Sonja Leskinen

m-Equine

IS Support for the Horse Industry

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Abstract

The horse industry is in many ways still operating the same way as it did in the beginning of the 20th century. At the same time the role of the horse has changed dramatically, from a beast of burden to a top athlete, a production animal or a beloved pet. A racehorse or an equestrian sport horse is trained and taken care of like any other athlete, but unlike its human counterpart, it might end up on our plate. According to European and many other countries' laws, a horse is a production animal. The medical data of a horse should be known if it is to be slaughtered, to ensure that the meat is safe for human consumption. Today this vital medical information should be noted in the horse's passport, but this paper-based system is not reliable. If a horse gets sold, depending on the country's laws, the medical records might not be transferred to the new owner, the horse's passport might get lost etc. Thus the system is not fool proof. It is not only the horse owners who have to struggle with paperwork; veterinarians as well as other officials often use much time on redundant paperwork.

The main research question of this thesis is if IS could be used to help the different stakeholders within the horse industry? Veterinarians in particular who travel to stables to treat horses cannot always take with them their computers, since the somewhat unsanitary environment is not suitable for a sensitive technological device. Currently there is no common medical database developed for horses, although such a database with a support system could help with many problems. These include vaccination and disease control, food-safety, as well as export and import problems.

The main stakeholders within the horse industry, including equine veterinarians and horse owners, were studied to find out their daily routines and needs for a possible support system. The research showed that there are different aspects within the horse industry where IS could be used to support the stakeholders daily routines. Thus a support system including web and mobile accessibility for the main stakeholders is under development. Since veterinarians will be the main users of this support system, it is very important to make sure that they find it useful and beneficial in their daily work. To ensure a desired result, the research and development of the system has been done iteratively with the stakeholders following the Action Design Research methodology.

Sammanfattning

Hästindustrin opererar huvudsakligen idag på samma sätt som i början av förra seklet. Samtidigt har hästens roll inom samhället förändrats dramatiskt från att ha varit ett redskap som underlättar fysiskt arbete till att nu vara en idrottsstjärna, ett sällskapsdjur eller helt prosaiskt - livsmedel. En tävlingshäst blir tränad och tas hand om som en idrottsstjärna, men kan till skillnad från sina människliga kolleger en dag bli vår måltid. I Europa, och i flera andra länder är hästen en del av näringskedjan, och blir därför behandlad som föda. Om en häst går till slakt bör hästägaren veta vilken medicinering den har fått under sitt liv, för att vara säker på att köttet inte är farlig som livsmedel. Idag är den informationen lagrad i hästens pass, som är i pappersform och kan gå förlorad (på olika sätt). Om en häst byter ägare under sin livstid, kan det hända att dess medicinska information inte gör det. Även om hästens medicinska information enligt finländsk lag tillhör hästägaren, är det inte så i alla andra europeiska länder. I vissa länder, behöver inte en säljare av en häst ge medicinsk information till köparen. Förutom ägarna, har också veterinärer och olika officiella instanser problem med hästarnas pappersarbete. För mycket tid används för att göra onödigt eller ibland mångfaldig arbete.

I denna avhandling är den centrala frågan om informationssystem kan användas för att hjälpa de olika intressenterna inom hästindustrin? Speciellt veterinärer som reser till stallet för att behandla hästar kan inte alltid ta med sig sina datorer, eftersom miljön – som belastas av fukt, damm och hästarnas avföring – inte är lämplig för känslig teknisk utrustning. För närvarande finns det inte heller någon gemensam medicinsk databas för hästar, även om en sådan databas (med ett effektivt stödsystem) skulle kunna avhjälpa många problem, bl.a. vaccinering och sjukdomsbekämpning, livsmedelssäkerhet, samt data- och informations-problem vid export och import av hästar.

De viktigaste aktörerna inom hästindustrin – veterinärer som är specialiserade på hästar och hästägare – studerades för att få reda på deras dagliga rutiner och behov av ett eventuellt stödsystem för att arbeta med data om hästarna. Mina studier visade att det finns olika funktioner inom hästindustrin där IS kunde användas för att stödja intressenternas dagliga rutiner. Som en följd av resultaten är ett stödsystem under utveckling, som ger intressenterna tillgång till data om hästarna både över nätbaserade och mobilstödda gränssnitt. Eftersom veterinärerna kommer att vara de huvudsakliga användarna av stödsystemet är det viktigt att de uppfattar det som användbar och nyttig i det dagliga arbetet. För att kunna vara säker på att intressenternas behov och åsikter beaktas

tillräckligt väl vid utvecklingen av systemet har utvecklingsprocessen genomforts enligt Action Design Research metodologin.

Acknowledgements

It might seem unusual for people to combine Information systems and horses in a dissertation. But here I will go even further and make a claim that the whole process of being a doctoral student and finally having a printed dissertation in your hand is very much the same as training a young horse into a competition horse.

The most important person(s) in a young horse's life will be the trainer. The trainer has to be encouraging, helpful, knowledgeable, yet also strict and sometimes push the horse's limits, to get the best results. I was very lucky to have the best of trainers, Professor Pirkko Walden, with also some help from Christer Carlsson. Working with Pirkko was always fun and encouraging. Even if things looked a bit gloomy; she always cheered me up. Pirkko and Christer you two I will most from my time at ÅA. I wish all young horses had trainers as skilled as you are!

Now of course the first thing that has to be decided with a young horse is which discipline it will specialize in? The idea for my "discipline" came from my former show-jumping coach, Pekka Larsen on one sunny day at the Finnderby competition in Ypäjä. He couldn't see which rider was entering the arena. This became the seed of the idea of m-equine. Now a young horse, despite the discipline needs also a proper place to train, for that I have to thank, Åbo Akademi University. Any good trainer also knows that occasionally you have to take your horse out of the comfort of its own stable and compete it against other horses, to see if it is up to muster. I would like to therefore thank Turku Centre for Computer Science (TUCS) for providing funding for these competition (conference) trips.

Finally the day comes that the horse is ready for that coveted goal competition; the dissertation. How will it go? It is nerve-racking for all parties involved. The judges can be very unforgiving, but luckily that was not the case for me. I would like to thank both the reviewers Matti Hämäläinen and Matti Rossi, for being "very kind judges".

Like any athlete a horse needs physical therapy and other medical help. For the "upkeep" of my body and soul, I have to give a humble bow to Fraser & Nicholas Bliss and Hanna Stenman. This horse would have been for a long time in stable-rest if it wasn't for the help of these three people.

I would like to thank Ben Sykes, Fred Sundwall and Tom Gordin for their help in different areas during the work of this dissertation. As they all know, good

horses require for their upkeep lots of people, time and funds. I would also like to thank my three Venezuelan friends who did their Masters theses in the m-equine project; Valentina Muñoz, Luis Rubén Rodríguez and Jorge Lucic. Although they were not formerly horse-people, they eagerly jumped into a "horsey" project like young happy spring foals.

Only work and no play is not a good way to train a horse, it is very important that they learn some social skills from other horses in a herd. These herd members become important friends, confidants, playmates, and shoulders to cry on. In my heard the most important members are Auli Laankoski, "Ikki" Honko and Sari Mattsson. I couldn't have done this without you, guys! Usually a herd of horses also has a more mature mare as a leader, who tries to pass on some wisdom to the younger generations. I have been very lucky to have two such mares in my herd, namely "Bebbe" Granberg and Gail Gregory. Believe it or not ladies, some wisdom did stick.

Last but certainly not least we cannot forget the young horse's most important people, the ones who have believed in her throughout it all. These people can be called owners, breeders, or in this case simply *family*. My family is small, widely spread, but that much more important. Katja thank you for always being on my side, and having the patience to listen to me. My amazing father has postponed retirement to take care of the family farm in Kangasala, so that I can get this dissertation done. Thank you, I know I can never repay you that sacrifice but I will try. I love you all.

Sonja Leskinen
Åbo, December 9th 2013

Contents

List of Figures

List of Tables

Appendices

Appendix I:

Survey 1 for riders and horse owners used for Article 1: Equine Vaccination, a paper mess waiting to get solved. Could ICT be the answer?

and

Article 2: Can Information Systems expand the limits of Equine Medication?

Appendix II:

Survey 2 for veterinarians used for a Poster: Veterinarians' attitudes towards digital technology – an empirical study.

Article 3: Veterinarian Work Enhanced by Mobile Technology – An Empirical Study.

And article 4: Enhancing the daily routines of equine veterinarians using mobile technology: the *m-equine* case

Part II –original research publications

1.
Leskinen, S. (2010) Equine Vaccination, a paper mess waiting to get solved. Could ICT be the answer? In *23rd Bled eConference eTrust: Implications for the Individual, Enterprises and Society* (20-23 June 2010) Bled, Slovenia, pp. 127-143.

2.
Leskinen, S. (2011) Can Information Systems expand the limits of Equine Medication? In *The 6th Mediterranean Conference on Information Systems (MCIS2011)* (3-5 September 2011), Cyprus. Paper nr 12.

3.
Leskinen, S. (2012) Veterinarian Work Enhanced by Mobile Technology – An Empirical Study. In *45th Hawaii International Conference on System Science (HICSS)* (January 4-7 2012), Maui, Hawaii, USA. pp. 1403-1412.

4.
Leskinen, S. (2013), Enhancing the daily routines of equine veterinarians using mobile technology: the *m-equine* case. *International Journal of Systems and Service-Oriented Engineering* Vol. 3, No. 4, pp. 1-19.

5.
Leskinen, S. (2011) Veterinarians' attitudes towards digital technology – an empirical study. In *7th International Equitational Science Conference* (26-29.October 2011) Hooge Mierde, the Netherlands. pp. 4.

Part I
Research Summary

Chapter 1

Introduction

Farming has developed from a mostly manual labor industry into a technology-aided business. The ever-growing need for more food for the expanding human population, yet at the same time vicious competitiveness between food producers has formed today's farming. The industry demands larger units with lower costs, so that food can be produced in an acceptable price range. Farmers have technology to support their work in the field all the way to milking their cows, and even warning if a cow is showing symptoms of an illness. The horse industry has not been affected by the use of technology on farms, in many ways horses are still cared for, identified and used for commercial purposes in the same way as over 100 years ago. With the exception of countries with old horse traditions or featuring strong racing cultures, horse units have not notably increased, in the last century. Basic stable work is still done manually, apart from automated water bowls that most of the stables with more than five horses have. Since the horse industry is not dependent for producing larger units for less money, there has not been a direct need to try to lower production costs, i.e. the amount of capital needed to raise and train a horse to a decent riding level. Very few horses actually earn money for their owners. As a rule of thumb horses that can (and often should) earn their own upkeep are riding school horses and racehorses. Often even a successful breeder might not earn back the money they have invested in breeding the horse.

The goal of this dissertation is to find out if and how IS could support the equestrian sport industry, and the stakeholders around it. There are many tasks that cannot be altered in a short period of time, due to old traditions or even just old stable buildings, but just by aiding the support work around horses e.g. paperwork in connection with stable keeping and

management could make a huge difference. The IS support subject is approached by first identifying the stakeholders and their needs. These needs are then met by developing a support system with web and mobile interface called *m-equine*. This system will be a tool that connects stakeholders and enables data storage and sharing in a way that has previously been unavailable.

1.1 The Stakeholders within the Horse Industry

The horse industry throughout the world varies very much, depending on the country and its heritage. In many countries from Mongolia to USA there are still herds of wild horses, but in these same countries there are also many domesticated horses that are used for sport, work or leisure activities. Both wild and domesticated horses are used as livestock because the meat is protein rich and often relatively cheap. Within the horse industry and more precisely with horses that are used in sports and leisure, it is important to understand the different types of stakeholders that are involved. In Figure 1 the various stakeholders are introduced, as well as their relationships to each other.

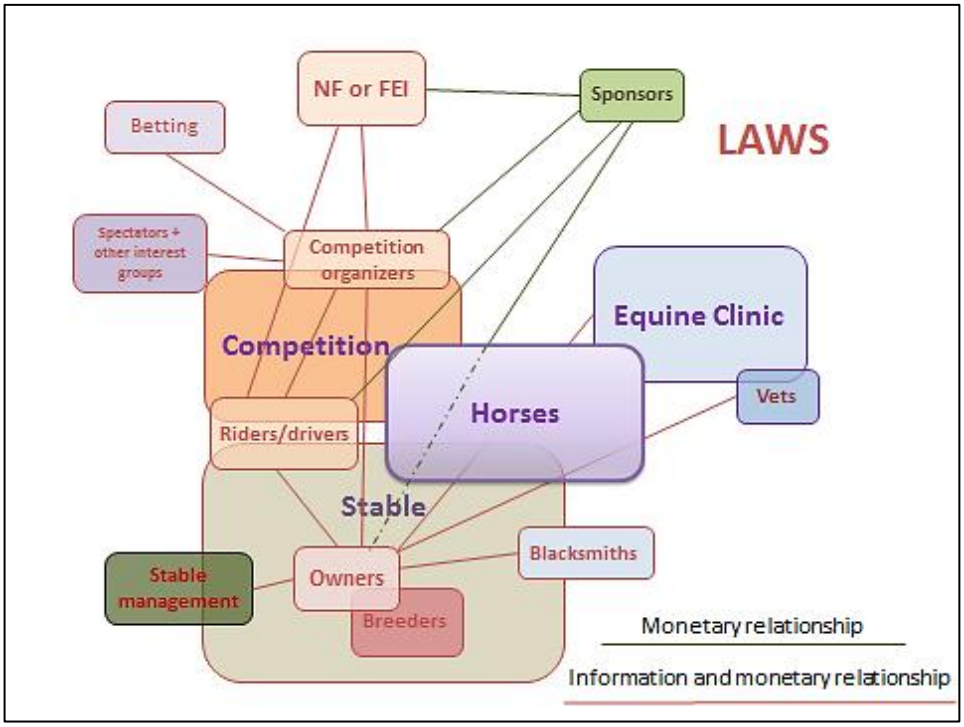

Figure 1. Stakeholders and their relationships to each other.

In Figure 1 the different environments that a domesticated horse will most likely inhabit or visit are: Stable, Equine clinic and a Competition site. In these environments there are various stakeholders and roles that interact with each other and the horse. A domesticated horse usually has a breeder, who is the initial owner of the animal when it is born. According to most European countries, Australia, New Zeeland, Northern America and the laws of some other countries, the owner of a horse is obliged to provide it with water, food, shelter, interaction with other horses and medical care when needed (World Society for the Protection of Animals (WSPA), 2011). The owner as well as the rider of the horse can change many times during a horse's lifetime. The rider and his/her responsibility towards the horse are of interest especially in the different horse sports, since there, the rider is always responsible for the horse's wellbeing and competition condition.

Horses often live in stables, especially in countries, where the climate is harsh and there is need of shelter from bad weather conditions. In some cases an open shelter is enough, or just an enclosure in which the horse's well-being can be monitored. In Finland the horse must have at all times the opportunity to seek shelter from the elements, especially during the winter it gets very cold. The stable is the living environment for the horse, and should be a place where it can feel safe and relaxed. Most of the day-to-day care of the horse happens in this environment. In Finland (and other countries) the owner of a horse does not necessarily own a stable, but rents the stabling service from someone else. In these cases, the horse lives in a boarding stable, where its daily needs are taken care of by the stable personnel, i.e. feeding, cleaning of the stall and some of the horse's daily exercise. Usually exercise provided by the stable includes letting the horse out in a paddock and/or walker for a few hours per day. The rider (or owner) should also preferably exercise the horse every day, since horses have evolved to move (McGreevy and McLean, 2010).

Horses need to have their hooves trimmed and balanced periodically, which is done by a professional blacksmith, also known as farrier. Horses' hooves grow throughout their life and need to be taken cared for because domesticated horses rarely move enough in various terrains to wear down the hooves in the same ratio as they grow. Blacksmiths usually come to the stable to treat the horse, but in some countries and with some specialist blacksmiths, the horse needs to be transported to the blacksmith's workshop.

Even if a horse never has an injury in its life, it still requires veterinary care, at least in the form of dental maintenance, vaccinations and de-worming. Horses can also be treated to some extent at their stables, but for large procedures, such as surgery, and in Finland even for x-rays, the horse has to be taken to a veterinary clinic for treatment. When veterinarians visit stables to treat horses it is called a "house-call"

At competitions, the rider (or driver) has responsibility of the horse, but also other stakeholder groups have an interest in the horse; the competition organizer, spectators, national federations and other interest groups such as a possible betting community. Indirectly, traffic and drivers to and from the competition site become stakeholders for a competition as well. During a large enough competition a whole city

might become a stakeholder, as the citizens of Caen, France will notice when they host the equestrian world championships 2014.

The green lines in Figure 1 represent the relationships between the stakeholders that are only monetary in nature, whereas the red lines are for both monetary and information relationships. Sponsors are a vital part for all horse sports. Naturally horse racing gets a lion's share of the sponsorship money, since it is followed worldwide, and the industry impact in the UK alone is £ 3,39 billion (British Horseracing Authority, 2009). Equestrian sports are, however gaining popularity, amongst sponsors. Here are some examples of sponsoring deals that can be found in the equestrian sport 2013: federation (SRL and LähiTapiola insurance), competition series (Furusiyya and Nations cup), competitions (Mitsubishi motors and Badminton horse trials), individual competitions classes (Prix de Gant class at 130 cm level), horses such as Eurocommerce Berlin or Sini Spirit and riders (Hennes & Mauritz and Malin Bayard).

1.2 Definitions and concepts

Some definitions have to be addressed for this dissertation. Since according to both the national and international equestrian sport regulations, the rider or driver is responsible for the horse's competition condition. To ease the writing, the human athlete will be written as rider, despite the fact that he/she might be a driver in a driving competition. An Equidae are hooved animals such as horses, donkeys and zebras and crossbred forms of these.

Information Systems (IS) consists of both hardware and software applications, such as information technology (IT) and mobile devices. Veterinary medicine utilizes IS directly to assist in operations, diagnostic and laboratory conditions. The various innovative medical solutions have been researched and published in veterinary journals such as Powell, (2012) and Schaefer *et al.,* (2012). In this research these types of IS solutions are not studied but used as rather "non-medical" IS-support tools that assist veterinarians and other stakeholder within the horse industry.

Mobile devices as a concept includes all types of mobile phones, tablets etc., unless specifically mentioned. Smartphone is both what today is considered smartphones and feature phones, since the main issue in hand is Internet accessibility.

Bosona and Techane (2013) research showed that the terms tracking and tracing are often used as synonymous to each other in scientific publications. They however suggest that these definitions should not be used synonymously (Bosona and Gebresenbet, 2013). In this dissertation Bosona and Techane (2013) suggested terminology differences are used, and thus tracking is not the same as tracing.

1.3 Overview of the dissertation

The dissertation is organized as follows.

Chapter 1
In this first introductory chapter the basis for the research is presented. The main problems within the equestrian world are briefly introduced for the reader to get a general picture of the needs within it. The main stakeholders and the goal of the research are presented.

Chapter 2
The research domain is introduced in detail, as well as the different aspects that have to be taken into account within the horse industry. The main problem areas are identified from the research domain and discussed separately. From these problems, the research questions could be formulated. Brief summaries of the original publications and their relationships to the research questions are presented at the end of the chapter.

Chapter 3
Within IS research there are many different approaches that can be used, from case-study to design research methodology. Chapter 3 introduces the most commonly used research methodologies for similar cases and introduces the action research methodology that has been used in this dissertation. The motivation for using action design research methodology is also discussed.

Chapter 4

To understand what type of similar IS research has already been done; a comprehensive literature review was conducted. The literature review consists of topics that are tangential with the research questions and area of interest, since there is a very limited amount of research literature available that is like this study. The research realms that are introduced have been clustered into groups that coincide with the research questions, when possible. The *m-equine* system introduced in chapter 1 will be built according to the specifications learned from the literature review, and research with the stakeholder groups. The system will also be tested with the stakeholder groups, to prove its validity.

Chapter 5

In chapter 5, how the *m-equine* system is developed in conjunction with the research questions and research methodology is introduced. The original papers and their findings are discussed in terms of their relation to the research questions and research timeline as well as their position within the research methodology. The motivation and reasons for the chosen sequencing are discussed as well as the results obtained from the whole research.

Chapter 6

The last chapter introduces the main findings and answers the research questions. The limitations of the research are stated and the research findings are tied together to the literature review and state-of-art discussion for further observations. Finally, future development both in the view of further research and next steps within the system development are discussed.

Chapter 2

Research domain

This thesis explores the world of IS and mobile systems as well as horses and veterinary medicine. Therefore to understand how these very separate worlds are going to be connected and studied, it is important to understand the backgrounds, regulations and future requirements for all of them. In this chapter the modern-day horse, veterinary requirements and the views of the stakeholders within the equine world are studied. This introduction into the equine world and equine veterinary builds the background for the research. At the same time we get a presentation on some of the problems within the equine and veterinary industries. After identifying the core problems that can be supported or even eliminated with the help of IS technology, the research science and appropriate methodology can be chosen to further investigate what is needed and why. At the end of this chapter, the research questions that have been derived from the problem formulation are presented.

2.1 The modern horse

The horse has been our companion for several thousand years. It has been used for work and war but in the end, also on the dinner plate. Before the industrial revolution, a horse was a valued possession, because of its many uses. However once cars and other machinery took over, the work that was previously done by horses, the status and usability of a horse changed considerably. Today a horse in the western civilization is not often used for work, but mostly for sport and companionship. The horse population can be roughly divided into three distinct, yet very different

uses. It can be an athlete, a companion and a meal. Since a horse can be, during its lifetime, in every one of the before mentioned three categories, this yields restrictions that will be discussed in the following sections.

Horses have been part of our domesticated animals for thousands of years. In some cultures it has been seen as an abomination to eat horseflesh, whereas, some cultures used horses even for sacrificial purposes and nourishment (Alerini, 27.3.2013). When cars were introduced to the common market a significant decline was seen in horse breeding. Transportation and many work tasks previously performed with the help of a horse were now transferred to engine driven vehicles. The horse did not earn its upkeep by working anymore, except for racing and riding school horses. At the same time the use of horses in sports increased, paving the way for new professions and past time activities. Today, horses are used in sport, but many people also want to ride and own a leisure horse just for their own enjoyment, basically as a pet. One aspect is unfortunately abundantly clear, when a horse becomes a pet, there is the risk that the owner does not know how to handle and give it proper care.

A sport horse can be everything from a polo pony, to a trotter, racing horse or a horse doing equestrian sports. In Figure 2 some of the sports where horses are used are presented. Fintoto Oy is in charge of the betting done at trotting events in Finland. In 2009, trotting races were organized on 363 days of the year, and these races were viewed by over 780 000 spectators (Suomen Hippos ry, 2010). The horse industry in Finland employs directly or indirectly, approx. 15 000 people, (fulltime and part-time employment) and it is estimated that the horse industry is approx. an € 830 million/year business (Suomen Hippos ry, 2010). In the UK, 2009 the amount of prize money won in horse racing was over £110 million. Naturally the largest amount of money in racing does not come from prize money, but from betting (British Horseracing Authority, 2010).

The study here will mostly concentrate on Equestrian sport horses, which are governed by the Fédération Equestre Internationale (FEI). “The FEI, founded in 1921 and is the international body governing equestrian sport recognized by the International Olympic Committee.” (FEI, 2012) Equestrian sports involve eight disciplines; Jumping, Dressage, Eventing, Endurance, Driving, Reining, Vaulting and Para-Olympics disciplines. Of

these, jumping, eventing and dressage are Olympic disciplines and in Para-Olympics, Para-Equestrian dressage is represented. In 2012 there were worldwide 556 international jumping, 146 international dressage and 226 international eventing competitions. Endurance riding is not one of the Olympic disciplines at the moment, but it has grown in popularity

in last several years, reaching 231 international competitions in 2012. In the beginning of 2013, FEI's international horse registration database held approx. 230 000 horses. This database only includes horses that have an FEI granted international passport. (FEI, 2012)

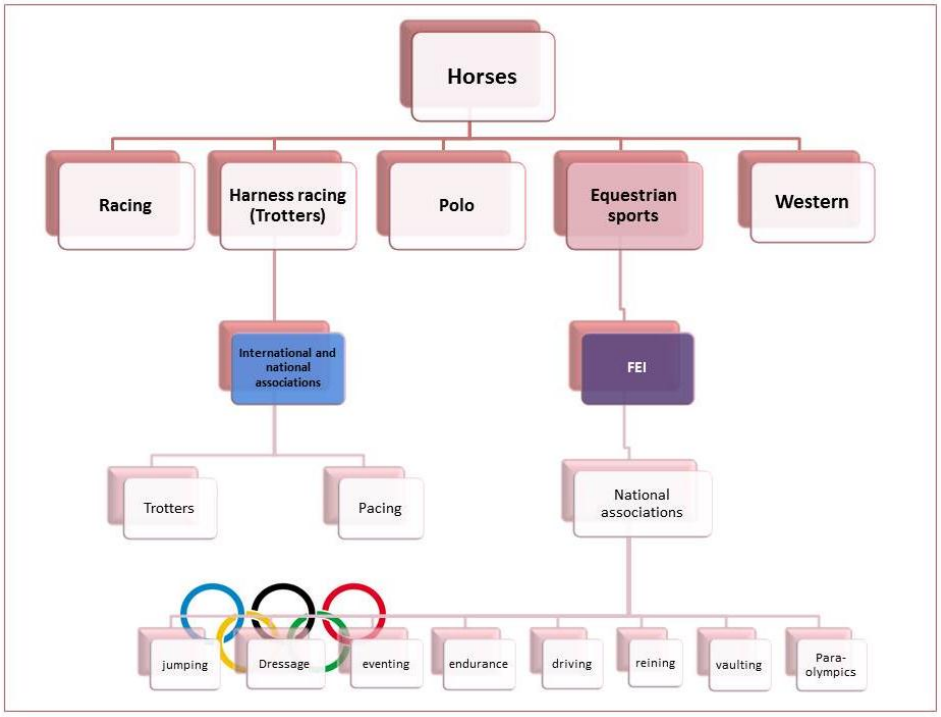

Figure 2. Modern horse sports.

2.1.1 Identifying a horse

In Finland, Suomen Hippos (the Finnish Trotting and Breeding Association) reported that there were approx. 75,500 horses in 2011 (Suomen Hippos ry (the Finnish Trotting and Breeding Association), 2012b). This amount includes all horses that are registered in Finland, trotters, leisure horses, competition horses and ponies. It was estimated that in 2009, 9100 horses were actively racing trotters and 6900 actively competing Equestrian sports horses (Suomen Hippos ry, 2010). A horse born in EU must have a life number and a passport of its native country (EC Directive 504/2008). If the horse is exported to another EU country it does not have to be re-registered to that country. Therefore there are no exact figures of how many horses are in Finland, since some of the imported horses are not registered in Suomen Hippos. Today a horse's national passport primarily identifies it and is the horse's official travel document required by EU. From 1.7.2009 forward, all foals born in Finland and all horses imported into Finland have to have an identifying microchip inserted into their neck and a national passport (Skarra, 2009). From January 2013 all new horses that apply for a FEI international passport also need to have microchip identification (FEI, 2013).

One of the main problems with identifying horses is that the microchip readers are costly and several standards are used. Mostly identification is still done with the help of the horse's passport. The horse's color, various identifying marks and/or swirls in its coat are drawn and described in the passport. Unfortunately, for a person not working around horses, these markings are of little or no use at all. Usually proper identification with only the help of a passport requires some knowledge about horses. One typical place where an untrained person or a person without knowledge of horses might have to identify a horse is at border control. Furthermore, veterinarians draw the markings in the passport and as a veterinarian confessed, they are not always the best artists in the world. It is also very simple to falsify the drawings, and then use the passport for another horse. The falsified passport can then be used to conceal a stolen horse's true identity, or to fabricate information during a horse deal. Below, in Figure 3 is an example of two horses and their national passports. With these passports these two horses are allowed to travel everywhere within

the EU, but as can be seen, the identification of the proper horse is not very easy.

Figure 3. Two almost identical horses for the untrained eye, but which passport belongs to which horse? (Leskinen, 2011a)

2.1.2 The equestrian sport horse

Sport horses are like any athletes; they have to be trained, fed and treated correctly so that they can reach their full potential. For equestrian disciplines, according to FEI rules, a horse has to be vaccinated against horse influenza and in some countries also against other diseases. This

information has to be marked on the horse's international passport, if the rider/driver wishes to compete with the horse in international competitions (Article 137) (FEI, 2013a). In Finland at district and national level equestrian competitions, the horse's vaccination rules differ slightly from the international ones (SRL, 2012). In Finland influenza vaccination information is checked from the passport at every competition, and this takes much time. In some other countries, the national federation has stipulated that the vaccinations are only checked at random competitions and/or for randomly picked horses. Neither the Finnish nor the random system is ideal.

Equine influenza vaccination

The horse must have received at least the two primary courses of vaccinations, given 21 to 92 days apart. After this for horses that have received the primary vaccinations before 2009, they must receive in Finland an annual booster vaccination. For horses that have received the primary vaccination after 1.1.2009, the first booster vaccination must be within 6 months (+21 days), and thereafter an annual booster vaccination. For internationally competing horses, a booster vaccination must be administered every 6 months (max 7 months). The horse's latest vaccination has to be administered at least 7 days before it is to compete (Article 1028) (FEI, 2013d) and (article 19.1) (SRL, 2012).

For older horses, the person checking vaccination information might have to search through many records to determine if the vaccination schedule is done according to regulations. Often the records are mixed into the influenza vaccination records, where there might be tetanus vaccination information. Consider that horses' national passports might vary and the vaccination information is not always in the right order (see Figure 4). At larger competitions there are even several people whose only task is to check the vaccination records, and yet the officials might not be able to check all the information before the horse in question is to start. In the strictest sense of the rules, one is not even allowed to bring the horse to the competition site, until the vaccination information has been checked. In practice at many national competitions in Finland, this type of checking has not been possible. During the author's study at competitions summer 2009, it was found that some riders never brought their horse's passport to the secretary office to be checked, horses that had

been competing for many years did not have their influenza vaccination records in accordance to regulations etc. Horse influenza is highly contagious, and even horses with the vaccination might get sick, although most often to a lesser degree (Hautala, 2009). This is why FEI, SRL and other national federations have a very strict policy regarding influenza vaccinations.

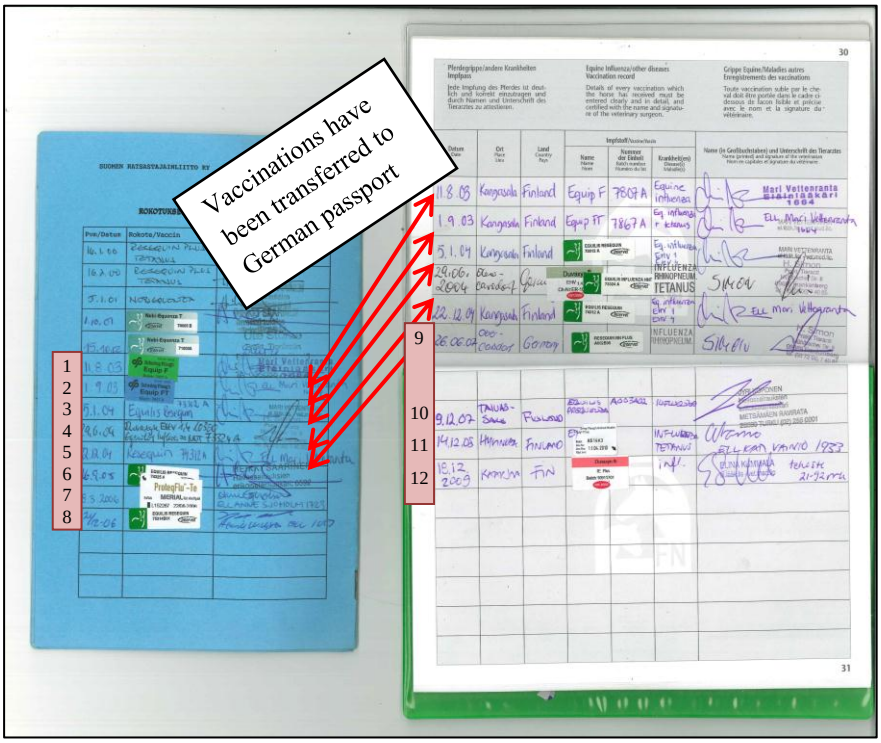

Figure 4. Checking vaccinations of a horse that had its initial vaccination 2003.

The horse influenza vaccination protocols and monitoring procedures at Finnish competitions are insufficient because of the number of horses taking part in them. With today's system it is virtually impossible to be sure that all the horses participating in a competition have their vaccinations in order. When the official or veterinary at a competition notices that a horse's vaccinations are not in order, it usually is already too late; the horse is at the competition site. Trotters in Finland are racing under the regulations governed by Suomen Hippos. They also have very similar influenza vaccination regulations as the equestrian sport horses

do. Therefore Suomen Hippos has launched a vaccination database, that supports the needs of horses, but there is no underlying program to support the database, and therefore the only difference is that instead of checking the vaccination information from the horse's passport it has to be checked from the electronic database. The Equestrian Federation of Finland has also realized the problem with checking at each competition for the horse's passports for vaccination information, and is looking for alternative solutions to this problem.

Doping

In 2010, FEI started the "clean sport" program against anti-doping, which requires that horses competing internationally must have a medical logbook (currently paper based) that includes the horse's medical history, article 1026, 3§ (FEI, 2013d). The logbook includes information on what and when the horse has received medication. Not all medication is given to treat a pain or enhance the performance of the horse, even though these substances are considered as doping. Mild tranquilizers and various myalgia treatments are used to take care of the athlete, not to medically treat the horse. Some horses have to be mildly tranquilized during shoeing, for example. If trace elements of this tranquilizer remain in the horse's blood, beyond the pharmaceutical company's safe date, then a positive doping test may result. To enforce the anti-doping regulations at every international competition, FEI veterinarians test a few horses for doping at the competition site. (Chapter VI FEI, 2013d).

It is very important that all horse sports have transparency in their medical treatment and an absolute zero tolerance of doping. This is not only a requirement that animal welfare organizations speak for, but also a vital image requirement for horse people to give to the outside world. Equestrian sports have a tarnished image after the Peking Olympic Games (which for the equestrian part was held in Hong Kong) 2008, because several horses gave positive doping results. Luckily there were no doping findings in the Olympic Games, 2012 held in London.

Riders and drivers

The human athletes can be divided into six categories. These are: Senior riders, Young riders, Juniors, Pony riders, Children and Veterans. Young

athletes have their own categories according to age and horse. Pony riders are children who are competing with a pony (a small horse of max. 148 cm height at the withers). For national level (in Finland) a Pony rider must be at least 10 or 12 years old, depending on the dicipline, to take part in Pony rider category's competitions. For international level the minimum age requirement for Pony riders is 12 years. A person may compete as a Junior rider beginning from the year he/she turns 12 years for national level (in Finland) and 14 years for international level. A junior athlete is allowed to take part in junior classes until the year he/she reaches 18. A person may compete as a young rider from the year they turn 16 and they can move to the category, senior riders, the year they turn 18, or at the latest, the year they turn 22 (FEI, 2011; FEI, 2013b; FEI, 2013c). The human athlete is responsible for the horse's fitness to compete, which includes that they are responsible of the horse's medical treatments and vaccinations. If the athlete is under 18 years old, ultimately the person responsible for the horse's vaccinations and fitness to compete is then a parent or other guardian of the rider, whether he/she is a pony rider or a junior rider.

Horses across borders

International equestrian competitions are held everywhere in the world, and many new countries want to be part of this lucrative sport. Horses fly frequently over continents to new countries for international competitions, but the organizing country's trade regulations might be a hindrance. Even if a horse is only going to be in a foreign country for a week and it never leaves the competition site, the horse still travels under the country's import and export regulations. These regulations have often been stipulated to protect the country's native horse population against foreign diseases. Often importing a horse to a foreign country requires several forms, veterinary inspections and even quarantine. A top athlete cannot suddenly be within weeks of an important competition without its daily workout. For the Olympics in Sydney and Beijing, the problem was solved by having in Aachen, Germany, a pre-quarantine for e.g. European horses, where riders could ride their horses every day. After this semi-quarantine the horses were flown to the closed competition site. The horses were not to have any kind of contact with the local horse population. For the Beijing Games, horses were not allowed to enter

mainland China, and therefore they competed in Hong Kong. FEI has started to investigate how horses could travel to different countries with more ease. The rigorous trade regulations are to prevent sick animals or animals with transmittable diseases entering the country. However horses competing at the top level are athletes, and would not be entered into a competition if ill. Furthermore, the horses do not visit local stables etc. but are transported directly to the closed competition site. Therefore FEI and World Organization for Animal Health (OIE) are together establishing guidelines and criteria for the high health, high performance horses (HHP). The goal is to then negotiate with countries to allow the HHP horses to travel with more ease than trade animals, and add more countries to the equestrian sport. (International Movement of Competition Horses Forum Panel, 2013)

2.1.3 Horse meat

Once a horse's status changes from being a "companion animal" or an "athlete", to "unwanted" it becomes livestock, and is, in most laws, treated as such. The term Unwanted horse was introduced by American Association of Equine Practitioners (AAEP) and basically means that these horses are not wanted anymore by their current owners (Lenz, Tom R., DVM, MS, DACT., 2009). Hundreds of horses are abandoned yearly in the UK, USA, Australia and other parts of the world. This is partly due to an old tradition that is still used today for horses that are not of use anymore. Horses are just left somewhere to fend for themselves, because horsemeat is not consumed, and the owner does not have the resources to pay for the feed anymore. In USA these wild horses wander in "Mustang" herds, but are really only a sad and cruel mockery of what the original Mustangs of the Wild West represented. People abandon unwanted horses, because it is unlawful to slaughter them in the US and expensive to put them down, so herds of horses breed and grow unchecked every year. In Finland, however there are slaughterhouses that receive horses, but it has become increasingly problematic to find suitable final solutions for injured, sick, unmanageable and old horses. Horsemeat has currently a very low value and most termination options are expensive, which leads to the situation that horses that should be put down are not! In the worst

case they are even shipped on long transports to countries where horsemeat has a better value (MTV 3 45 min, 2007). Apart from the high euthanasia cost, a horse's carcass is considered harmful waste, which is governed in Finland by the waste act, environmental protection act and degree (MMM work group, 2007). In Finland the approximate cost for a veterinarian to euthanize a horse and the carcass to be incinerated is 900-1200 € (www.ratsastus.net and www.lemmikkilehto.fi).

Horsemeat is a delicacy in many European countries, and yet often even cheaper than bovine meat. Consider the horsemeat scandal started in Britain, January 2013, people were shocked that they had been eating horsemeat, while believing it was bovine meat. In Finland an interesting opposite reaction has been noted; the use of horsemeat has increased in a short time, and has even doubled between 2009 and 2011 (Viitanen, 2013). Over 65 % of the horsemeat imported into Finland is from outside the EU which was in 2009 2.8 million kg (Pitkänen, 24.2.2013). In 2013 there are only 13 (of 43) slaughterhouses in Finland that will receive horses to be euthanized (Suomen Hippos ry (the Finnish Trotting and Breeding Association), 2012a). Although there are strict regulations about the information that should be given to the slaughterhouse of an animal that will be euthanized there, in reality there is no way to control that the regulations are actually followed. At slaughterhouses and meat factories occasional inspections are done to measure the level of trace elements in the meat produced there, but this is virtually the only way to check that a horse being slaughtered has not been medicated with substances that are not allowed to be found in the meat. The information the slaughterhouse will get of a horse depends mostly on the horse owner's information. This information might not be complete since a horse might have changed owners several times during its life, and veterinary information might thus have gone lost.

In Finland the slaughterhouses have very strict sanitation rules, and essentially the whole animal and meat procession area have to be disinfected before a new type of animal can be slaughtered. This is one of the reasons that many larger slaughterhouses in Finland will not receive horses, because with the small number of horses being slaughtered, the poor price on horsemeat and loss of time & money is not a good business. According to EU regulations and Finnish food legislation, all animals

slaughtered in EU for human consumption need to have proof of identity and a logbook stating what medications and feed the animal has received during its lifetime (MMM 23/2006). Some medications that are used on horses are considered dangerous for humans. If the horse has been treated with these medicines during its lifetime, the meat cannot be used for human food consumption. Since horses can be sold many times during their lifespan, the medical history is, in most cases in paper format and does not necessarily move along with the horse.

EU legislations

Equidae are separated into three categories under EU law. They are: equidae for slaughter, registered equidae and equidae for breeding and production.

EU legislations state rules for importation of equidae and/or meat products derived from equidae. Horses imported for immediate slaughter and all equine meat products imported into the EU have to meet the following requirements:

- The animal is from a country that has implemented a residue-monitoring plan. At the time of writing this dissertation, these countries are: Andorra, Argentina, Australia, Brazil, Botswana, Canada, Switzerland, Mexico, New Zealand, and Uruguay. Furthermore, the following countries can only export to EU live equidae for slaughter: Belarus, Croatia and Serbia. Annex to (EC Implementing Decision 2013/161).
- A residue monitoring plan, to ensure that the animals do not have medical residue that is harmful for human consumption (EC Directive 96/23) and (EC Directive 96/22).
- The horse has to be identified and registered into an EU country within 21 days of its importation and it should be identified by a single EU compliant identifying document (EC Directive 504/2008).
- The horse has been registered in an EU country for at least 6 months (EC Directive 504/2008).
- The horse's official passport/official identifying document accompanies the horse to the slaughterhouse (EC Directive 504/2008).

- All medical treatments must be recorded into the horse's passport (EC Regulation 852/2004) and in the horse's origin farm records article 10 (EC Directive 96/23).

The registered equidae imported into the EU or born in the EU is to be identified and registered in a studbook or register in that breed or into an international organization that manages the registration of race and or competition horses. In Finland this register is held by Suomen Hippos for all equidae. The law governing registered equidae, which are imported or meant for breeding and production (EEC Commission Decision 93/197). These animals can be slaughtered in the EU, and there is no need for a residue-monitoring plan from the country of origin, even for imported equidae, as long as the animal has been registered within the EU for at least six months. Naturally all equidae which are born in the EU and slaughtered are controlled with the EU's own residue monitoring plan stated in (EC Directive 96/23) and (EC Directive 96/22). All equidae born within the EU have to have a unique life number, but microchips are not yet mandatory, therefore a unique branding on the horse + DNA sample (EC Directive 504/2008) is also a sufficient identification method.

2.2 The veterinarians who treat horses in Finland

In the Finnish veterinary system a veterinarian can specialize in specific animals, but in this research the focus is on large animal veterinarians who treat production animals (bovine, pigs, sheep, chickens etc.) and equine veterinarians. Every county in Finland has to provide a veterinarian on call at all times, to care for the local animal population's medical needs. In smaller counties with only one appointed veterinarian, he/she has to be able to care for various production animals, horses, pets and even wildlife. When possible, separate large animal and small animal veterinarians are appointed. The county appoints its county veterinarians in accordance to the Finnish Law of Medical Services for Animals 16 § (MMM 2009/765). There are approx. 2,100 licensed veterinarians in Finland, 30 % work as county veterinarians and the rest work mostly at private practices or clinics (Ammattina eläinlääkäri (Veterinary as an occupation). 2011). In Finland there are both private and a veterinary

teaching hospitals for small animal and equine medicine. The University of Helsinki has the only production animal clinic. Apart from pets and production animals, a county veterinarian is also responsible for animal welfare and wildlife care within the county. The county veterinarian might also be the "hygienist veterinarian", meaning that he/she monitors the county's food production and overall health situation when it comes to food products. Equine medicine veterinarians specialize in treating hoofed animals, which in Finland is primarily horses. The veterinarians treat and/or inspect all kind of horses: leisure, harness sport, equestrian sport and horses going to slaughter.

Today, horses are increasingly seen as companion animals and used as sport animals; therefore one would think that an animal that can earn its owner even millions of euros would have a vast number of different medicines for treatment purposes. Yet horses have in Finland about the same number of different medicines to be used as other production animals. In 2013 there are 207 different medicine preparations that are approved to be used on horses in Finland, while the same numbers for bovine is 217 and for swine 212 (Evira, 2013b). Even if bovine, swine and horses have approximately the same amount of approved medicines that can be used, yet horses are treated to a much greater extent than production animals, since they usually have a higher monetary value and emotional value to the owner. At the same time household pets, such as dogs have a greater range of medicine at their disposal. In total 412 different preparations (Evira, 2013a). Many pharmaceutical products that have been developed for pets cannot be used for horses because of the risk of this medicine one day ending up in the food chain; therefore these types of medicines have not even been developed for horses.

Veterinarians today usually have their own patients' records on file and according to Finnish laws are required to do so for a minimum of three years, (MMM 29/2000). In 2009 there were 25 equine medicine veterinarians in Finland (Venäläinen, 2009). The problem is to find all the medical information of a horse. Apart from equine veterinarians, county veterinarians (over 600 county veterinarians, during 2009) might also have treated the horse and if the horse had been imported from another country, it is virtually impossible to be 100 % sure that all medical data is intact (Ammattina eläinlääkäri (Veterinary as an occupation). 2011).

In other animals such as cows, this would not usually be a problem, since a cow is very seldom treated to such an extent as horses. This is since a cow's value is more likely to be attached to the value of the meat, milk production or breeding value, opposite to a horse, whose value might lie in how fast they run etc. Furthermore the cow's value does not drop if it has been medicated during its life, and cows seldom change owners during their life. Basically a horse's minimum value is what its meat is worth. Depending on the horse's age, breed, pedigree, stage of education, competition level and price-money won so far, the actual price of the horse might be immensely different from the value of the horse that has meat. A horse's worth totally depends on its present day condition. Since horses can be sold many times during their lifespan, the medical history does not necessarily move along with the horse. Although the seller is obliged to tell the potential buyer the horse's medical history, he might opt out, in hopes of getting a better price for the horse. Naturally if one are buying a horse, one hopes that the seller has been honest, but it is difficult to find out for sure. Horse trade has therefore a bad reputation and fraudulence is unfortunately rather common. For the horse buyer the situation is equivalent as buying a car that has no inspection or service data and a car could have negative automotive issues.

2.3 Problem understanding

The previous chapters present the non-IS players, of the research domain. The various problems that these players have are presented, to give an overall picture of the situation. From these problems the research questions are derived and presented in the next chapter.

The horse industry has a history of various fraudulence situations, which leaves the stakeholders within it suspicious and aiming for their own personal goals. Co-operation between horse people can be limited and thus lead to several problems. When buying a horse one does not know for sure what they are buying. The previous negatively affecting medical records are not necessarily presented to a potential buyer, although by law they should be. Yet it is very difficult to later prove that a horse had some medical issues already when it was bought. In the worst case, the horse is not even the one that the official passport claims it to be. Passports can be altered to manipulate the situation, e.g. present a better decent, or even

hide the horse's origin. A microchip could prevent identity problems, but not all horses are microchipped, readers are costly, and there are several standards in use. There is even evidence of changing microchips or a horse having two microchips. Even if the horse's identity can be proven, there is no way of knowing its full medical history. Different countries have different regulations regarding who can access what medical information even within the EU. In Finland the owner should be privy to all medical information of his/her horse, whether the information dates to the time before the ownership began or not, but in practice this is not so. In Finland alone, there are hundreds of veterinarians who might have treated the horse in one stage or another, but there is no central place where this information is held. The veterinarian only needs to store medical information of a patient for three years, so older records might be lost. If the horse has been imported to Finland from another EU country, or from outside the EU, the new owner might not be privy to old medical records, since it might be against the exporting country's regulations.

Identification is an issue that will be discussed from different angles in this dissertation. Microchipping is considered a relatively humane and reliable method for identifying horses, but the system is not foolproof. In the EU especially Germans are outspoken in defending their traditional ways to brand horses for identifying purposes. They claim that the brand and the breed the brand represents add value to a horse, and is not harmful for foals, despite medical evidence to the contrary (Appels, 2011; ScienceDaily, September 2011; Waiditschka, 2013). The brand also makes it easier for people to see which breed the horse is. In many cases though, the identifying number below the breed brand cannot be seen, and sometimes not even the brand can be seen on older horses, if the branding job has not been made properly. Therefore branding is hardly a reliable method of identifying a horse. As for the claim that a specific breed can add value to a horse, it is not quite true, since the breed can even be the result of where the horse happens to be born. Top sport horses represent many different breeds; yet have an almost identical linage. Top stallions are often used in several breeds, and therefore, horse breeds like Hanoverian, Holstein, and Oldenburg etc. do not represent a certain type of horse as it maybe once did. Naturally some of the pure breeds that have had a very strict breeding program, the breed and the brand actually represent and diversify the horse from other breeds. In these cases though,

the horse can be recognized for its breed, even if it is not branded on the horse.

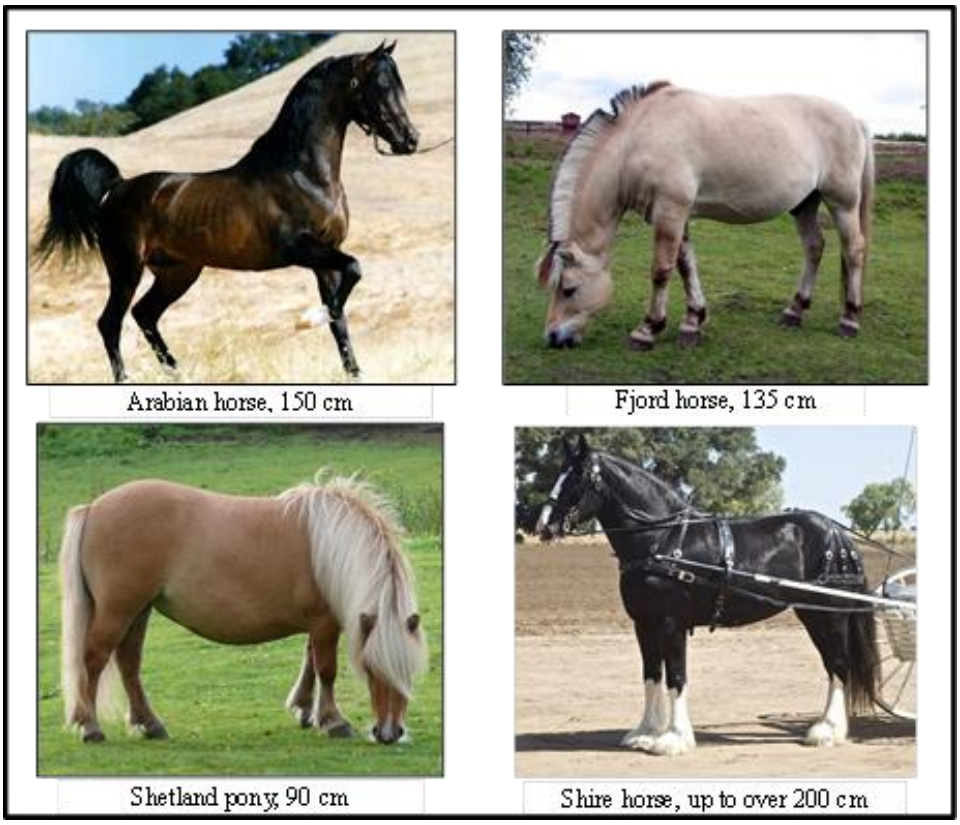

Figure 5. Different horse breeds and their approximate heights by the withers.

