Decision Enhancement for Poultry Farmers in East Africa

Rebecca Pearl Tumwebaze

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Preface and Acknowledgements

The idea of this research was born from practical decision making challenges faced by poultry farmers in East Africa. The initial trigger was my own experiences as a poultry farmer. As an engaged scholar, I engaged with fellow farmers and other stakeholders in the poultry farming arena to get a clear understanding of the issues affecting the industry and how they could be solved. This research was based on the premise that successful management of poultry farms can only be attained with effective and timely decision making by farmers. In this dissertation, the Poultry Decision Enhancement Studio (PDES) was designed, implemented and evaluated. PDES is based on the continuous interaction of the inter-related processes of poultry farm management in relation to the three major perspectives of a decision enhancement studio (i.e. people, processes and technology). This research makes a contribution to both practice and theory.

Right from childhood, I was taught to follow my passions: to dream about things worth pursuing and go for them. Without this foundation I probably would not have dared to do a PhD while being a working mother of two young children. Right from the beginning of my study, my aspiration was to present a thesis that does not only make a contribution to scientific progress, but that also provides significant contribution to the poultry industry, which I have operated in for the last six years. And I gravely hope that I have achieved this.

I would never have successfully accomplished my PhD without the guidance of the almighty God. Throughout my life's journey, the all-knowing God has guided my every step and has never let go of me. He has given me opportunities that enabled me to do my research to accomplishment. May His name be praised forever! I am also happy to remember and acknowledge the support of my promotors, family, friends, colleagues and institutions from whom I got immense support along this long but fulfilling journey.

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To God be the glory!

Rebecca Pearl Tumwebaze

To Patrick, Thalia and Holly

Table of Contents

PREFACE AND ACKNOWLEDGEMENTS v

CHAPTER 1- THE POULTRY FARMING LANDSCAPE 1

1.1 UNDERSTANDING THE POULTRY INDUSTRY 1
1.2 POULTRY FARMING IN EAST AFRICA 3
1.3 PROSPECTS OF POULTRY FARMING IN EAST AFRICA 5
1.4 CHALLENGES FACED BY POULTRY FARMS IN EAST AFRICA 6
1.5 STATEMENT OF THE PROBLEM 10
1.6 DECISION ENHANCEMENT 10
1.7 RESEARCH QUESTIONS 13
1.8 RESEARCH APPROACH 13
1.9 THESIS OUTLINE 20

CHAPTER 2- POULTRY FARM MANAGEMENT AND DECISION MAKING 23

2.1 THE SCOPE OF POULTRY FARMS IN EAST AFRICA 23
2.2 KEY OPERATIONAL ACTIVITIES AND DECISIONS OF POULTRY FARMERS 24
2.3 DECISION MAKING AMONG POULTRY FARMERS: THEORETICAL PERSPECTIVES 31
2.4 FROM DECISION SUPPORT TO DECISION ENHANCEMENT 34
2.5 APPLICATION OF DSS IN POULTRY FARM MANAGEMENT 36
2.6 DE AND POULTRY FARM MANAGEMENT IN EAST AFRICA 38

CHAPTER 3- EXPLORATION OF POULTRY FARM ENVIRONMENTS 41

3.1 CASE STUDIES 41
3.2 PRESENTATION AND DISCUSSION OF CASE STUDY FINDINGS 46
3.3 FINDINGS FROM CASE STUDIES 53
3.4 FOCUS GROUP DISCUSSIONS 54
3.5 PRESENTATION AND DISCUSSION OF FGD FINDINGS 56
3.6 GENERIC UNDERSTANDING OF DECISION MAKING AMONG POULTRY FARMERS 59

CHAPTER 4 - DESIGNING THE PDES 63

4.1 A DECISION ENHANCEMENT STUDIO FOR POULTRY FARMERS 63
4.2 WAY OF THINKING 66
4.3 WAY OF GOVERNANCE 69

4.4 WAY OF MODELLING 70
4.5 WAY OF WORKING 71

CHAPTER 5 - INSTANTIATION OF THE PDES 89
5.1 INSTANTIATION CONSIDERATIONS 89
5.2 DESCRIPTION OF THE PDES 90
5.3 AUTHENTICITY AND QUALITY OF DATA 107

CHAPTER 6 - EVALUATION OF THE PDES 109
6.1 EVALUATION PARAMETERS 109
6.2 EVALUATION APPROACH 110
6.3 FARMER EVALUATION RESULTS 115
6.4 EXPERT EVALUATION RESULTS 119
6.5 INSIGHTS FROM EVALUATION 123

CHAPTER 7 – EPILOGUE 125
7.1 THESIS OVERVIEW 125
7.2 REFLECTION ON RESEARCH APPROACH 130
7.3 RESEARCH CONTRIBUTION 132
7.4 GENERALIZABILITY OF THE PDES DESIGN 135
7.5 DIRECTIONS FOR FURTHER RESEARCH 137

REFERENCES 139

APPENDIX A - INTERVIEW SURVEY AND LETTER TO RESPONDENTS 163

APPENDIX B - PDES EVALUATION QUESTIONNAIRE FOR FARMERS 169

APPENDIX C - PDES EVALUATION QUESTIONNAIRE FOR EXPERTS 175

SUMMARY 179

SAMENVATTING 183

CURRICULUM VITAE 187

List of Figures

Figure 1 - 1: Decision Enhancement: The fusion of people, process and technology 11
Figure 1 - 2: Decision Enhancement – A field of Practice (Keen and Sol, 2008) 12
Figure 1 - 3: Strategy of abductive reasoning (Sol, 1982) 18
Figure 2 - 1: A description of poultry farmers' operations 25
Figure 4 – 1: Overview of the PDES 65
Figure 4 - 2: Framework to assess design approaches (Source: Sol, 1988) 66
Figure 4 - 3: Activity flow diagram of the planning suite 80
Figure 4 - 4: Activity flow diagram of the purchasing suite 81
Figure 4 - 5: Activity flow diagram for the rearing suite 82
Figure 4 - 6: Activity flow diagram for the feed mixing sub-suite 83
Figure 4 - 7: Activity flow diagram for the health management sub-suite 84
Figure 4 - 8: Activity flow diagram of the marketing suite 85
Figure 4 - 9: PDES Use-Case Diagram 87
Figure 5 - 1: A screen shot of the PDES main page 91
Figure 5 - 2: A Screen shot showing the budget service of the planning suite. 94
Figure 5 - 3: The supplier catalogue in the purchasing suite of the PDES 95
Figure 5 - 4: The "KPI reports" service in the rearing suite 99
Figure 5 - 5: The feed mixing sub-suite helps the farmer to generate feed formulations 100
Figure 5 - 6: The advertisement service in the marketing suite 103
Figure 5 - 7: The chatroom service on the PDES 106
Figure 5 - 8: A screen shot of the PDES dashboard 107
Figure 7 - 1: Research methods applied in the study 132

List of Tables

Table 1-1: Global chicken meat production (in million tonnes) 3
Table 1-2: Research instruments and outcomes of the research phases 19
Table 3-1: A description of farms which participated in the case study interviews. 44
Table 3-2: Important poultry farm activities where decisions are made 46
Table 3-3: Responses on performance indicators used for decision making 48
Table 3-4: Information sources during decision making 50
Table 3-5: Poultry farmers' decisions in the context of DTM 60
Table 4-1: The actors (people) on the PDES and corresponding roles 68
Table 4-2: PDES Suites and their functions 71
Table 6-1: Participants of the Evaluation Exercise and their Roles 111
Table 6-2: List of experimental tasks for poultry farmers 113
Table 6-3: Farmer evaluation results of PDES usefulness (positively formulated statements) 115
Table 6-4: Farmer evaluation results for PDES usefulness (negatively formulated statements) 117
Table 6-5: Farmer evaluation of the PDES usability (positively formulated statements) 117
Table 6-6: Farmer evaluation of the PDES usability (negatively formulated statements) 118
Table 6-7: Expert evaluation results of perceived usefulness of the PDES (positively formulated statements) 120
Table 6-8: Expert evaluation results of perceived usefulness of the PDES (negatively formulated statements) 120
Table 6-9: Expert evaluation results of perceived usability of the PDES (positively formulated statements) 121
Table 6-10: Expert evaluation results of perceived usability of the PDES (negatively formulated statements) 121

Chapter 1- The Poultry Farming Landscape

Because of agriculture's direct link to global food security, it is strategically important. This research recognizes the importance of a paradigm shift from subsistence to commercial agriculture for Africa to advance this strategic importance. This shift has particularly had significant impact on the poultry industry. The focus of the study is decision enhancement for poultry farmers to be able to efficiently monitor and manage their operations as they seek to take advantage of the trend of commercialisation of the poultry industry.

This chapter discusses the trends in the poultry industry and focusses on the East African region. It points out the challenges faced by poultry farmers in East African thereby leading to the research problem this study seeks to address. The chapter also discusses the research objective, questions and presents the research approach that was followed throughout the study. The chapter concludes by presenting the thesis structure.

1.1 Understanding the Poultry Industry

In the 21st century, management tasks in agriculture have gradually shifted to a new paradigm requiring increased attention to economic viability and the interaction with the surroundings (Dalgaard et al., 2006). This has been brought about by the evolving transformation of agriculture from largely subsistence to commercial and profit enterprises across Africa. McElwee (2008) described an emerging group of farmers who are highly opportunity-aware and often employing a variety of business strategies to ensure business success. Commercialisation in the poultry industry and generally in the agriculture sector has increasingly become popular in East Africa, mainly as an entrepreneurial response to income growth in the region (Katongole, et al., 2013; Ishagi et al., 2002). Benson & Mugarura, (2013) as well observed a growing number of economically progressive farmers in the region, which confirms a shift in trends from previous subsistence agricultural systems which focussed more on catering for the households rather than the business aspects.

