent paper by Hjørland (2002b) that a more practical framework for doing domain analysis is provided. Hjørland enumerates eleven approaches that guide the training and practice of domain-specific information specialists. These approaches can also be used in research to examine the contours of an information domain, neatly bridging practice and research. The eleven approaches are:

1. Literature guides or subject gateways
2. Special classifications and thesauri
3. Indexing and retrieving specialities
4. Empirical user studies
5. Bibliometrical studies
6. Historical studies
7. Document and genre studies
8. Epistemological and critical studies
9. Terminology, language, semantics and discourse studies
10. Structure and institutions of scientific communication
11. Cognition, expert knowledge and artificial intelligence

Many of these approaches precede, and exist independently of, domain analysis. By bringing them together domain analysis provides a more explicit and systematic basis for interrogating an information domain (Hjørland and Albrechtsen, 1995). Palmer (1999) recognises the extent to which domain analysis provides “scaffolding” for information science research that “is rigorous and broadly applicable” though she does advise the alignment of domain analysis with other general models, in particular user models, so that information science doesn’t lose knowledge accumulated across domains. Robinson (2009) suggests Hjørland’s approaches can be used to extend the information science conceptual model to show linkages with related subjects: for example, indexing and retrieving (option 3) with computer science; structure and institutions (10) with librarianship; or empirical user studies (4) with sociology. This extension into related disciplines is particularly relevant for sport.

In this sense domain analysis is both new, and yet not new; it is an orchestrating

paradigm that is philosophically coherent yet pragmatic providing a means of understanding information science as grounded in well-established general theories and practices and yet, through extension and specialisation, situation-specific. Certainly, Hjørland makes some bold claims for it's centrality in information science:

"Domain analysis offers a theoretical perspective, which in my opinion is able to satisfy the need for a comprehensive theory of IS. Domain analysis is an approach that connects theory and practice, has a coherent view of all major concepts in IS and provides an identity for IS consistent with the history of the field" (Hjørland, 2004)

Despite this, there is a relatively small body of work that explicitly draws upon domain analysis in the literature though it has been applied to knowledge domains as varied as healthcare (Robinson, 2010), nursing (Sundin, 2003), art disciplines (Ørom, 2003; Tidswell, 2010; Laurenson, 2013; Christensen, 2014), scholarly research (Fry, 2006), architecture (Nascimento and Marteleto, 2008), music (Penton, 2008; Pietras and Robinson, 2012), developmental biology (Cable, 2012), law (Crowhurst, 2004; Vieitez, 2010), dance (Bojkova, 2013) and travel (Kuhr, 2011). Only that of Robinson (2010) approaches a complete analysis with the others applying selected approaches to a domain of interest. These include 9 previous domain analyses by City LIS students. Each of these dissertations has applied 3-4 approaches on average to their chosen domain, with historical studies and epistemological and critical studies being the most prevalent.

This study will use four of the eleven approaches to consider information in relation to athletic tasks and goals:

- empirical user studies (primary approach)
- studies of documents and "genres" (secondary)
- terminology and discourse studies (secondary)
- studies in cognition, computing and artificial intelligence (secondary)

The selection of these approaches is somewhat arbitrary but is primarily based on the topics posed by the motivating research questions. The primary approach is an empirical user study that will gather data from athletes on their information use. The secondary approaches are used to illustrate how sport could be understood as an information domain and help reveal the types of documents, technologies, discourses and information practices that may be of interest within it. The purpose is to initiate a domain analysis of sport within an established research context that, whilst partial at this stage, suggests areas for future research and provides sufficient domain knowledge to make the empirical study more relevant.

Framing Domains

Tennis (2003), Fry (2006) and Christensen (2014) note that one of the drawbacks with domain analysis is the problem of how you define and delineate a domain of study: the definitional boundaries of domains are often indistinct, situational and unstable. Hjørland (2002a) asserts the purpose of domain analysis is “to investigate the nature and structure of the knowledge and communication at the *chosen level of specialization*” (italics added), yet provides no mechanism for defining or specializing the domain that is the object of study: the domain is delineated by the application of domain analysis approaches to it. As Christensen puts it “the domain does not exist out there, but surfaces through the recording of it” (2014, p.279). In his research Christensen is also concerned with how unstable domains are both over time and according to different perspective. Christensen recognises this can make domain analysis seem diffuse. Indeed, domain analysis is frequently invoked ‘in spirit’ rather than systematically and completely.

However, Christensen does argue that communication processes should ideally be situated in “relatively framed domains” to be more relevant (2014). Tennis (2003) addresses this definitional ambiguity by proposing two definitional axes that can be used to define domains in a transferable manner:

1. *areas of modulation* to define the name and extent of the domain
2. *degrees of specialisation* to qualify the domain and limit the intentional scope.

2.3 Serious Leisure

Much of the early work on domain analysis focused on scientific communication in scholarly domains but Hjørland explicitly rebutted any claim that it was only applicable to academic subjects (2004). These distinctions are not easily separated: sport is an example of an academic discipline, a professional workplace and a leisure activity. Jenna Hartel has led the advancement of domain analysis into everyday information and hobby domains, exemplified by gourmet cooking in her research.

Hartel has done this by uniting domain analysis with the serious leisure perspective (SLP) developed by Stebbins. Hartel introduced this combined LIS/SLP conceptual framework (2003) to ground her ethnographic study of gourmet cooks that revealed and analysed their information resources, practices and personal information collections (2006, 2007, 2010). There is a harmonious synergy between SLP and domain analysis. SLP provides a theory and typology for understanding and segmenting leisure with varying degrees of specialisation that can be used to classify and delineate areas of leisure activity as domains. Domain analysis provides a methodology of systematic research into the forms and structures within and across these information-

rich domains. By combining domain analysis with SLP, Hartel also negates perceptions that leisure domains are too vague, information poor and lacking in theory for inclusion in LIS research.

The Serious Leisure Perspective

The SLP has developed a growing body of theory and research on leisure since Stebbins first started studying amateurs in the 1970s (Stebbins, n.d.) and subsequently developed a conceptual statement on serious leisure (1982). The model has expanded to more formally define casual leisure (1997), project-based leisure (2005) and devotee work (2011). Elkington and Stebbins (2014) have recently summarised more than thirty years of work on the SLP conceptual framework, along with examples of its extension into related areas such as tourism, consumption and, in conjunction with Hartel, library and information science.

At the top level of its typography, the perspective identifies three main life domains:

1. Work
2. Leisure
3. Non-Work Obligation

Work and non-work obligation are activities participants wouldn't otherwise choose to do if they weren't obliged to. The difference between them is that work provides the means to earn a living whereas non-work obligation does not. Types of non-work obligation include unpaid labour, unpleasant tasks and self-care (Elkington and Stebbins, 2014 p. 11).

Leisure is defined as:

"un-coerced, contextually framed activity engaged in during free time which people want to do and using their abilities and resources, actually do in either a satisfying or fulfilling way (or both)." (Elkington and Stebbins, 2014 p.5)

The two key components of this definition is that, within the constraints on the participant, the leisure is freely chosen and that it is based around activities. Within the leisure domain Stebbins identified three main forms of leisure:

1. Serious Pursuits
2. Casual Leisure
3. Project-Based Leisure

Serious pursuits are further subdivided into serious leisure and devotee work (where participants earn income from something they would otherwise pursue as leisure). Casual leisure is essentially hedonic, requiring little skill or knowledge and conducted primarily for pure enjoyment rather than fulfilment (Stebbins, 1997). Conversely, seriously leisure requires special skills, knowledge and experience. It generally requires a more substantial and systematic commitment, but it motivated by more substantial rewards from which the participant can derive much personal fulfilment (Stebbins, 1982). Serious leisure is distinguished by 6 qualities (Elkington and Stebbins, 2014 p. 18):

1. It requires perseverance
2. It provides the opportunity for a leisure career
3. It requires personal effort using specially acquired skills, training and knowledge
4. It provides durable benefits
5. It is associated with a unique ethos
6. It provides participants with a distinctive identity

Project-based leisure is a reasonably complex activity but it is short-lived: either a one-off or frequent activity. It therefore lacks the systematic and career element of serious leisure and so doesn't persistently afford the qualities found in serious leisure. These main forms of leisure are further specialised in SLP into a full typology of leisure pursuits depicted in Figure 1.

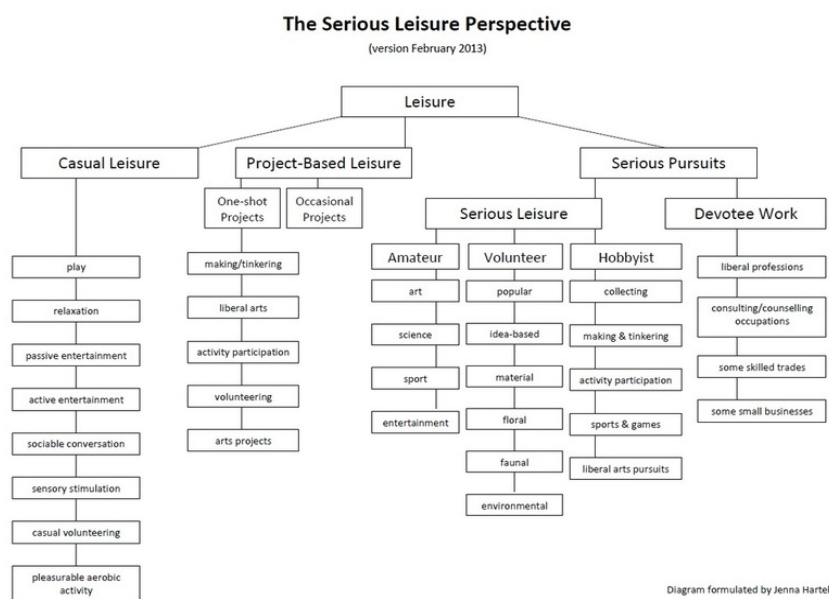


Figure 1: The SLP diagram. (Stebbins and Hartel n.d.b). The target population for this research is Leisure: Serious Leisure: Amateur: Sport

Amateurism

Within serious leisure three types are identified: amateur, volunteer and hobbyist. Whilst all three are evident in sport, only amateur and hobbyist apply to athletes in sport. The distinction between amateur and hobbyist in SLP is quite subtle: amateurs are defined in relation to professional counterparts whereas hobbyists are not, though there may be commercial interests within the hobby domain (Stebbins 1982). In some domains, such as sport, this distinction may be dynamic and unclear as activities professionalise. Stebbins also distinguishes between professionals (private funded athletes) and elite amateurs (public funded athletes) in sport:

“though professional by definition and by level of competence, elite amateurs usually lack the glamour and respect enjoyed by the pros”
(Elkington and Stebbins, 2014 p.61)

However, no evidence is provided for this debatable assertion. Glamour is a relative concept between sports depending on their level of exposure and material wealth and it is not clear why it is introduced as a relevant criteria of professionalism above the athlete’s income and competence. In this study elite amateurs are considered to be professionals as they earn their livelihood from their sport regardless of the origin of that funding or the level or glamour associated with that sport.

Stebbins classifies sports as amateur or hobbyist and within amateur further distinguish between sports with professional counterparts and those with elite amateurs. Stebbins classifies the sports in the scope of this study as follows:

	Serious Leisure Type	Professional Status
Long Distance Running	Hobbyist	Not Applicable
Cycling	Amateur	Elite Amateur
Swimming	Amateur	Elite Amateur
Rowing	Amateur	Elite Amateur
Triathlon	Not Classified	Not Classified

Table 1: Stebbins classification of the serious leisure type and professional status of sports in this study. Source: Elkington and Stebbins, 2014 pp. 59-60 and p. 77

Serious Leisure Studies in Sport

There are a number of studies that have applied the SLP to sport and physical activity. These are not primarily focused on information resources and use but a few are notable in relation to this research.

Liu et. al (2013) used a survey to measure the seriousness of leisure lifestyles. The

research asked a convenience sample of softball and volleyball players to rate their agreement with the six characteristics of serious leisure. These ratings were used to divide the sample into a lower half, who have a sport involved lifestyle (SIL), and an upper half who have a sport dedicated lifestyle (SDL). The study noted that whilst all characteristics were present in serious leisure those with a sport dedicated lifestyle rated identity, ethos and career contingencies more highly than the sport involved. This suggests that whilst the training, skills and knowledge linked to perseverance, effort and a leisure career applies to both lifestyles, motivational and social information may be more significant for the more dedicated.

Major (2001) studied the perceived benefits and costs of running in a representative sample of 24 runners. Here Major used weekly mileage and number of running days as the basis for measuring seriousness with the criteria being all runners should "meet the recommended quantity and quality of exercise for developing and maintaining cardiorespiratory fitness as established by the American College of Sport Medicine." (2001, p.15). This is a more sport-specific but less formal definition of serious sport than one based on the serious leisure inventory and measurement. Major also noted that 75% of female runners (N=9) and 83% of male runners (N=10) maintained a running log, a topic of interest in the empirical part of this research. The main benefits of running were a sense of accomplishment, health and fitness and social affiliation with the main costs being injuries.

Robinson et. al. (2014) provide an example of social affiliation in long distance running in their ethnographic study observing how athletes in an essentially individual sport nevertheless participated in social worlds that guided their practices, provided opportunities for interaction and reinforced their dedication and physical effort through identification with the sport. A social world is a diffuse unit of social organisation larger than a group but not necessarily formally defined in its boundary or associated with a specific geography (Unruh, 1979). Instead, social worlds are delimited by "effective communication not territory" (Shibutani quoted in Unruh, 1979) and "universes of discourse" (Shibutani quoted in Unruh, 1980). A social world is constituted by "an internally recognizable constellation of actors, organizations, events and practices" that interest and involve participants (Unruh, 1979). These participants are categorised by Unruh into four trans-situational social types: strangers, tourists, regulars and insiders. Such organising principles invite scrutiny using domain-analytic approaches, such as discourse studies or examining the structures and institutions involved in their communication networks.

Exploring this theoretical synergy between serious leisure and social worlds, Robinson et. al. (2014) used participant observation of 6 runners to document how the practices, tasks, attitudes and types of activities experienced by both group and individual runners changed over a 12-week training period preparing for a marathon.

The study mentions various activities and anxieties encountered at different stages and indirectly reveals ways the athletes used information to support these such as: an emerging fad for capturing training data using heart rate monitors and global positioning devices by group runners; the expression of commitment through goal setting, including becoming increasingly competitive about personal bests (which rely on keeping personal running records); the preparation of a training plan, where group runners followed a plan provided by their club but individual runners either created their own or followed no specific schedule; consulting running magazines, online websites and attending a seminar to increase knowledge about nutrition; and consulting professionals as the race approached and anxiety about potential injury increased. Finally, the authors concluded that social worlds were normative and the athlete's practices changed during the training period as they learnt new behaviours through their immersion in the social world of marathon running.

All of these exemplify the types of activities athletes perform during a training cycle and the types of resources they use to increase their knowledge and socialise with others but they don't explicitly consider the role of information in facilitating these types of learning and interaction and what capabilities and literacies are required to exploit this information in order to obtain the knowledge, learnt behaviour and benefits outlined.

Serious Leisure and Information

Thanks to the pioneering work of Hartel there has been a growing recognition of the intersection of leisure studies and library and information science and researching the role of information and documentation within leisure activities (Stebbins, 2009; 2012). As implied by the above serious leisure studies in sport, there are two main information use cases in serious leisure pursuits (Elkington and Stebbins, 2014):

1. fulfilment-related
2. social-world

Information in serious leisure domains is important not just because it facilitates the acquisition of the knowledge, training and skills required to advance in a serious leisure career (fulfilment-related information), but also because it helps establish the ethos, or community spirit, associated with a social world. This ethos is manifested in shared beliefs, practices, values and goals and is expressed through informal or semiformal mediated communication and information exchange (Elkington and Stebbins, 2014 p.18). This reinforces the idea, as advocated by Fry (2006) for scholarly communication and Robinson et. al., (2014) in their study of marathon runners, that domains should be viewed as social, as well as intellectual, information bearing spaces.

Hartel suggests the study of leisure domains question some assumptions of LIS research, particularly around information seeking. In the realm of leisure, information acquisition and exchange does not simply derive from needs or anomalous states of knowledge but can be a desirable part of the leisure experience. The idea of “confident” and “upbeat” serious leisure hobbyists taking pleasure in acquiring and curating knowledge related to their hobbies challenges the tenet that information seeking and use is driven by scarcity or according to principles of least effort (Hartel, 2003).

Many of the studies that combine serious leisure and LIS research study the seeking, retrieving, gathering, organising, storing, sharing and using information. These information processes are collectively referred to as information behaviour. Information behaviour is a sub-discipline of LIS that is well conceptualised and researched so it has an extensive literature to draw upon.

2.4 Information Behaviour

Information behaviour is a broad area of study within library and information science with a rich conceptual and empirical research base on the interactions between information and humans. There are many general conceptual models of information behaviour (Wilson 1981; Wilson and Walsh, 1996; Niedzwiedzka, 2003; Ingwersen and Järvelin, 2005; Choo, 2006; Godbold, 2006), with more specific models on information seeking and retrieval (Ellis, 1989; Ellis, Cox and Hall, 1993; Leckie et.al., 1996; Johnson, 1997; Johnson et.al., 2001; Kuhlthau, 2003; 2005; Foster, 2004) and everyday life information seeking (ELIS) (Savolainen, 1995; 2005). Robson and Robinson (2013) provide a useful summary of key models and compare LIS models with those in communication theory. Despite this volume and variety, information behaviour is still a difficult subject to define and scope precisely. This review concentrates on a few salient concepts and examples that most reflect how information behaviour is understood and used in this research. This research draws mainly on Wilson’s general models to provide the background theory for understanding information behaviour. These models have evolved over time via a number of key publications (Wilson 1981, 1999, 2005; Wilson and Walsh, 1996).

Wilson’s Original Model

Wilson’s original model (1981) depicted areas in the field of user studies and the relationships between them. It contained an information user, related to an information need, followed by information-seeking behaviour. This need could be resolved via information systems, information exchange with other people or other sources. If the information-seeking was successful, the information could be used and/or transferred to another person. Information use is not precisely defined by Wilson, but the actions and processes the term covers ultimately either satisfy or fail

to satisfy the need (Wilson, 1981 Fig 1 pp.4-5). It's important to recognise that needs are hard to know, not always acted upon and not always completely satisfied. Case points out that information needs are rarely well defined but commonly relate to the need to find answers, reduce uncertainty or make sense (2012 pp.81-85). Information needs are perhaps unknowable, unobservable and unreliable (Case, 2012 pp.87-88) whereas information behaviour is more accessible to researchers (Wilson, 1994).

Information needs are simply used in this research as any motivation, however well understood or articulated, for doing something with information; information behaviour is widely scoped as being any information-related process enacted by a user in response to this motivation. These high-level information processes are those generally typified by the information communication chain model and represent the kinds of interactions users have with information that might be observed during research.

Another part of Wilson's 1981 paper attempted to provide context for user studies and needs definition by depicting information-seeking pathways within a universe of knowledge. The user exists within their life-world of known experience and their more immediate reference groups with whom they identify and interact. Knowledge is embodied in information sources, such as documents or other people, and the user often accesses these sources via information systems: mediating people, techniques and technologies. There are many paths a user can take within this universe to fulfil their information requirements. (Wilson, 1981 Fig 2 pp. 5-6).

Wilson's Later Model

Wilson later reviewed not just user studies in information science (1994) but also relevant theories and studies from related disciplines in order to augment his original model (Wilson and Walsh, 1996; Wilson, 1997). The expanded model adds depth to the information user, need and information-seeking behaviour concepts from the original model. The concept of activating mechanisms is introduced to fill the gap between the situation of the information user (described as *the person-in-context*) and their decision to seek information (awareness and identification of information need). Activating mechanisms also exist between the information need and a decision to take action (articulation and satisfaction of need). Also affecting these stages is the concept of intervening variables. These variables act as constraints on behaviour and may include personal, emotional, educational, demographic, economic, social, environmental or information source factors (Wilson and Walsh, 1996). Whilst this enriches the concepts leading to information behaviour it still leaves information processing and use less well developed. How users incorporate information into their mental models and how this leads to changes in their world view or behaviour is, like information needs, also hard to observe (Wilson and Walsh, 1996).

Information Behaviour Models and Domain Analysis

These are highly abstract general models but introduce several useful concepts and also provide a way of thinking about individual users in relation to the ideas of discourse communities from domain analysis and social worlds in serious leisure. Another way Wilson's original model helps with a socio-cognitive approach is by recognising that the factors influencing needs and behaviours may not simply be the physiological, affective or cognitive human needs internal to the user, but may also include social and environmental factors (Wilson, 1981 Fig 3 pp. 7-10).

Wilson also reminds us that a full user study considers not just the *motivation* and *means* but also the "*ends served by information-seeking behaviour*" (1981, p.10). For example, in sport an injury may prompt information seeking; the means may include consulting documents, asking other athletes for advice or seeking expert opinion from medical professionals; the ends may include not just recovery, rehabilitation and return to exercise but also preventing recurrence. The latter may not initially be a consideration and an athlete may be satisfied with the information needed to get to recovery unless the injury subsequently returns and then the behaviour may be repeated with the same motivation and means but including prevention strategies as an additional requirement that needs to be met in order for the need to be satisfied. These factors could also be influenced by external factors such as the experience of other athletes with a similar injury or proximity to an important event.

As Wilson says this model provides a "*wider, holistic view of the information user*" and associated concepts but in order to be generally applicable needs to be tested by "*in-depth studies of well-defined categories of users*" (1981, p.11). Wilson's comparative work on information behaviour models also demonstrates how both general and more specific models can be linked and nested to adapt them to the level of detail appropriate for the type of study at hand (1999). As this study is exploratory, a general model will suffice. Whilst a general model provides a way of thinking about the nature of information behaviour, the sources, task and individual user within any observed situation will always be quite unique. As Bawden and Robinson (2013) conclude social factors are subtle influencers but the individual is the most significant factor in information behaviour. The information user is socially constituted but not necessarily socially conditioned so we must be careful of reducing individual agency too far and assuming too much about social determination when conducting user studies.

Information Behaviour Studies in Sport and Recreation

Only one empirical study of athlete information behaviour has been located so far. Vazquez Moctezuma and Calva Gonzalez (2013) studied the information behaviour of

amateur boxers in Mexico. They noted the lack of information behaviour studies about athletes in LIS and that where information was studied in sports science research, those studies often only partially addressed information needs in relation to the sporting issue discussed. The information-related tasks identified in their study varied in type and complexity and included: nutrition, technique, injuries, equipment, doping, regulations and competition logistics. The study indicated a range of information sources were consulted, with the main information source being their coaches and other boxers with libraries used only infrequently.

Whilst no further sport examples have been found there are empirical studies on information behaviour in other leisure domains that provide an evidence base on information seeking in serious leisure. These include: wilderness recreation (Ernest et. al., 2005), backpacking (Chang, 2009), photography (Cox et. al., 2008), cookery and food (Hartel, 2010; Cox and Blake, 2011), genealogy (Yakel, 2004; Fulton, 2009; Darby and Clough, 2013), crafts (Prigoda and McKenzie, 2007; Gainor, 2008), collectors (Lee and Trace, 2009; Margree et. al. 2014) and museum visitors (Skov, 2013).

The study of wilderness hiking is notable for its focus on the role of the Internet in recreational information seeking (Ernest et. al., 2005). The study found that various sources were consulted by hikers with 72% using the Internet which was considered to be as convenient and accurate as other sources. the Internet was seen as changing access to sources rather than the types of sources consulted. 10% had also used the internet to share information about their hiking. Fulton (2009) concentrated on information sharing rather than the more common information seeking. In her study of genealogists special value was placed on the Internet for its convenience and ability to facilitate reciprocal information sharing, an important part of community building. Finally, Chang's study of backpackers also found that a variety of sources were consulted as part of ongoing recreational information seeking (2009). In this case the leisure activity was divided into clear stages: before, during and after travel with distinct tasks involved in each stage. This affected the types of sources consulted and channels used. These studies suggest recreational information use involves varied information sources, a growing use of online channels, habitual information seeking and sharing for both fulfilment-related and social-world information and evidence of process/task orientation to prompt and structure these information activities.

2.6 Sport Informatics

Hjørland and Albrechtsen (1995) describe computer science as a "bordering science" to information science against which information science must define itself so it's important to relate the sociological conception of domain analysis in LIS to it's use as

a software engineering and knowledge elicitation method in computer science and related fields (Hjørland, 2002). Expert systems and artificial intelligence consider how subject knowledge can be reproduced and augmented, maybe even replaced, through computational means. This final section looks beyond LIS and social science to briefly note the emergence and definition of the nascent discipline known as sport informatics and the perhaps invisible place of information science within this it.

The application of cognition, computing and artificial intelligence to sport science has seen the emergence of a discipline known as sport informatics, also known as computer science in sport. The International Association of Computer Science in Sport (IACSS) was founded to co-ordinate co-operation between computer science and sport and they hold biennial conferences and publish an associated journal The International Journal of Computer Science in Sport (IJCSS). The key literature centres on this organisation and journal. Link and Lames (2015) summarise the early work on the history and structural model for sport informatics covering much of the definitional work on the subject to date. They note early applications of computing in sport included information management and documentation but has now extended to modelling, simulation, biomechanical analysis and virtual reality. Other concepts covered by the new discipline include game analysis, e-learning as well as the processes of collecting, storing and processing data generated by athletes (Baca, 2015a). Notable trends include: use of wireless and mobile networks; growth of cloud and ubiquitous computing; social networks; pervasive data collection, processing and analysis; feedback systems; and expert systems with applications in remote coaching (Baca, 2009). The discipline is interested in both researching the application of computer science in sport, and potentially the application of sport science in computer science (Link and Lames, 2015).