The pictures in Figure 5 are just a few of the breeds that are pure breeds and can be recognized rather easily for the breed they represent, because of unique features. Some new methods to identify horses have been trialed in the past few years, such as eye scanning (www.veteyed.com). Horses generally trust humans, but still might be cautious of anything happening around their head; therefore this might not be the most optimal solution for identifying, unless the eye can be scanned from a longer distance.

Since horses are often treated for mild injuries, teeth floating and first-aid etc. at the stable, veterinarians need to travel long distances to reach the

stables and record keeping in this unsanitary environment can be a hassle. The veterinary often ends up doing the paperwork twice, and the schedule rarely is upheld, since new patients might come up in the last minute when the veterinarian is already at the stable.

There is a limited range of medications offered to horses, because in the end they are seen as livestock animals, and can become a part of the food chain one day. This basic assumption of a horse's livestock status also hinders the treatment of horses that are not to be slaughtered. This of course limits very much how we can treat the horses that are competing at top level. Medications, such as cancer treatment, that have been developed for other companion animals, are not available for horses, because of the risk that the medication might end up in the food chain. Yet there are already in use some medications for horses that prevent the horse from ever being part of the food chain. If such medication has been used in the past, the veterinarian who administered it should mark it in the horse's passport, but sometimes this is forgotten. However if the passport gets lost, or a horse is imported to EU without any identifying documents, it can receive new documents, after it has been inside the EU for at least half a year. Then with the "clean" passport the horse can enter the food chain, although it should not. Furthermore since identifying a horse is not reliable at the moment, do we really know which horses end up in the food chain, and what medical traces they might contain? This is one of the reasons many horses are not slaughtered, because of the inconsistencies in the system. In Finland many slaughterhouses do not receive horses, because of very rigid regulations. This has led to the situation that often already old and/or sick horses are sold for virtually nothing to unsuspecting buyers, just to get rid of the animal.

Equestrian sports were already part of the first Olympic Games in 1912, and horse sport was already part of the Ancient Olympic Games. The equestrian sports have been growing in popularity in the last few years, especially in new areas of the world, where horse equestrian sports have not been traditionally in a large role. This though has also put more pressure on the sport to uphold a positive image to the public. Doping scandals are hopefully in the past, since FEI started its clean sport campaign, but all horse sports, including the racing industry must uphold vigorous rules against doping, to ensure the horses welfare. Because

people and horses are traveling more, also diseases carried by horses are spreading. FEI and some racing associations have enforced rules against equine influenza by mandatory vaccinations. Although the rules might be very clear, monitoring that the rules are upheld is difficult. There is no way to prove that a horse has been vaccinated, or vaccinated on the date that the passports vaccination records claim. Fraudulence runs rampant because of people's indifferent attitudes towards the regulations, and it is true that equine influenza rarely kills a horse, but an infected horse could be outside the competition circuit for several weeks. Both for veterinarians and competition organizers it is cumbersome to confirm that all horses have been vaccinated according to regulations. The "Heppa" system that was introduced by Suomen Hippos a few years ago helps the situation someways, but many veterinarians do not want to use it, and in the end the system only has the exact same data as the passports have. For both entering data, and checking vaccination data, the Heppa system is too cumbersome to use, and it does not support the user's routines.

2.4 Research Questions

The purpose of this research and the dissertation's research questions can be separated from the problem understanding presented previously. This section presents in detail the analytical core of the research questions to give a proper focus for the study.

Equine veterinarians, and county veterinarians who treat horses, are in a unique situation that they do not necessarily treat the horse at a clinic, but rather at the horse's stable. Furthermore veterinarians and other stakeholders around horses face situations often where they need to find the horse's previous medical information but it cannot be found. Therefore the research questions and clarifying additional questions are as follows:

A veterinarian's work is tough and hazardous because of unpredictable animals, but many forget that it is also highly stressful mentally. Not only do they have to deal with patients that cannot tell them what is wrong with them, but also with owners, that can range from indifferent to nearly hysterical. Across the globe there have been studies made about the mental health, and stress factors of veterinarians. The studies show that in

this line of work one is more prone to poor psychological health, stress, burnout, anxiety, depression and even suicide than the general population (Reijula, *et al.,* 2003; Hansez, *et al.,* 2008; Fritschi, *et al.,* 2009). In fact Business Insider estimated veterinarians to be 1 to 54 times more likely to commit suicide, ranking them as the 4th amongst occupations (Lubin, 2011). It is clear that a veterinarian's day is not ideal at the moment, and they need support in their routines to ease the workload. This problem has prompted the first research question. The two sub-questions to RQ1 are for ensuring both a qualitative and bottom-up approach to the study, which will be discussed more in chapter 3.

RQ1: What are the bottlenecks in a veterinarian's daily routines?

a. What are the veterinarians' daily routines?
b. What do the veterinarians feel they spend too much time on, and why?

In the latest years we have heard many attempts to bring IT, mobility and common databases into human healthcare, with various results. Mostly these projects and efforts have cost the governments millions of euros or dollars but results are hazy or negligible at best. Doubts and resistance is met from all corners and parties on the way to aim for grandeur. One highly ranked dean at a university hospital can with a word destroy years of work in implementing even the simplest IS support tool. Today we are more accustomed to use our mobile phones for different tasks, but this was not the situation in the beginning of the 21st century, when doctoral students Ville Harkke and Shengnan Han began working on their doctoral dissertations in a mobile project aimed towards physicians. In this project physicians were given a Nokia communicator that included the whole Pharma Fennica, i.e. the Finnish medicine encyclopedia. The physicians were asked to use it in their daily work and later on they were interviewed on their usage of it etc. It turned out that some of the physicians did not even take the device out of its package, because the thick user manual that came with it already overwhelmed them. Some had only tried it once or twice, but viewed the platform to be too complicated and the search

hierarchy too confusing to use. Other doctors confessed that they had used the communicator often, but not the specific program. They had e.g. liked the calendar function that Nokia offered in the phone. (Harkke, 2006 and Han, 2005)

Naturally veterinarians are not physicians, but their work and responsibilities are so similar that it begs to ask the following question.

RQ2: Can IS be used to support veterinarian work?

a. In which routines can IS be used to support the task?
b. What type of IS support tools are used today
c. How technologically competent are veterinarians?
d. What type of system would best support the veterinarian's routines and needs in a horse-stable environment?

We assume that we have a working support system platform for veterinarians. This is however a marginal group of people even if the system could have amazing penetration rates, therefore it would make sense to make the platform available also to other stakeholders within the horse industry. Now we are not talking about a marginal group anymore, as was stated in section 1.1, but a large group of people and thus a commercially viable IS support system. Most of the success stories within the apps markets depend on large volumes of users since this is the way the software industry makes its business (Holzer and Ondrus, 2011 and Carare, 2012).

Google and iOs and other mobile platforms, make the most money from game apps that are to be played on their devices. For iOs app related revenues are estimated to be around $12 billion (Costello, 2013). Therefore it is obvious that the mobile platform should be included into a support system for horses, as well as other stakeholders who are around horses, rather than just veterinarians. Therefore the third research question is as follows:

RQ3: What type of IS support would be beneficial for the main stakeholders?

a. What are the needs for the main stakeholders?
b. How should a support system be built, to meet the various stakeholders' requirements?

Once the potential user base can be increased and thus generate more results, it will be possible to do some generalizations that will help with further research and development. The social media and overall connectivity via internet have allowed people to communicate and form interest groups that were not possible even a decade ago. Horse people around the world can discuss their horses, training methods, competition success etc. to each other with ease. The negative aspects such as horse neglect and mistreatment also can spread like wildfire through the internet, all the way to the newspaper headlines. Recently a malnourishment case of horses in Poland owned by a well-known breeder from Denmark reached not only the horse media, but also the common media (Bolton, 26.8.2013 and Samuels 15.8.2013). Yet an even better example is the large attention that arose because of horsemeat ending up in European food, which became headlines around the world (der Spiegel, 10.4.2013; the Guardian 10.5.2013; the New York Times 25.2.2013). Since horse people obviously can communicate to each other, and a support system within the horse industry will bring transparency, what changes could this combination bring? This question could be infinite, and yet no one can truly guess all the answers, but research question four highlights a few most important aspects to contemplate.

RQ4: Could transparency with IS change the horse industry?

a. Can we divide the horse population into two, horses that can enter the food chain and horses that cannot? Are there benefits?
b. How to use transparency for disease control?
c. Can a support system help to monitor a horse's wellbeing?
d. How will transparency affect the horse trade?

The research questions and methods used to answer them have been studied in various research papers by the author. These papers will be introduced in the next section. The research has been done in iterations, according to the research methodology introduced in chapter 3. Figure 6 presents how the research questions have been studied in various iterations, and how the author's original papers have been derived from the iterations. The facts acquired from iteration I, have acted as an underlying structure for the whole research and all the research publications thereafter. The different iterations will be studied in chapter 5.

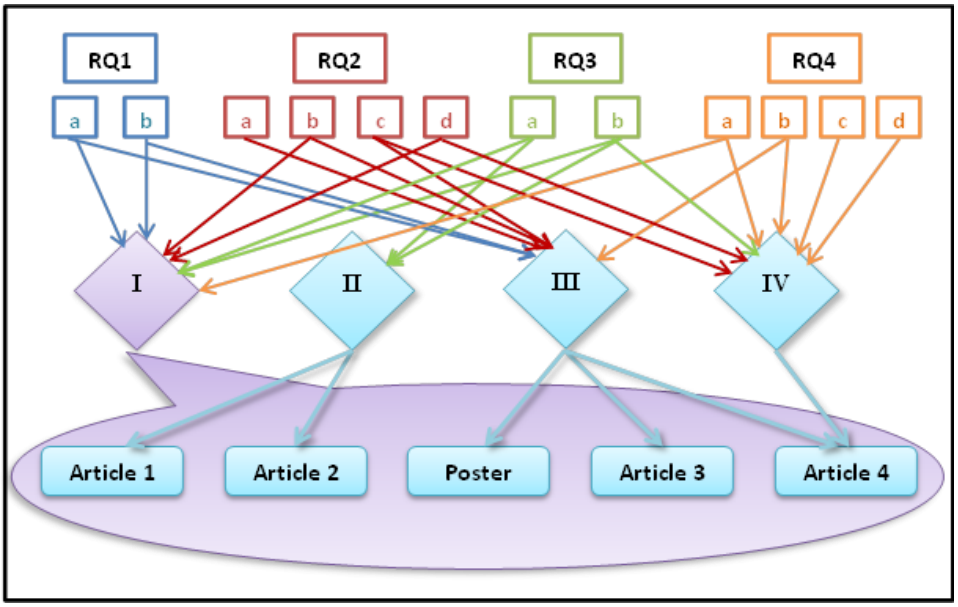

Figure 6. Research questions related to methodology iterations and original publications.

2.5 Contribution from original papers

In this section the original research publications are presented, to understand how they are combined with the research questions. As can be seen in Figure 6 the first two articles published within this field were done from the facts obtained in iteration II (cf. chapters 3 and 5.3).

- Leskinen, S. (2010), Equine Vaccination, a paper mess waiting to get solved. Could ICT be the answer? In *23rd Bled eConference eTrust: Implications for the Individual, Enterprises and Society* (20-23 June 2010) Bled, Slovenia, pp. 127-143.
- Leskinen, S. (2011), Can Information Systems expand the limits of Equine Medication? In *The 6th Mediterranean Conference on Information Systems (MCIS2011)* (3-5 September 2011), Cyprus. Paper nr 12.

The first of these two articles was about vaccination protocols, and how the different main stakeholders found them. The target was especially on competition riders, the horse owners, their understanding of the vaccination regulations, and need for reminder services etc. The second article discusses the opinions of the owners and riders on a possible common medical database for horses. Both of these article results were based on surveys that were performed with horse owners and competition riders.

The third iteration (cf. chapter 3 and 5.4) concentrated on the most important stakeholders for the research, namely veterinarians. The veterinarians' opinions were studied from their daily routines and computer usage for their opinions on a possible common medical database for horses. This article and poster presentation that resulted from this iteration, were vital, to achieve validation for the whole idea.

- Leskinen, S. (2011), Veterinarians' attitudes towards digital technology – an empirical study. In *7th International Equitational Science Conference* (26-29.October 2011) Hooge Mierde, the Netherlands. pp. 4.
- Leskinen, S. (2012), Veterinarian Work Enhanced by Mobile Technology – An Empirical Study. In *45th Hawaii International Conference on System Science (HICSS)* (January 4-7 2012), Maui, Hawaii, USA. pp. 1403-1412.

The last article is based partially in the third iteration, but mostly on the fourth iteration (cf. chapter 5.5). In this article the results from the research are presented by introducing possible solutions and an IS that

could be introduced as a support system for the different stakeholders. Some of the research questions from RQ 4 are answered, but some can be answered first in this dissertation. Iteration four is therefore not completed in article 4, but here first.

- Leskinen, S. (2013), Enhancing the daily routines of equine veterinarians using mobile technology: the *m-equine* case. *International Journal of Systems and Service-Oriented Engineering* Vol. 3, No. 4, pp. 1-19.

Chapter 3

Information System Design

This chapter introduces briefly the different methodologies that are commonly used in similar IS research, and discusses the pros and cons of these methodologies in regards to this research. Then the research method action design research is discussed and motivated as to why it has been used in this dissertation. The different steps and process of the methodology are discussed in correlation to this research. Since the aim has also been to develop a working e- and m-support system, the information system design theory used during development is introduced as well as the various survey techniques and methodologies. This chapter is concluded with a summary of the relevant data introduced earlier. The practical use of the methodology is discussed further in chapter 5.1.

3.1 Information System methodology jungle

Within the field of IS there are several methodologies that have been used to guide research. The aim is to shape the information system to meet the designated requirements of the IS project, and therefore several different types of methodologies have been used within IS research. Perhaps the methodologies most commonly used are case studies, natural science research, design science, action research methods and action design research.

Some IS artifact development studies and theory building research have been done with the case study methodology (Plummer, 2001). The case study method was introduced by Yin 1992 as an evaluation tool. With case studies one can extend the experience to what is already known from

previous research. The method can be used in many research areas, since the basic idea is to implement the research question to cases and then analyze the results (Yin, 1992). A combination of the case study methodology and usability context analysis by Thomas and Bevan (1996) were used in the RFID study done by (Masters and Michael, 2007).

IT research methods have been scrutinized to implement common standards within the IS and IT community. IT has according to March and Smith (1995) two types of scientific interests; descriptive and prescriptive. Descriptive research derives from natural science, since we seek knowledge and understanding of IT, but prescriptive research goals are to improve performance i.e. we use our current knowledge to improve IT performance (Hevner, *et al.*, 2004; March and Smith, 1995). However Iivari (2007) finds this approach too straightforward to be fitting for all applications. Furthermore, he suggests that the typology for IT applications should be categorized into seven archetypes (Iivari, 2007). Design science is linked with natural science and both are used in IS and IT research. Where design science attempts to create something for human purpose and then evaluate it, natural science is used to understand reality by discovery and justification (March and Smith, 1995). In a way it is like looking at the same penny from two sides, both methodologies can be used for IT and IS research, depending on the purpose and goal for the research. In fact March and Smith argue that "… appropriate framework for IT research lies in the intersection of design and natural sciences." p. 255, (March and Smith, 1995). We can even compare with each other design science (DS) and natural science (NS) research activities to find the common ground between these two research models. DS research activities are: build and evaluate, which parallels to discover and justify within NS research (March and Smith, 1995).

For this research, neither DS nor NS were considered to be the most appropriate research method to use, although Action Design Research (ADR) is a derivative from DS. The iterative processing that was required to construct a support system is not part of NS or DS research methodology per se. Iivari suggested in his 1991 article that a methodology he called "constructive research" should be used when the research goal is to build an artifact (Iivari, 2007). He did not detail this method, but found Nunamaker *et al*. (1990-1991) proposal of four

research activities; theory building, experimentation, observation and system development, interacting with each other as a valid approach (Iivari, 2007) and (Nunamaker and Chen, 1990). The later introduced ADR was however a more suitable methodology because of the many stakeholder groups involved in the development phase of the system.

An IT artifact is often subjected to a study from the IS behavioral-science perspective, or the IS research is done to create and evaluate an IT artifact (Hevner, *et al.*, 2004). As a framework for IS research Hevner *et al*., (2004) suggest the use of both behavioral-science and design-science paradigms. Design science is research through building and evaluation of artifacts (Hevner, *et al.*, 2004), whereas the Action Design research (ADR) presented by Sein *et al*., (2011) generates knowledge through building and evaluating an IT artifact within an organizational setting. The DS as presented by Hevner *et al*., (2004) also uses iterations to search for the optimal solution, as does ADR. The idea in DS iterations is to divide and simplify the main problem into several sub-problems that are then researched as such. Once the sub-problems have gone through the iterative research cycles, they can then be combined together to find a solution for the main problem (Hevner, *et al.*, 2004).

3.2 Similar work but which methodologies have been used?

Since this study is partly tangential with research done within the healthcare and veterinary industry some of the methodologies used in other works have been reviewed to compare their methodology approaches. In these studies qualitative surveys and literature reviews, integrating surveys, narrative data and epidemiologic studies are some of the methodologies used (Hartig, *et al.*, 2013a; Hartig, *et al.*, 2013b; Weitzman, *et al.*, 2010). These studies are however done for the field of medicine, and thus their research aim somewhat differs from this study.

Design science has been used as the methodology in several scientific papers that are somewhat similar to this dissertation's research, since partly the objective of these papers has been to build an IS product

(Carlsson, *et al.*, 2008; Carlsson and Walden, 2010; Krause, *et al.*, 2013; Radzuweit, *et al.*, 2013). The DS research methodology does not specifically take into account the end-users of a product that is being developed. In fact Hevner *et al*. (2004) warns users that they should not emphasize too much the technology development, but to maintain a strong theory basis for the DS research, which in itself was not the goal for this research. Therefore, although DS is a highly popular methodology to be used in IS research; it does not satisfy the methodology needs or the aim of this research

3.3 Action Research and Design Science

For this research the perfect methodology was found from a methodology that consisted of a combination of action research (AR) and design science (DS), presented in the 2011 paper "Action Design Research" by Sein *et al* (2011). Already in 2007 Sein *et al.*, had published papers about ADR receiving mixed criticism, but also Järvinen, in his article, studied the similarities between action research and design science in IS to prove that they are both valid and usable research methods to use (2007). Both methodologies are based on similar cyclical design and development routes, where evaluation and learning play large roles. Design research and design science are viewed as the same, but here, to avoid confusion, the term, Design Science (DS) will be used.

Action Research is described as a cyclical process; Diagnosing-> Action Planning -> Action Taking -> Evaluating -> Specifying learning-> Diagnosing… -> …-> etc. by Susman and Evered (1978) cited in (p. 126 Järvinen, 2004). Later in Järvinen's (2007) paper, he compares this AR cyclical process with the general DS methodology (see **Figure 7**) (Vaishnavi and Kuechler, 2012). In the end Järvinen found many similarities between AR and DS processes (Järvinen, 2007). He proposed that both action research and design science can be used as similar research approaches, since both are iterative in nature, and in both the process is evaluated. A few years later Sein, *et al* (2011) combined them to support new diverse research needs.

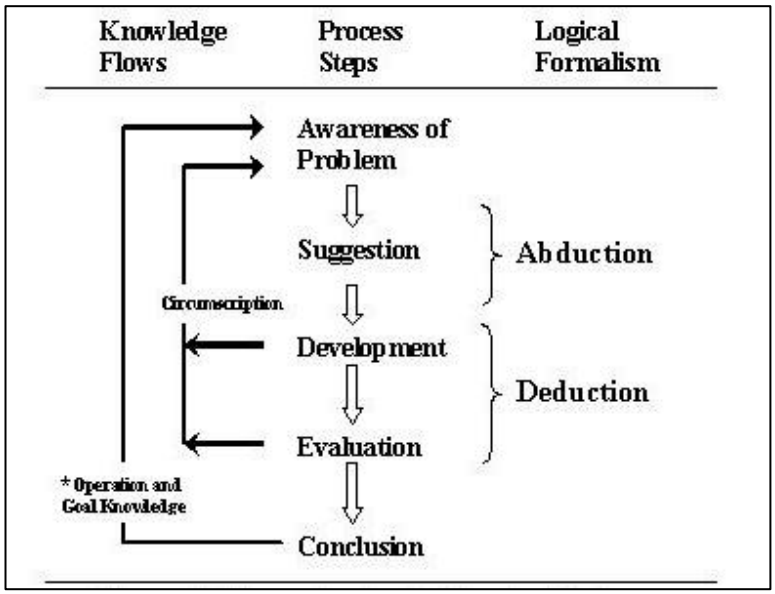

Figure 7. The General Methodology of Design science (Vaishnavi and Kuechler, 2004).

Järvinen summarized the fundamental characteristics of action research and design science into seven main "pairs", to demonstrate the two methodologies similarities. Of these pairs, two were distinctly characteristic for ADR and this research. These two pairs are introduced below

> *AR-3: Action Research means both action taking and evaluating*
> *&*
> *DS-3: Building and evaluation are the two main activities of design science*
>
> (Järvinen, 2007 p. 51)

The pair, as Järvinen calls them AR-3 and DS-3 both have characteristics of building something or taking action then stepping back to evaluate it. This is also characteristic for ADR's that will be discussed further in section 3.4.

The second pair from Järvinen's paper is

AR-7: Knowledge is generated, used, tested and modified in the course of the action research project
&
DS-3: Knowledge is generated, used and evaluated through the building action.

(Järvinen, 2007 p. 51)

These two research approaches from action research and design science, basically have the same message. Partially action design research methodology also follows AR-7 and DS-3's lines, as will be presented in the next section (although probably when going into more detail, many noted IS scholars will disagree with this statement). The similarities of the DS and AR approaches have also been noted by other researchers, as Sein *et al.,* (2011) points out. However, they also found research evidence on the dissimilarities in DS and AR (Iivari and Venable (2009) cited in Sein *et al.,* 2011). Sein, *et al.,* (2007) were already combining AR and DR in 2007, with mixed reactions.

3.4 Action Design Research methodology

In all simplicity, Action Design Research (ADR) focuses on two distinctive consecutive challenges; addressing a problem by intervening and evaluating it within an organizational setting and then constructing and evaluating an IT artifact that addresses this problem (Sein, *et al.*, 2011). The goal of this research is to introduce and understand the veterinarians' as well as the other stakeholder groups' needs and develop a system that would meet them. To fully meet the requirements presented, the system has to be built in a way that the stakeholders take part of the development. This will require several construction and evaluation phases, so that optimal solution is achieved (Cole, *et al.*, 2005). Therefore the research methodology Action Design research by Sein *et al*., (2011) is to be used, since it best suits this type of research and product development. Although this research is not done within an organization, ADR can still be used, since the stakeholder groups represent a whole industry, with similar goals, as does an organization. As has been mentioned earlier ADR is partially derived from design science. When IS

research is used for the development of an IT application, the research includes design science qualities (Iivari, 2007).

ADR is properly identified and sequences in four stages (Sein, *et al.*, 2011). Stage 1 Problem Formulation. Stage 2, Building, Intervention, and Evaluation (BIE) where the problem framed in stage 1 is used to build a general design for the IT artifact. The design is then "tested" or intervened and evaluated within the organization. Thereafter the IT artifact's design is reflected upon, i.e. stage 3 Reflection and Learning. The first three stages are cyclically iterated as many times as necessary so that the end product meets the requirements (see Figure 8). When comparing this cyclical process of ADR with the two cyclical processes introduced earlier (AR and DR) the same familiar steps and goals can be found. With the ADR the cyclical iterations can be evaluated faster, and different users can be better taken into account, until the "final" evaluation happens in stage four. This type of approach suits a research and system design, where the product should be developed to meet several end-users and practitioner needs, yet have one common goal.

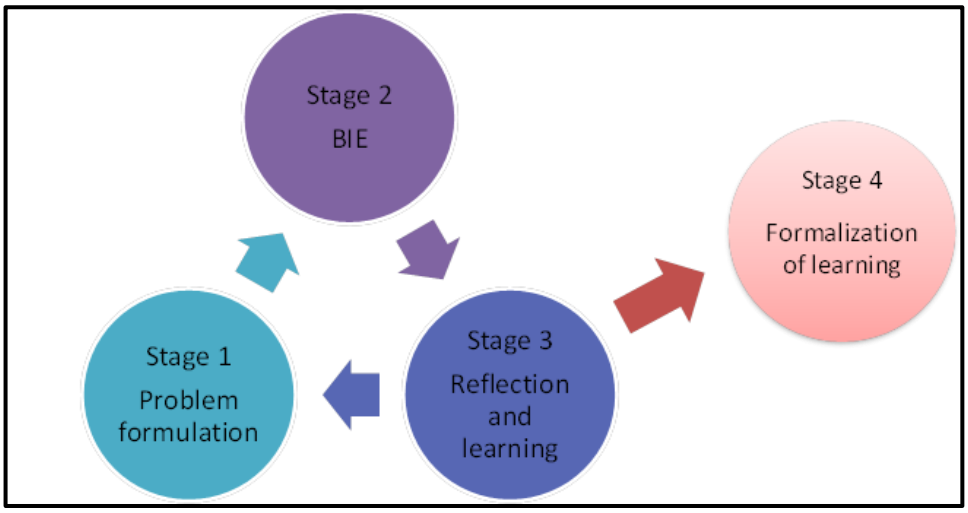

Figure 8. The ADR method pictured in a simplified way

The Problem formulation can be divided into two separate principles, namely "the Practice-Inspired Research principle" or "the Theory-Ingrained Artifact" (Sein, *et al.*, 2011).

In stage 2, the Building, Intervention, and Evaluation (BIE) is divided into two end points; IT-Dominant BIE and Organization-Dominant BIE (Sein, *et al.*, 2011). The IT-dominant spectrum end is ideal for situations where the ADR team consists of people who build the innovative technology and they have an active dialog with a small group of people who are specialists in the area for which the technology is developed. First, when the technology is developed to a satisfying point, will it be introduced to the end-users (see figure 9) ADR that is done at the organization-dominant end is in essence developed throughout the whole width of the organization. (Sein, *et al.*, 2011)

In Figure 9 the IT-Dominant BIE schema is presented, since this is the BIE that will be used in chapter 5.

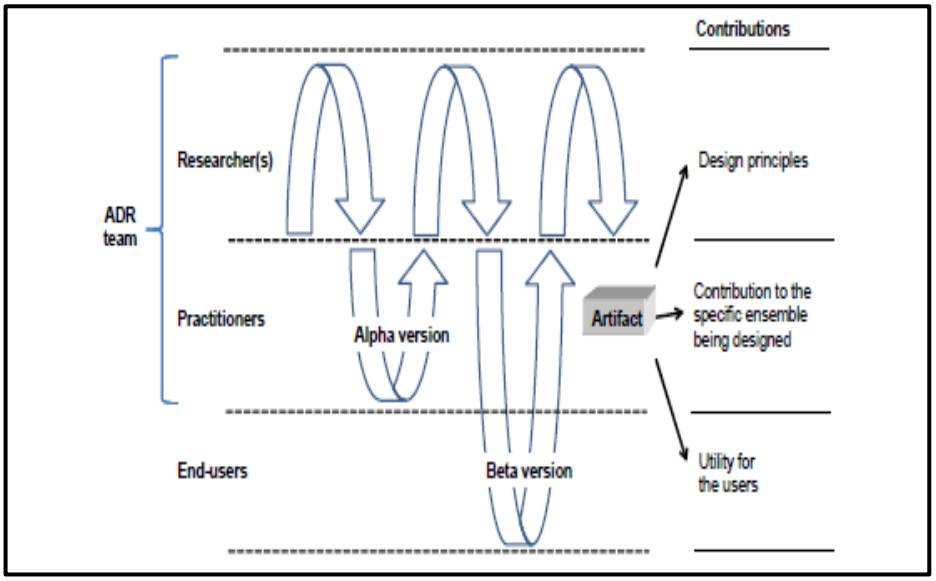

Figure 9. ADR stage 2 IT-Dominant BIE as presented in Sein *et al.*, 2011.

When comparing figure 9 with Hevner *et al.,* Test Cycle figure in "Design Science in Information Systems Research" (2004) (p. 89) it seems to be a more simplified version of Sein *et al.,* (2011) figure, although it has the same purpose.

3.5 Information Systems Design Theory

Information systems design theory as described by Walls *et al*., (2004) is when a theory integrates descriptive and nominative theories to build a more effective IS. In the research done by Ngai, *et al.*, (2009) the design theory used was the one developed by Walls already in 1992. The 2004 Walls *et al*., paper is an assessment and re-evaluation of their original theory published 1992 (Walls, *et al.*, 2004). This theory however does not take into account a design for a product, and therefore the theory has been expanded in an eight component system, to represent the whole Information System Design Theory (ISDT) (Gregor and Jones, 2007). Design science products can be separated into four types; constructs, models, methods and implementations (March and Smith, 1995) and (Walls, *et al.*, 2004). However, the article by Gregor *et al*., (2007), indicates that although constructs, models and methods can be connected to a theory, implementation (instantiation) cannot. Gregor *et al*., (2007) proposes that a design theory's goal is either methodology or a product.

In this case, the problem is how to get the stakeholders to use a new support system and especially the stakeholders who will mainly enter data into it, namely veterinarians? Therefore it is vital that the veterinarians and other stakeholders are involved in the development of the support system. In the project studied by Han (2005) and Harkke (2006) the Physicians were not consulted beforehand of their needs for the support system, so it was more or less designed by programmers and other people, i.e. it was done in a top-down approach. The project success rate in terms of how many physicians used the system was not very successful, where the top-down approach could be one of the underlying factors. To avoid such mistakes it is vital that the *m-equine* system will be developed with a bottom-up approach so that the stakeholders' input is noted throughout the development.

In an ideal situation (for a researcher) the veterinarians and other stakeholders could be all brought to a laboratory where they could be monitored, and would work with the support system. With their feedback, the system would be developed further. Naturally this is not possible, plausible nor even ideal. In reality, veterinarians work around the county, unexpected things happen all the time, and system has to be developed to accommodate this. The next option would be to have the veterinarians write a field report everyday, of what they have been doing, but since they claim not to even have time to learn how to use a new smartphone, it is doubtful that they would write field reports. Therefore, the best option to gather information was to make surveys, interviews and follow different stakeholders around to monitor their daily routines at their work.

3.6 Survey methodology

To acquire facts and knowledge through the ADR iterations, surveys were used in some situations. The survey research methodology that was used is defined within the dimensions described by Pinsonneault and Kraemer, (1993). According to their classifications a survey research can be exploration, description or explanation in nature. In the exploration survey research the main interest is to discover the responses likely to occur in some populations, while in descriptive research survey, the aim is to find what is occurring in a population. Both of these methods are used in cross sectional research. For longitudinal research, the method to be used is explanatory, since this type of survey research explains the relationships between variables. (Pinsonneault and Kraemer, 1993)

In Table 1 the minimum dimensions of Survey studies are introduced. Some aspects that Pinsonneault and Kraemer (1993) criticize are that within the management information systems' researches done in the past, many are lacking diversity in research methods, especially for explanation and exploration studies. In Table 2 there is a summary of their assessment for exploration and description surveys done within the management IS researches. Only these two research methods are presented here, since they are the survey methods used. In chapter 5 the survey research methods and survey results are compared to the assessment summary. The

weaknesses and statements that Pinsonneault and Kraemer (1993) have noted in Table 2 are assessed against survey results.

Element/Dimension	Exploration	Description	Explanation
Research Design			
Survey type	Cross-Sectional	Cross-Sectional	Cross-Sectional and longitudinal
Mix of research methods	Multiple methods	Not necessary	Multiple methods
Unit(s) of analysis	Clearly defined	Clearly defined & appropriate for the questions/hypotheses	Clearly defined & appropriate for the research hypotheses
Respondents	Representative of the unit of analysis	Representative of the unit of analysis	Representative of the unit of analysis
Research hypotheses	Not necessary	Questions or hypotheses clearly stated	Hypotheses clearly stated
Design for data analysis	Not necessary	Inclusion of antecedent variables and time order of data	Inclusion of antecedent variables and time order of data
Sampling procedures			
Representativeness of sample frame	Approximation	Explicit, logical argument; reasonable choice among alternatives	Explicit, logical argument; reasonable choice among alternatives
Representativeness of the sample	Not a criterion	Systematic, purposive, random selection	Systematic, purposive, random selection
Sample size	Sufficient to include the range of the phenomena of interest	Sufficient to include the population of interest & perform statistical tests	Sufficient to test categories in theoretical framework with statistical power
Data Collection			
Pretest of questionnaires	With subsample of sample	With subsample of sample	With subsample of sample
Response rate	No minimum	60-70% of targeted population *	60-70% of targeted population *
Mix of data collection methods	Multiple methods	Not necessary	Multiple methods

* Babbie (1973) and Dillman (1978)

Table 1. Minimum Dimensions of Survey Studies by Purpose (Pinsonneault and Kraemer, 1993 p. 86)

By exploring Table 1, and especially exploration and descriptive columns that are the survey methods used in this research, a few questions arise. Since this survey methodology was originally designed for management IS research, there are a few things that are not quite necessary for a research with veterinarians and other stakeholders around horses. Cross-sectional study is referred in this case to time dimension, and is longitudinal, if the survey is conducted in several points of time (Pinsonneault and Kraemer 1993). For the exploration survey in this situation there is no need for multiple research methods, since surveys will not be the only study method used (see section 5.2. iteration I). The units of analysis here refers to the *m-equine* system or other IS functionalities.

Some of the problems and inadequacies that Pinsonneault and Kraemer (1993) have discussed in Table 2 can be dismissed in the surveys, which are introduced in chapter 5. However there are several notions in Table 2 that should be considered and taken into account when designing the surveys, such as defining the analysis units and justification of sample choice in the descriptive survey.

Element/Dimension	Exploration	Description
Research Design		
Survey type	Adequate	Adequate
Mix of research methods	Need more use of multiple methods	Not necessary
Unit(s) of analysis	poorly defined	poorly defined
Respondents	Need to increase the number of respondents	Need to increase the number of respondents
Research hypotheses	Adequate	Adequate
Design for data analysis	Not necessary	Need to include time order for hypothesis-testing
Sampling procedures		
Representativeness of sample frame	Adequate approximation	Need better explanation and justification of choices
Representativeness of the sample	Adequate	Need more systematic random samples
Sample size	Adequate	Adequate at individual level; inadequate at organizational level
Data Collection		
Pretest of questionnaires	Need more reporting on tests	Need more reporting on tests
Response rate	Poor	Very poor
Mix of data collection methods	Need more use of multiple methods	Not a criterion

Table 2. Summary Assessment of Survey Studies by Purpose (Pinsonneault and Kremer, 1993 p. 83)

Chapter 4

Mobile and IT solutions

Smartphone architecture, functionality and design have developed in new dimensions during the research done for m-equine. Today apps and internet connectivity and even owning a smartphone is commonplace in the western society, which was not the case in 2009, when the study begun. The new developments in mobile software and hardware have opened new business and innovation opportunities. The power play within the mobile market has dramatically changed, since smartphones have brought new and old players back into the game. The different platforms and functionalities that the different smartphone brands offer can confuse a customer, but also make him loyal to one brand in all his IS and entertainment needs. The Internet and information is always at the customer's fingertips and we are getting accustomed to being able to access all information anywhere anytime. Today's top of the line smartphones and mobile pads have such memory, and operational capabilities, they can access and work as fast as computers, and are therefore viable work tools in environments where computers are not handy to use. Smartphones have also developed to help the users in ways that computers cannot, such as smart touch, and voice command. Also the smartphone has interactive applications that, in essence, help other applications to perform. It might be just a matter of time before in hardware; computers, notepads and phones all merge into one devise. Apps alone do not really have that much value, but they are the access points to different web-based services, etc. People want to separate apps from web services, but most apps need, in some point, web connectivity to work, and the more complex apps might need web-access all the time. For m-equine the technology platform will be web service based. The web service will be adaptive for smaller mobile phone screens, but otherwise the webpage is the same as on a computer. Therefore the technology platform does not include an app.

Cloud computing enables information to be accessed fast since nothing is stored in a server physically per se, but online. This sometimes makes people nervous, since they think that it is a security risk, but in fact, it is as secure as having information stored in a server somewhere. Security is ensured by sufficient encryption software. Cloud computing with mobile devices, enables them to get access to even larger data, than the device itself could store. This requires internet connectivity, which smartphones have. Mobile cloud services are advantageous to use among other things, with sensory data. Sensory and other data gathered from the mobile device(s) can be combined with each other to form a new type of knowledge (Fernando, *et al.*, 2013). This enables new query possibilities, and time accurate data collection on the field.

Different types of tracking systems are commonplace today. These include barcodes, QR codes and RFID. Barcodes have been around already for quite some time but QR and RFID offer some new aspects. QR codes or a 2-D code as they are also called, represents "Quick Response" code. QR codes can store more information in a smaller space than traditional barcodes. Smartphone users can usually download for no charge, an app that will allow their phone to become a QR-code reader, therefore they have become very popular, and a marketing avenue.

RFID has penetrated the market in many aspects especially within logistics and other B2B situations. For B2C relationships Near Field Communication is used in e.g. public transportation. NFC is basically RFID technology for frequencies that require close proximity between the reader and the tag, usually about 3-5 cm. NFC in combination with mobile technology has tried to penetrate the market for several years, yet so far, there are only a few success stories such as HongKongs "Octopus" system and a few mobile payment opportunities. The NFC forum is a non-profit organization, whose main objectives are to advance the use of NFC and to create standards for interoperability for all interested parties (www.nfc-forum.org). Nokia's Lumia phones are equipped with NFC technology, and many other smartphone manufacturers are following suit. The NFC enabled smartphone can operate as a reader, writer or tag, depending on situation and what options the smartphone features.

4.1 Background

Although veterinary science has developed much in the last few years and many notable publications have been made in the field, there is not much research where both veterinary work and IT tangents, except when discussing how technical advances have enabled new surgery technics etc. (Powell, 2012) and Schaefer *et al.*, 2012). In the human healthcare sector, much work has been done to achieve an electronic patient database and to try to get all medical information in electronic form (Stankovic *et al.*, 2005; Troshani and Wickramasinghe, 2013; Hansen *et al.*, 2011) . This development has been apparent and much discussed throughout the world. Today, the notion of having IT and mobile technology aid a veterinarian who specializes in Equine medicine and/or does many "house-calls" to stables in his/her practice is almost nonexistent. Therefore to research this topic, it is necessary to research what has been done in the tangential fields. In Figure 10 the various fields that are studied to achieve the required background knowledge for this research are presented.

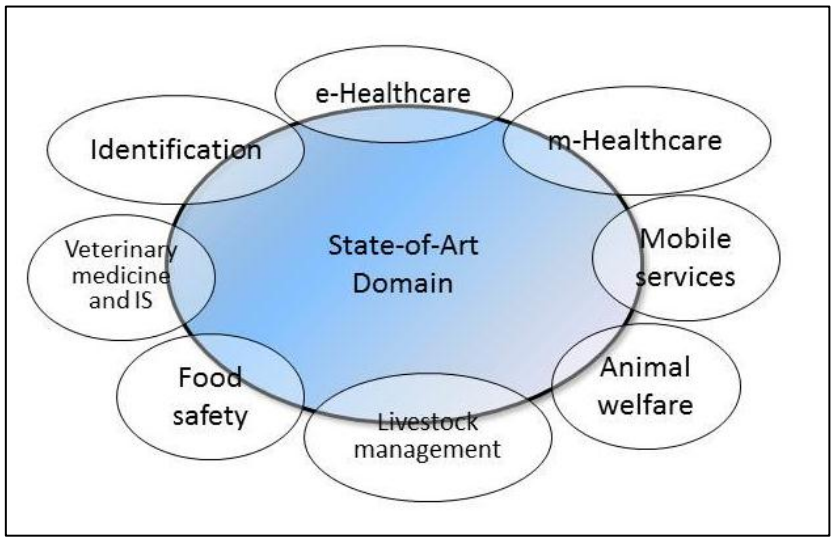

Figure 10. State-of-Art

There is little research done within the field of e- or m-veterinary health care, therefore research within the human e- and m-healthcare is studied to get an idea of what has been done and to avoid problems that have been

encountered there. Most of the equine veterinary medicine and IS research have been done in Scandinavian countries, but only a very limited number of these types of research papers have been published, therefore some of the literature review has been done within veterinary medicine and IS for small animal practices. Livestock management is well studied around the world, and many advances and research papers have been done within this field. The needs for improvement in food safety monitoring and animal welfare monitoring are just a few of the reasons that this field has been in a state of change. Since horses are seen as livestock animals according to many national laws, and the horse industry is scrutinized for animal welfare, these topics are relevant for this research. One key element to improve livestock management is a proper identification system for animal welfare and food safety. Within the horse industry many different identification systems are used, and none is 100 % reliable. Old customs, privacy issues and fraudulence are making the adoption of new safer IT-supported systems difficult to implement. Some of the issues raised in the identification discussions are very closely related to the human medical IT discussions. Since neither the animal nor human healthcare industry yet has a well established IS solutions. Other mobile services are studied to give a background to what can be done, and what has already been done.

The following sections will present recent studies in Identification and food safety, e- and m-healthcare, veterinary medicine and recent IT developments in it, including today's mobile services and applications within both the human medicine and veterinary medicine world. All of these research areas are regulated by laws and regulations, of which the more important ones for this research have been introduced in chapter 2. Since the literature review research papers have been done around the world, in some cases different laws might apply.

4.2 Identification and the benefits from them

Identification of people and material has become important for inventory reasons among others. RFID and other electronic tagging of material have helped companies to monitor inventory, transportation, installation and returns etc. In some of the traditional fields of industry, new technology is difficult to get implemented into the everyday work routines, because people are used to doing things "the old way" and do not want to change.

Veterinarians are skeptical towards new technology in their workspaces, as is the situation in many traditional industries. In traditional industries, such as veterinary, and construction industry IS can only be used as a support tool, to the actual main business. In the beginning of the 21st century, a pilot program by Buildercom was done in a few large Finnish construction sites. Some of the material was tagged with NFC tags, and were electronically "checked-in" with a NFC mobile phone, when the material came to the worksite. Also at this point, any defected items were noted, and information about these items was sent back to the manufacturer. This made the production chain more transparent, and problems could be rectified fast (Leskinen, 2008). In this same project, some of the construction sites' safety monitoring people were given a mobile phone with which they were to record all safety sightings they made daily. This was previously done manually at first the safety monitors did not want to start to use the mobile device for the task. After they started to use it, they became so enthralled with it that they did not want to go back to the old system. One inspector actually refused to continue to work, until he got a new mobile phone, after he accidentally dropped the old one. (Leskinen, 2008)

As mentioned in chapter 2, horses are still identified by different standards throughout the world. There are heated discussions on which identification method is most secure, humane and not too costly and cumbersome to use. In EU and according to FEI regulations horses have to be microchipped, which is basically a RFID chip inserted into the animal. A RFID tag that is either inserted into the animal's skin, or the RFID tag is fastened to the animal's ear for identification of livestock and pets. In many countries a RFID tag is mandatory for specific livestock, so that it is possible to track the animal (Trevarthen, 2007; Voulodimos, *et al.*, 2010). Accurate animal movement tracing also ensures that possible epidemics can be tracked and actions against further spreading can be done (Disney, *et al.*, 2001; Petersen, *et al.*, 2002). Some studies have also shown that an animal's identification can be read from a larger distance, and/or multiple animals can be identified at the same time (Leong, *et al.*, 2007; Swedberg, 2008). These features are of value when working with animals that might be shy towards people. For horses the RFID microchip is inserted into the neck, because an ear tag is not a viable option for animals in sports. A horse's microchip can be difficult to read, because some horses get very nervous when a strange person handles it or they might just be skittish around their head. Therefore it would be useful even

with horses if there were a possibility to read the microchip from a distance of more than one meter.

One problem that has raised much debate within all the horse sports is the opposition of inserted microchips: Can a microchip implantation cause foreign body reactions or tumor formations? In countries such as Germany microchip identification has met resistance since hot branding horses has been the way to identify animals for hundreds of years. Branding has been seen as a more reliable way to identify a horse than microchips, since there is fear that someone could replace the tag with another one. In Germany horses are branded with the breeding associations brand and number, but these cannot always be seen, which in turn deflates the presumption that branding is a more reliable way to identify a horse than microchips. Branding has been proven in multiple studies to cause much more pain to the horse than inserting a microchip. Furthermore, identifying with branding is only reliable in 30-50 % of cases where as the re-readability of microchips is very high (Lindegaard and Andersen, 2012). Horses could be identified by their eyes, since they are as unique as human fingerprints, but the technology to do this is still at its early stages.

4.2.1 RFID and identification

RFID is seen as a key component for a national livestock monitoring system (Trevarthen, 2007; Trevarthen and Michael, 2008; Michael and Michael, 2009b). At the moment of Trevarthens study, 2007, he stated that the larger the farm the more it would benefit from RFID and monitoring systems. Later though, it has been proven that RFID can be useful and beneficial also in smaller farms (Samad, *et al.*, 2010).

A passive RFID tag can store up to 4 kB of data. Most common standards used for animal identification microchips are ISO11784 and ISO11785, which complies with the FEI regulations for horses in equestrian sports. Electronically identifying cattle is especially in the western countries commonplace, and standardization of RFID frequencies to be used in animal identification has even helped to monitor livestock transportations (Ruiz-Garcia and Lunadei, 2011). The study by Ruiz-Garcia and Lunadei (2011) furthermore implicates that RFID is one of the reasons that farm

management has developed and is more efficient today than it was only a few years back. One large problem that RFID has in comparison to traditional bar codes is that it generates 10-100 times more data and therefore the monitoring software has to be able to process all this data without loss of speed and efficiency. Since there are still several different RFID frequencies used for animal identification, it would be more convenient to either restrict the RFID standard to be used to one, or have readers that can process multiple frequencies, i.e. "agile" readers as these multiband readers are called in Mallison (2005) sited in (Ruiz-Garcia and Lunadei, 2011).

When moving horses within EU they need to be accompanied with their national passport, which states their life number, and they need to be microchipped or branded for identifying purposes (See section 2.1.3). Similar regulations are also in the USA (Swedberg, 2007), UK and other countries. A horse's microchip cannot be hanging outside their body, as an ear tag on e.g. bovine animals, since it would impair the animal. A horse's microchip is therefore entered into the skin of the neck, but the standards of various microchip companies vary. The microchip can have a different frequency standard than the reader, so one might need more than one reader to be able to identify horses. FEI has enforced a new identification regulation starting January 2013, where horses competing at an international level have to be microchipped and only two types of microchip frequencies are to be used (FEI, 2013).

4.2.2 Identification and epidemic control

In studies conducted in Australia the need for bovine identification has been identified as a key concept for business management and traceability (Trevarthen, 2007; Trevarthen and Michael, 2008). A RFID tag can be used to monitor an animal's change of ownership, as well as its location changes inside a country. The information is thus traceable and used from the farm, to the slaughterhouse; all the way to the dinner table. Trevarthen (2007) also states that the system implemented in Australia promotes safe, disease-free animals and animal products from Australia. In EU, livestock and horses have to be identified and monitored in the same fashion as in Australia, as has been introduced in section 2.1.3, to promote transparency in the food chain. Still is it enough?

In 2001 a positive correlation was found between electronic animal identification inducing traceability and disease control in a study done in USA (Disney, *et al.*, 2001). In their paper they also found benefits with electronically managed animal identification in discovering and preventing the spread of e.g. hoof-and-mouth disease (Disney, *et al.*, 2001). At this point animal identification was not so sophisticated in USA so they took examples from Europe. A few years later, a study was done on tracing animal movements, the benefits thereof and mapping out a possible outbreak of foot-and-mouth disease (Mardones, *et al.*, 2013). This and other examples provide ample proof that proper reliable identification of animal does help to prevent diseases to spread among local equidae, as is asked in RQ4 b. This is however only part of the answer, since some animals, including horses are not monitored live during transportation, and therefore there is no knowledge if it could have been in contact with local animals during its transport thru a foreign country.

It has also been suggested, that if an animal were tracked during medical procedures and transportation, with the help of a mobile phone's GPS capability, it could enable monitoring the history of the animal's whereabouts. This logically leads to the possibility of tracking, containing disease outbreaks and promoting animal welfare (Pettitt, 2001; Teng, *et al.*, 2012). In these before mentioned studies the animal's proper identification was of the essence. There have also been studies on epidemic outbreak monitoring systems for low-income countries (Lin and Heffernan, 2011; Robertson, *et al.*, 2010). In several low- or middle-income countries a study was done to monitor HPAI ("bird flu") out-breaks. The system has mobile input that is linked to a database, which allows real-time tracking and mapping of an epidemic (Lin and Heffernan, 2011). These studies show that monitoring and controlling epidemics can be done with a smaller budget and do not necessary require heavy IS investments. There is also proof of the opposite, since in China a research project showed that an RFID based system had implementation costs that were too high and other system adoption barriers were inputting information and communication mechanism with RFID reader (Feng, *et al.*, 2013). This study however was not using already proven methods that have been in use in e.g. Australia, Europe and USA.

4.2.3 Identification and food safety

Identification of the animal and/or meat and food safety go hand in hand, since with only reliable identification can we ensure that the meat that is in the food chain is (a) the meat from the animal it is supposed to be and (b) it does not have trace elements of medicine that can be harmful for people. Proper identification with RFID technology promotes the use of IT services that help tracking the animal geographically and through the food chain. Certification of an animal's health is necessary for a farmer and ensures the flow of vital medical information throughout the production and food chain (Petersen, *et al.*, 2002). This type of identification also supports control of epidemic outbreaks (Disney, *et al.*, 2001; Petersen, *et al.*, 2002; Wang, *et al.*, 2006). In the Disney *et al.* (2001) study they state that proper 'id' also promotes the safety of food to consumers. In 2011 approximately 16.7% of the American population fell ill due to a food related occurrence (Resende-Filho and Hurley, 2012 cited in (Bosona and Gebresenbet, 2013). To maximize food safety, food traceability systems have been developed and implemented. These systems promote improvements in customer satisfaction, food crises management and agricultural sustainability (Bosona and Gebresenbet, 2013). It has been proven that real-time information leads to faster responses to a potential problem (Lin and Heffernan, 2011).