The shift has even been more pronounced in the poultry industry particularly with the increased popularity of chicken and eggs in boosting protein nutrition and economic empowerment of people on the African continent (Kingori, 2011).

World over, there is a growing preference for white meat to red meat due to the ecological, economic, social and health advantages associated with the former (Gueye, 2002). This has led to the growing commercialization of the poultry industry which has been pioneered by the first world and is already gaining momentum in the emerging economies, Africa inclusive. In the United States of America alone, chicken, which was once a distant third to beef and pork is now the most popular meat (Johnson, 2013; Pew Environmental Group, 2011). Other world leaders in poultry production are China, Brazil, Russia and Mexico (Valdes et al., 2015).

The poultry industry has also undergone both scientific and technological advances to meet its high commercialization growth rate. Chicken are now products of intense genetic selection with rapid and efficient growth and high rate of production (Renema & Robinson, 2004). In many first world countries across Europe and America, farms using high scale technologies are already enjoying the benefits of industrial poultry production. In many of the Asian countries such as China and India, the poultry industry is one of the fastest growing segments of the agricultural sectors. In these countries, extensive research has also been done in various fields of poultry production e.g. breeding (Kanginakudru et al., 2008; Parmar et al, 2006), nutrition (Klasing, 2005) , healthcare (FAO, 2008; Bagust, 1994 and management (Ramaswami et al, 2005).

The poultry industry in Africa has been growing steadily as well but still lags behind compared to the other continents. Though poultry production is widely practiced, it is mainly in small holder/backyard systems, which are characterized by low input and low output (FAO, 2011). The continent continues to import not only poultry but other agricultural products (Trostle & Seeley, 2013). Chicken imports across Africa continue to grow. In South Africa for example, chicken imports increased from 63,560 metric tons in 2001 to 354,728 metric tons in 2013 (Zhuang & Moore, 2015). China and Brazil are by far the biggest exporters of poultry products into Africa.

The last decade has however seen African poultry farmers take to commercial production systems to be able to take advantage of the opportunities in the industry. According to FAO, (2013), chicken meat production in Africa between 2006 and 2013 increased steadily by almost 5% per year. As global growth during this period averaged a little below 4% per year, Africa increased its contribution to the world total to 5.1% in 2013 (see Table 1).

Table 1-1: Global chicken meat production (in million tonnes)

Region	2006	2007	2008	2009	2010	2011	2012	2013
Africa	3.4	3.7	4.0	4.2	4.5	4.6	4.7	4.7
America	33.7	35.0	37.4	36.7	38.6	39.9	40.4	41.2
Asia	23.5	25.0	26.2	28.0	29.1	29.8	30.3	30.7
Europe	10.8	11.6	12.1	13.3	13.9	14.6	14.9	15.2
Oceania	1.0	1.0	1.0	1.0	1.1	1.2	1.3	1.3
World	72.3	76.2	80.6	83.3	87.2	90.0	91.6	93.2

Source: (FAO, 2013)

Across East Africa, poultry farming is equally growing with more farmers tending towards commercial rearing. The next subsection zooms in to the extent of poultry farming in East Africa with special focus on the prospects and challenges of the industry in the region.

1.2 Poultry Farming in East Africa

East Africa is the easterly region of the African continent constituting about 20 countries. Like most of Africa, poultry production in the East African region has been largely subsistence with the indigenous chicken accounting for about 70% of the total flock in the region (FAO, 2013; FAO, 2011; Kyarisiima et al, 2004). However, in recent years, this trend has significantly changed with increasing poultry flock numbers and more commercial farms being registered (FAO, 2011). Over the last decade, poultry production has continued to be very dynamic and has been typified with unprecedented growth across the East African region. This illustrates the shift from subsistence to commercial poultry farming.

Sonaiya & Swan, (2004) provide a clear distinction between commercial poultry farms and rural or subsistence poultry farms. According to them, subsistence poultry farms often have a flock of less than 100 indigenous birds, largely operate informally and in most cases do not employ salaried labour. They characterise commercial poultry farms as those rearing hybrid birds which are specially hatched for optimal meat or egg production. These hybrids are normally confined in either houses or cages and they require high balanced feed for optimal production; crucial veterinary hygiene and disease management; supplementary artificial light particularly for the egg laying birds; and artificial brooding. In this study, we use the

above description of commercial poultry farms by Sonaiya and Swan (2004) to define the scope of this research. We are further informed by FAO (2011) who emphasizes that commercial poultry farms involve high initial investment unlike backyard/subsistence poultry farms which are largely characterised by low input and low output. From this, we describe the poultry farmer considered in this research as one who rears over 100 birds, is concerned with the financial investment involved and pays explicit attention to the management of his/her poultry farm as a profit venture. This kind of farmer therefore must be concerned with aspects of housing, feeding, hygiene and disease management as raised by Sonaiya and Swan (2004)

In Uganda, the national chicken flock grew two-fold from 23.5 million in 2005 to 45.9 million in 2012 (Pew Environmental Group, 2013; UBOS, 2010). The figures for poultry heads in the country are much higher compared to other livestock (Pew Environmental Group, 2013). In Kenya, the poultry industry is equally growing and is one of the most popular livestock enterprises contributing about 7.8% of the total GDP ((RoK, 2007). The country has over the last decade continuously registered high poultry flock numbers in urban centres such as Nairobi where commercial poultry farming is highly practiced (RoK, 2007), which positions the poultry industry as a relevant income generating activity in Kenya. The growth of the poultry sector in Tanzania is also noteworthy. The number of day old chicks produced by hatcheries in Tanzania increased from 61 million in 2013 to 63.1 million in 2014 (NBS, 2014). The country has seen new and heavy investments in poultry breeding and hatcheries over the last five years which may explain why egg production increased from 3.3 billion eggs in 2010 to 4.15 billion eggs in 2014 (NBS, 2014). In Ethiopia the poultry industry was also largely characterised by traditional poultry production systems but has started registering a growing number of modern commercial farms (Demeke, 2008). The government of Ethiopia has in fact been playing an active role of promotion of poultry production to support poverty alleviation and food security initiatives (Demeke, 2008).

The above scenarios from the four East African countries are reciprocated across the wider East African region. They elucidate why economies of the East African region are coming up with innovative ways of boosting and supporting poultry farms and other agricultural enterprises to grow in scale (FAO, 2011). For example, Uganda's current policy framework of the poultry sector is guided by the Plan for Modernization of Agriculture (PMA), which seeks to convert subsistence farming into commercial farming (Ekou, 2013); while in

Rwanda, the Framework for Livestock Development seeks to enhance commercial livestock enterprises. The necessity of enhancing a sustainable poultry sector in East Africa is made even more relevant by the global context surrounding the industry.

While governments have up scaled their efforts towards supporting the growth of the poultry industry, little is known about the systems currently in place in East Africa for farmers to easily and successfully adapt from subsistence/ free range poultry production to managing high value commercial farms.

1.3 Prospects of Poultry Farming in East Africa

There is a general increase in population not only in East Africa but across Africa and globally. Africa makes up more than 15% of the world's population but contributes less than 5% of global egg production (FAO, 2011). The growing African and world's population directly leads to increasing food demands. Generally, there is increased preference for poultry products given the ecological, economic, social and health advantages they have over other types of food stuffs (Gueye, 2002). Poultry products rank highly in terms of protein quality (Prabakaran, 2003). Eggs have very high protein quality, contain amino acids required in the diet of a human being and they can also be readily included in a nutritionally balanced low-calorie diet since they are low in calories (Prabakaran, 2003). Poultry meat also contains more protein than its red meat counterparts and contains less cholesterol (Prabakaran, 2003). This explains the shift of consumer preferences to poultry products and the prospects of a big African and global market for poultry products which East African countries can tap into as they seek to grow their economies.

With the surging population growth, land is becoming a scarce resource. Poultry farming is not dependent on availability of large pieces of land unlike other livestock like cows, goats, sheep among others (Prabakaran, 2003). In fact, Lambin and Meyfroidt, (2011) substantiated the need for efficient land use allocation and innovation in agriculture to address issues of land scarcity. During the later period of the 20th century, more than half of the new agricultural land across the tropics came at the expense of forests, and another 28% came from disturbed forests (Gibbs, et al., 2010). With issues of global warming and other environmental concerns, intensive agricultural systems which use less land but reap high benefits have to be adopted. The poultry industry can be one of such systems.

Besides the high market demand already demonstrated above, poultry flocks also have short turnover rates compared to other livestock (Hamra, 2010) and enjoy economies of scale as most of their costs generally decrease with increasing scale (Ojepado, et al., 2012). The lifecycle of an egg-laying chicken flock usually covers a span of about seventy weeks while a broiler flock can be sold off with in a period of six to eight weeks. Because of this, poultry farmers are able to recover their revenue faster compared to other livestock farmers.

From this discussion, it is clear that poultry farming has high prospects in East Africa and can provide various opportunities like creation of employment, improved nutrition, poverty alleviation, improved livelihoods and economic growth.