The use of the term informatics is rooted in the German term *Informatik*: the systematic processing of information by computers (Link and Lames, 2015). The model of informatics used by Link and Lames extracts core informatics (theoretical, technical and practical informatics) from mathematics, engineering and human science with the use of computers for information processing as applied informatics, seemingly bypassing LIS. In their analysis they make a distinction between sport informatics, which includes information science, and computer science in sport:

“Computer science in sport stands exclusively for the use of computer technology in sport and sport science. Sport informatics also includes the application of methods and paradigms from computer/information science as well as from research programmes, which try to transfer sport scientific knowledge to computer sciences.” p. 10

However, their final definition of sport informatics seems to omit the earlier reference to information science to concentrate more on synergy with computer science:

“Sport informatics is a set of multi- and interdisciplinary research programmes which contain parts of sport science and computer science. The subject area is the application of tools, methods and paradigms from computer science on questions of sport science as well as the integration of sport scientific knowledge in computer science.” p. 10

Link and Lames also model a basic structure of sport informatics that identifies the areas of cooperation between computer and sport science. A more formal subject analysis on the potential for cooperation between information and sport science, such as that documented by Link and Lames for computer science, is beyond the scope of this study but a similar exercise may represent an interesting area for further research and alignment between the disciplines. Here, information science, computer science and sport science are simply noted as related disciplines, something that will be explored further in section 3.1.

2.7 Summary

LIS interest in sport information is mostly as an application field for library disciplines such as collection management, information literacy and archival functions. This work argues that sport information is broader and more complex than this and would benefit from greater interest by librarians and information scientists. One approach to pursuing this line of inquiry more rigorously is to approach sport as an information domain. The literature shows how domain analysis and information behaviour theory can be used to structure and frame such research and the work of Hartel demonstrates how the approach can be applied to leisure activities not just scholarly or professional domains.

Hartel’s work links domain analysis to the serious leisure perspective (SLP). The SLP literature is helpful in understanding, defining and categorising sport as a type of leisure activity and suggesting two broad classes of leisure information: fulfilment-related and social-world. This perspective also helps researchers recognise that information seeking can be pleasurable and motivated by gratification. In order to dig deeper into information use in practice, the literature of information behaviour has been drawn upon to explore models and empirical studies of information users and resources in leisure information seeking contexts. When combined with a domain-analytic orientation this can effectively synthesise the individual (cognitive) and the social (collective) dimensions within a domain. Information users may have certain tendencies and preferences from the way of life they have internalised and their attempts to maintain that way of life (Savolainen, 2005), but external social and environmental social structures are also subtle influences on their behaviour.

Finally, the increasing use of technology within sport reminds us that a number of other disciplines may be interested in researching information, communication and

media within sport. The discipline of sport informatics has emerged to research the links between computer science and sport and provides a small, but growing, body of literature to draw upon when considering how digital data may change the nature of sporting information environments. This all provides a useful general research context, from LIS and beyond, to build upon when researching sport as an information domain.

3. Sport as an Information Domain

This chapter translates the foundational theoretical approaches outlined in the literature review into a more sport-specific research context. In the absence of specific research on sport as an information domain it is necessarily definitional. An attempt is made to use various theoretical approaches to define and establish some parameters of the domain and its position at the nexus of several contributory disciplines. This is followed by some brief examples of how domain-analytic approaches could be applied to the domain. The intention here is not to attempt a comprehensive analysis for any of these approaches but to illustrate possible areas of interest and suggest why LIS researchers and professionals should consider sport a domain of interest.

3.1 Defining the Sport Domain

The idea of sport as a domain seems common-sense but a precise definition is elusive. Link and Lames (2015) raise the difficulty of defining the term sport, describing it as “still an open problem”, whilst Tennis (2003) notes the general problem of how to define domains is not clear from the domain analysis literature. In order to anchor this research within such definitional ambiguity this section puts forwards a few definitions that more formally delineate the object of study based on relevant theory.

The definitional axes provided by Tennis (2003) and introduced in the literature review are used to confront the definitional gap. Tennis quite rightly argues that a domain definition must be provided in order for domain analysis to be cumulative. The author agrees that a domain analysis should at least attempt a standardised definition that would be easily understood by other researchers interested in the domain and enable research to be compared and contrasted.

Areas of Modulation

Areas of modulation sets the broad parameters of the domain, demarcating how extensive it is, and provides it with a name. In this case the domain is called sport but a definition is still needed to establish what this covers. Coakley and Pike (2009) argue that definitions of sport are contested but provide the following definition:

“institutionalised competitive activities that involve rigorous physical exertion or the use of relatively complex physical skills by participants motivated by internal and external rewards”. p.5

The facet that most clearly distinguishes sports from games or play is their institutionalisation where standard rules, regulatory agencies, formalised learning and development pathways and organisational and technical control are established (Coackley and Pike, 2009). In his definition of sport, Giulianotti suggests sports have the following characteristics: structured, goal-oriented, competitive, ludic and culturally situated (2005). In the serious leisure perspective (SLP), Stebbins defines sport as "inter-human, competitive, executive, physical activity based on a shared set of rules" (Elkington and Stebbins, 2014 p. 59). Gutmann (2004) described sport as physical contests, a subset of competitive games (contests) which are themselves a subset of organised play (games), all of which come within the realm of play.

Traditionally then, definitions of sport include a competitive element and Stebbins in particular is clear that systematic physical activity that is challenging, but does not involve interpersonal competition is a hobby not a sport. However, for this research the challenge and developmental aspects of sport are of as much interest as inter-human competition. In some cases, the contest is provided by the pursuit of a quantifiable goal. Therefore, for sport as an information domain, goal-orientation rather than competition is perhaps a more significant factor and success in direct competition can be considered a subset of goal-orientation. There is still a contest, a win-lose outcome, but the contest does not necessarily involve direct competition with another human competitor. For this reason, the following slightly broadened definition, primarily adapted from Coakley and Pike (2009), is used to describe the extent of the sport information domain:

institutionalised goal-oriented activities that involve physical exertion and/or the use of relatively complex physical skills by participants motivated by internal and/or external rewards.

Having named and identified the extent of the entire domain it now needs to be qualified so that the intension of the domain reflects the scope of this study outlined earlier in the introduction. Degrees of specialisation is the axis Tennis proposes for limiting the domain to be described (2003). Within this he identifies two degrees: *Focus* and *Intersection*.

Degrees of Specialisation: Focus

At its broadest, sport is a large domain encompassing professional sport, governing bodies, media organisations, service and goods providers, the academic discipline of sport science as well as the leisure activity of many amateur athletes and fans. As seen in the serious leisure perspective (SLP) concept of life domains and leisure forms there are different levels of possible engagement with sport from those who earn their living from sport to those who enjoy watching it to relax. There are also different roles performed in sport such as athletes, fans, officials, coaches, reporters, researchers

and service providers to name some examples. Finally, whilst there are commonalities across the entire domain of sport, individual sports may have their own domain characteristics and operate as sub-domains with further levels of specialisation within them.

Each of these three aspects, **level of participation**, **role** and **sport** could be considered a *focus* for narrowing, segmenting and qualifying the sporting domain. They can be combined to formulate a transferable qualification of sport as an information domain that allows the domain of interest in this research to be clearly defined in a manner that is potentially reusable and extensible by other researchers. Each will be considered in turn before presenting a final model and definition.

1. Level of Participation: Revisiting Amateurism

In the literature review it was noted that the definition of amateurism by Stebbins relies on the use of professional alter-egos to distinguish amateur sports from hobbyist sports and is quite subtle and perhaps unclear. Additionally, the use of glamour to differentiate between professionals and elite amateurs was slightly spurious. Here the idea of amateurism as defined in this model of sport definition is revised and the selected sports slightly reclassified.

Leadbeater and Miller regard amateurs and professionals as more aligned along a continuum from casual interest to full employment then discrete types (2004) a view supported by Derom and Taks (2011 p.397) whose research also suggested a continuum of involvement between casual and serious leisure rather than a dichotomy with all participants in their study having mastery and intellectual (serious leisure) and social and escapist (casual leisure) motivations to various degrees. Leadbeater and Miller note the growth of 'Pro-Ams', amateurs that operate to professional standards, as blurring the boundary between professionals and amateurs and highlight the existence of quasi-professionals, pre-professionals, semi-professionals and past-professionals, joining the most committed amateurs in this hybrid pro-am type (2004, p.23). This is therefore included as a third type of professional status for sports.

A **Professional Sport** is one where there is a significant and widespread professional body. An **Elite Amateur Sport** is one where the elite are primarily publicly funded athletes with little evidence of professionalism. **Pro-Am Sports** are ones that are making the transition to professionalism or where there is a small pinnacle of fully-fledged professionals but a more significant elite cohort of quasi-professionals and elite amateurs at the top strata of the sport domain. On this basis, the serious leisure type and professional status of sports in this study are reclassified in Table 2 from the way they were previously classified by Elkington and Stebbins in Table 1:

	Serious Leisure Type	Professional Status
Long Distance Running	Amateur	Pro-Am
Cycling	Amateur	Pro-Am
Swimming	Amateur	Elite Amateur
Rowing	Amateur	Elite Amateur
Triathlon	Amateur	Pro-Am

Table 2: Revised classification of serious leisure type and professional status of sports in this study

SLP and Pro-Am conceptions of amateur are combined and adapted to produce a simplified scale for level of involvement in sport (Figure 2). In this study three broad classes of participants are used: *professionals*, *amateurs* and *casual*. Full and quasi-professionals are combined with the devotee worker and elite amateur types from the serious leisure perspective (SLP) in a *professional* class. Beneath them serious and skilled amateurs are classed as *amateurs* and this term is used for all sports with no sports being considered a hobby. Finally, the broadest and most numerous strata of domain participants, made up the dabblers and the broader public in a professional-amateur-public system (Elkington and Stebbins, 2014 p.16), are here all classified as *casual* participants within the domain.

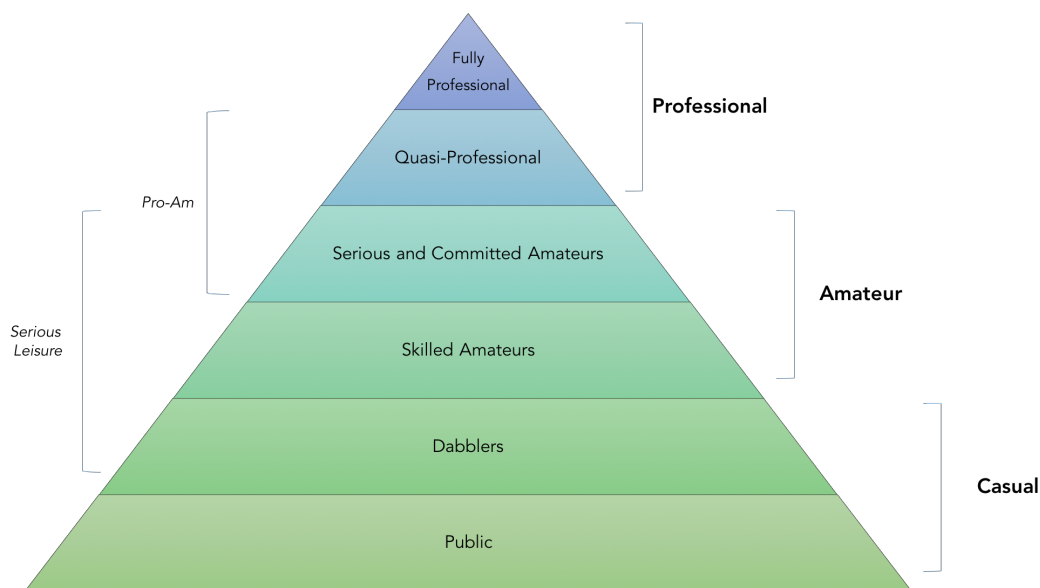


Figure 2: Aligning and simplifying different classifications of leisure participation

It should be noted that not all participants in a sport domain are necessarily engaged in sporting physical activity themselves as, for example, fans make up a significant proportion of the public for a sport and coaches are likely to be significant participants at professional levels. Next then, some possible roles in sporting domains are considered.

2. Roles in Sport

One major role adopted by sport participants is that of athlete. Again definitions of athletes are scarce so here athlete will mean a participant who takes an active, exertive part in a sport activity and who acquires the skills, training and knowledge to do so.

There are however, many other ways to participate in sport all of which require different information behaviours. For example those who follow and consume sport rather than participate in it (fans); those who report or commentate on sport (media); those who train or guide athletes and provide them with advice and instruction on how to perform (coaches); those who administer and govern sporting regulations or who organise and oversee events and competitions (officials); those who provide the equipment and venues that allow sporting activity to take place (service providers); and those who study and analyse sport within academia, professional sport or for pleasure (researchers).

This briefly enumerates several possibilities for types of role in sport that are sufficiently generic to be transferable and that could be validated, augmented and extended through the findings of other research. Only athletes are of interest in this research.

3. Selecting Sports

The final degree of focus in sport in individual sports themselves. Each sport could be conceived as a sub-domain itself within the broader sphere of sport. Even within sports there could be further specialisation based on specific disciplines or communities.

In the definition of sport proposed here an activity must be institutionalised in order to be considered a sport: meaning the standardisation and formalisation of rules, enforcement and technical control, organisation and learning and development pathways (Coackley and Pike, 2009). Practically, this is considered to mean having a governing federation for organising, regulating and promoting the sport at national and international levels. Qualifying individual sports are any currently recognised and affiliated to:

- the Association of Summer Olympic International Federations (ASOIF)¹
- the Association of International Olympic Winter Sports Federations (AIOWF)²

¹ Full list of sports available in the ASOIF Directory <http://www.asoif.com/IFDirectory/Default.aspx> (Accessed 28 July 2015)

² Full list of sports available via the International Olympic Committee Web site:

- the Association of IOC Recognised International Sports Federations (ARISF)³
- Sport Accord, the international federations union⁴

This research is interested in five sports: running, cycling, swimming, rowing and triathlon. All of these are Summer Olympic sports, they are predominately individual sports (though in some, most notably rowing, individuals can participate as a group) with relatively low barriers to entry when compared with many team sports.

Summary

In summary the domain of interest in this research can be qualified in a transferable way by using these three foci:

- Participant Role: Athlete
- Level of Participation: Amateur
- Sports: Running, Cycling, Triathlon, Swimming, Rowing

Athlete denotes a participant who takes an active, exertive part in a sport activity and who acquires the skills, training and knowledge to do so. **Amateur** is used to differentiate those who engage in sport as a leisure activity from the elite activity of funded athletes: whether that funding comes from paid employment or public investment via a public funding programme, such as the UK Sport World Class Programme. It also distinguishes serious leisure participants, who have a sustained higher level of skill and commitment, from occasional or casual participants. The **sports** identified are all predominantly individual sports with relatively low barriers to entry. They are all Summer Olympic sports with recognised national and international governing federations.

As this research studies a single role across several sports it could be described as horizontal in orientation. An alternative approach to qualifying a sport domain could be to study several roles and/or levels of involvement within a single sport providing a more vertical orientation.

This is not a complete, comprehensive or validated framework: these are initial suggestions for ways of qualifying the domain. The aim is to propose a definitional

<http://www.olympic.org/content/the-ioc/governance/international-federations/?tab=aiowf> (Accessed 28 July 2015)

³ Full list of sports in the ARISF Members Directory: <http://www.arisf.org/members.aspx> (Accessed 28 July 2015)

⁴ Full list of sports in the Members Directory: <http://www.sportaccord.com/members/> (Accessed 28 July 2015)

model that is potentially reusable and extensible by other researchers to facilitate comparisons and further the cumulative development of domain analysis. Ideally, further confirmatory research would be conducted to assess the applicability and reliability of the suggested definitional approach.

Degrees of Specialisation: Intersection

Intersection is the second degree of specialisation proposed by Tennis and refers to when an established domain intersects with another, potentially resulting in a new domain, or tension around competing definitions of a domain of interest (2003). In this case, the growing role of computational analysis in sport and the increasing quantification of sporting performance via data acquisition from external cameras or wearable sensors, suggests sport as an information domain overlaps with computer science and engineering disciplines in the field of technology. Additionally, sport can be approached as a science, emerging from the broader field of medicine and healthcare. Finally, sport is part of disciplines within the humanities and social sciences with significant contributions from history, sociology and philosophy in addition to the close relationship already noted with leisure studies. Sport is therefore a potential application field for multiple disciplines placing sport informatics and analytics at the centre of complex spheres of interest as the following model, first suggested in Pope (2015), indicates:

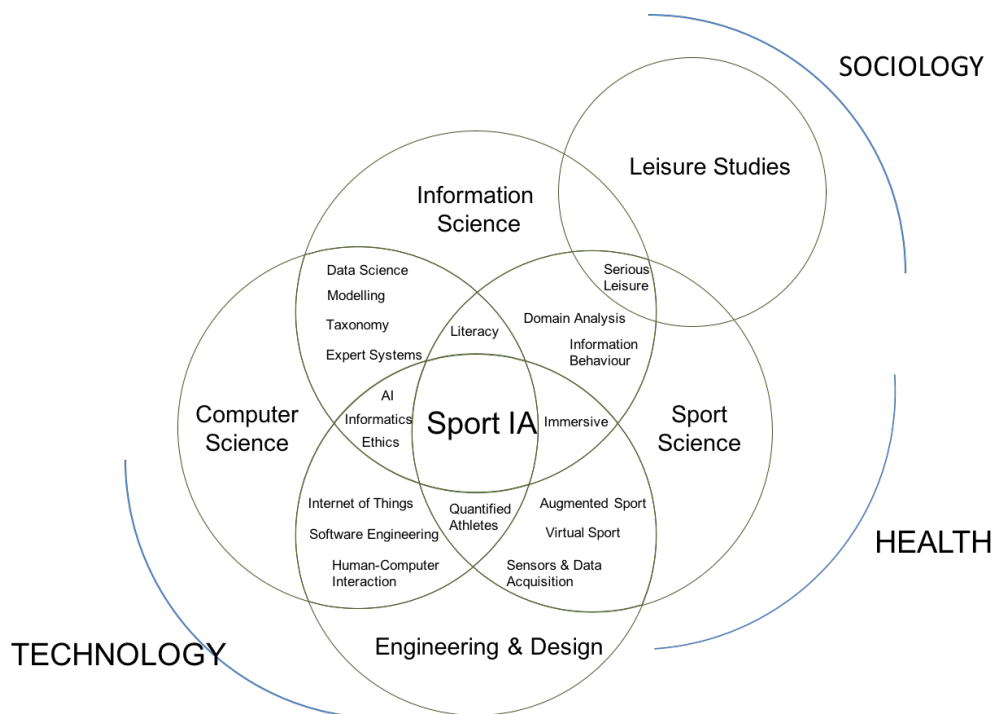


Figure 3: Intersecting fields, disciplines and overlapping topics in sport informatics

This is not an exhaustive analysis but suggests various areas of intersection between different disciplines, paradigms and theories and some topics and themes that might

exist where they overlap. If this kind of model represents in principle how intersections could be used to qualify a domain, this study is only concerned with the highlighted sections in Figure 4.

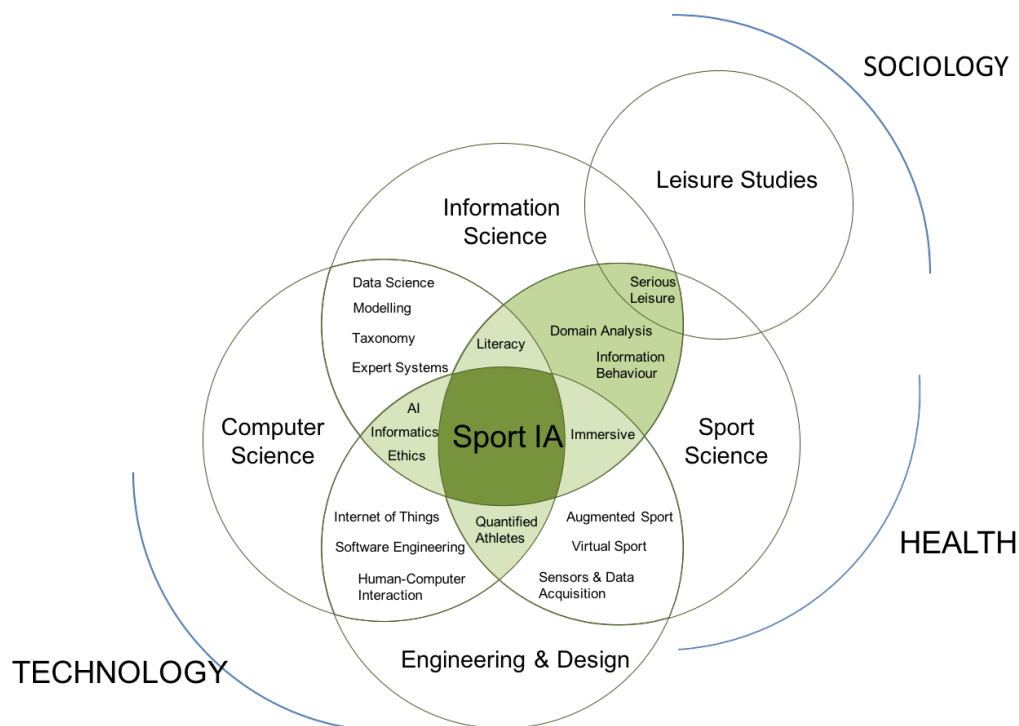


Figure 4: The intersections and topics of interest in this study

Fully exploring these themes and untangling the contributions different disciplines are making in establishing sports informatics and analytics is an area requiring more research than is possible here. This present study concentrates on intersections and topics that fit with the selected domain analysis approaches. The case studies and discussion in the rest of this chapter illustrate how the domain-analytic framework can be used to consider these themes further. Documents and genres and discourse and terminology approaches explore the intersection between information science and sport science. Cognition, expert systems and artificial intelligence explores how ever more precise and pervasive measurement devices expand the quantification of athletic performance; how transmedia and alternate realities bring new experiences to sporting participation; and the implications of these technology developments for literacies and ethics. Finally, the athlete survey described in chapter 4 and 5 obtains some data on how far these areas of sport informatics have been adopted by amateur athletes in practice.

3.2 Documents and Genres

One way of looking at LIS is as the study of recorded information (Buckland, 2012). This recorded information is instantiated in documents that change in type and form over time though many of the processes and issues related to them remain the same

(Bawden and Robinson, 2012). Information is not just about communication or knowledge, but also about evidence and our ability to place that evidence in a meaningful relationship to other pieces of evidence for reference or to establish authority (Buckland, 1997; Bawden and Robinson, 2012 pp. 76-77). This section will concentrate on the evidentiary nature of sport document types.

The document and genres approach aims to reveal the documentary forms within an information domain. It is predicated on the idea that "different disciplines or discourse communities develop special kinds of documents as adaptations to their specific needs" (Hjørland, 2002). Therefore, documents are constituted, instantiated, organised and used according to the functional requirements and communicative purpose of a domain. Genres are "a pattern of communication that conforms to community norms" and help understand record keeping as social action with intertextual links between genres forming more complex genres sets and genre systems that guide documentation practices within communities (McKenzie and Davies, 2012). Mapping genre systems provides a possible method for exploring documentation practices and motivations within a domain, and sport is arguably a domain where record keeping has become essential to its modern form and function.

From Ritual to Record

In Guttmann's sociology of sport, *From Ritual to Record*, he identifies 7 characteristics that distinguish modern sport from primitive, ancient and medieval forms (2004, p. 16). It is in four of these characteristics: rationalisation, bureaucratic organisation, quantification and the quest for records, that the history of documents and the history of sport align. For these characteristics would not be possible without the ability to accurately document sporting performance.

Rationalisation depends on the standardisation and codification of universal rules and the development and communication of a systematic science of sport through dedicated research institutes and journals. Rules are normally instantiated through the idea of a *rule book* even though this may manifest in different forms. Guttmann also argues that rationalisation in sport is evident in the shift from practice to training with training implying a willingness to experiment and improvement gained from the constant validation of results achieved (2004, p. 43). Again this progression would be difficult without mechanisms to collect and document performances and results.

Bureaucratic organisation is used to ensure that the application of rules is universal. Embodied in institutions they also organise hierarchies of competitions and ratify and publish records (Guttmann, p.47). In sport record takes on two meanings. There is the act of recording sporting evidence as an accurate and persistent document of record (a record), then there is the idea of record as an abbreviation for the superlative

recorded measurement of a particular type of activity (the record). Both of these give us the idea of the sporting *record book* though again, this may manifest in a variety of forms. Gutmann argues that the record is “a marvellous abstraction that permits competition not only amongst those gathered together on the field of sport but also among them and others distant in time and space” (2004, p.52). Records are not just factual; they also contribute to discourses of progress in sport elevating some athletes into sporting ‘halls of fame’ and shaping sporting narratives (Lopez-Gonzalez, 2014).

The record is the logical result of combining “the impulse to quantification with the desire to win” (Gutmann, 2004 p.51). Lopez-Gonzalez describe records as “climactic moments of quantification” and essential to modern conceptions of sport (2014, p.348). The measurement and quantification of sport, relying on ever more precise technology, gives sport ever more detailed *results*. These results are usually the published and archived outcomes of sporting performance, which is after all an ephemeral moment. The form results take can vary considerably from the outcome of a contest, distances, time to travel a certain distance or indeed the quantification of aesthetics in more artistic sports (Guttman, 2004). Whilst individual records provide sporting evidence, it is as results that they are usually compared, analysed, aggregated and communicated. The athlete survey conducted as part of this research asks athletes how they record their own performances and whether they use these documents and records to compare themselves with others.