In the study by Pettitt, (2001) the increasing problem of meat traceability from the farm all the way to your refrigerator has been discussed. In UK there was an increasing need for improvement of monitoring and tracing livestock animals, especially after the mad-cow disease and swine & hoof disease episodes. After these epidemics a database security system has been developed, to trace potentially sick animals before they infect larger populations. Apart from making sure that livestock is safe for human consumption, there is also an increasing demand for information on how the animal has been treated. Laws mostly govern the minimum requirements, but stringent animal welfare requirements also need to be met, to avoid altercations with Animal Rights movements (Pettitt, 2001). Today medication and possible transferable disease information for livestock and horses have to be traceable throughout the animal's life in e.g. EU, Australia and USA.

In France people came in contact with the ethical challenges within the production animal industry when the mass destruction of animals with

BSE was reported. These occurrences highlighted the need for transparency within the food chain. Thereafter tracking and tracing of the whole food supply chain has become mandatory in EU. The current systems that support food chain traceability are among others, FarmingNet and Sanibase, which have been developed and used with the co-operation of the farmers (Wognum, *et al.*, 2011). In Finland the equivalent systems are Naseva and Sikava (www.naseva.fi and www.sikava.fi). Wognum *et al*., (2011) noted that legislation should be modified to comply with the need for cooperation within the food chain. The government's role should be to stimulate and improve competitiveness (Wognum, *et al.*, 2011)

This section gives answers to RQ4 b and also partially to RQ4 c.

4.3 E- and m-healthcare

For the last ten years the digitalization of human healthcare has been a hot topic for both researchers and media. Several of the recent healthcare studies involve IT, smartphones and mobile technology. Various adaption models, business models and technology requirements are only a few questions that need to be answered (Boulos, *et al.*, 2011; Hansen, *et al.*, 2011; Michael and Michael, 2009a; Ngai, *et al.*, 2009). The development in mobile technology has enabled mobile phones and other mobile platforms to be used in one's profession, including healthcare (Free, *et al.*, 2010). In 2010 there were over 7000 documented cases of mobile phones being used in healthcare (Kailas et. al (2010) cited in (Boulos, *et al.*, 2011)). Smartphones and today's broadband connections have enabled possibilities that the previous mobile generations did not. Various applications and web services have revolutionized the way we use mobile devices. In healthcare, trials have been done from cardiac-rehabilitation programs (Hansen, *et al.*, 2011) to smartphone systems for doctors (Choi, *et al.*, 2011). One of the initial problems with m- and e-healthcare is to recognize in which healthcare areas it is beneficial to use mobile technology, who needs to use it, and thereafter how to properly categorize the different scenarios (Baru, *et al.*, 2012; Free, *et al.*, 2010; Hoffman and Podurski, 2008). Free *et al*., (2010) studies and categorizes the usage of various mobile devices in different healthcare situations from a technological point of view.

One of the challenges that e- and m-healthcare have faced are finding right business models and how to solve the complex privacy issues (Boulos, *et al.*, 2011; Ngai, *et al.*, 2009). Ideally a patient's relevant medical information should be available to the right people, without compromising the patient's rights for privacy. Naturally horses do not have such rigorous privacy issues, but still their value might be negatively affected if the medical records were open to the public. Furthermore depending on the legislation of a country, an animal's health information is either transferable to the new owner, or is the property of the vet and only accessible for the owner of the animal at the time being.

RFID has also been introduced to the healthcare industry, as a key-element in a healthcare management system. In their proof of concept study, the RFID tags were used to monitor patient drug intake, location and tracking of pharmaceutical inventories (Ngai, *et al.*, 2009). Farm management systems have been built in a much similar way, and will be discussed further in section 4.6.

4.4 Mobile services and applications supporting medicine

In her 2005 published doctoral thesis, Han (2005) studies the physicians' attitudes towards mobile services, which can, to some extent, be transferable to veterinarians' attitudes. A clear difference between a physicians' and veterinarians' work methods, in view of their need for mobile and IT support tools, are that they have very different working environments. If the equine veterinarian is working in the not-so-sanitary horse stable environment a mobile device could be useful to enter treatment information etc. This would not necessarily be the situation for physicians since they can usually enter data directly to a computer in their office. Han's dissertation points out some physicians' reluctance to implement new technical elements into their work, which somewhat complies with the attitudes of veterinarians and therefore it is important to get them to try out the system, (Han, 2005). However, once the physician started to use mobile technology he/she was positively inclined towards the technology's usefulness and usage (Han, 2005).

A study, on the m-healthcare system called "Dr Smart", was conducted in the end of 2010, which basically studied some of the same elements as

Han's (2005) dissertation. The results showed that younger residents in their 20s and 30s were more likely to use the smartphones and the "Dr Smart" mobile application, than older residents (Choi, *et al.*, 2011). One of the problems in the Dr Smart study was that the physicians did not know how to download the Dr Smart application to their smartphones (Choi, *et al.*, 2011). Although Han's dissertation (2005) did not involve mobile apps, still some physicians never learned how to use the Nokia communicator or did not want to learn to use it because they felt it took too much of their time. Any new mobile support system for veterinarians will result in some of the same problems that were discussed in the "Dr. Smart" research and Han's thesis. Therefore to achieve high penetration rate within the field, users need training to use the system. This deduction is also supported by American research, which emphasizes the importance of training the users properly, to promote the usage of a new e- health system (Strum, *et al.*, 2012). Further development of a mobile support system should be done with the help of the veterinarians, thus ensuring a simple enough system for them to start using.

Mobile personal health record (mPHR) applications take advantage of the smartphone's unique features to monitor and update health issues. There are several mPHR applications available for iOS, BlackBerry and Android devices and their functionality was evaluated in a study by Kharrazi *et al*. (2012). Although they did not find applications with all the desired functionality, the research proved the overall functionality and requirements for m-healthcare applications (Kharrazi, *et al.*, 2012). Apart from mPHR there are also several healthcare related mobile applications available. The highest ranked m-health applications were tracking tools such as calorie intake etc. and amongst purely medical applications, various educational and reference tools for medical students and practitioners were ranked highest (Liu, *et al.*, 2011).

4.5 Veterinary medicine and IS

In the 03-Vet project, the aim was the digitalization of animal hospitals and for them to be compliant with the Information Technology standards (Zaninelli, *et al.*, 2007). In this project, some of the human healthcare standards had been reused and fitted to suit animal and veterinarian needs. One of the aims was to maximize data sharing using web-oriented technology. In 2012, Zaninelli *et al*. published a follow-up research paper

to the 2007 one. The research was done in Chile, where they concluded that mobile devices would be useful for veterinarians to use even in a clinical environment, since they would allow the veterinarian to move around more easily. The open source patient management software that was used in the research proved to be appropriate for a veterinarian clinic, since it could be customized for various veterinarian needs. They also noted that the use of models for clinical datasets could improve time management and system quality (Zaninelli, *et al.*, 2012). These studies done by Zaninelli *et al*., (2007 and 2012), provide initial answers to especially RQ1 a and RQ2 a & b.

A common veterinary medical database would also require a common terminology and data hierarchy to achieve a logical and understandable medical database (Bosona and Gebresenbet, 2013; Hartig, *et al.*, 2013b; Houe *et al.*, 2011; Zaninelli, *et al.*, 2012). The European Committee of Standardizations (CEN/TC 251) and Health Level Seven International (HL7) coordinate and collaborate in the synchronization of medical data and terminology. Both organizations' aims are to fix the framework and standards for electronic healthcare and to achieve a harmonious standardized medical information system that would work everywhere, without language barriers (*European Committee of Standardizations.* 2011; *Health Level Seven International.* 2011). However Houe *et al.* (2011) find it problematic to standardize medical terminology within the veterinary field, since it is not as evolved as human medicine. Diagnoses can become more specific and get "sub categories" with specific names in a very short period of time. Therefore a diagnosis from only a few years back might mean something slightly different than it does today (Houe *et al.* 2011).

Since 2008 when research for this dissertation begun, some similar research has been conducted in other countries. Both veterinary science articles by Hartig, *et al.*, (2013a) and (2013b) discuss the problems of today's situation and propose a common medical database to support veterinarian work with horses. The articles focus on a survey done in Denmark, where various stakeholders around horses reflect their opinion on a possible common database for horses. The stakeholders have been named as: Veterinarians, veterinarian students, researchers, animal welfare organizations, horse owners, horse trainers, farriers, authorities, citizens, laboratories, insurance companies, medical equipment companies and pharmaceutical companies. In a 2010 published article,

willingness to share personal medical data for research purposes was studied. It was discovered that people were rather agreeable to share their own medical data for research purposes (Weitzman, *et al.*, 2010). Therefore one could deduct that owners would allow their horses' medical data to be shared amongst equine veterinarians and researchers. Hartig *et al*, (2013a) research supports this conclusion, as 84% of horse owners were willing to submit their horse's data to a common medical database. This type of sharing would improve the quality of equine medical care and save costs for owners. In the Danish research there were various views about the ownership of the database. It was considered a political issue, and there was no clear idea on which authority would be most appropriate to govern it (Hartig, *et al.*, 2013b). This uncertainty of ownership also reflected the attitudes of the various stakeholders. Veterinarians were the most hesitant towards a more transparent medical history although a clear majority of them wanted to have a national health and disease database in Denmark (Hartig, *et al.*, 2013b). The findings in both papers from Hartig *et al*. suggest some answers to RQ2 d and RQ3.

Scandinavian countries seem to have an interest in medical databases for equine veterinarians. Apart from this research and the one done in Denmark, in Sweden, a study evaluated the need for computerized medical records at equine clinics (Penell, *et al.*, 2009). Studies have indicated that there is a high willingness to supply data for a colic database to help and support veterinarian work (Hartig, *et al.*, 2013a; Mair and White, 2005). Colic is a common illness for horses, but its treatment is still marginal, and very few clinics have the facilities to perform colic surgery.

4.6 Livestock management system

Livestock management systems were developed to aid farmers, veterinarians and other production animal stakeholders, bringing further transparency into the food chain, and supporting epidemic outbreak control. Herd management software and RFID technology allows conclusive animal identification, and monitoring the individual animal's performance and medical information. In such a system it is also easy to add animal movements, pasture data, growth data, purchase and sale information as well as carcass data (Ruiz-Garcia and Lunadei, 2011). In the studies done with the National Livestock Identification Scheme

(NLIS) in Australia, RFID technology has been proven to aid farm management (Trevarthen, 2007). RFID ear tags and the NLIS web based support system (https://www.nlis.mla.com.au/) supports in animal property changes, animal transportation etc. Trevarthen (2007) also discusses the importance of proper animal identification and its monitoring so that changes in the animals behavior or health problems can be noticed and reacted upon fast. In a study done a year later the temperature of a horse was measured with RFID tags to find the suitable period for insemination (Wallace, *et al.*, 2008). This research proved that an RFID chip can be used for purposes other than simple identification.

The problems, when using herd management software with traditional desktop applications are that there is a limited access to the actual desktop. This hinders information updating, since one farmer might have several farms, as well as several animals (Teng, *et al.*, 2012). Therefore a livestock management system should include mobile applications, to support and aid the farmers' work. In the Teng, *et al.*, (2012) study, data synchronization between mobile field devices and the desktop system required physical connection, since a wireless connection could be costly to use and reduced battery time. They suggested that an alternative to avoid this problem would be an occasionally connected application (OCA). The mobile device would connect to the database only periodically and thus save battery life and expensive internet usage with the mobile device (Teng, *et al.*, 2012). A farm management system should meet the following requirements: Software upgrades to occur seamlessly, does not require action from the client workstation, data is automatically replicated and backed up daily, is not limited to a desktop, and multiple mobile devices can work simultaneously and synchronize with each other (Teng, *et al.*, 2012). These findings comply also with the studies presented by Samad, *et al.*, (2010) and Ruiz-Garcia and Lunadei, (2011). Teng *et al*. (2012) also suggested that a mapping service could be inlaid into the system to support data collection from multiple farms and animals, thus improving herd health and production.

In India, insurance companies wanted to minimize fraudulent farm animal loss claims. A novel system was developed and tested, where the Veterinary Health Worker (VHW) could only register and enter new data of the animal when his/her RFID reader was within reading range of the animal's ear tag. This authenticated the VHW visit and was proven to decrease fraudulent insurance claims. It is estimated that if using the

system could prevent even 0.5% of fraudulent insurance claims, investment costs would be recovered. To achieve a successful project, it requires coordination between all stakeholders. Therefore the transparency prospect was a good way to get farmers interested to take part in the project, since by partaking in the project the insurance claim could be processed faster. (Samad, *et al.*, 2010)

4.7 Summary

In the previous sections a literature review has been introduced to cover the different aspects within the state-of-art-domain of IS support for veterinarian medicine. A number of tangential subjects have been discussed to shed light on the various parameters that affect building an IS system to support equine veterinarians. This section summarizes the various subjects that have been discussed, and their relevance on the *m-equine* project.

RFID identification seems to be at the moment the most reliable way to identify horses, despite the fact that the system is not yet perfect for equine sports, and the need for a support system. Even EU and FEI have recognized microchip identifications values and promote the use of them. A proper uniform identification system is proven to reduce fraudulence, support livestock management, increase epidemic control and aid in animal transportation, medication and food safety. Today RFID identification's costs are low while at the same time, the amount of information that can be inserted into the microchip grows.

Some applications and web support systems have been introduced to the human healthcare industry and even to animal healthcare industry. Yet in neither industry is there a proper solution for a common database. The question still remains who should own the database, who would have access to it and how to secure privacy for the patients? There have been many trials and discussions on this matter, yet none of the systems have been able to support and answer all aspects. Such a system might not exist and might not ever be built. Therefore it is important to build the e- and m-support systems within human and animal healthcare in such a way that they work together, even if it is only in a smaller scale, and add value to the users. At the moment it is too complicated for one institution to build the whole IS-supported human healthcare system, because human

medicine has so many aspects to it. Animal healthcare is simpler and there might be a possibility to have one common system, but until such a system has been invented, the various patient management systems, livestock management systems etc. have to work together, to add value for the stakeholders. This literature review has opened up questions and problems that must be properly addressed in the research for building the *m-equine* system.

It is clear that the m-equine system must have mobile accessibility and web access at all times, or when web access is not available, a functioning (OCA). Since m-equine would not be connected to large farms, the OCA would have to be developed to accommodate the veterinarian, or other situations that might be required. Therefore it is obvious that basic mobile phones will not be sufficient for the system, and it will be developed directly for devices with web accessibility. This might immediately eliminate many users, but the trends and statistics are leaning towards increasing use of smart devices (OSF, 2012).

Chapter 5

Building *m-equine*

This chapter introduces how the methodology was used to build up to the alpha version of the *m-equine* system. The research design and building process required four iteration cycles that were conducted from 2009 to 2012. The whole idea to have IS aid the horse industry sparked during the Finnderby competition 2008. Basically the large Derby arena in Ypäjä is so vast that many of the spectators could not recognize which rider and horse was entering the arena, until they were relatively close to the stand. Even the announcer had trouble to be certain who was entering the arena, since the starting order had been changed and the horse's competition number could not be seen so far away. A few of us discussed that it would be good if the rider and horse would be somehow identified when they enter the arena, so we would not have to guess who it is. The talk continued about the matter on how identification is done today, and what is technologically possible. In conclusion we agreed that there should be a RFID reader by the gate where the horse and rider enter that would read both their microchips. Naturally this still cannot be done, since the horse's microchip has a range of only ca. 3-5 cm (Arnaud and Bellini, 2010) and so far humans have not been microchipped, for some obvious privacy reasons (Michael and Michael (2009b). This however led to some important underlying themes in this research; how should horse identification be done, and why? What kind of support system could we have around horses that would benefit the various stakeholders? Who are the main stakeholders?

5.1 Action design research in the development of *m-equine*

The action design research methodology is used to develop a support system to answer the research questions. The ADR approach has been

introduced in section 3.4. Another important aspect to this research is the bottom-up approach. If the users are not involved in the development of the support system, they will be less inclined to use it and it might not meet their actual needs.

Stage 1. Problem formulation

The research questions that are presented in section 2.4 are the basis for the problem formulation. The main research questions are:

RQ1: What are the bottlenecks in a veterinarian's daily routines?
RQ2: Can non-medical IS be used to support veterinarian work?
RQ3: What type of IS support would be beneficial for the main stakeholders?
RQ4: Could transparency with IS change the horse industry?

These questions are to be answered by developing a system that meets the needs of the various stakeholders. To fulfil these needs, they must first be identified and their relevance to the industry researched. Since one of the aims of the research has been to develop a functioning support system for stakeholders around horses, it cannot be seen as a Theory-Ingrained Artefact, but rather a Practice-Inspired Research. In the ADR method, this type of problem formulation is defined as the intersection between technological and organizational domains (Sein, *et al.*, 2011). The development of *m-equine* is not only a software challenge, but a knowledge based effort, where high tech and low tech worlds are to be combined in a mutual and beneficial way.

Stage 2 Building, Intervention, and Evaluation

In stage two the goal is to frame the problems that are defined in stage 1 and get a general design for the IT artefact. The design for the IT artefact gets more specifically shaped with each design iteration cycle. The research design continuum has two end points; of which iteration I-III represent IT-dominant BIE and iteration IV, Organization-Dominant BIE (Sein, *et al.*, 2011). This study however uses a modified version of the ADR since the BIE form is customized to fit the sport horse industry's needs, which in itself includes many various job descriptions. In Sein *et al*., (2011) paper they promote customization, when required. In this case the BIE is not built for an organization per se, but for the intersection of

all the various industries and stakeholders that are involved in the sport horse industry.

The main stakeholders for *m-equine* were identified to be owners, riders, veterinarians and competition organizers, since the primary study objects were people involved around equestrian sport horses.

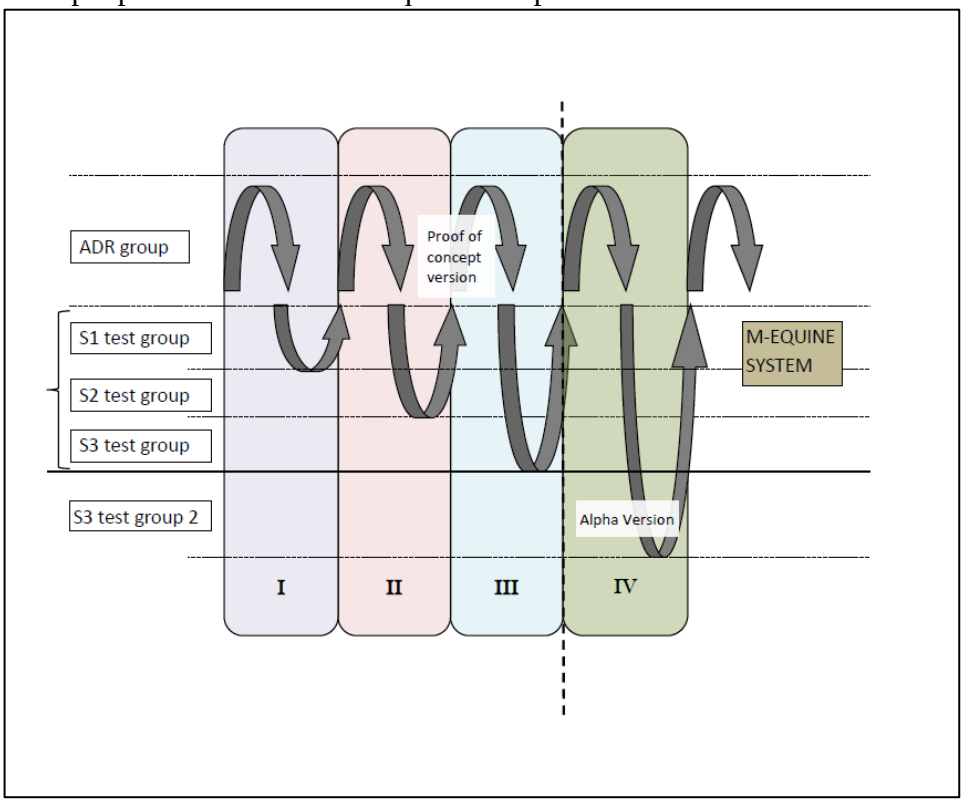

Figure 11. BIE Schema

The BIE schema presented in Figure 11 represents the BIE for the *m-equine* system. The four various iterations, and goals for the iterations will be presented in the following sections. The ADR group in this case was the author of this dissertation and partially also three master students (Jorge Lucic, Valentina Muñoz and Luis Rubén Rodríguez) who worked on the project mostly during iteration III. The various test groups, are to be presented in later sections, but they represent a section of various main stakeholder groups. The fourth iteration as well as the S3 test group 2 is separated from the rest of the BIE schema, since this iteration includes the development of the actual commercial product, *m-equine*.

	Iteration I	Iteration II	Iteration III
Research design			
Element dimension	Individual stakeholders around competition horses	riders / owners	Veterinarians
Survey type	Cross-Sectional	Cross-Sectional	Cross-Sectional
Unit(s) of analysis	Clearly defined and appropriate for the hypotheses	Clearly defined	Clearly defined and appropriate for the hypotheses
Respondents	1 county veterinarian	riders / owners of competition horses	county and equine medicine veterinarians in Finland
	workers from 3 equine clinic		
	2 FEI veterinarians		
	3 FEI officials		
Research hypotheses	Can competition officials' work be supported with IS?	Do people understand the current vaccination regulations?	County and private veterinarians' routines, tasks and treatments at a clinic and during house calls.
	What does a veterinarian do during house-calls?	What are riders and owners willing to divulge of their horses medical history and to whom?	Use of IS at work; current technology use and skills plus mobile phone features in use
	What does a veterinarian do in a clinic?	Do they need vaccination reminders and how much would they be willing to pay for this service?	Attitudes towards technology; willingness to use new IS and mobile technologies
		Where a horse's medical history could be stored?	
Sampling procedures			
Representativeness of sample frame	logical argument	Approximation	
Representativeness of the sample	purposive	no information	purposive
Sample size	sufficient for purpose	319	161 of 397
Data Collection			
Pretest of questionnaires	not necessary	author's own knowledge sufficient	with 5 individuals
Response rate	----	----	40,55 %
data collection methods	face-to-face interviews	questionnaire	internet survey
Survey research	**Exploration**	**Exploration**	**Description/Exploration**

Table 3. Survey studies in the three first iterations.

The survey methodology introduced in section 3.6 is presented here in Table 3 with the survey material for the research. The survey methods used in iteration I and II have been Exploration, yet given good indication of the situation in whole, and a map for how to continue with the research. The third iteration's survey is descriptive. The minimum dimensions for a descriptive survey in Pinsonneault and Kraemer, (1993) were defined as having a response rate of at least 60-70% of targeted population, but this criteria in the third iteration's survey is not met. This one-dimensional approach to what is considered to be sufficient response rate does not however take into account different professions, and the rather vast difference in these professions response willingness. A 40.55 % response rate with veterinarians can be considered a more than adequate response rate. Physicians and veterinarians are in general difficult to get to respond to surveys, and thus a 40.55 % response rate is good (Kellerman and Herold, 2001; Thorpe, *et al.*, 2008). With this argument in mind, the third iteration's survey can be considered a descriptive survey.

5.2 Iteration I

To get an idea on what kind of support is needed within the horse industry, the first step was to get a general feeling of the opinions and thoughts from the main stakeholders. Therefore the first iteration's problem formulation is derived somewhat from all the RQ's as has been shown in Figure 6. What do owners, riders and competition organizers do in view of a competition and what do the veterinarians do?

In accordance to the first problem formulation, ***stage 1*** for this iteration is clearly a practice-inspired research, as presented in Sein *et al*., (2011). There is a clear need to find out what problems there are within the equestrian sport horse industry and how IS could support it. With this problem framing the schema for the first iteration within the ADR can be built. To find out the facts that will shape the above mentioned IT support system for the stakeholders, a survey research method was chosen. In the ADR ***stage 2***, the BIE is IT-Dominant, since the goal is to create an innovative technology to support the horse industry and the stakeholders around it. The ADR team in this situation is the author and the practitioners who have been selected from different groups of the end-users. The practitioners form the S1 test group.

5.2.1 S1 Test group

The first step was to interview and survey people who preferably have a vast experience within the Equestrian sport. Therefore the initial discussions of the matter were done with a county veterinarian, three different equine medicine clinic's workers, two FEI veterinarians and three FEI competition officials during the International dressage (CDI) and Jumping (CSI) event in Tallinn, Estonia, 2010. This group is presented in Figure 11 as the S1 test group. These individuals were interviewed face-to-face and their daily activities monitored. The main findings from the interviews and monitoring are listed in Table 4. The problems that were recounted by several individuals are in the table with a yellow background. These problems are then categorized into problems that are either related to sport horses or to horsemeat and state officials (such as border control) in Table 5.

Identified problems	
Horse Identification	comparing horse-passport
	microchip reading
	drawing markings to passport
	fraudulence possibilities of passport
vaccination	checking from passport that vaccination data ok
	entering info passport (all different)
	fraudulence most common with vaccinations
	-passport-horse not same
	-changing dates
	Only Influenza mandatory. Specially in Scandinavia vaccinating against tetanus and herpes is not common
documentation	too much paperwork
	x-ray machine not connected to practice management software
	during house-calls all documentation done manually
	billing not connected to other software
	paper invoices still used
	often repetitive paperwork in treatment plans etc.
security	internet
	fraudulence common and part of horse "culture"
	Trustworthy medicine records that ban a horse to be used as food-product lacking
	FEI rules and monitoring not strict enough
	medical records property rights differences in the world
communication	discussions with horse owners take too much of a veterinarians time
over all	In Finland there are very few practice management software programs on the market
	Owners not reliant to veterinarian
	Veterinarians do not communicate enough with each other
	clinics not run as a business
medical	how to control coggins
	illegal distribution of medicine
	Horses viewed as production animals, which limits licensing of equine medication
	different cultures have different views on what is doping

Table 4. Identified problems in iteration I.

sport horse	horse meat/ officials	solution
comparing horse-passport		microchip-> mobile device
checking from passport that vaccination data ok		Information attainable from a database
passport-horse not same		microchip-> mobile device
changing dates for vaccinations		changes leave an electronic footprint
fraudulence common and part of horse "culture"		Make fraudulence virtually impossible
	Lack of trustworthy medicine records that ban a horse to be used as food-product	Info on a database
Horses viewed as production animals, which limits licensing of equine medication		clearly identified separation between sport horses and other horses
too much paperwork		Aim to automatize all paperwork possible.

Table 5. Problem understanding and categorization in iteration I.

The solutions in Table 5 are the initial ideas as solutions to these problems that were discussed with the S1 test group. Some of the problems listed above could be solved with the help of IS, but it would be important to find out what the main stakeholders around horses thought about these same problems, or perhaps these were not seen as problems for a larger group of people.

With these results obtained from group one, ***stage 3*** in this iteration can be presented and the first cycle completed. The main problems that competition organizers confront are obtained, but to fully answer the RQs, there is a need for more detailed questions for the owners, riders and veterinarian stakeholder groups. Therefore only the competition organizer group's contributions are presented here.

Competition organizers' contribution:

- Horse identification is not 100% reliable.
- It takes too much time to check vaccination statuses for all the entered horses.

5.3 Iteration II

In iteration II the riders and owners stakeholder groups needs were studied in more detail to find answers for RQ3 and RQ4. Again in this iteration ***stage 1*** is practice-inspired research and the ***stage 2*** BIE-scheme is IT-dominant. Since there was a need for exploratory information from owners and riders, a survey was chosen as the most appropriate research method.

5.3.1 S2 Test group

During summer 2009 an exploratory survey among horse owners and riders was conducted. The results of this survey are presented in (Leskinen, 2010; Leskinen, 2011a). The data collection was conducted at the following riding competitions:

- Niinisalo, Finland. National three-day-event competition (CCN*), 10-12 July 2009.
- Falsterbo, Sweden. International jumping and dressage competition (CSIO 5*-TL NC, CDI 3* CDIO 4*) 16-19 July 2009
- Salo, Finland. National jumping competition (CSN 2*, Tapiola GP) 31 July - 2 August 2009.
- Verden, Germany. International jumping and dressage competition (CSI 2*, CDI 3* CH-M-YH-D) 6-9 August 2009.
- Lempäälä, Finland. National dressage competition (CDN 2*, Finnish championship) 15-16 August 2009.

319 people answered the questionnaire. Of the respondents, 248 people listed themselves as horse owners and 224 were competition riders**.** The full results of this survey are presented for the vaccination information part in Leskinen (2010) and for the common medical database related questions in Leskinen, (2011a). The questionnaire was available in

English, Finnish, Swedish and German. The English version can be found in Appendix 1

Categories	**Disciplines**					
	does not compete	Dressage	Eventing	Jumping	Other disciplines	**Total**
junior	4	18	10	35	0	67
senior	86	40	18	67	2	213
young rider	5	6	3	15	0	29
Total	95	64	31	117	2	309

Table 6. Category and discipline ratio amongst respondents (Leskinen, 2010).

	My horses vaccination information could be public in		I would like my veterinary to help me keep my horses vaccinations on time	I would like to get a remainder when the vaccination is expiring via			
	The Internet	A national Database		Mail	e-mail	SMS	I do not need this service
Agree	143	233	133	70	159	132	113
percentage	*44,8 %*	*73,0 %*	*41,7 %*	*21,9 %*	*49,8 %*	*41,4 %*	*35,4 %*
Disagree	121	64	72	106	49	68	104
Percentage	*37,9 %*	*20,1 %*	*22,6 %*	*33,2 %*	*15,4 %*	*21,3 %*	*32,6 %*
Missing	55	22	114	143	111	119	102
Percentage	*17,2 %*	*6,9 %*	*35,7 %*	*44,8 %*	*34,8 %*	*37,3 %*	*32,0 %*
Total	319	319	319	319	319	319	319
Percentage	100,0 %	100,0 %	100,0 %	100,0 %	100,0 %	100,0 %	100,0 %

Table 7. Study results (Leskinen, 2010).

Both Table 6 and Table 7 have been presented in the original publication by Leskinen (2010), but paints an explorative picture on the diversity of the respondents and their views on vaccinations, and reminder services to vaccinate their horses. Table 6 represents the diversity of responders for the whole survey, and validates the exploratory nature of the survey. Table 7 represents interesting facts that help answer RQ3.

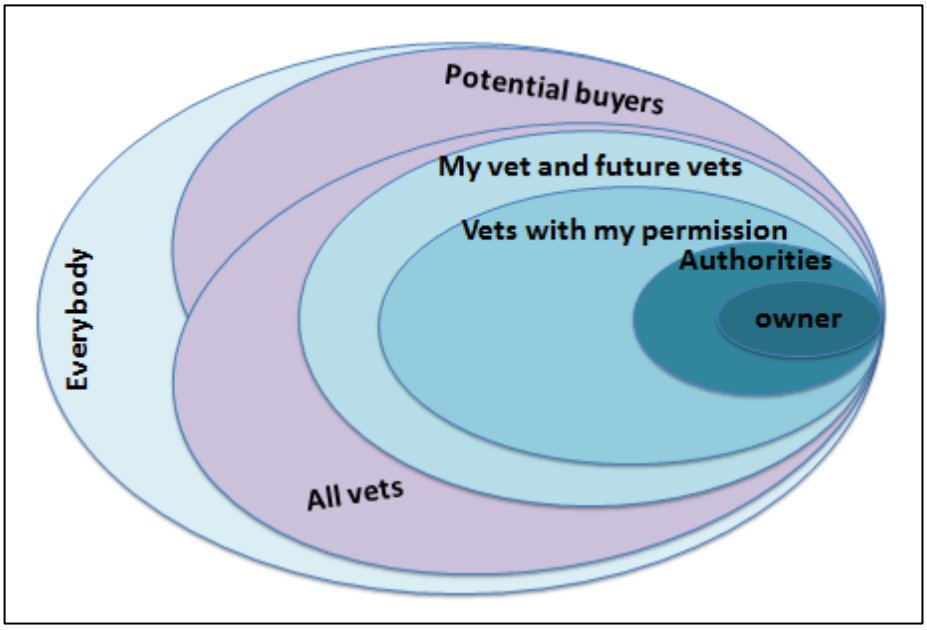

Figure 12. The building blocks of the questionnaire.

It was important to find out exactly how much owners and riders would be willing to divulge of their horses' medical information. The survey question was: Assuming that only veterinaries may enter information, which of the following statements about your horses' medication history would you be willing to give?

In Figure 12 the different "levels" of options are shown. In one extremity everybody could view any horse's medical history, while on the other end; only the current owner would have access to the medical information. From everybody, we can easily go down to giving permission that only potential buyers could see the medical information, and all veterinarians could access the info. A more strict view would be to

allow only “my” veterinarian, and future veterinarians for the horse to access information. In this case, the owner would allow the next owner’s veterinarians access the horse’s previous records, from the time that the horse still belonged to him/her. The level called “Veterinarians with my permission” includes only the veterinarians that are used during one owner’s time, i.e. the medical history, does not transfer to the next owner.

The answers to the survey question introduced above is presented in Figure 13 for three categories; riders, owners and people who are both competition riders and horse owners.

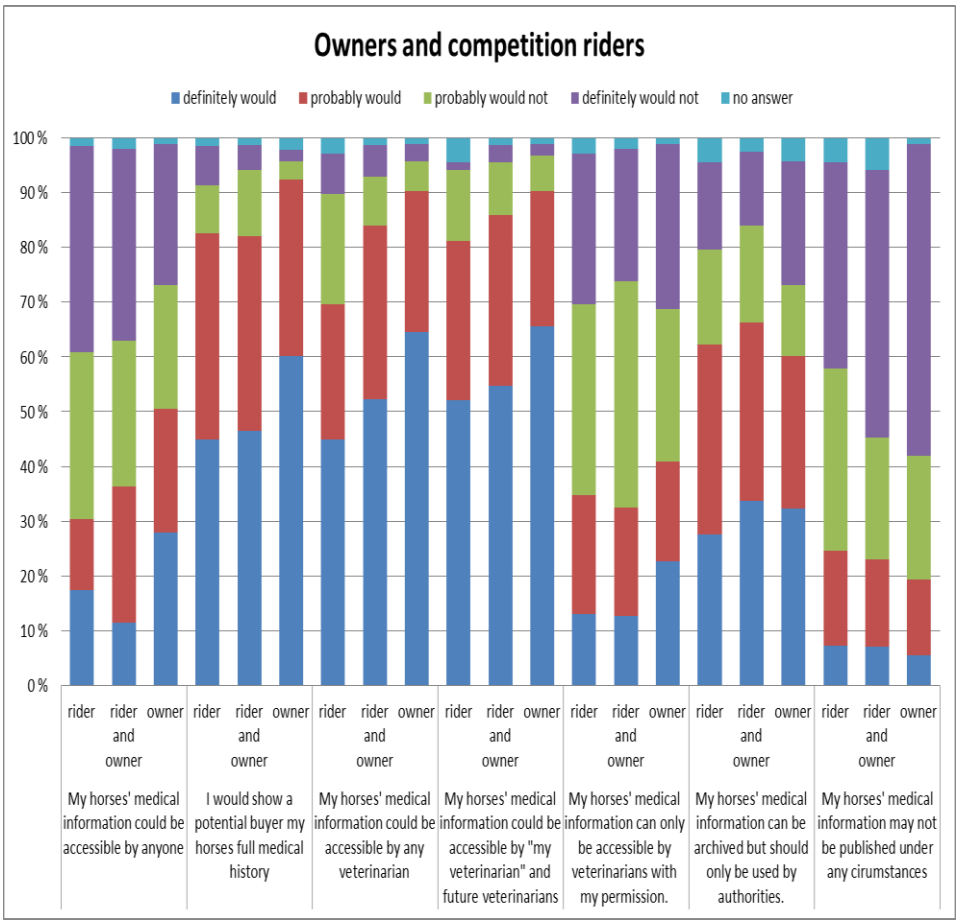

Figure 13. Survey results on medical database question for all stakeholders. (Leskinen, 2011a)

The second iteration's ***Stage 3*** states the following contributions for the different stakeholder groups:

Owners

- Owners need reminders to vaccinate their horses on time
- The owners would accept a common database where a horse's medical information is stored, as long as security aspects have been taken into account.

Riders

- Riders need reminders to vaccinate their horses on time
- Riders would accept a common database where a horse's medical information is stored, as long as security aspects have been taken into account.

Veterinarians

- The veterinarian's customer service and strengthening the reliance toward the veterinarian. (The project in India also had SMS alerts for the farmers (Samad, *et al.,* 2010).)

These contributions were somewhat anticipated, but especially the knowledge obtained for the veterinarian group was not anticipated. This unanticipated contribution helps to build up the next iteration cycle. With the information obtained from the first and second iteration, a proof of concept version of the system could be built, which is presented in the following section.

5.3.2 Building the Proof of concept

Three Masters Students worked on the proof-of-concept version of the *m-equine*. From the knowledge learned so far, we stipulated together what different stakeholders there are within the horse industry, and what type of services they need. Thereafter we concentrated on the main stakeholders, and what the major needs for them are.

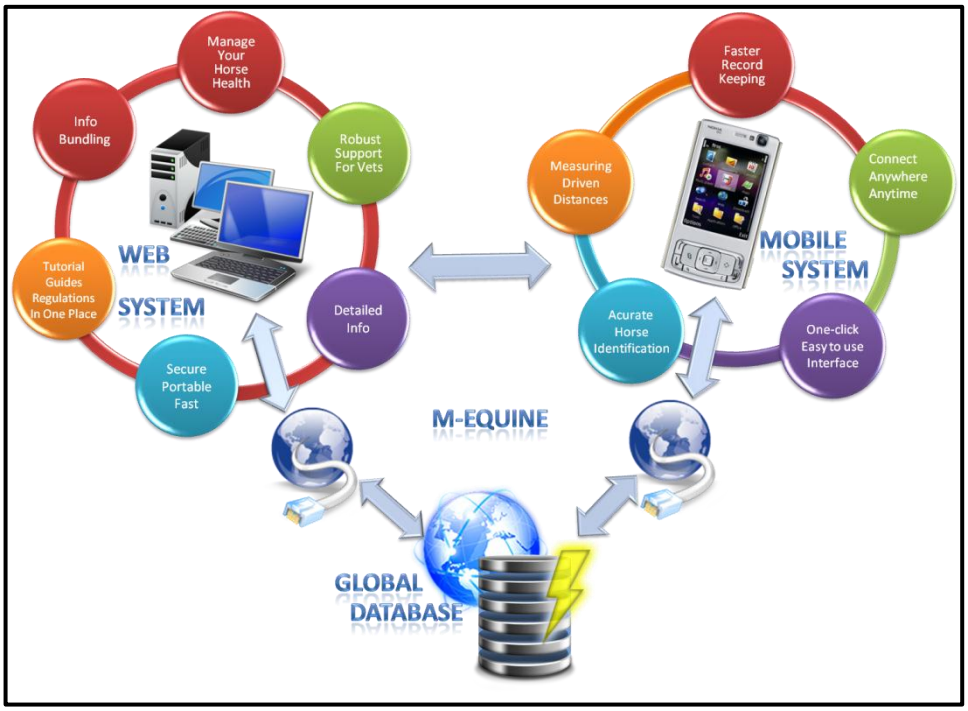

Figure 14. Basic idea behind *m-equine* system (by Jorge Lucic)

A prototype for both the web service and mobile service was built, to try out the usability of the system. This proof-of-concept version of *m-equine* had a small "horse database" that was built by us, and did not contain real horse information from the Suomen Hippos database. The database could be accessed with both the mobile and web version. The system was targeted for owners, riders, veterinarians and competition organizers. These groups had different hierarchy levels in the system, depending on what they were allowed to see and do in it.

Figure 15 is a mapping on what the proof-of-concept system included.

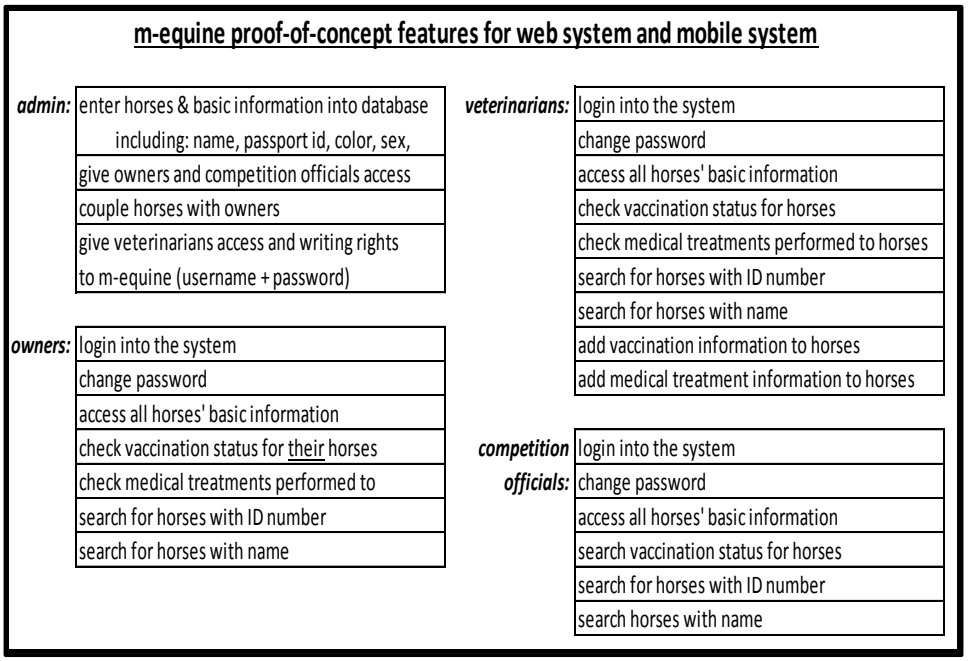

Figure 15. *m-equine* Proof-of-Concept features

The mobile application was developed by Luis Rubén Rodríguez and the web-support system by Jorge Lucic.

> *"The mobile application was coded in Qt for Symbian using Qt Creator IDE. A large number of widgets were employed in order to present information to the users. Among important libraries used to achieve the functional prototype are: script, network and GUI." (Rodrigues, 2011 p. 52)*

In Figure 16 are some screen shots on how the proof-of-concept mobile version worked.

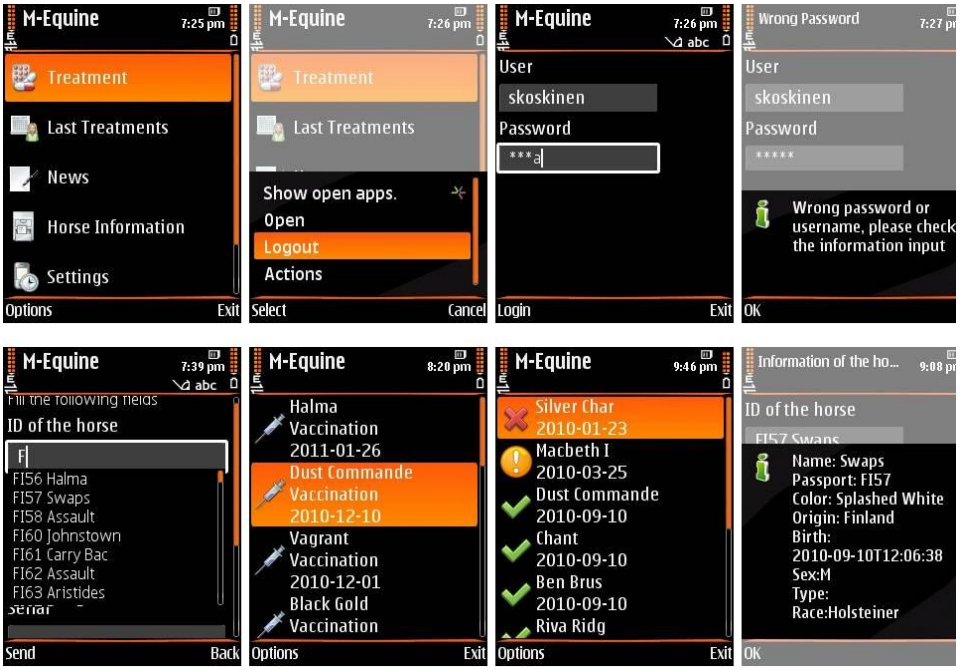

Figure 16. Screen shots of the mobile application of *m-equine* constructed by Luis Rubén Rodríguez

This proof-of-concept version was shown to a few selected end users from the veterinarian, owner/rider and competition organizer group. The system worked on a dummy database, and was a pivotal part of the master's student's theses. The most important aspect was to show that it could be done and to get some feedback on how to further develop the alpha version of the product.

5.4 Iteration III

To obtain answers for the RQ1 and RQ2, the veterinarian stakeholder group needed to be studied further. As in the previous iterations, also here ***stage 1*** is practice inspired, but ***stage 2*** contains characteristics for both IT-dominant and Industry-dominant BIE. Since the goal is still to build an innovative IS to support veterinarians and other stakeholders, it clearly is an IT dominant effort, but since third iteration bases to some extent also on the proof-of-concept version of the support system, it sustains features for an industry-dominant BIE. For this iteration an internet survey was done with a clearly specified group of veterinarians. The full results from

this survey are discussed in more detail in the paper Leskinen, (2012), and in the poster presentation Leskinen, (2011b).

The survey's questions were divided in three sections.

1. County and private veterinarian's routines, tasks and treatments at a clinic and during house calls.
2. Use of non-clinical technology at work; current technology use and skills plus mobile phone features in use
3. Attitudes towards technology; willingness to use new IS and mobile technologies

The full survey is presented in appendix 1

The main findings from the survey were used to build the knowledge for ***Stage 3***, in iteration III.

Veterinarians

- Today most of the veterinarians keep records manually during house calls.
- A majority of the veterinarians feel that too much time is used on paperwork.
- Over 70 % feel that there should be a common national medical database for horses.
- They very seldom remind their clients of upcoming appointments.
- Many use mobile phones also for other functions than only calling and SMS.

Veterinary practice for both equine veterinarians and county veterinarians

The three most common reasons a veterinarians sees a patient are:

- In the clinic environment: vaccination, ear problems and castration
- During house calls: emergencies, birthing problems and gastrointestinal problems

The poster presentation was presented at an equine industry conference, which was attended by various stakeholder groups from all over the world. This gave the author the opportunity to get feedback and critique from horse industry professionals on how the system should be developed

further. Some parts of the proof of concept were also presented in this venue. Since the conference was attended by non-IT people the feedback was extremely valuable for future development. The conference provided an opportunity to present and market the system to various stakeholder groups.

Since different countries have different laws and customs concerning the ownership of a horse's medical information, livid discussions arose around the topic of who would be the most natural "owner" of a potential equine medical database. This question had already arisen early on in the research, but many different options were still considered. Depending on the stakeholder's own profession within the horse industry, various views on the whole system were obvious. Some of the people who had already been within the industry for a longer time, doubted that people would be as open about their horses medical information as the *m-equine* system requires. They also were concerned about possible fraudulence that could be done via the *m-equine* system.

Iterations 1 through 3 have given many conclusions and a proof-of-concept version of the system. We have achieved many answers for the RQs from the facts obtained in the iterations. Yet there is need to develop a working alpha version of the system that can be tested with the end-users, since up to now testing and surveys have been done with practitioners, i.e. test groups S1-S3. There is also still the question of who would be the "owner" of the database. So far the most likely possibilities have been narrowed down to FEI (and national federations underneath FEI), governments, insurance companies or pharmaceutical companies. The two last options are not the best ones when considering marketing and commercializing the product beyond country borders. Various countries' governments, or e.g. in Europe EU-government level "ownership" of a medical database might hinder the natural and agile development opportunities for the system. Therefore at the moment, the most likely candidate as "owner" for a medical information system would seem to be FEI and the national federations that operate underneath them.

5.5 Iteration IV

The fourth iteration cycle problem formulation bases on the knowledge already obtained, but now it needs to be used for the systems alpha version. ***Stage 1*** continues to be practice inspired research, but the BIE

model is for this iteration Industry-dominated. In ***stage 2*** we use already obtained knowledge to build the alpha-version of the system that then is trialed with end-users from all the studied stakeholder groups. The system is initially based on the proof-of-concept version, with modifications motivated by the veterinarians. Since the initialization of this research and the proof-of-concept version, IT has evolved, which enables new user models and agile development cycles. The knowledge-creation target for this BIE is to implement as many of the perceived requirements as possible to the alpha-version. The alpha version should use actual data and test the reactions, and thoughts of the users, so that it can then be developed into the commercial version of *m-equine*.

Building the alpha version

The alpha version will only contain information about vaccinations, since this is an ideal platform to test the usability of the system. All competing horses in Finland have to be vaccinated according to the same regulations, which is at least once a year. At competition all the entered horses' vaccination information has to be checked either from Heppa system or at the competition site. Other treatments that horses receive are not done with the same regularity as vaccinating, and this information does not need to be secured. This will give an opportunity to test the system and trial security measures that would be included in the commercial version.

The initial trial idea was; how a vaccination database and protocols would be handled from when the veterinarian administering the vaccination to the horse entering the competition. The whole process has been described in Figure 17. A horse's influenza vaccination protocol will also be the test subject for the alpha version. Vaccinations are a nice test object, since all competition horses must have them in order, and they are not strictly speaking confidential information.

