

PRECISION LIVESTOCK FARMING

– A STUDY ON EASE OF USE AND USEFULNESS

Bachelor's Thesis in Informatics (15 credits)

Ayoub Boujrad
Jalal Behnam

HT 2019: KANI02



HÖGSKOLAN
I BORÅS

Svensk titel: Precision Livestock Farming - En studie på användarvänlighet och användbarhet.

Engelsk titel: Precision Livestock Farming - A study on Ease of Use and Usefulness.

Utgivningsår: 2020

Författare: Ayoub Boujrad & Jalal Behnam

Handledare: Ia Williamsson

Abstract

Livestock farms have recently experienced a significant growth in their size and this is due to the increase in animal products. This has a technical impact on farmers' daily activities. As there are more animals, it becomes more difficult for the farmers to monitor, take care of and ensure the animals are treated in a healthy manner. The purpose of this study is to examine how farmers are affected by the use of the Precision Livestock Farming (PLF) systems and how they have come to accept the technology. The study will take up an important aspect of the impact and effect of PLF. The aim of the study is to find out how farmers are affected by PLF systems in regard to Ease of Use (EOU) and Usefulness. A total of five semi-structured interviews consisting of two researchers, one product advisor, one support worker and one farmer were conducted. An observation was also conducted along with the farmer and support worker. During the interviews, the participants answered our questions regarding PLF and its EOU and Usefulness. The data was analyzed using a thematic analysis and the results showed that PLF systems are important and useful but need further EOU development. Furthermore, the results showed that the poorly designed user interfaces impact the farmers' attitude and intention towards using the system, which also affects their attitude towards the Usefulness of the PLF systems. The research confirms the importance of including farmers under the development phase of PLF systems. Lastly, this research might be the foundation for further research on how to improve and develop a more user-friendly PLF system.

Keywords: PLF, TAM, Ease of Use, Usefulness, External Variables, Farmers

Sammanfattning

Boskap har nyligen haft en betydande tillväxt i sin storlek och detta beror på ökningen av animaliska produkter. Detta har en teknisk inverkan på jordbrukarnas dagliga uppgifter. När det finns fler djur blir det svårare för bönderna att övervaka, ta hand om och se till att djuren behandlas på ett hälsosamt sätt. Syftet med denna studie är att undersöka hur jordbrukare påverkas av användningen av Precision Livestock Farming (PLF) system och hur de har kommit att acceptera tekniken. Studien tar upp en viktig aspekt av påverkan och effekten av PLF. Syftet med studien är att ta reda på hur jordbrukare påverkas av PLF-system med avseende på användarvänlighet och användbarhet. Totalt genomfördes fem semistrukturerade intervjuer, varav två forskare, en produktrådgivare, en support och en jordbrukare. En observation genomfördes också tillsammans med support och jordbrukaren. Under intervjuerna svarade deltagarna på våra frågor angående PLF och dess användarvänlighet och användbarhet. Uppgifterna analyserades med en tematisk analys och resultaten visade att PLF-system är viktiga och användbara men behöver ytterligare utveckling inom användarvänlighet. Resultaten visade dessutom att dåligt utformade användargränssnitt påverkar jordbrukarnas inställning och avsikt att använda systemet, vilket också påverkar deras inställning till PLF-systemets användbarhet. Forskningen bekräftar vikten av att inkludera användare under utvecklingsfasen av PLF-system. Slutligen kan denna forskning vara grunden för ytterligare forskning om hur man kan förbättra och utveckla ett mer användarvänligt PLF-system.

Nyckelord: PLF, TAM, Användarvänlighet, Användbarhet, Externa Variabler, Farmare

Acknowledgements

We would like to give our sincere thanks to the informants from SLU, Växa Sverige and Gård & Djurhälsan who contributed to this thesis. We truly appreciate and are grateful for the cooperation with these participants. We are very thankful to our supervisor Ia Williamsson, who shared the same love for animals as we. We would like to thank her for her feedback and guidance.

List of Abbreviations

Abbreviations	Explanation
PLF	Precision Livestock Farming
TAM	Technology Acceptance Model
PEOU	Perceived Ease of Use
PU	Perceived Usefulness
EOU	Ease of Use

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1.Introduction

This chapter addresses the background of the study and provides the framework for the topic of the study. The chapter also covers the purpose and the chosen research question.

1.1.Background

According to the United Nations Population (FAO - Food and Agricultural Organization of the United Nations, 2009), the population of the world is expected to grow a total of 34% by 2050, i.e. 9.15 billion people. As the world population grows, we will see an increase in demand for animal products worldwide (Our World in Data 2019). Therefore, you will see expansion in size for most farms and a demanding increase in production. Due to larger farms, observation of each individual animal will be increasingly difficult for farmers as they will have less time.

Recently, livestock farms have seen an adequate increase in their size and this is because of the increase of animal products. This affects the performance of the farm in a technical manner. As there are more animals, it becomes more difficult for the farmers to take care of them and to make sure that they are being treated in a healthy and rightly manner. This will affect the welfare of the animals (EU-PLF 2016).

Hostiou (2017) defines Precision Livestock Farming (PLF) as a system that consists of different types of technologies. PLF provides support to farmers by automated monitoring over animals. The main focus of PLF is to provide real time monitoring systems to farmers and help them manage the system based on data gathered from the monitoring of the livestock and this is done by using different types of PLF equipment such as sensors and cameras. Key factors can be translated from the gathered data which can be used to study productivity, animal health and welfare (EU-PLF 2019).

However, as much as PLF is useful and effective there is a common problem among farmers. Banhazi (2018), who is one of many researchers that have experienced the lack of emphasis on the farmers' perspective when developing a PLF system. Not involving farmers in the design process has created a complicated user interface. Thus, farmers show no intention of using PLF as it would stagnate their daily activity.

Makinde, Islam and Scott (2019) states that by including farmers in the early development phase and consider their opinions and feedback would make the system more user-friendly. Solving this problem would simplify the farmers' work and realize the Usefulness of using a PLF system.

1.2.How PLF Operates - Examples

1.2.1.Example of Real-time Monitoring on Cows and Broiler Chickens

The main thing about the study that Norton and Berckmans (2017) states, is when collecting data using real-time monitoring on cows or other livestock animals, is that it is important to know how to develop an algorithm for a specific issue regarding livestock animals. The aim of their study was to develop a PLF tool to analyze, detect and alert farmers if there is any type of lameness in their early stages. Lameness is a dysfunction that can be seen in animals with an abnormal posture or stance. By installing a top-view camera, side-view camera and a lower-side camera, they were able to find the correct variables that represent the status of lameness of cows.

A similar research was conducted by using a developed system to monitor broiler chickens. The research was done by installing top-view cameras in livestock houses and developing monitoring algorithms (Aydin et al. 2014). As visual inspections are difficult to conduct all the time, using the developed system can continuously do this. Three top-view cameras were installed in the ceiling to monitor the front, middle and back of the livestock house. By using two different indexes, zone activity and zone occupation, they were able to make conclusions whether the indexes were low or high. If one of the zones had less spatial distributions, that would mean that the zone occupation index is low, which increases the possibility that something is wrong. There could possibly be something wrong in the zone, for example the air flow or temperature. The system is also capable of detecting values that show abnormal signs, which can alert the farmer to check on the animals in livestock houses (Berckmans 2014).

1.3.Problem Formulation

Due to the lack of education of the PLF systems and advanced technology, the user interface of the system has become complicated to use (Banhazi 2018). Research done by Duncan (2018) shows that most PLF system developers do not put the time in to create a user-friendly interface. Thus, farmers will have a hard time using the system which will shape a negative attitude towards the PLF system. This will mostly affect the end users, which in this case are the farmers.

Ease of Use (EOU) can be defined as if a particular system is free from effort or not by a worker. If the system is easy to use, the worker will perceive it as useful and valuable. If not, it will cause the worker to be dissatisfied and unwilling to work with the particular system (Davis 1985). EOU is a new term in PLF research and thus needs more attention (Banhazi 2018). The development of PLF has not included the human factor, thus it has not been expected that it will be difficult for farmers to use the system's user interface. Nowadays, the development of PLF has started to include EOU of the user interface, which is an area that

needs more focus today (Banhazi 2018).

