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Injury Management: The Development and Implementation of Innovative Software in an Elite Sporting Club

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Abstract

This paper explores the business processes of injury tracking and the adoption of the term "injury management" in the context of elite athletes. It does this through a study of the development and implementation of innovative software which captures and manages critical knowledge concerning injuries and their management in an elite sporting club. Key findings indicate that injury management is a much broader concept than previously considered in the health and medical literature. Understanding the broader context for injury management provides an opportunity to use technology for competitive advantage, thus influencing the way elite sporting clubs and their business processes are perceived.

Keywords: Injury management, Elite sporting club, Knowledge capture, Competitive advantage

Introduction

Tracking injuries sustained by elite athletes has been a key concern over many decades for coaches and trainers as they attempt to understand the impact those injuries have on the athlete's treatment and subsequent performance. Within the past two decades specialist software has existed to track the injury; record the corresponding treatment; and document the athlete's training schedule and rehabilitation, so they may return to competition (Presagia, 2007).

This paper explores the business processes of injury tracking, but goes beyond to describe the term "injury management" in the context of elite athletes. Injury management is a term usually reserved for workers compensation. However, injury management for elite athletes has a broader context than described previously in the medical and health literature. Hence, this paper considers the processes of managing athletes' injuries. It does so in the context of the 'IS for competitive advantage' (strategic information systems) literature, taking into account the strategic goals of the business and the ways the business processes are influenced by innovative software that includes a new human-computer interface.

The paper describes the development and implementation of a speech-enabled human-computer interface which captures knowledge contemporaneously, therefore enabling improved quality and efficiency of data analysis as well as improved management of critical knowledge. The aim of this paper is to describe how the business processes of injury management are influenced in an elite sporting club. Hence, the research question framed to address this aim is: "How does the implementation of speech-enabled software influence the business processes of an elite sporting club?"

To address this question, the paper first covers the background literature concerning IS for competitive advantage, injury management and speech-enabled applications, followed by a description of the software that was developed and implemented. The discussion considers the influences of the software on the business processes of the club, as well as the broader context of injury management for other elite sporting clubs. Some propositions for future research are also provided.

Background
IS for competitive advantage
Since the early 1980s, considerable research attention has focused on the strategic role of information systems and their potential for creating competitive advantage (Ives and Learmonth 1984; McFarlan 1984; Parsons 1983; Piccoli and Ives, 2005; Porter and Millar 1985). It is now widely accepted that information systems can be used to create efficiency improvements, differentiation, and channel domination (Jessup and Valacich, 2006; Sethi and King 1994; Turban, Leidner, McLean and Wetherbe, 2008) thereby enabling a competitive advantage.

Strategic systems are argued to be the tools that raise entry barriers, increase bargaining power with suppliers and customers, offer new products and services, or change the rules of the competition (Bhatt and Grover, 2005). Even though competitors may duplicate a technology innovation, relative advantage can be created and sustained where the technology leverages some other critical resource. However, in his controversial article "IT Doesn't Matter", Carr (2003) argues that IT is ubiquitous, increasingly inexpensive, and accessible to all organisations. As such, Carr (2003) asserts that IT cannot provide differential (competitive) advantage, because it is scarcity (not ubiquity) that creates the ability to generate supernormal rents. The danger with this perspective is that senior managers would therefore assume a defensive and utilitarian posture with respect to IT (Bhatt and Grover, 2005).

In response to Carr's (2003) assertions, some researchers have framed the discussion in terms of IT capabilities, and argue that managing IT is a capability that can create uniqueness and provide organisations a competitive advantage (Bhatt and Grover, 2005). Kettinger, Grover, Guha and Segars (1994) describe a number of complementary resources, such as size, structure, and culture that could make it difficult for competitors to copy the total effect of the technology. Further, changes to the business processes or business activities may provide an advantage that is not easily replicated.

However, according to Jessup and Valacich (2006), using information systems to automate or improve processes has advantages, but using information systems to support the organisation's strategy enables the organisation to gain or sustain a competitive advantage. Hence, to be successful, the organisation must identify through strategic planning the investment in resources, such as information systems and technologies to help achieve competitive advantage (Jessup and Valacich, 2006; Turban et al., 2008).