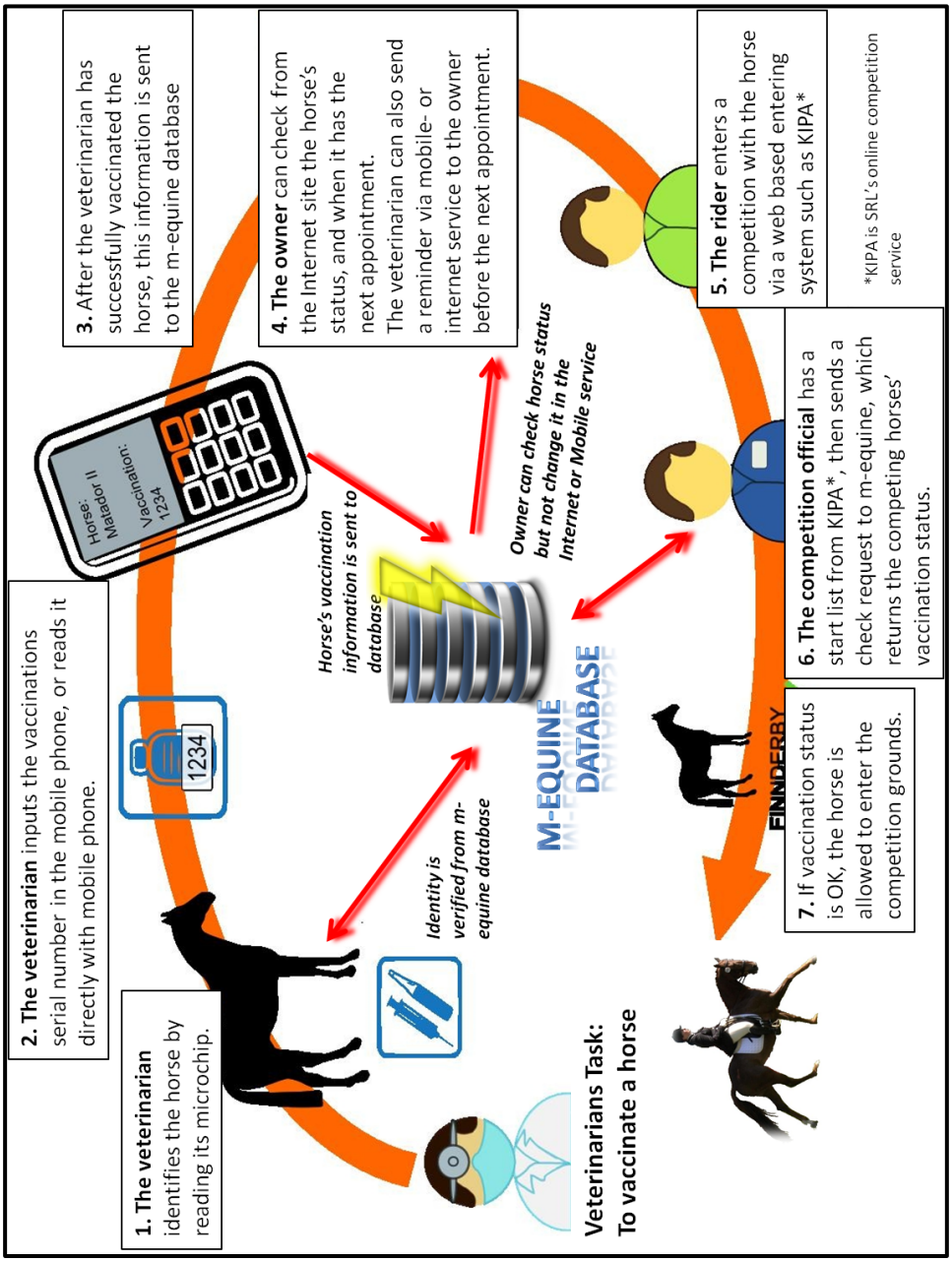

Figure 17. From vet to competition.

In Finland SRL keeps a horse-database of all the horses that have a competition license. This database includes the horse's name, competition license number, which is the same as the registration number if the horse is registered to Finland and owner information. The *m-equine* system will have its own horse database that is received from Kipa. The *m-equine* database will be updated daily from Kipa, so that it includes recent owner info, new registrations etc. In the *m-equine* database additional information can be stored for horses, in this case vaccination data. The system will know the vaccination regulations, and show if a horse's vaccination is in order or not. In Figure 18 and Figure 19 the basic views for veterinarians, who are highest in the hierarchy after the administrators, since they can enter new data, are shown.

In Figure 18 web supports mockup view is shown for a veterinarian inserting vaccination information. The veterinarian has to naturally log in the system, and the system must incorporate a system that recognizes which users are veterinarians, and should be given higher access level than e.g. owners. In the alpha version the authenticity of a veterinarian will be done with the help of the veterinarian's individual veterinary ID number, which each veterinarian in Finland must have, to be allowed to practice veterinary medicine. The second picture, shows how the veterinarian choses what he/she wants to do. The three options are: Add influenza vaccination. Add medical information and Check Patient status. The veterinarian chooses influenza vaccination and must in picture 3 insert either the horse's name or ID number. If there are several horses with approximately the same name, then a list will show up, from which the veterinarian must choose the correct horse to which he/she is about to administer the vaccination. The vaccination ampule's batch number must be typed into the system. Hopefully in the future both this step and the horse identification step could be automated by simply reading the RFID tag or QR code, which then automatically is inserted into the system. In picture 6 the veterinarian must select which type of vaccination he/she is going to administer to the horse, according to the vaccination regulations that have been presented in section 2.1.2. This example has been built assuming that the horse's vaccination will be entered into the database for the first time. Naturally once vaccination information already exists for a horse, the system knows which type of vaccination will be administered next. In this case the horse has been vaccinated according to regulations already for a few years, and thus with this vaccination, the veterinarian verifies and inserts into the database not only the vaccination information

he/she has administered, but also that all the previous vaccinations have been done according to regulations. This way, when changing to this system, all old data must have to be manually transferred to the database, which would take much time. To avoid mishaps, the system asks the veterinarian to verify that the information he/she is about to enter into the database is correct (picture 7). In the last picture, the veterinarian could continue entering vaccination data for another horse, or change to some other task. Naturally this is a very simplified figure to show how the system could work, but it is to give an idea of what is provided. The actual website can be found at www.m-equine.com.

Figure 18. m-equine alpha version's web-support view mockup

Figure 19. m-equine alpha version's mobile view for veterinarian's mockup

As has been mentioned before, the veterinarian on the road making house-calls needs a simple mobile solution to aid in the daily tasks. Figure 19 presents how the same vaccination task as was presented in Figure 18 could be done with a mobile device. With a mobile device the idea would be that the veterinarian chooses the appropriate icon (picture 1) to start working with the *m-equine* system. The veterinarian must log in (picture 2), insert horse information (picture 3) and vaccination batch number

(picture 5). Again the veterinarian chooses which type of vaccination he is administering (picture 6) and verifies that the information is correct (picture 7) (to make this explanation easier, let's assume that the veterinarian is male). Finally the veterinarian can continue to enter more vaccination information to other horses if need be. Today the veterinarian would have to write down all the vaccination information in the horse's passport, and during house calls also make somewhere a note for himself of it. Then once he goes back to his office he will enter the vaccination information into the "Heppa" database and into his own patient management software so that he can send the owner a bill of the treatment. In a worst-case scenario, the veterinarian remembers the horse's name wrongly which will result in double entries, unnecessary work and data in the patient management software. The veterinarian's patient database will have the same horse several times, with slightly different names, and he will have to call the owner to get the correct name, since he cannot enter the vaccination information into the "Heppa" database without it. Therefore iteration IV and the m-equine support system should answer some of the problems raised in RQ1 and RQ2.

Especially for the stable environment it would be important that as many steps as possible could be automated, or easier to do than the current methods. This might include Drop Menu's, simple choice boxes, and probably very little actual writing with the keyboard. Naturally how the final product looks and operates will be determined by what the veterinarians want. The veterinarians could prefer that the system would work even in off-line situations, which the end-product will do, but the alpha version of the *m-equine*'s mobile system is for testing, and does not have offline capability.

In the alpha version, the competition organizer will only have to send the list of entered horses to the *m-equine* system, which will then check through the list and send back to the organizer a list of horses that do not have their vaccinations in order. The organizer will have in the list also information on who is to ride the horse at the competition and who is the owner. They can then contact the owner or rider, and inform them about the situation, before the horse has even entered the competition site. This should immensely reduce the time the competition organizers have to use to check horses' vaccination information, which was one of the main problems the organizers pointed out (see section 5.2.).

The *m-equine* system will collect the basic horse information from the existing KIPA system (see Figure 20). Suomen Hippos keeps in its "Heppa" system the database of all the equidae registered in Finland, and KIPA attains regularly horse information for equestrian horses that are registered there. A few hundred horses competing in equestrian competitions in Finland are registered to other EU countries, and therefore only have a competition register number in SRL's KIPA system, and are not in the Heppa system. For the alpha version, because of

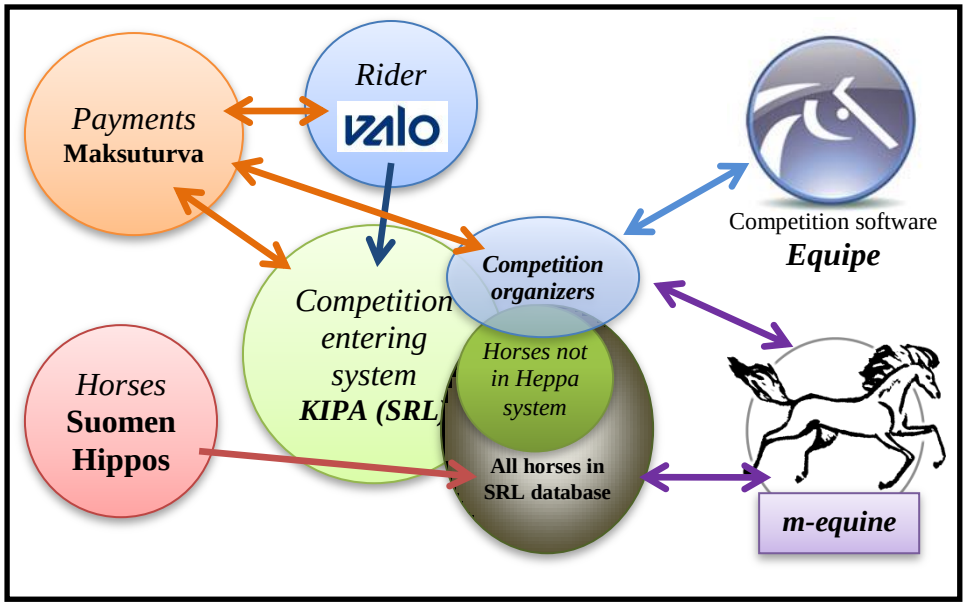

Figure 20. An illustration on how the whole competition entering system would work, when m-equine is introduced to it

software problems, it was considered easier to directly collect all horse data from the "Heppa" system (approx. 40 0000 entries). The horses that are only registered in the Kipa system did not take part of the alpha version's test round.

"Valo" is the Finnish sports organization, which upholds a register for human athletes in Finland (www.valo.fi). SRL gets the riders information from Valo. When a rider enters a competition with a horse, he/she is "paired" with the horse to e.g. competition *x* for classes *y* and *z*. In the next competition the rider and horse are not necessarily competing together, so the system has to be flexible. KIPA is also connected to a "Maksuturva" (Intelligent online payment services) system through which all payments between competitors, competition organizers and the

federation is transferred (www.maksuturva.fi). Once the entering deadline is passed, the competition organizer can check that all entry fees are paid, and transfer the paired list of horses and riders for different classes to the equipe system, which is the competition management software used in Finland (www.equipe.com). With the *m-equine* system involved, the idea is that when the competition organizer transfers the horse & rider lists to the equipe system, they also send the same list to *m-equine*, which will check the horses' vaccinations, and send back to the competition organizers a list of horses that do not have the vaccinations in order. The development that has been made for m-equine as well as the systems that already are in use within the Finnish equestrian sport by SRL are partial answers for RQ 3. Surely further development will also answer the research question more fully.

5.6 Results

From the four iterations ***Stage 4*** (Formalization of Learning) of the ADR methodology can be resolved. By bundling together what has been learned from the iterations, the problems and solutions can be generalized thus enabling conceptual research design outcomes. These have also been the founding stages for developing the *m-equine* system and what type of functionalities it should have.

5.6.1 Competition organizers

The competition organizers need a support system that helps them to track incoming horses and check competing horses' vaccination status. In the future also doping monitoring, the FEI medical logbook, travel route plans, upcoming competition calendars and blood test results etc. would help the competition organizer to co-operate with local and border authorities to ensure smooth transportation of the horse. All of this however relies on verifiable horse identification that today is not 100 %.

5.6.2 Owners

Horse owners, especially if they own several horses, need remainders to vaccinate their horses. Also other reminder services could be handy. This would be an avenue that veterinarians have used so far poorly to ensure that their customer stays loyal to them. A common medical database for

horses is rather accepted by owners, in both the surveys done in Finland and Denmark, but there is still discussion on who would be the owner of such a database, and the support system around it (Hartig *et al.*, 2013a and b and Leskinen 2012 and 2013). Yet there is no doubt that the owners would benefit from finding all of their horses medical information from one place, and there would not be a need for more guess work. This could also ensure their horse better treatment and reliable diagnosis in cases where the previous findings are vital for the current diagnosis.

5.6.3 Riders

Riders as owners also need reminders to vaccinate their horses on time and they also have the responsibility to upkeep the horse's medical logbook, which is cumbersome today in its paper format. Riders are also more likely to accept a support system with an underlying medical database, since they would gain similar benefits of it, as owners and competition organizers would.

5.6.4 Veterinarians

Veterinarians need to strengthen their customer reliance, which can be done by improving customer service. The treatment reminders could be a part of the improved customer service. The *m-equine* system would allow all veterinarians to change from cumbersome paperwork to a digital work environment. The goal is to develop the system so that it eliminates as much unnecessary paperwork, double entries etc. as possible. The system should be usable in both clinic and stable environment on different devices, from laptop, to smartphones. Most of the veterinarians would want to have a common national medical database for horses. They understand, that already a simple database would simplify their work immensely, so what could further IS support do?

Chapter 6

Conclusions

This chapter presents the contributions of the research, and presents the answers to the research questions. Overall findings are then discussed and compared to other similar research and their findings. Finally, the limitations to this research are presented, as well as future development scenarios.

6.1 Main findings

In section 2.4 the research questions were presented and chapter 4 analyzed and partially answered them with the help of a state-of-art literature review that stretched over the entire research domain. Chapter 5 presented the iterative ADR work over the development of the m-equine support system. Also here, some analytical data and solutions to the research questions were found. This section will discuss these findings further.

RQ1: What are the bottlenecks in a veterinarian's daily routines?

a. What are the veterinarians' daily routines?

Veterinarians who work in small animal clinics have been studied in the 03-vet project, (see section 4.5) and in this project already some routines and bottlenecks were noted that correlate also to equine veterinarians (Zaninelli, *et al.* 2007 and 2012). The third and fourth iterations (sections 5.4 and 5.5.) in the ADR were about veterinarian work, routines, IS customs etc. During the survey that was conducted with the veterinarians, they reported that they spend their time on treating patients, paper-work and driving (when on house call). The most common treatments in the clinic environment were: vaccination, ear problems, castration and

euthanasia. For house-calls the most common treatments were: emergencies, gastrointestinal problems and birthing problems.

b. What do the veterinarians feel they spend too much time on, and why?

Veterinarians find paperwork and other non-patient relevant work as time consuming and these activities easily cause fragments to their daily activities. Some veterinarians find the current system with patient management software and the "Heppa" system offered by Suomen Hippos, cumbersome to use, since they easily cause double workload. Many veterinarians were positively inclined to try to do the necessary paperwork with a mobile device during house calls. Several veterinarians considered a national medical database for horses as a good idea. Since stable environments are not always within good 3G or higher mobile bandwidths, offline work should be an option.

RQ2: Can IS be used to support veterinarian work?

a. In which routines can IS be used to support the task?

As with the previous research question also here part of the research answer can be obtained and validated with Zaninelli *et al.*, (2007 and 2012) research work on their 03-vet project (see section 4.5). Especially mobile devices are useful when the veterinarian cannot be near a fixed computer or during house calls, as was noted during the survey conducted in iteration III (see section 5.4). In all cases the IS tool can be used to make notes, and look up information, since unlike paper, the information could not get lost, and it can be transferable from one device to another.

b. What type of IS support tools are used today?

The survey done with county and equine veterinarian's in Finland during iteration III (see section 5.4) resulted in a slight minority using laptops for record keeping during house calls (Leskinen, 2012). However in Finnish equine clinics paperwork is done by computer. Mobile phones were not yet used much as support tools during the iteration III survey, but since it was conducted in the late 2010, much more might have already changed (Leskinen, 2012). Different types of tablets also have become more popular, and could eventually be used by veterinarians, if their patient management software were to be developed to support them.

c. How technologically competent are veterinarians?

In the veterinarians' own words, they often think that they are not very good with technology. This is not quite true, since they often might not simply have the time or interest to learn how to use a new piece of technology, unless they can see the value of learning to use it, as some of the veterinarians stated during discussions in iteration I.

d. What type of system would best support the veterinarian's routines and needs in a horse-stable environment?

The support system should be connected to the veterinarian's patient database or similar and other necessary databases. It should also be easy to use, without too many complex hierarchies that might become frustrating to use. There should be a minimal number of main treatment options but the system should be flexible, so that the user can modify it to his/her needs. However from the literature review both Hartig *et al.*, (2013a and b) papers suggest that veterinarians are hesitant towards full transparency, although they did see the benefits of a national database (see section 4.5). The same type of hesitancy from the veterinarians did show up in the iteration III survey and should be taken into account when developing a support system (Leskinen, 2012). In the Hartig *et al,*. (2013a and b) the ownership of the database seemed to be one of the major issues for the veterinarians, which was not discussed during iteration III survey.

RQ3: What type of Information System support tool would the main stakeholders around equestrian sport horses need and why?

a. What are the needs for the main stakeholder groups?

As has been established in section 5.2, the competition organizers would want to reduce time they use when inspecting horse passports. For the veterinarians, the question has been answered in the previous two RQs. The riders and owners, and their opinions were mostly presented in section 5.3. In the original publication, by Leskinen, (2010) it was noted that riders and owners need remainders for horse treatments, such as vaccinations. A horse's paper medical records get easily lost, and even passports get lost, which makes it much more difficult for the horse owner to remember what possible medical ailments the horse has previously had. A horse can easily live over twenty years, and have several owners and be treated by several veterinarians during that time, quite frankly it is a

wonder if all records are intact. Buyers are also worried about possible old injuries or problems a horse might have had, when buying a horse. It is extremely difficult to find all veterinarian information today, since there is no central database where the information can be stored. (Leskinen, 2011a) These same concerns and statements were also focal points for non-veterinarian stakeholders in the Hartig *et al.*, (2013a and b) papers. Also Zaninelli *et al.*, (2007 and 2012) papers have some similar findings although they concentrated on small animals that do not have the same ownership exchange related problems as horses do.

> b. How should a support system be built to meet the various stakeholders' requirements?

To accommodate most of the stakeholders' needs, it is important that they can use a support system as easily as possible in environments that suit their needs. Therefore such a system would have to have both a web interface, and a mobile interface. According to the user's "user group" he/she can see and write information on the support system. It is vital that the different user groups' have clearly stated usability rights, so that the systems security level stays rigorous. The support tool should accommodate several languages and have connectivity with other important software, such as competition management software and patient management software. These functionalities will allow the possibility to enter other countries and aid the stakeholders, and not cause them more work.

RQ4: Could transparency with IS change the horse industry?

> a. Can we divide the horse population into two, horses that enter the food chain and horses that cannot? Are there benefits?

Identification will still be an issue among horse people for a while, but with proper identification, and a medical database, it would seem that horses could be divided into two separate groups, those that can be slaughtered, and those that cannot, i.e. sport horses. This would lessen the risk of medical traces ending into the food chain, yet at the same time horse medication could be further developed, since the production animal limitations would not apply any more for the sport horses. This would seem like an ideal situation, but it will take much more time until it could be fully operational, since it will not only require changes in the way we store a horse's medical records but also changes in legislation.

b. How to use transparency for disease control?

A common medical database, proper identification of horses and tracking ability of horse transports could help to prevent disease spreading among equidae and between species, as was already discussed in sections 4.2.2. and 4.2.3. With these three vital elements, we could have faster response time and better backtracking information if a disease has spread somewhere. With sport horses especially, future studies could even make more accurate predictions and prevent horse diseases from spreading, since with the tracking ability we could estimate the risk that a certain horse would carry a disease. Naturally this is something that could be done first in the future, when the elements are in place. At any moment a medical database could help with the before mentioned FEI's HHP program (see section 2.3). If all vital information is stored in one place it is easier for even border control to check from the system any vaccinations the horse has been given, and which tests have been taken, veterinarian testimonials, route plans, visitation length and even certificates that the horse is taking part in a competition in the country. Hopefully, in the future this way HHP horses will not need to go through difficult quarantine programs when entering countries, then new exiting equestrian sports competition sites would emerge around the world.

c. Can a support system help to monitor a horse's wellbeing?

Hopefully with a consistent harmonized identification system for horses, owners of abandoned horses could be tracked down, and penalized accordingly. Unfortunately a medical database alone cannot stop animal abuse, but maybe some of the support system elements can at least help, by notifying if a horse has not received e.g. vaccinations, dental treatments or de-worming in a long time. The system could then notify the local authorities of such a horse, and they could take the matter further. As was mentioned before, identification and tracking could also help to monitor transportations, so that livestock trucks will not transport suffering animals, and will make certain that they get proper rest, food and water on the road (see 4.2.3).

d. How will transparency affect the horse trade?

Assuming that a national (or even international) medical database for horses could be built, according to specifications discussed earlier, it would open up a diversity of new opportunities, since such a support

system would enable transparency levels that have not been possible before. Many parts of the horse industry, especially horse dealing, international competitions; transportation among others will have to evolve to accommodate new needs. Since a horse's medical history can be available for potential buyers, or at least buyers could demand to see the full medical history, fraudulence would most likely diminish or at least made much more difficult. This is why it is possible that many horse dealers will resist such transparency, because it will change the way we manage horse dealing. But will it be for the worse? This subject will be discussed more in the future development chapter.

For veterinarians, the *m-equine* system could help their work, since they then can receive information throughout the horse's medical history when choosing the course of treatment. Co-operation among veterinarians would be available on a totally different level than it is today, which can lead to improvement and new opportunities in equine medicine as also was noted in research by Hartig *et al.*, (2013a and 2013b) and Penell *et al.*, (2009). Naturally, medical transparency can also be harmful for veterinarians, since it could lessen customer loyalty as well as the treatments they have given patients would be more open for criticism. Customer loyalty can be however taken to a whole new level, if only the veterinarians utilize the potential a medical database can give and start seeing their industry as not only medical care, but also as partially a customer service.

The main contribution of *m-equine* is for the main stakeholders, veterinarians, and horses. In the end the system is developed to support the stakeholders around the equestrian sports, and to ensure the wellbeing of horses. Technologically speaking, the idea is not monumental since the components have been in the market for some time. The main problem is to find somebody who can combine it all together in the right way. The m- and e-health projects can show several cautionary tales how everything can go wrong, and a large amount of money is unwisely spent. The equestrian sport is still in the eyes of the large IT and mobile companies such a niche sport that they are not interested in developing a support system that requires so much research.

6.2 Limitations

The limitations of this research were that more international riders and owners could not be included in the survey. Although the results were sufficient, it would have been interesting to have respondents from several nationalities, so that the responses could have been cross-tabulated to find variances between nationalities. In Scandinavia the idea of a common medical database for horses has been met with slight positivism. This might however not be the matter in other countries, with long horse culture traditions, and different horse trade legislations when it comes to medical records.

During the course of the research especially mobile device functionality has rapidly developed. Since the survey with veterinarians was conducted and the proof-of-concept version was developed in 2009, smartphones and internet usage with phones has changed in Finland.

There is not yet a conclusive solution on who would be a suitable "owner" for the medical database. Naturally it could even be owned by *m-equine*, but would it then be able to reach government level penetration? Assuming that the *m-equine* system is used by member states of FEI and once HHP has been lobbied to governments, then the system could be very useful in e.g. border control.

6.3 Discussion

In the research domain chapter some problems within the horse industry were identified, of which one in particular was considered problematic; identification. Although it is not directly related to the research questions, it still is an important underlying element in several of the topics discussed earlier and is recognized as insufficient at the moment by all the main stakeholder groups. Proper identification enables more efficient tracking of animals to e.g. avoid extreme transportation issues that rose a few years ago (MTV 3 45 min, 2007). Apart from transportation monitoring and disease control (Disney, *et al.*, 2001; Mardones, *et al.*, 2013), the equine industry could also use tracking tools for stable management, owners and trainers. Animal identification, including horses is largely done by RFID technology today, but even in the EU horses can have microchips with one of the two types of frequency standards allowed. Therefore, it would be more convenient to either restrict the used

RFID standard to one, or increase the availability for the before mentioned “agile” readers.

Mobile devices, in different sizes and purposes have increased in popularity throughout the world for the last decade (mobiThinking, 2013). At the same time, especially in Finland mobile networks have become more efficient, which enables internet access almost anywhere. Therefore we have the opportunity to use mobile devices in a larger range than previously was possible. The stable environment is not the best place for veterinarians to try to maintain sanitary conditions, and work efficiently. Therefore it would seem obvious that mobile devices will find their place as a support tool in this environment. Mobile apps markets offer already some tools for veterinarians, although at the moment they are mostly reference and educational tools for students and professionals alike. Depending on the place and the patient, veterinarians need different support tools. Thus the trend of today, the ability to fluently change mobile devices while continuing to work on the same patient management software can truly enhance a veterinarian’s work. This hypothesis is supported by studies done by Liu and Hefner (2011) and Kharrazi *et al*., (2012), where they discuss the need for using, the obvious tool that we today carry with us, the mobile phone, to aid in our daily work.

In the equine world, the information that would be essential to send by mobile phone would have to be restricted to predetermined users and have higher security levels, in comparison to the Lin *et al*., (2011) system. This would ensure that the information in the system is reliable and will follow with the horse throughout its life. Even if the horse industry is not ready to embrace the type of transparency that *m-equine* can offer the system is still invaluable for the food industry to ensure horse meat’s purity and safety for human consumption.

In the research done by Teng *et al*., (2012) they use in their system a locally cached system for every farm, which probably would not be the most optimal solution for the horse industry. With livestock you can have a local database that only includes one farm’s animals, since a farm might have even several hundred of animals. Horse stables are smaller entities than livestock farms, and rarely have more than 10-20 horses; therefore creating a local database for one stable is not a feasible solution, except in rare cases. An equine database would have to include e.g. a whole country’s equidae population. Since this could include thousands of

horses and their medical information, an idea could be that veterinarians would have local databases of their clients + OCA architecture. New entries into the local database could then be updated into the nation wide database periodically to maintain an up-to-date unity.

In this dissertation, only the main stakeholders for equestrian sports have been included, i.e. veterinarians, horse owners, horse riders and drivers and competition organizers. Therefore the results of Hartig *et al.,* (2013a and 2013b) are interesting, since the research groups somewhat differ and the research states the situation and views for a possible common medical database for horses, from other perspectives than just the main stakeholders'. In their survey 65% of owners and 64 % of vets found that it is important to have all the horse's disease history and information recorded, but 75% of vets think it is important to have a national health and disease database in Denmark. The researchers were surprised that the percentage of owners and veterinarians, who thought it important to have the horse's whole medical history in one place, was so low. In the view of a competition rider, and horse owner, I find the percentages actually higher than expected. This just shows that the horse industry's various stakeholders are different, and perceive things in various ways. In the Hartig *et al*., case, the top five things the researched stakeholder groups would include in a database were: contagious diseases, medical disorders, veterinary clinical records, lameness and congenital malformations. Stakeholders could list freely what they wanted on the database. In this study, the veterinarians were given options what they thought would be important to have on a medical database, and their top five were: medical data, medication data that forbids the animal becoming human food, vaccination data, diagnoses and treatments performed at the clinic, private practice or during house call. Of the respondents over 70 % answered either "definitely agree" or "somewhat agree" to these five options. The lists between this study and the Danish study somewhat differ, and it is especially interesting that vaccination data was not in the Danish study's results.

The commercial version of the *m-equine* system is already under construction, and the as mentioned before, the alpha version will be tested in the beginning of 2014. The complete commercial version will be available in 2014, if the test period goes according to plan. The first "product" that will be offered in *m-equine* is the vaccination system, and then the development to other areas within the horse industry will be

added, simultaneously as the system is translated and offered to different countries. Naturally after the equestrian sport the system can be developed to be used in other horse sports, such as racing and harness racing. To maximize the odds to penetrate the different horse sports markets, and even other markets, that are discussed later, research into the needs of these sports is crucial.

The *m-equine* system has so far been developed by Oy Cemron Ab from Tampere, Finland. Initial negotiations have started with several Equestrian federations around the world, and new vaccination needs have also been included into the system. Figure 21 is a screen shot on how the system looks like for a veterinarian and the horse owner on a mobile device. In the example of Figure 21 the horse ST Remy has the equine influenza vaccination in order, but needs to get a new Hendra vaccination shot shortly. The Hendra vaccination feature is something that has been developed in November 2013, because of the Hendra virus outbreak in Australia. The Hendra virus is deadly and can be transmitted from animals to humans. It will be mandatory for horses attending high risk events in NSW to have HEV vaccination against Hendra starting January 1st 2014 (Equestrian NSW, 2013).

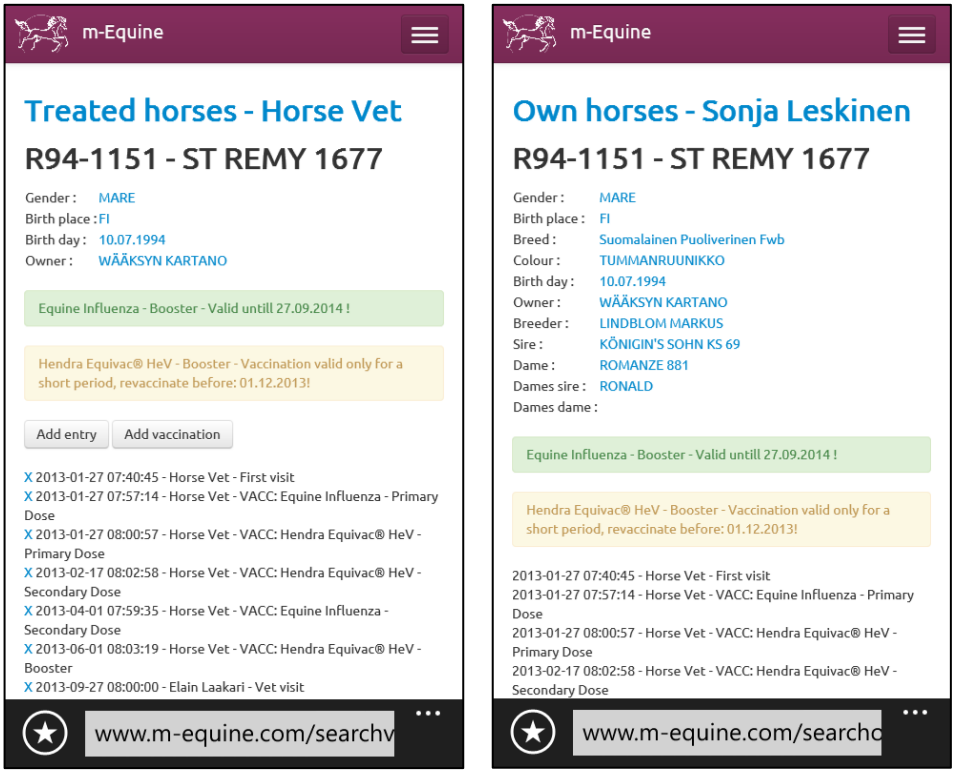

Figure 21 m-equine view on a mobile device 27.11.2013 for a) a veterinarian and b) for the horse owner.

The system can already be updated with the Finnish "Heppa" system and should undergo trial in the beginning of 2014. This trial will be done with veterinarians so that the system is then further developed according to their needs and requirements. The system will however be flexible, so that other stakeholders can have different features than veterinarians, according to their needs. It is important that all users' needs are acknowledged and attempted to be fulfilled. Today's technology allows personalization at a level that ensures fast and positive user experiences with IS.

6.4 Future development

For research purposes it would be interesting to see how insurance companies could use the m-equine system, and what type of situations it could bring. As stated in the study by Samad, *et al.*, (2010) insurance

claims on animal sickness or death were easier with the help of the RFID based animal data recording system. Could insurance policies become different in Finland, with *m-equine*? Insurance companies would definitely get reliable data, and the whole medical history of the horse. Today horse owners can purchase for their animals both life insurance and medical insurance. A veterinarian examines the horse, and from his examination, the insurance company then states what the insurance covers, in much the same way as done with medical insurance for humans. In the future if the medical database were available, the insurance company could see directly from there what problems the horse has possibly had, and have those ailments outside the insurance coverage.

For development outside Finland, there is a need to develop some common terminology to use within the database. This will ensure that even if a horse is treated in different countries, veterinarians with different linguistic backgrounds still can understand and benefit from the use of the *m-equine* system. This complies with the findings in Zaninelli *et al.*, (2012) O3-Vet project. Although Houe *et al.* (2011) did not believe in a common terminology. For the purpose that *m*-equine would have, it would be possible, since especially in the beginning the most important information that needs to be recorded are medications, vaccinations and blood test results, not diagnoses etc. Yet to obtain optimal market penetration in different countries, the *m-equine* system will be offered in different languages, to ease its use for all the stakeholders involved. Therefore the terminology that is important to all parties involved, such as vaccination, blood test results; medication etc. would need a common terminology. Luckily since veterinary medicine uses often Latin, in diagnoses and anatomy, and a medication's active substance are chemical formulas, much of the needed terminology is already in place. The more difficult task will be, the ability to "separate" the important information from the non-essential information. The new veterinarian would be interested in a possible recurring injury; or what was the last diagnosis, or seeing possible pictures or ultrasounds of the injury for comparison purposes, or even how the animal was treated for the injury (meaning here in essence what medicines the horse got). Naturally in this situation all relevant data on the horse's possible allergies to medicine need for more or less would also be good information to have available. The competition officials and border control in export and import situations need even less information, since they are interested in the former case with medicinal treatments and in both, vaccination and possible blood test results. All this

information can be easily extracted from a veterinarian's full report if there is good co-operation with practice management software companies, so that unnecessary information is reduced to a minimum.

Cattle identification with RFID technology has been commonplace for several years in many countries around the world. Also co-operation between countries has increased so that livestock monitoring has become easier. In today's world, animal abuse and poor conditions cannot be swept under the carpet because mobile technology has enabled people to have "eyes everywhere". This can only mean good news for the animals, because technology has awakened us into reality and made us face the problems that are apparent, to which we must deal. With the help of today's livestock monitoring system, it has even been used to monitor transportation situations (Ruiz-Garcia and Lunadei, 2011). There is no hindrance why horses and their transporting situations could not be monitored in the same manner, thus reducing cruel transportation situations, to monitor transportation time and even transportation route. In the future not only can we monitor where animals are traveling from afar, but possibly even their health condition and changes in it during the transport.

In Figure 22 the development stages for the equestrian sport part of the *m-equine* system is introduced. The development can be divided into six main components; Database, Internet services for veterinarians, Mobile services for veterinarians, Internet services for competition organizers, Internet services for owners and Mobile services for owners. Naturally, with today's smartphones and other internet able mobile devices, there is not really a need for having separate development fields for both the mobile and the internet version, but the mobile version has to be fitted for smaller screen size etc. The first stage in Figure 22 shows the functionalities that would be available for the first version of the *m-equine* once it is launched commercially. Stage two and three describes the future functionalities that would be added to the system, once the previous stage has been successfully implemented. In a way although the ADR ends with the fourth iteration presented in section 5.5, the future development stages presented in Figure 22 could be viewed as a continuum to the ADR thus being iterations five and six. Since the future development stages are not yet certain, it is too premature to start to discuss the possibilities of two more iterations, let them be for future research.

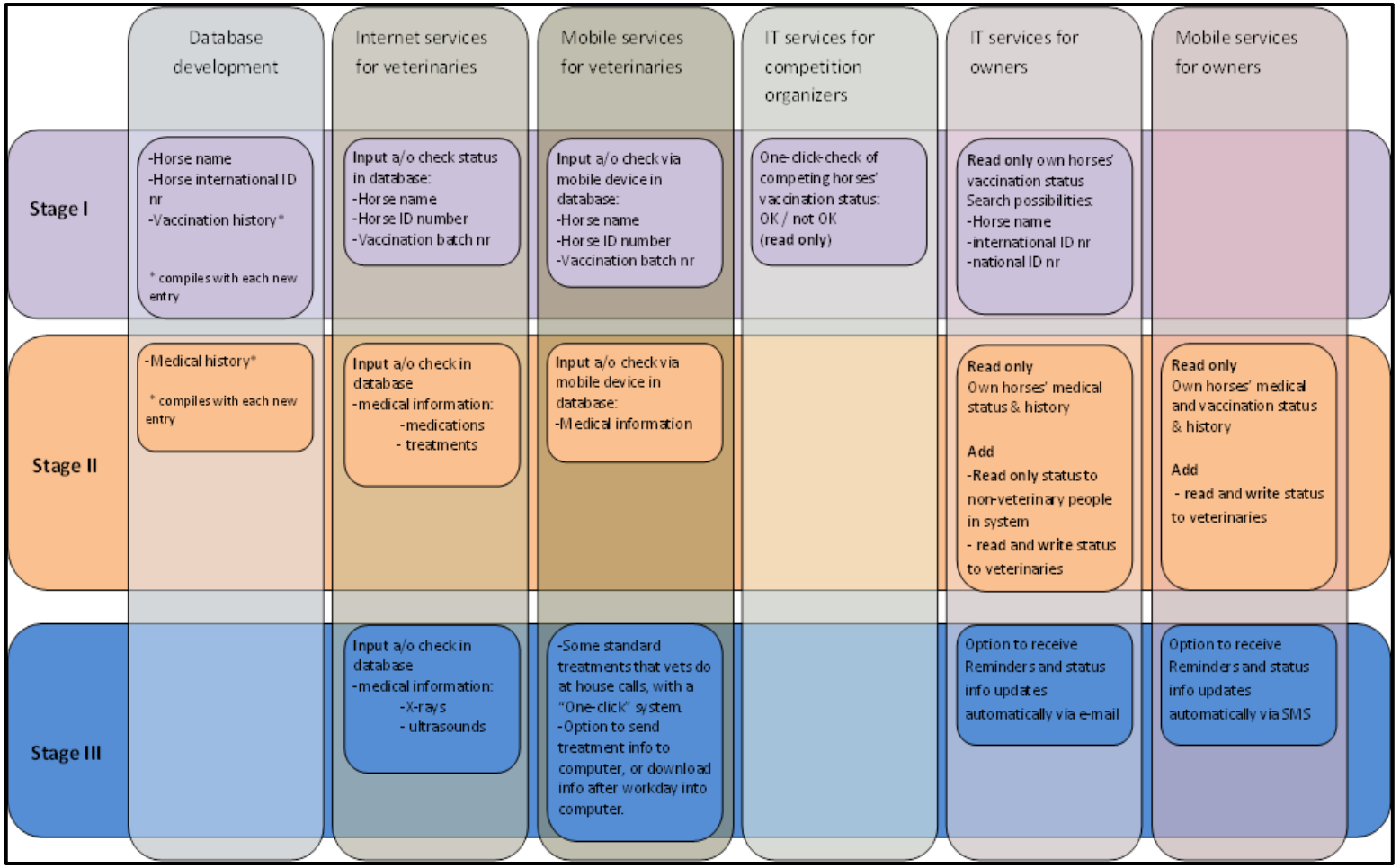

Figure 22 Future development stages into the m-equine system

In the future the *m-equine* support system and its services are easily transferable to other animal groups, such as pets and livestock. A common international system could be beneficial, especially for epidemic and food control. Pets are members of their family, and often travel with their owners on vacations etc. Suomen Kennelliitto informs that 2011 there were over 600 000 dogs in Finland they arranged over 300 dog shows, which were attended by over 195 000 dogs. Other dog activities, such as agility are also very popular (Suomen Kennelliitto (Finnish Kennel club), 2013). Suomen Kissaliitto ry is a member of the international cat federation, and in 2012, they organized 30 international cat shows in Finland, having an attendance of over 18 000 cats (*Suomen Kissaliitto ry*. 2013). Once we add to these figures all the international dog shows, Finnish dogs and cats attended, abroad Finland, not to mention common household pets travelling, the number of pets and pet owners benefiting from a support system and services will be in the millions.

References

Ammattina eläinlääkäri (Veterinary as an occupation). [online] http://www.sell.fi/ammattina_elainlaakari/ (Accessed 5.4.2013).

European Committee of Standardizations. [online] www.cen.eu (Accessed 28.2.2011).

Health Level Seven International. [online] www.hl7.org (Accessed 28.2.2011).

Alerini, L. (27.3.2013) *Yhä tabu -mutta miksi? (Still tabu -but why?).* Espoo: Suomen Hevosurheilulehti Oy

Appels, A., *Branding, Topic on Fire in Germany.* [online] http://www.eurodressage.com/equestrian/2011/03/17/branding-topic-fire-germany (Accessed 2.7.2013).

Arnaud, A. and Bellini B. (2010), 'Full ISO 11784/11785 compliant RFID reader in a programmable analog-digital, integrated circuit' *Argentine School of Micro-Nanoelectronics Technology and Applications (EAMTA), 2010,* pp. 107-111.

Baru, C., Botts N. and Horan T. (2012), 'A Seeded Approach to Health Cyberinfrastructure: Preliminary Architecture Design and Case Applications' in Ralph H. Jr Sprague (Ed.)Maui, Hawaii, pp. 2727-2734.

Bolton, P. (26.8.2013) 'Atlantan leads effort to Rescue Starving Horses from Danish Breeder'. *Global Atlanta* [online] http://www.globalatlanta.com/article/26447/atlantan-leads-effort-to-rescue-starving-horses-from-danish-breeder/ (accessed) 31.8.2013

Bosona, T. and Gebresenbet G. (2013) 'Food traceability as an integral part of logistics management in food and agricultural supply chain'. *Food Control* Vol. 33 No. 1, pp. 32-48.

Boulos, M., Wheeler S., Tavares C. and Jones R. (2011) 'How smartphones are changing the face of mobile and participatory healthcare: and overview, with example from eCAALYX'. *BioMedical Engineering*

OnLine [online] http://www.biomedical-enginering-online.com/content/10/24 (Accessed 6.9.2011).

British Horseracing Authority. (2009) *Economic Impact of Brittish Racing.* London, UK: Deloitte LLP

British Horseracing Authority. (2010) *Annual Review 2009.*

Carare, B. (2012), 'The Impact of Bestseller rank on Demand: Evidence from the App Market'. *International Economic Review* Vol 53 No. 3, pp. 717-742. [online] http://onlinelibrary.wiley.com/journal/10.1111/%28ISSN%291468-2354 (accessed 31.8.2013)

Carlsson, C., Havnen A. and Walden P. (2008), 'Making the Fun of Fishing Legal with Mobile Value Services' *Hawaii International Conference on System Sciences, Proceedings of the 41st Annual*, pp. 86-86.

Carlsson, C. and Walden P. (2010) 'Supporting Tourists at the Bomarsund Fortress with Mobile Value Service'. *Journal of Information Technology Theory and Application* Vol. 10 No. 1,

Choi, J.S., Yi B., Park J.H., Choi K., Jung J., Park S.W. and Rhee P. (2011) 'The Uses of the Smartphone for Doctors: An Empirical Study from Samsung Medical Center'. *Healthcare Informatics Research* Vol. 17 No. 2, pp. 131-138.

Cole, R., Purao S., Rossi M. and Sein M.k. (2005), 'Being Proactive: Where Action Research meets Design Research' in David E. Avison and Dennis F. Galletta (Eds.) *International Conference on Information Systems (ICIS),* Las Vegas, NV, USA, pp. 325-336.

Costello, S. (13.6.2013) 'App Store Dominates in Mobile Game Sales, but Google Play Growing Fast'. *Mobile World Live* [online] http://www.mobileworldlive.com/app-store-dominates-in-mobile-game-sales-but-google-play-growing-fast (accessed) 31.8.2013

Der Spiegel (10.4.2013) 'Möglicher Pferde-Anteil: Niederlande Rufen 50.000 Tonnen Fleisch Zurück' [online] http://www.spiegel.de/wirtschaft/service/pferdefleisch-verdacht-

niederlande-rufen-50-000-tonnen-ware-zurueck-a-893657.html (accessed) 31.8.2013

Disney, W.T., Green J.W., Forsythe K.W., Wiemers J.F. and Weber S. (2001) 'Benefit-cost analysis of animal identification for disease prevention and control'. *Revue scientifique et technique* Vol. 20 No. 2, pp. 385-405.

European Commision. (1993) *93/197/EEC: Commission Decision of 5 February 1993 on animal health conditions and veterinary certification for imports of registered equidae and equidae for breeding and production.* (93/197). Brussels

European Commision. (2008) *Commission Regulation (EC) No 504/2008 of 6 June 2008 implementing Council Directives 90/426/EEC and 90/427/EEC as regards methods for the identification of equidae.* (504/2008). Brussels, Belgium

European Commision. (2013) *2013/161/EU COMMISSION IMPLEMENTING DECISION of 11 March 2013 amending Decision 2011/163/EU on the approval of plans submitted by third countries in accordance with Article 29 of Council Directive 96/23/EC.* (2013/161). Brussels

Evira. (2013a) *Pieneläimille hyväksytyt lääkevalmisteet (Aproved medicine for small animals) 8.4.2013.* Helsinki: Elintarvike-turvallisuusvirasto Evira (Finnish Food Safety Authority Evira);

Evira. (2013b) *Tuotantoeläimille hyväksytyt lääkevalmisteet (Medicine approved for production animals) 8.4.2013.* Helsinki: Elintarviketurvallisuusvirasto Evira (Finnish Food Safety Authority Evira)

Equestrian NSW (2013), Hendra Vaccination Policy update, decision 27.10.2013. ABN 17 157 619 696 [online] http://www.nsw.equestrian.org.au/site/equestrian/nsw/downloads/Hendra%20Policy%20Update%20%20111113.pdf

Fédération Equestre Internationale (FEI). (2011) *Rules for Dressage Events 24rd ed.* Switzerland: FEI

Fédération Equestre Internationale (FEI). (2013a) *General Regulations 23rd edition, 1 January 2009, updates effective 1 January 2013.* Switzerland: FEI

Fédération Equestre Internationale (FEI). (2013b) *Rules for Eventing 24rd ed.* Switzerland: FEI

Fédération Equestre Internationale (FEI). (2013c) *Rules for Jumping Events 24rd ed.* Switzerland: FEI

Fédération Equestre Internationale (FEI). (2013d) *Veterinary Regulations 13th ed.* Switzerland: FEI

FEI, *Fédération Equestre Internationale.* [online] www.fei.org (Accessed 19.02.2013).

FEI, *Identification and Passports.* [online] http://www.fei.org/veterinary/identification-and-passports (Accessed 6.5.2013).

Feng, J., Fu Z., Wang Z., Xu M. and Zhang X. (2013) 'Development and evaluation on a RFID-based traceability system for cattle/beef quality safety in China'. *Food Control* Vol. 31 No. 2, pp. 314-325.

Fernando, N., Loke S.W. and Rahayu W. (2013) 'Mobile cloud computing: A survey'. *Future Generation Comput.Syst.* Vol. 29 No. 1, pp. 84-106.

Free, C., Philips G., Felix L., Galli L., Patel V. and Edwards P. (2010) 'The Effectiveness of M-Health technologies for improving health and health servies: a systematic review protocol'. *BMC Research Notes* [online] http://www.biomedcentral.com/1756-0500/3/250 (Accessed 14.5.2012).

Fritschi, L., Morrison D., Shirangi A., Day L. (2009) 'Psychological well-being of Australian veterinarians'. *Australian Veterinary Journal* Vol. 87 No. 3 pp. 76-81.

Gregor, S. and Jones D. (2007) 'The Anatomy of a Design Theory'. *Journal of the Association for Information Systems* Vol. 8 No. 5, pp. 312-335.

Harkke, V. (2006) *Knowledge Freedom for Medical Professionals - An Evaluation Study of a Mobile Information System for Physicians in Finland*.Turku, Finland: Turku Centre for Computer Science (TUCS)

Han, S. (2005) *Understanding User Adoption of Mobile Technology: Focusing on Physicians in Finland.* Turku, Finland: Turku Centre for Computer Science (TUCS)

Hansen, D., P., Gurney P., Morgan G. and Barraclough B. (2011) 'The Australian e-Health Research Centre: enabling the health care information and communication technology revolution'. *The Medical Journal of Australia* Vol. 194 No. 4, pp. S5-S7.

Hansez, I., Schins F., Rollin F. (2008). 'Occupational stress, work-home interference and burnout among Belgian veterinary practitioners'. *Irish Veterinary Journal* Vol. 61 No. 4 pp. 233-241. [online] http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3113869/. (accessed 16.8.2013).

Hartig, W., Houe H. and Andersen P.H. (2013a) 'Monitoring of equine health in Denmark: A survey of the attitudes and concerns of potential database participants'. *Prev.Vet.Med.* Vol. 109 No. 1–2, pp. 83-91.

Hartig, W., Houe H. and Andersen P.H. (2013b) 'Monitoring of equine health in Denmark: The importance, purpose, research areas and content of a future database'. *Prev.Vet.Med.* Vol. 109 No. 1–2, pp. 92-105.

Hautala, K. (16.10.2009). Hevosinfluenssa tarttuu helposti (Horse influenza transmits easily). *Hevosurheilu* pp. 15.

Hevner, A.R., March S.T., Park J. and Ram S. (2004) 'Design Science in Information Systems Research'. *MIS Quarterly* Vol. 28 No. 1, pp. 75-105.

Higgins, A., Castle, S. (25.2.2013) 'Ikea Recalls Meatballs after Detection of Horse Meat'. *The New York Times* [online] http://www.nytimes.com/2013/02/26/world/europe/ikea-recalls-its-

meatballs-horse-meat-is-detected.html?pagewanted=all&_r=0 (accessed) 31.8.2013.

Hoffman, S. and Podurski A. (2008) 'Finding A Cure: The Case For Regulation and Oversight Of Electronic Health Record Systems'. *Harvard Journal of Law & Technology* Vol. 22 No. 1, pp. 2-64.

Holzer, A., and Ondrus, J. (2011) 'Movile Application Market: A Developer's Perspective'. *Telematics and Infromatics* Vol. 28 No. 1, pp. 22-31.

Houe, H., Gardner, I.A. and Nielsen, L.R. (2011) 'Use of information on disease diagnoses from databases for animal health economic, welfare and food safety purposes: strengths and limitations of recordings'. *Acta Veterinaria Scandinavica* Vol. 53 No. (Suppl 1): S7 [online] http://www.actavetscand.com/content/53/S1/S7

Iivari, J. (2007) 'A Paradigmatic Analysis of Information Systems As a Design Science'. *Scandinavian Journal of Information Systems* Vol. 19 No. 2, pp. 39-64.