1.4 Challenges Faced by Poultry Farms in East Africa

While poultry farms are faced with a wide range of opportunities and prospects as discussed in section 1.3 above, they have also been faced with various challenges which have held back the growth of the poultry industry. Unless strategies are put in place to address these challenges, the prospect of East African economies reaping high from the poultry industry remains blurry. Some of the challenges are discussed in this section:

High feed cost, poor quality and availability:

Farmers are faced with challenges of feed scarcity, quality and price fluctuations (Katongole, et al., 2013; Katongole et al, 2011). Feed costs account for about 70% of a poultry farm's costs (Katongole, et al., 2013; Walker & Gordon, 2003; Gopalakrishnan & Mohanlal, 1994) hence any increase in cost or changes in availability or quality largely affects farmers' revenue. The prices of feeds in the East African region are highly susceptible to fluctuations leading to unstable returns for poultry farmers. Currently, chicken compete with humans for their primary feed ingredients such as maize, soya bean and fish, which makes such feed ingredients scarce and expensive. In Uganda for example, from September 2010 to September 2011, the price of maize bran, a major source of energy for chicken, increased by 400%, forcing farmers out of business (Kyesimira & Batte, 2011). Challenges stemming from feed cost, quality and availability cast a shadow of uncertainty among poultry farmers as this is a key input of the production process.

Supply of poor quality chicks:

Reddy, (1991) observed that there is no strict and compulsory quality control measures either in hatcheries in the market for most countries in Africa. With day old chicks as the major production input, poor quality of the same becomes a major setback for the farmers. The problem is often acerbated by the fact that poor quality chicks are not always realized early enough until a considerable level of costs has been incurred in raising the chicks (Adeyemo & Onikoyi, 2012). Due to this, farmers lose a lot of revenue which discourages them from further investment into large scale production.

Wide gap between local demand and supply of grandparent stocks:

East African countries like most of Africa import grandparent stock and eggs for hatching (FAO, 2009). This has been carried out without following strict legislative control leading to outbreaks of diseases that were either not known or did not previously exist in the region (Adeyemo & Onikoyi, 2012). Importing of grandparent stock is also a sign that the region lacks capacity to maintain supply to its farmers independently.

Lack of sufficient regulation:

Probably due to the traditional mentality often attached to poultry farming, there has been little attention directed to veterinary policies. No comprehensive laws or policies have been established in most East African countries (Msoffe & Ngulube, 2015; FAO, 2009). In Uganda for example, there is lack of specific attention to poultry as far as agribusiness policies are concerned (FAO, 2009). Adei & Asante, (2012) also observed a general lack of an adequate legislative environment to support efficient functioning of poultry farms which is reciprocated in most African countries. The need for a strong policy for any sector is very crucial.

Limited use/application of technology:

Farming across Africa is in the midst of major transformations in both technology and production practices (Roucan-Kane et al., 2010). According to Batte, (2005), farmers are now able to use computers and software systems to organize their financial data, keep track of any transactions with third parties and monitor farm business processes more effectively. In fact, ICT is universally regarded as an essential business tool. In agriculture, ICT can be used to meet information, communication and knowledge needs of farmers aimed at improving the quality of decisions they make throughout their business processes. Unfortunately the use of

ICT has not yet been widely adopted by farmers in East Africa (World Bank, 2008; 2007). Yet it has been noted that any ICT interventions that improve decision making of farmers will likely have significant direct and indirect impact on enhancing agricultural production (Aregu, 2014).

Inadequate information availability:

In agriculture, the role of information in enhancing productivity and development is crucial. The poultry industry equally has a strong reliance on information exchange among farmers and other stakeholders. Singh et al. (2011) noted that for farmers in Africa to be able to comfortably compete on the global market, they require to always be up to date with all relevant information concerning their processes and other mediating factors. In the East African region, like most African countries, farmers' biggest source of information is their social network, which includes fellow farmers, neighbours and other players in their environment (Chaudhry et al., 2008; Edeoghon et al., 2008; Nosheen et al, 2010). Unfortunately, sometimes the members of this social network may not necessarily be credible especially because of a general lack of agricultural information or education programmes in the region (FAO, 2009). In fact, most farmers have largely built their knowledge base from experience. Msoffe & Ngulube (2015) also noted that information gaps among farmers have hindered successful running of poultry enterprises. The poultry industry therefore requires a systematic approach of farm management largely supported by information availability and dissemination to the farmers as this influences effective and efficient decision making.

Inadequate Farm Management Competences:

The aim of management is to provide conditions that ensure optimum performance of a business (Bell & Weaver, 2001). Unfortunately, modern management approaches have been widely applied in different industries but not routinely applied to agricultural production (Corkery et al., 2013). Unlike the case with backyard poultry systems, it is vital that commercial poultry farms are managed with the highest possible efficiency standards because of the high cost of inputs and the need for farmers to realize profit to keep business running. Unfortunately, poultry farms in East Africa are largely characterised by inadequate management practices (Msoffe & Ngulube, 2015; Karanja, 2014).

High diseases prevalence:

Diseases are a major encumbrance affecting the pace of the growth of the poultry industry in East Africa and the wider African continent (Natukunda et al, 2011; Adei & Asante, 2012). And yet, the prevalent diseases in these countries are not any different from poultry diseases in other parts of the world (Orsi, et al., 2010). Unfortunately farmers in most of Africa face a problem of inadequate poultry rearing knowledge (Jamali et al., 2011); which would be instrumental in helping them adapt disease prevention and control measures. While studying the extent of the damage of New Castle disease in Tanzania, Sonaiya and Swan (2004) observed that the disease is capable of causing up to 100% mortality in unprotected flocks. This is the same for most poultry diseases as they are highly infectious. Poultry diseases cause other secondary problems for farmers which include poor production performance, increased mortality rates, and increased medication costs which dig into the farm's revenue. It is important that farmers be supported to adopt disease prevention and control approaches in their management strategies through periodic vaccination, adoption of bio-security measures and real time monitoring to be able to curb diseases before they spread to the entire flock. FAO (2009) recommended training and education of farmers for them to be able to prevent and control poultry diseases.

Concerns about environmental pollution:

Increasing poultry production levels pose severe pressure on the environment via the emissions to air, water and soil. Today, the livestock sector is responsible for about 15% of the global anthropogenic emissions of greenhouse gases, besides using about 70% of all agricultural land (de Olde & de Boer, 2014; Steinfeld et al., 2006). Adeyemo and Okinoyi (2012) highlighted that waste management as one of the major challenges of poultry production in Africa. Large quantities of poultry waste continue to be generated on continuous basis in poultry production systems to the extent of the intensity of operation, posing a challenge concerning sustainability.

Inadequate poultry extension services:

Due to a general shortage of agricultural extension agents in East Africa, most farmers lack adequate guidance from poultry extension workers (Adeyemo and Onikoyi, 2012). Extension agents are instrumental in passing on key information to farmers and offering them relevant support in their business processes.

1.5 Statement of the Problem

From the discussion so far, we note that in spite of the prospects and opportunities of the poultry industry in the East African region, poultry farmers are faced with challenges which threaten further growth and sustainability of the industry. We also note that poultry farmers operate in a volatile and complex business environment because of the challenges they face, which must equally impact their ability to make effective and timely decisions. Msoffe and Ngulube (2015) and Karanja (2014) observed that poultry farms in East Africa are already largely characterised by inadequate management practices which is mainly caused by a lack of adequate systems to guide farmers in decision making. Begum et al (2010) classify a poultry farm as a decision making unit, in which farmers must make decisions concerning management of the farm and its flocks.

While East African governments seek innovative ways of supporting poultry farms to grow in scale (FAO, 2009), the farmers' decision making capabilities are hindered by the complexities that come with the challenges discussed in section 1.4 above. Sustainable growth of the poultry industry in the region should be underpinned by approaches that are integrated and responsive to the volatile and complex settings in which poultry farmers operate. Unfortunately little is known about the approaches and systems currently in place in East Africa to enhance farmers' decision making in poultry farm management.

1.6 Decision Enhancement

Decision Enhancement (DE) of Keen & Sol (2008) is grounded from sound theory and proven practice that is underpinned by the application of principles and tools for implementing Decision Support Systems (DSS). Keen and Sol (2008) define DE as a "management lens or way to look out at the dynamic and volatile domains of complex private and public sector decision-making and, increasingly, their interdependencies and necessary collaborations". DE aims at enhancing decision making processes through professional practices that fuse human skills and technology (see figure 1-1); bringing together the best of executive judgment and experience with the best computer modelling, information management and analytic methods while facilitating scenario building and evaluation, collaboration and simulation to rehearse the future as illustrated in the Fig. 1-2 (Keen and Sol, 2008).

Keen and Sol (2008) instituted decision enhancement following a studio-based approach as an improvement in the decision support systems research field focusing on ill-structured and complex decisions termed as decisions that matter. The concept of a studio is defined as a facilitative, interactive environment or shared space or forum designed around a process or processes, that contain a set of integrated tools/technologies that enable stakeholders (people) to interactively collaborate to generate and analyse possible solutions to a given problem (Keen and Sol, 2008). Keen and Sol (2008) further explain that decision enhancement studios are (virtual) environments in which people, processes and technology are brought together to improve collaboration and enhance complex decision making in a specific domain. Studios facilitate decision making processes by providing a collaborative and interactive work space using suites (i.e. integrated sets of technology) and sets of guidelines. A suite of software services is the foundation for meshing technology and process (Keen and Sol, 2008). Suites contain domain specific information and communication services, which form building blocks and support recipes for repeatable processes (Katumba, 2016; Keen and Sol., 2008). Studios and suites comprise of services to the people that make the decisions but not a technical product as is with decision support systems (Keen and Sol, 2008).