For this research, evidence suggests that the information pertaining to injuries and the management of injuries is strategic to the elite sporting club. The organisation considers that improvements in data capture and knowledge management of injuries are likely to create a competitive advantage. This would occur in two ways fulfilling both short and long-term strategic goals of the organisation, including 1) the ability to capture data efficiently and

effectively so that decisions may be made in a timelier manner; and 2) the ability to develop a knowledge management system for data mining and analytics over many years. However, in order to develop a longer term strategy, firstly the data needs to be captured by the information system. Then subsequent analytics and knowledge management would be possible.

The focus of this paper is the development and implementation of innovative software with a new human-computer interface to capture the critical injury management data. This addresses the above short-term business driver. This research describes the strategic use of technology at the cutting edge (Jessup and Valacich, 2006) which results in influencing some business processes. Of necessity therefore, this research describes the software and the innovative human-computer interface. However, the interest lay not merely in describing the technology, but the influences on the business processes resulting from the new human-computer interface and the strategic use of the technology for competitive advantage

Injury management and speech-enabled applications

The concept of tracking an athlete's injuries has a history stretching back to the 1950s with coaches and trainers recording the type of injury and any impact on their training schedule. Injury tracking software is available and this has automated the processes of recording injuries, including their severity, where/when they occur, the treatment recommended by medical practitioners, and the necessary rehabilitation (Presagia, 2007). Injury tracking is therefore not a new concept. However, at the association or code level of elite sports, there has been a distinct trend towards ensuring that trainers and coaches consistently collect and control knowledge of injuries, comply with risk management policies, provide identified level of injury knowledge across clubs, and maintain current insurance costs. This has resulted from increasing litigation from players (Australian Football League [AFL], 2005), and the subsequent need to provide evidence that players have been correctly diagnosed, treated and rehabilitated before returning to competition (Kessler, Summerton and Graham, 2006). Hence, due to the increasing volume and type of information needed, the emphasis has now moved from tracking of injuries to managing the injury, as well as managing the long-term health and well being of the athlete.

Injury management is a commonly used term in workers compensation, denoting the management of an injured worker and their timely, safe and durable return to work following an injury (Workers Rehabilitation and Compensation Act 1988, cited in WorkCover, 2004). Injury management in this context is a concept recognising that employers and injured workers are the primary stakeholders in the workers compensation system, with the injury management process being transparent, cost-efficient and effective (WorkCover, 2004). Key principles of injury management include early intervention, proactive management and rehabilitation policies to achieve "return-to-work" goals (WorkCover, 2004).

While injury management for elite sporting clubs also concerns the safe return of athletes to work, how well the injury is managed determines how quickly athletes return to competition. Further, preventing injuries from occurring, assists in limiting the number of missed competitions. Part of an elite sporting club's role today is injury prevention and knowing what are the most common injuries and why they occur. This can assist medical staff to develop strategies to prevent injuries, and this should occur across the entire sporting code (AFL, 2005).

As Marjoribanks (2006) suggests, the organisational dynamics of professional sporting codes or associations require that while the clubs are competitive on the field, there is considerable communication and co-operation required between clubs over shared interests. Injury tracking across the clubs is one such issue that is high profile in the media and among players and their supporters, as injuries cause public concern at all levels of the game (AFL, 2005). Further, it is increasingly important that players moving between clubs have access to prior injury records. Within the past decade, elite sporting clubs have identified the increasing workload and cost associated with tracking and reporting athletes' injuries.

One key concern of elite sporting clubs when gathering and managing knowledge relating to injuries is the volume of data to be captured by a range of medical and operational staff within very tight timeframes. For example, a match may be played interstate on the week-end and the players/officials travel home the next day; yet diagnosis, treatment and the consequences of any injuries must be reported to management and the media, as soon as possible to allow planning for the next match. The business drivers for the software in this research are explained in more detail in Section 4. However, to provide some background literature, it is worth noting that evidence from the elite sporting club in this research suggests that improved human-computer interaction (HCI) is essential to enable the volume of data to be captured in an accurate and timely manner.

This paper views HCI from an information systems perspective, as the software developed and implemented occurred in an organisational setting with definite managerial, business and human factors to be considered. According to Carey, Galletta, Kim, Te'eni, Wildemuth and Zhang (2004), the overarching goal of HCI is to achieve both organisational and individual user effectiveness and efficiency, while ensuring system functionality and usability, effective user interaction support, and enhancing the user experience when interacting with the system. The information systems researcher's perspective affords emphasis to managerial and organisational contexts by focusing on the analysis of tasks and outcomes at a level that is relevant to organisational performance and effectiveness (Zhang, Nah and Benbasat, 2005). With this in mind, the authors have described the HCI and its influences on the business processes or activities with particular interest in the efficiency of speech-enabled data capture.