International Movement of Competition Horses Forum Panel, *International Movement of Competition Horses (FEI Sports forum 2013, held at Lausanne, Switzerland 8.4.2013).* [online] https://next.fei.org/fei/about-fei/fei-sports-forum/supporting-docs (Accessed 3.6.2013).

Järvinen, P. (2004) *On Research Methods.* 1st. Juvenes-Print, Tampere, Finland: Tampereen Yliopistopaimo Oy

Järvinen, P. (2007) 'Action Research is Similar to Design Science'. *Quality & Quantity* Vol. 41 No. 1, pp. 37-54.

Kellerman, S.E. and Herold J. (2001) 'Physician response to surveys: A review of the literature'. *Am.J.Prev.Med.* Vol. 20 No. 1, pp. 61-67.

Kharrazi, H., Chisholm R., VanNasdale D. and Thompson B. (2012) 'Mobile personal health records: An evaluation of features and functionality'. *Int.J.Med.Inf.* Vol. 81 No. 9, pp. 579-593.

Krause, M., Hampe J., Felix and Brenk C.R. (2013), 'Concept and Implementation of a Vaccination Card Application for Mobile Devices.' *26th Bled e-Conference eInnovations: Challenges and Impacts for Individuals, Organizations and Society,* Bled, Slovenia, pp. 382-394.

Lawrence, F., (10.5.2013) 'Horsemeat scandal: timeline the key moments of revelation in the investigation' *the Guardian* [online] http://www.theguardian.com/uk/2013/may/10/horsemeat-scandal-timeline-investigation (accessed) 31.8.2013.

Lenz, Tom R., DVM, MS, DACT. (2009) 'The Unwanted Horse in the United States: An Overview of the Issue'. *Journal of Equine Veterinary Science* Vol. 29 No. 5, pp. 253-258.

Leong, K.S., Ng M.L. and Cole P.H. (2007), 'Investigation on the deployment of HF and UHF RFID tag in livestock identification' *Antennas and Propagation Society International Symposium, 2007 IEEE,* pp. 2773-2776.

Leskinen, S. (2008), 'Mobile Technology in the Finnish Construction Industry - Present Problems and Future Challenges' *21st Bled eConference eCollaboration: Overcoming Boundaries through Multi-Channel Interaction,* Bled, Slovenia, pp. 13-24.

Leskinen, S. (2010), 'Equine Vaccination, a paper mess waiting to get solved. Could ICT be the answer?' *23rd Bled eConference eTrust: Implications for the Individual, Enterprises and Society,* Bled, Slovenia, pp. 127-143.

Leskinen, S. (2011a), 'Can Information Systems expand the limits of Equine Medication?' *The 6th Mediterranean Conference on Information Systems (MCIS2011),* Cyprus,

Leskinen, S. (2011b), 'Veterinarians' attitudes towards digital technology – an empirical study' in Machteld von Dierendonck, Patricia de Cocq and Kathalijne Visser (Eds.) *7th International Equitation Science Conference,* Hooge Mierde, The Netherlands, pp. 44.

Leskinen, S. (2012), 'Veterinarian Work, Enhanced by Mobile Technology-An Empirical Study' *System Science (HICSS), 2012 45th Hawaii International Conference on,* pp. 1403-1412.

Leskinen, S. (2013), 'Enhancing the Daily Routines of Equine Veterinarians using Mobile Technology: The m-Equine Case' *International Journal of Systems and Service-Oriented Engineering* Vol. 3 No. 4, pp. 1-19.

Lin, Y. and Heffernan C. (2011) 'Accessible and inexpensive tools for global HPAI surveillance: A mobile-phone based system'. *Preventive Veterinary Medicine* Vol. 98 No. 2-3, pp. 209-214.

Lindegaard, C. and Andersen P.H. (2012) 'The branding iron: A museum exhibit'. *The Veterinary Journal* Vol. 191 No. 2, pp. 143-144.

Liu, C., Zhu Q., Holroyd K.A. and Seng E.K. (2011) 'Status and trends of mobile-health applications for iOS devices: A developer's perspective'. *J.Syst.Software* Vol. 84 No. 11, pp. 2022-2033.

Lubin, G. (18.10.2011). 'The 19 Jobs Where You Are Most Likely to Kill Yourself' *Business Insider* [online] http://www.businessinsider.com/most-suicidal-occupations-2011-10?op=1 (accessed 16.8.2013).

Maa- ja metsätalousministeriö (Ministry of Agriculture and Forestry). (2006) *Elintarvikelaki (Food Legislation) 13.1.2006/23.* (23/2006). Helsinki

Mair, T.S. and White N.A. (2005) 'Improving quality of care in colic surgery: time for international audit?'. *Equine Vet.J.* Vol. 37 No. 4, pp. 287-288.

March, S.T. and Smith G.F. (1995) 'Design and natural science research on information technology'. *Decis.Support Syst.* Vol. 15 No. 4, pp. 251-266.

Mardones, F.O., Zu Donha H., Thunes C., Velez V. and Carpenter T.E. (2013) 'The value of animal movement tracing: A case study simulating the spread and control of foot-and-mouth disease in California'. *Prev.Vet.Med.* Vol. 110 No. 2, pp. 133-138.

Masters, A. and Michael K. (2007) 'Lend me your arms: The use and implications of human centric RFID'. *Electronic Commerce Research and Applications* Vol. 6 No. 1, pp. 29-39.

McGreevy, P. and McLean A. (2010) *Equitation Science.* Wiley. com

Michael, K. and Michael M.G. (2009a) *Innovative Automatic Identification and Location-Based Services: From Bar Codes to Chip Implants.* 1st. Hershey, USA: Information Science Reference (an imprint of IGI Global)

Michael, M.G. and Michael K. (2009b) 'Uberveillance: Microchipping People and the Assult on Privacy'. *Quadrant online* [online] http://www.quadrant.org.au/magazine/issue/2009/3 (Accessed 2.3.2010).

Maa- ja metsätalousministeriö (Ministry of Agriculture and Forestry). (14.4.2000) *Act and access to and Pursuit of the Profession of Veterinary Surgeon.* (29/2000). Helsinki, Finland

Maa- ja metsätalousministeriö (Ministry of Agriculture and Forestry). (2009) *Eläinlääkintähuoltolaki (Law of medical service for animals).* (2009/765). Helsinki

MMM work group. (2007) *Selvitys eri vaihtoehdoista hevosten teurastamisen järjestämiseksi.* Helsinki: MMM

mobiThinking, *Global Mobile statistics 2013 Home: All the latest statson mobile Web, apps, marketing, advertising, subscribers and trends...* [online] http://mobithinking.com/mobile-marketing-tools/latest-mobile-stats (Accessed 21.6.2013).

MTV 3 45 min. (2007) *12.12. Teurashevosten tuskien tie (The slaughterhorses' tormented journey).*

Ngai, E.W.T., Poon J.K.L., Suk F.F.C. and Ng C.C. (2009) 'Design of an RFID-based Healthcare Management System using an Information System Design Theory'. *Information Systems Frontiers* Vol. 11 No. 4, pp. 405-417.

Nunamaker, J.F., Jr. and Chen M. (1990), 'Systems development in information systems research' *System Sciences, 1990, Proceedings of the Twenty-Third Annual Hawaii International Conference on*, pp. 631-640 vol.3.

Official Statistics of Finland (2012) Tieto- ja viestintätekniikan käyttö - tutkimus 2012, Tilastokeskus (Use of information and communications technology survey 2012, Central Statistical Office of Finland) [online] last updated 7.11.2012. http://www.stat.fi/til/sutivi/2012/sutivi_ 2012_2012-11-07_kat_003_fi.html (accessed) 9.2.2013.

Penell, J.C., Bonnett B.N., Pringle J. and Egenvall A. (2009) 'Validation of computerized diagnostic information in a clinical database from national equine clinic network'. *Acta Veterinaria Scandinavica* [online] http://www.actavetscand.com/content/51/1/50 (Accessed 2.2.2010).

Petersen, B., Knura-Deszczka S., Pönsgen-Schmidt E. and Gymnich S. (2002) 'Computerised food safety monitoring in animal production'. *Livest.Prod.Sci.* Vol. 76 No. 3, pp. 207-213.

Pettitt, R.G. (2001) 'Tracebility in the food animal industry and supermarket chains'. *Revue scientifique et technique (International Office of Epizootics)* Vol. 20 No. 2, pp. 584-597.

Pinsonneault, A. and Kraemer K.L. (1993) 'Survey Research Methodology in Management Information Systems: An Assessment'. *Journal of Management Information Systems* Vol. 10 No. 2, pp. 75-105.

Pitkänen, S. (24.2.2013) *Hevosenlihan tuonti moninkertaistunut (Horse meat import multiplied).* Helsinki: Maaseudun Tulevaisuus

Plummer, A.A. (2001), 'Information systems methodology for building theory in health informatics: the argument for a structured approach to case study research' *System Sciences, 2001. Proceedings of the 34th Annual Hawaii International Conference on,* pp. 10 pp.

Powell, S.E. (2012), 'Low-field standing magnetic resonance imaging findings of the metacarpo/metatarsophalangeal joint of racing Thoroughbreds with lameness localised to the region: A retrospective

study of 131 horses'. *Equine Veterinary Science* Vol. 44 No. 2, pp. 169-177.

Radzuweit, M., Grütz S., Wenke B. and Lechner U. (2013), 'Prototype Design and Evaluation of ICAT: A health Application for Tablet Computer' *26th Bled eConference eInnovations: Challenges and Impacts for Individuals, Organizations and Society,* Bled, Slovenia, pp. 370-381.

Reijula, K., Räsänen K., Hämäläinen M., Juntunen K., Lindbohm M-L., Taskinen H., Bergbom B., Rinta-Jouppi M. (2003), 'Work Environment and Occupational Health of Finnish Veterinarians'. *American Journal of Industrial Medicine* Vol. 44 No. 1, pp. 46-57.

Robertson, C., Sawford K., Daniel S.L.A., Nelson T.A. and Stephen C. (2010) 'Mobile Phone-based Infectious Disease Surveilance system, Sri Lanka'. *Emerging Infectious Diseases* Vol. 16 No. 10, pp. 1524-1531.

Rodrigues, L. (2011) *Master's Thesis in Information Systems M-equine: Mobile supporting tool for horse health management.* Turku, Finland: Department of Information Technologies Åbo Akademi University

Ruiz-Garcia, L. and Lunadei L. (2011) 'The role of RFID in agriculture: Applications, limitations and challenges'. *Comput.Electron.Agric.* Vol. 79 No. 1, pp. 42-50.

Samad, A., Murdeshwar P. and Hameed Z. (2010) 'High-credibility RFID-based animal data recording system suitable for small-holding rural dairy farmers'. *Comput.Electron.Agric.* Vol. 73 No. 2, pp. 213-218.

Samuels, K. (15.8.2013) 'Prominent Sport Horse Owner & Breeder Accused of Gross Neglect'. *Eventing Nation* [online] http://eventingnation.com/home/prominent-sport-horse-owner-breeder-accused-of-gross-neglect.html (accessed) 31.8.2013.

Schaefer, A.L., Cook N.J., Bench C., Chabot J.B., Colyn J., Liu T., Okine E.K., Stewart M., Webster J.R. (2012) 'The non-invaisive and automated detection of bovine respiratory disease oset in receiver calves using infrared thermography'. *Research in Veterinary Science.* Vol. 93 No. 2, pp. 928-935.

ScienceDaily, *Branding or Microchip Implant for Identification: Tradition or Stress? Research in University of Veterinary Medicine -- Vienna.* [online] http://www.sciencedaily.com/releases/2011/09/110928125303.htm (Accessed 2.7.2013).

Sein, M., Rossi, M. and Purao, S. (2007) 'Exploring the Limits of the Possible A Response to Iivari' *Scandinavian Journal of Information Systems* Vol. 19 No. 2. pp. 105-110.

Sein, M., Henfridsson O., Purao S., Rossi M. and Lindgren R. (2011) 'Action Design Research'. *MIS Quarterly* Vol. 35 No. 1, pp. 37-56.

Skarra, P. Rekistöröinti takaa hevosten oikeusturvan: Anna hevosellesi identiteetti (Registering your horse, guarantees your horse's legal protection: Give your horse an identity.) (2009) *HIPPOS Suomen Ratsastajainliiton jäsenlehti (HIPPOS The Equestrian Federation of Finland's official memebership magazine)* pp. SRL info 7-8.

Stankovic, J.A., Cao, Q., Doam, T., Fang, L., He, Z., Kiran, R., Lim, S., Son, S., Stoleru, R, and Wood, A. (2005) 'Wireless sensor networks for in-home healthcare: Potential and challenges. In *Proceedings in High Confidence Medical Device Software and Systems Workshop (HCMDSS).*

Strum, R.A., Fruhling A. and Schumaker A. (2012), 'Public Health Informatics: Increasing the Use and Access' in Ralph H. Jr Sprague (Ed.) *45th Hawaii International Conference on System Sciences,* Maui, Hawaii, pp. 2745-2751.

Suomen Hippos ry. (2010) *Raviurheilu ja Hevoskasvatus lukuina (Trottingindustry and horse breeding in figures).*

Suomen Hippos ry (the Finnish Trotting and Breeding Association), *Hevosia vastaanottavia teurastamoja (Slaughterhouses that receive horses).* [online] http://www.hippos.fi/rekisterointi_ja_omistaminen/hevosen_hyvinvointi/teurastamot (Accessed 20.2.2013).

Suomen Hippos ry (the Finnish Trotting and Breeding Association), *Hevoskannan kehitys maassamme 1910-2011 (Horse stock development*

in our country 1910-2011). [online] http://www.hippos.fi/files/4481/Hevosmaara_kokon_1910.pdf (Accessed 20.2.2013).

Suomen Kennelliitto (Finnish Kennel club), *Suomen kennelliiton toiminta (Finnish Kennel club).* [online] http://www.kennelliitto.fi/FI/toiminta/toiminta.htm (Accessed 23.6.2013).

Suomen Ratsastajainliitto ry (The Equestrian federation of Finland). (2012) *Kilpailusäännöt I (Competition rules I).* Helsinki, Finland: SRL

Swedberg, C. (Sept. 13, 2007). USDA Approves Implantable RFID Tag to Track Horses. *RFID Journal*

Swedberg, C. ZigBeef Offers Ranchers a Long-Distance Cattle Head Count. *RFID Journal*

Teng, C., Brown K., Caro C., Nielsen W. and Wells J. (2012), 'A service oriented livestock management system using occasionally connected mobile-cloud architecture' *Systems Conference (SysCon), 2012 IEEE International*, pp. 1-5.

The Council of the European Union. (25.4.2004) *Corrigendum to Regulation (EC) No 852/2004 of the European Parliament and of the Council of 29 April 2004 on the hygiene of foodstuffs.* (852/2004).

The Council of the European Union. (29.4.1996) *Council Directive 96/22/EC of 29 April 1996 concerning the prohibition on the use in stockfarming of certain substances having a hormonal or thyrostatic action and of ß-agonists, and repealing Directives 81/602/EEC, 88/146/EEC and 88/299/EEC.* (96/22). Luxembourg

The Council of the European Union. (29.4.1996) *Council Directive 96/23/EC of 29 April 1996 on measures to monitor certain substances and residues thereof in live animals and animal products and repealing Directives 85/358/EEC and 86/469/EEC and Decisions 89/187/EEC and 91/664/EEC.* (96/23). Luxembourg

Thorpe, C., Ryan B., McLean S., Burt A., Stewart M., Brown J., Reid G. and Harris S. (2008) 'How to obtain excellent response rates when

surveying physicians'. *Family Practice The International Journal for Research in Primary Care* Vol. 26 No. 1, pp. 65-68.

Trevarthen, A. (2007) 'The National Livestock Identification System: The Importance of Traceability in E-Business'. *Journal of Theoretical and Applied Electronic Commerce Research* Vol. 2 No. 1, pp. 49-62.

Trevarthen, A. and Michael K. (2008), 'The RFID-Enabeled Dairy Farm: Towards Total Farm Management' *7th International Conference on Mobile Business,* Barcelona, Spain, pp. 241-250.

Troshani I. and Wickramasinghe N. (2013) 'The Wow Factor of e-Health' In *26th Bled eConference eInnovations: Challenges and Impacts for Individuals, Organizations and Society* June 9-13, 2013; Bled, Slovenia.

Vaishnavi, V. and Kuechler B., *Design Science Research in Information Systems (2004).* [online] http://desrist.org/design-research-in-information-systems/ (Accessed 26.6.2013).

Venäläinen, A. (2009) *Eläinlääkärit 2009 (Veterinarians 2009).* Helsinki, Finland: Evira (Elintarviketurvallisuusvirasto) (Finnish Food Safety Authority);

Viitanen, J. (2/2013). Hevonen näytti ruokabisneksen todelliset kasvot. (Horse's true face in the food-industry). *Hevoset ja Ratsastus* pp. 46-49.

Voulodimos, A.S., Patrikakis C.Z., Sideridis A.B., Ntafis V.A. and Xylouri E.M. (2010) 'A complete farm management system based on animal identification using RFID technology'. *Computers and Electronics in Agriculture* Vol. 70 No. 2, pp. 380-388.

Waiditschka, G., *Branding under discussion.* [online] http://www.in-the-focus.com/magazine/?p=889 (Accessed 2.7.2013).

Wallace, L.E., Paterson J.A., Gagnon L., Clark R., Davis K. and Miller M. (2008) 'Evaluation of Implantable RFID Microchips for Readability and Measurement of Body Temperature in Mature Horses'. *American Society of Animal Science, Western Section* Vol. 59 pp. 99-101.

Walls, J.G., Widmeyer G.R. and El Sawy O.A. (2004) 'Assessing Information Systems Design Theory in Perspective: How Useful was our 1992 Initial Rendition?'. *Journal of Information Technology Theory and Application* Vol. 6 No. 2, pp. 43-58.

Wang, N., Zhang N. and Wang M. (2006) 'Wireless sensors in agriculture and food industry—Recent development and future perspective'. *Comput.Electron.Agric.* Vol. 50 No. 1, pp. 1-14.

Weitzman, E.R., Kaci L. and Mandl K.D. (2010) 'Sharing Medical data for Health Research: The Early Personal Health Record Experience'. *Journal of Medical Internet Research* [online] http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2956225/ (Accessed 21.2.2013).

Wognum, P.M., Bremmers H., Trienekens J.H., van der Vorst J.G.A.J. and Bloemhof J.M. (2011) 'Systems for sustainability and transparency of food supply chains – Current status and challenges'. *Advanced Engineering Informatics* Vol. 25 No. 1, pp. 65-76.

World Society for the Protection of Animals (WSPA), *Animal Mosaic Global Animal Connections.* [online] http://www.animalmosaic.org/legislation/resources/ (Accessed 12.07.2013).

Yin, R.K. (1992) 'The case study method as a tool for doing evaluation'. *Current Sociology* Vol. 40 No. 1, pp. 121-137.

Zaninelli, M., Tangorra F.M., Castano S., Ferrara A., Ferro E., Brambilla P.G., Faverzani S., Chinosi S., Scarpa P., Giancamillo M., Di, Zani D., Zepponi A. and Saccavini C. (2007) 'The O3-Vet project: A veterinary electronic patient record based on the web technology and the ADT-IHE actor for veterinary hospitals'. *Computer Methods and Prorams in Biomedicine* Vol. 87 pp. 68-77.

Zaninelli, M., Campagnoli A., Reyes M. and Rojas V. (2012) 'The O3-Vet project: Integration of a standard nomenclature of clinical terms in a veterinary electronic medical record for veterinary hospitals'. *Comput.Methods Programs Biomed.* Vol. 108 No. 2, pp. 760-772.

Internet sources

www.equipe.com	accessed	05.07.2013
www.kennellitto.fi	accessed	01.09.2013
www.kissaliitto.fi	accessed	01.09.2013
www.lemmikkilehto.fi	accessed	10.04.2011
www.m-equine.com	accessed	31.08.2013
www.maksuturva.fi	accessed	05.07.2013
www.naseva.fi	accessed	15.02.2010
https://www.nlis.mla.com.au/	accessed	15.02.2010
www.ratsastus.net	accessed	13.04.2011
www.sikava.fi	accessed	15.02.2010
www.valo.fi	accessed	05.07.2013
www.veteyed.com	accessed	20.07.2013

Appendices

Appendix I:

Survey 1 for riders and horse owners used for Article 1: Equine Vaccination, a paper mess waiting to get solved. Could ICT be the answer?

And article 2: Can Information Systems expand the limits of Equine Medication?

Appendix II:

Survey 2 for veterinarians used for a Poster: Veterinarians' attitudes towards digital technology – an empirical study.

Article 3: Veterinarian Work Enhanced by Mobile Technology – An Empirical Study.

And article 4: Enhancing the daily routines of equine veterinarians using mobile technology: the *m-equine* case

Appendix I
Survey 1

Dear competition rider and/or horse owner thank you for participating in my research!

I am currently working on my doctoral thesis at the Institute for Advanced Management Systems Research, Faculty of Technology, Åbo Akademi University, Finland. My research is about animal medication and welfare. Therefore I would need your opinion on your horse's vaccinations and medication.

Please answer the following questions:

I represent (Country) _____

Age _____ **Main discipline** *Dressage*
Jumping

I am a horse owner ☐ *Eventing*

I am a competition rider ☐ *other, what*

Mark your opinion for the following statements so that 1= I am completely of the same opinion, 2= I am somewhat of the same opinion, 3= I am somewhat of a different opinion and 4= I am of a different opinion.

	1	2	3	4
My country's national vaccination rules are clear and understandable				
The international vaccination rules are clear and understandable				

My horses' vaccination information could be public in	The Internet				
	A national database				
It takes too much time to check through my horses' vaccination information at the competition office					

I would like my veterinary to help me keep my horses vaccinations on time					
I would like to get a remainder when the vaccination is expiring via	Mail				
	e-mail				
	SMS				
	I do not believe that I need this service				

I am prepared to pay for the reminder service max

0 € / horse

1 € / horse

5 € / horse

10 € / horse

Assuming that only veterinaries may enter information, which of the following statements about your horses' medication history would you be willing to give?

	Definitely would	Probably would	Probably would not	Definitely would not
My horses' medication information could be publicly accessible by anyone, e.g. via internet.				
I would show to a potential buyer my horses full medical history				
My horses' medical information could be accessible by any veterinarian.				

My horses' medical information could be accessible by my current and future veterinarians (e.g. the horses' new owner's veterinarian)				
My horses' medical information can only be accessible by veterinarians with my permission, and all information has to be disposed of if I am not anymore in the possession of a horse				
My horses' medical information can be archived but should only be used by authorities, e.g. in the case that a horse is going to be slaughtered				
My horses' medical information may not be published under any circumstances				

All answers will be handled anonymously and single answers will not be published.

Thank you once more for your help in my research. If you are interested to learn more about it, please do not hesitate to contact me.

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Appendix II

Survey 2

M-Equine

Thank you for your participation in this study. I am Sonja Leskinen and am working on my doctoral dissertation at Åbo Akademi University. My research aim is to find technological solutions that would support horse owners (and later also other animal owners), veterinarians, competition organizers and conform to the criteria stated by the EU-regulations. Three master's students also work in this project on their master's thesis.
My interests lay in how veterinarians utilize technology and how it could be used to support their work routines. The aim of this study is to find out how veterinarians regard technology and what they feel are the bottlenecks of their work.

The answers will be confidentially handled and the data collected through this questionnaire will only be analyzed in an aggregate level. If you have any questions, please contact me. (Sonja.leskinen@abo.fi)

1. - In what type of practice do you work?

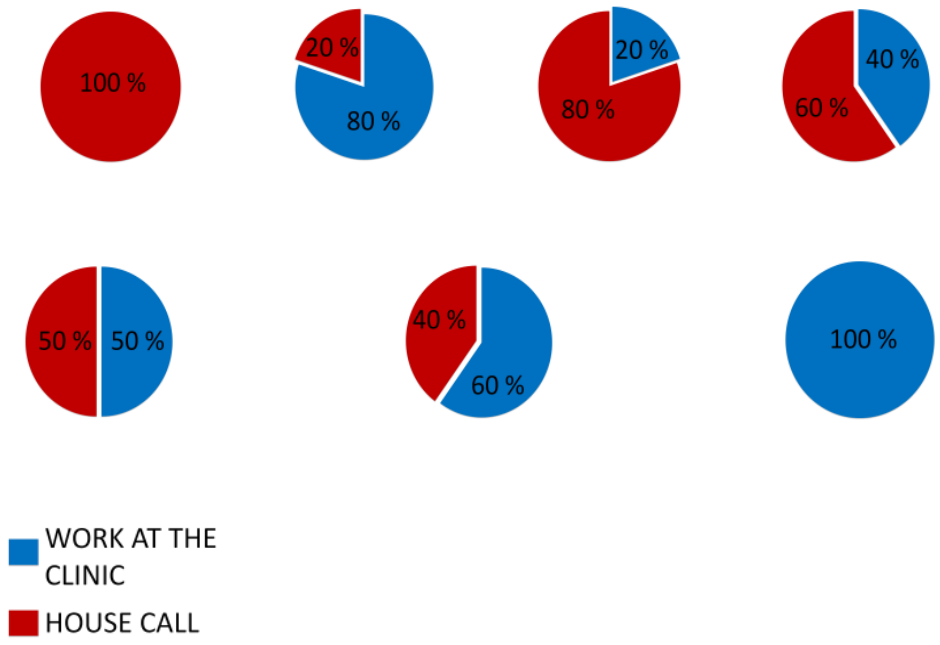
- I work at a private practice.
- I have my own private practice.
- I work at a County Practice.
- I work at a private practice and a county practice.
- I work at an University practice
- Other, please specify.

2.-Please choose the option(s) that best suit your type of veterinarian practice?

- Small Animal

- Production Animal
- Equine Medicine
- Research
- Other, please specify.

3.-How is your work time wise divided? (Click the one that best suits your situation)



4.-What are the main reasons a patient needs to see you? Select 3-5 options

CLINIC HOUSE CALL

- Birthing problems
- Castration
- Dentistry
- Emergencies
- Euthanasia

- Gastrointestinal
- Lameness
- Neurology
- Orthopedic problems
- Problems in ears
- Problems with eyes
- Respiratory problems
- Surgery
- Vaccination
- Other, please specify

5. - How do you keep records during **house calls** of
the patient treatment travel distance?

- Manually
- Laptop
- Mobile phone.
- Assistant keeps records
- I memorize the needed information
- Other, please specify

6. - How is your work time divided in percentages?

- Patient examination and treatment_____%
- Travel _____%
- Paperwork _____%
- Communicating with clients _____%

7. - Express your opinion about the following statements:

Columns

- Definitely agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Definitely disagree

Rows

- I feel I spend too much time doing paperwork.
- It's common that paperwork gets postponed and thus accumulates.
- I feel that I spend too much time communicating with my clients.
- I feel that I spend too much time on the phone with my clients.

8. - During **house calls** please express your opinion about the following statements:

Columns

- Definitely agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Definitely disagree

Rows

- I feel that I could improve the way I keep medical records during house calls.
- I would use a mobile device (mobile phone, PDA etc.) if it improved my work performance.
- I would use a system that automatically measures the distance I travel.
- I would use a system that would hasten my billing procedure.

9. – Approximately how many kilometers do you travel per week for work purposes?

10. – Approximately how many patients do you see per month?

11. - Assuming that you have the owner's permission, would you be comfortable in storing and sharing patient information with other veterinarians via:

- A global database
- A EU database
- A national database
- No database at all

12. - Your opinion was "No database at all" in the last question, could you please specify why?

- I do not trust that an electronic database is secure enough to store patient information.
- I do not feel that a common patient database would convey benefits.
- I feel that patient information should not be shared
- I am concerned that it might negatively affect the veterinary / patient (owner) relationship.
- Other, Please specify

13.- Express your opinion on the following statements.
In the database: How comfortable would you feel sharing the following?

Columns

- Definitely agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Definitely disagree

Rows

- Diagnostic data
- Medication data
- Treatments performed at the clinic, private practice or during house call

- Home care instructions
- Vaccination data

- Deworming data
- Medication data that forbids the animal to become human food.

14. – I use a computer at work

- Daily
- Weekly
- Occasionally
- Never

15. - Do you use Practice Management Software in your work? (Software to manage the day-to-day operations of a medical practice to perform tasks such as scheduling appointments, keeping medical records and billing)

- Yes
- No

16. What is the name of the Practice Management Software?

_____

17. - Do you use an electronic patient database?

- Yes
- No

18. - What is the name of the software?

_____

19. - Do you use billing software?

20. - Why do you not use a computer at work?

- I lack the skills
- My computer skills are too weak to be useful at work.
- I do not need a computer at work
- An assistant or someone else does my computer work
- I do not trust a computer's storage capacity.
- Other, please specify

21. - Do you regularly use a method to remind your customers of upcoming events?

Columns

- Yes
- No

Rows

- Appointments
- Treatments
- Vaccinations

22. – How do you remind customers?

- I call the customer
- I send a SMS to the customer
- I send an e-mail to the customer
- I send a mail to the customer
- Other, please specify

23. - Please mark your opinion on the following statements

Columns

- Definitely agree
- Somewhat agree

- Neither agree nor disagree
- Somewhat disagree
- Definitely disagree

Rows

- I am comfortable using computers.
- I am comfortable using a mobile phone for other functions than calling.

24. - What of these computer features do you use?

- Spreadsheets (e.g. Microsoft Excel)
- Word Processors (e.g. Microsoft Word)
- E-mail
- Communication (e.g Skype)
- Games
- Internet
- Media Players (e.g. watch movies, listen music)
- Other, please specify

25. - What type of mobile phone do you use?

- Smartphone, with advanced functions and possibility to download and install new applications. (e.g. Nokia N-series and iPhone)
- Basic phone, with only basic functions available, such as calls and text messages.
- I do not use a mobile phone

26. - What is the brand of your mobile phone?

- Nokia
- Samsung
- Motorola
- Apple
- HTC

- LG
- Sony Ericsson
- Blackberry
- Palm
- Other, please specify

27. - Do you use internet services on your mobile phone?

- Yes
- No

28. - Which one of these mobile phone features do you use? Have you tried?

- Calendar
- Calling
- Camera
- E-mail
- GPS
- Notes
- MMS
- SMS
- Other, please specify

29. - I would like my mobile device to help me in my work in the following way:

30. - Where do you practice your profession?

Rows

- Southern Finland
- Western Finland
- Eastern Finland
- Oulu

- Lapland
- Åland
- Abroad
- No answer

31. – Gender

- Female
- Male
- No answer

32. – Age

- <-29
- 30-39
- 40-49
- 50-59
- 60-69
- 70->
- No answer

- If you would like to help me with my research in the future, in the form of interviews or being part of a pilot project, please leave your email address in the box below. This will not in any way affect your anonymity

Thank you for taking part in this survey!

Part II
Original research publications

Research paper 1

1.
Leskinen, S. (2010) Equine Vaccination, a paper mess waiting to get solved. Could ICT be the answer? In *23rd Bled eConference eTrust: Implications for the Individual, Enterprises and Society* (20-23 June 2010) Bled, Slovenia, pp. 127-143.

23rd Bled eConference
eTrust:
Implications for the Individual, Enterprises and Society
June 20 - 23, 2010; Bled, Slovenia

Equine Vaccination, a Paper Mess Waiting to get Solved. Could ICT be the Answer?

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Abstract

Equine sports have long traditions, and is part of the Olympic disciplines. Yet even if the rest of the sports events have welcomed the 21st century and ICT, equine sports are yet to fully embrace the values and help ICT may bring to this noble sport. Horses need to get influenza vaccinations according to regulations, yet the way to register a horse's vaccination and checking that vaccinations are in order is done in a very old-fashioned way, basically manually. The research addresses the question how IS and mobile technology could help the various bodies involved in the equine sports to perform their duties with more ease and precision. In this paper the research topic is what competition riders and horse owners are prepared to divulge of their horses vaccination information.

Keywords: Innovative ICT, information system, mobile technology, equine sports, vaccination database, future solutions.

1 Introduction

Horses have been used throughout history for various tasks, but today they are mainly used as sport horses or leisure horses. A sport horse can be everything from a polo pony, to a trotter, racing horse or a horse doing equestrian sports. "The FEI, founded in 1921, is the international body governing equestrian sport recognized by the International Olympic Committee." (Fédération Equestre Internationale, 2007) Equestrians sports involve seven disciplines; Jumping, Dressage, Eventing, Endurance, Driving, Reining and Vaulting. Furthermore, in dressage and driving there are Para-equestrian disciplines. Of these disciplines, jumping, eventing and dressage are Olympic disciplines. In 2009 there were worldwide 526 international jumping, 126 international dressage and 213 international eventing competitions. At the moment of writing this article FEI's international horse registration database held 161 423 horses. This database

only includes horses that have an international passport (Fédération Equestre Internationale, 2007). If a horse is to compete in international level, it must have a FEI international passport. For horses competing in national or lower level, a national passport will suffice.

In Finland, Suomen Hippos (the Finnish Trotting and Breeding Association) informs that there are approx. 70 000 horses during the time of writing this article (Soini, 2010). This amount includes all horses that are registered in Finland; trotters, leisure horses, and competition horses. The figure might though be a bit misgiving, since if a horse has been imported from another EU country and it has this country's passport, it does not necessarily have to be registered into Hippos. Furthermore, Hippos' database has several horses listed that are not alive anymore. Owners do not always inform Hippos if a horse has had to be put down or sold. Today horses are identified primarily by their national and/or international passport. From 1.7.2009 forward all foals born in Finland and all horses imported to Finland have to have a microchip for identification and a national passport (Skarra, 2009).

When horses are transported within the EU, they are required to be accompanied by a passport (national or international) (93/623/EC). The problem is that, today for the most part, horses are recognized by their passports at borders, since not all horses have a microchip. From 1 July 2009 the new Commission Regulations entered into force that states that equidae born or imported within EC are to have a transponder, a lifetime identification number and a passport (Article 5 and Article 8) (504/2008/EC). A border control personnel is not educated to properly recognize a horse, and therefore has basically very little knowledge on which horses are really being transported (see Figure 1).

Figure 1: Can you identify which horse has which passport?

1.1 Background to equine vaccination

For Equine disciplines, according to FEI rules, a horse has to be vaccinated against horse influenza and in some countries also against other diseases. This information has to be marked on the horse's international passport, if the rider/driver wishes to compete with the horse in international competitions (Article 137) (FEI General Regulations, 2010). Some countries that have equine sports have their own vaccination regulations, that might be the same as the international rules or somewhat differ. Today at international equine sports competitions, and in some countries, such as Finland even at district and national level competitions, the horses vaccination information is checked from the passport at every competition. Because of the vaccination rules, the checking process might take much time.

The horse has to have received at least the two primary course of vaccinations, given 21 to 92 days apart. After this for horses that have received the primary vaccinations before 2009, they must receive in Finland an annual booster vaccination. For horses which have received the primary vaccination after 1.1.2009, the first booster vaccination must be within 6 months (+21 days), and after this an annual booster vaccination. For

internationally competing horses a booster vaccination must be administered every 6 months (max 7 months). No vaccination shall be given within 7 days of competition (Annexe VI) (FEI Veterinary regulations, 2010) and (article 19.1) (SRL Competition regulations I, 2009).

For older horses, the person checking vaccination information might have to go through many vaccinations and determine if the vaccination schedule is done according to regulations. It does not help either that mixed into the influenza vaccination information, there might be tetanus vaccination information, horses national passports might vary and the vaccination information is not always in the right order (see Figure 2). At larger competitions there needs to be one person whose only task is to check the vaccination information, and yet this official might not be able to check all the vaccination information's in time. In the strictest sense of the rules, you are not even allowed to bring your horse to the competition site, until the vaccination information has been checked. In practice at many national competitions in Finland, this has not been possible. During the author's study at competitions summer 2009, it was found that some riders never brought their horse's passport to the secretary office to be checked, horses that had been competing for many years did not have their influenza vaccination records in accordance to regulations etc. Horse influenza is very contagious, and even horses with the vaccination might get sick, although most often in a lesser degree (Hautala, 16.10.2009). This is why FEI and SRL (Equestrian Federation of Finland) has a very strict policy when it comes to influenza vaccinations.

Horses used for leisure or breeding might not have received influenza vaccinations, but if the horse is to take part in a national or district equestrian sport event in Finland they have had to have received horse influenza vaccinations in accordance to national federation regulations.

Today's horse influenza vaccination protocols and monitoring procedures are insufficient. With the amount of horses taking part in competitions, to get the competition to go smoothly it is virtually impossible with today's system in Finland to be sure that all the horses participating in the competition have their vaccinations in

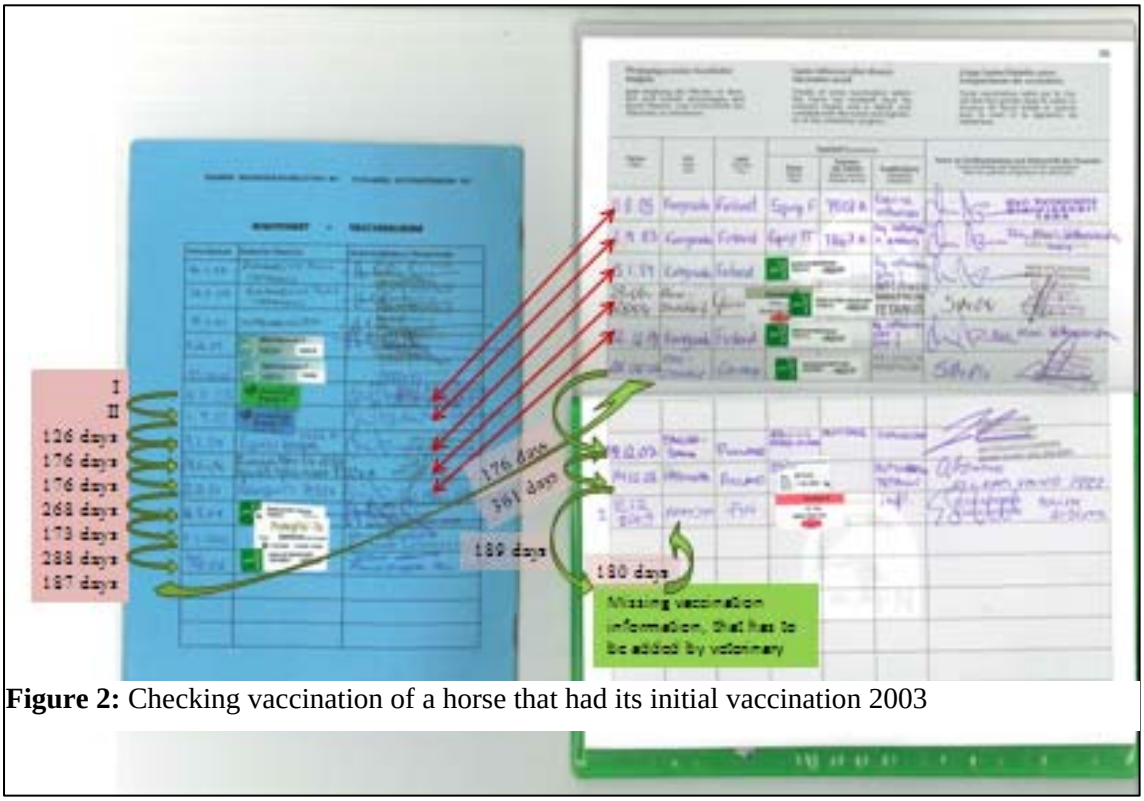

Figure 2: Checking vaccination of a horse that had its initial vaccination 2003

order. When the official or veterinary at a competition notices that a horse's vaccinations are not in order, it usually is already too late; the horse is at the competition site.

1.2 Motivation for research

This study is only a first step into a larger research. There are no standards for how to report equine vaccination and medical information. Furthermore this information is still recorded for large parts manually. A horses vaccination and medication information does not have a central database or similar where all relevant information, for authorities, veterinaries, competition organizers etc. can be found. This paper addresses how IS and mobile technology can be used to help the various bodies involved in the equine sports. The aim is to find a way for all involved to perform their duties with more ease and precision. The main research question in this paper is what competition riders and horse owners are prepared to divulge of their horses vaccination information?

This paper is structured in the following way: Section 2 presents the research background, and introducing research that has been done in this area. In section 3 the research methodology and design is introduced. Section 4 introduces this study's findings, while in section 5 the findings are further discussed. Conclusions and implications are presented in section 6. Discussion on further research is reserved for section 7. Here the author's next steps in the equine research are also presented.

2 Research background

This study's aim is to find what IT can do for equine sports. At competition sites, many tasks are today supported by IT, but at the same time some tasks are still done manually. One such task at competitions is checking that the horse's influenza vaccination record is in accordance to current regulations. As stated before this can take up much time so it is clearly a bottleneck in the system.

Although the equine sports do not involve as much money as other horse sports that rely on betting income, such as racing and trotting, it still involves a considerable amount of money. Sponsorship deals are commonplace in equine sports; competitions, competition series, riders and horses etc. can have sponsorship deals. E.g. Rolex is the sponsor for the Rolex FEI World Cup™ in Jumping. Furthermore horses are perceived partially as valuable sports equipments and athletes, therefore a horse competing successfully at international level can cost a considerable amount of money, prices going up to millions of Euros.

2.1 Related research

Much research into IS support for vaccination information, or IS involvement in the horse industry has not been done. The previous researches done, tangent to this paper are more focused on medication data, especially for livestock animals and animal identification. In Australia, Trevarthen and Michael (2008) did an extensive research on how dairy farms use RFID technology to help farm management. At farms, it was difficult to manage a large herd, and vital information about every cow was traditionally on a paper-based system. Now at some dairy farms, RFID technology is used to get cow monitoring and herd monitoring systems in IS. In this study the cows RFID tags information was received either with an ID code from the database or by scanning. E.g. the milking station has a RFID reader that automatically identifies the cow and inputs

the cow's milking information and other valuable information into the system. The farmer can also add information into the system with his PDA or directly input data into the computer. This type of ICT is in full-scale use in e.g. Australia.

Some similar kind of approach could also be usable with equine sports. In both cases mobility and IS technology can support various users' work. The system has to be easy to use, and reduce the need for duplication work and duplication data.

After the author had done the field work for this study, Hippos started to develop their horse database. From 1.1.2010 onward all horses competing in trotting have to have received horse influenza vaccinations according to Hippos regulations (very similar to FEI regulations). In Finland there are over 500 trotting competitions per year, and three times more trotters than equine sport horses. Since the equine sports in Finland had had in use influenza vaccination regulations for many years, Hippos could develop their system from the basis of the Equestrian Federation of Finland's know-how. They decided to have the vaccination information included into the already existing horse database. Only veterinaries and racetrack personnel are allowed to enter data into this system. The database is working to Hippos' satisfaction, since it is easy to check the horse's vaccination record from it. The horse's owner cannot see his/her horse's vaccination information (Hippos, 2010).

The Equestrian Federation of Finland has also realized the problem with checking at each competition the horse's passports for vaccination information. Today when entering a competition the owner or rider can give the horse's vaccination information during the entering process. Then competition organizers can then see if the horse's vaccination information is entered, but still the competitor must prove that this information is correct, by showing the horse's passport at the competition's secretary's office (SRL KIPA, 2010).

Many researchers have undertaken the issue with animal identification. Proper identification is important to be able to trace back where an animal is from in order to prevent and control diseases amongst animals, and to prevent harmful diseases to enter consumer consumption (Disney, et al., 2001; Petersen, et al., 2002; Wang, Zhang and Wang, 2006). One research has been studying the need for a clinical database at equine clinics. This research was done in Sweden and it evaluated the need for computerized medical records (Penell, et al., 2009).

In human medicine the same issues are being tackled. Ideally a patient's relevant medical information could be accessed when needed where ever needed, without compromising the patient's rights for privacy. In many countries there are various designs how this could and somewhat is done; now one of the many tasks is to get a harmonious standardized system that would work everywhere. Especially CEN/TC 251 and HL7 tackle these issues and since 2006 also coordinate and collaborate on various issues. Both organizations' aims are to get framework and standards for electronic health information (CEN, 2010; HL7, 2010).

2.2 Research rationale

The research objectives for the study are the following:

- To find out how well people understand the current vaccination regulations.

- To obtain a view on what and in what form are horse owners and competition riders willing to reveal about their horses' vaccination information.
- Determine if they require help in remembering when to vaccinate the horse.
- What is the best way for a reminder to reach them and how much would they be willing to pay for this service.

As mentioned before horses are used in various sports, but this research concentrates on vaccination information on equine sports. In Figure 3 some of the various activities horses are used in are presented, and the governing of equine sports is mapped out. National and district competitions are organized by riding clubs, or organizations that the national federation has given a competition organizing permit. The competitions are governed by the national federation and must abide by their regulations. International competitions are governed by international regulations. In Finland some specific organizations and riding clubs may organize international competitions in co-operation with the national federation (SRL, 21.1.2010).

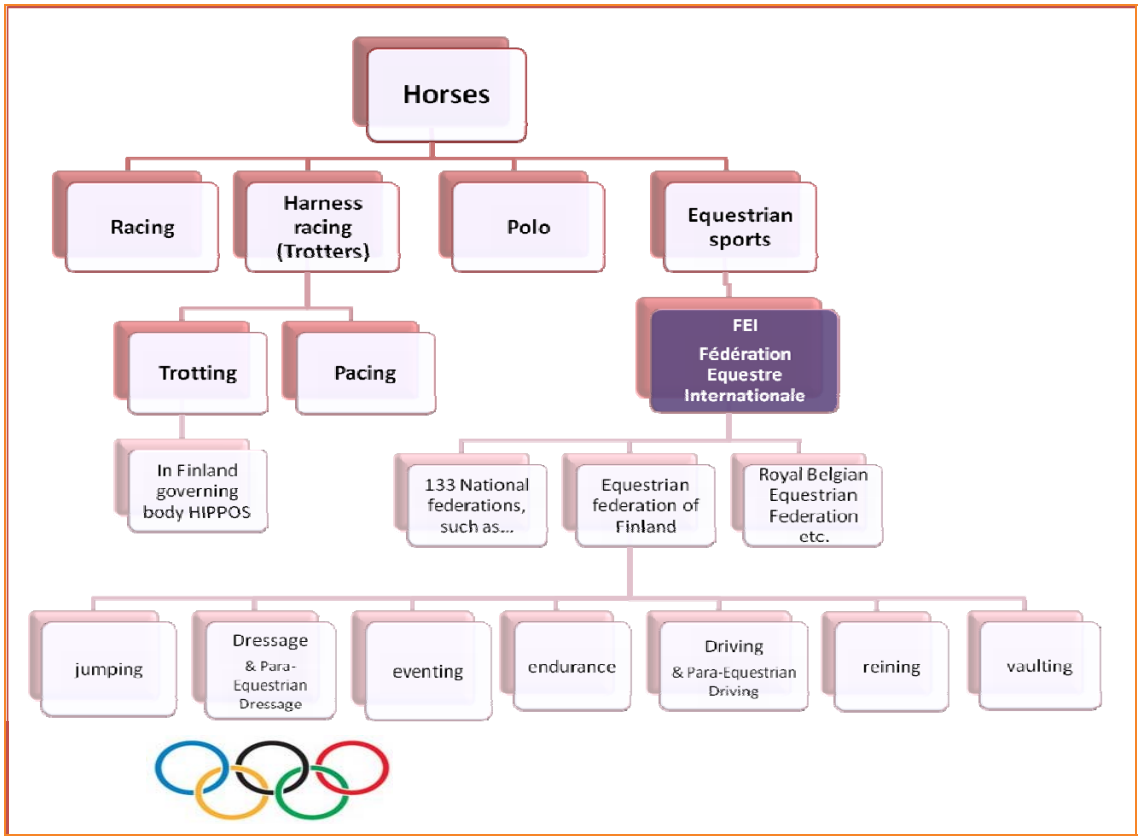

Figure 3: A diagram over well known horse sports, and how the equine sports are governed

3 Methodology and research design

In order to find answers to the research objectives a study was done during the summer of 2009. The study was exploratory in nature, to get a better understanding of the interest holders' opinion of the research objective. For this study people were interviewed at Finnish and international riding competitions and studying the customs of vaccination control at these competitions. Three disciplines were chosen, since they

are the most popular equine sport disciplines in Europe, mainly jumping, dressage and eventing. These three disciplines are also the disciplines in competition at the Olympic Games. For this study only equine sports disciplines were chosen, to better support the author's extensive knowledge in the field.

3.1 Questionnaire design

The interviews were done by means of a questionnaire. The questionnaire was developed according to the "Flowerpot-designed questionnaire" (Shiu, et al., 2009). The author wanted to find out about the vaccination protocols in order to achieve better understanding of where and how this information becomes a bottleneck at competitions and what respondents are willing to divulge of their horse's vaccination information. This way the author would get a better understanding on how IT and mobile technology could be used, to ease the problematic areas. The respondent's background information that was of interest was: Age, are you a horse owner, are you a competition rider, competition level and discipline. At the international competitions the nationality was also asked.

In this study a structured questionnaire was used. The questionnaire about views on vaccination was done by giving various statements, where the respondent would choose his/her answer from one of the following statements: I am completely of the same opinion, I am somewhat of the same opinion, I am somewhat of a different opinion and I am of a different opinion. The author used a forced scale in order to find out if the respondents were for or against the statement (Shiu, et al., 2009).

In the three disciplines, the athletes can be divided into six categories. These are: senior riders, Young riders, Juniors, Pony riders, Children and Veterans. Young athletes have their own categories according to age and horse. Pony riders are children who are competing with a pony (small horse which's height is max. 148 cm at the withers). For nation level (in Finland) the pony rider must be at least 10 years old to take part in pony rider category's competitions, and 12 for eventing. For international level, in any of the three disciplines the age requirement for pony riders is 12 years. A person may compete as a junior rider beginning from the year he/she turns 12 years for national level (in Finland) and 14 years for international level. The junior is allowed to take part in junior classes until the year he/she reaches 18. A person may compete as a Young rider from the year they turn 16 and they can move to the category, senior riders, the year they turn 18, or in the latest the year they turn 22 (FEI Rules for Dressage Events, 2010; FEI Rules for Eventing, 2010; FEI Rules for Jumping Events, 2010).