Documentation in Sport

This consideration of the characteristics of modern sport provides some idea of potential sporting genre systems but doesn’t tell us much about the mechanisms and forms used to document these. A full systematic domain analysis could provide much greater insight into the genres and forms that exist now, and how these have changed over time.

In this study, the focus is on how amateur athletes keep track of their training. Two key genres that are important to this is the training plan and the training diary. These cover how athletes create a schedule of what activities to perform as part of their training (planning function) and whether and how they keep a log of the activities they have performed (evidence function). The athlete survey is to a large extent concerned with the documents and data that athletes use to create and curate these.

Training Plans

In order to complete a challenging goal, whether this is to compete in a event, tackle a new distance, achieve a personal best or some other aim, a structured period of training is usually required to improve the performance of an athlete. This training will

usually be periodised and systematic in order to increase the training and skills of the athlete over a set period of time without causing injury. Yet very little is known about these training plans are compiled, in particular how amateur athletes obtain the knowledge needed to put together and execute a training schedule.

Training Diaries

As discussed above the idea of progress, by incremental improvement, is important in sport and is usually arrived at by testing new training methods. In order to measure progress and identify methods that work some kind of evidentiary log is required. Additionally, athletes may include more experiential details of activities to create a training diary. Wallenfels (n.d.) lists some of the common reasons for keeping a diary. As an example, Runner's World magazine provides guidance on keeping a training diary and provides both a paper journal and an online platform to enable runners to record their training (Doyle, n.d.)

Research on the use of training diaries by athletes is scarce. One significant study analysed various athlete self-report measures (ASRM) and factors influencing their implementation (Saw et. al, 2015). This revealed that athletes favoured paper diaries but these were considered archaic for information management and analysis. Increased uptake of electronic diaries was evident, and preferred, but limited by accessibility and interface issues. Some athletes kept a personal hand-written diary that was used as an information source for data entry into electronic systems. Additionally, one small study of female rowers in New Zealand found that 68% of the athletes studied kept a diary with 23% sharing their diary with a coach. The study also reported that the rowers would be more motivated to keep a diary if they could share it with their support network and it was more user friendly (Cummins and Gordon, 2003).

These studies were of elite level athletes and no scientific studies have been found relating to how amateur athletes record their activity. With the growth of online blogging some anecdotal evidence of amateur training diary use is emerging (for example Poritsky, 2015) whilst some runners publish their training diary publicly as a blog (Kynaston, n.d.). In order to provide more data on training diary usage by amateurs the athlete user survey is interested in the forms these training diaries take: do all athletes keep them, what are they used for, what forms do they take, what tools facilitate the creation and curation of these documents and how long do athletes keep them for?

In two further papers (1998; 2014), Buckland questioned the nature of documents as electronic technologies evolve documents into new digital forms. This theme is taken up by Robinson who envisages implications for literacy, the information communication chain and information behaviour as documents become more

pervasive, multi-sensory and immersive (2015a; 2015b). The next section ventures into this territory and examines how technology innovation and ubiquitous connectivity are influencing the experience and evidence of athletic performance.

3.3 Cognition, Expert Knowledge and Artificial Intelligence

This approach is where Hjørland highlights the common territory between computer and information science. However, Hjørland argues information science is interested not just in system engineering but also in exploring the broader sociological and human dimensions of information systems (Hjørland, 2002). As digital technologies evolve there are lots of possible areas of interest for information scientists from the use of social media to support social words, through the datafication of athletic performance, to experiences training, competing and watching sport in virtual worlds (IBM, 2014). These new forms of knowledge and experience generate data that can be easily processed by computers but raise questions around the practice and ethics of collecting and publishing such data and the ability of athletes and coaches to store, organise and make sense of it.

Social Media for Social Worlds

Initially the world wide web was a documentation and publication system, but around 2004 it became increasingly social thanks to the rise of practices and technologies that advocated interoperability, interactivity and the syndication of user-generated content. Two of the main principles that made up this 'Web 2.0' mentality were harnessing collective intelligence and providing architectures of participation. (O'Reilly, 2005). Leadbeater and Miller in their study of Pro-Ams noted that networks, whilst not displacing traditional clubs, operate alongside them and provide new modes of social organisation and co-ordination of the bodies of knowledge held by communities (2004).

UKSportsChat⁵ is an example of a network that uses social media, such as Twitter, Facebook, Instagram and YouTube, along with blogs to create a community. It was founded as UKRunChat in 2013 and has expanded to include cycling, triathlon and swimming. Their values include being an inclusive and supportive space and a trusted and respected place for advice (Williams and Weigh, n.d.). Consequently, they don't just offer community interaction via activities such as regular chat hours on Twitter, but also feature 'Ask the Expert' sections along with competitions with brand partners and promotion of events. This is an example of a social world, but by making greater use of social media much of that world's interaction is public and theoretically accessible as a data source for new forms of research such as network and content analysis.

⁵ <http://www.ukrunchat.co.uk> (Accessed: 23 August 2015)

He et. al. (2013) used tweet analysis to overcome the scarcity of running activity data and gain greater insight into amateur running behaviour. They collected 929,825 tweets produced by Nike+ tracking users and using data mining to analyse patterns of running behaviour. This provides useful quantitative data but doesn't provide any qualitative answers to explain why for example runners run least on Friday or the high rate of attrition (32.6% of users only posted one tweet). The authors suggest analysing running data pattern analyse may help health professionals, coaches and city planners (see also Ferrari and Mamei, 2011 for use of sport activity data to map city dynamics).

Vickey et.al (2013) collected 2.8 million tweets from 5 different tracking applications over 6 months but used text classification to devise a conceptual model for the categorising fitness tweets, describing text classification as "one of the most important research fields in information retrieval and data mining" (2013, p. 305). In their analysis most tweets were workout related and they proposed further qualitative studies on why there were so few conversational tweets. The existence of communities like UkSportChat may help explain this as both these studies were limited to the automated, and more structured, tweets from tracking applications and perhaps failed to expand their analysis to the messier social worlds surrounding measured activity data.

This "tapping into the world's collective brain" (Vickey et. al 2013) could also help information professionals understand more about athlete information needs and behaviour by analysing the types of information seeking and exchange that take place via social media, perhaps expanding the Vickey et. al conceptual model to classify types of interaction and information exchange in UKSportChat posts.

From Documents to Data to Assemblages

These studies indicate the use of quite sophisticated tracking technology by everyday athletes. He et. al. in particular provide a good overview of the development of personal fitness tracking devices and how these have matured and become more affordable over the last decade (2013). The increasing precision and specialisation of devices enables new types of measurements to be taken that no longer limit the recording of sporting performance to simple outcomes but provide continuous streams of data throughout physical activity and contextual information around it. Variables such as location, pace, heart rate, power, cadence, elevation, vertical oscillation can now be added to distance and duration measures. Some of these are measured and some of these are calculated by software (Silver, 2014; Baca, 2015b).

Previously, measures such as rate of perceived exertion (RPE) required athletes to qualitatively assess and document how they were feeling during exercise against a

numerical scale (Borg, 1982). Wearable fitness devices and smartphone applications bring data previously only accessible via sport science laboratories to the masses. However, consumer research suggests current usage is low (about 8%) albeit increasing (Warriner, 2014). It's important to note that mass consumer availability of accurate yet affordable devices does vary across sports with cycling, running and triathlon well catered for by companies such as Garmin (Silver, 2014) but sports such as swimming (MySwimPro, n.d.; Speedo, n.d.; Palermo, 2015) and rowing (ErgStick, n.d.) have not had the same access to this type of technology until more recently.

This type of fitness tracking relies on ubiquitous and pervasive sensors to quantify and record physical activity at new levels of transparency and granularity (Baca et. al, 2009; Shilton, 2012; Lupton, 2015a). It also requires new data interchange standards and formats such as GPX (a global positioning schema for exchanging waypoint data).

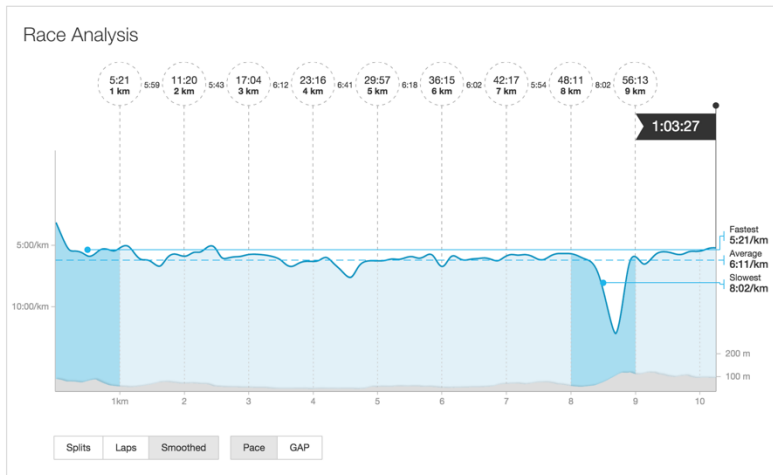
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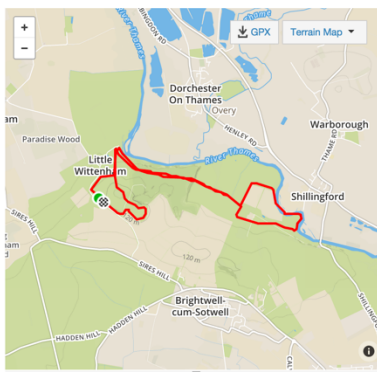
Figure 5: An example of raw data from an activity tracker stored as GPX

Network connectivity is needed if data is to be shared or analysed using sport applications or online fitness platforms. Examples include Garmin Connect, Strava, Nike+, Runkeeper, Endomodo and Dailymile (He at. al, 2013; Vickey et. al, 2013). These platforms create records from the data collected on each physical performance and visualise that data as statistics, maps and graphs. They can also rank each activity, or even section of an activity, against previous activities or other users of the service.



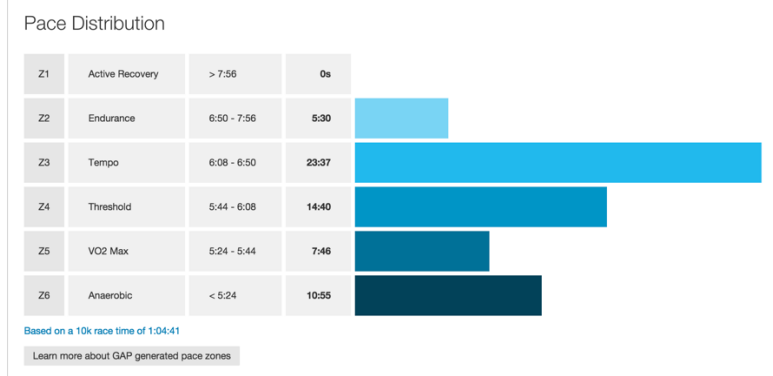
Splits

KM	Pace	GAP	Elev	HR	Cadence
1	5:21 /km	5:50 /km	-33 m	103 bpm	176 spm
2	5:59 /km	5:37 /km	13 m	155 bpm	176 spm
3	5:43 /km	6:05 /km	-18 m	151 bpm	176 spm
4	6:12 /km	6:20 /km	-6 m	151 bpm	174 spm
5	6:41 /km	6:25 /km	9 m	153 bpm	176 spm
6	6:18 /km	6:22 /km	-4 m	159 bpm	176 spm
7	6:02 /km	5:36 /km	17 m	154 bpm	176 spm
8	5:54 /km	6:02 /km	-9 m	156 bpm	178 spm
9	8:02 /km	6:16 /km	52 m	160 bpm	158 spm
10	5:53 /km	6:05 /km	-16 m	160 bpm	176 spm
0.2	5:21 /km	5:27 /km	-1 m	163 bpm	180 spm



10.2km 6:11/km 1:02:28 126m 881

Distance Pace Run Time Elevation Calories



10.2km 1:02:28 6:11/km **Extreme** 177 121

Distance Time Pace Suffer Score Points in the Red



Figure 6: The data from the activity tracker when visualised and analysed by an online fitness data platform (Strava)

When Lomborg and Frandsen (2015) studied self-tracking they framed it as a form of symbolic communication. Indeed, they identified it as not just utilitarian, but also a pleasurable activity where documentation is a source of gratification, reinforcing Hartel's (2003) point about the leisure potential of information. With echoes of Gutmann, they also suggest that ritual, now secular, remains immanent in sport through the act of record keeping. Their method involved both semi-structured interviews and analysis of one month's tracking data from each subject in the apps they used for exercise logging and sharing. They developed a conception of self-tracking as media that enables the logging, analysis and sharing of activities as conversations between the system, the self and social networks. They also reveal that users adapt these media systems to their personal motivation and information needs.

By drawing on the quantified self movement (Wolf, 2010; Naffs and Sherman, 2014), self-tracking athletes could be described as quantified athletes. One proposed definition of quantified athletes is "connected sports participants whose activity in the biosphere is ... projected into the infosphere by a range of sensing devices" (Pope, 2015a). Mayer-Schönberger and Cukier use the term *datafication* to describe the transformation of things not previously recognised as information-bearing into quantified forms that make their information accessible for tabulation and analysis (2013, p.78). In the world of big data, electronic sensors augment biological sensors to increase the volume, velocity and variety of data collection; the more comprehensive, messy and inexact data sets this provides require new forms of analysis (Mayer-Schönberger and Cukier, 2003). In the case of quantified athletes their embodied performance is transformed into data for in-depth analysis.

It is less evident whether athletes and coaches have the skills to interpret this data and making use of it in their training or indeed how they acquire such skills and incorporate it into decision making (Baca et al., 2009). This is an emerging area of practice and research that will likely require new skills in order to be able to extract expert knowledge from bigger data. Data and statistical literacy will join information literacy as important capabilities in navigating an increasingly quantified world (Schild, 2004; Calzado Prado and Marzal, 2013). In sport, this is likely to involve collaboration between information professionals, computer scientists and sport scientists to help athletes interpret their training data and apply it in their training to improve performance and reduce injury. With sufficient data, new algorithms and expert systems could even replace or augment human based coaching with that provided by intelligent systems (Lowe and ÓLaighin, 2012).

Personal Participatory Data and Critical Data Studies

Shilton describes such data as personal participatory data and argues it poses a new problem for information science that has behavioural, conceptual, legal and practical

dimensions (2012). Personal participatory data is neither surveillance data or research data as the data subject is either an active participant in data collection and curation or is able to access the data for these purposes if desired (2012, p. 1906). Shilton persuasively argues that this challenges the agency of data collectors, the organisation and management of data and mechanisms of data preservation requiring new information perspectives on privacy, access and curation (2012). Lupton uses the term 'digital data assemblages' to describe "configurations of discourse, practices, data, human users and technologies" (2015b). Such assemblages could even represent new documentary forms with generic and structural dimensions (Kitchen and Lauriault, 2014). Duus and Cooray (2015) adopt a transhumanist perspective to this kind of data tracking. They envisage the extension of sensors into clothing and even our bodies transforming humans into cyborgs where the boundaries between our biology and our information environment cannot be so easily delineated. In their study of activity tracking they found this can be perceived as empowering but also potentially constraining and controlling.

There are implications for personal safety, self-actualisation and identity and ethics when thinking of humans as machines or data assemblages that can be monitored, manipulated, transmitted and aggregated in unseen ways (Rintala, 1995). A new interdisciplinary field, critical data studies, is emerging to address those questions combining sociologists, computer scientists and hopefully information scientists to work out how to appropriately and effectively link philosophy, policy and practice in order to work with these assemblages throughout the information communication chain (boyd and Crawford, 2012; Dalton and Tatcher, 2014; Kitchen and Lauriault, 2014).

These data assemblages also raise questions about the nature of sporting performance and whether athletes and coaches should rely more on analysis or instinct, science or nature. Is a virtual exoskeleton of data a better source of athletic insight than our intuition? If so at what point might exploiting this become unfair? Butryn has explored how "cyborgification" of humans affects athlete autonomy and subjectivity, sporting narratives and discourses around the purity and pollution of the 'natural' competitor (2003).

It is still too early to fully grasp how pervasive sensing, ubiquitous computing and big data are being used and how they may change the ways we think about information systems or the nature of sporting performance. However, it is not too early to envisage they will have an effect on how we think about documents, collections and information practices. Will, for example, the practices of everyday data accumulation join more established research topics within LIS such as everyday information seeking? The athlete survey asks some questions about how much athletes are using tracking-devices and how they share and use their data to gather some evidence on

current practice and attitudes. LIS researchers and practitioners will need to work with other disciplines in developing both data fluency and critical data studies for this increasingly datafied information environment if these data are to be used effectively and ethically. In sport, LIS perspectives would also be invaluable in bridging any potential data management and policy gap between computer science and sport science as this type of data grows.

Alternate Realities and Participatory Experience

Thirdly, engineering is increasingly providing new devices and spaces that potentially augment or replace our idea of reality with alternatives. These may create new kinds of participatory experiences and interactive documents to collect, curate and use. Whilst wearable trackers augment our bodies there are technologies emerging that extend or replace the spaces and methods used to experience sport and participate in athletic activity via augmented reality (AR) and virtual reality (VR) technologies. AR overlays computer generated information onto the perception of reality we receive via our biological sensors creating a mixed reality. VR completely immerses participants within a computer generated reality and there are examples of prototype VR systems for a range of sports (Katz et. al., 2006; Wiemeyer and Mueller, 2015). At present this is mostly visual immersion rather than a total sensory experience.

“The idea is to create artificial realities in which rendering, perception, immersion, presence, feedback, visualization, and interaction with others are combined to give the user experiences that approximate and go beyond what is physically possible.” (Katz et. al, 2006 p.13)

AR and VR are much anticipated but not yet mainstream technologies in sport. The design and engineering of such systems is complex and the costs of development potentially higher than the benefits. Coaches and athletes may require new capabilities and attitudes to adopt them effectively. However, testing of prototypes does suggest that motivation, enjoyment, perceived competence and exertion increase with immersion (Katz et. al., 2006). Major use cases seem likely to be enhancing the spectator experience and in training environments to simulate practice scenarios (Kluwe, 2014; Kelk, 2015; Schroeder, 2015; von Thron, 2015). There is also potential for improving general fitness and in rehabilitation if environments are transparent and easy enough (Katz et. al., 2006). Recently activity holiday company Neilson have been offering VR skiing, mountain biking and windsurfing experiences in shopping malls as part of their marketing campaign that was integrated with social media using a #haveagobeforeyougo campaign (Oakes, 2015; Atticus Digital, 2015a, 2015b).

Virtual Cycling and Running

When it is too inclement to ride outside cyclists can set their bikes onto a fixed trainer, like a treadmill, so they can train indoors. It can be quite a dull, isolated way to train but augmented by technology it can become much more interactive, competitive and sociable by connecting dispersed participants in a virtual environment. This is not necessarily a new concept as a cartoon (Figure 7) from the January 15, 1897 issue of *The Wheel and Cycling Trade Review* reveals (Novak, 2015; *The Wheel and Cycling Trade Review*, 1897).

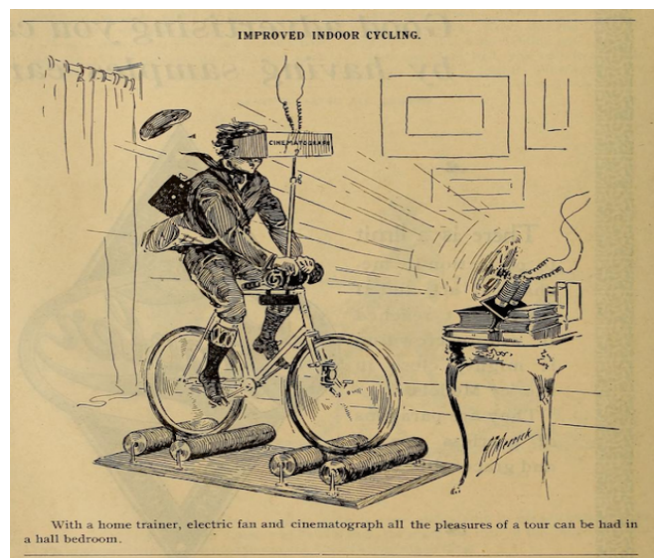


Figure 7: A Victorian immersive indoor cycling experience. Source: *The Wheel and Cycling Trade Review*, 15 January, 1897

Zwift⁶ is an example of such an experience (Figure 8). This system has created a virtual world, Zwift island, that where people can ride virtually against other people or against AI cyclists. The system links into the trainer using the speed and power transmitted by the trainer sensors to synchronise the activity with the virtual world. Using smart trainers makes the experience more realistic as the trainer can then also receive feedback from the world and can set the resistance of the trainer accordingly to simulate environmental conditions in the virtual world such as terrain, wind and drafting (the benefit cyclist receives by riding behind another cyclist and being protected from the full effects of wind resistance). A companion application allows you to send gestures into the virtual environment to communicate with other riders and the data from a completed workout can be synchronised with data sharing platforms like Strava and Garmin Connect.

⁶ <http://www.zwift.com/> (Accessed: 2 September 2015)



Figure 8: A current indoor cycling experience showing an athlete cycling with Zwift. Source: Mercanti, 2014

Additionally, the races can be recorded and participants are documenting efforts by adding commentary and posting races on social media such as YouTube (Williams, 2015) or by writing race narratives and comparing training data across virtual and real world races (Pait, 2015). It also enables new experiences, such as being able to compete against pro cyclists (Global Cycling Network, 2015) or cycle replica courses from world championship events (Owen, 2015; Roethenbaugh, 2015) raising the prospect of a new form of spectatorship that combine watching a live sporting event with virtual participation in the same arena. Following Robinson's vision of pervasive, multi sensory and immersive (2015), it is not inconceivable to envisage the rise of mixed reality sport where transhumans exercise, alone or with others, in transmedia arenas.

Such experiences are more established in cycling but are extending into other sports. The Falmouth Rode Race has partnered with a Virtual Runner⁷ application for runners to offer virtual participation in the oversubscribed race (Hetzl, 2015) demonstrating the potential for event organisers to extend their race experience to remote participants. Mueller et al. (2003; 2007) call these 'exertion interfaces': the bike or the treadmill is how you interact with the system. They provide many other examples of such interfaces and games that require intense physical effort to use but enable sport to take place over a distance and facilitate social bonding through play. This combines the wellbeing benefits of both physical exertion and social interaction.

Combining them All: Sufferlandria as Social World

The case of Sufferlandria demonstrates how these three factors, social media, datafied athletic performance and alternate reality combine in the creation and

⁷ <http://outsideinteractive.com/runners/> (Accessed: 12 June 2015)

maintenance of a social world for cyclists. Sufferlandria is an established social world that turns indoor cycling into the motivating ethos of vibrant community mediated by a range of virtual and connected technologies, documentary forms and community vocabulary. The Sufferfest⁸ is a company that combines indoor workouts with video sourced from real events (The Sufferfest, 2012). The videos feature workout instructions, a storyline and music all cut with footage from actual races (The Sufferfest, 2014). A community, the Sufferlandrians, has grown up around The Sufferfest that provides social-world information and turns training boredom and effort into a celebratory discourse. This encompasses the appropriation of physical space, known as bike torture chambers, and the creation of Sufferlandria⁹ as a mythical place with a national anthem, flag, a ministry of tourism, it's own elite, the Knights of Sufferlandria, an annual race The Tour of Sufferlandria and a motivational book (The Sufferfest, n.d. a,b,c,d). These are also supported by social network communities.

Roles for Information Science

LIS strengths in areas such as information organisation, access and literacy will be important for managing digital sport information. Physical performance is ephemeral but it can be captured using sensor data, encoded records, video and virtual simulation. Information professionals will be involved in organising these new documentary forms and data assemblages. Cataloguing these so they relate to the same performance is an information challenge, as is segmenting them so patterns can be detected across different performances. Conceptual models will be required for sporting information, such as the BBC's sport ontology (BBC, n.d.), and information professionals will be involved in designing and implementing these information architectures.

Another question for information professional is around ensuring access to these virtual worlds and environments. The equipment can be expensive and most services require payment to access content. This paid approach could exclude many who might be more keen on exercise if they could access these interactive indoor options. Just as libraries have added services to provide access to online information and games, they could add exertion interfaces widening access to the associated social and wellbeing benefits. A 21st-century library might include such participation spaces, or supply content to public leisure centres. Libraries and leisure centres might not in future be considered such distinct spaces. Training workouts, videos and environments could also be loaned to library members for use in their homes or facilitate groups in collaboration with local clubs for organising training events or races.

⁸ <http://www.thesufferfest.com/> (Accessed: 27 August 2015)

⁹ <http://www.sufferlandria.com/> (Accessed: 27 August 2015)

Finally, there is the question of how online communities and social worlds, such as e-magazines, UKSportChat and Sufferlandria, and data sharing platforms, such as Garmin Connect and Strava, fit into the structures and organisations producing and circulating information about sport? Online and mobile applications mean that even data collection that seems personal and individual is closely coupled with structures and organisations mediating and aggregating these data assemblages, yet Lupton (2015b) suggests most people are unaware what happens to their data and how it may be used once it is transmitted. Analysing these communicative structures and organisations is another possible area of LIS research and helping people negotiate these complex networks a potential role for practitioners.

3.4 Terminology and Discourse Studies

This approach explores the discourses used within a particular domain. Important to this approach is how language is used by different actors within a domain for their purposes. This can be particularly important for information retrieval (Hjørland, 2002). Previously the case of Sufferlandria has shown how the appropriation of vocabulary can turn something negative, the pain and isolation of tough indoor training, into a source of pride. In this section the barefoot running debate in running is used as a case study to further illustrate the potential significance of terminology and discourse studies in sport and the relevance to information professionals. The barefoot running debate is an example of the negotiation between running lore and running science and shows how a discourse can form and circulate and how new, potentially confusing, terms can enter the common lexicon within a sporting community.