Usefulness is the term that can be defined as if a person thinks that a particular system would improve their job performance. EOU and Usefulness are coherent, if the system is difficult to use it will affect how the person perceives the usefulness of the system (Davis 1985). The term “difficult to use” means that the user interface is hard to navigate and views raw data that are hard for farmers to understand.

Some farmers have chosen not to adopt PLF because they feel it is complicated and not user-friendly. The majority of PLF research focuses on the technological aspects rather than the user point of view (Duncan 2018). There has not been a lot of research regarding EOU of the system. For this reason, this research is conducted to contribute to the theoretical and practical side of PLF.

1.4.Target Group

The target group for this thesis are organisations that develop PLF and are interested in how EOU of the system may impact the farmer. Also farmers who are interested in PLF and want to gain more knowledge about the value of having a PLF system. Experts within the field of PLF such as researchers can use this study as an example of how PLF impacts the farmers in regard to the EOU of the system.

1.5.Purpose and Research Question

The purpose of this study is to examine how farmers are affected by the use of the PLF system and how they have come to accept the technology. The study will take up an important aspect of the impact and effect of PLF. The following is the research question:

- How has the use of PLF systems impacted the daily activity of the farmers? - A study on Ease of Use and Usefulness.

2.Method

The Method chapter describes the method choices that suit this study the best to answer the research question. This chapter also describes the design for the data collection as well as the analysis method.

2.1.Research Strategy

In this study, the research question was conducted using a qualitative method. In a qualitative study, the focus is on how people interpret and what meaning they bring to a specific phenomenon. Qualitative research, which has multi-method in focus, uses different kinds of methods to develop an understanding of the subject. By using methods that study people or groups in their natural settings, it will be possible for researchers to understand the reality and how the people or groups actually experience it (Bryman & Bell 2011).

A qualitative approach allowed us to experience PLF systems very closely, we were able to listen to two different points of views, the farmers, and researchers, and see what the user interface of the PLF system looked like. The semi-structured interviews were done with researchers and farmers that have a deeper understanding of the PLF systems.

The reason why a qualitative approach was chosen, is because in a quantitative approach, it is not possible to draw a conclusion after a day of observing how the farmer used the system. Also, not being able to collect firsthand data and summarize into statistical forms. In addition, a quantitative study requires more informants which is why it was not suitable for this study (Bryman & Bell 2011).

2.2.Data Collection

This study applied three different types of data collection. Firstly, scientific documents about PLF were studied. Secondly, semi-structured interviews with researchers. Thirdly, observation in a farm who uses PLF technology.

2.2.1.Scientific Documents

Scientific documents were collected and used as a data source in this study. The main data collection in this subsection was to find relevant data. This meant that all information about PLF was gathered, such as what it is and what the purpose is. Most of the scientific documents were found through the University of Borås databases. We also compared different databases in the beginning to find the most relevant to our work. The databases that had scientific documents that suited our study were ScienceDirect, Web of Science and Scopus. We also spent a lot of time browsing ResearchGate which is a professional network for researchers and scientists (ResearchGate 2020). On ResearchGate, researchers and scientists can publish their work for everyone to see. Some of the articles were locked so there was an option to request the full text

from the scientist which we did with some articles. On the different databases and ResearchGate, we tried searching for scientific documents using different keywords related to our study. Here, we found lots of TAM and PLF related research which suited our study. The scientific documents that we chose had fit the research question. The data collected from the documents helped us gain more knowledge about PLF and TAM which helped us form the interview guide.

2.2.2.Interview(s)

The most effective approach to collect data in our study was to perform an observation and interviews. An observation was necessary in our study, the observation provides an insight into how the PLF system works, how user-friendly it is and also how the farmer experienced the user interface. Farmers who do not use a PLF system are not included as it is unreasonable because there is no EOU or usefulness to examine. Semi-structured interviews were the suitable approach to gather data. Semi-structured interviews according to Recker (2012) is when the researchers have a series of structured questions about the related topic. The series of questions consists of general questions, ordered questions and also a third part where the informant can speak freely about the topic without answering any questions in order. Semi-structured interviews let the interviewer and the informant have a flexible conversation with each other about the topic to get more detailed information and also cover new aspects that can be interesting for the research (Recker 2012). The interviews provide results on important aspects of what we are studying, specific questions about the focused area that we have limited ourselves to study will be answered through the questions.

The interview guide was made before conducting our interviews and contacting the informants (see table 1). Along with the interview guide we sent an informed consent (see appendix C) and a short description about the purpose of our study when contacting different researchers and farmers through email. The informants never mentioned that they wish to be anonymous, therefore they are all anonymous in the study.

All interviews were conducted through phone calls, we first determined the date and time with the informants through email. During the phone talks we were able to ask our questions to put in order and then the informants were also able to talk to us freely about other factors concerning the subject studied. The phone interview was also recorded with the informants' permission. The first interview was held on the 17th of December, the second was held 19th of December. Due to holidays in December the third interview was conducted after the holidays on 14th of January, the same day as our observation and interview with the supporter and farmer from Gård & Djurhålsan. The time on the interviews varied between 25 to 55 minutes. The time differed on each interview, due to different ways of answering the questions, different positions in the PLF field of research and organisation. We interviewed these particular people because of their experience with PLF. They work within different areas of PLF, two of them work with the research and development of PLF. These two researchers work within

technological solutions and innovations for livestock and agriculture, for example sensor technology and facial recognition. One of the participants is a support worker which means that they have worked with the ease of use and usefulness of the system. The support worker helps farmers who are new to the PLF system and will continuously provide support whenever needed. The support worker also receives feedback from the farmers which the support company can use for further development. One of the people we interviewed, the farmer, was learning how to use a certain PLF system for the first time. The last person who previously worked researching PLF is today a product advisor. The product advisors' main job is to help farmers choose and install the right PLF system. The five participants chosen helped us see PLF from different perspectives and how it is used, researched, and developed.

2.2.3.Observation

The observation and interview that were conducted with the organisation Gård & Djurhälsan were different from the other interviews, the observation was conducted through the platform Microsoft Team Meeting Call & Screen Sharing. The support worker from Gård & Djurhälsan preferred that the observation would be through Microsoft Team Meeting and it was also due to the geographical distance between us. We observed the support worker demonstrating the system for us along with a farmer. To do this, we used Microsoft Team Meeting Call & Screen Sharing as a tool to help us observe the system. Due to this meeting being online, the observation method that suited us the most was unstructured observation. As we did not have a lot of knowledge about this specific system, we came into the observation with general ideas about how it might work (Given 2008). Which is why we decided that this observation method was the most fitting.

The observation was actually divided into two parts, the first part was a short review of the system for a farmer to see how it works. The second part was when we had our own review with the supporter of the whole system and then an interview where we asked our questions in order. During the observation, we were able to see how the system worked, how the support worker helped the farmer and how the farmer worked with the interface. We observed how a support worker had a review of the program with a farmer. Then we could also get an understanding of how the farmer reacted to the PLF system for the first time.

All of the interviews were conducted before the observation. The interviews helped us gain more knowledge about PLF in general. This allowed us to have discussions and understand the purpose of PLF. However, interviews were limited as we could not exactly see how a PLF system actually works. The observation helped us see how a system operates and its strengths and flaws. During the observation, we used the information knowledge gained from previous interviews (Recker 2012).

Respondents	Profession	Company/ Organisation	Interview time (minutes)	Type of interview
A	Senior Lecturer and Researcher at the Department of Biosystems and Technology	SLU	55	Phone interview
B	Researcher at the Department of Biosystems and Technology	SLU	25	Phone interview
X	Production Advisor	Växa Sverige	30	Phone interview
Y	Support and Agronomist	Gård & Djurhälsan	45	Microsoft Team Meeting Call & Screen Sharing
Z	Farmer	Gård & Djurhälsan	30	Microsoft Team Meeting Call & Screen Sharing

Table 1 - Shows information about the participants, interviews and observation.