Since the categories Children and Veterans are very rarely used in Finnish competitions and the categories were not present at any of the competitions where research was done, the categories are omitted from the study. Furthermore the author makes the following assumption that all riders between 21-18 are Young riders and people under 18 are juniors. This simplified categorizing has been made, since for athletes under 18, the person responsible for the horse's vaccination is often a parent of the rider, whether he/she is a pony rider or a junior rider.

3.2 Research methodology

In order to increase the response rate, respondents of the questionnaire in Finland got a ticket for Helsinki International Horse Show's 16.10.2009 "Welcome to Helsinki Performance" show. According to FEI regulations the rider or driver of the horse is

responsible that the horse has been vaccinated according to FEI regulations at the competition site (Article 118) (FEI General Regulations, 2010). This is why the questionnaire was only intended for people who either own a horse or compete with a horse. Even that the rider or driver of the horse is responsible that the horse has been vaccinated against horse influenza; at home this responsibility might fall in the hands of the horse's owner. It all comes down to various possibilities such as; the horses owner and rider are the same person or in the same family, the owner cares for the horse, and the rider only rides and competes the horse once and awhile or the horse is totally cared for by the rider.

The data collection was conducted at the following riding competitions:

- Niinisalo, Finland. National three-day-event competition (CCN*), 10-12 July 2009.
- Falsterbo, Sweden. International jumping and dressage competition (CSIO 5*-TL NC, CDI 3* CDIO 4*) 16-19 July 2009
- Salo, Finland. National jumping competition (CSN 2*, Tapiola GP) 31 July - 2 August 2009.
- Verden, Germany. International jumping and dressage competition (CSI 2*, CDI 3* CH-M-YH-D) 6-9 August 2009.
- Lempäälä, Finland. National dressage competition (CDN 2*, Finnish championship) 15-16 August 2009.

At the competitions in Finland questionnaires were handed out to riders with their competition information and timetable pamphlet. Questionnaires were also handed out in various places of the competition site. Respondents could return the filled questionnaires to either the author or to a box by the competition secretary's office. At Falsterbo competition the author attached the questionnaire to horseboxes, where the rider could see it. The answer box was by the international stable-area secretary office. From Falsterbo competition there were 3 responses, which lead to experiment another strategy, where horses would not be likely to try to eat up the questionnaire or the questionnaire tossed away by grooms. At Verden the author asked personally people to answer the questionnaire. This was proven to be a much better approach since in Verden 64 non-Finnish people filled in the questionnaire.

4 Results of the Study

4.1 Results background

319 people answered the questionnaire. Of the respondents, 248 people listed themselves as horse owners and 224 were competition riders. In Table 1 the responders' frequency at the above mentioned competition sites can be seen.

	Frequency	Percent	Cumulative Percent
Falsterbo SWE	3	0,9	0,9
Kangasala FIN	71	22,3	23,2
Lempäälä FIN	40	12,5	35,7
Niinisalo FIN	45	14,1	49,8
Not defined comptition site	10	3,1	53,0
Salo FIN	73	22,9	75,9
Verden GER	77	24,1	100,0
Total	319	100,0	

Table 1: Responders frequency for Study

Of the respondents, 21,6 % were Juniors, 9,1 % Young riders and 69,3 % Senior raiders. People were urged to choose only one of the three disciplines, while the forth option was else. This fourth option was meant for use of people who might compete in one of the other FEI disciplines etc. Despite the request to only choose one discipline, ten respondents chose more than one discipline. In these situations the author chose to invalidate the answer from statistics involving disciplines (see Table 2).

Categories	**Disciplines**					
	does not compete	Dressage	Eventing	Jumping	Other disciplines	**Total**
junior	4	18	10	35	0	67
senior	86	40	18	67	2	213
young rider	5	6	3	15	0	29
Total	95	64	31	117	2	309

Table 2: Category and discipline ratio amongst respondents

People were also asked their competition level, if they are competition riders. The levels were district, national and international level (see Table 3). If the person had chosen more than one level, the author in compiling the statistics used the highest level, and other levels were omitted. The highest level in the questionnaire was competing in international level, next national level, and the lowest level is competing in district level.

Categories	Level				Total
	does not compete	district	national	international	
junior	4	15	40	10	69
young ri	5	4	11	9	29
senior	86	37	53	45	221
total	95	56	104	64	319

Table 3: Categories and Level ratio in questionnaire answers

As can be seen from the tables above there is a good representation of riders and horse owners. This table also gives an idea of how many of the respondents should know the international and national horse influenza vaccination rules.

4.2 Vaccination study results

As mentioned in chapter 2.2 the aim of the research was to find answers to the following questions: How well do competition riders and horse owners understand the current vaccination regulations? What are they willing to reveal about their horses' vaccination information and what is the right medium for this? Do they require help in remembering when to vaccinate the horse? What is the best way to remind them and how much would they be willing to pay for this service?

In the majority of the cases, the respondents did find the national and international vaccination regulations clear and understandable. Only a few disagreed with this, and for the most part these respondent's were non-competitors. A forced Likert scale of four was used in the study, 1 being of same opinion and 4 being of different opinion.

For the Agree and Disagree values and percentages, 1 and 2 (I am completely of the same opinion and I am somewhat of the same opinion) results are combined together for "Agree", whereas 3 and 4 (I am somewhat of a different opinion and I am of a different opinion) are combined together for "Disagree". The way the questionnaire was constructed, was interpreted by some respondents that they should choose mail, e-mail, SMS or no need for service option. This is why all respondents did not express the specific opinion on each option. For these people often only one favored option was marked as either "I am completely of the same opinion" or "I am somewhat of the same opinion". However this did not impact the research in a negative way. In tables 4 and 5 the amount of respondents not voicing an opinion to statements are listed as »Missing«

	My horses vaccination information could be public in		I would like my veterinary to help me keep my horses vaccinations on time	I would like to get a remainder when the vaccination is expiring via			
	The Internet	A national Database		Mail	e-mail	SMS	I do not need this service
Agree	143	233	133	70	159	132	113
percentage	44,8 %	73,0 %	41,7 %	21,9 %	49,8 %	41,4 %	35,4 %
Disagree	121	64	72	106	49	68	104
Percentage	37,9 %	20,1 %	22,6 %	33,2 %	15,4 %	21,3 %	32,6 %
Missing	55	22	114	143	111	119	102
Percentage	17,2 %	6,9 %	35,7 %	44,8 %	34,8 %	37,3 %	32,0 %
Total	319	319	319	319	319	319	319
Percentage	100,0 %	100,0 %	100,0 %	100,0 %	100,0 %	100,0 %	100,0 %

Table 4: Study results

As can be seen in Table 4 the majority of the respondents are ready to have their horse's vaccination information freely available in the Internet and an even larger majority is positively inclined towards a national database where the vaccination information would be stored. Respondents are overall eager to receive help from their veterinary to keep their horse's vaccinations on time, but there are some variables into how this would be done. Mailing is not considered to be a good option, while e-mail and SMS reminders are perceived as good options. Over a third of the respondents did not feel the need to have any kind of reminder service, while at the same time, almost as many people felt a need for the service. From discussions at competition sites, it became clear that respondents, who owned more than one horse, were keener to get a vaccination reminder service, than people who only had one horse. This is naturally true since one horse's vaccination date is easier to remember than several horses' vaccination dates. In afterthought, it would have been important also to include the question "How many horses do you own / compete with?"

In Table 5 we can see a few patterns. The results on the respondents' answers on the possibility to have vaccination information on a database, has gotten throughout all the various categories, a positive inclination. Also the option on having the information on the Internet has gotten positive responses except in the category "Young riders" Since these people are 18-21 it could be assumed that they are knowledgeable of the hazards that Internet might have, and are therefore skeptical on whether the security aspects can be sufficient. Overall the option to have vaccinations on a national database had a more positive feedback from all categories in comparison to the Internet option.

		My horses vaccination information could be public in		I would like my veterinary to help me keep my horses vaccinations on time	I would like to get a remainder when the vaccination is expiring via			
		The Internet	A national Database		mail	e-mail	SMS	I do not need this service
Junior	Agree	34	46	31	14	32	32	27
	Disagree	26	19	18	26	13	16	22
	Missing	9	4	20	29	24	21	20
	Agree (%)	49,3	66,7	44,9	20,3	46,4	46,4	39,1
	Disagree (%)	37,7	27,5	26,1	37,7	18,8	23,3	31,9
	Missing (%)	2,8	1,3	6,3	9,1	7,5	6,6	6,3
	total answers	69	69	69	69	69	69	69
Young Rider	Agree	10	22	13	11	19	16	9
	Disagree	17	7	7	14	5	8	15
	Missing	2	0	9	4	5	5	5
	Agree (%)	34,5	75,9	44,8	37,9	65,5	55,2	31,0
	Disagree (%)	58,6	24,1	24,1	48,3	17,2	27,6	51,7
	Missing (%)	0,6	0,0	2,8	1,3	1,6	1,6	1,6
	Total answers	29	29	29	29	29	29	29
Senior	Agree	99	165	89	45	108	84	77
	Disagree	78	38	47	66	31	44	67
	Missing	44	18	85	110	82	93	77
	Agree (%)	44,8	74,7	40,3	20,4	48,9	38,0	34,8
	Disagree (%)	35,3	17,2	21,3	29,9	14,0	19,9	30,3
	Missing (%)	13,8	5,6	26,6	34,5	25,7	29,2	24,1
	Total answers	221	221	221	221	221	221	221
owner	Agree	108	180	100	56	121	95	94
	Disagree	94	53	58	82	45	57	78
	Missing	46	15	90	110	82	96	76
	Agree (%)	43,5	72,6	40,3	22,6	48,8	38,3	37,9
	Disagree (%)	37,9	21,4	23,4	33,1	18,1	23,0	31,5
	Missing (%)	18,5	6,0	36,3	44,4	33,1	38,7	30,6
	Total answers	248	248	248	248	248	248	248
Compe-titor	Agree	95	163	97	54	112	95	83
	Disagree	94	49	55	78	35	49	74
	Missing	35	12	72	92	77	80	67
	Agree (%)	42,4	72,8	43,3	24,1	50,0	42,4	37,1
	Disagree (%)	42,0	21,9	24,6	34,8	15,6	21,9	33,0
	Missing (%)	15,6	5,4	32,1	41,1	34,4	35,7	29,9
	Total answers	224	224	224	224	224	224	224

Table 5: Study results divided into various categories

Again, throughout the categories, the need for help from veterinarians to keep the vaccination on time is beheld positively. This is in hue with what the author expected that people are struggling to remember when to vaccinate which horse etc. This also indicates that the veterinarians or other instances that could be responsible of the reminder service have a possibility to significantly improve their customer service. Especially horse owners, who often are the ones responsible in taking care of the horse's vaccination, are positively inclined to the option. People would like to get a reminder of vaccination expiration, as can be seen in all categories. In how the vaccination reminder should be offered to the horse owners (or riders in some cases) it was obvious that mail was not considered a very good option. The majority of the respondents preferred to get the reminder by e-mail, but also SMS had a majority support by all in the various categories.

The question "I do not believe that I need this [a reminder] service" got overall a very neutral reception. Apart from the Young rider's category, the "Agree" and "Disagree" percentages were within 10 points apart. The "Agree" category got slightly more responses, except in the Young rider's category, where over half of the respondents did not agree with the statement "I do not believe that I need this service". As discussed before, this might be in correlation with how many horses the respondent is responsible for, i.e. either competing with the horse or owning it. The way the question was formulated, might also have confused some responders.

The questionnaire also held a question concerning what people would be willing to pay for a reminder service, if any. The options on costs were 0 €, 1 €, 5 € and 10 €. The mean for the results was 2,63 €, and 37,7 percent were not ready to pay for a reminder service, while 9,6 percent considered this service to be worth 10 €.The largest group, 28.4% of the respondents were willing to pay for the reminder service 5 €.

5 Discussion

Based on the study the author can conclude that people are in need and would be positively inclined to a vaccination database and a vaccination reminder service. Since mobility and mobile applications give more freedom, it would be advisable that the services offered to horse owners, competition riders, competition officials, veterinaries and border control would also have mobile applications to help the process. For veterinaries a mobile service would most likely prove to be beneficial, since many veterinaries travel around when working. For horse owners and/or competition riders a mobile reminder service or an e-mail reminder service would most likely be beneficial. A larger question remains; who would be the body behind these services?

For a unified database, FEI could be an option, since they would benefit of an up to date data on horse's vaccination information. The problem then lies with horses that do not compete, or do not compete in equine sport, such as trotters and racehorses. For these FEI is not necessarily the most logical choice to uphold vaccination data. Another idea would be to have vaccination data in the country's official horse breeding association, but does every country have such an organization, or what if they have several? Maybe for EU there could be a comprehensive database for all horses within the EU region? This solution would create a conclusive database, but within the competitive sports; equine, trotting and racing, competitions can include competitors from outside the EU. A pharmaceutical company that supplies influenza vaccinations could instigate the database, but will they have vaccination customers in all the countries? Since it is rather

clear from the research done for this article that a common database would be preferred it is likely that one or several of the bodies mentioned before will initiate a vaccination database. If the database is successful, other countries, sports and institutes will voice interest towards it, and the problems mentioned before will find solutions.

For the various mobile services suggested earlier the same issues will arise as with the database. Who is in charge? Who will offer and maintain the service? The same bodies could also here be an answer to this question, but also private veterinaries. One solution would be that veterinaries are allowed to upload vaccination data of their customers' horses from the database. Then the veterinary can send a SMS or an e-mail reminding the customer to update their horse's influenza vaccination (or tetanus etc.). Since some respondents to the questionnaire were willing to pay for the reminder service, whether it be via SMS or e-mail, this could be a way to partially finance the upkeep of the database and mobile and/or e-mail service.

6 Conclusions and implications

Based on the study it is obvious that there is a need for more efficient systems within the equine sport disciplines. Technology has already been used in various degrees at competitions to ease up the registration, time schedules and result service, but vaccination control, amongst others, is still dealt with manually. When during a two-day competition even in a relatively small equine country, such as Finland, there might be over 800 competitions starts time is of essence. The vaccination information added during entering to a competition, mentioned in section 2.1. relies on horse owners, riders and drivers honesty to enter the valid vaccination dates. (SRL KIPA, 2010). This is why the author suggests that the information should be entered by a veterinary, or in some cases the competition officials, which would be a more trustworthy source.

The database that Hippos uses for trotting competitions is nice, and certainly helps the competition organizers in their work, but it does not help the owner or rider/driver of the horse. At the moment this system does not have a reminder service, or any kind of mobile services. Veterinaries have to input vaccination data on a computer, it is though in the authors opinion, that since veterinaries are often on the move, the vaccination input application should also be available on a mobile device. Rarely owners take their horses to a clinic or a vet to get the horse vaccinated, the veterinaries travel to the stables to do this task.

7 Further research

It is clear that a convergent database, where all horses competing under FEI regulations have their vaccination information, would ease the work for competition secretary office. The question is how to get it implemented around the world, and how to get veterinaries to use the system. A software program, which sends the horse's owner a message when the horse's vaccination needs to be renewed could be simply added to the database. This option could also be used by veterinaries, to ensure continuous customer relationship. The next step in research would be to find ways for veterinaries to use the database so that aids them in their work. Could a mobile application be of use? Since veterinaries might also work with other animals than just horses, could even other animals benefit from a vaccination database, e.g. pets?

From results upheld from this study, the author also suggests further research and investigation into how a horse's medical information could be placed into a database

and would horse owners allow it? What kind of safety measures need to be taken, so that only certain people will be allowed to access the horse's medical information? Could an international animal health database help prevent or control the spreading of epidemics?

References

Disney, W.T., Green, J.W., Forsythe, K.W., Wiemers, J.F. and Weber, S. (2001). Benefit-cost analysis of animal identification for disease prevention and control, *Revue scientifique et technique*, **20** (2), 385-405.

European Committee for Standardization. (2010). CEN/TC 251 Health Informatics. Retrieved 29.04.2010, from http://www.cen.eu/cen/Sectors/TechnicalCommitteesWorkshops/CENTechnicalCommittees/Pages/default.aspx?param=6232&title=CEN/TC%20251

Fédération Equestre Internationale. (2010). *Rules for Jumping Events 23rd ed.* Switzerland:

Fédération Equestre Internationale. (2009 (including updates for 01.01.2010)). *Rules for Eventing 23rd ed.* Switzerland:

Fédération Equestre Internationale. (2009 (including modifications for 01.01.2010)). *Rules for Dressage Events 23rd ed.* Switzerland:

Fédération Equestre Internationale. (1 January 2010). *General Regulations 23rd edition.* Switzerland: Fédération Equestre Internationale

Fédération Equestre Internationale. (5th May, 2010). *Veterinary Regulations 12th ed.* Switzerland:

Fédération Equestre Internationale. *FEI* Retrireved 29.01.2010, from www.fei.org

Hautala, K. (16.10.2009). Hevosinfluenssa tarttuu helposti (Horse influenza transmits easily), *Hevosurheilu,* 15.

Hippos. (2.2.2010). *Heppa-Järjestelmä (Horse-system)* Retrireved 20.2.2010, from http://heppa.hippos.fi/heppa/app

HL7. (2010). Unlocking the Power of Health Information. Retrieved 29.4.2010, from http://www.hl7.org.

Penell, J.C., Bonnett, B.N., Pringle, J. and Egenvall, A. (2009). Validation of computerized diagnostic information in a clinical database from national equine clinic network, *Acta Veterinaria Scandinavica,* **51** (50), Retrieved 2.2.2010, from http://www.actavetscand.com/content/51/1/50

Petersen, B., Knura-Deszczka, S., Pönsgen-Schmidt, E. and Gymnich, S. (2002). Computerised food safety monitoring in animal production, *Livest.Prod.Sci.,* **76** (3), 207-213.

Shiu, E., Hair, J., Bush, R. and Ortinau, D. (2009) *Marketing Research.* New York, Ny, U.S.A: McGraw-Hill Higher Education

Skarra, P. (2009). Rekistöröinti takaa hevosten oikeusturvan: Anna hevosellesi identiteetti, *HIPPOS Suomen Ratsastajainliiton jäsenlehti,* SRL info 7-8.

Soini, P. (2010) *Toimintasuunitelma 2010 (Strategy 2010).*

SRL. (21.1.2010). *Kilpailujen järjestämismääräykset.- ja ohjeet (Competition organizing regulations and directions)* Retrireved 24.2.2010, from http://www.ratsastus.fi/asp/system/empty.asp?P=157&VID=default&SID=892152782274198&A=closeall&S=0&C=29578

SRL. (1.1.2009). *Kilpailusäännöt I (Competition rules I).* Helsinki, Finland:

Suomen Ratsastajainliitto ry (The Equestrian federation of Finland). (20.2.2010). *Kisapalvelu - KIPA (Competition service)* Retrireved 20.2.2010, from http://kipa.ratsastus.fi/

The Commission of the European Communities. (8 June 2008). *Commission Regulation.* (504/2008/EC) Brussels, Belgium: European Union.

The Commission of the European Communities. (20 October 1993). *Commission Decision.* (93/623/EC) Brussels, Belgium: European Union.

Trevarthen, A. and Michael, K. . (2008). The RFID-Enabled Dairy Farm: Towards Farm Management. *In 7th International Conference on Mobile Business,* Barcelona, Spain, 7-8 July, 2008, pp. 241-250. ICMB.

Wang, N., Zhang, N. and Wang, M. (2006). Wireless sensors in agriculture and food industry—Recent development and future perspective, *Comput.Electron.Agric.*, **50** (1), 1-14.

Research paper 2

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CAN INFORMATION SYSTEMS EXPAND THE LIMITS OF EQUINE MEDICATION?

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Abstract

Equine sports have long traditions, and is part of the Olympic disciplines. Horses are athletes among other athletes, and also medicated accordingly, within doping regulations. In this research the aim is to find out what medical information horse owners would be willing to divulge, and to whom. The research addresses the question how IS and mobile technology could help the various bodies involved in the equine sports to execute their tasks with more ease and precision. In human medicine the aim is to get the medical information digitalized. An important aspect is that patients have the right to privacy and therefore medical information has to be secure. A horse's medical information is private, and the property of the horse's owner, however, a horse can have several owners during a lifetime, and mostly paper based medical history might get lost during the years. On the other hand, horses are sold as merchandize, like e.g. cars. Very few would buy a car that does not have it's papers in order.

Keywords: Innovative ICT, information system, mobile technology, equine sports, medical database, future solutions.

1 INTRODUCTION

Sport horses are like any athletes, they have to be trained, fed and treated correctly so that they can reach their full potential, but with horses they cannot say when something hurts or does not feel right, this is why horse medication is a very important but difficult task within the horse industry. A sport horse can be everything from a polo pony, to a trotter, racing horse or a horse doing equestrian sports. "The FEI, founded in 1921, is the international body governing equestrian sport recognized by the International Olympic Committee." (Fédération Equestre Internationale. 2007). Equestrians sports involve eight disciplines; Jumping, Dressage, Eventing, Endurance, Driving, Reining, Vaulting and Para-Olympics. Of these disciplines, jumping, eventing and dressage are Olympic disciplines. In 2009 there were worldwide 526 international jumping, 126 international dressage and 213 international eventing competitions. At the moment of writing this article FEI's international horse registration database held 161 423 horses. This database only includes horses that have an international passport (Fédération Equestre Internationale. 2007).

In Finland Suomen Hippos (the Finnish Trotting and Breeding Association) informed that there are approx. 73 000 horses during the time of writing this article (Soini. 2010). This amount includes all horses that are registered in Finland, trotters, hobbyhorses and competition horses. The figure might though be a bit misleading, since if a horse has been imported from another EU country and it has this country's passport, it does not necessarily have to be registered into Hippos. Today primarily their national and/or international passport identifies horses. From 1.7.2009 forward all foals born in Finland and all horses imported to Finland have to have a microchip for identification and a national passport (Skarra 2009). It is estimated that in Finland there are 9 100 actively competing trotters and 6 900 competing equine sports horses in 2009 (Suomen Hippos ry. 2010).

According to EU regulations and Finnish food legislation all animals slaughtered in EU and the meat used for human consumption; need to have proof of identity and what medication and feed they have received during their lifetime (23/2006). Horses need to be registered into a EU country and the registration must have been done at least 6 months prior to the slaughtering. Slaughterhouses also have very strict sanitation rules, and essentially the whole animal and meat procession area have to be disinfected before a new type of animal can be slaughtered. This is one of the reasons that many larger slaughterhouses in Finland will not receive horses, because with the small amount of horses being slaughtered, the poor price on horsemeat and loss of time & money it is not a good business. Some medications that are used on horses are considered dangerous for humans, and if the horse has been treated with this medicine during its lifetime, the meat cannot be used for human food consumption. In other animals such as cows, this would not usually be a problem, since a cow is very seldom treated to such an extent as horses. This is since a cow's value is more likely to be attached to the value of the meat, milk production or breeding value, opposite to a horse, which value might lie in how fast they run etc. Furthermore the cow's value does not drop if it has been medicated during its life, and cows more seldom change owners during their life. With horses here is the pickle; horses have "two prices". One price is basically what the horse is worth as meat; this is the horse's minimum price. Depending on the horse's age, breed, pedigree, stage of education, competition level and price-money won so far, the actual price of the horse might be immensely different from the value the horse has as meat. A horse's worth totally depends on its situation at that moment. Since horses can be sold many times during their lifespan, the medical history does not necessarily move along with the horse. Although the seller is obliged to tell the potential buyer the horse's medical history, he might opt not to, in hopes of getting a better price for the horse. Naturally if you are buying a horse, you hope that the seller has been honest, but it is difficult to find out for sure. Veterinaries today keep usually their own patients' records on file, and are even obliged to do so in Finland for at least three years (6/EEO/2000). The problem is that there were 2009 25 registered veterinarians, who inform that their specialty is horse medication. Furthermore, also community veterinarians might treat horses, as well as other animals, and naturally if the horse has been imported from another country, it is virtually impossible to be 100

% sure that you have received all the medical data of the horse (Evira (Elintarviketurvallisuusvirasto). 2009). So there are both pros and cons into getting a horse's medical information into one place. Internationally competing horses must have a paper based medical logbook that includes the horse's medical history according to FEI veterinary regulation, article 1026, 3 § (Fédération Equestre Internationale 2010). This logbook has become mandatory after FEI started the "clean sport" program, against doping. The logbook informs FEI doping inspection veterinarians what medication and when the horse has received and when. E.g. some horses have to be mildly tranquilized for shoeing, and trace elements of this tranquilizer might still be in the horse's blood, after the safe date the pharmaceutical company informs.

Once a horse's status changes from being a "companion animal" or an "athlete", to "unwanted" it becomes livestock, and is in most laws treated as such. The term Unwanted horse was introduces by American Association of Equine Practitioners (AAEP) and basically means that these horses are not any more wanted by their current owners (Lenz, Tom R., DVM, MS, DACT. 2009). In Finland, there are slaughterhouses that receive horses, but it has become increasingly problematic to find suitable final solutions to injured, sick, unmanageable and old horses. Most options cost the owner money, and this leads to the situation that horses that should be put down are not, or they are even shipped on long transportations to countries where horsemeat has a better value (MTV 3 45 min, 2007). E.g. in Finland the approximate cost for a veterinarian to euthanize a horse and then the horse to be incinerated is 900-1200 € (www.ratsastus.net and www.lemmikkilehto.fi). Horse meat is used around Europe, but the way the system works often now, is that horses are transported to southern Europe for slaughter, and then it is transported back as meat products to e.g. north Europe. Transporting a live horse or even meat in a refrigerated transport is costly, so there must be a better and cost effective way to solve this problem.

This paper is structured in the following way. Chapter 2 handles the research background done for this paper, and chapter 3 concentrates on methodology and research design. In chapter 4 the results of the study are presented and further analyzed in chapter 5. The conclusions of the study and other material are discussed in chapter 6. Some further research points are presented in chapter 7.

2 RESEARCH BACKGROUND

2.1 Related research

Much research of IS support in the horse industry has not been done. The previous researches done, tangent to this paper are more focused on livestock animals and animal identification. In Australia, Trevarthen and Michael (Trevarthen and Michael 2008) did an extensive research on how dairy farms use RFID technology to help farm management. At farms, it was difficult to manage a large herd, and vital information about every cow was traditionally on a paper-based system. Now at some dairy farms, RFID technology is used to get cow monitoring and herd monitoring systems in IS. In this study the cows RFID tags information was received either with an ID code from the database or by scanning. E.g. the milking station has a RFID reader that automatically identifies the cow and inputs the cow's milking information and other valuable information into the system. The farmer can also add information into the system with his PDA or directly input data into the computer. This type of ICT is in full-scale use in e.g. Australia.

Some similar kind of approach could also be usable with equine sports. In both cases mobility and IS technology can support various users' work. The system has to be easy to use, and reduce the need for duplication work and duplication data.

Many researchers have tackled the issue with animal identification. Proper identification is important to be able to trace back where an animal is from in order to prevent and control diseases amongst animals, and to prevent harmful diseases to enter consumer consumption (Disney, Green, et al. 2001, Petersen, Knura-Deszczka, et al. 2002, Wang, Zhang, et al. 2006). One research has been studying the

need for a clinical database at equine clinics. This research was done in Sweden and it evaluated the need for computerized medical records (Penell, Bonnett, et al. 2009).

In (Pettitt 2001) the increasing problem of meat traceability from farm all the way to your refrigerator has been discussed. In UK there is an increasing need to better monitor and trace livestock animals, especially after the mad-cow disease and swine & hoof disease episodes. Because of this a database security system has been developed, to trace potentially sick animals before they infect larger populations. Apart from making sure that livestock is safe for human consumption, there is also increasing demand for information on that the animal has been treated well, i.e. that more stringent animal welfare requirements have been met, than just what is governed by law. (Pettitt 2001)

Much research has been done in human healthcare, and how it could be digitalized, without the patient privacy being endangered. There is a need for a larger common database in the whole EU. CEN/TC 251 is amongst the standards development organizations that are working towards EU extensive standards within healthcare (*European Committee of Standardizations* 2011). Health Level Seven (HL7) has same motives as CEN but it is striving toward international standardizations (*Health Level Seven International* 2011). Naturally with horses there are also security and standardization issues, but they are not as severe as the need is for human healthcare. Depending on the country's law, the animal's health information is either transferred to the new owner, or is always the property of the owner at the time being.

2.2 Research rationale

The main questions of this research are:

- What are riders and owners willing to divulge of their horses medical history and to whom?
- Where a horse's medical history could be stored?

This study is part of a larger research that aims to find what the daily routines and bottlenecks are for veterinarians, owners and competition organizers. Then with new technological innovations better their time use, ease up routines and make monetary savings. This study is conducted with a bottom-up approach, to ensure that all stakeholders' needs are met. In this paper the horse owner and rider's opinions on various storage and information exchange of their horse's medical data is studied.

As mentioned before horses are used in various sports, but this research concentrates on medication information on equine sports. In Figure 1 some of the various activities horses are used in are presented, and the governing of equine sports is mapped out. National and district competitions are organized by riding clubs, or organizations that the national federation has given a competition organizing permit. The competitions are governed by the national federation and must abide by their regulations. International competitions are governed by international regulations (FEI).

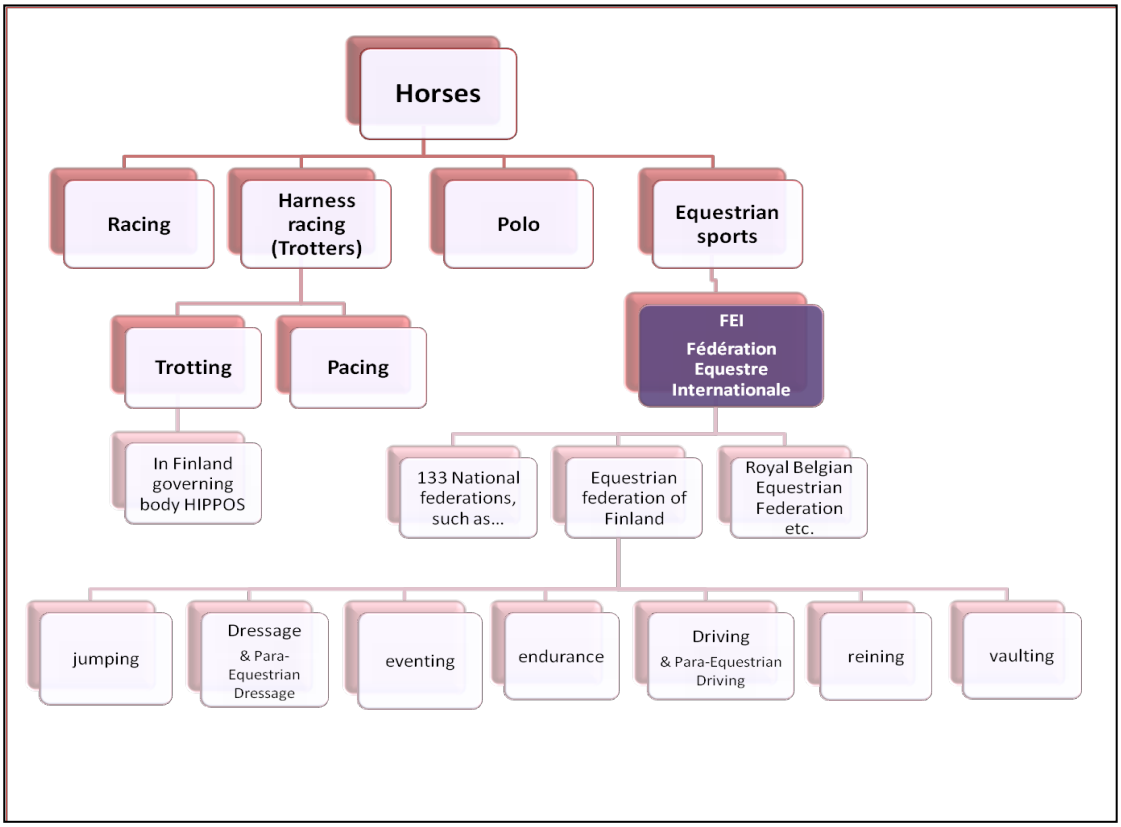

Figure 1. A diagram over well-known horse sports, and how the equine sports are governed

3 METHODOLOGY AND RESEARCH DESIGN

In order to find answers to the research objectives a study was done during the summer of 2009. For this study people were interviewed at Finnish and international riding competitions. Three disciplines were chosen, since they are the most popular equine sport disciplines in Europe, mainly jumping, dressage and eventing. These three disciplines are also the disciplines in competition at the Olympic Games. For this study, only equine sports disciplines were chosen, to better support the author's extensive knowledge in the field.

In the three disciplines, the athletes can be divided into six categories. These are: senior riders, Young riders, Juniors, Pony riders, Children and Veterans. Young athletes have their own categories according to age and horse. Pony riders are children who are competing with a pony (small horse which's height is max. 148 cm at the withers). For nation level (in Finland) the pony rider must be at least 10 years old to take part in pony rider category's competitions, and 12 for eventing. For international level, in any of the three disciplines the age requirement for pony riders is 12 years. A person may compete as a junior rider beginning from the year he/she turns 12 years for national level (in Finland) and 14 years for international level. The junior is allowed to take part in junior classes until the year he/she reaches 18. A person may compete as a Young rider from the year they turn 16 and they can move to the category, senior riders, the year they turn 18, or in the latest the year they turn 22 (*Rules for Dressage Events 23rd ed.* 2009 (including modifications for 01.01.2010), *Rules for Eventing 23rd ed.* 2009 (including updates for 01.01.2010))(*Rules for Jumping Events 23rd ed.* 2010).

Since the categories Children and Veterans are very rarely used in Finnish competitions and the categories were not present at any of the competitions where research was done, the categories are omitted from the study. Furthermore the author makes the following assumption that all riders between 18 and 21 are Young riders and people under 18 are Juniors. This simplified categorizing has been

made, since for athletes under 18, the person responsible for the horse's wellbeing and medical status is often a parent of the rider, whether he/she is a Pony rider or a Junior rider.

3.1 Questionnaire design

The interviews were done by means of a questionnaire. The questionnaire was developed according to the "Flowerpot-designed questionnaire" (Shiu, et al. 2009). The aim in the flowerpot-designed questionnaire is to have a hierarchy-based questionnaire, where sets of questions ensure a general to specific data collection approach. The author wanted to know what respondents are willing to divulge of their horse's medical information and if electronic data storage could be a possibility. This way the author would get a better understanding on how IT and could be used, to ease the problematic areas. The respondent's background information that was of interest was: Age, are you a horse owner, are you a competition rider, competition level and discipline. At the international competitions the nationality was also asked.

In this study a structured questionnaire was used. The questionnaire about views on medication was done, by having various statements where the respondent would choose his/her answer from one of the following answers: Definitely would, probably would, probably would not and definitely would not. The author used a forced scale in order to find out if the respondents were for or against the statement (Shiu, et al. 2009).

3.2 Sampling

In order to increase the response rate respondents of the questionnaire in Finland got a ticket for Helsinki International Horse Show's 16.10.2009 "Welcome to Helsinki Performance" show. According to FEI regulations the rider or driver is responsible of the horse, which includes responsibility under the general and veterinary regulations (Article 118)(*General Regulations 23rd edition.* 1 January 2010). This is why the questionnaire was only intended for people who either own a horse or compete with a horse. Even that the rider or driver of the horse is responsible that the horse has been treated and medicated according to FEI's veterinary regulations, at home this responsibility might fall in the hands of the horse's owner. It all comes down to various possibilities such as; the horses owner and rider are the same person or in the same family, the owner cares for the horse, and the rider only rides and competes the horse once and awhile or the horse is totally cared for by the rider.

The data collection was conducted at the following riding competitions:

- Niinisalo, Finland. National three-day-event competition (CCN*), 10-12 July 2009.
- Falsterbo, Sweden. International jumping and dressage competition (CSIO 5*-TL NC, CDI 3* CDIO 4*) 16-19 July 2009
- Salo, Finland. National jumping competition (CSN 2*, Tapiola GP) 31. July- 2 August 2009.
- Verden, Germany. International jumping and dressage competition (CSI 2*, CDI 3* CH-M-YH-D) 6-9 August 2009.
- Lempäälä, Finland. National dressage competition (CDN 2*, Finnish championship) 15-16 August 2009.

At the competitions in Finland questionnaires were handed out to riders with their competition information and timetable pamphlet. Questionnaires were also handed out in various places of the competition site. Respondents could return the filled questionnaires to either the author or to a box by the competition secretary's office. At Falsterbo competition the author attached the questionnaire to horseboxes, where the rider could see it. The answer box was by the international stable-area secretary office. From Falsterbo competition there were 3 responses, which lead to experiment another strategy, where horses would not be likely to try to eat up the questionnaire or the questionnaire tossed away by grooms. At Verden the author asked personally people to answer the questionnaire. This was proven to be a much better approach since in Verden 64 non-Finnish people filled in the questionnaire.

319 people answered the questionnaire. Of the respondents, 248 people listed themselves as horse owners and 224 were competition riders. In Table 1 the responders' frequency at the above mentioned competition sites is stated. Maintaining the Integrity of the Specifications.

	Frequency	***Percent***	***Cumulative Percent***
Falsterbo SWE	3	0,9	0,9
Kangasala FIN	71	22,3	23,2
Lempäälä FIN	40	12,5	35,7
Niinisalo FIN	45	14,1	49,8
Not defined competition site	10	3,1	53,0
Salo FIN	73	22,9	75,9
Verden GER	77	24,1	100,0
Total	319	100,0	

Table 1 Responders frequency for study

Of the respondents, 21, 6 % were Juniors, 9, 1 % Young riders and 69, 3 % Senior raiders. Some responders sent their survey later by mail, and thus it was undetermined from which competition the survey had been from. Therefore Table 1 contains a "Not defined competition site" row for these responders.

People were urged to choose only one of the three disciplines, while the forth option was other disciplines. This fourth option was mainly a choice for the people who might compete in one of the other FEI disciplines, or in harness racing etc. Despite the request to only choose one discipline, ten respondents chose more than one discipline. In these situations the author chose to invalidate the answer from statistics involving disciplines (see Table 2).

	Disciplines					
Categories	Does not compete	Dressage	Eventing	Jumping	Other disciplines	Total
junior	4	18	10	35	0	67
senior	86	40	18	67	2	213
young rider	5	6	3	15	0	29
Total	95	64	31	117	2	309

Table 2 Riding category and discipline ratio amongst respondents

People, who are competition riders, were also asked their competition level. The levels were district, national and international level (see Table 3). If the person had chosen more than one level, the author in compiling the statistics used the highest level, and other levels were omitted. The highest level in the questionnaire was competing at an international level, then national level, and the lowest level was competing in district level. These levels are the same as Suomen Ratsastajain Liitto (SRL) (Equestrian federation of Finland) and many other country's national federations use.

	Level				
Categories	does not compete	district	national	international	Total
junior	4	15	40	10	69
young rider	5	4	11	9	29
senior	86	37	53	45	221
total	95	56	104	64	319

Table 3 Categories and level ratio in questionnaire answers

4 RESULTS OF THE STUDY

In this chapter the results of the various questions from the survey are analyzed further. In the survey the aim was to find out what medical information, if any, the owners and riders would be willing to divulge and to whom. To achieve this, the following statements were presented:

- My horses' medical information could be accessible by anyone e.g. via Internet.
- I would show a potential buyer my horse's full medical history.
- My horses' medical information could be accessible by any veterinarian.
- My horses' medical information could be accessible by my current and future veterinarians (e.g. the horses' new owner's veterinarian).
- My horses' medical information can be accessible by veterinarians with my permission, and all information has to be disposed of if I am not anymore in possession of the horse.
- My horses' medical information can be archived but should only be used by authorities, e.g. in case that the horse is going to be slaughtered.
- My horses' medical information may not be published under any circumstances.

As a core postulation for these statements only veterinarians would be allowed to enter medical information about one's horse. The respondents were then to give their corresponding agreement or disagreement to the statements. The responder could wither choose "definitely would", "probably would", probably would not" or "definitely would not" for each statement.

These seven questions were asked to get as comprehensive a picture as possible. The variations on the questions are small, but very relevant when looking at the horse industry in general. When you buy a horse, unlike with a car, where you can get the cars entire maintenance history, you are totally at the mercy of the seller to tell the truth. In chapter V more of today's legal aspects regarding veterinarian work, buyers rights etc are discussed further.

Today a seller is obliged to share with the buyer the horse's medical history, and any other aspects about the horse that might influence the buyer's decision. The problem is how can you as a buyer check that the seller really has told everything? If all horses' medical information would be archived in a way, that any veterinarian could read it we would have a more secure system for buyers, but are the sellers willing to go to that length? Horse sellers and buyers are mostly private people. Some horses are also sold in Finland from Finnish or foreign horse dealers.

In Figure 2 the survey results are divided in accordance to the various age groups, discussed earlier. The tendency is that people would not want anybody to be able to read their horses' medical information, which is understandable. The interesting fact is that most seem to be positively inclined, i.e. they answered either "definitely would" or "probably would", to let veterinarians see their horses past medical information, even after the horse has changed owners.

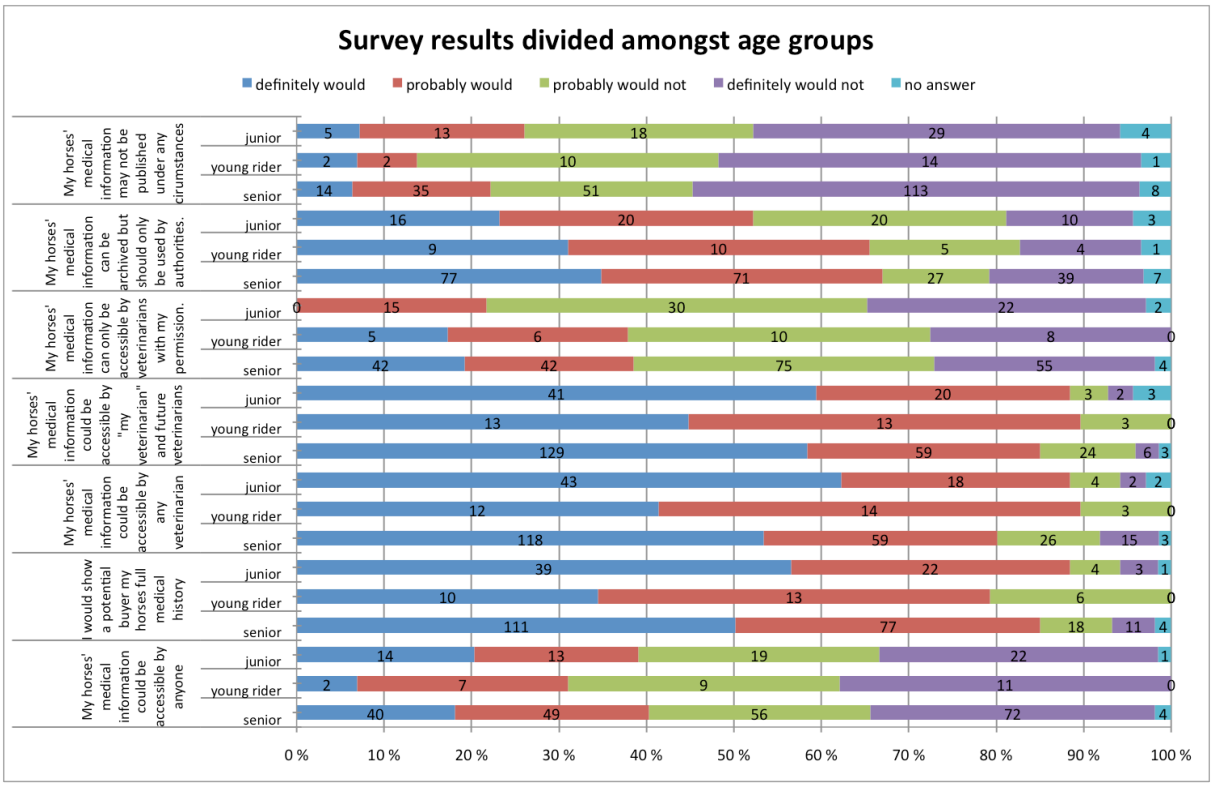

Figure 2 Survey divided amongst age groups

In Figure 3 the results from the survey are shown in accordance to if the responder owns a horse and/or competes. This is interesting since the owners are the ones buying and selling horses, whereas the competitors seem to have a more “negative” view on what and to whom medical information could be divulged. Competition riders, especially when competing in higher levels are more likely to be so called professionals in the horse industry.

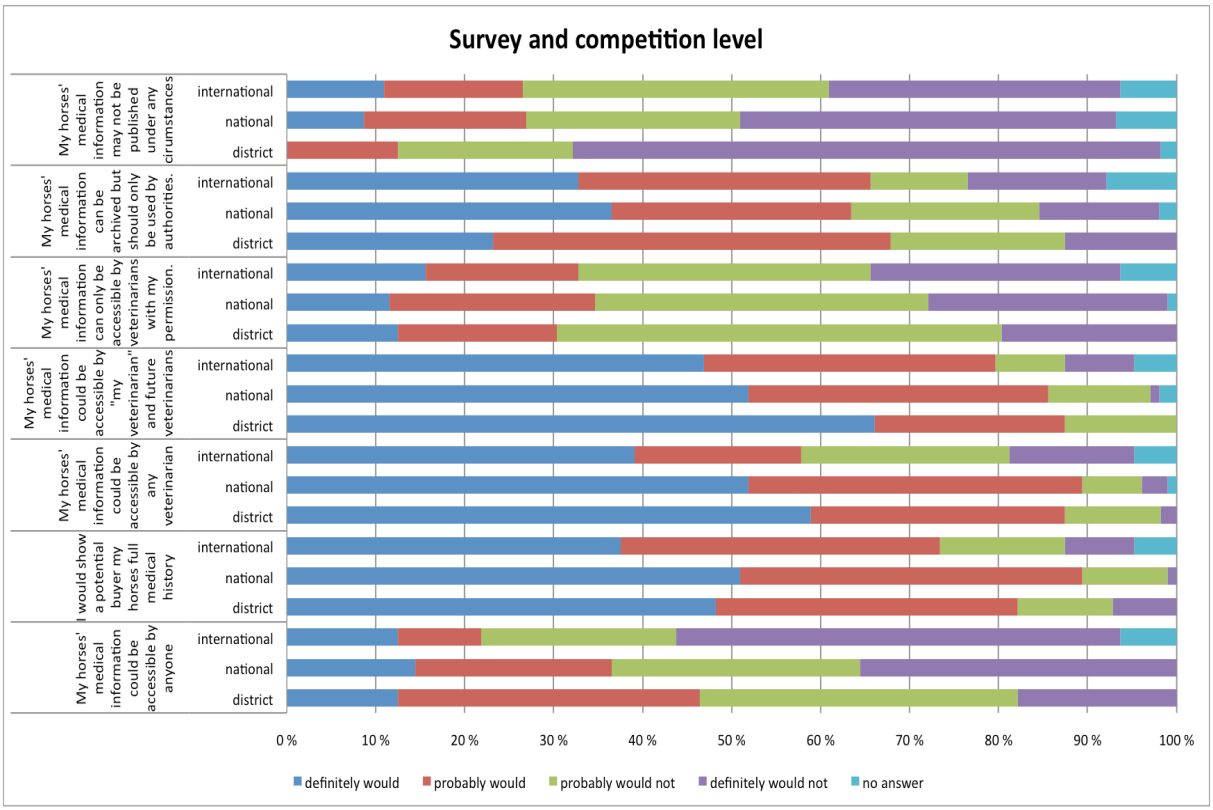

Figure 3 *Survey results in the view of owners and riders*

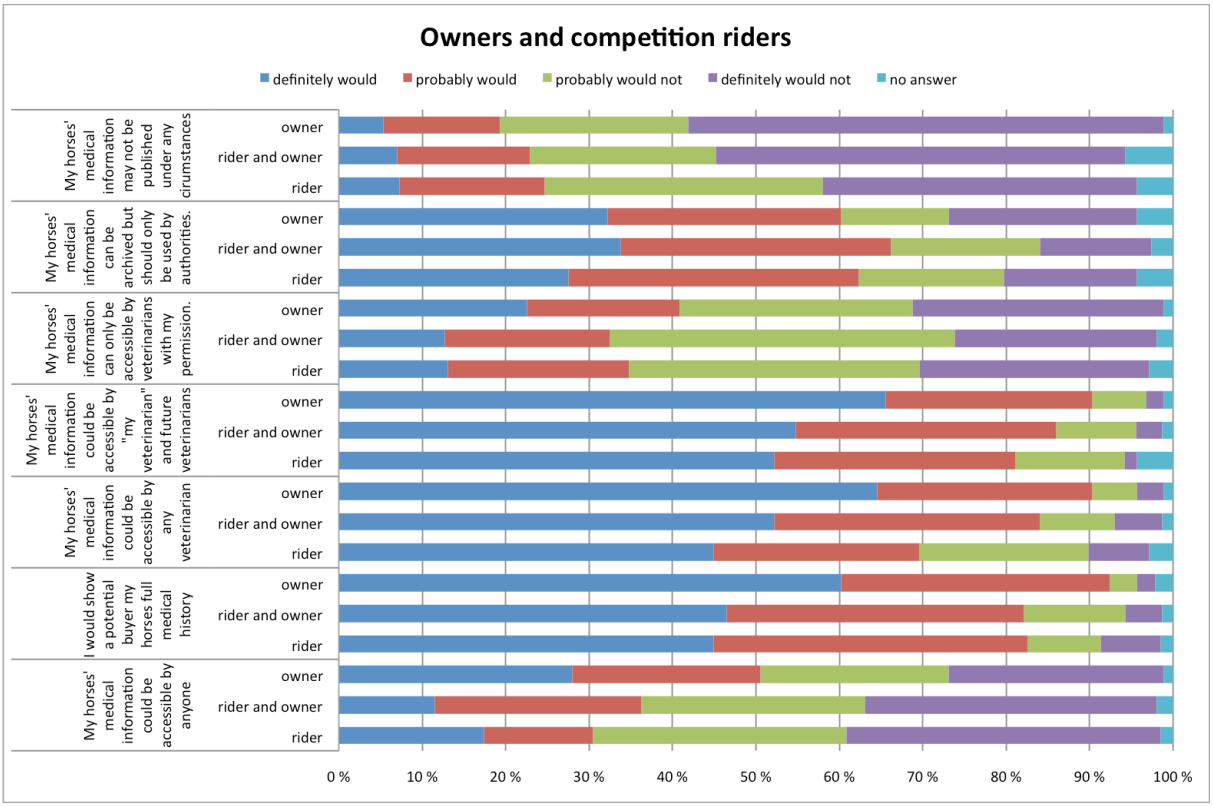

Figure 4 *Survey results in aspect of the responders' competition level*

Horse business gets more expensive and “tough” the higher the stakes are. In other words, horses that have competed in international or have the potential to compete in international level have a much higher price than other horses. It is interesting to see in Figure 4 that all levels are extremely positively inclined (i.e. answered “definitely would” or “probably would”) towards giving a horses medical information to certain veterinarians, but also very many would only give the medical history to proper authorities. Today if you want to slaughter your horse, you have to be able to prove that it has not been treated with medications that might be harmful in the human food chain (23/2006). This legal aspect does explain why this statement got very much “positive” feedback.