Mapping the Barefoot Running Debate

The debate is about what type of shoes to wear when running, indeed whether to wear shoes at all, and how this relates to running biomechanics including foot strike and gait analysis, running shoe selection and injury rates. Whilst there may have been steady scientific interest in running biomechanics previously there does seem to have been more recent rise in publications on barefoot running (running without shoes) or minimalist running (running in lightweight shoes that allow some barefoot biomechanics but provide some foot protection) (Perkins et.al, 2014).

Searches in Web of Science and ProQuest show an increase in papers on barefoot or minimalist running since 2010 against a backdrop of more regular publications on running shoes and running biomechanics, and a lesser but consistent interest in publications on running form. Table 3 provides a summary of the number of articles retrieved for each query for each publication year 2008-2014. These are plotted as a graph in Figure 9 using a base 10 logarithmic scale for easier comparison given the disparity in publication volume for different queries. Overall the number of retrieved

publications for barefoot or minimalist running and running form, whilst increasing, remain small in comparison to those on running biomechanics and shoes. A full breakdown of the number of publications retrieved for each search conducted is provided in Appendix 2.

Total Articles Year/Database	Query Barefoot	Biomechanics	Form	Shoes	Grand Total
2008	22	925	34	1035	2016
2009	38	939	38	934	1949
2010	76	1074	61	977	2188
2011	125	1168	65	1145	2503
2012	114	1270	62	1088	2534
2013	110	1275	78	1263	2726
2014	101	1270	83	1266	2720
Grand Total	586	7921	421	7708	16636

Table 3: Summary of literature searches relating to running form, shoes and biomechanics 2008-2014 (Databases: Web of Science and ProQuest All Sources)

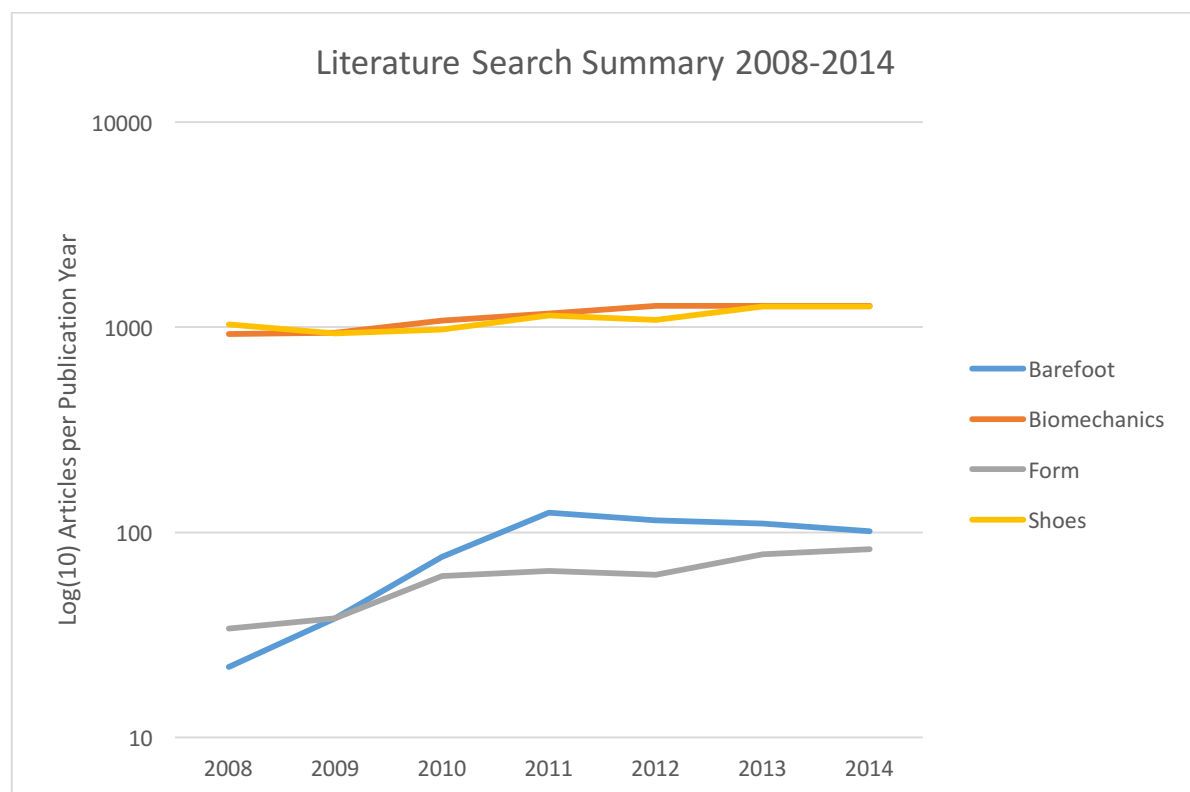


Figure 9: Comparison of query results 2008-2014 (Databases: Web of Science and Proquest All Sources) using base 10 logarithmic scale

This kind of trend is mirrored in Google search trends showing patterns of general web searches (Figure 10). Barefoot running starts to rise from around 2009 along with a smaller interested in foot strike, a more technical term. There's also a smaller rise in searches for minimalist running with barefoot running gradually declining from a peak in 2010 whilst general searches for running form remain at a roughly constantly level.

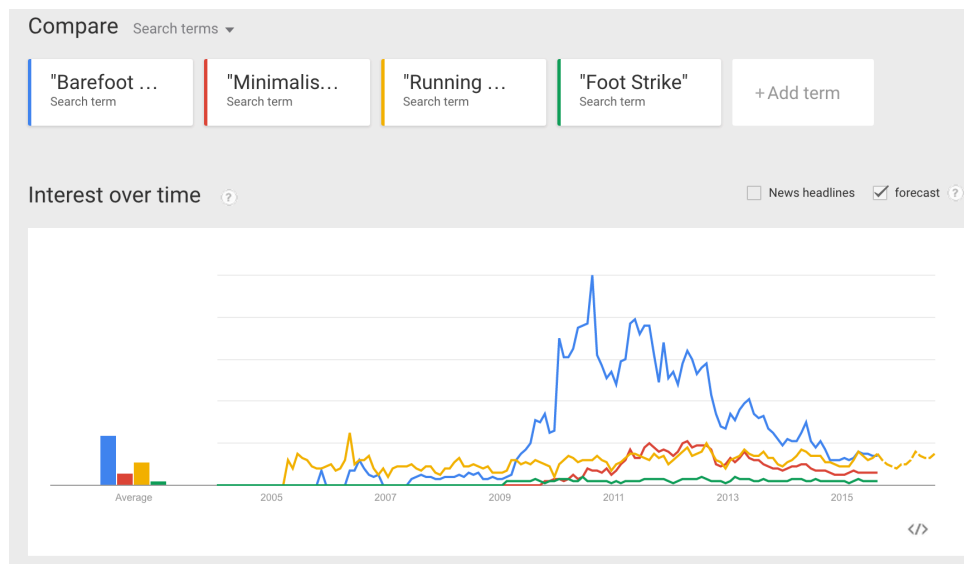


Figure 10: Results from Google Search Trends showing the rise and decline of Google searches for barefoot running compared to similar terms (Accessed: 12 August 2015)

In 2009 Christopher McDougall published *Born to Run* which compared the scientific view of running with the practices of the Tarahumara Indians. In doing so he also began to question running shoe orthodoxy, criticising the powerful vested interests of sport manufacturers, and explicitly triggered what he called the “barefoot running debate” (McDougall, n.d.). Slightly lost in the ensuing dichotomy of barefoot vs shod running advocacy was McDougall’s point that running is a skill that needs to be learnt and mastered via a process of adaptation that in some respects aspires to reclaim running as a carefree, more organic activity in reaction to the controlling boundaries technology places on bodies as discussed earlier (Collier, 2011; Duus and Cooray, 2015). This debate also relates to the broader discourse around sporting purity and enhancement highlighted by Butryn (2003). Runners interested in being informed about the debate could consult various sources from magazines like *Runner’s World* (Burfoot, 2010) to scientific literature. Some bloggers with expertise in sport science attempted to bridge the information gap between formal and informal sources by summarising the dense scientific literature in accessible ways (Kelso, n.d.; Tucker, 2011; Payne, 2013a) whilst remaining sceptical about whether there was yet sufficient research to support support the claims that barefoot running is superior and leads to fewer injuries (Tucker, 2013; Payne, 2013b).

One study has been found that surveyed barefoot running adoption and attitudes amongst runners providing empirical insight into runner behaviour in the light of the debate (Rothschild, 2012). This surveyed 785 runners: 46.4% were recreational (equivalent to casual in this research), 48.4% competitive (amateur) and 5.2 elite (professional). The research indicated an interest level of 80.2% in barefoot and minimalist running with 21.9% having tried barefoot running and 30.2% minimalist running. The research gives some indication of the types of information resources runners used when faced with this type of knowledge gap with advice from friends

and books (both 24.5%) and online resources (24.2%) used most and journal articles and advice from coaches being used the least (7%). Some consulted no resources at all (7%). This suggests more use of informal, anecdotal sources than formal, evidentiary sources. Despite this, instruction from a reputable source was most frequently chosen as being a motivating or helpful source for trying out the new technique. 85.6% reported they would continue with or try barefoot running if they had sufficient instruction suggesting a role for sports scientists and information scientists in facilitating access to more reputable knowledge and instruction.

The scientific evidence about the benefits of different running biomechanics remains inconclusive without further longitudinal research (Collier, 2011; Perkins et. al, 2014; Altman and Davis, 2015) and the fashion for barefoot running appears to have slowed with runners opting for either a medium position between the two extremes or the selective use of more natural running in more minimalist shoes for specific workouts (Tucker, 2013; Lobby, 2013). The terms, and associated vocabulary around running gait and biomechanics such as foot strike and pronation, have though become accepted parts of the running lexicon that many serious runners will now be familiar with (Faherty, 2014) but until recently these terms were rather imprecisely defined. A Delphi study (Esculier et al., 2015) has attempted to standardize the terminology by developing a rating scale, the Minimalist Index (MI) for classifying running shoes according to their degree of minimalism. This more rigorous definition of terminology and the development of the MI classification scale for shoes is intended to help inform athletes when selecting shoes and it will be interesting to see if the proposed MI is adopted by runners, manufacturers and proves useful for information retrieval.

What this case study really illustrates from a LIS perspective is the different ways terminology and discourse can be created and circulated via both formal and informal information channels with various levels of information quality. In this case, a popular book spawned a noticeable trend based on limited evidence (Collier, 2011). It is not clear whether athletes have the information fluency or are prepared to make the effort to navigate and evaluate information sources relating to debates such as this in order to make decisions about their equipment and training that will reduce their risk of injury whether they continue to wear technical shoes or choose to transition to minimalist alternatives.

Born to Run is available in many public libraries but less evident is how active libraries were at helping runners access and evaluate related literature. This type of scenario suggests using this domain approach to monitor discourses within communities would be a beneficial research area for LIS with practical implications for library collections and literacy programs. The Rothschild study (2012) demonstrates how empirical user studies can relate behaviour to discourses and also suggests the types of information resources typically used by runners when faced with a knowledge gap.

3.5 Empirical User Studies

Empirical studies is a user-centered approach that is interested in understanding how subjects within an information domain view information by observing their behaviours and preferences within it (Hjørland, 2002). This approach is closely related to information behaviour research and there have been many models and studies of information use within library and information science, in many case examining a specific domain. However, without reference to domain-analytic theory they are user studies applied to a domain. Of more interest is perhaps the synthesis of domain analysis with information behaviour to consider the “resources, tasks and knowledge” relevant to that domain (Bawden and Robinson, 2012 p.96). It is the beginnings of this type of synthesis that has been attempted here.

Sport-specific User Studies

Diverse studies relating to sport data collection and information behaviour have already been cited in this research. To summarise:

- Robinson et. al. (2014) conducted an ethnographic study that followed marathon runners over a complete training cycle noting how they interacted with various types of information resources and communities for both fulfilment-related and social-world information
- Saw et. al (2015) focused on factors influencing implementation of athlete self-reporting
- Cummins and Gordon (2003) concentrated on one particular document genre, the training diary, and how this was used by elite rowers
- He et. al (2013) and Vickey et. al. (2013) mined social media for evidence of self-tracking and patterns of fitness behaviour
- Duus and Cooray (2015) surveyed users of everyday activity trackers to investigate how people feel about the embodiment of tracking technologies
- Lupton (2015b) examines self-tracking as data assemblage;
- Lomborg and Frandsen (2014) conducted an ethnographic study of self-tracking as communication practice between systems, self and social worlds;
- Rothschild (2012) studied the motivation and behaviour of runners when faced with a new emerging discourse around technique and injury prevention.

Most of these are not explicitly information user studies nor do they acknowledge LIS

theory. They demonstrate sport information is researched from a number of perspectives across disciplines such as: sociology, critical data studies, information system design, sports science and sport medicine. Despite these different backgrounds, all these user studies touch on the information communication chain and athletic activity in some way and suggested some important tasks and resources for athletes that guided the design of the survey conducted for this research. As noted in the literature review, one study on amateur boxers in Mexico is the only user study found that researches sport information in relation to LIS theory and practice (Vazquez Moctezuma and Calva Gonzalez 2013). This study is very similar to the athlete survey conducted for this research and provides a useful point of comparison for the survey results.

3.6 Summary

This small introduction to mapping out sport and using Hjørland's approaches as a method for researching it suggests a large and varied information domain with potential dimensions in professional sport management; entertainment and fan engagement; sport governance; research, teaching and training; and of course the enjoyment of sport as a leisure pursuit. It is also a fuzzy and fragmented domain where concepts are indistinctly defined, subject areas intersect, information structures are opaque and the volume and variety of documents, data and information sources are difficult to gauge. There is evidently an emerging enthusiasm for the use of technology in sport, including the application of computer science and engineering and design to sport, but the organisation, dissemination, indexing, storage, use and ethical implications of the data and information generated by sport measurement devices and analytic systems remains relatively unexamined.

Many actors within the domain, from athletes, coaches and fans to journalists, researchers and sport officials, have an interest in using information to help them achieve their sporting goals and there is a real need to think about whether there is more than an archival or collection management role for information practitioners in sport, working alongside computer, data and sport scientists. Areas where LIS perspectives would be welcome include: data and information literacy; the policy and privacy challenges of personal participatory data; data management and preservation; and facilitating access to wider ranges of document forms and information sources. The approaches afforded by domain analysis prompt many possible areas of future research in this domain and provide a useful framework for conducting a more systematic and complete analysis that co-ordinates theory and empirical research.

This chapter has set out some of the information possibilities that exist for amateur athletes. The remainder of this dissertation utilises the empirical user study approach to examines how amateur athletes exploit these possibilities. It shifts the research

from the macro/social towards the micro/cognitive by focusing on the athlete as an information user. The method is a small quantitative user survey asking a group of amateur athletes about the information sources they consult, the types of document and data they use and their adoption of technology in relation to their sporting goals and activities.

4. Athlete Survey

The main purpose of the survey was to find out what types of information resources athletes used, both in general and in relation to particular sport-specific tasks, how frequently these were used and how these are acquired. A secondary aim was to understand how easily athletes could find, access and understand the information they wanted in order to get a sense of their information fluency. The survey also probes athlete's use of technology for collecting training data and tries to gauge the extent to which athletes systematically record athletic activity and whether they feel confident at interpreting their data and using it to further their sporting goals. As this is exploratory research the aim was to collect as much data as possible to identify areas for further research. Therefore, a quantitative survey was used rather than a more focused but in-depth qualitative study though space was allowed for respondent to provide comments about their answers if desired. It was anticipated that the survey will give an indication of topics that may guide follow up investigation by more qualitative methods.

4.1 Context and Hypotheses

The survey was designed with some hypotheses and expectations in mind based on the background literature review and initial analysis of sport as an information domain. Firstly, it was expected that information use by amateur athletes is related to the functional requirements of their level, goals and activity phase. However, it is also suspected that information acquisition and exchange is as much a motivational and social activity for amateur athletes as fulfilment-related. Secondly, the survey is based on the hypothesis that athletes increasingly use sensors to obtain feedback during activity and quantify their performance for data analysis post-activity. In isolation this provides them with fulfilment-related information that supports their mastery (improve performance) and intellectual (learn new training methods and skills) motivations, however when shared this data also supports their social motivations and possibly changes the idea of competition from direct (competing against others or for a personal best in a race) to indirect (competing with others or for a personal best by comparing and ranking dispersed activities). Consequently, virtual communities and online data sharing platforms are anticipated to be increasingly important information structures for amateur athletes.

4.2 Research Method

The research instrument used for this survey was an online questionnaire. The questionnaire was piloted by a group of 5 athletes and was disseminated through a variety of online and personal networks. Convenience sampling was used to select participants and a total of 91 completed responses were received and analysed.

Participants and Data Collection

The survey was administered using an online survey tool (SurveyGizmo¹⁸) and was aimed at runners, cyclists, triathletes, swimmers and rowers. Participants were advised in the project information that they should be aged 20 or above (this makes them eligible for senior competition in the selected sports) and be training regularly. The survey was supported by a project website providing further information about the project and project researcher¹⁹.

Convenience sampling was used to select participants in order to recruit as many athletes as possible across a diverse, but not necessarily representative, range of sports, age groups and commitment levels. The survey was disseminated using the following methods:

- publishing on the project website;
- posting to social media (Facebook, Twitter and LinkedIn) as general posts that could be shared by others;
- posting to social media targeting specific communities (for example, on Twitter using the hashtags #ukrunchat, #uktrichat, #ukbikechat and #ukswimchat);
- shared to groups and clubs within the personal networks of the researcher and the pilot group members. This included 3 triathlon clubs, 1 running club and 1 rowing club known to the author;
- a request sent directly by email directly to 5 local clubs in the Thames Valley region in the UK: 4 running clubs and 1 cycling club;
- leaflets handed out at a running event attended by the author.

Different tracking links were used so that responses received via different dissemination routes could be tracked. Although local clubs and events were targeted by the researcher the survey was not limited geographically and received some responses from outside the UK. As the survey could only be accessed online and most distribution methods utilised electronic channels there is an element of bias in the survey in that it already favours athletes familiar with electronically mediated communication and with a reasonable level of IT literacy. This could be alleviated for similar research in future by conducting more surveys on site at race or club events. This was not possible within the logistical and time constraints of this research.

¹⁸ <https://www.surveygizmo.com/>

¹⁹ <https://sportinformatics.wordpress.com>

Participants responded voluntarily and were free to withdraw at any time. Respondents gave informed consent by checking a participation agreement statement on the survey information page before proceeding to the survey. Participants were allowed to withdraw consent at any point up until final submission of the data by exiting the survey. Any partial responses were treated as withdrawn consent and were not included in the data analysis. 36 partial submissions were received and discarded and 91 submissions were completed giving a 71% completion rate. The average completion time was 21 minutes with 50% completing on a mobile device, 46.1% via desktop and 3.9% on a tablet. Of the 91 completed surveys 28 came from personal networking efforts of the researcher and pilot group, 24 via Facebook posts, 20 via Twitter and 19 via the project website.

Responses were received from all five sports though running and triathlon were best represented with 34 triathletes and 31 runners responding. 14 participants were cyclists, 9 were rowers and only 3 were swimmers. 66% of respondents were male (N=60) and 34% were female (N=31). The survey received responses from a spread of ages with the youngest in the 20-24 age group and the oldest in 70-74. The majority were in the three age groups spanning 35-49 (N=53) with a mean of 41.6 (standard deviation = 10.5). Finally, 79% were members of a club (N=72) whilst 21% were individual athletes (N=19).

Research Instrument

An online questionnaire was used to collect data for this survey. The questions were based on similar surveys in the literature review, themes from the exploratory domain analysis, the motivating research questions and the author's personal experience as an athlete. An initial version was tested via a pilot group consisting of 4 athletes (3 triathletes and 1 runner). Following discussions with a 5th athlete the decision was made to add rowing as a sport included in the study. There are questions over whether rowing is directly comparable with the highly individual sports of running, cycling, swimming and triathlon but the author felt the opportunity to collect data on a slightly different sport and check for variance would be beneficial. Additionally, including rowing only required adding it as an option in the demographic section and no major changes were required to existing question structures and so its inclusion did not affect data collection from the existing sports.

The survey was divided into 5 sections:

1. Athlete Profile
2. General Information Use

3. Information for Training
4. Feedback During Activity
5. Logging and Analysing Activity

The **athlete profile** has two purposes:

1. to check that respondents fit the desired profile of serious amateur athletes
2. to obtain some basic demographic data that could be used to segment responses during data analysis. This included gender, age group, club membership, frequency of training, current sporting aims and athlete's assessment of their level of participation/attainment.

This latter variable is used to assess fit with the target amateur athlete profile. To help athletes evaluate their level of participation the theoretical definition of amateur (section 3.1) was mapped to a sport-specific participation model and descriptions from this model were used to phrase statements in a five-point scale from which the athletes could select one option.

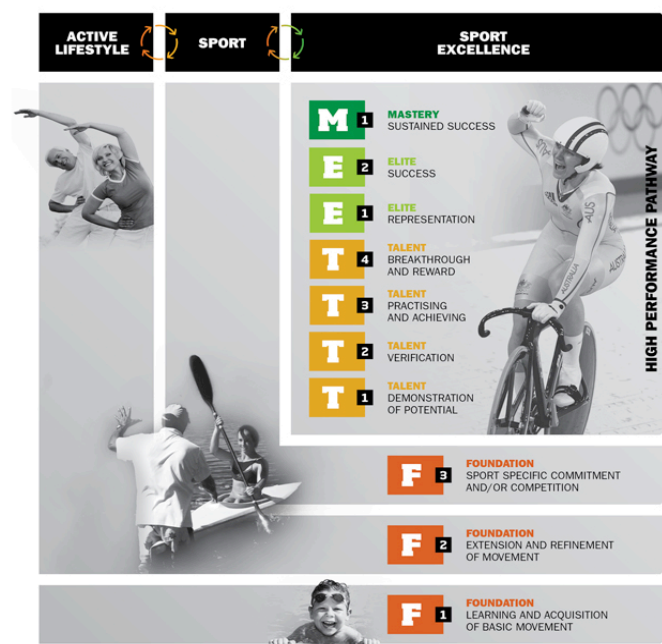


Figure 11: The FTEM Framework (Gulbin et.al., 2013)

The sport-specific framework used for guiding athlete selection (Figure 11) is the Australian Institute for Sport Athlete Development Pathway classification framework FTEM (Foundations, Talent, Elite, Mastery), a holistic model that is not chronologically prescriptive and recognises sport-specific commitment not just talent identification

(Gulbin et. al., 2013). It was also selected because the framework explicitly includes the idea of self-competition and motivation via “personal bests” whether this is in competitive or non-competitive environments (Gulbin et. al, 2013). Linking domain theory to such a model enables information research to be linked more meaningfully to sport science practice.

Figure 12 shows how the domain definition levels of participation were mapped to the FTEM framework. In this mapping, domain amateurs roughly translate to phases Foundation 3 to Talent 2 in the FTEM model, with those at Talent 3 or Talent 4 making the transition to quasi-professionals. Foundation 3 (sports specific commitment and/or competition) sees an increase in the athlete’s skill level and engagement based on their established proficiency. The majority of amateurs will remain in this phase for much of their sporting life but some may out perform their peers and have representative ambitions. The Talent phases (T1 to T4) involve talent identification and the progress of recognition towards elite programmes.

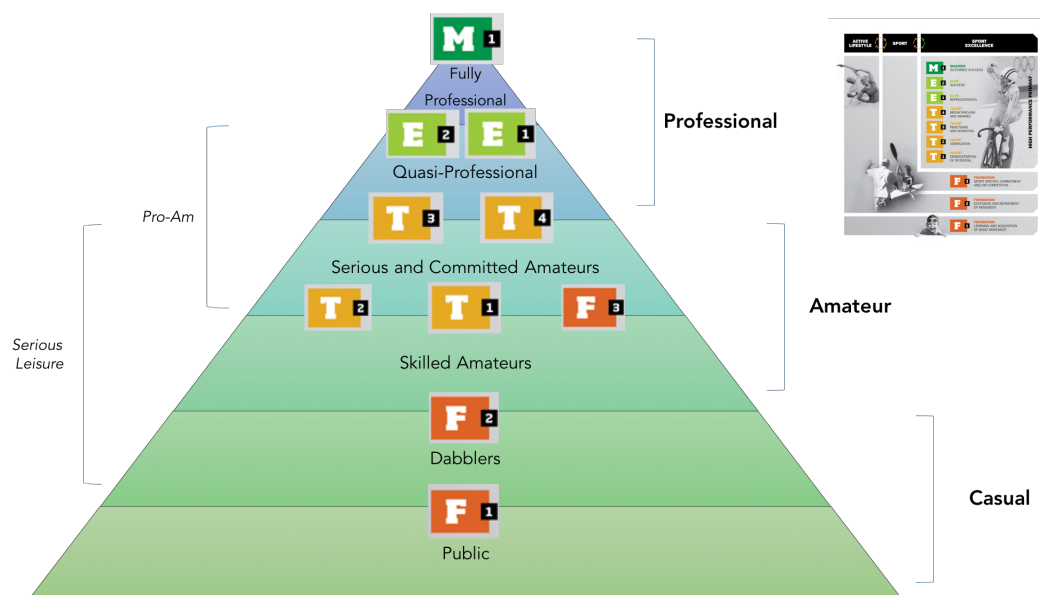


Figure 12: Mapping the FTEM scale to levels of leisure participation

These levels are imprecisely defined and to a large extent subjective. For the purposes of this study such a precise classification isn’t important; the key thing is the athletic behaviour of interest is clearly somewhere between a casual participant and a professional, defined as F3 to T4 level athletes on the FTEM scale. Working from the descriptions provided by Gulbin et. al. (2013) the first three statements in the five-point scale used in the survey related to F3 athletes and the 4th and 5th statements related to T1-4 athletes.