Zhang, Broun, Mersereau and Clements (2002) suggest there has been a growing interest in introducing speech as a modality into HCI. In the past, research has mainly centred on the improvements to speech recognition accuracy and natural language understanding of complete works (Saygin, Cicekli and Akman, 2000). Complete works include books, manuscripts or other published works (Saygin et al., 2000). It is a challenge for researchers to develop speech recognition accuracy and natural language understanding in the business environment.

Speech-enabled applications are proving to be successful from a business perspective (Washburn, 2002) even though speech recognition accuracy has been problematic (Lewis and Powers, 2002), and this "raises questions about how to make natural-language understanding systems robust to recognition errors" (Moore, 1995, p.1). However, Washburn (2002) considers that speech recognition is likely to be an important component to the future success of business applications, particularly those that require data collection in the field.

While one hundred percent speech recognition accuracy would be ideal, the reality is that the speech recognition accuracy deteriorates significantly in today's operational business environment, which is noisy, contains telephones ringing, has humans using complex language, and relies on the correct positioning of microphones (Lewis and Powers, 2002). However, business continues to seek solutions that are touted to provide a competitive advantage or at least improvements in productivity and business efficiency using speech technology. Currently, speech interfaces to business software applications are gaining momentum in the market place (Washburn, 2002). For example, software development applications range from directory services to ordering a pizza via a speech-enabled interactive interface. The main business driver for these systems is considered to be the reduction of costs associated with customer support centres.

Commonly, speech-enabled applications are very specific and used for automating repetitive transactions which are simple and within a limited industry/application domain. Consumers typically interact with these systems via phone. However, this results in significant challenges around speech recognition accuracy. As there is no ability for a consumer to train the speech engine for their particular voice, the applications are deployed using speaker-independent speech recognition engines. This obviously impacts on the accuracy of the speech recognition requiring tradeoffs in terms of language flexibility versus restrictions in type of language and voice prompts to improve accuracy.

Speech interfaces to improve the HCI with business systems utilised by employees have experienced similar problems concerning poor speech recognition. This has occurred even though employees use personal speaker-dependent speech recognitions. They have found that language (grammar and vocabulary) in the work environment is complex, therefore requiring significant training of the speech recognition engine. Further, even after training, the speech recognition accuracy is still considered inadequate and in some cases unacceptable for general rollout across the business.

With the background concerning IS for competitive advantage, injury tracking, injury management and HCI in mind, this research describes the software that provided an innovative HCI and achieved the business outcomes.

Research Methods

To better understand the processes of injury management and to answer the research question concerning the influences of the speech-enabled HCI on an elite sporting club, an ethnographic approach (Creswell, 1998) was employed. This enabled the researchers, (who were involved in the systems development process), to participate and reflect on the implementation of the software. Further, it enabled the researchers to immerse themselves in the organisational activities and gain a rich understanding of the influences of the speech-enabled HCI.

Data was collected principally by taped in-depth interviews with the software developers, operational experts, club management, and medical staff during numerous meetings between April 2005 and November 2006. The interviews were informal and semi-structured with non-directive, open-ended questioning to encourage interviewees to describe the complexities of their practices, experiences and problems. Interviewees were encouraged to compose stories through which they could reflect on both their processes of reality construction and those of their colleagues. These stories enabled the interviewees to be more conscious of the meanings

which they attributed to the activities of their club, and the practices specific to their industry (Louis and Sutton, 1991). The interviews were transcribed and coded thematically, with descriptions and assertions as detailed in Creswell (1998) and Miles and Huberman (1994). The researchers were closely associated with the software development, and therefore had access to all schema, development documentation, electronic mail and observation notes. This, together with the interview transcripts, provided a rich set of data available for analysis. Through an analysis of the field notes and interviewees' stories and symbols, shared themes emerged which highlighted the ways in which the practices of the users were constructed and shared, and the ways the speech-enabled HCI influenced the business processes of the organisation. The conclusions reported in the following analysis of the data represent the authors' interpretations of the evidence.