2.2.4.Organisation Description

The informants from the institutes and organisations that we interviewed, that actively works with PLF.

Swedish University of Agricultural Sciences (SLU): SLU was founded in 1977 and is the only nutrition and agricultural university in Sweden. SLU operates in various locations in Sweden with headquarters in Uppsala, Umeå and Lund.

Växa Sverige: Växa Sverige is one of the largest breed associations in Sweden. Växa Sverige works towards a sustainable, profitable and competitive agricultural output.

Gård & Djurhälsan: Gård & Djurhälsan maintains sustainable Swedish meat production in the long term, with a focus on healthy animals and productive farms.

2.2.3 About WinPig and PigVision

The program is used by pig farmers who can record animal data and convert it to useful information. The information can later be analyzed and shared with others in the organisation. It can be used by farmers who specialize in sows, growers or breeding. Today, there are 3 “versions” of the program. Pigwin, which was developed in Denmark during the 1980s and introduced in Sweden in 1999, was owned and developed by the company Agrosoft. The breeding production companies and slaughterhouses then decided that they would invest in a program for the Swedish market so that it would be representative to compare data nationally. WinPig is the development of PigWin from 32-bit to 64-bit which they started using around 2015. In 2017, the program was acquired by Agrovision and changed its name to PigVision. In 2019, it became possible to put the data on a server instead of a local installation and also use an app outside in their stables. Recently, Agrovision developed a mobile application which Gård & Djurhälsan has recently started using (Gård & Djurhälsan 2019).

Winpig and Pigvision is based on three types of production,

- Integrated production: Covers the entire production process, from piglets to slaughter.
- Piglet production: When the pigs are born until they are approximately 11 weeks.
- Pig slaughter production: From 11 weeks to slaughter.

Gård & Djurhälsan are resellers of the program in Sweden and help customers through support, e-mails and even customer visits if needed (Gård & Djurhälsan 2019).

2.4 Analysis Method

The semi-structured interviews will be analyzed using a thematic analysis which is an analysis plan that can be used to generate specific themes from interview data. The thematic analysis was inspired by Bryman & Bell (2011) but was not followed step-by-step as the categories were determined in advance. The interview guide was based on PLF and the

Technology Acceptance Model (TAM). As TAM has major functions, it was divided into three categories, External Variables, PU and PEOU. These are the three categories that we can follow when analyzing our results and finding themes.

Firstly, we will start by specifying the objectives of this study. The interview must be read fully, minimum twice. In the transcription, the grammar or language has not been corrected. Writing will be standardized to increase readability of quotes raised by farmers. Getting familiar with the data is important to be able to continue with the next step of thematic analysis. The next step is to code the data, which means identifying important data that can be generated into themes. This was done by reading the transcript and connecting similar answers to each other. The categories were defined as External Variables, PU and PEOU who are connected to TAM and are used to analyze the interaction with PLF. Thereafter, the categories were reviewed to determine if the data was correctly assigned. The categories are for grouping the coded segments and reducing the different data. Now we are able to select representative text extracts to highlight the categories (Bryman & Bell 2011).

2.5 Analysis Method

Reliability is measured whether a study is repeatable depending on its results and consistency. Whether the results of the study have changed if the study was conducted again, or if the results were affected by coincidences (Bryman & Bell 2011). As technology is developing, so will PLF. Therefore, if someone would perform this study again, the results might be different. The informants are anonymous but not the organisations, that would make it easier for someone to find researchers and farmers to conduct a similar study.

2.6 Analysis Method

Validity concerns whether a measurement of a concept is really measured or not. The concept of validity which can be divided into two parts, internal and external, which can be used to reflect over the importance and meaningfulness of the results of the study. Internal validity depends on how well a study has been performed. The less confounding the study is, the higher internal validity. External validity is connected to the results and how that can be applied to the real world (Bryman & Bell 2011). The people that we interviewed closely work with the topic that we have chosen, which is something that we made sure of before conducting any interview or observation. The internal validity in this case is high. However, the external validity is low because the result is not applicable to all situations. The development of PLF might be different in other parts of the world or in other settings.

2.7 Analysis Method

There are different types of PLF that consist of many parts of high technology. Each PLF system has its own purpose. The main focus of the study is to investigate how PLF impacts the farmer in regard to the three key factors from the theory of the TAM, External Variables,

PU and PEOU. These key factors are applicable to this study as they are most relevant from the TAM model.

To get a better perspective on PLF and answer the research question we chose to get data from both researchers of PLF in Sweden by interviewing them. We also conducted an observation through screen sharing with a farmer and support worker in Sweden. The theoretical part of the study consists of different types of research of PLF in different parts of the world.

2.8 Analysis Method

Before visiting or interviewing anyone, we first asked for consent as well as informing the purpose of the study. We informed the participants about ourselves and the university we attend. We also respected and followed the instructions of the farmer. Permission was needed from the participant to record, take pictures and note-taking. We considered and respected if the participant required anonymity (Research Methodology 2019).

3.Theory

This theory chapter addresses the definition and impact of PLF and also its principles and how the technology itself works. Then there is also the theory which this study is based on which is the TAM theory.

3.1.Technology Acceptance Model (TAM)

The Technology Acceptance Model is an information systems theory that was developed by Fred D. Davis to predict the behaviour and intentions of computer technology acceptance, the model includes farmers and the environment in which the user is located. Making sure that everyone is able to use the technology and come to accept it. According to Davis (1985), the three major functions are External Variables, Perceived Ease of Use (PEOU) and Perceived Usefulness (PU).

Davis defines PU as "the degree to which a person believes that using a particular system would enhance his or her job performance". He states that depending on the system, if it is not useful for their work, the farmers would not use it. Similarly, he defines PEOU as "the degree to which a person believes that using a particular system would be free from effort". If a user feels that the interface is difficult to work with, there will only be grudges towards the technology. Technology and interface which is easy to use will go a long way with the farmers and shows positive signs of acceptance and usage (Davis 1985).

The arrows in the TAM model (see figure 1) are defining the relationship between the factors represented. External Variables, PEOU and PU are key factors that affect the rest of the model. Users develop their own opinions and understanding of the technology which leads to them actually using the system or not. External Variables can impact both the PEOU and PU depending on what the user thinks of the system. A user can have a different view of the PEOU and PU. One might interpret PEOU as positive and PU as unuseful or the opposite way around. Users who understand the technology and who believe that it is user-friendly and useful, will develop an attitude towards using the system. This also creates a behavioural intention to use the system and eventually actually using the system. A user who finds the technology easy to use but not useful, will not develop a behavioural intention to use the technology (Davis 1985).

TAM theory was chosen precisely because it contains the EOU and the aspects of the unseen that help us answer our research question. The TAM theory also helps us understand what causes a farmer to accept a PLF system. A similar theory to TAM is Human-Computer Interaction (HCI) that we have not included or used in this study. With the help of HCI, you can study the interaction between users and the technology (Dix, Finlay, Abowd & Beale 2004). However, TAM theory shows the interaction between users and the technology but also the reason why they accept or do not accept the new technology. The reason why we chose

TAM instead of HCI is because we are able to analyze the EOU, usefulness and how the farmers have come to accept the technology. Using the TAM theory also helped narrow down the important aspects of this study and focus on how the current PLF systems are useful or not and if the user interface is easy to navigate and use.