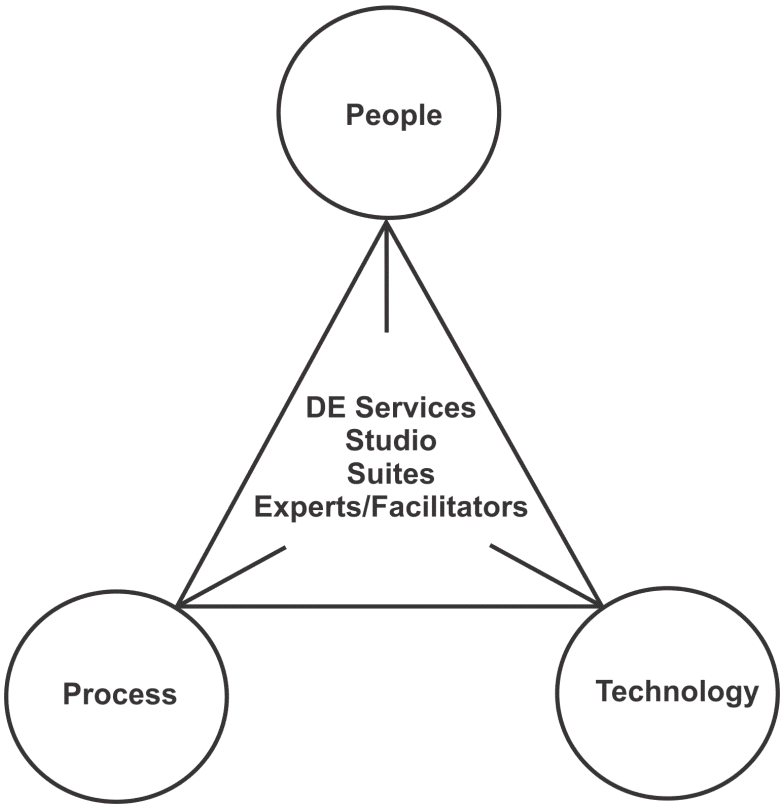

Figure 1 - 1: Decision Enhancement: The fusion of people, process and technology

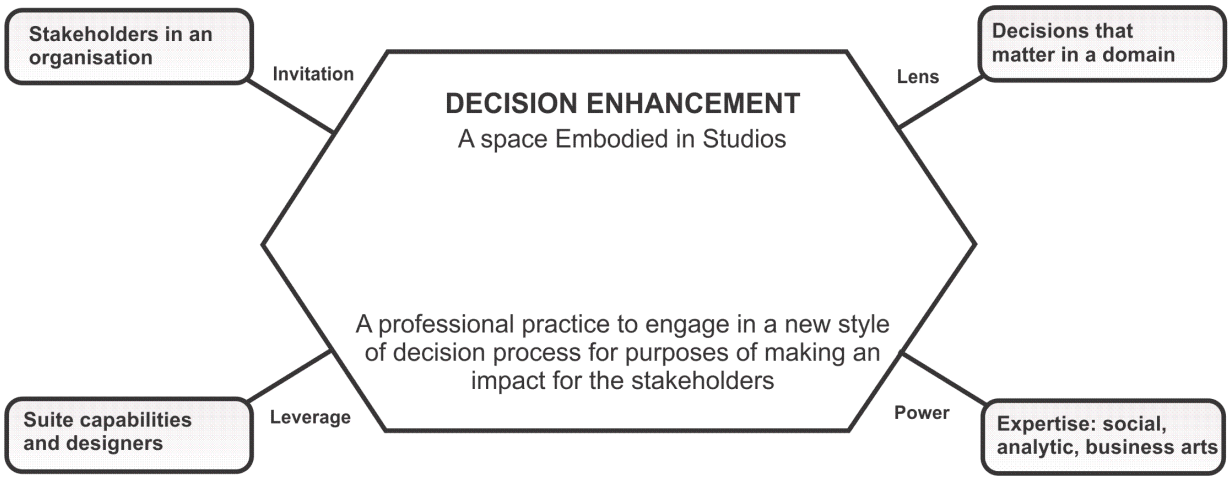

Figure 1 - 2: Decision Enhancement – A field of Practice (Keen and Sol, 2008)

The concept of DE is not new to solving complex problems in East Africa. Several researchers addressing decision making challenges in various domains have applied decision enhancement successfully. Mulira (2007) designed a studio that supports inter-organizational service systems in volatile environments. This studio enhances decision making within inter-organizational service systems among independent actors with diverse, technical infrastructure and scarce resources. Amiyo (2012) handled a complex situation of increased demand for business process agility in organizations in Uganda and developed a Business Process Agility Decision Enhancement Studio (BPA-DES) that provides business process analysis, simulation, collaboration and communication services. With the increased demand for business process agility in organisations, Amiyo's BPA-DES supports continuous business process improvement and enhances organisations' ability by enabling timely identification of improvement opportunities. Ssemaluulu (2012) designed and evaluated a studio for assessing information systems (IS) success in developing countries. This studio enables managers and other users of IS to collaborate in assessing IS with an aim of avoiding potential failures of IS. Ejiri (2012) handled a complex situation of enhancing start-up processes of small medium enterprises in rural Uganda with a decision enhancement studio, which consists of services for participants in an interactive environment. This studio facilitates the mining knowledge service centres in their enterprise start up role in Uganda and could also be equally helpful in countries with similar contexts. Mirembe (2015) on the other hand used the decision enhancement approach to design the ThreNet tool to address the practical challenges of coordinating actors during the threat analysis process. The ThreNet tool provides recipes to security experts on how to infer threat likelihood of vulnerabilities

and threats, threat business impact and return on investments in threat mitigation controls. Katumba (2016) developed a decision enhancement studio to support sector managers at the strategic, tactical and operational levels to enhance decisions in asset management among water utilities. These studies substantiate DE as a credible approach for increasing decision process agility in volatile and complex environments. This study therefore is based on the premise that a decision enhancement studio can be instrumental in facilitating poultry farmers' decision making agility considering the complex and volatile business environment in which they operate.

1.7 Research Questions

Considering the steady growth of poultry operations in East Africa, little attention has been paid to the decision making processes of poultry farmers across their operations. Therefore, the key research question this thesis seeks to address is:

How can decision making among poultry farmers in East Africa be enhanced?

In order to provide definite direction and to guide a deeper investigation of the problem domain, the following specific research questions were derived from the key research question to guide this study:

1. What are the key processes involved in the operations of poultry farms in East Africa?
2. What factors influence the poultry farmer's decisions throughout these processes?
3. How can we design a studio for decision enhancement for poultry farmers in East Africa?
4. How can we evaluate the perceived usefulness and usability of the decision enhancement studio for poultry farmers?

1.8 Research Approach

A research approach defines how a researcher conducts his/her research highlighting the philosophy, strategy, research methods and instruments or techniques that are used throughout the research (Galliers, 1992). Following the philosophies of design science

research and engaged scholarship and a strategy of Singerian inquiry in a pragmatist abductive framework, this research was undertaken to provide solutions to the identified problems as discussed in subsequent subsections.

Research Philosophy

A research philosophy forms the ideological basis of a methodology. This study used the research philosophy of engaged scholarship (Van de Ven, 2007) and adopted key principles of design science research (Hevner & Chatterjee, 2010). The choice is because of the significance of both philosophies in addressing key challenges within the information systems discipline in a way that addresses the gap between practice and theory.

Engaged Scholarship is "a participative form of research for obtaining the different perspectives of key stakeholders (researchers, users, clients, sponsors and practitioners) in studying complex problems" (Van de Ven, 2007). A relevant response to Information Technology failure to impact practice (Costello & Donnellan, 2012), engaged scholarship expands the capabilities of scholars to study complex problems and create the kind of knowledge that advances both science and practice (Van de Ven, 2007). The choice of engaged scholarship in this study was inspired by the need for action oriented solutions to the problems faced by poultry farmers in East Africa.

With engaged scholarship, research is not a solitary exercise but rather a collective achievement. The poultry industry in East Africa is quite complex and this study engages different groups of people whose perspectives are relevant in the different activities with an aim of advancing fundamental knowledge in achieving impactful research. The different people include poultry farm managers, poultry farmers, product consumers, experts like veterinary doctors and animal nutritionists, suppliers of poultry farm inputs, industry regulators and farmer group associations among others. Henrickx (1999) asserted that engaged scholars adopt a participant frame of reference to learn about and understand a subject through discourse with other stakeholders.

Design Science is a "research paradigm in which a designer answers questions relevant to human problems via the creation of innovative artefacts" (Hevner & Chatterjee, 2010). The creation and implementation of innovative artefacts in design science enhances the

performance of business organizations (Hevner & Chatterjee, 2010; March & Storey, 2008) and should enhance performance of poultry farms in the case of this research.

Artefacts can be constructs, models, methods or instantiations (March & Smith, 1995). As constructs, they provide a formal representation of problems and solutions; as models, artefacts use constructs and abstractions to facilitate the understanding of problems and solutions; as methods, artefacts provide procedures for problem solving; and as instantiations, artefacts demonstrate the feasibility and effectiveness of solutions through implementations, prototypes and expert evaluations. The design artefacts are achieved through developing theories and artefacts, and evaluating these artefacts/theories to assess effectiveness and efficiency of the solution through simulations, experimentation, case studies among others. Information technology artefacts can indeed be seen as enablers of business strategy and organizational infrastructure (Orlikowski & Barley, 2001). In information systems, design science research involves the construction of a wide range of socio-technical artefacts such as decision support systems, modelling tools, governance strategies, methods for information systems evaluation and information systems change interventions (Gregor & Hevner, 2013). This study focuses on designing/building an artefact for decision enhancement among poultry farmers.