5 DISCUSSION

Even though this survey was done as an exploratory research it still gives some indication into how riders and horse owners would like their horse's medical information be archived and used. Since a horse’s value is rather directly correspondent to the horse’s age, gender, achievements and health status, it is understandable, that the horse’s value might change radically if the potential buyer knows some serious health problem. On the other hand, according to Finnish commercial laws, chapter 4, §17 - 21 the seller of the merchandise must inform the buyer of all the vital information that affects the merchandise (27.3.1987/355). So basically the seller is e.g. obliged to inform the buyer of the horse's medical history. The new owner of a horse is entitled to get all the horses medical history from the veterinarian who has treated the horse 6 §. The veterinarian is obliged to archive the horse’s medical information for at least three years 7 § (6/EEO/2000). The conundrum is that if the previous owner has not informed the new owner of all the horse’s medical history, how will he know? There are hundreds of veterinarians in Finland alone who treat horses, and what if the horse is imported from some other EU country, not to mention outside of EU where similar legislations may not be used?

Both horse owners and riders were rather willing to divulge medical information about their horses, but it is questionable if in reality the results would be the same. There is also most likely a significant difference in how much information is transferred between seller and buyer, depending on from whose viewpoint the situation is observed. Naturally the seller would like to downplay the horse's possible medical problems, whereas the buyer would want to know the truth.

When we think about the results from the veterinarians and horse’s point of view, it would seem obvious that the more previous information available, the better the veterinarian can help and treat the horse. If all medical data from a horse were in one place, from where the treating veterinarian could get it, he would then be able to compare past treatments, findings, x-rays etc. with what he is seeing now, and make a more accurate diagnosis. Since not all veterinarians treat horses at clinics with computers, but also in stable environments, for some sort of medical database to work, there would need to be mobile applications and services around the system to also facilitate the veterinarian on the road.

6 CONCLUSIONS AND IMPLICATIONS

This survey gave much to think about within the horse industry. There is a desire to have all the medical information available. According to FEI rules, the horse’s medical history should be available, e.g. in suspicion of substance abuse and according to Finnish commercial laws, the seller should inform the buyer of all aspects that might relate to the horse (Fédération Equestre Internationale 2010, 27.3.1987/355).

The question is, how would the whole horse industry change and what would be the implications if a medical database were available? Naturally a medical information database would bring transparency into the industry. Even if the database would only be available for official use, it could raise the amount of horses that could be safely slaughtered in Finland and put into the human food chain, thus eliminating unnecessarily long travels to foreign slaughterhouses. New business opportunities and models could emerge, as buyers would have a better opportunity to view the horse’s medical history,

and be sure that the information is valid. New roles such as consultants would be needed to decrease the gap between the "professionals" and the "hobby" people. Insurance companies would also benefit from extensive medical records, but they could partially shift this benefit to horse owners, by lowering the insurance premiums.

As discussed in chapter 2.1 a medical database would have several relations to the digitalization of human healthcare. Security of the data is of upmost importance, and also who is allowed to enter information about a horse. Heavy sanctions would have to be implemented to discourage potential misuse of the database or falsifying data. At the same time to get people to use a medical database they should feel that they benefit from using it. The surrounding service to the database must therefore be well designed and aimed for the various users specific needs.

In the title one of the most important questions are asked. Finally we can answer the question, can IS expand the limitations of Equine medicine? The answer seems to be a hesitant yes. Already at this point, the benefits of a medical database for various stakeholders can be seen. Veterinarians can save time and money, when all horse information would be in one place. They could read how the pervious veterinarians have treated the horse, and what problems the horse has previously had. Even if the same veterinarian treats a horse that has had the same owner for all its life, neither veterinarian nor owner can remember everything the horse has been treated for. Owners would have real time information on their horse's health status, and can control when some regularly occurring treatments, such as vaccination should be given to the horse. The competition organizers can easily check the horses' identifications and vaccinations and a horse's medical information can be checked by FEI testing veterinaries if necessary. Thus the competition organizer gets fast reliable and necessary information, as well as the possible FEI veterinary, without risking the horse owner's right to the horse's private medical records.

The general public can be ensured that the horsemeat they eat, is safe and without traces of harmful medicines. If a medical database could expand to other countries, horses welfare, when traveling could be more efficient. Border control can also effectively and reliably control that dangerous horse diseases, or diseases harmful to humans that could be transported by horses are not allowed to enter the country. Slaughterhouses would get reliable information about the animal, and thus it could increase the amount of horses slaughtered in their own native country, e.g. Finland. This way we, as consumers can also be sure that the horse has been ethically put down, and that it has not had to suffer during the trip to the slaughterhouse. Monetary savings are also large, since live horses from northern Europe do not have to be transported to southern Europe for slaughter, only to be transported back as meat in refrigerated transports.

Last but not least, with a functioning mobile- and internet-service connected with an electronic database, the horse can get more accurate and reliable medical service. The horse would not have to go through unnecessary medical treatments, and in some cases a more reliable diagnosis can be given, since new information could always be compared with old ones. This all saves time and money (and some gray hairs) for both the veterinarian and the owner.

7 FURTHER RESEARCH

Naturally within the equine sport industry it is not only about the horse owners, riders/drivers and competition organizers, for a medical database to even be a fusible idea, the veterinarian community must accept the idea. They have to get benefits from the database e.g. with services built around it such as IT and mobile technology services. These aspects will need further research. The technical aspects and requirements are also a point of research, not to mention a comprehensive research on the possible effects a medical database could have in the whole horse industry. The next question naturally is how could such a service be used with companion animals, and within the livestock industry. The electronic database connected with mobile- and Internet services (m-equine) can also function as a model to resolve problems within the digitalization of human healthcare information.

References

European Committee of Standardizations (03.01.2011). Retrireved 28.2.2011, from www.cen.eu

Health Level Seven International Retrireved 28.2.2011, from www.hl7.org

Fédération Equestre Internationale. (2010). Rules for Jumping Events 23rd ed. Switzerland:

Fédération Equestre Internationale. (2009 (including updates for 01.01.2010)). Rules for Eventing 23rd ed. Switzerland:

Fédération Equestre Internationale. (2009 (including modifications for 01.01.2010)). Rules for Dressage Events 23rd ed. Switzerland:

Fédération Equestre Internationale. (1 January 2010). General Regulations 23rd edition. Switzerland: Fédération Equestre Internationale

Disney, W.T., Green, J.W., Forsythe, K.W., Wiemers, J.F. and Weber, S. (2001). Benefit-cost analysis of animal identification for disease prevention and control, Revue scientifique et technique, 20 (2), 385-405.

Evira (Elintarviketurvallisuusvirasto). (2009) Eläinlääkärit 2009 (Veterinarians 2009).

Fédération Equestre Internationale. (2010). Veterinary Regulations 12th ed. Switzerland:

Fédération Equestre Internationale. FEI Retrireved 29.01.2010, from www.fei.org

Lenz, Tom R., DVM, MS, DACT. (2009). The Unwanted Horse in the United States: An Overview of the Issue, Journal of Equine Veterinary Science, 29 (5), 253-258.

Maa- ja metsätalousministeriö. (2006). Elintarvikelaki (Food Legislation) 13.1.2006/23. (23/2006) Helsinki: Maa- ja metsätalousministeriö.

Maa- ja metsätalousministeriö. (14.4.2000). 6/EEO/2000 Laki eläinlääkärinammatin harjoittamisesta (29/2000) 15 §; Potilasasiakirjojen laatiminen ja säilyttäminen. (6/EEO/2000) Helsinki, Finland: Maa- ja metsätalousministeriö.

MTV 3 45 min. (2007) 12.12. Teurashevosten tuskien tie (The slaughterhorses' tormented journey). http://www.mtv3nettitv.fi/?progId=3603&itemId=885

Penell, J.C., Bonnett, B.N., Pringle, J. and Egenvall, A. (2009). Validation of computerized diagnostic information in a clinical database from national equine clinic network, Acta Veterinaria Scandinavica, 51 (50), Retrieved 2.2.2010, from http://www.actavetscand.com/content/51/1/50

Petersen, B., Knura-Deszczka, S., Pönsgen-Schmidt, E. and Gymnich, S. (2002). Computerised food safety monitoring in animal production, Livest.Prod.Sci., 76 (3), 207-213.

Pettitt, R.G. (2001). Tracebility in the food animal industry and supermarket chains, Revue scientifique et technique (International Office of Epizootics), 20 (2), 584-597.

Shiu, E., Hair, J., Bush, R. and Ortinau, D. (2009) Marketing Research. New York, Ny, U.S.A: McGraw-Hill Higher Education

Skarra, P. (2009). Rekistöröinti takaa hevosten oikeusturvan: Anna hevosellesi identiteetti, HIPPOS Suomen Ratsastajainliiton jäsenlehti, SRL info 7-8.

Soini, P. (2010) Toimintasuunitelma 2010 (Strategy 2010).

Suomen Hippos ry. (2010) Raviurheilu ja Hevoskasvatus lukuina (Trottingindustry and horse breeding in figures).

The Parliament of Finland. (27.3.1987). Kauppalaki (Commercial law). (27.3.1987/355) Helsinki: Parliament of Finland.

Trevarthen, A. and Michael, K. . (2008). The RFID-Enabled Dairy Farm: Towards Farm Management. In 7th International Conference on Mobile Business, Barcelona, Spain, 7-8 July, 2008, pp. 241-250. ICMB.

Wang, N., Zhang, N. and Wang, M. (2006). Wireless sensors in agriculture and food industry—Recent development and future perspective, Comput.Electron.Agric., 50 (1), 1-14.

Research paper 3

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Veterinarian Work, Enhanced by Mobile Technology – An Empirical Study.

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Abstract

The aim of this paper is to find out if mobile technology can be used to enhance a veterinarian's work during house calls. The main focus is toward Equine medicine veterinarians. The results obtained from this research, which were conducted with Finnish veterinarians, are also transferable, to some degree, to other countries. We will find out what the current situation during house calls for veterinarians. We need to understand their daily routines and bottlenecks, how they regard new technology and how they currently use Information Systems (IS) and mobile technology. With this information we can then develop working IS and mobile solutions that will enhance the veterinarians work during house calls and at the same time improve the veterinarian's customer service.

1. Introduction

Traditionally veterinarians have been divided into small animal or large animal specialization. At the University of Helsinki, faculty of veterinary medicine, implement the same during studies toward the Licentiate of Veterinary Medicine degree. Small animal veterinarians treat companion animals, such as dogs and cats, whereas large animal veterinarians treat production animals and horses. Since production animals and horses are more difficult to transport than companion animals, the large animal veterinarians are more likely to make house calls. This study researches the way veterinarians use mobile technology in their daily routines and their attitudes toward mobile technology. The "house call" veterinarians that were interviewed for this paper usually use a paper and pen to record animal treatments and diving distance. This information was then entered into a computer, so that the diagnoses, treatment plans and bill could be sent to the clients. This method takes time and produces unnecessary duplication of work. Veterinarians need to improve their allocation of time. Especially in the small animal clinics, the development has been to emphasize the business aspects of the clinic more than in equine medicine clinics or amongst private veterinarians. Today in the U.S.A., there are veterinarian clinic chains, both large and small animal, which produce healthcare as part of their business. This development is also seen in private healthcare clinics for humans [1]. A few years ago, this was unheard of in Finland and is currently very rare with small animal practices. It is practically non-existent in large animal or equine medicine practices in Europe.

In human healthcare the digitalization process has already begun. Many papers have been written about the challenges and advantages technology will bring [2, 3, 4, 5]. Identification [3] [5], digitalization healthcare [2] and mobile technology in homecare [4] have been addressed in recent years. A part of the problem is to get common standards within EU [6] and internationally [7]. For livestock there are various Information and Communication Technology (ICT) applications in use. Studies have been made on identification of livestock [8, 9], farm management [10, 11] and practice management [12] to name a few.

In various scientific publications from Australia, Trevarthen (2007), Michael (2008) and Michael (2009) have made extensive studies on livestock identification, information gathering and farm management [5, 9, 10, 13]. In these publications, a large number of animals from various farms have been studied. However, in the farm management articles, information gathering is mostly done at one place (e.g. milking station) on the farm. Furthermore, livestock

identification by Radio Frequency Identification (RFID) tags was introduces to Australia 1999 and has since expanded to include sheep, cattle and goats [14]. This type of tagging cannot be used with horses since the RFID tag is a plastic tag that hangs from the animal's ear like a human earring. For sport-horses, this is not an option, since it would disturb the horse's concentration. In addition, a horse's earlobe is thicker than on bovine or swine, thus increasing the risk of infection. Horses are identified by inserting a microchip under the skin, as are dogs and cats. Currently the microchip only contains the animal's life number, which can be traced to the animal's owner by e.g. veterinarians. The use of mobile devices such as mobile phones has not been studied to a great extent in articles [5, 9, 10, 11], since these studies concentrate more on the enhancement of knowledge that can be gained from the RFID tags and not the reading terminals of the tags.

In human healthcare studies, the digitalization of healthcare information and the use of mobile technology have been discussed [2, 3, 4, 5]. The veterinarian's house visits to stables and barn environments are not always sanitary giving new aspects and problems for future studies to address.

To get a better understanding on veterinarians' use of mobile technology in their daily routines, the problem has to be divided into three main research questions. These questions are: (i) What are the bottlenecks in a veterinarian's daily routines? (ii) How do veterinarians use mobile technology? (iii) What are their attitudes towards new technological innovations that would support their work? This study does not only contribute to the veterinarian society, but also to production animal farms, sport horses and horse owners. Some of the problems that will be studied in this paper can also relate to problems within human healthcare.

This paper is structured in the following way. The conceptual study, Chapter 2, will present the research domain, concept and literature review. In Chapter 3 the empirical study is presented from data collection to analysis. Chapter 4 is divided into discussions, conclusions and recommended future research.

2. Conceptual study

2.1. Research domain

In the Finnish veterinary system a veterinarian can work on various tasks, but in this research we focus on large animal veterinarians who treat production animals (bovine, pigs, sheep, chickens etc.) and horses. Every county in Finland has to provide a veterinarian on call at all times, to care for local animal needs. In smaller counties with only one appointed veterinarian, he/she has to be able to care for various production animals, horses, cats, dogs and even more exotic pets. When possible, a large animal and a small animal veterinarian are appointed for the county. The county appoints the county veterinarians in accordance to the Finnish Law of Medical Services for Animals 16 § [15]. There are approx. 2,100 licensed veterinarians in Finland, 30 % work as county veterinarians and others mostly work at private practices or clinics [16]. In Finland there are both small animal and equine private clinics. The University of Helsinki has the only production animal clinic. Apart from pets and production animals, a county veterinarian is also responsible for animal welfare and wildlife care within the county. The county veterinarian might also be a "hygienist veterinarian", meaning that he/she monitors the county's food production and overall health situation when it comes to food products.

Equine medicine veterinarians specialize in treating hoofed animals, which in Finland is primarily horses. These veterinarians treat and/or inspect all kind of horses: leisure, harness sport, equestrian sport and horses going to slaughter. Today, horses are increasingly seen as companion animals and used as sport animals. Thus also equine medicine has developed further than bovine or swine medicine. A bovine animal is seldom treated to the extent of horses. A bovine's worth is more likely to be attached to the value of the meat, milk and/or breeding. A horse's value is connected to the horse's quality as a racehorse, dressage horse etc.

According to EU regulations and Finnish food legislation, all animals slaughtered in EU for human consumption need to have proof of identity and a logbook stating what medications and feed the animal has received during its lifetime [17]. Some medications that are used on horses are considered dangerous for humans. If the horse has been treated with these medicines during its lifetime, the meat cannot be used for human food consumption. Since horses can be sold many times during their lifespan, the medical history that, in most cases, is in paper format does not necessarily move along with the horse.

Veterinarians today usually have their own patients' records on file and are required to do so for a minimum of three years, according to Finnish laws [18]. The problem is to find all medical information of a horse. Veterinarians, who informed that their specialty is equine medicine, could have medical information about the horse that is relevant for e.g. slaughter (2009 there were 25 equine medicine veterinarians). County veterinarians might also have treated it and if the horse has been imported from another country, it is virtually impossible to be 100 % sure that all medical data is intact [19]. Horses

competing internationally must have a paper-based medical logbook that includes the horse's medical history according to FEI (Fédération Equestre Internationale) veterinary regulation, article 1026, 3§ [20]. This logbook has become mandatory after FEI started the "clean sport" program against doping. The logbook includes information on what and when the horse has received medication. E.g. some horses have to be mildly tranquilized for shoeing. If trace elements of this tranquilizer remain in the horse's blood, beyond the pharmaceutical company's safe date, then a positive doping test may result.

According to Suomen Hippos (the Finnish Trotting and Breeding Association), there were approx. 73 000 horses in Finland in 2010 [21]. This amount includes all horses that were registered in Finland; harness sport, leisure horses and equestrian sport horses. This figure might be misleading if a horse has been imported from another EU country and it has the importing country's passport, then it does not necessarily have to be registered into Hippos. Horses are primarily identified by their national and/or international passport(s). Beginning July 1, 2009, all foals born in Finland and all horses imported to Finland must have a microchip for identification. They must also have a national passport since this is still officially used for identification at racetracks, equestrian competitions and border control [22]. It is estimated that in Finland there were 9,100 actively competing harness racing horses and 6,900 competing equestrian sports horses in 2009 [23].

County veterinarians mostly treat production animals, while both county and private practice veterinarians treat horses. These veterinarians are specialized in large animal and/or equine medicine veterinary. Both county and private practice veterinarians might make house calls and are an essential part of this study. Record keeping is difficult when working in less than ideal environments and animal owners might loose medical information. This medical information must to be presented if the animal owner desires to slaughter the animal.

2.2. Literature review

In recent literature, the digitalization of human healthcare has been much discussed [2, 3, 4, 5]. The development of mobile technology has enabled mobile phones to be used not only as personal devices but also as work tools in one's profession. In her 2005 publicized doctoral thesis, Han discusses the mobile technology usage and adaption among Finnish physicians. In this study, once the physician started to use mobile technology (in these cases the content of the service was basically a Nokia phone that included the whole Pharma Fennica, i.e. the Finnish medicine encyclopaedia) he/she was positively inclined towards the technology's usefulness and usage [24]. This dissertation gives a picture of the physicians' attitudes. For large animal veterinarians the mobile phone usage would be somewhat broader for them to obtain maximum benefits. A veterinarian on the move needs much more than just the list of medicine he can prescribe during house calls. A mobile device could be used by a veterinarian to enter treatment information, which physicians would not need since they usually work in offices with computers. Therefore, in this paper the research question has been taken a bit further than Han's dissertation.

In the 03-Vet project, the aim is the digitalization of animal hospitals compliant with the Information Technology (IT) standards [12]. In this project, some of the human healthcare standards have been reused and fitted to suit animal and veterinarian needs. One of the aims is to maximize data sharing with web-oriented technology. This study, at the moment of writing this paper, is limited to animal hospitals and does not study the mobile possibilities.

One of the problems that need to be addressed is the ideal way to identify the animal the veterinarian is treating. For livestock, the industry has already stipulated the need for clear identification, thus e.g. ear tags on bovines and swine. Often the identification today is RFID-based, as in the studies of Trevarthen, Trevarthen & Michael, Voulodimos, et al and Wallace et al articles [9, 10, 11, 25]. In these studies, apart from the aforementioned article from Wallace et al, the studies have been about the need for bovine identification in business management and the importance of traceability. The main issue in these studies are that via the id-tag of the bovine animal, information about the animal can be traced. Whether with RFID-tag technology a cow's milk production is monitored or a heifer's movements across the country from various owners can be monitored. Information can be traced and be used from the farm to the slaughterhouse to your table. Since, especially in Europe, a horse might end up as a meal for people, the same level of monitoring is needed.

Both FEI and harness racing sports have strict rules about medication usage and vaccination requirements. Accurate identification of the animal is one of the key features that are needed to gain trustworthy information. Inserting a microchip identifies horses, but often the standards of various microchip companies vary, so the veterinarian needs more than one reader to be able to identify the horses. These microchips only contain the horse's life number. There is a need to develop horse identification in the direction discussed in the Voulodimos et al and Trevarthen articles [9, 10,

11]. In Wallace et al, the study involved temperature measurements done in horses with RFID tags. This study shows other issues that could be raised with id-tags and veterinary monitoring. One of the problems that were discussed in this study is the much-debated issue raised by many who oppose inserted microchips: Can a microchip implantation cause foreign body reactions or tumour formations? In our research these aspects are not discussed. The ideas how a microchip can be used in veterinarian work and the digitalization of a horse's healthcare information as discussed in Wallace et al article is an excellent basis for this research.

The article by Lin and Heffernan on HPAI (Highly Pathogenic Avian Influenza) surveillance is one of the few that study veterinarian work and animal health information with mobile technology [26]. The mobile system in their research is used to get information on outbreaks of HPAI. The system has many basic applications that could be used by a veterinarian's mobile service. Information is input via the mobile phone into a database. In our case the study is taken somewhat further. The information that would be essential to send via the mobile phone is larger and the information has to be restricted to predetermined users and have high security levels. In aspects of food safety, the Lin and Heffernan study is on the same path as this research; real-time information leads to faster responses to a potential problem. But in the mobile application they study, anybody can report their suspicion of HPAI via the mobile phone and it is the only information that can be sent in this service. .

The importance in food safety and monitoring animals with proper identification has also been discussed in many papers [8, 27, 28, 29]. Although this paper does not study identification of animals per se, some of the same issues and important factors are parallel to the problems discussed in the above-mentioned articles. Medication and possible transferable disease information for production animals and horses have to be traceable throughout the animal's life. Equally, the veterinarian treatment of horses has to be traced in doping suspicion cases. Unlike a sport horse's human equivalent, the horse is chipped and monitored throughout their life, which would be a violation of privacy for a human athlete. As mentioned in Chapter 2.1, a horse's value is dependent on the privacy of the animal's health information and thus it is important that access to this information be restricted.

2.3. Conceptualization

This research is tangent with many other areas in the literature review. Figure 1 is a visual representation of this. A veterinarian's core business is naturally the healthcare of the animal, but also non core-business tasks, such as paperwork need to be done. This work, which is not directly related to the core business, has not been studied before but is addressed in this paper. Similarities to this research had to be found in other tangential areas.

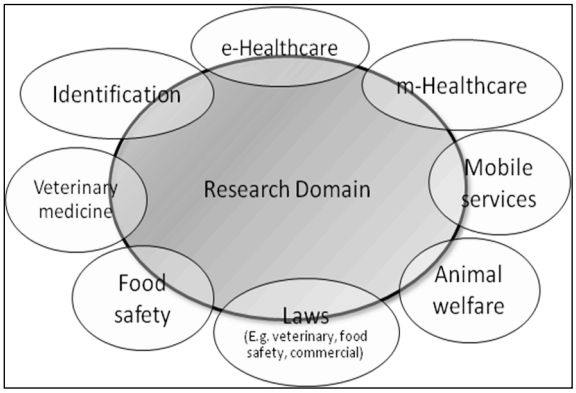


Figure 1. Research area.

To understand the bottlenecks in a veterinarian's daily routines this paper will illuminate a veterinarian's daily routines and especially the time spent on the non-core business tasks. As in Han's dissertation, it is imperative that we understand the veterinarians' attitudes towards mobile technology and current usage of various mobile applications [24]. This will further illustrate what kind of applications could be built for them. The ideal platform and how tech-savvy the veterinarians in reality are needs to be studied.

3. Empirical study

To gather information on veterinarian's daily routines, use of mobile devices and attitude towards new technological innovations, a survey was conducted in Finland. Prior to forming the survey, we recorded interviews and discussions with a county veterinarian and veterinarians working at three different horse clinics. The horse clinic veterinarians also did house call work. These preliminary interviews were important for the research since we needed a picture of what tasks a veterinarian performs at a clinic and during house calls. We accompanied some of the veterinarians during their workday to get a better feel of their daily tasks. With this knowledge we then composed a survey, taking into account what information we needed and the previous feedback we had gotten from the veterinarians. This type of iterative research gave us the opportunity to better understand the veterinarians' work and to explore ways it could be enhanced through mobile technology. The survey was

exploratory since we knew little about a veterinarian's day. This type of research had previously not been done in Finland. After the personal interviews and observations, we conducted an online survey with 32 questions. Our survey was done with Webropol, an online survey and analysis software. An Internet survey was chosen, as there are many advantages to it as is stated in Shiu et al (2009) and Dillman (2007) works [30, 31]. We were able to track down most of the e-mail addresses of the veterinarians. A link to the Webropol survey was included to the cover e-mail letter. This contact method is recommended in Shiu et. al and Kaplowitz et.al to obtain interest in respondents [30, 32].

The survey's questions were divided into three parts.

1. County and private veterinarian's routines, tasks and treatments at a clinic and during house calls.
2. Use of non-clinical technology at work; current technology use and skills plus mobile phone features in use
3. Attitudes towards technology; willingness to use new IS and mobile technologies

The cover letter e-mail contained a short description of the research and a link to the Webropol survey. It took approx. 10 minutes to answer the questions and the survey could be done in Finnish, Swedish, or English. From the Finnish Food Safety Authority, Evira, a list of all the veterinarians that were working in Finland in 2009 could be found [19]. The veterinarians listed as practicing equine medicine or working at a horse clinic and all county veterinarians were included to the survey. Since not all veterinarians had informed Evira of their e-mail addresses or they were incorrect, e-mail information had to be double checked from county websites. This way some of the non-response errors could be omitted. Some veterinarians had several e-mail addresses, in these cases the e-mail was sent to all the addresses.

3.2. Data Analysis

In total, the survey link was sent to 543 veterinarians, of which 146 veterinarians' e-mail addresses were not valid or could not be found. The veterinarians, whose e-mail addresses could not be found, were located in various areas of Finland. The represented percentile regionally of these non-partaking veterinarians had approximately the same variance in between the different areas of Finland, as did the veterinarians who took part of the survey. Of the 397 veterinarians, who received the e-mail, 161 veterinarians took part in the survey, resulting in a response rate of 40.55%. The survey link was sent to 383 (70.5%) women veterinarians and 160 men (29.5%). This ratio between men and women is veterinarians. This ratio somewhat differs from the ratio that the Finnish Veterinary Association listed in their annual report 2010, women 73 % and men 27 % [33]. Of the respondents, 72,7 % was women and 27,3 % men.

Of the respondents, 47.8 % were under 40 years old and the largest group was in the 30-39 years old age category. In table 1 the gender and age differences in the question of Internet use on the mobile phone are presented

Table 1. Mobile phone and Internet

Veterinarians' Internet usage on their mobile phones.					
Age	Gender	Yes	No	No answer	Total
20-29	Man	0	3	0	3
	Woman	4	16	0	20
30-39	Man	3	4	0	7
	Woman	19	27	1	47
40-49	Man	3	7	0	10
	Woman	5	21	0	26
50-59	Man	2	12	0	14
	Woman	2	13	1	16
60-69	Man	1	9	0	10
	Woman	1	6	0	7
No answer				1	1
Total		40	118	3	161

We wanted to know whether there is a large difference between men and women's use of Internet on their mobile phones. From Table 1 we can see that 27.2 % of the women use Internet on their mobile phones, whereas only 20.5 % of men use Internet on their mobile phones. Approx. 30 % of men and 35% of women who are under 40 years old use Internet on their mobile phones. But it is intriguing that none of the men in the age category 20-29 years old use Internet on their mobile phones, although when the survey was done, Internet usage on mobile phones was already relatively cheap in Finland and many phones offered this feature.

Table 2, on the other hand, gives a picture of what functions veterinarians are already using on their mobile phone. We were interested in information on the mobile features they currently use or have tried on their mobile phones. In this table, the respondents are only from the group "large animal veterinarians", i.e. Equine and production animal veterinarians. 137 of the 161 respondents are large animal veterinarians and 100 of them are county veterinarians. Many of these veterinarians are general practitioners.

Table 2. Mobile phone functions that veterinarians use or have tried

Equine and production animal veterinarians usage of their existing mobile phones' functions.				
		Use	Tried	Total
Calling	Man	18	0	74
	Woman	56	0	
SMS	Man	20	0	76
	Woman	56	0	
MMS	Man	4	6	48
	Woman	23	15	
Calendar	Man	6	4	53
	Woman	21	22	
E-mail	Man	3	4	33
	Woman	11	15	
GPS	Man	1	3	18
	Woman	5	9	
Camera	Man	11	5	69
	Woman	42	11	
Notes	Man	6	1	33
	Woman	16	10	

Calling and sending SMS were the most common services that veterinarians use on their mobile phones. In table 2, women use more actively their mobile phone functions than men. Men only use the notes and SMS functions on their mobile phone more than women do. On the other hand, women use the Camera, GPS and MMS functions more than men. Overall, it seems that notes, e-mail and GPS functions are the least used of the mobile phones functions.

Tables 3, Table 4 and Figure 2 are more specifically about house call routines. These tables and figure only contain answers from respondents who are either production animal or equine medicine veterinarians and make house calls. 137 veterinarians fit these requirements, of which 100 are women and 37 men.

We were especially interested in the large animal veterinarians' record keeping during house calls. We specifically wanted to know how many have manual computer or mobile recordkeeping. Table 3 presents how veterinarians' keep records for three different house call actions. These actions are: patient information, treatment information and driven distance information. In the survey, there was various record keeping options that were chosen as being the most likely methods according to the veterinarians who were interviewed prior to the survey.

Table 3. House call routines

Equine and production animal veterinarians record keeping during house calls.						
	Patients		Treatments		Driven distance	
Manually	74	54.0%	73	53.3%	68	49.6%
Laptop	67	48.9%	68	49.6%	45	32.8%
Mobile phone	1	0.7 %	1	0.7%	0	0.0%
Assistant	4	2.9%	4	2.9%	3	2.2%
Memorize	2	1.5%	2	1.5%	2	1.5%

It seems that the large animal veterinarians who make house calls are divided into two almost equally sized groups; those who keep patient and treatment records manually and those who keep records electronically on a laptop. Distance records were primarily kept manually. Half of all the women used a laptop for patient and treatment recording. Interestingly, younger veterinarians (under 40 years old) did not use a laptop as frequently as the older ones did. Fewer than 40 % of the young veterinarians used a laptop for patient and treatment records. According to our survey, mobile phones are rarely used as a record keeping option.

One of the research questions was to find out what the veterinarians routines and bottlenecks are at work. In table 4, the attitudes toward some of the non core-business routines and possible technological innovations that could support the veterinarian's work are presented.

Table 4. Daily routines and attitudes toward them.

The equine medicine and production animal veterinarians' attitudes towards various non-core business tasks and methods.					
	Definitely agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Definitely disagree
I feel I spend too much time doing paperwork	43	66	18	8	0
	31.4%	48.2%	13.1%	5.8%	0.0%
It's common that paperwork gets postponed and thus accumulates	59	53	6	11	7
	43.1%	38.7%	4.4%	8.0%	5.1%
I feel that I could improve the way I keep medical records during house calls	19	57	24	27	10
	13.9%	41.6%	17.5%	19.7%	7.3%
I would use a mobile device (mobile phone, PDA etc.) if it improved my work performance	22	50	24	27	10
	16.1%	36.5%	22.6%	12.4%	10.9%
I would use a system that automatically measures the distance I travel.	28	39	23	25	21
	20.4%	28.5%	16.8%	18.2%	15.3%
I would use a system that would hasten my billing procedure	57	54	15	5	5
	41.6%	39.4%	10.9%	3.6%	3.6%

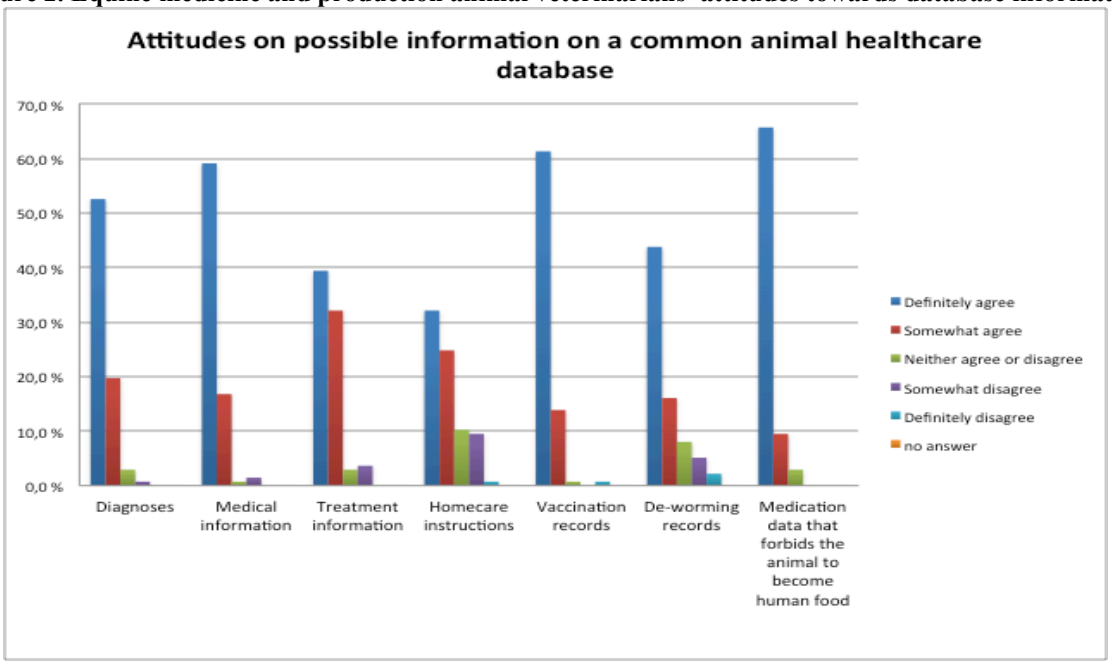
As is presented in Table 4, many of the veterinarians felt that they use too much of their time doing paperwork and that it often gets postponed. Over 50% of the veterinarians use 20% or more of their time doing paperwork. 75% use more than 20% of their time driving. Billing procedures seem to be one of the major actions that veterinarians wish could be done with more smoothly.

Figure 2 represents the veterinarians' attitudes towards a patient database. A database with various IS and mobile services could be used to help a veterinarian in their daily routines. Today such services do not exist, although in Finland there are databases for both cattle and swine (www.naseva.fi and www.sikava.fi). These databases have information about the animals or group of animals ID's and medical treatments. Owners are allowed to enter data into these databases and the agricultural ministry provides tutorials and guides to animal owners.

Over 75% of the veterinarians would prefer a database where all animal information could be inserted. Of the responders who opposed a common database, they most often stated that patient information should not be shared (approximately 32% of the database opposing respondents). 24.5% of the opponents stated that they do not believe such a database would be beneficial for them. Security issues were the third most common reason that veterinarians did not want a common database (13,5%).

With this survey we wanted to get a better insight on what veterinarians could see as being useful information on an animal healthcare database. In Figure 2, these results are presented.

Figure 2. Equine medicine and production animal veterinarians' attitudes towards database information



4. Discussion & Conclusion

Overall, women seemed to use and have a more open mind towards various mobile phone functions. Laptops are also coming to be a normal device to have during house calls, but still manual record keeping is equally popular (Table 3). As was expected veterinarians felt that they use too much time on paperwork. At the same time they were rather positively inclined towards having some sort of mobile or other digital system to help them with the non-core business time consuming problems, such as billing, paperwork and distance calculation (Table 4).

The veterinarians were given options of information that could be stored on a database if it existed. Many either agreed or somewhat agreed that diagnostic data, medical data, vaccination data and information that the animal is not suitable to enter the human food chain, would be considered useful. Treatment information, homecare instructions and de-worming data also had a more positive feedback then negative.

All the information gathered from the survey points towards the need for assistance in one of the most common veterinary occupational bottleneck, i.e. paperwork. Since the veterinarians were rather positive towards new technology, a mobile phone application and Internet service that is connected to a national database could have potential. To get the approval of these services main users, veterinarians, it would be imperative that the system is built with their help. This bottom-up approach would allow fast iterations when developing the services and thus the criteria's of the veterinarians would be met. The system has to be flexible to meet the various veterinarians' needs and the needs of other stakeholders, such as the animal owners, slaughterhouses and the government.

From previous studies the importance of proper and accurate animal identification has been established and would be one of the core information in a IS support system for veterinarians. As in the 03-Vet project, common standards would have to be established and these standards should be easily transferable to other countries' veterinary systems and practices [12]. As in the many of both Michael's and Trevarthen's studies, management is one of the key features that is to be gained from a IS support system [5, 9, 10, 13]. Veterinarians would get better patient management and animal owners would get accurate and up to date essential farm management information. In addition, the healthcare, food safety and disease control units would gain vital real-time information enabling them to react fast.

4.2. Further research

A horse is the only animal in the world that can be used for food, leisure activities, Olympic sports and

professional sports. This poses many challenges to a medical database supported by mobile and Internet services. The central figure, the horse, however is the same, despite its career in the human world. The surrounding stakeholders, on the other hand, have varying various needs.

Further research should be done to determine other usage areas, such as other horse sports, small animal veterinarians, other countries and other animals. Even the possibility of a medical database with supporting IS and mobile systems could be used, as a model for the digitalization of human healthcare should be explored.

5. References

[1] VCA Antech (Veterinary Centers of America) [Internet] by VCA antec inc.; c2010 [cited 2011 10/06]. Available from: www.vcaantech.com.

[2] M. N. K. Boulos, W. S. S., et al. "How smartphones are changing the face of mobile and participatory healthcare: And overview, with example from eCAALYX". BioMedical Engineering OnLine [Internet]. [revised 2011 cited 06/09/2011]; 10(24) Available from http://www.biomedical-enginering-online.com/content/10/24.

[3] E. W. T. Ngai, J. K. L. Poon, et al. "Design of an RFID-based healthcare management system using an information system design theory", Information Systems Frontiers, 2009, 11 (4) pp. 405-17.

[4] D. Hansen P., P. Gurney, et al. "The australian e-health research centre: Enabling the health care information and communication technology revolution", The Medical Journal of Australia, 2011, 194 (4) pp. S5-7.

[5] M. G. Michael, K. Michael. "Uberveillance: Microchipping people and the assult on privacy". Quadrant Online [Internet]. [revised 2009 cited 02/03/2010]; LIII(3) pp. 85-89 Available from http://www.quadrant.org.au/magazine/issue/2009/3.

[6] European Committee of Standardizations [Internet] European Committee of Standardizations; c2011. Available from: www.cen.eu.

[7] Health Level Seven International [Internet] Health Level Seven International; c2011 [cited 2011 10/3]. Available from: www.hl7.org.

[8] R. G. Pettitt. "Tracebility in the food animal industry and supermarket chains", Revue Scientifique Et Technique (International Office of Epizootics), 2001, 20 (2) pp. 584-97.

[9] A. Trevarthen. "The national livestock identification system: The importance of traceability in E-business", Journal of Theoretical and Applied Electronic Commerce Research, 2007, 2 (1) pp. 49-62.

[10] A. Trevarthen and K. Michael. The RFID-enabeled dairy farm: Towards total farm management. The RFID-enabeled dairy farm: Towards total farm management. *7th international conference on mobile business,* (pp. 241-250). 7-8 July 2008; ICMB; 2008. .

[11] A. S. Voulodimos, C. Z. Patrikakis, et al. "A complete farm management system based on animal identification using RFID technology", Computers and Electronics in Agriculture, 2010, 70 (2) pp. 380-8.

[12] M. Zaninelli, F. M. Tangorra, et al. "The O3-vet project: A veterinary electronic patient record based on the web technology and the ADT-IHE actor for veterinary hospitals", Computer Methods and Prorams in Biomedicine, 2007, 87 pp. 68-77.

[13] K. Michael, M. G. Michael. Innovative automatic identification and location-based services: From bar codes to chip implants. 1st ed. Information Science Reference (an imprint of IGI Global), Hershey, USA, 2009.

[14] Livestock identification [Internet] by MLA.: Meat & Livestock Australia; c2011 [cited 2011 30/08]. Available from: http://www.mla.com.au/Meat-safety-and-traceability/Livestock-identification.

[15] Eläinlääkintähuoltolaki (Law of Medical Service for Animals), (2009) Parliament of Finland. Helsinki. 2009/765.

[16] ammattina eläinlääkäri (Veterinary as an occupation) [Internet] ammattina eläinlääkäri (Veterinary as an occupation): Suomen eläinlääkäriliitto; c2011 [cited 2011 14/06]. Available from: http://www.sell.fi/ammattina_elainlaakari/.

[17] Elintarvikelaki (Food Legislation) 13.1.2006/23, (2006) Maa- ja metsätalousministeriö (Ministry of Agriculture and Forestry). Helsinki. 23/2006.

[18] 6/EEO/2000 Laki Eläinlääkärinammatin Harjoittamisesta (29/2000) (Law on Practicing Veterinary) 15 §; Potilasasiakirjojen Laatiminen Ja Säilyttäminen (Patient Record Framing and Upkeep), (14.4.2000) Maa- ja metsätalousministeriö (Ministry of Agriculture and Forestry). Helsinki, Finland. 6/EEO/2000.

[19] Evira (Elintarviketurvallisuusvirasto) (Finnish Food Safety Authority). Eläinlääkärit 2009 (veterinarians 2009). ; 2009.

[20] Fédération Equestre Internationale (FEI). (2010) Switzerland .

[21] Soini P. Toimintasuunitelma 2010 (strategy 2010). Suomen Hippos (The Finnish Trotting and Breeding Association); 2010.

[22] P. Skarra. Rekistöröinti takaa hevosten oikeusturvan: Anna hevosellesi identiteetti (registering your horse, guarantees your horse's legal protection: Give your horse an identity.). HIPPOS Suomen Ratsastajainliiton Jäsenlehti (HIPPOS the Equestrian Federation of Finland's Official Memebership Magazine) 2009;43(4/2009):SRL info 7-8.

[23] Suomen Hippos ry. Raviurheilu ja hevoskasvatus lukuina (trottingindustry and horse breeding in figures). ; 2010.

[24] S. Han. Understanding user adoption of mobile technology: Focusing on physicians in finland. Turku, Finland: Turku Centre for Computer Science (TUCS); 2005 No 59.

[25] L. E. Wallace, J. A. Paterson, et al. "Evaluation of implantable RFID microchips for readability and measurement of body temperature in mature horses", American Society of Animal Science, Western Section, 2008, 59 pp. 99-101.

[26] Y. Lin, C. Heffernan. "Accessible and inexpensive tools for global HPAI surveillance: A mobile-phone based system", Preventive Veterinary Medicine, 2011, 98 (2-3) pp. 209-14.

[27] B. Petersen, S. Knura-Deszczka, et al. "Computerised food safety monitoring in animal production", Livest Prod Sci, 2002, 76 (3) pp. 207-13.

[28] N. Wang, N. Zhang, M. Wang. "Wireless sensors in agriculture and food industry—Recent development and future perspective", Comput Electron Agric, 2006, 50 (1) pp. 1-14.

[29] W. T. Disney, J. W. Green, et al. "Benefit-cost analysis of animal identification for disease prevention and control", Revue Scientifique Et Technique, 2001, 20 (2) pp. 385-405.

[30] E. Shiu, J. Hair, et al. Marketing research. McGraw-Hill Higher Education, New York, Ny, U.S.A, 2009.

[31] D. D. Dillman. Mail and internet surveys: The tailored design method. 2nd ed. Wiley, Hoboken, New Jersey, USA, 2007.

[32] M. D. Kaplowitz, T. D. Hadlock, R. Levine. "A comparison of web and mail survey response rates", Public Opinion Quarterly, American Association for Public Opinion Research, 2004, 68 (1) pp. 94-101.

[33] Suomen Eläinlääkäriliitto ry (The Finnish Veterinary Association). Hallituksen kertomus vuodelta 2010 (executive committees annual report 2010). ; 2011.

Research paper 4

Leskinen, S. (2013), Enhancing the daily routines of equine veterinarians using mobile technology: the *m-equine* case. *International Journal of Systems and Service-Oriented Engineering* Vol. 3, No. 4, pp. 1-19.

Enhancing the daily routines of equine veterinarians using mobile technology: the m-equine case

Abstract

The goal of this paper is to introduce and understand the equine veterinarians' needs in their daily routines and develop a web-based support system to promote their work. An equine veterinarian works in both clinic and stable environments, which requires resilience and smart functionality from the support system's interfaces. Especially when horse treatment is in the stable environment, a mobile interface is required. The development of the system must also take into account the needs of the other stakeholders around horses. This paper introduces the requirements to develop a mobile interface for the web-based support system, m-equine. The trial of m-equine will start with an influenza vaccination protocol that is used by veterinarians, horse owners and riders as well as competition organizers. In conclusion the future developments and added values of the system are introduced.

Keywords: mobile technology, mobile solutions, IT solutions, mobile interface, web interface, web-based support system, database, vaccination protocol, equine veterinarian

Introduction

Currently veterinarians work on unnecessary and often repeated routine paperwork, that is time consuming and not part of the core business, i.e. helping patients. At horse clinics information can naturally be inserted and stored in a computer, but this cannot be done as easily when the veterinarian is on a "house call" i.e. visiting a stable. Paper work can get misplaced or illegible because of the non-sanitary environments. In the worst cases, the information has to be input several times into various programs, such as the veterinarian's own practice software, database and billing software. Yet after all this work, if the owner decides to use another veterinarian to treat their horse the next time, all the same work has to be done again and the previous veterinarian's findings can be difficult to acquire. All of this extra work takes time and money, not only for veterinarians, but also for other stakeholders within the equestrian world.

The problems have been noted for some time and even Fédération Équestre International (FEI), the international body governing equestrian sport, is trying to find a logical, long term solution how to store and verify a competing horse's medical information. In Denmark a recent study also discussed the potential of a medical database for horses (Hartig, Houe, & Andersen, 2013). Horse identification is also somewhat lagging behind from e.g. bovine animals. Many countries have a database where all bovine animals are registered and can be traced with the help of their ear tags (Trevarthen, 2007; Trevarthen & Michael, 2008). In the European Union since July 2009 all member states have to identify new equidae (horses amongst other) with a microchip or a branding + dna sample (European Commission, 2008). With a reliable medical history, and proper identification methods, a competition horse's travel between countries could be made easier. One of the first problems to get tackled in a horse's medical information is to get a uniform vaccination database for all competing horses. Vaccination regulations for competing

horses are not only a problematic area for veterinarians but also for horse owners, riders, competition organizers and state officials.

Within the small animal practice industry the competition is growingly larger, and therefore not only the quality of treatment matters but also good customer service when potential clients choose the clinic they are going to use. Within the equine practice, the same trend is likely to occur in the future. Digitalization of healthcare, whether it is for production animals, pets or humans seem to be today's trend. With horses the problem is that a horse can have several uses; production animal, companion animal and athlete. Depending on which category a horse falls under, it will have significantly different medical needs and requirements. One of the problems to implement a medical database for horses' which is connected to an IT and mobile service is the adoption willingness of veterinarians and other stakeholders around the horses. Security and privacy will naturally play an important role in the development of such a system, as in human healthcare (Weitzman, Kaci, & Mandl, 2010). Some of the problems introduced in this paper have been tackled and researched within human healthcare digitalization (Hoffman & Podurski, 2008).

M-equine is a system that will be built to support stakeholder's daily routines around horses. It is to be a web-based support system for veterinarians, with both a mobile and web- interface. In time this will include medical, vaccination, stable and competition information as well as other relevant data of the horse. Depending on the user's "access level" he/she would only see parts of the information, i.e. a veterinarian with permission from the horse's owner can read and write treatment information into the system, whereas an outsider would not be allowed to read this information. The specific focus of this paper will be on the *m-equine* system's solution for equine veterinarians using mobile devices. For this research it was not necessary to make a difference between mobile phones and various tablet solutions, but all are presented as mobile devices. Within the mobile devices the only distinction done is the difference between basic phones and smart phones. Here within the smartphone category all phones with internet availability are included, thus also phones that could be categorized as "feature phones". The mobile technology and IT requirements have been established with the help of veterinarians and other stakeholders within the equestrian sports.

Since the goal is to build a system that supports veterinarian work with the help of web- and mobile interface, the question is; how to build a web-based system, that has the potential to expand and support the daily routines of veterinarians? A large obstacle to overcome is the veterinarians' possible reluctance to use new technical innovations. The system however would give benefits to the equestrian sports, the veterinarian profession in general and for other stakeholders around horses. Furthermore, the *m-equine* system could serve as a model for other applications and research fields.

The paper is structured as follows. The research domain is introduced, followed by a brief state-of-the-art summary of the current mobile solutions within health industry as well as IT solutions in the meat and milk industry. Thereafter the methodology for this research will be discussed. The design and building processes of the mobile service including the systems conceptualization and design follows thereafter. The paper is concluded with a discussion of the design and upcoming testing of the service with stakeholders.

Research domain

Every county in Finland has to provide a veterinarian on call at all times, to care for local animal needs including production animals, horses, cats, dogs and even more exotic pets. The county appoints the county veterinarians in accordance to the Finnish Law of Medical Services for Animals 16 § (Ministry of Agriculture and Forestry, 2009). There are approx. 2,100 licensed veterinarians in Finland, 30 % work as county veterinarians and others mostly work at private practices or clinics (Ammattina eläinlääkäri (veterinary as an occupation).2011).

Equine medicine veterinarians specialize in treating hoofed animals, which in Finland is primarily horses. The veterinarians treat and/or inspect all kind of horses: leisure, harness sport, equestrian sport and horses going to slaughter. According to Suomen Hippos (the Finnish Trotting and Breeding Association), there were approx. 73 000 horses in Finland in 2010 (Soini, 2010). Horses must have a national passport and unique life number when traveling since this is the official identification method at racetracks, equestrian competitions and border control (Skarra, 2009) and (European Commission, 2008). Today, horses are increasingly seen as companion animals and used as sport animals; therefore equine medicine, and particularly treatment methods have been developed further than e.g. production animal medicine. Production animals are seldom treated to the extent as horses, since their worth is more likely to be attached to the production value of e.g. milk and meat or to the breeding value of the animal. A horse's value is connected e.g. to the horse's age, breed, training level, quality as an athlete but also to its value as meat.