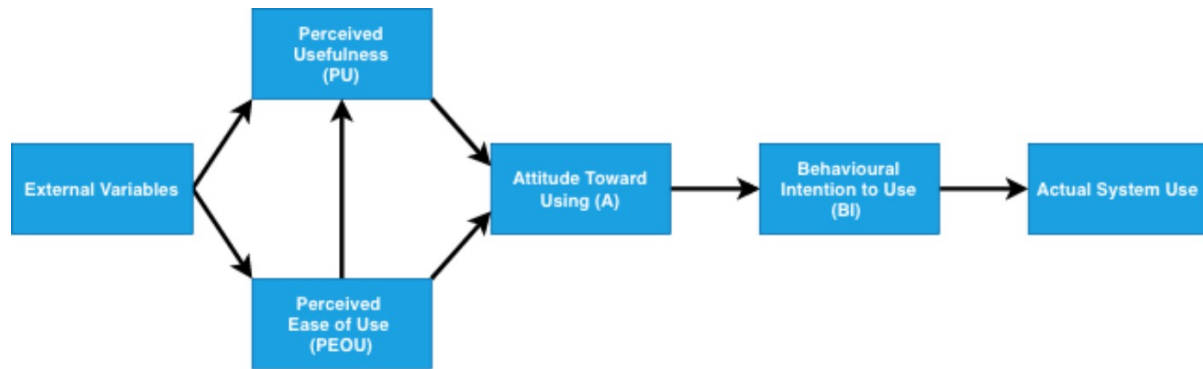


Figure 1 - Technology Acceptance Model (TAM)

3.2.TAM - Example on Adopting New Technology

TAM can be used in different areas that are technology related. Pierpaoli et al. (2013) researched the key drivers of TAM that affect farmers to accept Precision Agriculture (PA) technologies. The difference between PA and PLF is that precision technology is used in agriculture and not on animals. The main focus of the study was the acceptance of the technology and studying what it is that makes the farmer not accept/adopt the technology because there are not many studies on that specific area (Pierpaoli et al. 2013).

There are different types of factors that Pierpaoli et al. (2013) mentions that impacts the intention of adopting new technology such as farm size, higher income, positive assets, education, knowledge, and information technology (IT) skills. However, the farm size is the number one impact on technology adoption, the study confirms that bigger the size of the farm, the higher the chance is to buy PA technologies.

Usefulness and EOU are particularly important and essential factors. Pierpaoli et al. (2013) links technology acceptance to the farmer's attitude towards technology using the TAM theory. TAM focuses on human behaviour, such as someone's attitude towards adoption and use of a new technology (Pierpaoli et al. 2013).

There are two groups of farmers, the one who has a positive attitude towards the use of new technology, in this case the PA technology and the second group who are non-adopters of the new technology. An important aspect in this study is showing that many farmers are very appreciative when getting demonstration on how the technology works, trials and support so the technology they are using becomes even easier to use. This shows that External Variables,

EOU and Usefulness are an important and essential factor for the technology adoption (Pierpaoli et al. 2013).

3.3.Key Drivers of TAM - Intention to Adopt New Technology

The reason for farmers to adopt PLF according to a research done by Kaler & Ruston (2019) that was based on a research done by Lima et al. (2018). The study focused on reasons on what made UK sheep farmers experience low productivity and profit margins compared to other livestock sectors and also to understand the reason behind why they use or not use precision technology on their farms. To understand this and from 36 farmers to analyze the factors that are related to go deeper the researchers collected data adoption of precision technology of the type electronic identification technology (EID). Having EID means that each animal has a unique identification number which is saved on an electronic transponder. It turned out that a large proportion of farmers had a great chance of using this technology to collect data from their flock and then use it to make better decisions. This, according to Lima et al. (2018) means that farmers felt more pressured and had a negative image of the precision technology were related to non-adoption Lima et al. (2018). Nonetheless farmers who understood how effective and useful EID technology is were more likely to accept the technology (Kaler & Ruston 2019).

The 36 farmers that were interviewed during this study were between the ages of 26 and 65. Four of the farmers reported that they were very experienced with IT, 23 of them had medium IT skills and nine of them said that their IT skills were low. All of these 36 farmers used the technology in a different way, five of them invested in both the software and hardware of the technology to be able to read and monitor their sheep and used the data to help them in their decision making. Eight of the farmers purchased some equipment of the precision technology to collect data on their livestock but they were using it partly. The other 23 reported that they are not using the technology but had only the EID ear tag on the sheep. To accept and implement a new precision technology, farmers must first understand the advantages and Usefulness of the change and have a good understanding of how the system works and accept how it will change the current work activities (Kaler & Ruston 2019).

A common criticism of using PLF has been that farmers believe that they are irreplaceable. Researchers Kaler & Ruston (2019) had identified a similar issue that all farmers experienced with the technology during their study. The issue was that farmers thought that the system could never replace a good farmer and a good farmer is one who is directly connected to their animals. Meaning that they thought the system was seen as useless when it comes to some activities that only the farmer could perform and not the system. Sheep farming according to the farmers they interviewed is that it is dependent on the skills of the farmer, even if the system was effective and helpful it still needs the farmer to be in charge. After the interviews that they conducted, some questions were about if the farmers were adjusting the technology to fit their daily activities. Most of the farmers reported that they experienced many issues

with the technology including the EOU of the system (Kaler & Ruston 2019).

3.4.Literature review

3.4.1.Precision Livestock Farming (PLF)

3.4.1.1 Definition of PLF

PLF technology is introduced to the farmers today because of the growth of the world population which leads to an increase of demand for animal products (EU-PLF 2016).

The definition of PLF according to Hostiou (2017) is the use of different types of technology that help the farmer to measure various indicators of the animals such as behaviour, physiology and production. The main reason for measuring these aspects is to improve the management of animals, but also to facilitate the working process of the farmer and to offer better management strategies. By continuously using different types of real-time monitoring of health, welfare, environmental impact, as well as production and reproduction, you'll be able to manage animals individually which is the goal of PLF. The use of PLF technology will help farmers analyze every second of every day. When measurement limits have been exceeded, the farmers will be alerted and are now aware of a potential problem and can check on the animal that is in need of help. There are different types of monitoring that can be done, such as by camera and real-time image analysis, by microphone and real-time sound analysis, also by sensors that can be on or around the animal (Berckmans 2017).

Automatic monitoring technologies such as PLF play a very important role in the farming area today, the PLF technology is a solution to solve the higher demand for animal products and at the same time have more control of animal health and welfare (EU-PLF 2016). According to Berckmans (2017), one of the main goals of having a PLF system is to monitor the animals health and welfare.

Figure 2 below shows how a PLF system operates. Data from sensors and cameras sends real-time data to information services in a PLF company, the relevant information will then be integrated and analyzed. Lastly the information will be visual to the farmer as feedback. The feedback can be used to advise or warn the farmer.

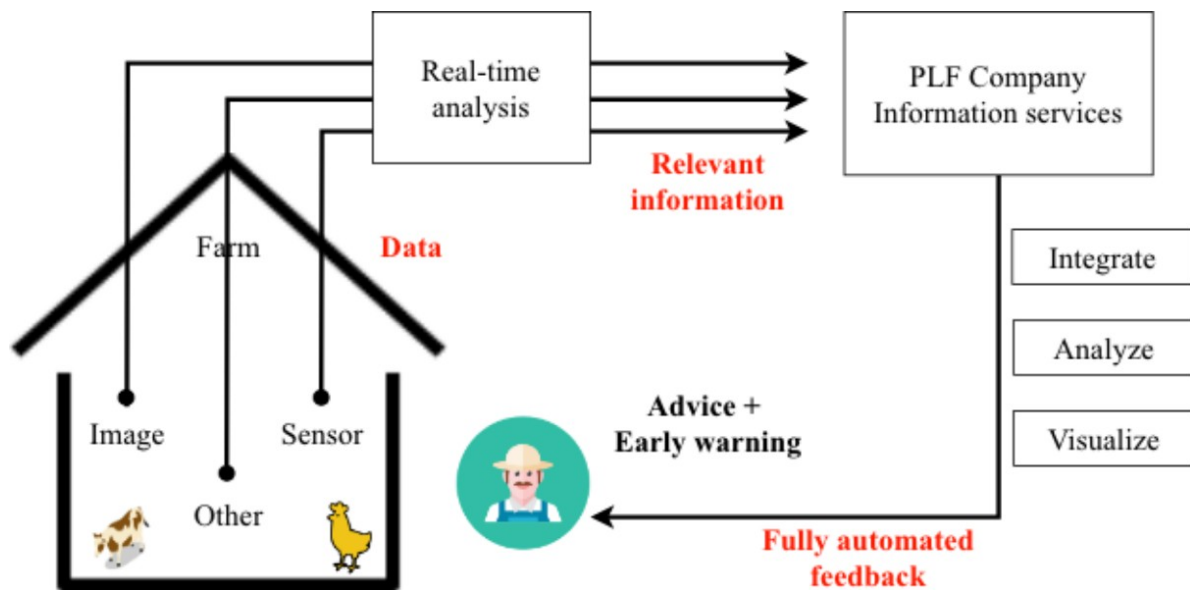


Figure 2 - Illustrates how PLF operates.