Largely viewed as a problem solving philosophy, design science adds relevance and meaning to information science and business research thereby bridging the practice-theory gap that has largely characterised research previously (Holmstrom et al., 2009; Benbasat & Zmud, 1999).

The Design Science research philosophy embodies three closely related cycles: The ***Relevance Cycle*** inputs requirements from the contextual environment into the research and introduces the research artefacts into environmental field testing. The ***Rigor Cycle*** provides grounding theories and methods along with domain experience and expertise from the knowledge base into the research and adds the new knowledge generated by the research. The ***Design Cycle*** supports the aspect of research for the construction and evaluation of design artefacts and processes.

Gonzales and Sol (2012) highlighted three epistemological choices available for design science research projects as positivism, interpretivism and pragmatism, with corresponding ontological positions. Epistemology is the study of knowledge and is concerned with the

origin, nature, limits, methods and justification of human knowledge (Hofer, 2000) while ontology is the study of being (Bryman & Bell, 2011) and is concerned with the nature of reality (Mertens, 2005).

According to Stahl (2003), ***positivism*** is a research approach that is based on the ontological doctrine that reality is independent of the observer. Positivist researchers believe that "the truth is already there" (Gonzalez & Sol, 2012; Wynn, 2000). Positivist approaches rely immensely on experimental and manipulative methods; thereby detaching the subjective biases of the researcher and his/her objective reality (Cohen & Crabtree, 2006). The positivist paradigm mainly uses quantitative methodology and utilizes experiments and tests to enhance credibility (Taylor & Medina, 2013). The fact that positivism can only investigate phenomena that are already created has however faced wide criticism (Stahl, 2003).

Interpretivism on the other hand gives an in-depth understanding of the research problem (Gonzalez & Sol, 2012) because both the subject matter and the researcher are actively involved (Nandhakumar & Jones, 2002)). Interpretivist researchers assume that "reality is socially constructed and the researcher becomes the vehicle by which this reality is revealed" (Andrade, 2009). Unlike positivism, interpretivism uses qualitative analysis. The interpretivist paradigm assumes a value-neutral stance and always implicates the researcher in phenomenon being studied (Orlikowski & Baroudi, 1991). Interpretivism can also be related to the ontological position of *relativism* which "holds that reality is a subjective construction of the mind" (Hirschheim, 1992, p13). However, interpretivism has largely been criticized for lack of generalization, (Lee & Baskerville, 2003) which is often perceived as undermining the doctrine of science and rationality (Mingers, 2004).

The essence of ***pragmatism*** is actions, which must be guided by knowledge (Goldkuhl, 2012). Basically, pragmatism uses acquired knowledge as a tool for action and evaluates it to serve human interests (Cornish & Gillespie, 2009). "To a pragmatist, the mandate of science is not to find truth or reality, the existence of which are perpetually in dispute, but to facilitate human problem-solving" (Powell, 2001). Goldkuhl (2012) pointed out that pragmatism is associated with action, intervention and constructive knowledge. Unlike the interpretivists and positivists, pragmatists utilize pluralist research methods (both quantitative and qualitative methods). Pragmatism has however been critiqued for lacking common philosophical standards for theory evaluation. According to Orlikowski & Baroudi (1991),

ambiguity of evaluation may be difficult for proponents of the dominant research tradition to accept, given their experience with positivism's relatively unambiguous criteria for what constitutes valid knowledge".

This research draws on the epistemological choice of pragmatism integrated with ontological realism. While epistemological pragmatism facilitates problem solving (Mingers, 2004), ontological realism facilitates appreciation of the underlying perceptions, theories and constructions that exist in the real world independent of the researcher's ideas.

Research Strategy

A research strategy provides the overall direction of the research including the process by which the research is conducted (Remenyi et al., 2003). Research strategies underline five inquiry systems: Leibnizian, Lockean, Kantian Hegelian and Singerian inquiry systems (Amiyo, 2012; Lester, 2005; Sol, 1982; Mitroff, 1973). Given the ill-structured nature of the decision making problem in poultry farm management in the complex and volatile business environment of East Africa, a research strategy based on Singerian inquiry in a pragmatist framework of abductive reasoning was adopted in this study.

While abductive reasoning is substantial because of its ability to generate hypothesis about the observations or with reasoning to the best explanation (Schvaneveldt & Cohen, 2010), Singerian inquiry entails a constant questioning of assumptions (Lester, 2005), which is important to the pragmatist nature of this research. According to Wijnhoven (2013), Singerian pragmatism is an epistemology and ethical theory stating that the value of knowledge should be expressed in terms of how the knowledge improves the human interaction. This study indeed seeks to develop a solution for decision making in poultry farm management based on both theoretical and practical knowledge of the industry in the East African context. Since this study has special focus on practical problem solving, the Singerian inquiry in a pragmatist abductive reasoning framework can be seen to fit it best. As Schvaneveldt and Cohen (2010) put it, an identified problem in research motivates a search for a solution; abductive reasoning in our case guides the search for potential solutions after clear problem identification. The framework will follow five major steps of initiation, abstraction, theory formulation, implementation and evaluation (Sol, Simulation in information systems development, 1982) (see figure 1-3).

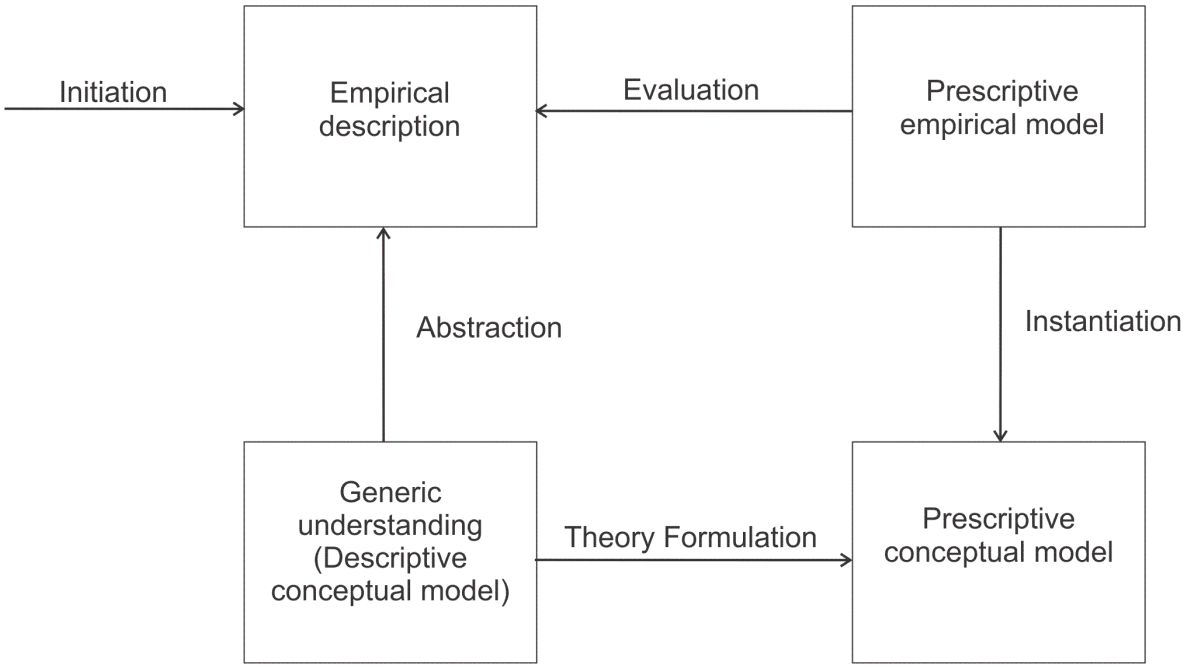

Figure 1 - 3: Strategy of abductive reasoning (Sol, 1982)

Initiation: This study was concerned with the decision making challenges in the management of poultry farms in the East African region. The initiation stage mainly involved pilot case studies, preliminary interviews and literature review with an aim of scoping, formulating and grounding of the problem. The output of this stage was an empirical description of the problem.

Abstraction: At this stage, exploration was carried to gain a generic understanding of the problem domain. Exploration included farm visits, observation, structured and semi-structured interviews with farm managers and farm owners and focus group discussions with farmers and selected stakeholders of the poultry industry. The information gathered from exploration was analysed to identify key decisions in poultry farm management, the decision processes involved, the decision influences and the challenges farmers encounter in decision making throughout their operations. This information was generalised to the East African region. The output of this phase was a generic understanding of poultry farm operations and poultry farmers' decision making practices in East Africa.

Theory building: In theory building, we departed in orientation from problem formulation to problem solving. The target of theory building was to formulate an appropriate solution for the conceptualised problem (Aregu, 2014). At this stage, the output was a prescriptive conceptual model. This is the design of the Poultry Decision Enhancement Studio.

Instantiation: This stage covers implementation of the studio design derived from the theory formulation stage. In this study, the implementation outcome is an empirical prescription. In theory, an empirical prescription implies putting the conceptual prescription into practice (Van de Kar E. A., 2004), which in this research was achieved by deploying the Poultry Decision Enhancement Studio for poultry farmers packed with suites of services and recipes.