Elite Sporting Club (ESC)* Description

ESC is a professional sporting club at the elite level which exists within a league of similar-sized clubs which are highly competitive at the national level in Australia. The clubs are governed by an independent league regulator, to which they are accountable and financially dependent (Majoribanks, 2006). While the league regulator holds considerable power base (Stewart, Nicholson and Dickson, 2005), the clubs have some autonomy to pursue activities that best suit their needs, such as training methods and performance measurements. Many clubs have opted for some form of software application to track athletes' injuries.

Prior to the development of the software in this research, ESC employed a commercially available database application for injury tracking. However, the software became obsolete and the database was no longer supported by the company which created it. That company has developed a new database, with improved web-based HCI; however, due to the significant costs associated with accessing the new database, support and licence fees required for each user, ESC considered moving to the new database to be cost-prohibitive.

While using the injury tracking database application, ESC was also using Dragon Naturally Speaking (DNS) for data entry in the field. ESC identified that they needed to improve data entry rather than acquire a new database. ESC considered that a new database would not provide obvious benefits from a data entry perspective in the field. Hence, a local IT software development company, (which specialises in home automation and speech recognition/natural language understanding), was contracted to improve the HCI and user data entry.

During the first meeting between the IT software company's Managing Director and ESC management, it was clear that ESC's use of speech technology was primitive. That is, the speech recognition product (DNS) was not integrated with the injury tracking user interface and was only used essentially to replace the keyboard for data entry. ESC users highlighted the problem was poor speech recognition accuracy as this was estimated to be only 80-85% accurate. The poor recognition was compounded by a large vocabulary of complex medical terms with equally complex grammar requirements. Often there were considerable differences in accuracy between various staff for both enunciation of words and their context.

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* pseudonym

The perceived problem was that the poor speech recognition accuracy led to significant rework and reduced the data quality. ESC's initial high level user requirement therefore was to improve speech recognition with the ultimate aim that speech recognition would improve data entry productivity. However, further analysis of the problem by the IT software developers indicated that the business outcomes ESC sought would not be achieved by improvements in speech recognition accuracy alone.

Hence, after undertaking detailed business analysis, the IT software developers considered that the initial proposed user requirement was inadequate to provide the desired business outcomes. To obtain substantial outcomes in productivity, the solution required integration with the injury tracking business process. However, integration with the business process was problematic due to the large number and type of users involved, as well as the nature of the operational environment.

The key findings from the detailed business analysis were:
- The operational environment is high pressure;
- There is time dependency on information availability;
- There are numerous and various users (doctors, trainers, physiotherapists, managers);
- There is a variety of computer literacy among different staff;
- There is a large volume of transactions weekly;
- Data must be complete and accurate to be useful;
- The language is complex with various medical and sport-specific terms; and
- There is complex language for the type of information captured (consultations, injury diagnosis, illness diagnosis, prescriptions, inoculations and treatments).

The effective management of athlete injuries is seen as a major contributor to achieving a competitive advantage in ESC. As the Training Services Manager recounts,

> "Being at the top in competition is all about finding that extra 1% in performance. Managing injuries effectively and using this injury information can lead to the desired performance outcomes."

As speech recognition for data input was ESC's preferred HCI, further research was undertaken to model the language (both vocabulary and grammar) used by medical staff for collecting medical information. This was a detailed study which required recording audio scripts of athlete consultations by medical staff, including doctors and physiotherapists.

The Training Services Manager also recounts,

> "We want the medicos to use the injury tracking application. For the medicos to use it they must see value in it. To be of value the information in the system must be relevant, timely and complete".

There was a clear business driver for the software application to be developed and facilitate the effective and efficient collection of key injury information. The detailed research and analysis with the medical staff formed the basis for the design of the speech-enabled software.

Discussion

The speech-enabled application described in this research used DNS speech recognition software to translate medical speech data into text. A critical success factor for the software application was to improve substantially the speech recognition of DNS, which occurred by raising the speech recognition accuracy from 80-85% to 95%. Interestingly, new users accomplished the same level of accuracy even after only the standard five minute DNS enrolment training. This occurred by applying the results of the language modelling exercise to five years of injury tracking input data and loading the resulting vocabulary and grammar into the internal user grammar slot (called "Middle Slot") of DNS.

The speech-to-text output from DNS was then parsed by the software application (SA) to interpret and understand the input injury data, and to correct, if necessary, then translate and upload the data into the backend injury tracking database. This process was automated requiring a user to execute the software program running in the background. However, where the data provided by a user could not be deciphered, and/or the data were ambiguous, the SA prompted the user to verify/correct the problem data. This step was essential to ensure data quality before the data were uploaded to the injury tracking database.