3.4.1.2 PLF Principles

According to Berckmans (2004), there are three key principles that must be taken into consideration when implementing the PLF system.

- There are different animal variables such as behaviour, weight, activity, feed intake, as well as physiological variables such as blood variables and body temperature. These variables must be measured continuously, and the information that is gathered should be analyzed continuously as well.
- To establish accurate monitoring and management of the animals, reliable predictions must be set and available during all times. These predictions shall include how the animal might respond to environmental changes and/or variations of animal variables. Berckmans (2004) clearly states that the word “environment” in this case has a different meaning, it deals with the variables that aren’t genetically defined. By having predictions and measured values, you will be able to compare between and tell if something abnormal is happening.
- Being able to continuously monitor online or having control over actions, such as feeding and climate control, means that you have to have an analyzing algorithm. Therefore, an integration of the predictions and online measurements must be done, to create an analyzing algorithm.

Banhazi et al. (2012) mentions other principles regarding measurements and staff members.

- What happens if the measurements breach the set limits? Corrective action must be applied beforehand, this means that the user should know of any consequences and what should be done if something occurred. Having set corrective actions beforehand, will be beneficial for the user since it reduces the stress level.

- It is important to make sure that the manager and all staff members can carry out all types or procedures that are necessary. Standard Operating Procedures (SOP) must be established. SOP will be established for essential processes of the enterprise, making sure that each essential processes is measured, within the set limits as well as being executed properly by manager or staff. (Banhazi et al. 2012).

3.4.1.3 First Time Interacting with PLF

As the PLF technology is new, it is hard for farmers to use because some did not have proper training and guidance. A project which lasted between 2012 and 2016, was coordinated by EU-PLF and the objective of the project was to create a blueprint. The blueprint is a manual for farmers on how to use this type of technology such as real-time monitoring by using sensors, cameras and microphones, and how to install it. EU-PLF installed PLF for three species, dairy cows, broilers and pigs. As the farmers were unfamiliar with the technology, it was important to help them familiarize with the installation of the system and later analyze how the farmers experienced this technology. Therefore, workshops and discussions were set up to train the farmers how to use the interface, understand the data and how to use the data given from the PLF system, and gain feedback from the farmers. The coordinators of the project used the feedback to create the manual for PLF. EU-PLF who was behind this project, experienced that it is important for farmers to understand the principles of PLF and how the system works. The feedback from the farmers showed that it is highly essential that the farmers need guidance and training to make it work properly for their farms (EU-PLF 2017). Berckmans (2014) stumbled on the same experience, that this type of technology is rather unknown among farmers, which is why they need training to understand and how to use PLF technology. A different research conducted by Hartung et al. (2017) about European farmers' experience with PLF systems, showed that even though this kind of technology is exciting, farmers felt uncertain due to not knowing enough about PLF systems and how to manage them. Another research within PLF came to the conclusion that it had been difficult to learn the fundamentals of PLF and how to use its features. Difficulties arose for farmers when the system provided an overload of information, they had a hard time making decisions because it was hard to identify the most relevant information (Fournel, Rousseau & Laberge 2017).

Some farmers chose not to adopt PLF as they feel it is complicated and not user-friendly. A research conducted by Duncan (2018) shows that most PLF research has mostly been focused on the technology aspects, rather than the farmers point of view. Makinde, Islam and Scott (2019) also mentions that the focus has largely been on the technology of the PLF. The user interface was not a priority which is why the design of the interface was not something that they put in a lot of effort into. This may be why some farmers choose not to adopt PLF as they feel it is not user-friendly and complicated. However, this field of study has started to reflect why there is a lack of adoption and what can be done to change this. Makinde et al. (2019) continues to mention that the user interface would benefit if the farmers would be directly involved in the design process. Involving farmers would not only create a friendly user

interface for them, it would also ease the learning and usage of the PLF technology.

3.4.1.4 Impact of PLF

Farmers must evaluate their needs and reasons before they decide to purchase a PLF system. According to Hostiou (2017), a reason why farmers choose to go for PLF is because it can improve the overall quality of life and productivity. She continues to elaborate on how PLF can impact the farmer and his daily activities, how they are able to save time and how the nature of their work can change for the better. A study done by Rodenburg (2012) in a farm using automatic milking system (AMS), showed that the farmers were able to spare a total of 29% of work time which they could use somewhere else. They can instead use this saved time for personal activities. managing the farm or activities related to production. This was confirmed by 28% of farmers who uses AMS, that they had more free time during the weekends which also meant more time spent with their families. 68.9% of the farmers who uses AMS confirmed that their quality of life has improved. Other researchers report a significant decrease in time when having an AMS. Manually feeding each individual calf took approximately 8 minutes per calf per day, when the milking system was automated and being able to oversee calves by group resulted in approximately 4 minutes per calf per day (Hostiou 2017).

As well as saving time by using automated systems, the farmers had high praise for PLF as they were able to gain more flexibility and control when organizing their daily activity and personal life (Butler et al., 2012; Schewe & Stuart, 2015). However, there are farms who may struggle more than others when introduced to a new technology. Having a dairy farm means that each day will be structured based on milking. Installing an automated milking system will suddenly break that structure which means that the farm will be more dependent on timing schedules, farmers' choices and other activities that can be more difficult than previous ones (Houstiu 2017).

Positive signs have come from PLF regarding the mental health of farmers as it helps them to ease their mental workload. There are physiological factors in farms which are hard for humans to notice such as diseases that are difficult to detect, air flow and temperature which is a reason why farmers feel that PLF has helped farmers mentally. Hostiou (2017) reported that when farmers can detect the high temperature in animals, they can quickly take action which has reduced the pressure on them.

Other farmers have developed a negative attitude towards the PLF system, as it generates a high amount of information which increases the difficulty of decision making and which information is most accurate (Schewe & Stuart, 2015). Hansen (2015) mentions that farmers were under a lot of stress due to the mismanagement of alarm warnings, it is important to establish a structure and prioritize correctly so when they receive alarm warnings they know when to intervene.

4.Results

This chapter presents the important parts of the result of all the interviews with the researchers of PLF. It also covers the interview and observation with the farmer and support worker. The titles presented in this chapter are identified as the important factors of our study.

4.1.PLF Impact on Farmers Daily Activities

All of the informants had the same answer about how PLF has affected the farmer. PLF has greatly facilitated the farm's work and affected different farmers in different ways. Some who had a hard time during the first period of using PLF had a negative experience as the system was difficult to use, which made their work slightly different and complicated at the beginning. When farmers use the system correctly, they will have a positive impact of PLF on their daily activity. Since the PLFs main purpose is to facilitate farmers daily activity, the use of the system should also be easy to use so the system must be user-friendly to achieve its full function. If the program is not user- friendly, it will make it harder for the farmer which is not the purpose of the PLF.

4.2.PLF - External Variables

Of those we interviewed, all had similar responses regarding the impact on farmers' attitude towards the system whether it was influenced by gender, age or social impact. According to informant A from SLU, the age did not matter a lot and he also thought that the older had more experience than the younger generation.

Other informants claimed that it is all about personality, interest and to have a positive attitude. The external factors like age, sex or social impact does not matter. The farmers who were most interested in production had the most success using PLF according to informants A and B.

“No, actually some do just fine with PLF technology when they are 60 years old or older. If they start using the system at age of 50, the user will know a lot about it. Everything is about getting used to it.” (X)

“Well, actually I was surprised when we did a survey where I work, everything is about personality. I have met people that are in their twenties who said that it is flawed with PLF technology and does not use it, and there are 65 year old who find it really fun with new technology and buy new if needed. The past experience can also impact the user, therefore, if you have bought something previously that has not worked, you become a little more cautious and have such an attitude toward the system.” (B)

4.3.PLF - Ease Of Use

All of the informants shared the same experiences concerning PLF and its EOU. Most PLF systems have focused on the technology more than the user interface itself. Informant X expressed how the user interface of the system was complicated before due to the presentation of data can be hard to read because it is presented as raw data and complex graphs. The development of the user interface is getting better according to informant X.