General information use asked about types of resource used and frequency of use. The information resources included document genres, such as physical or e-books; people and institutions, such as professionals and libraries; and technologies, such as

online tools or tracking devices. A 7-point Likert scale from daily to never was used to rate frequency of use. Respondents were also asked why they used these resources by rating their agreement with a number of common leisure motivations and also selecting from a list of common athletic tasks. Respondents were also able to provide their own reasons and activities. Finally, respondents were asked a series of questions on information discovery, access, acquisition and literacy.

The remaining sections of the survey were based on a simple 3-phase model (Figure 13) that adapts the idea of the information communication chain to the athlete activity cycle. In this simple model information inputs are required before exercise to help plan and prepare for the activity. Activity feedback may be used during exercise and may result in the collection of information outputs from the training that are stored and used for analysis and reflection after the activity has taken place. This analysis may provide input into the preparation for the next activity and may also prompt new information needs or behaviours.

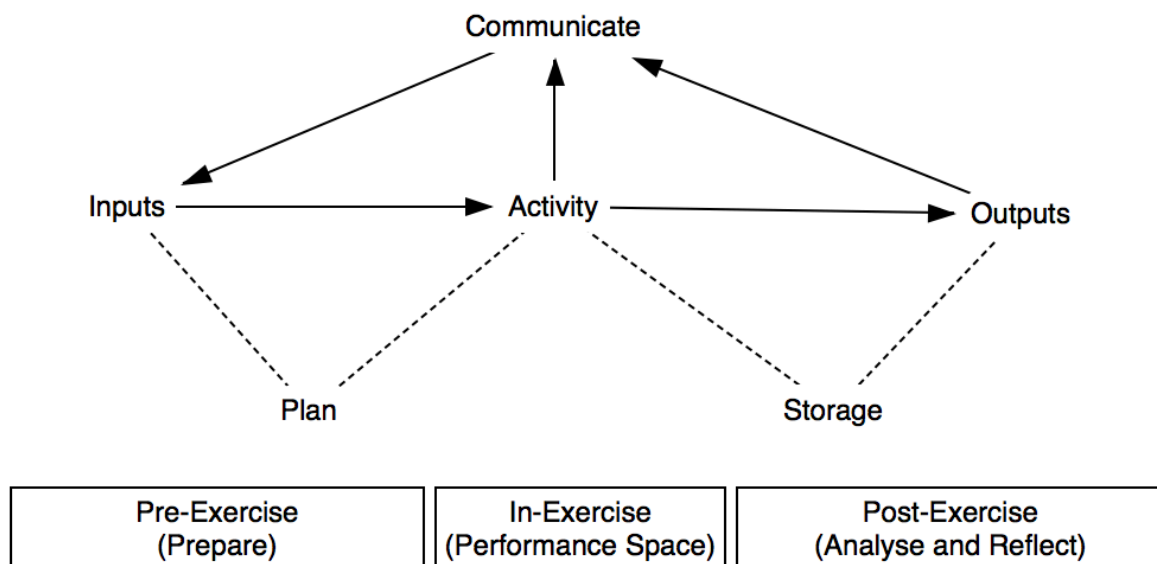


Figure 13: A 3-phase model for structuring athlete information behaviour around physical activity

Information for training asks similar questions to the general section but tailored more specifically to athletic tasks and events in the pre-exercise preparation phase. These tasks and events act as critical incidents for information use and covered: creating a training plan, injury treatment and rehabilitation, event logistics, and the purchase of new equipment or kit. Respondents rated how frequently they used selected information resources for each task using a 5-point Likert scale from always to never. The intention is to understand whether certain document types or communication structures are preferred for different types of activity when different types of expertise or interactions may occur. Comparisons can be made between these activities and with the general information use reported.

Feedback during activity concentrates on the information used whilst exercising, whether in training or competition, and how this information is received. Respondents were also asked if they have ever used a connected device to broadcast an activity and whether they use any form of virtual competition/coaching during their training.

In the final section, **logging and analysing activity**, the athletes were asked about what they did with their data and thoughts after training. Athletes were asked why they kept a training diary, and if they do, what method they used for keeping their records. Athletes were also asked whether it was important to keep their training data, rated on a 7-point agreement scale, and if so what tools and devices they used. They were also estimated how much training data they have and how confident they were at analysing and interpreting it to assess data fluency. Two questions related to sharing and asked whether the athlete shared their training data, if so with whom and whether they had any privacy concerns about exposing their data. Finally, athletes were asked if they measured anything else related to their general health and well-being though not necessarily their training. This can be used to assess how much data usage was focused on athletic training and how much might be tied to an interest in the broader quantified self movement.

Data Analysis

The data was analysed using tools provided within SurveyGizmo. This includes a question explorer, individual responses, summary reports and data analysis reports. This provided sufficient analytical capability for exploring the initial data set through summary tables, segmentation and cross tabulation. Data exports were also extracted to archive the data in csv, xml and SPSS formats for more in-depth data or statistical analysis in future.

4.3 Limitations of the Survey

There are some limitations with the survey method. Firstly, the sample was self-selecting and is not large or representative therefore so caution is required when interpreting the results and drawing general conclusions from them. The data is subject to volunteer bias and of limited use in making generalisations about the amateur athlete population.

Secondly, the survey is further constrained by the online delivery mechanism that restricted participants to those with access to the internet; this may result in a 'techno-centric bias' that selects athletes with a greater interest in internet based information and contemporary innovations such as fitness tracking technology. Ways to reduce this bias would include receiving responses via non-electronic channels. A good way to do this would be to invite participants at club or race events to take the survey on

site though with this number of sports that research would be logistically challenging.

A third issue with the survey is the uneven distribution of responses across the selected sports with a low number of cyclists, rowers and swimmers in the sample. This could be a reflection of the digital bias above but it is also likely due to selection bias in the pilot group. Although the survey was published generally it was also heavily promoted on the personal networks of the researcher (a runner) and the pilot group (3 triathletes and one runner). Either the pilot group and distribution points need to be more representative or more likely it would be better for future studies to focus on a smaller number, perhaps even individual sports, for this type of research.

Finally, no demographic information pertaining to the affluence or education level of athletes was collected in the athlete profile. So whilst the data can be segmented by sport, gender, age group and geographical location no conclusions can be reached about how things like social and cultural capital or material constraints may affect information access and use and this may be a relevant variable to consider in future work.

5. Survey Findings

5.1 Results

Most athletes in this study were indeed committed amateurs. Table 4 shows how athletes rated their own participation using the statements listed in the value column (the athletes did not see the level or FTEM coding). This is an almost ideal distribution for this research with some newly committed athletes and some quasi-professional but the majority of athletes (N=60) rated themselves as either improving or committed to training and participate in events.

Value	Level	FTEM	Count	Percent
I train regularly but don't participate in events	1	F3	3	3.3%
I train often and feel I am improving. I participate or intend to participate in events	2	F3	27	29.7%
I am committed to training and sport specific development and I often compete in events	3	F3	33	36.3%
I regularly compete, have a detailed training plan and/or I perform above average for my age group	4	T1/T2	20	22.0%
My training and competitive events are planned with age group representation in mind	5	T3/T4	8	8.8%

Table 4: Athlete participation level (self-classification by selecting one of the statements in the value column)

This commitment was reflected in quite high training frequencies with 46 athletes saying that they trained 6-7 days per week and a further 34 training 4-5 days per week. Most athletes (N=72) were also members of a club with the remainder being individual athletes (N=19). Some respondents listed multiple club affiliations for different sports, particularly triathletes who often listed a triathlon club and a club related to an individual discipline (swimming, cycling or running). Club membership was more noticeable in swimming (100%), rowing (100%) and triathlon (85.3%).

Sporting Motivations

Athletes were asked about their sporting goals to try and understand their overall aims when training. These goals may indicate motivations for information seeking. The most common aims were training for an event (N=49) or trying to achieve a particular time or personal record (N=36). These could be described as target-related goals. The next most common reasons were fitness-related and including losing weight, getting leaner or stronger (N=33), maintaining current fitness (N=23) or recovering from injury (N=18). The final set of goals are more technique related with athletes saying they were either trying to improve a skill (N=15), try a new distance (N=15) or trying to establish a new training routine (N=9). In the comments some

expanded on their motivations and current athletic status. These comments mostly related to health, either physical health or mental health for example “to maintain sanity” or “escape work”. These reflect similar motivations to those identified by Major (2001) but are less technique focused than in Vazquez Moctezuma and Calva Gonzalez (2013). Others were more focused on achievements, explicitly mentioning target race times, their “career” or GB representation. There were some quite long careers and a recognition that their activity was changing as they either wound down or transitioned to a different sport following injury. One response mentioned they previously trained seriously but were now a “casual participant” due to prioritising other facets of their life.

General Information Seeking

The athletes were asked how frequently they used a range of resources, their reasons for consulting these sources and which athletics tasks they actively sought information about. As with similar user studies on information seeking in recreation, the athletes use a variety of information sources with a preference for informal over formal sources (Table 5). When using people as information sources a coach was the least used with 34 respondents never using a coach. Those who did use a coach (N=50), most typically consulted them weekly (N= 18). Another source of personal information exchange was with training partners and club mates. Despite the bias towards club affiliation, training partners were consulted more frequently than club members perhaps indicating this forms a tighter reference group than a more formally organised group. Friends in general were another popular source with only 8 respondents saying they never consulted their friends for information relating to their sport. Despite the focus on health motivations, medical professionals were consulted rarely. This may reflect an absence of injury but 32 athletes had never consulted a physiotherapist and 57 had never consulted a doctor in relation to their sport.

The majority of athletes consulted documentary sources, whether printed or electronic, infrequently. Only a small number of respondents, less than 10 on average, consulted documentary sources at least weekly or more frequently. Of these, journal articles were most frequently consulted and in fact only 24 respondents to this question said they had never consulted a journal indicating a preference for more formal documentary sources. Paper magazines were the most popular documentary source with only 12 out of 87 respondents to this question having never consulted a paper magazine relating to their sport and a third using these at least monthly. Paper books had a similar readership though were read slightly less frequently overall. Electronic documentary sources were less popular, e-books more so than e-magazines with 38 athletes never using an e-book and 33 never reading an e-magazine. Athletes are not acquiring these documents from a library as 62 said they never used a library and a further 23 used a library infrequently (less than monthly). It

is unclear from this type of survey whether athletes interpreted this as visits to a physical library rather than use of electronic sources, particularly given the higher than expected preference for journal articles.

	Daily		2-3 Times per Week		At Least Weekly		At Least Monthly		Less than Monthly		Rarely		Never		Total	
Coach	5	6.0%	7	8.3%	18	21.4%	11	13.1%	1	1.2%	8	9.5%	34	40.5%	84	100%
Training Partners	2	2.3%	18	20.9%	25	29.1%	13	15.1%	6	7.0%	10	11.6%	12	14.0%	86	100%
Club Members or Crew Mates	2	2.3%	14	16.3%	26	30.2%	15	17.4%	9	10.5%	5	5.8%	15	17.4%	86	100%
Friends	3	3.4%	13	14.9%	15	17.2%	21	24.1%	12	13.8%	15	17.2%	8	9.2%	87	100%
Physiotherapist	0	0.0%	0	0.0%	2	2.4%	5	6.0%	19	22.9%	25	30.1%	32	38.6%	83	100%
Doctor	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	1.2%	26	31.0%	57	67.9%	84	100%
Paper Book	2	2.3%	1	1.2%	2	2.3%	20	23.3%	20	23.3%	25	29.1%	16	18.6%	86	100%
E-Book	4	4.8%	0	0.0%	4	4.8%	10	11.9%	12	14.3%	16	19.0%	38	45.2%	84	100%
Paper Magazine	0	0.0%	1	1.1%	5	5.7%	29	33.3%	21	24.1%	19	21.8%	12	13.8%	87	100%
E-Magazine	3	3.5%	2	2.3%	4	4.7%	18	20.9%	12	14.0%	14	16.3%	33	38.4%	86	100%
Journal Article	0	0.0%	4	4.7%	8	9.4%	16	18.8%	14	16.5%	19	22.4%	24	28.2%	85	100%
Library	0	0.0%	0	0.0%	0	0.0%	0	0.0%	4	4.7%	19	22.4%	62	72.9%	85	100%
Social Media e.g. Facebook, Twitter	31	35.2%	21	23.9%	15	17.0%	11	12.5%	3	3.4%	1	1.1%	6	6.8%	88	100%
Blog or Website	18	20.7%	17	19.5%	20	23.0%	17	19.5%	7	8.0%	7	8.0%	1	1.1%	87	100%
Discussion Forum	10	11.8%	6	7.1%	17	20.0%	15	17.6%	10	11.8%	16	18.8%	11	12.9%	85	100%
Online Application e.g. Strava, Training Peaks	29	33.3%	13	14.9%	11	12.6%	3	3.4%	3	3.4%	12	13.8%	16	18.4%	87	100%
Mobile Application e.g. iSmoothRun, MapMyFitness	12	14.0%	5	5.8%	6	7.0%	8	9.3%	2	2.3%	21	24.4%	32	37.2%	86	100%
Desktop Application e.g. Sport Tracks	10	11.5%	5	5.7%	1	1.1%	2	2.3%	2	2.3%	14	16.1%	53	60.9%	87	100%
Podcast	0	0.0%	4	4.6%	8	9.2%	5	5.7%	8	9.2%	23	26.4%	39	44.8%	87	100%
Video e.g. YouTube or DVD	1	1.2%	4	4.7%	14	16.5%	18	21.2%	8	9.4%	24	28.2%	16	18.8%	85	100%
Attend Courses or Workshop	0	0.0%	1	1.1%	0	0.0%	1	1.1%	13	14.9%	32	36.8%	40	46.0%	87	100%

Table 5: General information resource usage by athletes (Question 10)

Electronic sources were the most frequently used information sources, especially social media and online data sharing platforms. Around a third of respondents used these daily. Only 6 athletes never used social media and only 1 never used a blog or website. Whilst online data sharing platforms were popular there was a more uneven

distribution with around third of respondents using these rarely (N=12) or never (N=16). Online applications were preferred to mobile applications and desk applications. Multimedia sources were only used sporadically with a preference for video over podcasts/audio. A formal course or seminar was one of the least used information sources with 72 athletes using rarely or never.

Education and information were the most popular reasons for using information (Table 6). Around three quarters (N=66) agreed or strongly agreed they needed information for a specific purpose whilst 62 agreed or strongly agreed they used information resources to learn new things. Few disagreed with these reasons. Motivation also featured strongly with 26 athletes strongly agreeing and 78 agreeing to some extent. There was more muted agreement that information was used for competitive reasons with 17 disagreeing with this to some extent. The most uneven distribution was for socialising. Whilst 18 respondents strongly agreed they used information sources to make friends or join a community and more than half agreed at least slightly with this reason it also prompted the strongest disagreement with 21 athletes disagreeing to some extent. Given the regular use of social media sources this is slightly surprising and suggests that social media use is as much about seeking fulfilment-related information as social-world information.

	Strongly agree		Agree		Somewhat agree		Neither agree or disagree		Somewhat disagree		Disagree		Strongly disagree		Total	
Education: I use them to learn new things	28	32.6%	34	39.5%	16	18.6%	7	8.1%	1	1.2%	0	0.0%	0	0.0%	86	100%
Information: I use them to find information I need to know for a specific purpose	23	26.4%	43	49.4%	14	16.1%	5	5.7%	2	2.3%	0	0.0%	0	0.0%	87	100%
Motivation: I use them to keep me enthused and on track	26	30.2%	32	37.2%	20	23.3%	4	4.7%	1	1.2%	3	3.5%	0	0.0%	86	100%
Competition: I use them to compare myself to others	11	12.6%	29	33.3%	21	24.1%	9	10.3%	9	10.3%	8	9.2%	0	0.0%	87	100%
Socialising: I use them to make friends and hang out with a community	18	20.7%	16	18.4%	24	27.6%	8	9.2%	5	5.7%	11	12.6%	5	5.7%	87	100%

Table 6: Reasons for information seeking and information resource usage (Question 11)

Finally, these information sources were used in relation to a variety of tasks with the most popular being finding events to compete in (N=72) but only 51 saying they needed information on event venues or logistics. Fulfilment-related tasks were the next most popular with training methods (N=69) technique development (N=64) and sourcing equipment all popular (N=69). Nutrition (N=55) and injury advice (N=57) were also information-related tasks for the majority. Reflecting the level of engagement information on athlete development pathways and regulations were not

common information-seeking activities (both N=15). One popular social activity was reading about other athletes or role models (N=47) and one respondent added getting motivation and support as an additional reason but again these tasks could be classified more as fulfilment-related rather than social-world.

Task-Specific Information Seeking

Athletes were asked more specifically which information resources they consulted for four tasks:

1. Creating a training plan
2. Injury treatment and rehabilitation
3. Finding and participating in events
4. Deciding on new kit or equipment purchases

The first task is quite complex but usually voluntary. The second tasks whilst also reasonably complex is often involuntary and is more a problem solving type scenario. The third task is more straightforward search for transactional information and the fourth task involves making a decision.

Generally, most athletes had no favoured source for creating a training plan (Table 7). Most athletes compiled their own training plan from a variety of sources with 78 doing this at least sometimes. Only 8 athletes never used this method. The other sources give some indication of where this information might come from. Finding a plan online was used at least sometimes (N=54) with 14 having never used this method. Using plans from books or magazines were also popular sometimes though over a third had never used these methods. One athletes commented that magazines articles were often too generic to be useful and they only read them if at least 3 pages long.

	Always		Often		Sometimes		Rarely		Never		Total	
I use a plan from a book	2	2.3%	9	10.3%	26	29.9%	19	21.8%	31	35.6%	87	100%
I use a plan from a magazine	0	0.0%	3	3.4%	29	33.3%	25	28.7%	30	34.5%	87	100%
I use a plan I find online	4	4.7%	10	11.6%	40	46.5%	18	20.9%	14	16.3%	86	100%
I use an application to create a plan for me (e.g. My Asics, Adidas MiCoach)	1	1.2%	3	3.5%	12	14.0%	12	14.0%	58	67.4%	86	100%
A coach provides me with a plan	11	12.8%	10	11.6%	8	9.3%	15	17.4%	42	48.8%	86	100%
I create my own plan from various sources	22	24.7%	29	32.6%	27	30.3%	3	3.4%	8	9.0%	89	100%

Table 7: Information resources used when creating a training plan (Question 18)

There is evidence of a dedicated group who most frequently use a coach for a training plan with 21 using a coach always or often. Less popular is algorithmic coaching with the most athletes (N=58) having never tried this method and just one respondent who said they always used application to generate their plan. 2 respondents said they have no specific plan but just did what they felt like. This suggests most amateurs here build a plan that suits them from a variety of sources, using materials found online or less frequently in books and magazines.

When it comes to injury, the most favoured information sources seem to be searching for information online or consulting a physiotherapist (Table 8). This may depend on the severity of the injury as one athlete commented they favoured self-diagnosis unless “seriously painful”. 19 always consult a physiotherapist with 51 consulting a physiotherapist at least sometimes. Physiotherapists were consulted more frequently than doctors and friends or training partners were more frequently consulted than coaches.

	Always		Often		Sometimes		Rarely		Never		Total	
Consult a physio/sport therapist	19	21.8%	21	24.1%	21	24.1%	14	16.1%	12	13.8%	87	100%
Consult a doctor	4	4.5%	4	4.5%	19	21.6%	33	37.5%	28	31.8%	88	100%
Ask friends or club/crew mates	3	3.4%	18	20.7%	39	44.8%	17	19.5%	10	11.5%	87	100%
Ask my coach	8	9.2%	11	12.6%	13	14.9%	10	11.5%	45	51.7%	87	100%
Get advice from an academic journal	2	2.3%	8	9.2%	16	18.4%	19	21.8%	42	48.3%	87	100%
Get advice from a book	0	0.0%	4	4.6%	23	26.4%	32	36.8%	28	32.2%	87	100%
Get advice from a magazine	0	0.0%	4	4.6%	27	31.0%	30	34.5%	26	29.9%	87	100%
Search for advice online	10	11.5%	45	51.7%	20	23.0%	6	6.9%	6	6.9%	87	100%
Ask on social media	2	2.3%	12	13.8%	24	27.6%	15	17.2%	34	39.1%	87	100%

Table 8: Information resources used when treating injury (Question 19)

Of printed sources, overall magazines were preferred over books and then journals for this task. Responses for journals were more unevenly distributed with 10 respondents using these at least often. However, amongst the printed sources journals also had the greatest number never using them for treatment of injury (N=42). Less athletes said they always search online (N=10) but half (N=45) said they often used this source and 75 used this source at least sometimes though social media was less favoured for this task with less than 38 using at least sometimes but 34 never using.

Online sources were again popular for finding and entering events 73 using this at least often and over 83 using at least sometimes (Table 9). Friends and social media were also popular routes for finding out about events with 75 athletes asking friends at least sometimes and 69 using social media. A noticeable few, 12 never used social

media for this task. Another electronic channel, receiving an email, was also slightly more popular than any printed sources such as magazines or flyers. The impression is that this is a task where online or personal networks are the more important sources.

	Always		Often		Sometimes		Rarely		Never		Total	
Listing in a magazine	1	1.2%	13	15.3%	26	30.6%	26	30.6%	19	22.4%	85	100%
Listing online	26	29.9%	47	54.0%	10	11.5%	2	2.3%	2	2.3%	87	100%
Friends or club/crew mates	14	16.1%	42	48.3%	19	21.8%	7	8.0%	5	5.7%	87	100%
Social media	10	11.6%	32	37.2%	27	31.4%	5	5.8%	12	14.0%	86	100%
Coach	7	8.1%	10	11.6%	16	18.6%	12	14.0%	41	47.7%	86	100%
Receive an email	2	2.3%	18	20.7%	45	51.7%	13	14.9%	9	10.3%	87	100%
Printed poster or flyer	1	1.2%	3	3.5%	38	44.2%	27	31.4%	17	19.8%	86	100%

Table 9: Information resources used for finding and entering events (Question 20)

The final task is for equipment purchase and once again online and personal networks predominate (Table 10). 78 browsed an online shop at least often and by all respondents. Consulting online reviews was also popular with 80 athletes consulting these at least sometimes. Reviews in magazines were slightly less popular with 65 using at least sometimes but 2) using always compared to 13 for online reviews and 25 for online shops. One person commented that they though magazines reviews are biased as they don't ever give a bad review another indication that athletes are quite sceptical about magazines, even considering them less reliable than online sources and commercial sites (e.g. online shops and manufacturers). Once again friends were a popular source with 70 athletes saying they ask their friends at least sometimes for this task. The use of social media was again unevenly distributed as whilst 53 used at least sometimes, 17 said they never used this source for this task.

	Always		Often		Sometimes		Rarely		Never		Total	
Visit a physical shop	6	6.9%	34	39.1%	36	41.4%	9	10.3%	2	2.3%	87	100%
Browse online shop or manufacturer website	25	29.1%	53	61.6%	7	8.1%	1	1.2%	0	0.0%	86	100%
Reviews in a magazine	2	2.3%	30	34.5%	33	37.9%	17	19.5%	5	5.7%	87	100%
Reviews online	13	14.9%	44	50.6%	23	26.4%	4	4.6%	3	3.4%	87	100%
Ask friends or club/crew mates	4	4.5%	37	42.0%	29	33.0%	10	11.4%	8	9.1%	88	100%
Social media	2	2.3%	22	25.6%	29	33.7%	16	18.6%	17	19.8%	86	100%
Advice from a coach	4	4.5%	12	13.6%	15	17.0%	15	17.0%	42	47.7%	88	100%
Advice from a physio/sport therapist	0	0.0%	8	9.0%	16	18.0%	25	28.1%	40	44.9%	89	100%

Table 10: Information resources used for purchasing kit and equipment (Question 21)

Information Acquisition and Satisfaction

When it comes to acquiring information most athletes in the survey use sources that are freely available. 77 said they often or always acquire information this way. Despite this preference for freely available information, borrowing from a library was the least used acquisition method with 60 athletes saying they never use a library. More likely was the borrowing of information from other people than a library. This suggests that the information obtained may be free, but not necessarily from quality sources or formal channels. Despite this, the athletes were confident about their information seeking: no respondents thought that they were unable to find relevant information. 48 strongly agreed that they could find relevant information for their sporting needs, only 2 weren't sure. There was slightly less agreement on access to information with 32 strongly agreeing they could access all the information they found without limitation. 2 respondents disagreed with this to some extent. Still, most athletes agreed they could access the information they found. Some respondents did comment that there was a large volume of information but that this can be inconsistent and it's hard to find validated and trusted sources. There were also some respondents who felt limited in some areas e.g. swimming was mentioned as lacking in free sources compared to running.



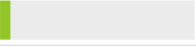
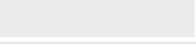
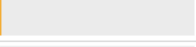
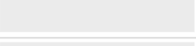
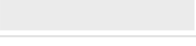
				Statistics	
Strongly Agree	39.8%		35	Average	6.3
Moderately Agree	53.4%		47	StdDev	0.7
Slightly Agree	5.7%		5		
Not Sure	0.0%		0		
Slightly Disagree	1.1%		1		
Moderately Disagree	0.0%		0		
Strongly Disagree	0.0%		0		
Total			88		

Table 11: Extent that athletes agree they understand the information they find and can relate it to their sporting aims and activities (Question 14)

Most athletes were confident about their information literacy and agreed that they could understand the information found and could use it to support their sporting aims (Table 11). Only 1 respondent slightly disagreed. The impression is that these amateur athletes are confident information seekers who can access the information they find readily, often freely, and understand how to relate it to their sporting needs. A range of sources are used with athletes gravitating towards online sources and personal networks, particularly when their information seeking is task-related.