From the description of the ESC and the data analysis of the interview transcripts, two main themes have emerged in this research. These are: 1) the change in business processes from manual to speech-enabled HCI has influenced the way ESC perceives the tracking of athletes' injuries; and 2) this perception has in turn changed the way injury management is perceived in ESC.

Once implemented, the speech-enabled application resulted in significant benefits to the ESC. This was attributed to the integration to the injury tracking business process, and the improved accuracy and efficiency of the HCI. However, the integration required changes to the business process on two levels, namely; the business procedures, and the organisational level. The business procedures were changed to reflect the new way to collect athlete injury data. These changes occurred due to the increased scope of data and the high level of detailed data now collected.

Business procedures

Improvements to data quality were considered a direct result of the actual software. Hence, ESC reported that once the software was implemented, even when data were entered manually, the data entry quality measures (in terms of correctness, completeness, timeliness and conciseness) were increased from 90% to 95%. Figure 1 highlights the data quality.

Organisational

At the organisation level, the person who creates the data (for example, the doctor) is responsible for entering and validating the data. This was a significant shift in responsibility and ownership for reporting the injury. Previously, medical staff would write on paper the outcomes of an athlete's consultation, which would later be interpreted and analysed by an operational staff member, who would enter the data into the injury tracking database.

This change in organisational process has resulted in data quality improvements, especially accuracy, because the medical staff validate their own data. The software requires the collection of data at point of capture; hence the accuracy is improved because the data are complete. It is important to note that this is not onerous as the speech-enabled HCI has improved the usability, and the speech interface is very easy to use. Figure 2 demonstrates the

processes using the manual data entry, prior to the software implementation, followed by the processes now that the process is automated.

One of the major benefits of the software application and HCI is the improved timeliness of information for decision making due to the decreased timeframe between consultation and data entry to the database. For ESC, the dramatic reduction in manual work from three days full-time data entry to less than a few hours has brought significant organisational benefits.
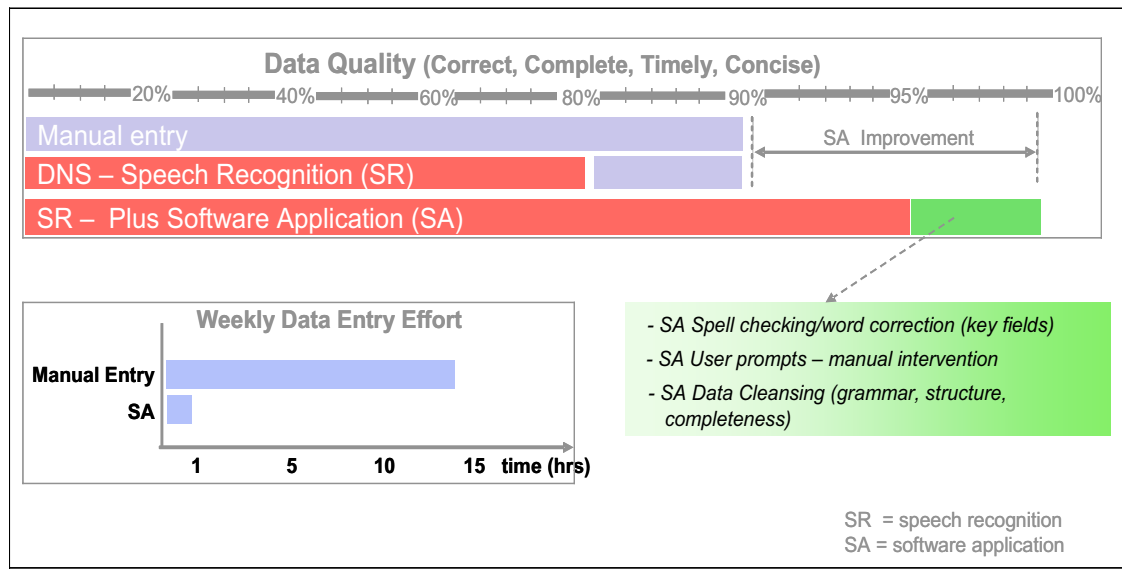
Figure 1: Data quality and performance before and after speech recognition and software application

The high level of automation reflects the strategic use of technology to improve efficiency by introducing the new HCI (Jessup and Valacich, 2006; Sethi and King 1994; Turban et al., 2008). In this case ESC was able to reduce the cost of data capture in order to gain an advantage over competitors, and changes to the business processes or business activities may provide an advantage that is not easily replicated (Kettinger et al., 1994; Bhatt and Grover, 2005; Piccoli and Ives, 2005).