“The solutions on the screens on the farms which become more easy to use as it became more difficult before because data was represented as graphs and mass numbers etc (raw data). Now it is much easier to read the data, etc. The goal is to make it easier to use.” (X)

Informant Y who works as a support worker for farmers that uses WinPig, says that there have been many reports by the farmers complaining about the complexity of the user interface (see figure 3). Informant Z says that WinPig has helped the farm a lot in regards to pig production but that it was difficult in the beginning. Informant Z criticized the system as there were many tabs to navigate between and that took time to familiarize with. WinPig is divided into parts depending on what type of pig production the farmers are working with. The system has been built to adjust to the farmers' needs. There are three types of main production which are integrated, piglet, and pig slaughter production.

WinPig works with all-in-all-out production which means that sows, who are the mother pigs, are divided into groups. informant Y says that there is an average of seven groups at the same time. These groups are created to be followed, which makes it easier than tracking each individual sow as the average herd is around 280 sows. Each group is denoted and the farmer can for example keep track of certain events, where they are located, breed and when it is expected to give birth. Informant Z mentions that when there are groups, it is easier to navigate but it is also troublesome to insert data manually.



Figure 3 - Shows the WinPig menu. The image illustrates different icons such as piglet production, sow cards and work lists.

Recently, a mobile application has been developed named PigVision according to informant Y. The application has been tested by quite a few farmers who feel that the user interface is much more user-friendly (see figure 4.1).

The application is also supported by a Quick Response (QR) code that each pig has. The farmer can easily with the mobile phone scan the QR code and gain access to the information about a specific pig (see figure 4.2).

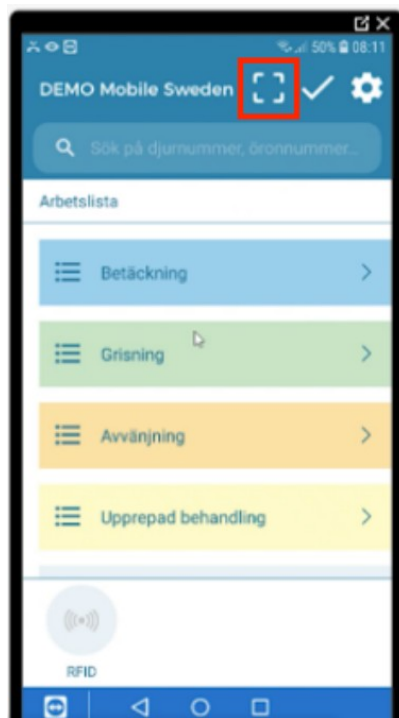


Figure 4.1 - Shows the PigVision Application. QR Scanner can be seen on the top header

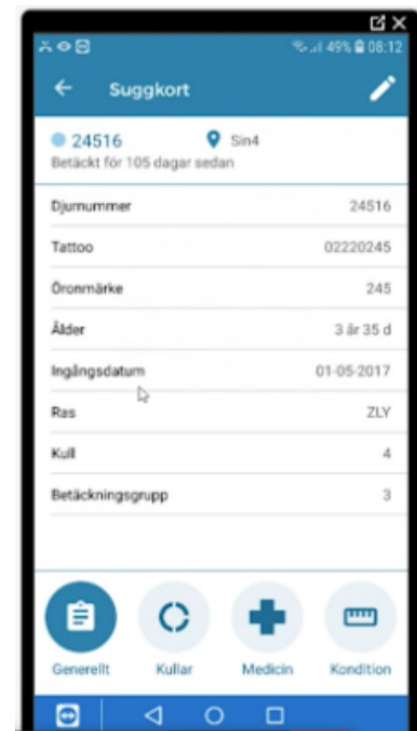


Figure 4.2 - Shows sow card after scanning the QR code.

4.4.PLF - Usefulness

Usefulness is about how the system can help and improve farmers daily activities. PLF technology makes it basically more efficient for the farmer and provides continuous monitoring of animals which makes it very useful. To make a system useful it must first simplify the work of the farmer and also be easy to use according to informant B.

An example of the informants Y and Z mentions that you can create work lists on WinPig and PigVision. Using work lists in daily activities is an easy way to keep track of, for example, which animals to farrow, litter or wean, and you can create the list per breeding group or for a certain period. You can register events directly on the work list and quickly enter, for example, farrows on a whole group of pigs. You can also print out all sow information cards for the pigs on the list at the same time.

“The first step to make the system useful is to make the user interface easier for the farmers. The second step is to integrate all the systems so the users do not need to log in to other systems, same goes with the screens so they have all the views of data in one screen.” (X)

4.5.Educating, Training and Support

Informants A, B and Y mention that all the farmers who purchase a PLF system, require education and training. It is important to understand how it works before dividing into the system. Informant Y states that every new customer who purchases WinPig needs to have at least two hours of training to understand how it works and how to navigate the system. Support is also something that is a must and that can be given in different ways. Support can be different depending on the company. Depending on the size of the company, companies with a lot of farmers today try to develop a support framework where the farmers themselves can read how different problems can be solved. Basically companies have phone support available 24/7 or on-site support and some have a combination of both (B).

4.6.Advantages and Disadvantages of PLF

The answer to the question of the advantages of PLF was really simple to answer, the researchers had a common answer which was “monitoring” the animals which is a huge advantage. Informant A specified that an advantage with PLF systems is when some activity in the farm gets enhanced and more efficient by for example continuous automated monitoring of animals and production. The informant cited:

“Advantages of PLF are basically efficient production and continuous monitoring of animals. If the sensors and other equipment work well, the system would continue doing that constantly.” (A)

A common reflection among the informants was that there were issues with PLF interfaces not being user-friendly enough. The interface should be logical and simplified, and there must be a sense of humility towards how the farmers experience the interface when designing it. Also, the raw data can be hard for the farmers to interpret. Therefore, when the researchers were asked about integrating the farmers into the early development phase of PLF to enhance user interfaces, they all agreed and mentioned that some companies that produce PLF systems have already started doing that.

For the future, researchers state that the systems must always be reliable and functional, which they are not at the moment. At the same time, there must be a system for managing downtime. There have also been problems with handling real and false alarms. Imagine if the system would miss a real alarm, how would it be handled? Too many false alarms is a problem in itself and it is important that the system is so accurate that it communicates all alarms in the right conditions. One of the researchers states that it is very important and accessible that you conduct proper customer analyzes to get good feedback.

Since some PLF systems may be complicated and still are in the developing phase, there will be difficulties and risks in using it. Failure with the system could be an example of the PLF sensors, if it does not work properly it will send incorrect data which can change all the values

and make it very difficult for farmers to recover from that failure (X). A risk informant X mentioned during the interview is the collars around the animal's neck which works as GPS and sends information to the system, data becomes narrow when farmers change or remove the collars. There are more than 100 cows with these collars and because the collar can be too tight or too loose, the farmer must keep track of all the collars, and this is something you want to avoid as a farmer. Difficulties according to one of the informants X might be that the farmers do not trust the PLF program as some farmers may find it difficult to change their way of working.

5. Analysis

This chapter will present the analysis done by comparing data from the theoretical framework and the gathered data.

5.1. Impact of PLF

PLF makes it easier for farmers as it controls many factors such as animal health and welfare and measurement of food and water. However, there has been a major problem with PLF's EOU which means that it does not serve its main purpose which is to ease the workload of the farmer. With a difficult user interface, the farm is affected as the farmers develop a negative attitude towards the system that is meant to be helpful and should simplify the farmers' daily activities. Both scientific articles and our informants believe that more time should be spent on developing user aspects. This could result in the system finally affecting the farm in a positive way. According to a study by Makinde, Islam and Scott (2019) if the farmers are included when developing PLF systems and developers consider their feedback, the PLF system will become more user-friendly. This in turn allows the farmer to experience this technology the way it was meant to be perceived.