Evaluation: The Poultry Decision Enhancement Studio was subjected to testing and assessment among a team of selected poultry farmers and experts in the domains of information systems and poultry farm management. The aim of the testing was to evaluate perceived usability and usefulness of the studio in enhancing poultry farmers' decisions.

Research Instruments

Instruments are described as specific methods that are used to execute research strategy. Table 1-2 shows the different instruments which were adopted at the different phases of this research as well as the corresponding outcomes.

Table 1-2: Research instruments and outcomes of the research phases

Research Phase	Research Method	Outcome
Initiation	• Pilot study • Literature review	• Overview of poultry farm management in the context of East Africa • Refining the research instrument
Abstraction	• Literature review • Case studies • Focus group discussions	• Generic understanding of decision making of poultry farmers • User and functional requirements

Theory Formulation	• Literature Review • Expert interviews • Focus group discussions • BiZaGi Process Modeller	• Studio design
Implementation	• HTML, Javascript, PHP, MySQL	• Decision Enhancement Studio
Evaluation	• Case Studies • Literature review • Expert testing • Questionnaires	• Testing • Evaluation results

1.9 Thesis Outline

This thesis is organised in seven chapters.

The first chapter presents the background to the research domain and introduces various contextual issues in the field of poultry farm management with special focus on the East African region. From this background, the research problem is defined and the objective and research questions are identified as well. The chapter presents the research approach which guided the process of conducting the study.

The second chapter discusses the theoretical underpinnings and perspectives of the problem domain based on the existing knowledge base. The chapter presents an in-depth understanding of poultry farm management operations and applies different theoretical perspectives to decision making of poultry farmers.

The third chapter is a presentation and analysis of the exploratory study findings. The exploratory study was carried out among 13 case study farms in East Africa and 24 stakeholders participated in focus group discussions where deeper insights into the issues gathered from the case studies were gained. The insights from exploration were generalized to poultry farm management across East Africa and these set the scene for the design of the Poultry Decision Enhancement Studio.

Using the information from second and third chapters, the Poultry Decision Enhancement Studio (PDES) was designed. The fourth chapter gives a description of the PDES using the "Ways of" framework (Sol, Simulation in information systems development, 1982). The chapter presents the design of the PDES, including suites, services and recipes. Chapter five is a discussion of the prototyping and instantiation of the PDES with emphasis on studio architecture and development tools and strategies. The implementation is mainly described using sampled studio services.

Chapter six describes the methods engaged in testing the studio prototype, the evaluation approach and the evaluation results regarding the parameters of usefulness and usability. Finally reflection on the overall research agenda, possible generalisability and the recommendations of this study are presented in chapter seven.

Chapter 2- Poultry Farm Management and Decision Making

As a basis for grounding this research, this chapter discusses the literature encompassing poultry farm management and decision making. Section 2.1 presents the scope of poultry farming in East Africa. Section 2.2 maps out the operations of poultry farm management thereby providing insight into the decisions made by poultry farmers. Section 2.3 analyses decision making among poultry farmers from a theoretical perspective. Section 2.4 discusses the research field of decision support systems and how it has evolved over the years to decision enhancement. Section 2.5 reviews the application of decision support systems in poultry farm management. Section 2.6 justifies the possible application of decision enhancement to poultry farm management to address farmers' decision making challenges.

2.1 The Scope of Poultry Farms in East Africa

The Food and Agricultural Organisation classified poultry farms into four operational sectors (Adeyemo & Onikoyi, 2012). The first sector is highly industrialised with high levels of bio-security, mainly located in major cities and has a very good share of the export market; the second has moderate to high levels of biosecurity, can be found in both urban and rural areas and has a large share of the national market and minimal export; the third sector has low to minimal levels of biosecurity and produces mainly for the local markets; the fourth sector is a typical household farm with minimal biosecurity and its products are consumed by family and the rest sold to friends and probably neighbours (Adeyemo & Onikoyi, 2012). These classifications are mainly based on the conceptual, structural and operational characteristics of the farms. In East Africa, as the poultry industry takes shape from previous deep rooted backyard poultry systems, the third and fourth sectors still dominate the poultry industry (FAO, 2011). However, with the increasing attention to viability of the industry by the East African governments, the industry continues to register developments and has the potential of having more poultry farms in the second sector and probably the first in the long run.

Commercial poultry farms in East Africa mainly rear layer and/or broiler chicken. Farmers rear layers to produce eggs and spent layers (for meat) for the market (Okello et al., 2010). Layer chicken are bred and reared for maximum egg production. A single layer bird is raised to lay up to 306 eggs in its laying life before it is finally sold off for meat (Kitalyi, 1998). For the broilers, farmers rear day old chicks to maximize body growth so as to sell off the chicken

for meat. In a life span of six to eight weeks, a broiler is expected to accumulate between 1.5 to 2 kilogrammes of chicken meat. The broiler value chain is similar to the layer value chain except for their final product which is only meat and therefore their markets differ. The bi-product of the poultry farms is poultry waste, which is a valuable source of plant nutrients and often used extensively as fertilizer (Harmel et al., 2009; Chan et al., 2008). Poultry waste has also been fronted by some researchers (Bolan, et al., 2010; Pereira et al., 2010) as a valuable source of animal feed.

The variable inputs for poultry farms include one day-old chicks, feeds, vaccines, feed supplements, brooding materials, veterinary drugs, labour and veterinary services while fixed inputs include land, housing structures and feeding equipment (Okello et al., 2010). The main players in the poultry value chain are poultry farmers, hatcheries and other input suppliers, veterinary personnel and farm extension workers, industry regulators, retailers, customers and processors. The focus of poultry farmers in this chain is to work with these players with an aim of providing the conditions that ensure optimum performance of their flocks (Bell & Weaver, 2001).

2.2 Key Operational Activities and Decisions of Poultry Farmers

The operations of most poultry farms in East Africa begin with the acquisition of day-old chicks from a hatchery and undertaking various rearing activities to convert the day old chicks into chicken meat and/or eggs for sale. Throughout these core activities, various decisions are made by farmers. In this section, we take a succinct look at each of the activities described in the figure 2-1 and the decisions involved under each activity.

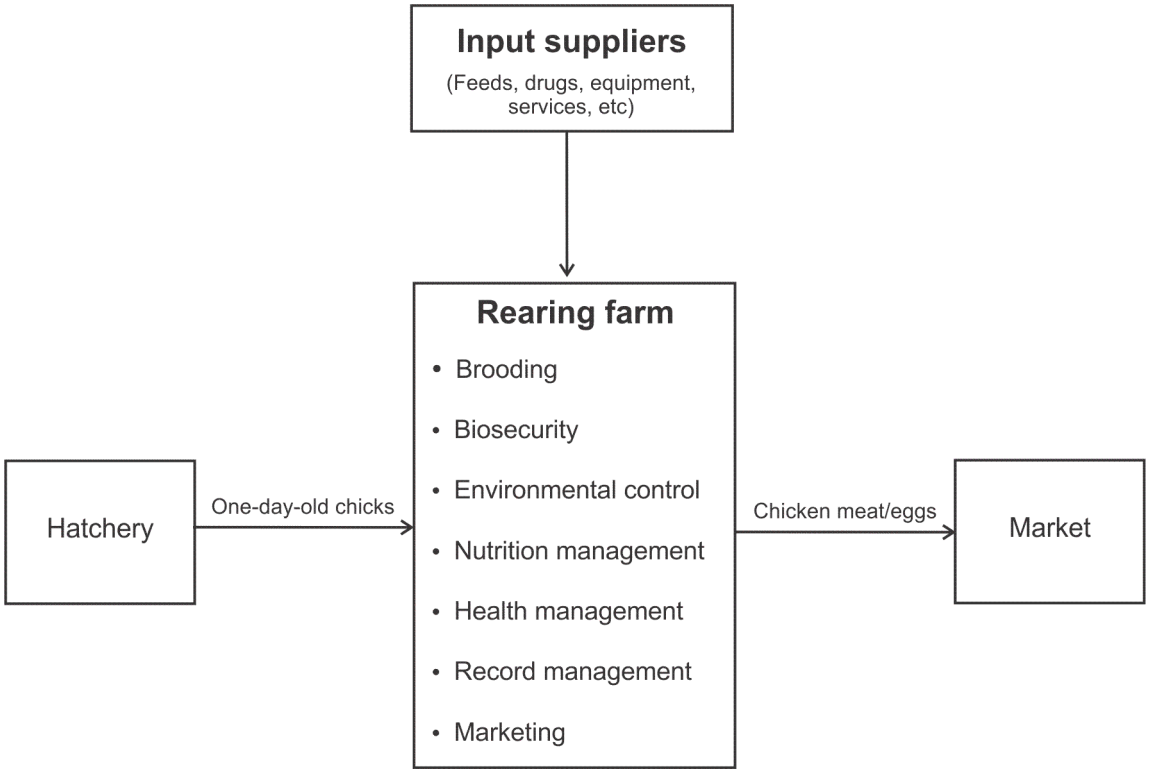

Figure 2 - 1: A description of poultry farmers' operations

Input Purchasing

Farmers in the region make their own decisions to purchase farm inputs and are highly involved in all aspects of purchasing from placing their orders till delivery of inputs to the farm (FAO, 2011). These inputs together are transformed into chicken meat and eggs for market consumption. Common considerations at input purchasing include quality, price, preparation costs, storage and handling costs and availability (Mishra & Perry, 1999). Some of the key inputs discussed here include day-old chicks, feeds and vaccines.