In-Activity Feedback

Most athletes surveyed trained with at least one device logging their activity. 65 always train with a device and 15 often train with a device. Only 2 athletes never train with a device. The most popular type of device was a GPS device with 74 athletes using this kind of tracker. 51 athletes use a heart rate monitor. As one athlete pointed out “quite a lot of this stuff is in one device” though some athletes did use different devices for different sports e.g. watch when running, a bike computer when cycling and the poolside clock when swimming. Some athletes commented they used devices for “serious training” but not if they wanted a relaxed session as they found themselves chasing targets too much.

The main things athletes wanted to know during an activity were distance and duration with around two thirds wanting to know how fast they were going. More technical feedback like heart rate, cadence and power were less popular and only 7 athletes liked to receive any audio cues such as coaching prompts.

Most athletes had never used functionality to live broadcast a session though 17 athletes had tried this. This functionality allows tracking data to be published online live so that others can track the activity. More popular, was the use of a virtual competition where a device can be used to compete against yourself or others, usually by tracking yourself against a previously recorded activity. About half (N=45) had tried this function. Many athletes who commented said they found virtual pacers “boring” but did express more enthusiasm for social-world virtual competition with 7 athletes saying they were regular users of Sufferfest videos and found it “inspiring”. One was also interested in linking it with Zwift. One athlete said they only used a device for major events, renting a GPS device so supporters could track them, and one athlete never uses “training devices” preferring to go by feel and their own body.

Training Diaries and Data

11 athletes said that they don’t keep a training diary to record their training but the remaining athletes did keep a diary in one or more forms. This is reflected in the importance placed on training data: only 8 athletes disagreeing that it was important to collect and keep training data. Most athletes thought collecting and keeping detailed training data was important with just over half (N=46) strongly agreeing. Reasons for keeping a training diary were varied. Most popular was to monitor progress with 67 athletes citing this reason. Other reasons included wanting to keep on track (N=54), improve performance (N=50), stay focused (N=49) and motivation (N=49) and finding trends or patterns (N=40). 37 athletes kept a diary for keeping memories but few used it for tracking their wellbeing, whether physical or mental. Only 9 athletes said their diary was an emotional outlet and only 5 used it to prevent injury.

The athletes were asked to estimate how much training data they had accumulated using their own metric. Responses here varied but indicating a reasonably systematic and long-term commitment to maintaining a training log. Most athletes reported this in years though some athletes also included their total or average yearly mileage. Some multi-sport athletes reported different timeframes and volumes for different sports. When the different responses for those who had reported a time period were coded and tabulated the majority had been keeping a diary for between 3-4 years (Figure 14).

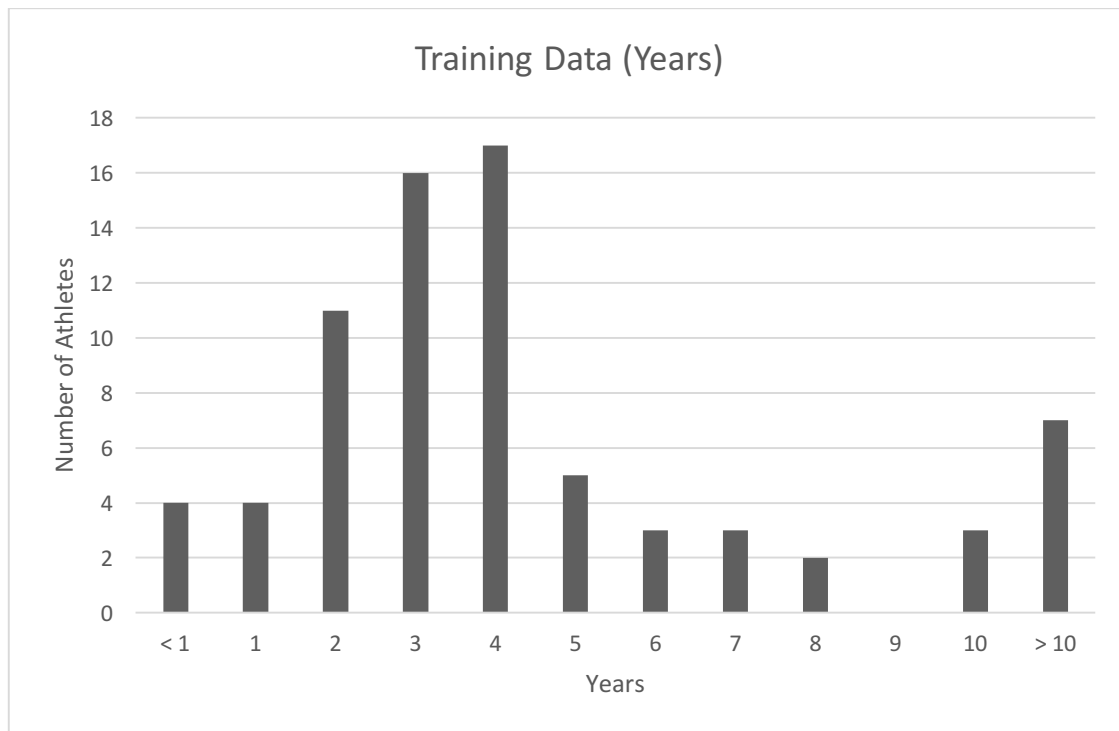


Figure 14: Years of training data recorded by athletes (Question 39)

Of the 80 athletes that kept a diary the most popular method is to use an online application with this being selected by 58 athletes. Garmin Connect (N=50) and Strava (N=44) were clearly the two most popular online platforms. The second most popular method is to use a phone application (N=20) followed by a more traditional paper diary (N=16). The three most popular reasons for analysing or reviewing data collected were to compare performance over time, evaluate effort and to check lap/split times (Table 12). Also done at least sometimes by over two thirds of the athletes were visualising data, reviewing graphs and charts or looking at a mapped view of the activity. Tracking achievement in the form of new personal records or receiving badges was preferred to comparing oneself directly with others, though 57 athletes did this at least sometimes. More technical tasks such as checking heart rate zones or crunching the raw data were more unevenly distributed with some always checking their data to this level of detail but most doing this rarely or never.

	Always		Often		Sometimes		Rarely		Never		Total	
Crunching the raw data	9	10.3%	20	23.0%	28	32.2%	18	20.7%	12	13.8%	87	100%
Lap/split times	32	36.0%	28	31.5%	17	19.1%	8	9.0%	4	4.5%	89	100%
Reviewing graphs and charts	23	26.1%	26	29.5%	18	20.5%	13	14.8%	8	9.1%	88	100%
Replaying my activity	4	4.6%	13	14.9%	27	31.0%	24	27.6%	19	21.8%	87	100%
Visualising on a map	24	27.3%	25	28.4%	15	17.0%	10	11.4%	14	15.9%	88	100%
Checking my heart rate zones	10	11.4%	25	28.4%	19	21.6%	14	15.9%	20	22.7%	88	100%
Evaluating my effort	22	24.4%	41	45.6%	20	22.2%	2	2.2%	5	5.6%	90	100%
Comparing myself to others	8	9.1%	19	21.6%	30	34.1%	19	21.6%	12	13.6%	88	100%
Getting new PRs, badges, trophies	22	25.3%	21	24.1%	21	24.1%	10	11.5%	13	14.9%	87	100%
Monitor training intensity	16	18.0%	40	44.9%	20	22.5%	7	7.9%	6	6.7%	89	100%
Monitoring training load	13	15.1%	30	34.9%	19	22.1%	15	17.4%	9	10.5%	86	100%
Comparing my performance over time	32	35.2%	42	46.2%	14	15.4%	1	1.1%	2	2.2%	91	100%

Table 12: How athletes use their training data (Question 37)

The athletes seemed slightly less confident in their data literacy than their information literacy (Figure 15). Whilst 81 athletes agreed they knew how to interpret and analyse their data only 16 strongly agreed with 38 moderately agreeing and 27 slightly agreeing.

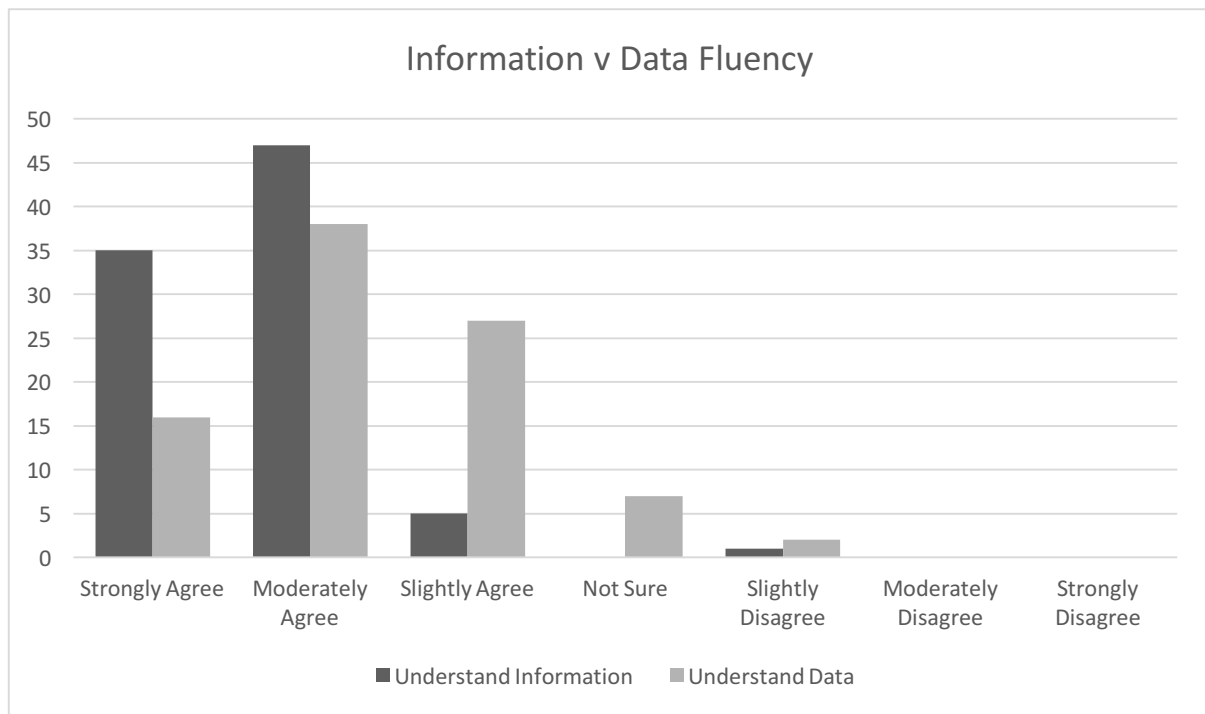


Figure 15: Comparing information and data competency: the confidence athletes have that they understand the information they find vs understanding their training data

Whilst athletes were keen to quantify their training there were less enthusiastic about

tracking other aspects of their health and well being with most never tracking any wellbeing metrics though 10 athletes did say they always wore an everyday activity tracker. The most popular wellbeing metric logged by athletes was weight with 68 saying they tracked this at least sometimes.

Finally, athletes had mixed feelings about sharing their training data (Table 13). Only 15 athletes share their data publicly with more choosing to share with selected audiences (Figure 16) with the most common audience being friends (N=33).

Value	Count
Yes, I share all of it	23
Partially, I share some data and/or with selected people	35
No, I Keep it private	29

Table 13: Attitudes towards sharing training data (Question 34)

Other audiences include coaches (N=16), online communities (N=14) and social communities (N=14). Though training partners were a source of information for many athletes, only 13 share their training data with training partners. Perhaps this data isn't seen as being useful or isn't considered to be part of the information exchange between training partners.

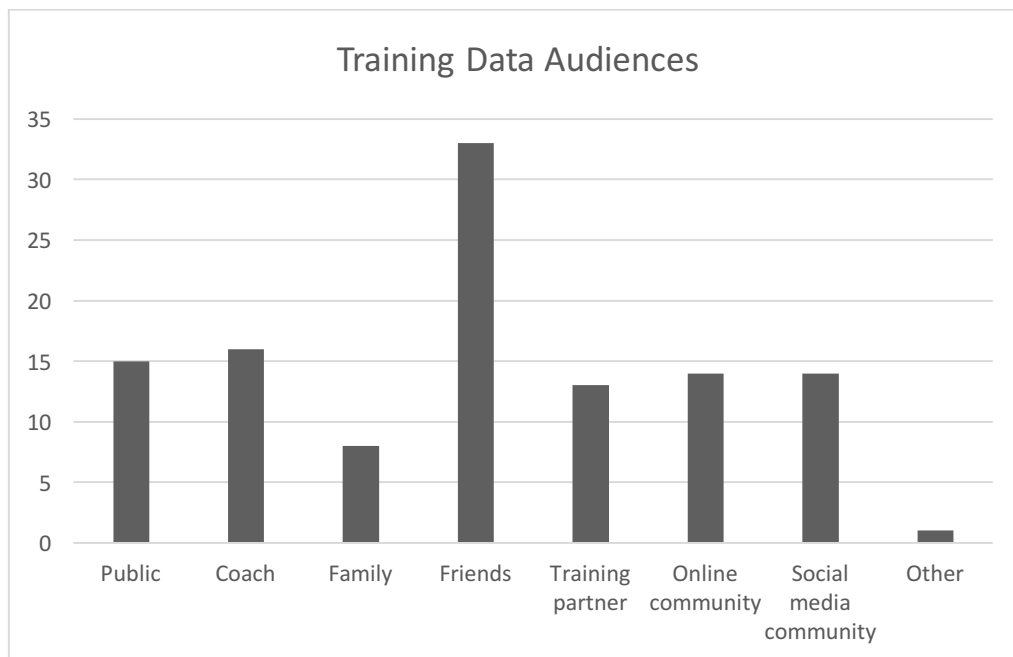


Figure 16: Audiences for shared training data (Question 35)

Evidence of Variation

This initial analysis looks at amateur athletes as a group to draw some initial

conclusions. A more detailed analysis was conducted by cross-tabulating some questions against athlete profile demographics to test for any possible variations between different athlete segments. Questions were selected for analysis in five broad thematic groups:

Theme	Included Questions
General Information Use	Q10
Satisfaction and Literacy	Q13, Q14, Q16, Q38
Data Collection	Q23, Q26, Q27, Q31, Q40 (everyday activity level option only)
Logging and Sharing	Q29, Q34, Q36, Q37
Motivation	Q11, Q12, Q30

Table 14: Cross tabulation themes with questions included in analysis

These were analysed against five demographic factors: age group, gender, sport, level of participation and club membership. Table 15 summarises cases where a p-value < 0.05 was found when comparing a question with a demographic factor, indicating a possible correlation for further investigation.

Theme	Age	Sport	Level	Gender	Club Membership
General Information Use	None	Q10 Coach (0.0211) Q10 Club Members (0.0016) Q10 Online Application (0.0013) Q10 Mobile Application (0.047)	None	Q10 Coach (0.0125) Q10 Club Members (0.0191) Q10 Friends (0.0111)	Q10 Coach (0.0445) Q10 Training Partners (0.0004) Q10 Club Members (0)
Satisfaction and Literacy	Q14 Understanding Information (0.0051)	None	None	None	None
Data Collection	Q23 Device Use (0.0017)	Q23 Device Use (0.0002) Q27 Virtual Tool (0.0113) Q31 Data Importance (0.0264)	Q23 Device Use (0.0416)	Q27 Virtual Tool (0.0147)	Q26 Live Broadcast (0.035)
Logging and Sharing	None	Q34 Data Sharing (0.0441) Q37 Laps/Splits (0.0093) Q37 Graphs and Charts (0.0492) Q37 Training Load (0.0429) Q37 Training Intensity (0.0344) Q37 Performance over Time (0.0132)	None	Q37 Graphs and Charts (0.0233) Q37 Visualise on Map (0.0446)	None
Motivation	None	None	None	None	None

Table 15: Cross tabulation of themes and athlete profile demographics showing possible areas of correlation (p-value < 0.05)

It is difficult to draw any firm conclusions from this level of evidence or analysis but it does provide some areas for closer analysis and hypothesis testing in future research, particularly around sport and gender specific information behaviours and the many possible demographic influences on attitudes towards data collection.

5.2 Discussion

The athlete survey findings conclude with a reflection on some themes emerging from the initial results. Overall, the findings are consistent with those in other recreational information behaviour studies (pp. 25-26) in that information use involves: varied information sources, the growth of online channels for both information seeking and sharing and evidence of process/task orientation. However, in this survey information seeking and sharing concentrates more on fulfilment-related information and evidence of social-world information behaviours is not as pronounced as in other studies.

Reference groups and online systems predominate for most tasks

The results suggest a variety of sources are used by athletes when seeking information and a variety of devices and systems are used for collecting, logging and analysing training records and data. This compares with Vazquez Moctezuma and Calva González (2013) who estimated athletes used on average 5 types of information source and the sources are similar to those mentioned in Rothschild (2012) and Robinson et al. (2014). Unlike Chang's survey of backpackers (2009), these systems and sources vary only slightly with different tasks and activities. A slight preference amongst athletes for freely available information via more informal channels can be inferred.

What isn't clear is whether this reflects the principle of least effort or 'satisficing', where the most accessible rather than the best information sources are used (Bates, 2005; Case, 2005; 2012), or whether for amateur athletes these do represent the most effective channels and sources for their needs. Some of the survey comments hint at frustration that whilst information for athletes is abundant, it can also be inconsistent and difficult to obtain for the athlete's level. One alternative hypothesis to the principle of least effort is that much information on sport is either too generic (suitable for casual leisure) or too scientific (more suitable for elites and professionals) to be relevant to amateurs. There was a higher than anticipated use of journals though it is not clear how these are being acquired and more evident scepticism about the quality of information in magazines than online.

In order to obtain the best information for their sport and level, amateur athletes may rely more on information exchange with other athletes like them. This involves searching online for relevant information but also utilising their reference groups, such as training partners or club mates, extensively. However, the emphasis on personal reference groups doesn't predominate as in boxing, possibly because the sports in this study aren't practiced in a fixed, internal venue. This survey revealed much less use of coaches as an information source than in boxing with athletes taking greater responsibility for their own information needs.

Athletes prefer social channels but aren't necessarily regulars in social worlds

The user study indicated a preference for fulfilment-related information over social-world information. The reasons for seeking information were mainly educational and informational and on topics similar to those reported in the boxing user study: technique, nutrition, injury and competition logistics. This suggests that information seeking and use is strongly related to the functional requirements of their level, goals and activity phase. The use of information for motivation and social world maintenance, whilst present, is not as significant as hypothesised and there are mixed attitudes towards social worlds. Athletes were happy to seek this information from social channels but this use of social media and reference groups was not accompanied by a strong preference for socialising as suggested by Liu et. al. (2013) and Robinson et. al. (2014). The exception is cycling where communities such as Sufferlandria and Zwift are used to augment and motivate training. Beyond cycling there is little evidence from the athletes surveyed here of widespread investment in social world participation and maintenance or seeing online and virtual information structures and paces as important to their sport.

Most amateur athletes lean towards quantification but don't fully embrace it beyond their training

Evidence is emerging that amateur athletes are committed to logging their training and keeping records of the data, especially when they see their training as serious. There is evidence of increasing use of sensors, electronic training diaries and quantification of training data. Some use different methods for data feedback and recording when they are exercising for relaxation than when they are training hard. This perhaps indicates that data tracking can be both a utilitarian and gratifying communication practice (Lomborg and Frandsen 2015). There are some dissenting opinions. One respondent rejected the use any of kind of training planning or devices preferring to rely on their experience, knowledge of their body and feel to decide on their training activity. Despite this more natural, intuitive perspective, most athletes trained with a device and most had accumulated several years of records. They used these diaries and data to monitor their progress, keep on track and stay motivated. However, their enthusiasm for quantification is not all-encompassing. These are more evidently quantified athletes than quantified selves and their commitment to datafied training is not matched by the regular monitoring of general health and wellbeing metrics or use of everyday activity tracking. Their data collection, sharing and analysis seems to be quite focused on their sport.

Athletes don't seem to be too concerned about the implications of these tracking devices as data assemblages with athletes evenly divided between keeping their data private, sharing it publically or sharing it with selected groups or worlds. This was

reflected by a third of athletes saying they had concerns about putting their data online and around two thirds having no concerns. The nature of these concerns cannot be determined from this research.

In researching these devices, it was noted in section 3.3 that the consumer availability of accurate yet affordable devices varied across sports. Data collection is related not just to athlete motivation, goal and preference but the devices and systems available to collect and analyse data. Despite this, athletes in all sports, including swimming and rowing with less established data collection technology, trained with at least one device sometimes and felt collecting training data was important to them. This desire for data was stronger in runners, cyclists and triathletes but wasn't absent in swimmers and rowers and the variation between attitudes towards collecting data was not as significant as anticipated given the maturity of the consumer device markets in these sports. Cycling is the sport most attached to data collection being the only sport surveyed with all athletes saying they always train with a device and the highest proportion (85.7%) who said collecting data was very important to them. The data collected in this study provides a benchmark for a longitudinal investigation of attitudes towards training data and the adoption of training devices over time.

Amateur athletes are confident consumers, producers and record keepers

The athletes surveyed here seem confident of the ability to find, access and understand information. This fits with Hartel's view of leisure participants as "confident" and "upbeat" (2003) and supports the claim by Lomborg and Frandsen (2015) that users adapt systems to their personal motivations and needs. The impression given is they have a good awareness of the sources available to them and can find sufficient information to satisfy their needs. Their information seeking doesn't involve using libraries but without further qualitative data it's difficult to propose any theory on why this may be the case or how library services could be more relevant for amateur athletes. This finding matches that in the boxing study where less than 20% of the boxers surveyed used books or libraries (Vazquez Moctezuma and Calva González, 2013). Amateur athletes make greater use of journals than libraries but the survey results don't provide direct insight into how journal access is obtained if not via a library. This may reflect a perception of 'library use' as physically visiting a library rather than accessing electronic services or athletes may be unaware that journal access may be available to them via libraries. Either way this seems an area of interest for library advocates interested in promoting library services or demonstrating value.

There is evidence that athletes are not simple consumers of information but both remix and produce their own information products. Most obviously they collect, store and share their training data, usually online. However, the tasks relating to training planning and injury rehabilitation also suggested a preference for self-coaching and

self-diagnosis drawing on and processing a variety of information sources. For the majority, the use of experts such as physiotherapists, coaches or doctors seems to be reserved for situations beyond the athlete's current knowledge when other information sources have been exhausted. This suggests a confidence not just to take packaged information but select and combine information sources in order to meet their goals. It is not clear, however, how rigorous the evaluation of information by athletes is and whether they can distinguish between information and misinformation, such as in the case of the barefoot running debate. There are also a few who are more obvious consumers and frequently use expert or automated sources and seem happier to rely on the expertise of others suggesting different types of information behaviour could be identified.

This confidence does not necessarily mean that athletes don't require libraries or information services. They may benefit from assistance in accessing higher quality resources, such as journals; more specific collections of resources relevant to their sport, role and level; resources that synthesise research, particularly in relation to new discourses or debates where evidence is unclear; they may welcome assistance navigating and accessing newer technologies and understanding how to store, organise, archive and analyse the data they generate more effectively.

Information use may vary according to athlete profile

Whilst there is evidence of common behaviours and sources amongst athletes it would be incorrect to assume they are a homogenous group and infer generalisations from their behaviour. Initial statistical analysis suggests there may be some areas where information behaviour varies based on an athlete's demographic profile. This variation is less in their goals and motivations and more in their attitudes and preferences around general information sources, data collection and data analysis. This indicates that sport may be a significant degree of specialisation in the sporting domain, more so than other factors such as club membership and level of participation. Even sport librarianship might be insufficiently specialised to assist athletes from different sports and subject expertise in individual sports may be helpful in providing services to athletes. For example, cycling emerges as a particularly techno-centric sport in this research with the greatest interest in quantification, virtual participation and social worlds. It's also possible there may be gender-specific differences in information use.

6. Conclusion

This dissertation makes a small contribution to making the “quasi-existence” of sporting information a bit more explicit (Hjørland and Albrechtsen, 1995). It helps understand information behaviour within this domain and demonstrates the applicability of some core LIS conceptual models by applying them within a new context. The research contribution made by this dissertation can be summarised as follows:

1. Demonstrates that domain analysis is an effective and extensible method for researching sport information

This study has shown that the domain analysis approach is a good basis for conducting research on sport information, despite the potential diversity of the domain. This has been illustrated by a examples of four approaches:

1. document and genres
2. computing, expert knowledge and artificial intelligence
3. discourse and terminology studies
4. user studies

Desk research was used to exemplify the first three approaches to outline possible areas of interest for LIS researcher and practitioners. In documents and genres, the idea of athletic performance is related to questions about documentality in LIS. Guttman's *Ritual to Record* was used to demonstrate that record keeping is an essential characteristic of modern sport and two genres were proposed as being of special interest when researching amateur athletes: the training plan and the training diary. Paired with historical and epistemological studies it would be interesting to research the role of documentation in sport and how this may change again in the future as sport embraces new technologies.

This was envisaged by the three areas of interest at the cutting edge of sport information discussed in the computing and artificial intelligence approach. Firstly, linking the growth of social media to serious leisure concepts of social worlds. Secondly, quantification and ubiquitous, pervasive computing are moving the focus of record keeping from documents to data and the implications of this for information literacy, critical data studies and indeed the nature of sporting performance. Thirdly, new types of athletic participation were hinted at due to the emergence of augmented and virtual reality. The research suggested that such exertion interfaces could change not just sport spectatorship, but also athletic participation but

questioned how established they are and how accessible they might be. Sufferlandria, and more recently Zwift, provide interesting early case studies in the sport of cycling of how all three can work together to provide athletes with both fulfilment-related and social-world information spaces.