5.2. TAM - Analysis of PLF

5.2.1. External Variables

Among the informants, everyone had almost similar responses regarding the impact of External Variables, such as gender and age, on the user's attitude towards the system. Informant A from SLU thought that age did not matter and that older farmers are more experienced with PLF systems, while other informants claimed that personality, interest, and a positive attitude are big factors. External factors such as age, sex or social impact did not matter. The results from the interviews and the observation made in this study differed somewhat with another research done on the subject. The age of the farmer, according to research done by Kaler & Ruston (2019), plays a role in the IT/PLF system knowledge. The younger farmers that were interviewed in that study had a high level of IT skills, the middle-aged ones had a medium level of IT skills, and the older farmers among the informants had no IT skills. This had an impact on how they approached the PLF system and how they used it (Kaler & Ruston 2019). According to informant B, the young generation of farmers do not want to use the PLF systems as the informant gathered data from a conducted study.

“The young farmers think it is difficult to use such systems”. (B)

5.2.2. Ease of Use

The informants of this study who were interviewed had common answers about how important user-friendliness is and explained that the systems can be complicated to use. Poorly designed user interface complicates the farmers' work when in reality the system

should be free from effort (Davis 1985). The informants mentioned that the development of the system today takes into account user-friendliness which makes the systems easy to use for the farmers. The companies, according to the informants, focus a lot on the system being user-friendly by including farmers in the early phase of the system's development. To achieve EOU in PLF, according to Banhazi (2018), the user interface of PLF systems should get more attention. Unlike today, the EOU was not considered during the early development phases of PLF (Banhazi 2018).

5.2.3. Usefulness

In line with the TAM theory, Usefulness is considered a factor that is affected as the PLF systems are not so easy to use, this causes farmers to fail to see how effective the system actually is. According to the TAM model, to accept and understand the value of PLF, it must be easy to use the system. This provides the opportunity for the farmers to have a positive experience with PLF. It is doubtful that the farmer will even try to see the value and Usefulness of the system if the user interface is complicated (Davis 1985).

It is clear from the data collected from the interviews that the PLF systems are now in the developing phase. The informants mention that companies have previously never taken the farmers into account when developing systems that are meant to be used and appreciated by farmers. The organisations today are starting to make PLF more user-friendly due to the feedback they have received from the farmers. Informant B from the interview mentioned that this is already taking place and claims that more farmers are now using the system due to the user-friendly technology including feedback from the farmers. As the systems are becoming more user-friendly, the farmers will understand the Usefulness of the system (Davis 1985).

5.3. The Importance of Education, Training and Support

Based on the interviews, it was highlighted that there are uncertainties surrounding the use of PLF systems which is supported by Duncan (2018) along with Makinde, Islam and Scott (2019). There are farmers that are reluctant to use PLF due to their lack of understanding what it is and how it works. This is stated by Berckmans (2014), who says farmers are unfamiliar with the PLF technology which is what informant A, B and Y mentioned during our interviews. All of the informants also spoke about the user interface and how it is complicated to use for some farmers. Informant Y, who closely works with farmers who use a PLF program, says that one of the key problems has been the complicated user interface. Communication is important which is why farmers need to be involved in the early development phase of a PLF system. This is once again supported by Makinde et al (2019) who talks about the benefits of involving the farmers in the design process.

All of the above is supported by the organisation EU-PLF (2017) who created a PLF manual for the farmers to use. The manual was created so that farmers could gain knowledge about PLF, how it works, how it is installed, and how it can be used. While creating the manual, the

organisation noticed that farmers really needed guidance and training for their PLF system to successfully work for their respective farm. The thought behind creating a manual supports the results gathered from the informants. It may be easier for farmers to use the system with the help of a manual, but it can still be a complicated user interface to navigate.

The results from the data collection of interviews, observation and scientific documents provided the same information. They all agreed about the importance of education, training, and support which would all lead to a successfully operational PLF system for farmers to use.

6. Discussion

From the analytical chapter, we can now conclude that the TAM model's factors are extremely important in making the PLF system user-friendly and useful for farmers. The key factors are: External Variables, Ease of Use and Usefulness. This part will include the importance of the TAM categories in relation to PLF.

6.1. The Impact of PLF on Farmers

Our analysis shows that the PLF system can impact the farmer in various ways. The farmer can have a positive impact from PLF if he or she thinks a system is user-friendly, which in turn makes it very usable. In turn, when they find it difficult to use it can also negatively impact them. It ensures that when the program is not user-friendly, PLF will make the work harder for the farmer rather than simpler. The PLF system itself has an effect on the farm's day-to-day operations, since it may be complicated to use, it may have a negative impact.

6.2. PLF Ease of Use Issues

We were not surprised at our results at first, as most of the opinions we got from previous research about PLF and its EOU. What surprised us most was that everyone we interviewed during our study said the same thing about user-friendliness, partly that it was very difficult to use and farmers were not included during the development phase. We thought this was interesting since all the informants thought the same thing, which means it is a very well-known problem that needs more attention.

The impact of External Variables such as age, gender and social impact is something that really shocked us in this research. The information surrounding External Variables varied from the scientific articles and the informants. Most research showed that age affected what farmers thought of PLF and the informants stated that it was more about personality and getting used to the system. We did not know how to interpret these results as researchers can have different experiences with farmers. Even though the results do not agree, we understand that there are several External Variables that can affect the farmers opinion and attitude towards the PLF system.

6.3. Developing PLF Using TAM

We believe that when developing PLF, it is not enough for developers to only be satisfied with the technology aspects such as installing cameras or sensors. Taking the farmers into account, will benefit the developers in the long run. Showing that the system is user-friendly will attract customers. That is why a theory such as TAM can be useful as it can help developers recognize the issues with the system. TAM helped us set a basis for our interviews and observation, and the results among all the informants were similar. It helped us ask the right questions and really find the root of the problem. Pierpaoli et al. (2013) also acknowledged this in one of his reports on TAM's factors related to PLF. He notes that many farmers enjoy whether the program becomes more user-friendly because they find it hard to use. Our study

shows how important TAM's factors, External Variables, Usefulness and EOU, are for accepting the technology which is something that Pierpaoli et.al (2013) states in his study. In this case, connecting the theory of TAM showed that the main problem was the EOU. Most farmers acknowledged the Usefulness of a PLF system and what it would bring to the farm, but like Makinde et al. (2019) mentions, the poorly designed user interface made farmers reluctant towards it.

6.4.Involving Farmers

We consider it important that farmers should be included in the PLF systems development phase. This is what our informants also believe is one of the most important aspects that companies have not thought about before, but they also note that companies have begun to take customer preferences into account when designing a PLF program.

For example, farmers who use WinPig and the mobile application PigVision have grown a liking towards the application. This can be seen in figure 4.1 where they have focused on the simplicity of the user interface. We think the most important thing about a PLF system after analyzing our result is that it should be easier to use as its purpose is to simplify the work of a farmer. This can be achieved by including the farmers in the early development phase as described previously, but also by using a model such as TAM that incorporates the factors that impact the farmers trying to adopt the system.

6.5.Method Reflection

The purpose of this study is to examine how farmers are affected by the use of the PLF system and how they have come to accept the technology. By carrying out a qualitative study we were able to understand what PLF is, how it works and how it has impacted the farmers. According to Bryman & Bell (2011), the aim of a qualitative study is to utilize different kinds of methods to develop a more meaningful understanding of the subject which is why we chose to use qualitative methods over quantitative methods.

Usually quantitative research has more informants than qualitative research, which is why you can question the reliability of our results. This is one of the drawbacks when using a qualitative method. The fact that the informants had different job titles also could have affected the reliability of the results (Recker 2012). All of the informants have worked closely with PLF, but they have been assigned to work with different aspects of PLF. Therefore, during the interviews, the feedback we got varied depending on the participant's type of expertise in this field of work.