In poultry farms, day old chicks are the hinge that determines economic efficiency. From the potential of chicks to survive in their first week of life, their ability to grow uniformly, their production capacity and finally their health throughout rearing to slaughter entirely depends on the quality of the day old chicks (Negash, 2012; Decuypere and Bruggeman, 2007; Tona et al., 2004;). On the other hand, day old chicks also depend on the genetic line of the breeders, breeder age, egg weight, egg storage conditions and duration and incubation conditions such as temperature and humidity, (Decuypere and Bruggeman, 2007; Tona et al., 2004, 2005; Decuypere et al., 2001; Viera and Moran, 1999; Peebles et al., 1999; Wilson,

1991). This points to the fact that a poultry farmer expecting returns from his chicken flock needs to have access to a lot of information concerning the quality and strain of day old chicks as well as hatchery conditions before he can make the purchasing decision. It also points greatly to the need for high levels of collaboration and feedback among poultry farmers and hatchery owners to ensure transparency aimed at quality processes.

Poultry feeds account for 70% to 75% of the total variable costs of poultry farms in Africa (Achoja, 2013), which makes the farmers' role in purchasing of feed and feed ingredients quite significant. The high genetic potential of hybrid poultry strains can only be achieved with properly formulated feeds. A bird's growth rate, meat yield and egg production heavily rely on the quality and quantity of feeds used during rearing (Achoja, 2013; Decuypere and Bruggeman, 2007; Decuypere et al., 2001). Thus the farmer's role in this case is to ensure that they purchase feeds that can be utilized efficiently to produce eggs and/or meat at an economic rate. Many farmers in East Africa prefer to purchase feed ingredients and mix their own feeds to ensure that the right proportions of the ingredients are used to maximise output (FAO, 2011). The practice is considered to be cheaper than buying branded feeds from commercial producers/agents (FAO, 2011). Poultry feed ingredients include energy concentrates such as corn, oats, wheat, barley, sorghum; protein concentrates such as soybean meal and other oilseed meals (peanut, sesame, safflower, sunflower, etc.), cottonseed meal, animal protein sources (meat and bone meal, dried whey, fish meal, etc.), grain legumes such as dry beans and field peas, and alfalfa (FAO, 2011). These are often mixed with vitamins and mineral supplement to make nutritious feed for chicken. Farmers therefore make numerous decisions concerning purchase of feeds such as whether or not to buy branded whole feed, where to purchase quality feeds or feed ingredients, what feeds to purchase and how to mix feed ingredients to make balanced and quality feed.

Vaccines and drugs are also key inputs for which poultry farmers must make strategic decisions. Because diseases are the greatest constraint to successful poultry farm management and safe utilization of poultry products (FAO, 2009; 2008; Byarugaba, 2007), farmers purchase drugs and vaccines to control and prevent diseases at farms. Drugs and vaccines in East Africa are largely supplied by the private sector (FAO, 2011); though, governments still maintain the regulatory function exercised by different autonomous bodies such as the National Drug Authority for the case of Uganda. The private sector however is highly characterized by inadequate regulation (FAO, 2011). Poultry farmers' decisions on where and

when to purchase drugs, the drugs to purchase and how to purchase them are important and must be timely and efficient.

Other key inputs which farmers purchase include labour, equipment and consultancy services. For all inputs to a poultry farm, the decisions of the poultry farmer revolve around the type or brand of input to be purchased; the amounts to be purchased; the suppliers from whom to purchase; the price to pay for the purchases; the kind of service level agreements to take up with suppliers and decisions on how to put the inputs to use once they are at the farm inventory.

Brooder Management

Raising chicken commercially entails artificial brooding of large numbers of day-old chicks. Newly hatched chicks are subjected to the farmer's care so that they can become a source of income once they are grown. Getting chicks off to a good start is extremely important because it may never be easy to make up for any early growth losses. In fact, it is proven that the early stage of chicken (chick phase) is very critical and has immense influence on final performance of the birds (FAO, 2011; Dozier, 2001). This is because psychological processes such as sell hyperplasia and hypertrophy maturation of the thermo-regulatory and immunological systems, as well as growth and differentiation of the gastrointestinal tract would subsequently influence body weight and feed conversion until market age (Moraes et al., 2002). Brooding involves providing artificial heating since the chicks are too young to regulate their own body weight (Gietema, 2005). Chicks which brood at inadequate temperatures often have high mortality rates (Renwick & Washburn, 1982). During this period, chicks also require special lighting to be stimulated to eat. Gietema (2005) recommended that chicks be given twenty four hours of light in the first week and gradually reduced to twenty hours in the second week, sixteen hours in their third and fourth week and twelve hours a day (day light) after four weeks. This kind of lighting arrangements helps birds to eat as much as their bodies require in their first weeks of life thereby taking off at the right growth pace for them to generate profits in their adult age. The main objective of brooding is to efficiently and economically provide a comfortable, healthy environment for chicks as they adjust to their new environment. This is only possible if farmers and farm workers are aware of the relevant information concerning brooding to be able to monitor their brooders effectively and consequently make timely decisions concerning brooding factors such as temperature, lighting and aeration. These decisions are important for farmers to avoid high mortality rates in the first weeks of life of a flock.

Biosecurity Management

Biosecurity is a set of practices put in place to prevent the entry and spread of infectious diseases into and from a farm (Segal, 2011). In fact it is considered the most economical and effective method of disease prevention and control at poultry farms. Diseases are associated with bird mortality, low performance (slow growth and drop in egg production) and increased farm expenditure (medication); which all have a direct negative economic implication on the farm. Because poultry farms are continuously faced with threats of infectious diseases which pose a significant threat of revenue loss, it is important that they undertake high levels of biosecurity. Biosecurity minimizes the risk of disease introduction into the farm (Van Steenwinkel et al., 2011; Niemi et al., 2009; Boklund et al., 2004). Transmission of diseases into the farm can be through movements of humans, wild birds and rodents, air and other formites (e.g. delivery trucks, visitors' clothes and farm equipment) (Ssematimba et al., 2012; Sawabe et al., 2006; Sievert et al., 2006). Segal (2011) proposed three elements of a farm's biosecurity plan: segregation and traffic control, cleaning, and disinfection. Segregation and traffic control involves keeping disease agents from entering the farm through barriers which can be physical, temporal or procedural. Cleaning involves keeping surfaces, equipment and personnel hygienic while disinfection involves the application of disinfectant solution/drugs to ensure the destruction of disease agents. Disinfection can cover surfaces, equipment, vehicles entering the farm and anything that can support the movement of disease agents at the farm. To prevent diseases or control spread of diseases, poultry farmers must make decisions on which elements of biosecurity to use and at what point. Biosecurity decisions are significant and must be timely to be able to prevent and control disease.

Nutrition management

Hybrid poultry strains are a result of intensive genetic selection for rapid and efficient growth, which makes the need for quality feeds for these strains important. Intensely reared chicken require a balanced array of nutrients for maximum growth and production (FAO, 2013; Richards et al., 2010). The nutrients required however vary according to strain, age, condition and purpose of rearing. According to FAO (2013), birds need a steady supply of energy, protein, fats, minerals, vitamins and most importantly water. These nutrients enable body growth and egg production. Energy in poultry feed is the major determinant of feed intake and can be derived from simple carbohydrates, fat and protein; proteins supply amino acids for maintenance, muscle growth and synthesis of egg protein; minerals are necessary for the formation and maintenance of the skeletal structure and for good egg shell quality;

fats help to achieve the needed dietary energy concentration as they contain greater energy density; vitamins participate in all bio-chemical pathways in the body; while water, which is also the most important nutrient in poultry nutrition, helps in digestion of feed, absorption of nutrients, excretion of waste and regulation of body temperature (FAO, 2013). Farmers have to give significant attention to poultry nutrition management and related decisions because feeds alone take up to 70 percent or even more of a poultry farm's costs (FAO, 2011). Poultry nutrition is of utmost importance especially concerning quantity and quality of feeds and water. Decisions related to nutrition management include decisions on which feeds to use, how much feeds to give, what nutrients to consider in feed mixing and how to feed the birds. Nutrition is major determinant of chicken growth and productivity; these have direct impact on the farm's profitability. Thus decisions concerning nutrition are highly consequential.

Health Management

Poor poultry health is one of the threats associated with limited profitability in poultry farms in East Africa. Chicken are particularly known to be susceptible to diseases hence the importance of optimizing poultry health in farms. Disease can be economically devastating to farms, which makes decision making on poultry health management a continuous activity for farmers throughout their rearing operations. Common causes of disease in poultry farms are infectious agents such as viruses, bacteria, fungi and protozoa and parasites (Segal, 2011) (see table 2-1). However, Tablante (2013) noted that not all poultry health problems are caused by these infectious agents but also non-infectious agents such as chemicals, toxins, nutrition deficiencies, sanitation and water quality. In their decision making processes, farmers must be aware of both infectious and non-infectious agents so as to eliminate them from farms. Flocks that face health challenges such as chronic diseases often do not perform well and can be costly to maintain (Mobley and Kahan, 2007). Poor health also comes with other implications like mortalities, financial loss and possible human infection and death and decisions concerning health management of poultry flocks can't be avoided by the farmers. In health management of flocks, decisions made include how to diagnose disease, when and how to contact a health expert, which health experts to contact, when and which drugs and vaccines to purchase, when and how to administer treatment.