Following the high level of automation and the improved accuracy and timeliness of the information, ESC's management now understand the power of the information, and in the broader context, are seeking new ways to manage and exploit their new-found knowledge. This is a longer-term strategic goal that requires future research.

Injury management: broader context
The second theme that has emerged from this research is the broader context of injury management for elite athletes. Injury management for elite athletes has gone beyond the tracking of injuries and their rehabilitation, to a higher level of knowledge captured at the organisational level. This knowledge is used extensively for planning and executing weekly competitions; as well as long-term recruitment or delisting of athletes. Injury management, hence, includes the end to end management of the athlete's health and well being.

Figure 3 demonstrates the similarities and differences between elite athletes and other injured workers. Clearly, every injured worker (including the elite athlete) needs intervention for

injuries sustained and proactive management with rehabilitation to return safely to the work environment (Roberts-Yates, 2003). However, for elite athletes there is considerable pressure (often from the athlete) to return to competition level.

The difference highlighted here is that returning to most working environments does not require the worker to be 100% fit, while competing at the elite level requires athletes to perform beyond what is "normal" in the working sense. This involves ongoing management of the athlete's condition.
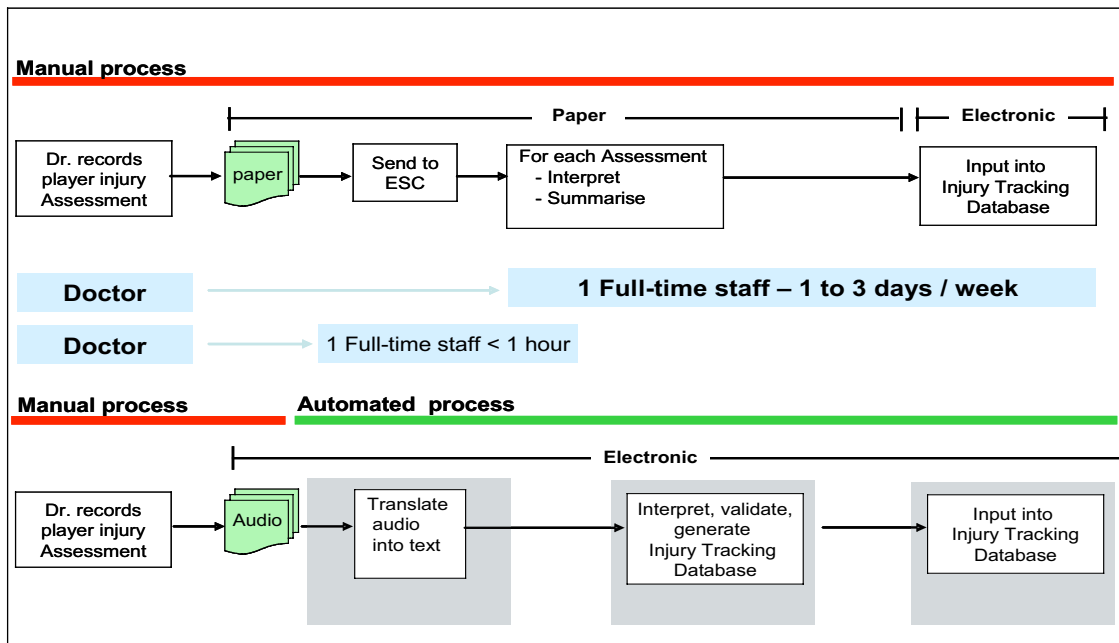