When using semi-structured interviews as a method of research, there might be some drawbacks. For example, informants might want their answers to be better understood so they may exaggerate their positive and negative experiences with PLF. This may jeopardize the validity of the information. There is also the possibility of unexpected events and behaviours

during interviews which can be seen as disruptive for the interviewers, especially if they are inexperienced interviewers. Informants would possibly not accept being recorded because being recorded can be seen as a risk, and this could create difficulty in transcribing the interviews. As for us, these drawbacks never arised. For the most part, the results of the interviews were positive. Answers and inspiration together from the interviews created additional follow-up questions to ask (Bryman & Bell 2011).

The purpose of the observation was to see how the farmer interacted with the PLF system closely. An observation is more effective if it is done on-site. Gård & Djurhålsan recommended conducting the observation by screen sharing the PLF system instead. A flaw of having the observation through screen sharing was that we were not able to see how the farmer reacted to the system. Not observing on-site also meant that we could not see the farmer in their natural setting.

7. Conclusion

The purpose of this study was to research how the use of PLF systems impacted the daily activity of the farmers in regard to EOU and Usefulness. By studying scientific articles, gathering data by interviewing people who work closely with PLF and observing a PLF system, we have come to conclude the following:

Generally, we found that the primary challenge facing PLF today is the EOU of the system. Our informants expressed their opinions about the EOU of the PLF system, such as the navigation in the program but also presentation of data on screens can be difficult for farmers to translate. Furthermore, the user seems to be disregarded in the design process of the user interface. This has been seen in both scientific research and data from our informants.

Early on, the balance between developing the system and designing the user interface has been relatively uneven due to not including farmers in the design process and taking in feedback and opinions. Data from the informants showed that some companies are starting to include the farmers during the development of the user interface. Poor EOU is a challenge which affects the user's attitude and intention towards the system, and that can be seen in theoretical findings and the data from the interviews and observation.

Another challenge was revealed within the EOU of PLF. It caused farmers to question the Usefulness of the PLF system. Based on our research, farmers will be positively impacted if they know how the system works and manage it. The Usefulness of the system is there, such as having an automatic milking system which will save the farmer time to use somewhere else. PLF systems are already useful and are still continuously developing. The priority should not be on the Usefulness as it is heavily affected by the EOU. We predict that moving forward, developers of PLF systems will engage with the farmers early on in the development and create a system with a user interface that is user-friendly. In return, farmers will form a positive attitude towards the system and show intentions to use it. The data from the theoretical findings and from the interviews and observation has been consistent with the primary challenge that we found.

We believe that the goal of the research has been achieved but we cannot draw general conclusions as the selection of informants has not been large enough. We identified the impact that PLF can have on the farmers in regards to EOU and Usefulness. We also identified the main challenge which is the EOU of the PLF systems. We interviewed three different organisations with a total of five participants. The results may vary depending on each organisation that develops PLF systems. We believe that our findings were consistent and would most likely be the same in regards to other companies who develop PLF systems. The main issue that we identified will present similar kinds of challenges that we experienced in this study.

This study may form the basis for further research on enhancing and creating a more user-friendly PLF program. The results can be used by organisations developing PLF systems and researchers who are involved in this subject of matter.

7.1.Further Research

7.1.1.Theoretical Contribution

We would like to recommend further research on PLF and EOU, since this is such an important issue for PLF farmers, companies and the future of PLF. Research done in the same field is minimal. The purpose of this study is to examine how farmers are impacted by the use of the PLF system and how they have come to accept the technology. However, the aim of the research was not to solve the issue but to highlight the problem for further research.

The main issue still remains but some companies today try to improve the system by making it more user-friendly by involving farmers in the development phase of PLF. Since the purpose of our study was not to solve the problem, we suggest further research that investigates and focuses on how to solve the problem of EOU in PLF systems. We think there should be more studies concerning the EOU of PLF as there are few studies about this issue today. The PLF systems are useful but the EOU is the main issue as it affects farmers negatively.

There has been little research regarding both PLF and TAM and this study can help other researchers to see the importance of the three major TAM functions. This study can also contribute to advance previous knowledge regarding the importance of education and support of farmers.

7.1.2.Practical Contribution

To examine the issue, the theory of TAM may be used in practice. Working towards the theory of TAM can help developers recognize the issues concerning EOU. To solve the problem, we think that companies should use observations and surveys where they see how the farmer uses the PLF systems. This can be done by including a number of farmers during the development when working with the farmers' perspective. This increases the likelihood that other farmers find it easy to use. More research can lead to a bigger picture of the problem that can help companies find a way to solve the problem of EOU. The PLF area is very broad and fairly new, we believe that there should be further research covering different aspects of PLF.

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9.Appendix

A. Interview Guide - Farmer

Background information

What's your name?

How old are you?

What kind of animals do you have? How large is the herd?

How long have you worked as a farmer? (without and with PLF).

Do you have employees? If so, how many?

Is it only you who can use the PLF system or can the employees also do it?

PLF and its impact

How familiar are you with the concept of PLF?

Why did you decide on this technology?

Was it your decision to install PLF?

How long have you been using PLF?

How was it before compared to now (PLF)? With regard to animals, work situation and other daily activities?

How do you feel that PLF has affected your daily activities?

Did you learn how to use the system when it was implemented? If so, how?

Do you get the support you need when an error occurs? How fast do you get support?

What happens to animals and workers when the technology does not work?

TAM - Ease of Use

How easy is it to use the system? Have you accepted the use of the system?

Are you used to the system? Impact on your activities?

How do you experience the user interface?

How do you think the use of the system can be improved / simplified? With regard to ease of use.

TAM - Usefulness

What are the pros and cons of having a PLF system?

In what ways do you think PLF has improved your work and results?

What are the negative aspects, risks and uncertainties associated with PLF technology?

TAM - External Variables

What was your first impression of the PLF system?

Did you have a positive or negative attitude towards the system? Why?

B. Interview Guide - Others

Background information

What's your name?

How old are you?

How long have you been researching/working in this area?

About PLF

How does PLF work?

What do you assume / think about when developing a PLF system?

How have you tested the system? How did you test it?

How do you know it makes it easier for the farmer?

Of the PLF you have installed, what have you received for feedback from the farmers regarding ease of use of the system (user interface). How do you get feedback?

How do you know what needs the farmer has?

What requirements do you have on the systems?

What will PLF look like in the future?

TAM - Ease of use

Since it is important that the system is user-friendly, how do you develop it in order to make it easier for the farmers to use (in their respective farms environment) as well accept the technology?

Are users involved in an early development phase? Or later?

If the technology has not been accepted by the farmers, how do you go about it?

What can you do to facilitate the use of the system for farmers?

How do you provide support for farmers at the beginning of the implementation?

- What kind of training / education does the farmer need to understand how it works?

TAM - Usefulness

What is the advantage of having this system?

What are the negative aspects, risks and uncertainties associated with PLF technology?

External Variables

How do farmers develop the attitude towards the system? (For example: What triggers an attitude change about PLF, positive or negative?)

Is there any difference among farmers such as age or gender that has shown different types of attitudes towards the system?

C. Informed Consent

Information letter and request for participation in an interview study, entitled:

How has the use of PLF systems impacted the daily activity of the farmers? - A study on Ease of Use and Usefulness.

We are named Ayoub and Jalal and are now studying Business Informatics with a focus on International Marketing and IT at the University of Borås.

The purpose of this study is to examine how farmers are affected by the use of the PLF system and how they have come to accept the technology.

Participation in the study means that an interview will be conducted either at a physical meeting, via Skype, or phone. The interview is expected to take about 40 minutes. The entire interview will be recorded. The interviews are then treated confidentially, which means that the interviews will be de-identified and processed in accordance with the provisions of the Privacy Act. Your participation is voluntary and can be canceled at any time. The study is conducted as part of our education in informatics at the University of Borås. If you agree to participate in the study, we will contact you by telephone to determine a time for meeting and conducting the interview.

Regards

Ayoub Boujrad & Jalal Behnam
University of Borås
Allégatan 1, 503 32 Borås
033-435 40 00

Supervisor: Ia Williamsson
Department for Information Science



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I BORÅS

Besöksadress: Allégatan 1 · Postadress: 501 90 Borås · Tfn: 033-435 40 00 · E-post: registrator@hb.se · Webb: www.hb.se