In discourse and terminology studies the example of a recent debate around running form was used to show how new technology emerges and how information and misinformation can play a role in discourses. The increase in both public search and scientific literature around this topic was illustrated using a simple bibliometric analysis to raise how mapping such debates may help with information provision.

2. Proposes a transferable definition for the sport information domain

A theoretically grounded, transferable definition of sport as an information domain has been proposed to facilitate comparison across studies researching the domain. This definition has indicated that sport information features many intersecting disciplines including, but not limited to, sport science, computer science, engineering and design, leisure studies, library and information science, sociology and healthcare. Level, role and sport are possible ways of qualifying the domain allowing both broad and narrow studies to be undertaken within the overall framework of sport information.

Definitions of these facets have been provided as has clarification on definitions of amateurism and the categorisation of amateur sports with reference to the serious leisure perspective (SLP). The definition has also been mapped to the foundation, talent, elite, mastery (FTEM) framework to show how it could be connected or augmented by sport-specific taxonomy such as long-term athlete development pathways. This may provide an effective route for linking LIS and sport science research and practice. Basing this research on a transferable domain definition allows comparison with studies of information behaviour in other sports or parts of the sporting information domain as well as other types of leisure. It may also be useful in the indexing and retrieval of sport information resources so that sport information can be classified according to sport, level and role.

3. Provides evidence of amateur athlete information behaviour and how athletes use information to help them achieve sporting goals

The user study of amateur athletes is an example of the fourth domain analysis approach and has provided a benchmark evidence dataset on the information resource use by these types of athlete. The results indicate amateur athletes use a variety of information sources but seem to prefer information found online and exchanged within their immediate reference groups. It suggests a preference for

fulfilment-related information, on training methods, technique, nutrition, injuries and events but obtained via social channels. Most information is freely available. There was a higher than anticipated use of journals but low library usage.

Athletes are avid collectors and organisers of training data and information foragers who prepare their own training plans, diagnose their own injuries and collect and archive their own training data for longitudinal analysis and comparison with others. An understanding of athlete information behaviour should therefore consider the entire information communication chain not just information seeking. Athletes use training diaries to help them monitor progress and keep on track. The most popular way of keeping a training diary is to use an online application. This indicates one area where digital technology is influencing athlete behaviour. Athletes are enthusiastic about quantifying and analysing their training data, but this tendency towards quantification is not extended to other areas of their health and well-being. Whilst virtual and alternate reality promise to change sporting spectatorship and participation there is little evidence of adoption in any of the sports surveyed except cycling.

Amateur athletes seem confident and satisfied information users but further research would be needed to determine if they are 'satisficing' or accessing the best information for their needs. This evidence may be of use to libraries and information providers in considering the services and resources to meet the needs of this group and how well these needs are currently satisfied. Certainly it seems that whilst amateur athletes use a variety of sources and prefer not to purchase information, they are not library users and it's difficult to say whether this is because athletes are able to satisfy their information needs without libraries or don't perceive libraries as helpful in meeting their needs.

Whilst this study is library and information science focused, it may contribute to other disciplines such as leisure studies and sport science or those involved in the governance and practice of athletic training. Gulbin et. al. (2013) note that the FTEM framework allows strategic, educational and intergovernmental solutions tailored to each FTEM level. The LIS perspective could add information needs and behaviour to this model ensuring sport governing bodies consider information literacy alongside physical literacy as part of long-term athlete development pathways (LTAD). Connecting information behaviour to sport development will help both sport and library and information professionals select and provide access to appropriate information resources for athlete information needs at casual, amateur and elite levels.

Suggestions for Future Work

This still leaves many questions and there are many areas of future work suggested by this research through deeper, broader or comparative studies. The most obvious next step would be to dig deeper into the evidence provided in this study either through more detailed statistical analysis or, more fruitfully, a qualitative ethnographic study concentrating on individual athletes, critical incidents and detailed task analysis. The use of domain analysis approaches also opens the way to in-depth research projects concentrating on specific approaches. For example, detailed training diary/data analysis could be undertaken alongside a historical and epistemological approach to sport documentation. Network analysis, including qualitative content analysis, quantitative data analysis or social world observation, could take a detailed look at the information exchange involved in social channels and worlds. These studies could be narrowed to concentrate on individual sports and build up a rich picture of their information ecosystems.

Other research approaches could broaden the scope of the research. Within individual sports research could be expanded to include different levels of participation examining differences between casual, amateur or elite participants. Research could also extend to include other domain analysis approaches, attempting a more comprehensive domain analysis. The degrees of specialisation identified also suggest further extensions to consider different roles comparing the information behaviour of different types of actor in different sports and tracing some of the complex professional-amateur-public connections within sports and how these are sustained by information exchange.

Finally, by proposing a transferable definition of sport information it may be possible to draw comparisons between different user studies, such as this athlete survey and the study of Mexican boxers by Vazquez Moctezuma and Calva González (2013), and ultimately attempt a meta-analysis of similar studies.

Final Thought

It is not apparent what role library and information science has in current sport information beyond an archival function for major events and the selection of material in library collections for sports fans and casual athletes. As this research has shown sport as an information domain is much bigger and more diverse than this. The transition of sport during the nineteenth century from a form of ritual to a modern standardised, bureaucratic practice based on record keeping parallels the emergence of librarianship and documentation as a discipline and profession that systematically organises and standardises access to the world's knowledge. Despite these similar origins, the LIS discipline risks becoming increasingly irrelevant to sport in the 21st century. Whilst sociologists write about the nature of record keeping, transmedia and

data assemblages in sport; computer scientists and data scientists are in demand to collect, encode, store and analyse vast data assemblages; and business information systems experts provide expertise on information management and governance; sports librarians and information professionals are more invisible in sporting domains despite the demand for quality information services and the skills and expertise the discipline can contribute. This research proposes domain analysis as a toolkit that helps bring LIS knowledge, researchers and practitioners more fully into sport. As the inaugural European Week of Sport²⁰ takes place to inform, inspire and facilitate access to sport and physical activity, it seems timely to ask what role will library and information science play in sport information in the 21st century?

²⁰ The inaugural European Week of Sport (7-13 September 2015) is a European Commission initiative to encourage sport and physical activity and promote the economic and wellbeing benefits of exercise and sport participation. The campaign features the themes inform, inspire and facilitate (European Commission, 2015a, 2015b).

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Appendices

Appendix 1: Reflection on Dissertation Process

This dissertation has evolved during the research process shifting slightly from the original proposal to the final thesis. Whilst reading the literature on domain analysis and information behaviour I felt more strongly than when I wrote the proposal that the user study of athletes needed to be situated more firmly in the idea of sport as an information domain and anchored to a more rigorous definition than originally formulated in my proposal. Whilst a full domain analysis was beyond the scope of this project I wanted the research to be a user study informed by domain analysis rather than simply an information behaviour user study. My interest lies in understanding sport as an information domain and understanding athletes as information users is but one element of that. Therefore, over the course of the work the research became more evenly balanced between desk research on the idea of sport as an information domain, and the ways domain analysis could help research it, and the athlete user study. This made it longer and more involved than envisaged though not as long and involved as it could be. Despite the expanded scope many more ideas were left behind. I also changed the domain analysis approaches I included in the desk research switching approach 10, studies of structures and organisations in the communication of information, with approach 9, terminology and discourse. Once I started looking into the structures and organisations of communication in sport I realised this was a huge topic and a whole research project in itself to do it justice, ideally tied to a historical study about how these structures and organisations have emerged and changed. The barefoot running debate provided a smaller case study that has more relevance to the types of information flow relevant to the amateur athlete and their need to accommodate new terminology.

Whilst reading more broadly beyond LIS, the idea of sport itself seemed both self-evident and problematic and was often omitted or ignored. I found myself agreeing with Tennis (2003) that cumulative research would be impossible without a domain definition. His model proved useful for thinking about how to segment sport and for exploring the interdisciplinary nature of sport informatics. I also found many disciplines that seemed more interested in sport informatics than library and information science. There is a vast literature bursting with interesting research in this area across a much broader range of disciplines than I'd envisaged when I'd started. I finished this project thinking sports informatics remains a hugely inviting area for research with many prospective areas for research across multiple disciplines, including LIS.

Most gratifying for a project that concludes a course of study is that the work drew upon things I had learnt in all of my previous modules to varying extents:

- from information management and policy (IMP) there was ubiquitous, cloud computing and continuous data collection with issues around information governance this raises;
- from LIS foundation there was a continued interest in the nature of documents both historically and in the future in digital, data-rich, transmedia and participatory information environments;
- from digital information technology and architectures (DITA) was the awareness of how social media provides new research opportunities and digital ethnographies, the need to think critically about data assemblages from our sensing devices and also the need to think about access to research and the preservation of my own research;
- from information domains came by interest in domain analysis and my curiosity about the lack of interest in sport as an information domain;
- from information resources and organisation (IRO) came an interest in terminology and classification and a reflection on how this was lacking in sport information;
- from information retrieval I had the opportunity to think about how athletes might search for information, the systems and strategies they might use and how they might evaluate the information sources they found;
- from data visualization I learnt more about the art and science of using data to find deeper insight in the world around us and had the opportunity to investigate examples that brought data analytics to sport;
- finally, I tried to remember what I learnt about good research practice from research evaluation and communication skills (RECS) and apply it in my work on this project when reading the literature and designing and writing up my own research. Research is difficult though and it is definitely easier to critique than it is to create!

On Research and Running

This research was inspired by noting how different my partner and I approached our running training. My partner has a training plan provided by a coach, can't leave the house for a workout without being fastened into an array of sensors and spends much time pouring over data and chatting with a dispersed network of fellow cyclists and

triathletes about it. I just like to run and I pace myself by feel though I do discreetly collect my data and file it away. The contrast in our personal information practices provided me with a starting point for combing my research with my hobby.

Much like a good trail run this has covered familiar ground whilst also exploring the new. Along the way many tantalising pathways have revealed themselves some of which have been followed, others that must be left for another day. I have been training for a trail half marathon alongside my writing and these have proved to be complementary challenges. Running has afforded time and activity away from my desk and an opportunity to mull over the reading and themes in my mind whilst I enacted the very things I was writing about. It also provided an empirical way to try out new ways of documenting my own activity, interacting with other athletes and reflect on my personal information practice. Now that this work has been completed I just have to run that half marathon.

I'm still more of a free runner than a big runner and write about technology innovation in sport with more enthusiasm than I adopt it: I refuse to wear a watch when running; my training plan is on paper and tracked using highlighter pens; I run outside whatever the weather; I record my runs using a phone app and sync my training data to online platforms but forget to look at it; I get bored of logging my activity religiously and don't tidy up my metadata; as an experiment I wore a Fitbit for about four weeks before it annoyed me; I only sporadically log my nutrition and I don't fully understand my stats. I have, however, started writing a diary entry about my runs in the Day One journaling application, following #ukrunchat and running with a heart rate monitor though I don't check the data until I finish. I'm still somewhere closer to a minimalist than a cyborg but I'm slightly better at thinking about what those terms mean for sport.

Finally, I've come to realise that research and running are my choice of serious leisure. They provide me with fulfilment and social worlds and both are exhilarating even as the many individual mental and physical efforts that go into them are exhausting.

Appendix 2: Barefoot Running Literature Search and Analysis

These tables show the full results of literature searches in Web of Science and ProQuest (all sources and limited to scholarly journals only) for search queries on barefoot running, running shoes, running biomechanics and running form. Each table lists the total number of records found for that search query for each publication year and the percentage of the total records retrieved for that query. The tables are captioned with the database and search query used to conduct the search.

Table A2. 1: Web of Science ("Barefoot Running" or "Minimalist Running")

Publication Years	records	% of 117
2015	12	10.26
2014	25	21.37
2013	19	16.24
2012	20	17.09
2011	13	11.11
2010	5	4.27
2009	4	3.42
2008	4	3.42
2005	3	2.56
2003	2	1.71

Table A2. 2: Web of Science ("Running Shoes")

Publication Years	records	% of 280
2015	22	7.86
2014	42	15.00
2013	23	8.21
2012	18	6.43
2011	15	5.36
2010	26	9.29
2009	14	5.00
2008	11	3.93
2007	7	2.50
2006	7	2.50

Table A2. 3: Web of Science (Running AND Biomechanics)

Publication Years	records	% of 1201
2015	68	5.66
2014	139	11.57
2013	112	9.33
2012	105	8.74
2011	83	6.91
2010	94	7.83
2009	67	5.58

Publication Years	records	% of 1201
2008	75	6.25
2007	70	5.83
2006	55	4.58

Table A2. 4: Web of Science ("Running Form")

Publication Years	records	% of 14
2015	0	0
2014	2	14.29
2013	2	14.29
2012	3	21.43
2011		
2010	0	0.00
2009	0	0.00
2008	0	0.00
2007	0	0.00
2006	0	0.00

Table A2. 5: ProQuest ("Barefoot Running" or "Minimalist Running")

Publication Years	records	% of 624
2015	40	6.41
2014	76	12.18
2013	91	14.58
2012	94	15.06
2011	112	17.95
2010	71	11.38
2009	34	5.45
2008	18	2.88
2005	21	3.37
2003	4	0.64

Table A2. 6: ProQuest ("Running Shoes")

Publication Years	records	% of 17,041
2015	742	4.35
2014	1224	7.18
2013	1240	7.28
2012	1070	6.28
2011	1130	6.63
2010	951	5.58
2009	920	5.40
2008	1024	6.01
2007	995	5.84
2006	804	4.72

Table A2. 7: ProQuest (Running AND Biomechanics)

Publication Years	records	% of 15380
2015	486	3.16
2014	1131	7.35
2013	1163	7.56
2012	1165	7.57
2011	1085	7.05
2010	980	6.37
2009	872	5.67
2008	850	5.53
2007	805	5.23
2006	795	5.17

Table A2. 8: ProQuest ("Running Form")

Publication Years	records	% of 787
2015	55	6.99
2014	81	10.29
2013	76	9.66
2012	59	7.50
2011	65	8.26
2010	61	7.75
2009	38	4.83
2008	34	4.32
2007	46	5.84
2006	22	2.80

Table A2. 9: ProQuest Journals ("Barefoot Running" or "Minimalist Running")

Publication Years	records	% of 36
2015	8	25.81
2014	2	6.45
2013	14	45.16
2012	1	3.23
2011	2	6.45
2010	4	12.90
2009	1	3.23
2008	1	3.23
2005	2	6.45
2003	0	0.00

Table A2. 10: ProQuest Journals ("Running Shoes")

Publication Years	records	% of 492
2015	30	6.10
2014	33	6.71
2013	53	10.77
2012	25	5.08
2011	34	6.91
2010	30	6.10
2009	13	2.64
2008	23	4.67
2007	9	1.83
2006	18	3.66

Table A2. 11: ProQuest Journals (Running AND Biomechanics)

Publication Years	records	% of 1589
2015	152	9.57
2014	204	12.84
2013	263	16.55
2012	188	11.83
2011	113	7.11
2010	117	7.36
2009	95	5.98
2008	62	3.90
2007	47	2.96
2006	56	3.52

Table A2. 12: ProQuest Journals ("Running Form")

Publication Years	records	% of 31
2015	5	16.13
2014	2	6.45
2013	5	16.13
2012	3	9.68
2011	0	0.00
2010	4	12.90
2009	1	3.23
2008	0	0.00
2007	0	0.00
2006	1	3.23

Figure A2. 1: Barefoot and minimalist running query results 2008-2014 (Databases: Web of Science and ProQuest All Sources)

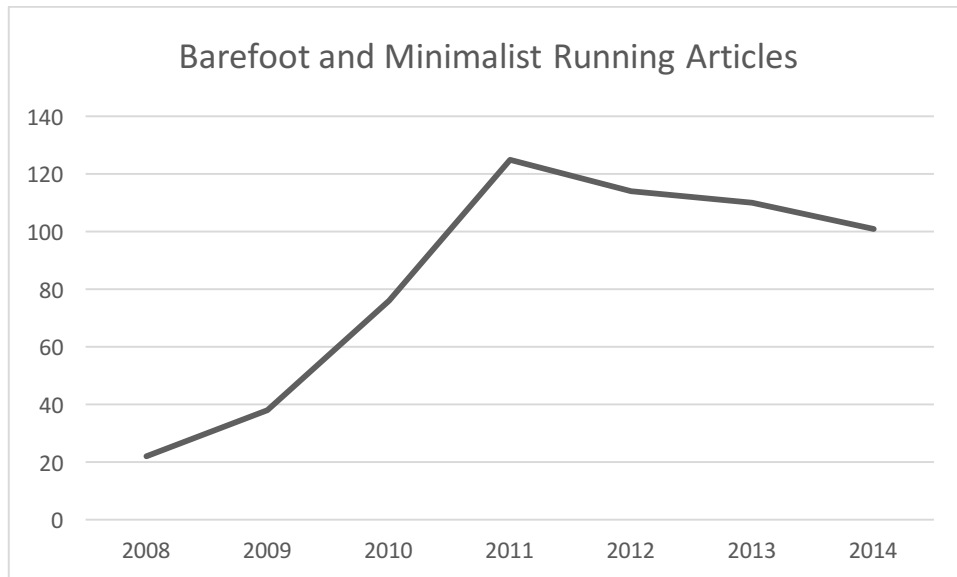


Figure A2. 2: Biomechanics query results 2008-2014 (Databases: Web of Science and ProQuest All Sources)

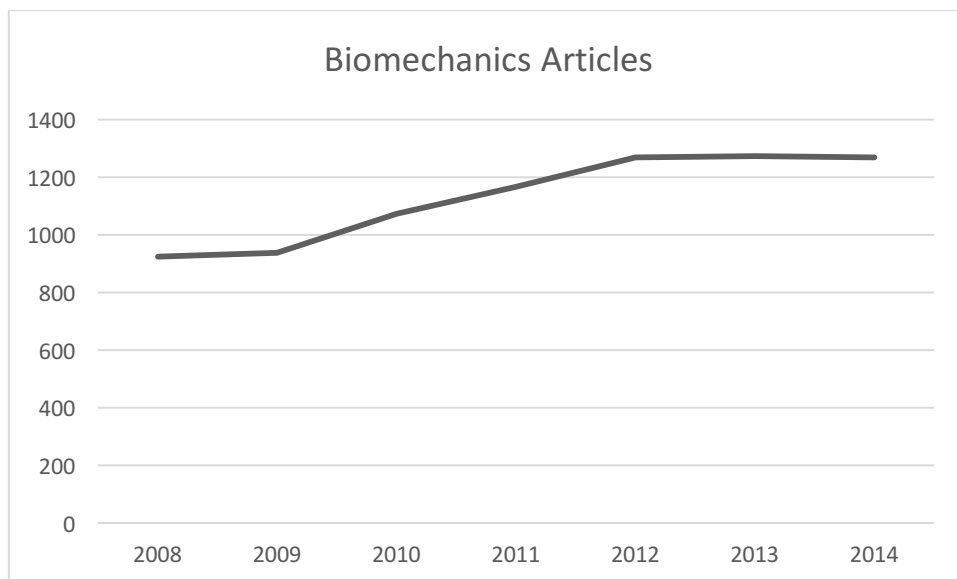


Figure A2. 3: Running form query results 2008-2014 (Databases: Web of Science and ProQuest All Sources)

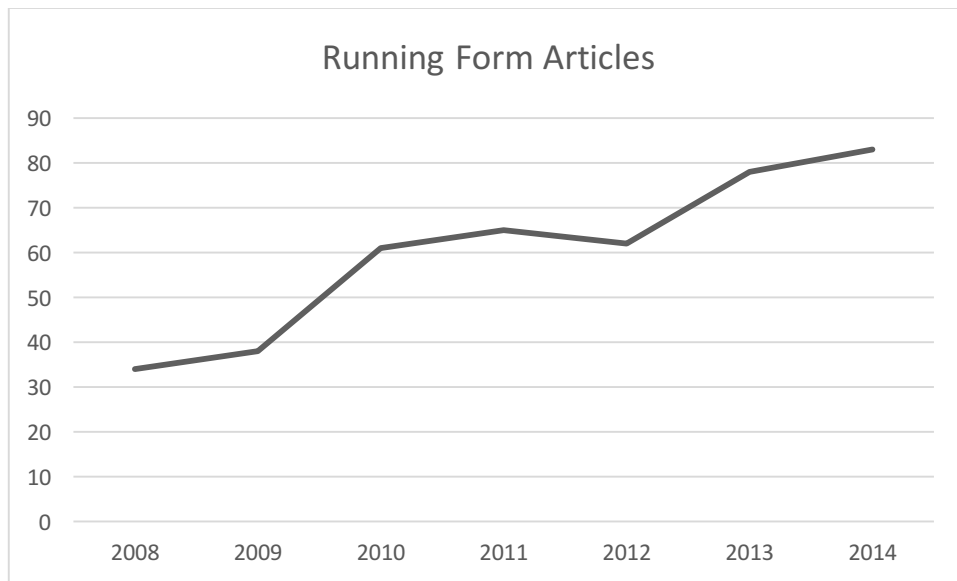
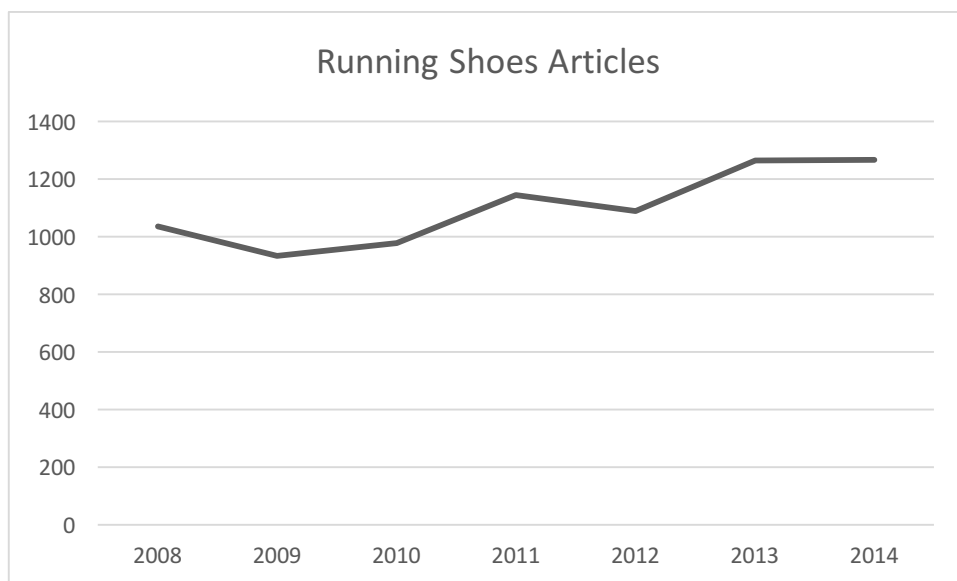


Figure A2. 4: Running shoe query results 2008-2014 (Databases: Web of Science and ProQuest All Sources)



Appendix 3: Athlete Survey Questions

The full athlete questionnaire is provided in accompanying file [A3_SurveyQuestions.pdf](#)

Appendix 4: Athlete Survey Results

Summary results from the athlete survey are provided in the accompanying files [A4_SurveyResults.pdf](#)

Appendix 5: INM363 LIS Dissertation Project Proposal

Working Title

Inform to Perform: exploring how amateur athletes use information to support sporting goals.

Introduction

Despite popular participation in sport, as athletes or fans, and the diverse and growing volume of sporting information generated there is little evidence that library and information science (LIS) has given sport much consideration as an information domain. This study conducts some exploratory research in this area.

Adopting a socio-cognitive perspective on athlete information seeking and use, the study uses the information communication chain to unify information behaviour and domain analysis conceptual models in an empirical user study of serious leisure activity. This pathfinder study aims to survey amateur runners, cyclists and triathletes to collect evidence on the type of information resources used by amateur athletes to support their sporting goals.

The study will help understand information needs within this domain and demonstrate the applicability of some core LIS conceptual models by applying them within a new context. It will add to the existing information behaviour evidence base and could prompt further comparative studies. The research could also identify information science paradigms that could contribute to the interdisciplinary study of sport informatics, currently seen as a collaboration between computer and sport science. Beyond academia, the results may also be of interest to library and information centre professionals or those involved in the governance and practice of athletic training who provide services to meet the information needs of athletes.

Aims and Objectives

This research is situated with the broad aim of understanding sport as an information domain, a relatively unexamined domain in LIS. This is a small exploratory study to start understanding the nature of information resources and information behaviour within this domain.

Within this overall theme, the purpose of this particular study is to examine the information behaviour of a particular type of athlete and to understand the nature of the information resources they use. The motivating research question is: **how do committed amateur athletes use information to help them achieve sporting goals?**

This raises numerous supplementary research questions such as:

- what information resources do athletes use, what information areas do they cover and who provides them?
- how does the information communication chain apply to athletes?
- how does information use change at different points in the development, training and exercise cycle?
- what is the role of the training diary in supporting athletic achievement and progression?
- why do athletes seek information? Are motivations primarily task-related, educational, social or motivational?
- what does the library and information science perspective contribute to understanding sport information and analytics?
- how well do libraries and information centres support athlete information needs?
- how satisfied are these athletes with the information they access?
- how has/is digital technology changing athlete information resources and behaviour?
- how does information behaviour of athletes compare to other serious leisure pursuits or performance domains?

It is clear that even this narrow focus on a particular aspect of the sporting information domain prompts many questions: the objective of this study is to make progress towards addressing some of these. It is not anticipated that such a small study will be able to completely answer all of them but it is hoped that it will make a contribution to mapping this terrain and the initial findings will prompt ideas for more detailed research.