Figure 2: Manual and automated processes at ESC

Figure 3 shows that once injured workers have been rehabilitated and return to work, they exit the injury management system (WorkCover, 2004). However, our findings indicate that the elite athlete is monitored continually, even beyond returning to competition where they are considered 100% fit. Elite athletes are monitored for each and every illness and injury that eventuates, regardless of whether or not these occur at work; as well as their diet, exercise regime and performance measurements. This demonstrates a significant difference between injured workers and elite athletes. For the elite athlete, there is a blurring in the distinction between injury, rehabilitation and competition, because they do not exit the injury management system.
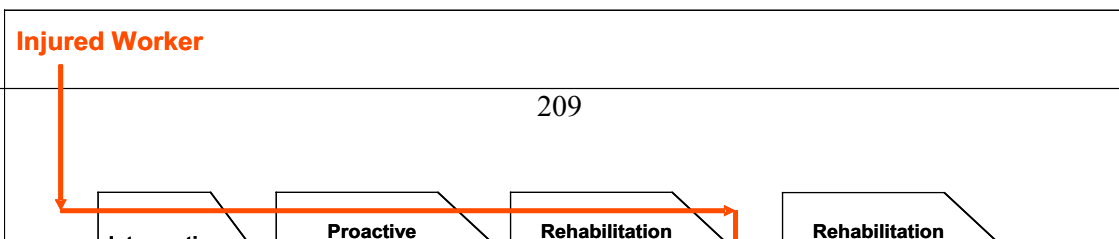
Figure 3: Injury management processes for injured workers and injured athletes

Further, from the club perspective, injury management involves comparisons with other athletes and records retained for many years as players move from club to club. Our research supports Kessler et al., (2006) who suggest that medical liability is an increasing issue, and maintaining medical records is of paramount importance. However, unlike evidence from Roberts-Yates (2003), where injured workers feel ostracised and isolated from colleagues due to injuries, elite sporting clubs understand that injuries are commonplace for elite athletes. The evidence from this research suggests that, while injuries are frustrating for the athlete and the club, there is no stigma associated with becoming injured. Hence, the main focus is early intervention and positive management of the injury (AFL, 2005).

From the trainer and coach perspective, the injury prevents the player/elite athlete from competing. In a club which is a team sport, such as ESC, this influences the way the club performs. So it is not merely a single worker and their journey to return safely to work, but the club's results and financial situation may depend upon the return of elite athletes to competition level. However, trainers and coaches may also be in the precarious position of "being pressured" to allow athletes to compete before they are fully rehabilitated. This pressure may come from the athlete, but also from the media and supporters. This type of pressure is less likely in normal working environments. Hence, recording information and using wisely the knowledge captured is essential in the elite sporting environment.

Propositions for future research
This research is in the embryonic stage and further work is required in the future. Using information systems for injury management to gain a competitive advantage is attracting increasing interest, and there is considerable scope for more research in the area. Hence, we provide some propositions for future research.

The first proposition is based on the evidence that injury tracking is becoming increasingly more important, yet more onerous, (Kessler et al., 2006) and that injury management will be a key concern for elite sporting clubs.

Proposition 1: Injury management will be a key concern for elite sporting clubs across a variety of sports.

The second proposition is based on the evidence that technology can be used to gain competitive advantage (Jessup and Valacich, 2006; Turban et al., 2008). In particular, innovative technology using speech-enabled HCI will influence the business processes that are linked with data capture (Washburn, 2002; Zhang et al., 2002). When changes to business processes (or other complementary resources) as described by Kettinger et al., (1994) occur, there is the opportunity for gaining or sustaining competitive advantage.

Proposition 2: Innovative speech-enabled HCIs will increasingly improve data capture across a range of business activities to provide a competitive advantage.

Elite sporting clubs are beginning to embrace technology for injury tracking (Presagia, 2007). Further, the results from this research indicate that managers of ESC perceive benefits beyond data capture to the development of knowledge management systems. The third proposition is based on this evidence.

Proposition 3: Elite sporting clubs will increasingly use IS for injury management.

Conclusion

This paper has described the successful development and implementation of an innovative software application that uses speech recognition and natural language understanding in an elite sporting club. The application alone is interesting as it demonstrates a new approach to HCI that has not been described previously in the literature.

Notwithstanding the technology, there exist the social and human factors associated with new HCI. The elite sporting club in this research experienced changes to business processes at the procedural as well as organisational levels. Further, there now exists a new context for injury management beyond the concept of workers compensation.

This research is exploratory; hence there is considerable scope for future research. This paper has studied one elite sporting club and there is the need to understand how injuries are managed in other clubs and across other elite sports. Further research is needed to determine the applicability of the software application to other elite sporting clubs. However, this paper demonstrates a growing need for research in sports information systems and the ways innovative speech-enabled HCI influence the business processes of organisations.

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