According to EU regulations and Finnish food legislation, all animals slaughtered in EU for human consumption need to have proof of identity and a logbook stating what medications and feed the animal has received during its lifetime (Maa- ja metsätalousministeriö, 1.1.2012). Some medications that are used for horses are considered dangerous for humans. If the horse has been treated with these medicines during its lifetime, the meat cannot be used for human food consumption. Since horses can be sold many times during their lifespan, the medical history that, in most cases, is in paper format does not necessarily move along with the horse. Veterinarians today usually have their own patients' records on file and according to Finnish laws are required to do so for a minimum of three years, (Ministry of Agriculture and Forestry, 14.4.2000). In 2009 there were 25 equine medicine veterinarians in Finland (Venäläinen, 2009). The problem tough is to find all the medical information of a horse. Apart from equine veterinarians, county veterinarians (over 600 county veterinarians, during 2009) might also have treated the horse and if the horse had been imported from another country, it is virtually impossible to be 100 % sure that all medical data is intact (Ammattina eläinlääkäri (veterinary as an occupation).2011).

For Equine disciplines, according to FEI rules, a horse has to be vaccinated against horse influenza and in some countries also against other diseases. This information has to be marked on the horse's international passport, if the rider/driver wishes to compete with the horse in international competitions (Article 137) (Fédération Equestre Internationale (FEI), 2013a). In Finland at district and national level equestrian competitions, the horse's vaccination rules differ a bit form the international ones (Suomen Ratsastajainliitto ry (The Equestrian federation of Finland), 2012). Vaccination information is checked from the passport at every competition, and this takes much time. Suomen Hippos has launched a vaccination database, mainly for harness

racing horses, but there is no underlying program to support the database, and therefore the only difference is that instead of checking the vaccination information from the horse's passport it has to be checked from the database.

In 2010, FEI (Fédération Equestre Internationale) started the "clean sport" program against anti-doping, which requires that horses competing internationally must have a medical logbook (currently paper based) that includes the horse's medical history, article 1026, 3§ (Fédération Equestre Internationale (FEI), 2013b). The logbook includes information on what and when the horse has received medication. E.g. some horses have to be mildly tranquilized for shoeing. If trace elements of this tranquilizer remain in the horse's blood, beyond the pharmaceutical company's safe date, then a positive doping test may result.

The *m-equine* system would be developed to support a veterinarian's daily routines. The web-based system with both a web and mobile interface would help solving some of the main problems that have been identified within the research domain. Standardized electronic identification of horses, combined with an underlying medical database would ease the identification of the animal and its medical care. Different stakeholders need different information, and not all of these stakeholders know horses. The information a border control officer needs is vastly different from what e.g. FEI's doping control, veterinary examination or pre-slaughter examination needs. The *m-equine* system would allow different users to access different information, so that the information is relevant and useful for the user in hand.

Related research

In recent literature, the digitalization of human healthcare has been much discussed (Boulos, Wheeler, Tavares, & Jones, 2011; Hansen, Gurney, Morgan, & Barraclough, 2011; Michael & Michael, 2009; Ngai, Poon, Suk, & Ng, 2009). The development of mobile technology has enabled mobile phones to be used not only as personal devices but also as work tools in one's profession. Already in 2010 there were over 7000 documented cases of mobile phones being used in healthcare (Kailas et. al cited in (Boulos et al., 2011)). The introduction of smart phones has opened up much more possibilities for various applications that the previous mobile devices did not have. In many of the papers mentioned above security and privacy issues have been mentioned as an important factor that should be addressed when dealing with mobile healthcare.

In her 2005 published doctoral thesis, Han discusses the mobile technology usage and adaption among Finnish physicians. In this study, once the physician started to use mobile technology (in these cases the content of the service was basically a Nokia communicator that included the whole Pharma Fennica, i.e. the Finnish medicine encyclopaedia) he/she was positively inclined towards the technology's usefulness and usage (Han, 2005). This dissertation gives a picture of the physicians' attitudes towards mobile services, which can, to some extent, be related to veterinarians' attitudes. For both professions the core business is mostly diagnosing and treating a patient. Any mobile or IT service will therefore have the role of a support tool. One of the large differences between physicians and veterinarians, from the viewpoint of their IT and mobile needs, is that they have very different working environments, especially if the veterinarian is working in the horse stable environment. Even in the not-so-sanitary horse stable environment a mobile device could be used by a veterinarian to enter treatment information, which physicians

would not need since they usually work in offices with computers. Therefore, in this paper the research question has been taken a bit further than Han's dissertation.

In a more recent study, by Choi et al (2011), the research focused on how doctors use smart phones and the "Dr Smart" mobile application. This study was conducted in the end of 2010 and the results showed that younger residents in their 20s and 30s were more likely to use the application. In this research one reason why some doctors did not use the app was because they did not know how to download the app onto their smart phone (Choi et al., 2011). This same kind of problem was also already discovered in Han's dissertation (2005). A notable amount of physicians never even tried to use the mobile phone and the medicine encyclopaedia within it, since they did not want to try something new, which could possibly be difficult to use and take time to learn to use (Han, 2005). Many of the same problems that were discussed in the "Dr Smart" research by Choi et al (2011) and Han's (2005) study have to be solved, so that a working mobile service for veterinarians will reach a high penetration rate within the field. Users should be trained to use the system and with their experiments, the system can be developed in such a way that it is easy to use and take into use.

One of the problems that need to be addressed is the ideal way to identify the animal the veterinarian is treating. For livestock, the industry has already stipulated the need for clear identification, thus e.g. ear tags on bovines and swine. Often the identification today is RFID-based, as in the studies by (Trevarthen, 2007; Trevarthen & Michael, 2008; Voulodimos, Patrikakis, Sideridis, Ntafis, & Xylouri, 2010; Wallace et al., 2008). In these studies, apart from the aforementioned article by Wallace et al (2008), the studies have been about the need for bovine identification in business management and the importance of traceability. The main issue in these studies is that via the id-tag of the bovine animal, information about the animal can be traced. Whether with RFID-tag technology a cow's milk production or a heifer's movements across the country from various owners can be monitored, the information should be traceable and used from the farm to the slaughterhouse to your table. Since, a horse might end up as a meal for people, the same level of monitoring is required.

Both FEI and harness racing sports have strict rules about medication usage and vaccination requirements. Accurate identification of the animal is one of the key features that are needed to gain trustworthy information. Inserting a microchip identifies horses, but often the standards of various microchip companies vary, so the veterinarian needs more than one reader to be able to identify the horses. In the Australian bovine monitoring systems, the key concept is that the animal can be tracked by their ear tag (Trevarthen, 2007; Trevarthen & Michael, 2008). In this way the animal's identification can be read from even a larger distance, which is of value when working with animals that might be shy towards people. Today a horse's microchip is inserted into the neck of the horse, which can be difficult for the veterinarian to read, because some horses get very nervous when a strange person handles it or they might just be skittish around their head. The microchip might also be unreadable, since it can have a different frequency standard than the reader. A horse's microchip cannot be hanging outside their body, as an ear tag on bovine animals, since it would impair the animal. The question is could a microchip or other identification system be available, which would have one standard, could be read by a mobile phone and be readable from a short distance? Even 1-2 meter reading range from the animal could make a huge difference. The microchips used for horses today only contain the horse's life number. There is a need to develop horse identification in the direction discussed in other studies

such as (Trevarthen, 2007; Trevarthen & Michael, 2008; Voulodimos et al., 2010). In Wallace et al., (2008), the study involved temperature measurements done in horses with RFID tags. This study shows other issues that could be raised with id-tags and veterinary monitoring. One problem that has raised much debate within all the horse sports is the opposition of inserted microchips: Can a microchip implantation cause foreign body reactions or tumour formations? These aspects are not discussed here but the ideas on how a microchip can be used in veterinarian work are presented later. The digitalization of a horse's healthcare information, as discussed in Wallace et al (2008), proved therefore to be a good basis for the research conducted here.

Since various mobile applications have become popular, and include all types of apps imaginable, there are naturally also apps for physicians. According to studies amongst physicians the most popular m-health apps for iOS devices were medical information references, educational tools and tracking tools (Liu, Zhu, Holroyd, & Seng, 2011). Their research was done in the beginning of January 2011, and can be used as a general guide to what types of m-health applications were then in use. Later in this text I will briefly explore applications that are made for veterinarians, and compare if they relate to the apps physicians prefer and how they compare to *m-equine's* web-based support system.

Liu et.al (2011) also found in their m-health research that the apps that took advantage of the smart phones unique features to bring real convenience to the users were amongst the most popular iOS device applications (Liu et al., 2011). The highest ranked m-health apps were therefore various tracking tools, such as health, calorie intake etc. This is largely due to the fact that the app is always available on the Smart phone for the user. The second highest ranked tools were educational and reference tools for medical students and practitioners (Liu et al., 2011). When comparing these results with veterinarians' needs, tracking would seem to be more of use for the owner of the animal, but reference tools could be of use for a veterinarian. In the apps market there are already a few reference and educational tools for veterinarians and veterinary students such as "Vet Anaesthesia Guide" by Guilherme Caldas, "Veterinary Terms +Plus" by Wan Fong Lam and "VetMed EQ" by FES Solutions (Apple Inc, 2013). The tracking that a veterinarian needs to do of his/her patients can be done at the veterinary office with a computer, and does not necessarily require "anytime & anywhere" access that a mobile device can offer.

Methodology

The methodology used in this research is a combination of both action research and design science research. The goal is to introduce and understand the veterinarians' needs and develop a system that would meet these needs. This will require several construction and evaluation phases, to achieve an optimal solution (Cole, Purao, Rossi, & Sein, 2005). Amongst others one definition of this type of research has been described in the article "Action Design research" by Sein*, et al.* (2011). In their paper they identify four stages that properly identify and sequence Action Design Research (ADR). Stage 1: Problem Formulation, Stage 2: Building, Intervention, and Evaluation, Stage 3: Reflection and Learning and Stage 4: Formalization of Learning (Sein, Henfridsson, Purao, Rossi, & Lindgren, 2011).

The Problem formulation can be divided into two separate approaches, namely "the Practice-Inspired Research principle" or "the Theory-Ingrained Artefact" (Sein et al., 2011). In this research the former has been used. In stage 2, the Building, Intervention, and Evaluation (BIE) are divided into two end points; IT-Dominant BIE and Organization-Dominant BIE (Sein et al., 2011). The IT-dominant spectrum suits ADR, where practitioner and some specialists create the innovative technology. The organization-dominant BIE is ADR that is done by using, as the primary source, the organization to generate design.(Sein et al., 2011)

In Figure 1 the *m-equine* BIE schema is introduced. In this research the ADR group mainly consists of one researcher. The S1 test group consists of: one county veterinarian, three different equine medicine clinics, two FEI veterinarians and three FEI competition officials during the International dressage (CDI) and Jumping (CSI) event in Tallinn, Estonia. The individuals taking part in the S1 test group were interviewed and their daily activities were monitored and recorded. With the feedback obtained from these discussions, other stakeholders around horses could be approached. The S2 test group consists of riders and owners of competition horses. They took part in an exploratory survey summer 2009, from which the results from this survey were presented in two separate papers (Leskinen, 2010; Leskinen, 2011). With the feedback obtained from both S1 and S2 a proof of concept could be built and introduced to some extent to the S3 test group. The S3 group consisted of Finnish equestrian and county veterinarians partaking in a web-based survey during fall 2010. The following iteration now is to build and launch the *m-equine* system's alpha version in accordance to the previous iterations' collected information. Some of the participants in S3 test group voiced interest to try out the alpha version and are therefore separated to their own group; S3 group 2. After the alpha version has been launched, a new round of interviews and monitoring will be conducted, to evaluate the alpha version and record the veterinarians' opinions and suggestions. Changes will be made to the system accordingly and this will naturally lead to the next step i.e. a beta version. The final iteration ends with the launching of the commercial version. These iterations will be discussed more with the future research and development.

The three first iterations (I, II and III) are of nature IT-dominant (see Figure 1), whereas the last iteration (IV) has more trademarks from the Organization-Dominant spectrum. The Reflection and Learning stage is part of each iteration loop to learn and identify problems and processes, but also to reflect the problem solving and theories used. Iterations are done until the result equals the set goals of the project. Once this has been achieved, the ADR method is transferred to the fourth stage; Formalization of Learning. (Sein et al., 2011)

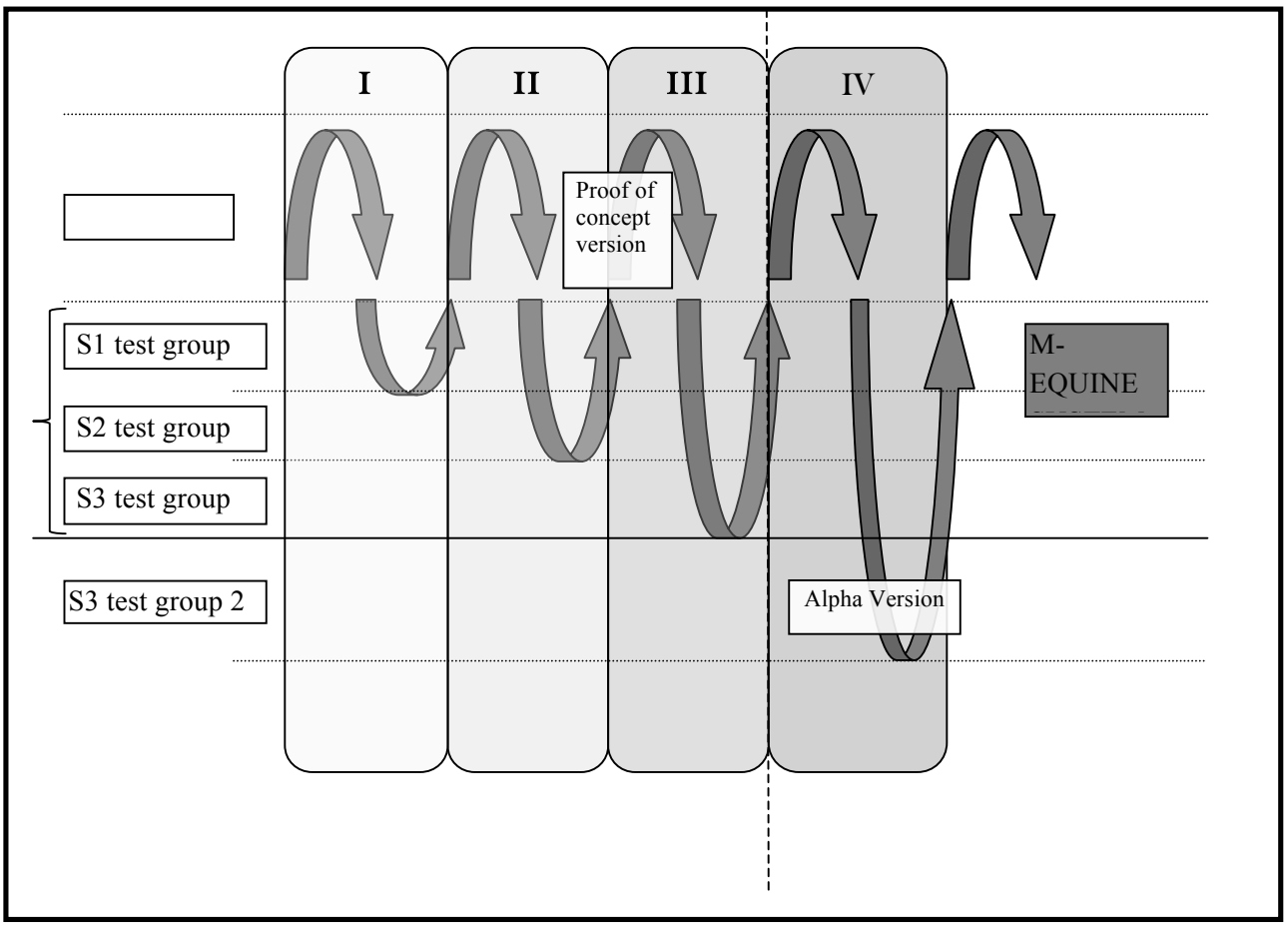


Figure 1 *m-equine* BIE schema

At the moment the fourth stage, Formalization of Learning, is presented for the alpha version in this paper. Several iterations will concur, until the *m-equine* mobile system for veterinarians is finalized, first then stage four can be fully explored.

Design and Building Process

The process on how the design for the system has been done follows the ADR requirements. There are various patient management systems used at veterinary practices and also some apps that have been designed for veterinarians. In Finland equine veterinarian's mostly use ProVet patient management software which has recently started to provide even a web and mobile support to its customers (www.provet.fi).

Background information

A brief study of the current app market situation for veterinarians led me to choose to make this system web-based, since an app alone could never cover the broad area of usage and information that is required for a functioning support system for both veterinarians and other stakeholders

around horses. Today's veterinary and pet related apps sold in Apple's app store and the equivalent store for Android are very similar to what Liu et.al (2011) discovered in their research with physicians. Many vet related applications – as many physician related applications (Liu et al., 2011) - were educational in nature or provided drug information or amount calculations for drug administration. With a brief study there could not be found any direct vet-horse-vaccination related apps. Liu et.al (2011) study did however rise the potentials what even a simple app could have in supporting a physician's or students work. However, simple apps cannot meet the requirements needed for such a large and complex system as the *m-equine* web-based support system will be in the future. The mobile devices have though opened up new possibilities to support different type of work, but it is evident that no mobile support system will be of use for veterinarians unless they are included into the development process. Furthermore, since other stakeholders' needs also have to be satisfied to get the *m-equine* system to work it is paramount that the developer understands these needs as well. Therefore for this system to work, the developer has to have IT and mobile system knowledge as well as knowledge in the equine sports.

Veterinarians' needs

The veterinarians' needs are the primary basis for the IVth iteration cycle presented in Figure 1. The previous iterations state the main requirements for the system. To gather information on a veterinarian's daily routines, use of mobile devices and attitude towards new technological innovations, preliminary interviews were conducted in Finland with a few veterinarians (see figure 1, group S1). Research on veterinarians' usage of mobile services to support their work had not been previously done in Finland. After the personal interviews and observations with group S1 and the survey done with the test group S2, three Master's students (Jorge Lucic, Valentina Muñoz and Luis Rubén Rodríguez) and I conducted an Internet survey with Finnish veterinarians (figure 1, group S3). These survey results are a basis for the upcoming alpha version of *m-equine*. Some of the basic findings that will mould the alpha version are the veterinarian's need to eliminate unnecessary paperwork, improve their time management, and overall positive attitude towards a common database. Although many veterinarians voiced their reluctance towards new technology, many would be willing to try it out, if it were beneficial for their work performances.

One aspect that would be paramount for a successful web-based support system is that it works even outside the clinic environment. Many equine veterinarians as well as county veterinarians make house calls to treat horses. At a stable the environment is not as sanitary as in a clinic, and much work might have to be done outdoors, regardless of the weather. Therefore the veterinarian needs a working system for book keeping during house calls. Currently the data acquired during a house call often has to be inserted into the veterinary clinic's patient software, billing software etc.

The veterinarians found that vaccination data is something they could share and that it could be shared in a common database (Leskinen, 2012). In a Danish survey conducted 2012 veterinarians and other stakeholders around horses were keen on having a common database, to support equine veterinary care (Hartig et al., 2013). With this information and the information attained from previous studies it is apparent that the majority of all the major stakeholders accept and even

desire a common database and services for up keeping and controlling horses' influenza vaccination. This also complies with the view of FEI and its attempt to facilitate competition horses' movements across borders (FEI, 2013).

Conceptualization

From the survey, literature and existing cases presented I started to work on how the mobile platform would work. The IS architecture is presented in Figure 2. Although the design and development of the mobile system is in the foreground, a working IT structure and database are equally important. Many Finnish veterinarians still use basic phones but especially the younger veterinarians are accustomed to use smart phones and other mobile devices. The Central Statistical Office of Finland stated that in spring 2011 42 % of Finnish consumers in the age groups 16–74 were using a smartphone (Statistics Finland, 7.11.2012). Since the market share for smart phones have increased, it is safe to assume that also veterinarians would upgrade their mobile devices in an acceptable space of time. Therefore, at first the system would be built to work on smart phones or similar mobile devices, but if necessary have some of the functions available for basic phones so that veterinarians would be more inclined to try the system.

General design

The *m-equine* architecture is visualized in *m-equine* system architecture Figure 2. The database and access to it play a pivotal role for a successful system. Since stables today are not necessarily within a good 3G or 4G network, there would be need for a backup system if internet accessibility is not available. All data input done in *m-equine*, regardless of the interface used, should be simultaneously updated into the underlying database.

Figure 2 *m-equine* system architecture

The *m-equine* system has to be easily accessible for veterinarians and other stakeholders wherever they are. Therefore the system must have an interface for both mobile devices and computers. In the following table the key needs that must be met in the alpha version are listed. The requirements, security and interface options for *m-equine* have been stated for the main stakeholders, i.e. veterinarian, owner, rider/driver and competition organizer in Figure 3.

stakeholder	requirement	access	security	interface	
				mobile	computer
owner	list of own horses. check horse's vaccination status. reminder to vaccinate horse on time.	access to own horses' information	read allow access to horse's information	possible	yes
veterinarian	find specific horse from database with ID number or name. check horse's vaccination status. insert vaccination data	owners give access to horse's information.	read and write.	yes	yes
rider/driver	list of own horses. check horse's vaccination status. reminder to vaccinate horse on time.	owner gives access to horse's information.	read owner can allow rider to give further access to e.g. Veterinarian.	possible	yes
competition organizer	check that a list of horses are vaccinated according to regulations.	access to all horses in database, via search engine	read	no	yes

Figure 3 Design requirements for various stakeholders

Veterinary specific design

The alpha version of the *m-equine* mobile system for veterinarians will be tested in Finland and will include the possibility to enter vaccination data only for horses that have a competition license in the Equestrian Federation of Finland (SRL). Since only the veterinarians would be allowed to change vaccination information, it is of pivotal importance that the system is such that the veterinarians want to use it. Although many respondents of the veterinary survey were rather positive to use mobile services, they would not use a service that is of any inconvenience. Many of the interviewed veterinarians self-proclaimed that they are not computer or mobile device savvy. This type of modest demeanour is typical for people who are not quite sure about their computer or mobile technology skills (V. Venkatesh & Davis, 1996; V. Venkatesh, 2000). Venkatesh and Davis (1996) also stated that it would be important to enhance and support the user's knowledge in computers, so that he/she would better accept new innovations and get a positive outlook on computers. To accept and use new mobile innovations, the user should be able to access and use it with ease (Kaasinen, 2005). With these statements in mind both the mobile and computer interface of the system would have to be easy and convenient to use, and have suitable support for users. The veterinarians would have to be guided how to use the

system, so that they would get more self-assured around computers and mobile devices, and find the system beneficial.

With these conditions in mind, I started to work out the fundamental requirements that the *m-equine*'s mobile system would have for a veterinarian to input vaccination data. In Figure 4 the *m-equine* system's conditions and the fundamental requirements to meet these conditions have been listed. This information has been gathered from the author's previous knowledge and interviews with veterinarians. The figure represents requirements that the alpha version (see Figure 1) should meet. The figure is divided into three sections; (i) Work Description, (ii) Requirements and (iii) Solutions (Figure 4). The work description column has the different steps that a veterinarian would have to go through to be able to use the system's mobile interface. To be able to go through the various steps in downloading and using the *m-equine* mobile interface, each step has various requirements that have been stated in the second column

Work description	Requirements	Solutions
Download m-equine on smart phone or mobile tablet device	m-equine mobile interface should be easy to download onto mobile device (one-click-principle)	Access and downloading of software for both mobile and web interface automatically when user subscribes to the system
	Updates should also be easy to download and take into use (one-click-principle)	Automatic search for software updates
	Devices with internet connection availability	Smart phones and at least Wi-Fi enabled computers used for interface.
Login into m-equine system	Security, so that nobody else can use the system if mobile device is lost	Username and passwords are individual for every user.
	The m-equine icon should be easy to find on the mobile device's menu and opens directly to the login page.	Design of icon has to be memorable for users.
	Preferably user recognition available, to ease usage	Smart programming needed
Overall usability	Logical and simple menu	Find optimal menu order during alpha test
	Lucid style of text	Easily accessible option for increasing text size.
		Optimize colour choices to ensure good usability
	Understandable and easily accessible choice options	Large enough choice "buttons"
	Anywhere and anytime usability	The system should be able to contact the database. If there is no internet availability, store new information until connection to database is possible once again.
		Possibility to beforehand download some horses' information if it is known that internet connection will be poor at stable.
Security	No risks of doing errors a/o errors easily repairable	Help menu a/o help pop-up when user has done a mistake.
	No risk of misinterpretation.	Security questions to make sure that the user is aware of his/her choice
	Digital fingerprint	All changes made into horse's information must include information on who did it.
Entering horse's data	Fast confirmation that the horse or the ID number is in the database	If several options for a name, "ask" user which one is the correct one.
Finding a horse in the database		Predictive text input
Entering vaccination info	Fast & easy input of vaccination batch number	Large number "buttons" for input. Copy/paste option, if several vaccinations are from the same batch
	Date for vaccination	Automatically propose current date.
Verification	Check that horse's vaccinations are according to the International or national regulations.	Access to database, and previous vaccination information.
		System has "knowledge" of the current regulations

Figure 4 Fundamental requirements

The work description stipulates the main actions the veterinarian would come across and/or use in the *m-equine* mobile version. Requirements state what is needed that an action would be

successful. The solutions have to meet the work description and the requirements stated to ensure a successful action.

Veterinarians, who took part in the survey by Leskinen (2012), mostly agreed that too much time is used on paperwork and that they should have a better system in book keeping when on house calls. Veterinarians would therefore need a web-based support system that works on mobile devices and supports their bookkeeping during house calls. The information that is entered on the mobile device, should automatically also be uploaded into the veterinarian's patient management system or similar, so that he/she does not end up entering the same information all over again at the office after a long day driving around the countryside stables. Although at this point it is suggested that the *m-equine* web-based support system would only have vaccination functionality, this would not be directly beneficial for veterinarians, but more beneficial for the horse's owners, riders and competition organizers. As a possible improved stable routine, the veterinarian could insert all necessary treatment and medical data on a mobile device. This would be possible since the treatments that a veterinarian can perform in a stable environment are limited. If the system could also include an automated travel expense monitor and billing opportunity, it would significantly reduce the time a veterinarian has to use on paperwork after a "house-call".

Input model for veterinarians using mobile devices

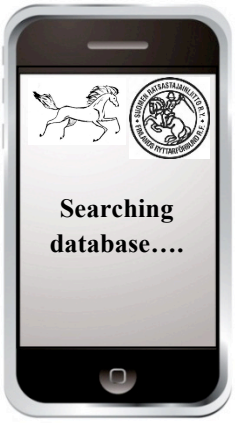
For better understanding how the *m-equine* vaccination support system on mobile devices would work, the general idea on what it could look like, and what functionalities it would have is presented below. The still-pictures of *m-equine*'s mobile system below are done, assuming that the underlying database would be SRL's database of horses with national competition licenses, since this would ultimately be one of the major target groups for the *m-equine* system.

Veterinarian inputs vaccination information with a mobile device: ADR group

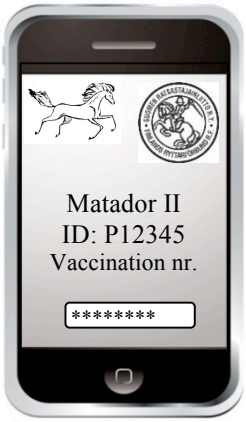
1. Veterinarian chooses the SRL vaccination

2. Veterinarian inputs his/her username & password to access the service.

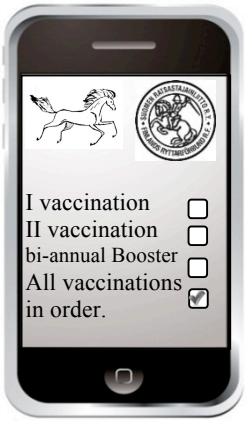
3. Input either international ID number or horse's official name.



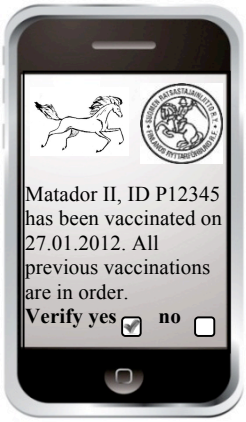
4. System checks from the online database for the right horse.



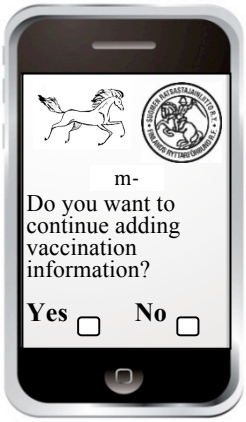
5. Veterinarian writes in vaccination's batch number or scans the bar- or QR-code.



6. Veterinarian marks the right type of vaccination.



7. Veterinarian verifies that the information is correct.



8. Vaccination info is stored in database and vet can continue to add vaccinations or quit working with the vaccination service.

The process pictured above has eight steps, which displays how a veterinarian would use the *m-equine* system with his/her mobile device to record an equine influenza vaccination for a horse. Here is a brief description what the various steps are for, and how they work.

Steps 1-2 and 8 are self-explanatory and will not be discussed further. Competing horses have to have an identifying passport, and competition license from their national federation, and/or an international competition passport from FEI. Every passport has a unique identifying code for the

horse, and it also has a unique competition name. In step 3 and 4 the veterinarian is given an option to search for the horse from the underlying database by either its name or its ID code. In step 5 the system has found the horse and shows both the horse's name and id number. For horses competing in national or international level (in Finland and other European countries) they must have their vaccinations in order, according to FEI or national regulations. The veterinarian can confirm that he is vaccinating and adding the new vaccination record to the right horse in step 6. Today the equine influenza vaccination vials have a batch number that has to be inserted into the passport for monitoring reasons. Here the same batch number has to be inserted into the *m-equine* system, but hopefully in the future the batch number identifying the vaccination vial can be scanned directly into the system with the help of either bar-, QR-code, RFID tag or similar. In the next step the veterinarian choses the right vaccination option, depending on the horse's previous vaccination record. Step 7 is just a precaution to make sure that the veterinarian is inserting the right information to the right horse.

In this example the horse Matador II has been competing for some years already, and is now inserted into the system for the first time. So that the veterinarian, or other officials, does not have to copy all the old vaccination records into the system, he can simply check that the vaccinations so far have been done according to regulations. Now when he enters the new vaccination, that is a continuum to old vaccination records, he simultaneously verifies that all vaccination records so far, including the one he has inserted is according to regulations. This option would have to be available for the few first years that the *m-equine* system is in use. New horses entering the system, that start their vaccination records directly in the *m-equine* system, never been in the old paper based system would not need this option. Their vaccinations would be inserted as I vaccination, then 21-92 days later, II vaccination, and thereafter bi-annual booster vaccinations. Since the system has time awareness, it can "count" that the vaccinations are done within regulation parameters.

The benefits of such a system would be that a veterinarian could save time using this system, in comparison to writing the information into the horse's passport. Since the information would be saved into the database, the vet would not have to enter the same information again into another IS system, as is the situation with the current vaccination system Suomen Hippos is offering. Furthermore this system would know the vaccination rules, for international and national competitions, and thus automatically state if all vaccinations are according to regulations for the horse. The veterinaries do not have to worry nor even know what the current regulations are, since the system has the parameters for them, except in the beginning, if the veterinarians verify the old vaccinations as well, as has been done in this example.

Discussion & Conclusion

I have studied and analysed how to develop a web-based support system for veterinarians, which would have both a mobile and web interface. As the action design methodology suggests the next step is to build the working prototype of *m-equine*, and test it with veterinarians. From user experiences I then further develop the system, so that it can be taken into commercial use. At the same time mobile and IS systems have to be developed to support riders, owners and competition organizers, so that the value of using *m-equine* is maximized. It is also important to develop, in

an early stage, more functionality for veterinarians, so that they have visible benefits from using *m-equine*.

As with various m-heath applications previously studied, also here it is important to recognize the stakeholders and the users, and distinguish their different needs. Users have to be properly educated so that they understand how the mobile solution supports their work and what benefits they can gain with it (Boulos et al., 2011; Choi et al., 2011; Liu et al., 2011). Some of the studies that have been done with physicians and m-health applications can be used as a basis for a mobile veterinary system. This research however provides a deeper insight on veterinary work and veterinarians' needs, in situations that are not comparable with physicians. One of the differences is that physicians mostly work in an indoor environment, where they have access to computers and internet all the time. A veterinarian who mostly works on the road and visits stables does not have this same luxury, and therefore has to rely on devices and support that he/she can bring to a horse stable environment. As could be seen from the results of various surveys, the veterinarian's recognize that they could improve the way they use time, and they are interested to try a system that would help them in their everyday work. This is why it is my belief that veterinarians can greatly benefit from the *m-equine's* mobile and web based support system, since it could assist their everyday work around horses. There is a need for a web based system, built on top of a comprehensive database of horses, that would support veterinarian work, but it has to be logical and easy to use and proper education has to be given to ensure that the veterinarian's will start to use the system.

To get a better picture of what the *m-equine* system can offer for veterinarians and its potential future developments I have chosen to do a SWOT analysis of the system. The SWOT analysis is done in accordance to the specifications introduced in (Kotler & Armstrong, 2009). With a SWOT analysis of *m-equine* the following properties can be identified.

The *strengths* of *m-equine* are that it can be used wherever and whenever needed. The system reduces paperwork for veterinarians and gives the horse owner a central location where to find all his/her horses' vaccination information. With the system the veterinarian can also improve customer service towards the horse owner. Competition organizers will need less workforce since vaccination control at the secretary's office is all but eliminated, thus also gaining significant time savings. Later down the road, sport horses can be better distinguished from non-sport horses that might be used in the food industry, which in turn can expand the pharmaceutical market available for sport-horses.

One of the main *weaknesses* is that since a common medical database does not exist it will take time until the build-up of information will yield positive results. It is also imperative that the stakeholders' needs are met, which can be complicated to achieve, since something is always lost in the development chain from the stakeholder to the programmer.

The system naturally opens up *opportunities* to be developed into a much broader information database. The vaccination information for horses, leads naturally to a platform for other support functions including the horse's whole medical history. It can be multi-lingual and usable throughout the world. More operations can be implemented into the system to support other stakeholders around horses such as blacksmiths, stables, breeders and betting community for both trotters and racehorses. Although *m-equine* is developed primarily for stakeholders around

horses a similar system could be developed for e.g. cats and dogs that travel to other countries with their owners or for shows.

The *threats* are mainly ignorance and unwillingness to change among people who are to use the system. If the veterinarians cannot be educated properly to use the system, and have access to a well-organized support system when help is needed, they might stop using the system because of the problems they have encountered. It will also take time for the system to yield a positive outcome, as this will require a vast database. Since sport-horses are the main target initially, their vaccination information can be updated into the database relatively fast. The *m-equine* system would be used within FEI and/or national equestrian federations, where competent people can collect vaccination information into the database, during e.g. competitions. Thereafter any new information is to be input by a veterinarian. It will be natural that in the beginning people might be suspicious to the security of the system. This is why it is best to start the system's development from vaccination information since it does not have to be secure in the same sense as e.g. other medical information might need. However since many people (including horse owners) already use the Internet for many operations that require heavy security (e.g. banking) the supposed threat for security should be minimal.

Naturally anybody can develop a nice app that could have some of the basic features as the *m-equine* system, but a simple app does not cover the range of needs required for a system with so many stakeholders. An app cannot be expanded to meet the future needs of the various stakeholders, as the *m-equine* system will. Furthermore a similar system built by developers knowledgeable only in web-based support systems but lack the knowledge of the horse industry, will result in a system that stakeholders do not want to use, since it will not support their daily routines.

Figure 5 SWOT analysis

After the alpha version has been tested, and feedback has been attained from the users, a more in depth SWOT analysis can be made. At the same time, each iteration stage during the development of the system offers opportunities to improve it in such a way that weaknesses and threats are minimized.

Implications for practice

The obvious benefit from using a mobile veterinary system would be that notes and information would not be lost, and the veterinarian would not have to do double paper work after visiting a stable. From the veterinary mobile solution it would be easy to build a chart from which it can be studied when certain vaccinations are most demanded and keep an inventory in accordance to this information. Vaccinations have expiration dates, and with some previous knowledge into "hi-season" the veterinarian can prevent unnecessary loss of merchandise.

By having detailed information easily at hand for when a horse has been vaccinated the veterinarian can send a reminder to the horse owner of the need for a new appointment, before the next vaccination is due. This service could even be automatic so that it will not interfere with the veterinarian's busy schedule. It is a win-win-win situation where the customer gets his/her

horse vaccinated before the previous vaccination gets too old. With the customer reminder service the veterinarian can attract previous customers to once again use his/her services, by giving some nice bundle of services offer. The horse naturally can keep on living his happy life without getting the deceases the vaccination prevents.

Limitations

At the moment the upcoming alpha version of the mobile system for veterinarians is still rather limited, since it only deals with horse vaccinations. In order to get the alpha version to work successfully the other main stakeholders need to be able to access and read the vaccination information. Especially the competition organizers need the system to work smoothly and only deliver them information on the horses that do not have the vaccination information in order. One of the main benefits in this system would be lost if the competition organizers would have to go through a list of horses and their vaccination data at every competition. Therefor in *m-equine* the mobile and IT solutions have to work side by side, and have smart solutions that are user friendly.

Future research

As already has been mentioned, the *m-equine* system should be developed further from the vaccination service to include other services that are beneficial for veterinarians. The commercial system will already support the three main stakeholders, and the value of the system increases with the amount of data attained into the underlying database. Although the commercial product is the initial goal for the system and it is the final iteration in the BIE-schema introduced earlier, the system will need to be developed further after its initial launch. A continuous development ensures that the system meets future needs, and enhances all the stakeholders' lives. The system should also be developed to support other stakeholders around horses, such as the owners, riders, competition organizers, stables and FEI's clean sport program. The mobile system requires a supporting web system since for some stakeholders this would be the more natural platform to use. In the future there would be need for mobile phones or pads to be able to "read" a horse's ID tag, so that one unanimous protocol and standard are used everywhere. This type of system would considerably hasten the processes that a veterinarian has to do, help border control officials and limit frauds.

Equine disciplines are just one part of all the horse sports. Already in Scandinavia harness racing federations require influenza vaccinations for racing horses, in a much the similar way as FEI does for equine disciplines. Anti-doping and vaccination protocols, not to mention the efforts to stop various animal diseases from spreading are not only limited to horses, also cats, dogs, and other pets as well as production animals travel between countries and might carry diseases, without their owners knowledge. Vaccination protocols are also in use for e.g. dog and cat shows, and for now is mostly done the same way as for horses, namely by checking the animal's passport. Maybe one day the *m-equine* system can be a forerunner for all animal health information and why not even a basis for some human m- and e-health systems.

References

Ammattina eläinlääkäri (veterinary as an occupation). (2011). Retrieved 14/06. 2011, from http://www.sell.fi/ammattina_elainlaakari/

Apple Inc. (2013). App store > medical. Retrieved from https://itunes.apple.com/fi/genre/ios-medical/id6020?mt=8

Boulos, M., Wheeler, S., Tavares, C., & Jones, R. (2011). How smartphones are changing the face of mobile and participatory healthcare: And overview, with example from eCAALYX. *BioMedical Engineering OnLine, 10*(24) Retrieved 6.9.2011 from http://www.biomedical-enginering-online.com/content/10/24

Choi, J. S., Yi, B., Park, J. H., Choi, K., Jung, J., Park, S. W., & Rhee, P. (2011). The uses of the smartphone for doctors: An empirical study from Samsung medical Centre. *Healthcare Informatics Research, 17*(2), 131-138.

Cole, R., Purao, S., Rossi, M., & Sein, M. k. (2005). Being proactive: Where action research meets design research. In D.E. Avison & D.F. Galletta. (Ed.), *International Conference on Information Systems (ICIS):* (pp. 325-336). Las Vegas, NV, USA

European Commission. Commission regulation (EC) no 504/2008 of 6 June 2008 implementing council directives 90/426/EEC and 90/427/EEC as regards methods for the identification of equidae, (2008).

Fédération Equestre Internationale (FEI). General regulations 23rd edition, 1 January 2009, updates effective 1 January 2013, (2013a). Retrieved from http://www.fei.org/sites/default/files/General%20Regulations%2023rd%20Edition%201%20January%202009%20updates%20effective%201%20January%202013.pdf

Fédération Equestre Internationale (FEI). Veterinary regulations 13th ed. (2013b). Retrieved from http://www.fei.org/sites/default/files/2013%20Veterinary%20Regulations%2C%20edition%2013%2C%20effective%201%20January%202013.pdf

FEI. (2013). International movement and transportation. Retrieved from http://www.fei.org/veterinary/international-movement-and-transport

Han, S. (2005). *Understanding user adoption of mobile technology: Focusing on physicians in Finland*. Turku, Finland: Turku Centre for Computer Science (TUCS).

Hansen, D., P., Gurney, P., Morgan, G., & Barraclough, B. (2011). The Australian e-health research centre: Enabling the health care information and communication technology revolution. *The Medical Journal of Australia, 194*(4), S5-S7.

Hartig, W., Houe, H., & Andersen, P. H. (2013). Monitoring of equine health in Denmark: A survey of the attitudes and concerns of potential database participants. *Preventive Veterinary Medicine, 109*(1–2), 83-91.

Hoffman, S., & Podurski, A. (2008). Finding A cure: The case for regulation and oversight of electronic health record systems. *Harvard Journal of Law & Technology, 22*(1), 2-64.

Kaasinen, E. (2005). *User acceptance of mobile services – value, ease of use, trust and ease of adoption*. Helsinki, Finland: VTT Technical Research Centre of Finland.

Kotler, P. J., & Armstrong, G. (2009). *Principles of marketing* (13th ed.). USA: Pearson Education.

Leskinen, S. (2010). Equine vaccination, a paper mess waiting to get solved. could ICT be the answer? In Anonymous (Ed.), *23Rd Bled eConference eTrust: Implications for the Individual, Enterprises and Society:* (pp. 127-143). Bled, Slovenia

Leskinen, S. (2011). Can information systems expand the limits of equine medication? In *The 6th Mediterranean Conference on Information Systems (MCIS2011):* Cyprus

Leskinen, S. (2012). Veterinarian work, enhanced by mobile technology--an empirical study. In, *System Science (HICSS), 2012 45th Hawaii International Conference on:* (pp. 1403-1412).

Liu, C., Zhu, Q., Holroyd, K. A., & Seng, E. K. (2011). Status and trends of mobile-health applications for iOS devices: A developer's perspective. *Journal of Systems and Software, 84*(11), 2022-2033.

Maa- ja metsätalousministeriö. Maa- ja metsätalousministeriön asetus lihantarkastuksesta (ministry of agriculture and forestry's statue on inspection of meat), (1.1.2012).

Michael, M. G., & Michael, K. (2009). Uberveillance: Microchipping people and the assault on privacy. *Quadrant Online, LIII*(3), 85-89. Retrieved 2.3.2010

Ministry of Agriculture and Forestry. Act and access to and pursuit of the profession of veterinary surgeon, 29/2000 (14.4.2000). Retrieved from http://www.finlex.fi/en/laki/kaannokset/2000/en20000029.pdf

Ministry of Agriculture and Forestry. Eläinlääkintähuoltolaki (law of medical service for animals), 2009/765 (2009). Retrieved from http://www.finlex.fi/fi/laki/ajantasa/2009/20090765?search[type]=pika&search[pika]=el%C3%A4inl%C3%A4%C3%A4kint%C3%A4huolto

Ngai, E. W. T., Poon, J. K. L., Suk, F. F. C., & Ng, C. C. (2009). Design of an RFID-based healthcare management system using an information system design theory. *Information Systems Frontiers, 11*(4), 405-417.

Sein, M. k., Henfridsson, O., Purao, S., Rossi, M., & Lindgren, R. (2011). Action design research. *MIS Quarterly, 35*(1), 37-56.

Skarra, P. (2009), Rekistöröinti takaa hevosten oikeusturvan: Anna hevosellesi identiteetti (registering your horse, guarantees your horse's legal protection: Give your horse an identity.). *HIPPOS Suomen Ratsastajainliiton Jäsenlehti (HIPPOS the Equestrian Federation of Finland's Official Membership Magazine), 43*, SRL info 7-8.

Soini, P. (2010). *Toimintasuunitelma 2010 (strategy 2010)*. Helsinki: Suomen Hippos (The Finnish Trotting and Breeding Association).

SRL. Kilpailusäännöt I (competition rules I), (2012). Retrieved from http://www.ratsastus.fi/instancedata/prime_product_julkaisu/ratsastajainliitto/embeds/ratsastajainliittowwwstructure/40645_KS1_2012_2013liitteilla_nettiin.pdf

Statistics Finland. (7.11.2012). Tieto- ja viestintätekniikan käyttö -tutkimus 2012, tilastokeskus (use of information and communications technology survey 2012, central statistical office of Finland). Retrieved from http://www.stat.fi/til/sutivi/2012/sutivi_2012_2012-11-07_kat_003_fi.html

Trevarthen, A. (2007). The national livestock identification system: The importance of traceability in E-business. *Journal of Theoretical and Applied Electronic Commerce Research, 2*(1), 49-62.

Trevarthen, A., & Michael, K. (2008). The RFID-enabled dairy farm: Towards total farm management. In Anonymous (Ed.), *7th International Conference on Mobile Business:* (pp. 241-250). Barcelona, Spain

Venäläinen, A. (2009). *Eläinlääkärit 2009 (veterinarians 2009)*. (No. 6). Helsinki, Finland: Evira (Elintarviketurvallisuusvirasto) (Finnish Food Safety Authority);.

Venkatesh, V., & Davis, F. D. (1996). A model of the antecedents of perceived ease of use : Development and test. *Decision Sciences, 27*(3), 451-481.

Venkatesh, V. (2000). Determinants of perceived ease of use: Integrating control, intrinsic motivation and emotion into the technology acceptance model. *Information Systems Research, 11*(4), 342-365.

Voulodimos, A. S., Patrikakis, C. Z., Sideridis, A. B., Ntafis, V. A., & Xylouri, E. M. (2010). A complete farm management system based on animal identification using RFID technology. *Computers and Electronics in Agriculture, 70*(2), 380-388.

Wallace, L. E., Paterson, J. A., Gagnon, L., Clark, R., Davis, K., & Miller, M. (2008). Evaluation of implantable RFID microchips for readability and measurement of body temperature in mature horses. *American Society of Animal Science, Western Section, 59*, 99-101.

Weitzman, E. R., Kaci, L., & Mandl, K. D. (2010). Sharing medical data for health research: The early personal health record experience. *Journal of Medical Internet Research, 12*(2) Retrieved 21.2.2013 from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2956225/

Research paper 5

Leskinen, S. (2011) Veterinarians' attitudes towards digital technology – an empirical study. In *7th International Equitational Science Conference* (26-29.October 2011) Hooge Mierde, the Netherlands. pp. 4.

m-equine

Veterinarians' attitudes toward digital technology - an empirical study

Current problems

• It is challenging to accurately identify a horse.
• A horse's medical history does not necessarily move with it to new owners. This can be a problem if the horse is to enter the human food chain.

Equine sports
• Record keeping is time consuming, tiresome and often causes double work for both veterinaries and competition officials.
• How can we reliably uphold anti-doping measures?
• Horse dealing should a more reliable and transparent action to all parties involved.

Research questions

• What are the bottlenecks in a veterinarian’s daily routines?
• How veterinarians use technology?
• What are the veterinarians' attitudes towards new technological innovations that could support their work.

Equine and production animal veterinarians record keeping during house calls.

	Patients		Treatments		Driven distance	
Manually	74	54.0%	73	53.3%	68	49.6%
Laptop	67	48.9%	68	49.6%	45	32.8%
Mobile phone	1	0.7 %	1	0.7%	0	0.0%
Assistant	4	2.9%	4	2.9%	3	2.2%
Memorize	2	1.5%	2	1.5%	2	1.5%

Opinions on what a medical database for horses could include, according to the Finnish equine medicine and production animal veterinarians.

	agree or somewhat agree	neither agree nor disagree	somewhat disagree or disagree	no answer	TOTAL
diagnostic data	59	1	0	17	77
	76,6 %	1,3 %	0,0 %	22,1 %	100,0 %
medical data	61	0	1	15	77
	79,2 %	0,0 %	1,3 %	19,5 %	100,0 %
treatment information	58	3	1	15	77
	75,3 %	3,9 %	1,3 %	19,5 %	100,0 %
homecare instructions	46	7	9	15	77
	59,7 %	9,1 %	11,7 %	19,5 %	100,0 %
vaccination information	60	0	1	16	77
	77,9 %	0,0 %	1,3 %	20,8 %	100,0 %
deworming information	43	8	10	16	77
	55,8 %	10,4 %	13,0 %	20,8 %	100,0 %
medication data that forbids the animal to become human food	60	2	0	15	77
	77,9 %	2,6 %	0,0 %	19,5 %	100,0 %

The equine medicine and production animal veterinarians' attitudes towards various non-core business tasks and methods.

	Definitely agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Definitely disagree
I feel I spend too much time doing paperwork	43	66	18	8	0
	31.4%	48.2%	13.1%	5.8%	0.0%
gets postponed and thus accumulates	59	53	6	11	7
	43.1%	38.7%	4.4%	8.0%	5.1%
I feel that I could improve the way I keep medical records during house calls	19	57	24	27	10
	13.9%	41.6%	17.5%	19.7%	7.3%
I would use a mobile device (mobile phone, PDA etc.) if it improved my work performance	22	50	24	27	10
	16.1%	36.5%	22.6%	12.4%	10.9%
I would use a system that automatically measures the distance I travel.	28	39	23	25	21
	20.4%	28.5%	16.8%	18.2%	15.3%
I would use a system that would hasten my billing procedure	57	54	15	5	5
	41.6%	39.4%	10.9%	3.6%	3.6%

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167. **Bo Yang**, Towards Optimal Application Mapping for Energy-Efficient Many-Core Platforms
168. **Ali Hanzala Khan**, Consistency of UML Based Designs Using Ontology Reasoners
169. **Sonja Leskinen**, m-Equine: IS Support for the Horse Industry

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