Three key objectives are:

1. to document the changing nature of information resources used by amateur athletes.
2. obtain some evidence on how these resources are used by these athletes.
3. test the hypothesis that virtual communities and online data sharing platforms are becoming increasingly important information interaction spaces for these

athletes.

Scope and Definition

Sport is a broad and diverse domain, so this study concentrates on committed amateur athletes in selected sports to narrow the target population and resources to a scope feasible for a project of this size.

The sports included in the study will be running, cycling and triathlon.

Athletes means those actively participating in regular training and competitive activities in the selected sports.

Committed amateur means that the athletes should be training and competing at a higher level than entry-level of casual participants but aren't elite amateurs or professionals as these groups often have highly developed support and coaching frameworks to guide their development. The athletes are essentially self-supported and motivated in pursuing a training or competitive goal. These sporting goals will act as critical incidents in this study for considering the use of information resources. This conforms to the serious leisure perspective definition of **amateur** (Stebbins, R. A. and Hartel, J., Basic Concepts, n.d.a) that distinguishes these participants from *professionals* (elite) and *hobbyists* (casual).

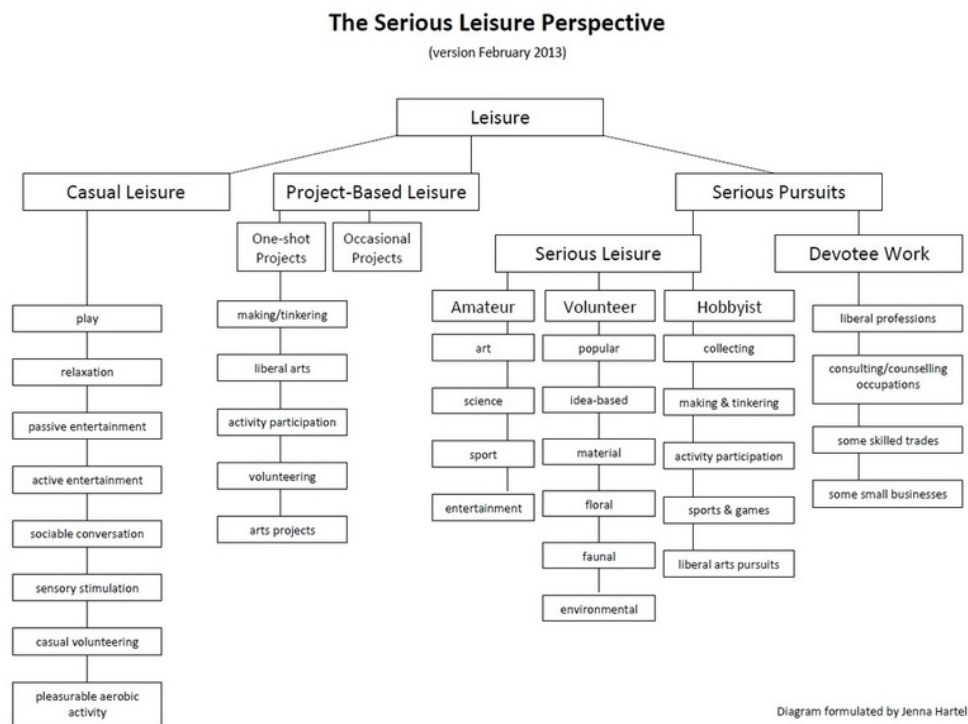


Figure 1: The SLP diagram shows the position of the target population (Leisure: Serious Leisure: Amateur: Sport) (Stebbins and Hartel n.d.b).

Another way to classify these athletes is as F3 or T1 on the Australian Institute for Sport Athlete Development Pathway classification framework FTEM (Foundations, Talent, Elite, Mastery), a holistic model that is not chronologically prescriptive and recognises sport-specific commitment not just talent identification (Gulbin et. al., 2013).

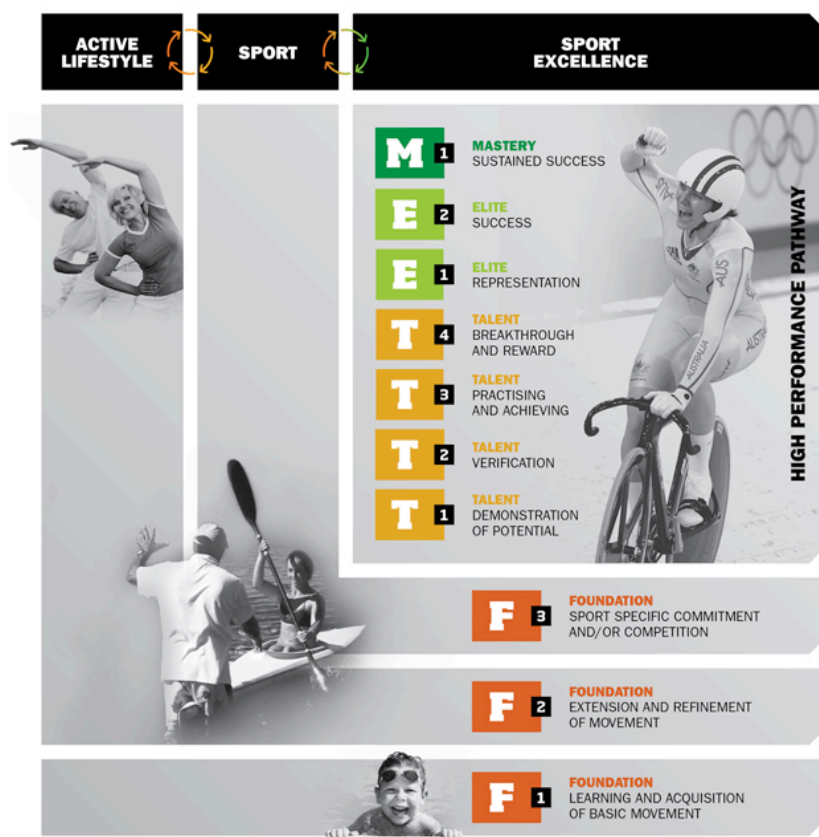


Figure 2: The FTEM Framework (Gulbin et.al., 2013)

These classifications are imprecisely defined and to a large extent subjective. Ascertaining whether athletes fit the target profile will require either self-identification by the participant or classification by the researcher based on evidence of the athlete's activity level. For the purposes of this study precise classification isn't important; the key thing is the athletes are clearly somewhere between a lobbyist and a professional.

In summary, the study will focus on information resources used by amateur runners, cyclists and triathletes who self-identify, or whose activity level indicates, they are mid-level athletes who ideally have a training or race goal in mind.

Research Context

This study researches a relatively unexamined area of information behaviour in library and information science (LIS), drawing on related studies and supported by relevant theory.

Sport and exercise is a significant leisure activity. In the UK, Sport England's Active People Survey (APS8) suggests 15.6 million adults, about 35% of the population, play sport at least once per week (Sport England, 2014b). Around 17% participate in sport at least three times per week. There are around 2 million regular runners, swimmers and cyclists (Sport England, 2014c). In the US, the 2015 Physical Activity Council report, indicates 209 million Americans participate in physical activities with 61% of Americans participate in fitness sports and 35% in individual sport. Despite this, a preliminary search uncovered little literature at the intersection of library and information science (LIS) and sport as a recreational activity.

In general, Allen (2005) provides a guide to reference and information sources and collection selection advice for the domain (2004). Delwiche and Hall (2007) analysed athletic training literature with a more academic library focus. In a 2013 paper Crook discusses the relationship between sport and LIS, finding that whilst sport entertainment is well represented in public libraries, resources on fitness and exercise are less well provided for. He also notes the growing volume of sport-related information that requires management and the types of services information professionals could provide to support this. In a novel example, Waelchli describes how the information tasks associated with Fantasy Sports can be used to teach information literacy (2008). Whilst these suggest a number of possibilities for LIS engagement with sport information, preliminary searching suggests this body of sport information and research data is under-represented in LIS.

Sport as an Information Domain

One method for researching sporting information from a LIS perspective is domain analysis. This theory introduced by Hjørland and Albrechtsen (1995) argues for information as a social collectivist, rather than individual cognitive science. In this case it provides a theory for considering whether sport, or sports and associated communities, can be considered information domains. Hjørland (2002) provides an architecture for analysing domains via eleven approaches, some of which underpin this research. As Hartel (2003) puts it, this research will proceed in "general domain analytic spirit" in order to explore the information features of sporting participation.

Information Behaviour and Practice

Information behaviour is a broad area of study within library and information science with a rich conceptual and empirical research base on the interactions between infor-

mation and humans. There are many general conceptual models of information behaviour (Wilson 1981; Wilson and Walsh, 1996; Niedzwiedzka, 2003; Ingwersen and Järvelin, 2005; Choo, 2006; Godbold, 2006), with more specific models on information seeking and retrieval (Ellis, 1989; Ellis, Cox and Hall, 1993; Leckie et.al., 1996; Johnson, 1997; Johnson et.al., 2001; Kuhlthau, 2003; 2005; Foster, 2004) and everyday life information seeking (ELIS) (Savolainen, 1995; 2005). Robson and Robinson (2013) provide a useful summary of key models and compare LIS models with those in communication theory.

As in many cases, information behaviour in athletes is not limited to information seeking and this study is as interested in the processing and use of information as information seeking. Regular athletic tasks can prompt information needs relating to physical activity. Information use could include training planning and practice to prepare for activity, feedback mechanisms they use in exercise, and how they record their training activity in training diaries and logs post-exercise to use these in analytical and reflective practices to inform future physical activity.

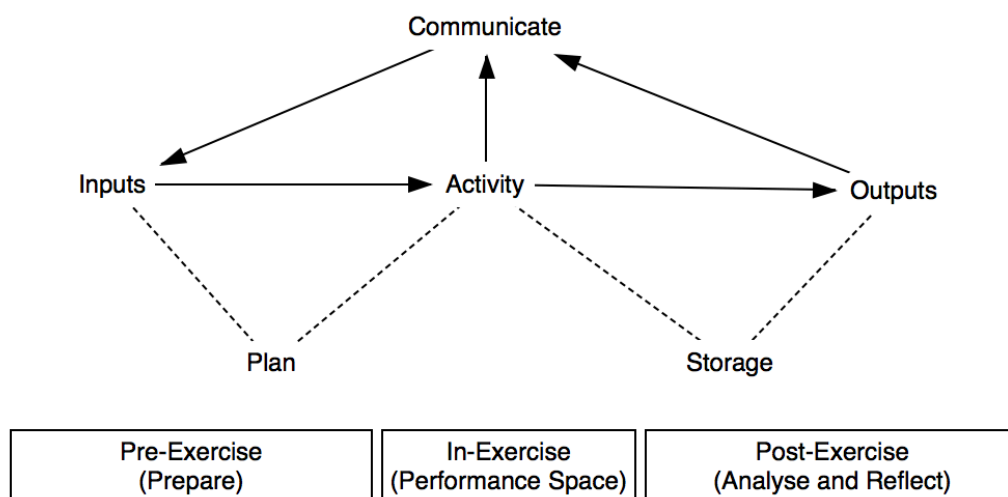


Figure 3: Diagram on the phases of athlete information behaviour during training routines.

The habitual nature of athletic training when pursuing a specific goal may inform the debate on umbrella terminology between information behaviour, taking place within a specific content but predominantly individual, and information practice, which is more socially situated (Savolainen, 2007; Wilson and Savolainen, 2009). Athletes in these sports perform individually but within social networks of clubs and training groups and the broader discourse of their sport.

Information use within the performance space presents a possible new frontier in information behaviour given recent developments in near-time video analysis and biometric telemetry mediated by tracking devices.

Information behaviour and practice may also change across different phases of the cycle from off-peak work to training periodisation, encountering plateaus, injuries of preparing for competition may act as 'critical incidents' that prompt different information interactions.

Information Communication Chain Model

The overall approach fits with the conception of information science as the application of the information chain within domain analysis (Robinson, 2009). This study will examine the athlete information communication chain informed by four of the eleven approaches enumerated by Hjørland(2002):

- (4) empirical user studies (primary)
- (7) studies of documents and "genres" (secondary)
- (10) studies of structures and organisations in the communication of information (secondary)
- (11) studies in cognition, computing and artificial intelligence (secondary)

For this exploratory study all components of the information chain are of interest, the primary domain approach is an empirical user study, scale is constrained to the amateur athlete group and media is agnostic: the study is interested in understanding how diverse athlete information media is.

Empirical User Studies

Only one empirical study of athlete information behaviour has been located so far. Vazquez Moctezuma and Calva Gonzalez (2013) studied the information of amateur boxer in Mexico. They noted the lack of information behaviour studies about athletes in LIS and that where information needs were studied in sports science they often focused only on partial information needs in relation to the science discussed. Information needs identified were both complex and situational and included: nutrition, technique, injuries, equipment, doping, regulations and competition logistics. The study indicated a range of information resource types consulted with the main information source being their coaches and libraries used infrequently.

However, there are many more empirical studies on information behaviour in other domains, including recreational activities, that provide an evidence base of on information seeking and use when engaged in serious pursuits. Work place and everyday life information behaviour studies include artists (Cobbledick, 1996; Hemming, 2008; 2009; Mason, 2009; Mason and Robinson, 2011), commuters (Lopatovska et.al., 2011), creative professionals (Olsson, 2013), economists and business analysts (Thivart, 2005) and vets (Wales, 2000).

Serious Leisure

Serious leisure is a perspective from leisure studies closely associated with Stebbins (1982; 1997; 2006; 2007; Elkington and Stebbins, 2014). Stebbins identifies serious leisure as having six qualities: perseverance, career paths, effort that requires knowledge, training or skill, durable benefits, a unique ethos, and participants identify strongly with the activity (1982). Participation in sport, particularly those that involve competitive or organised events, fulfil many of these qualities. Stebbins and Hartel have collaborated to discuss and bridge the gap between LIS and leisure studies and who each can enhance the other discipline (Stebbins, 2009; 2012; Hartel, 2003).

Serious leisure has elicited several information behaviour studies in LIS. These include: wilderness recreation (Ernest et. al., 2005), travel and tourism (Chang, 2009), photography (Cox et. al., 2008), food (Hartel, 2010; Cox and Blake, 2011), genealogy (Yakel, 2004; Fulton, 2009; Darby and Clough, 2013), crafts (Prigoda and McKenzie, 2007; Gainor, 2008), collectors (Lee and Trace, 2009; Margree et. al. 2014) and museum visitors (Skov, 2013).

Quantified Athletes: Sport Science and Sport Information and Analytics

Meanwhile, there is evidence of a growing interest in sport informatics and analytics (SIA) with an emerging literature, a regular conference on computer science in sport (IACSS)¹ an online course (MOOC) on sport information and analytics from the University of Canberra (Lyons, 2015) and technology companies predicting sporting revolution (IBM, 2014). He et.al. (2013) provide a case study on how the data from fitness tracking applications, published via Twitter, can be used to analyse runner performance and behaviour.

SIA is seen as an interdisciplinary subject combining sport science and information science. Link and Lames (2015) define sport informatics as:

Sport informatics is a set of multi- and interdisciplinary research programmes which contain parts of sport science and computer science. The subject area is the application of tools, methods and paradigms from computer science on questions of sport science as well as the integration of sport scientific knowledge in computer science.

This research will hopefully explore the possibility of tools, methods and paradigms from information science also contributing to sport informatics.

Context Summary

In summary, this study builds upon theory and empirical studies within library and information science, primarily domain analysis framework, information behaviour

¹ The 10th International Symposium on Computer Science in Sport (ISCSS 2015) will be held at Loughborough University in September 2015 <http://gradients.lboro.ac.uk/iacss2015/>

models, particularly those of Wilson, and the information communication chain model. This recognises individual information behaviour, but also the wider context of discourses and communities of practice that individuals act within. It also draws upon the epistemology of information and documentation. Further context is provided by Stebbins' work on serious leisure and the growing interest in sport informatics and analytics (SIA) within computer/sport science.

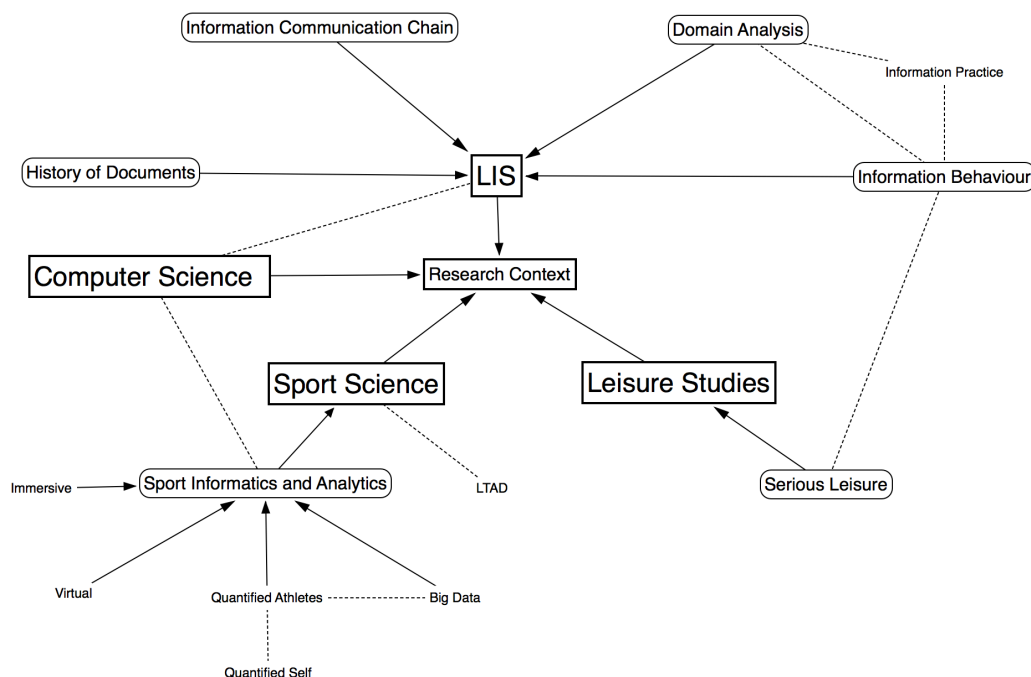


Figure 4: An overview of the research influences that contribute to the research context for this study.

Expected Benefits/Future Work

This study will point the LIS evidence base towards the sporting information domain. It will help understand information needs within this domain and demonstrate the applicability of some core LIS conceptual models by applying them within a new context. As a study more interested in breadth than depth, this exploration may highlight specific areas for more detailed research within the domain using different combinations of component, approach and context (Robinson, 2009). With so little specific literature on sport participants in information science this kind of pathfinding study is a necessary starting point.

The focus on amateur athletes will contribute an exploratory evidence dataset on the information resource use by this cohort. This may be of use to libraries and information providers in considering the services and resources to meet the needs of this group and how well these needs are currently satisfied.

It would be interesting to consider how the information behaviour of amateur athletes differs from that of hobbyists or elite athletes. This work could contribute to future

comparative studies examining these differences and how well each group is catered for. It also provides a comparative basis for studies of information behaviour in other sports or parts of the sporting information domain.

In addition to taking the LIS academic evidence base into a novel domain the study may be of interest to practitioners working in library and information centres as it will provide evidence of information needs that may encourage library professionals to consider in their service provision.

This study is library and information science focused but may contribute to other disciplines such as leisure studies and sport science or those involved in the governance and practice of athletic training. Gulbin et. al. (2013) note that the FTEM framework allows strategic, educational and intergovernmental solutions tailored to each FTEM level. The LIS perspective could add information needs and behaviour to this model ensuring sport governing bodies consider information literacy alongside physical literacy as part of long-term athlete development pathways (LTAD).

Methodology

The study will use a combination of surveying and desk research to investigate the research questions. The primary purpose is to uncover what information resources amateur athletes use, how they use them and why they use them.

Survey

The main research method will be to ask athletes about their information use using an online questionnaire. The purpose of the questionnaire is exploratory and will elicit both quantitative and qualitative data.

The sample for the questionnaire will be non-probabilistic and will use convenience sampling to collect data from a self-selecting group. The questionnaire will be seeded using local clubs and clubs of friends. It will also be disseminated through the web and social media channels.

The data will therefore be subject to volunteer bias and of limited use in making generalisations about the amateur athlete population. It is further constrained by the online delivery mechanism that will restrict participants to those with access to the internet; this may result in a 'techno-centric bias' that selects athletes with a greater interest in internet based information and contemporary innovations such as fitness tracking technology.

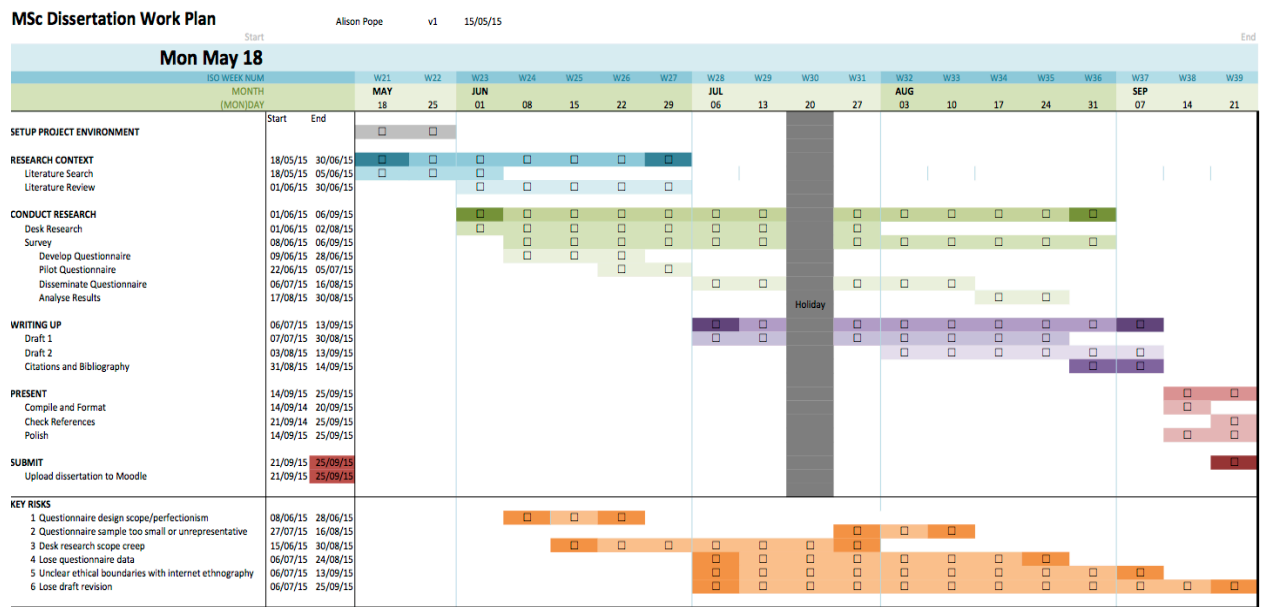
Desk Research

The main survey tool will be supported by elements of desk research. This will include a literature review but also an evaluation and discussion of information resource types identified via desk research and survey responses. Of particular interest are newer

types of documentary forms, such as data rich fitness tracking applications and platforms such as Strava², Nike+³ and RunKeeper⁴ or immersive virtual coaching tools such as miCoach⁵ or The Sufferfest⁶, and their interaction with more established forms.

Work Plan

The work plan contains three main phases: research context, conducting the research and writing up. Supporting tasks include setting up the right project environment and the final presentation of research outputs. The critical path is designing and piloting the survey questionnaire to allow sufficient time for dissemination and responses. Key risks have been identified so that mitigation strategies can be prepared.



Resources

A suitable tool will be required to deliver the online questionnaire. If the university has a preferred tool for conducting online surveys this will be used. If not a research tool will be selected that provides appropriate functionality, data security and terms of use.

² <https://www.strava.com>

³ <https://secure-nikeplus.nike.com/plus/>

⁴ <http://runkeeper.com>

⁵ <http://micoach.adidas.com>

⁶ <http://www.thesufferfest.com>

Ethics

No specific ethical issues are envisaged at this time though the research involves human participants so does have some ethical implications. The project will at all times comply with any relevant legislation, the university's research ethics guidelines and the CILIP code of professional practice.

Survey participants will be provided with information about the project online. The first page of the online questionnaire will be an information sheet and consent form; by proceeding to complete the survey they will be providing informed consent. Each question will have the option to not provide an answer and the researcher contact details will be provided to participants.

Personal data will only be used for stated purposes and stored for the duration of the project. It is not expected that any sensitive or personally identifiable information will be collected via the questionnaire. Individual, anonymised responses may be archived as a data product. Data will only published in aggregate or anonymised form: no individual will be personally identifiable in any research output from this project.

Desk research may involve the study of social media, data sharing or fitness tracking platforms. The ethics of observing online interactions or analysing data in public, or semi-public, domains and using them in research is constantly challenged as technologies and the nature of documents and virtual spaces evolve. The publication of fitness data online pushes ethical and privacy implications further and this is an area worth investigating.

Some guidance on ethical research in this shifting terrain is provided by the Association of Internet Researchers (AoIR) (Ess and AoIR, 2002; Markham and Buchanan, 2012; AoIR,2013) and texts on internet ethnography practice such as those by Hine (2000; 2005; 2015).

To avoid ethical grey areas, any observation of these spaces will only be discussed in very general terms in this research. Should a situation arise where using a specific interaction or data point would substantially contribute the research, this would only be done if it was possibly to contact the participants, explain the research and obtain informed consent. Any concerns will be discussed with my supervisor and/or other experts within the school.

Confidentiality

It is not anticipated any issues of confidentiality will arise during this project.

Appendix 6: Ethics Checklist

A completed ethics checklist is provided in the accompanying file [A6_EthicsChecklist.pdf](#)