Record keeping and management

Record keeping and management at a farm involves keeping an account of the daily operations for reference. Torres (2001) defined record keeping as the keeping of detailed records by a farmer of his farm's daily operations, incomes and expenses. These records are

important because they guide farmer decision making. Poggio (2006) classified farm records under four basic types: resource inventories, production records, financial records and supplementary records. Of these, farmers are normally more concerned with production records which keep an account of mortalities, production, drug administration, weight, feed and other day to day activities (Torres, 2001). All records however are important and require attention especially in the era of commercialization of poultry farms. Commercialisation requires farmers to have necessary records to assess profitability, competitiveness, general performance and most importantly guide management decision making. Records can also be used for research, obtaining credit opportunities, audits, planning and budgeting. Several researchers (Poggio, 2006; Minae, 2001; Torres, 2001; Dixon and Minae, 2001) have pointed out several reasons for lack of record keeping among farmers in Africa which include:

1) The cumbersome nature of record keeping due to high illiteracy levels and low numeracy levels of farmers and farm managers.
2) Only a few farmers view farming as a business, hence most of them do not appreciate the importance of record keeping and management.
3) Lack of necessary skills and resources (e.g computer software).
4) Lack of a central database or reference point for farm information to provide some form of harmonisation and coordination in data collection methodologies, indicators and variables.

These reasons are another sign of the gap experienced by farmers as they transition from subsistence to commercial production systems. Record management involves decisions like which records to keep, how to store records, when to consult the records and how to interpret the records. Besides this, the role of record keeping in guiding decision making is very significant.

Marketing and sale

The main source of income for poultry farmers is revenue earned from the sale of chicken meat and/or eggs. Marketing and sale involves farmers collaborating with potential customers of their products and also ensuring that they put quality products on the market. Farmers in East Africa have largely left activities of marketing and sale to middle men, which leads to less revenue margins for poultry farms (FAO, 2011). Marketing and sale involves farmers making decisions on pricing of products, which buyers to focus on and how to deliver their products to the market.

Environmental control

Rearing of poultry results in waste such as chicken excrement, litter from bedding materials and on-farm mortalities. Equally the slaughtering of chicken for sale, normally after rearing, also results in waste from feathers, organs of slaughtered birds and waste water. This waste if not properly managed gives rise to environmental concerns (Williams, 2013). With the trend of large flocks and intensified systems which characterize poultry farms, the issue of environmental management concerning these wastes is even more complex. These wastes are potential pollutants for water, air and soil (FAO, 2008; Nahm & Nahm, 2004; Williams et al., 1999). With issues of air pollution, odour and gas emission, pollution of surfaces and ground water, poultry wastes can have harmful effects to both environment, human and bird health. On the other hand, these wastes can also provide organic and inorganic nutrients if managed and recycled properly (Williams, 2013). It is thus imperative that every poultry farmer makes decisions to address issues related to storing, managing and utilizing waste in order to minimize negative environmental impact. The uncertainty regarding the impact of decisions made on such complex issues requires due attention.

2.3 Decision Making Among Poultry Farmers: Theoretical Perspectives

The discussion in section 2.2 above gives insight on the operations involved in poultry farm management as well as the complex, continuous and consequential nature of the decision making role of poultry farmers. In this section, we discuss the decision making practices and behaviours of poultry farmers from a theoretical perspective. Decision making involves searching for information on the problem to be solved, identifying possible alternative solutions, evaluating the different alternatives and choosing among these alternatives and finally controlling the implemented decision (Simon, 1960). Mintzberg et al. (1976) defined a decision process as a set of actions and dynamic factors that begin with the identification of an incentive for action and ends with a specific commitment to action. To characterize decision making styles, both rationalistic and bounded rationality models (March, 2010) are of importance. Rational decision making implies that the decision maker operates under certainty, knows the alternatives as well as the related outcomes, is conversant with the decision criteria and has the ability to make an optimum choice and implement it (Towler, 2010; Simon, 1997, 2009). In reality, this is not the case among actors operating in uncertain and complex business environments (Keen & Sol, 2008), such as the agricultural domain (Aregu, 2014; Parker, 2001). In chapter one, the complexities of poultry farm management

were highlighted and these underscore the reality that poultry farmers can hardly be rational decision makers.

The decision mechanism of a typical farmer is not that of the rational man who consciously considers all alternative options (Osinga, 2015). The decision making strategies farmers pursue do not only depend upon the actual effects, but also on how they perceive and cognitively process their experiences (Aregu, 2014). Simon (2009) uses the term bounded rationality to describe a decision maker who would like to make the best decision but instead (due to unavoidable constraints) settles for a less than optimal decision. Nair (2006) and FAO (2006) both noted that farmers' decisions are greatly influenced by time constraints, cost and inability to process needed information. In this study, we recognise that poultry farmers' decisions in East Africa will most likely be influenced by challenges in their environments such as inadequate regulation, unstable economies, compromised quality of inputs, inadequate information availability and inadequate management competences. Osinga (2015) noted that farmers take on a satisficing rather than an optimizing approach in decision making. The satisficing approach implies that not only cognitive abilities, but time, resources or personal circumstances constrain decision making (Keen & Scott Morton, 1978) And because of this, they will most likely apply heuristic rules since heuristics mainly stem from the decision maker's observations, perceptions and past experiences (March, 2002; Antonides, 1996). Heuristic practices are cognitive short cuts that enable the decision makers (poultry farmers in this case) to make evaluations based on one or a few simple rules thereby avoiding the processing and time costs related to exploring an exhaustive set of possibilities (Marsh, 2002).

Several researchers (Gocsik et al., 2014; Knowler and Bradshaw, 2007; Edwards-Jones, 2006 etc.) have mentioned farmers intrinsic motivation as another influence to farmer decision making. In fact Greiner and Gregg (2011) suggest that intrinsic motivation can sometimes outweigh financial motives when it comes to farmer decision making. In their study, Sadler-Smith and Sparrow (2008) found out that often decision making relied a lot on the decision maker's tacit knowledge than on formal data. This is supported by the social psychological theories, which explain why some members of a given population exhibit a given behaviour while others in the same population do not (Fishbein et al., 2001). This is also well explained by the emotional theory which states that everyone is influenced by their past experiences, expectations, emotional state and emotional memory when making a decision. Looking at

poultry farmers in East Africa and the complex nature of their business environment, their experiences and emotions can't be ruled out of their decision making processes.

Osinga (2015) observes that farmers are social creatures who will make their decisions with in the context of other decision-makers. This is influenced by the multi-stakeholder setting in which they operate. Farmers are most likely to make decisions based on the views of others in their social networks. Sociology literature (Commandeur, 2006; Van der Ploeg, 2010) asserts that farmers are not rational, conscious, individual decision makers, and their decisions are influenced by interactions with other farmers, farm advisors, farm suppliers, veterinaries, and others (Bock and Van Huik, 2007; Jansen and Vellema, 2011). From the discussion in section 2.2, we note that poultry farmers operate in highly multi-stakeholder settings and the different stakeholders in poultry farm operations are likely to have role in decision making processes of poultry farmers.

From the discussion so far, we observe that an individual farmer's goals, values, experiences, networks, expertise, personal norms and attitudes are highly reflected in the decisions they make. In East Africa, poultry farming is still evolving from previous subsistence/backyard systems to commercial systems (FAO, 2011), this may have an influence on farmer attitudes and experiences. The challenges faced by the industry in the region as discussed in chapter 1 also have a direct influence on the kind of decisions poultry farmers. These challenges cause farmers to make decisions under conditions of uncertainty. For example a poultry farmer making a decision in an inadequately regulated business environment is bound during the decision making process.

Further to the above, decision makers in poultry farms may rely on heuristic practices of decision making. As pointed out by Marsh (2002), heuristics are cognitive short cuts which enable decision makers to make evaluations based on one or a few simple rules, thereby, avoiding the processing and time costs related to exploring an exhaustive set of possibilities. The complex and multi-stakeholder nature of the poultry industry in the region compels poultry farmers to use heuristic rules in decision making to simplify mental tasks into simpler ones. Jager and Janssen (2012) proposed Consumat, a set of four decision strategies based on their consumers studies: repetition (do as you always do), imitation (do as your close peers do), inquiring (study what all peers do and do as the majority do), and optimizing (calculate all alternatives and choose the best). It is plausible to assume that poultry farmers use similar kinds of heuristics when faced with their complex decisions. By applying Consumat to

decisions in the context of poultry farm management, two key issues are apparent: 1) the focus of the poultry farmer in decision making is more on the decision making process and not the final decision; and 2) the views and experiences of stakeholders in the poultry farmers' decision making arena are important to the farmers' decision making process. These two are key decision making requirements for enhancing decision making among poultry farmers.

2.4 From Decision Support to Decision Enhancement

The decision support concept originated probably in the late 1950s and early 1960s from studies on organizational decision making at the Carnegie Institute of Technology by Herbert Simon and Allen Newell, and on interactive computer systems at the Massachusetts Institute of Technology by Tom Gerrity (Power, 1999). In the 1970s, there was increased focus on Decision Support Systems (DSS), which arose from the need for better decision-making support as difficult and complex semi-structured and unstructured decisions became a primary area of research (Power, 2003). Over the years, DSS have been developed to facilitate better decision making for complex structured, semi-structured and unstructured decisions. Keen and Scott Morton (1978) defined DSS as computer-based support systems for management decision makers who deal with semi-structured problems. The main aim of DSS is to provide the user with tools that improve their decision making process, resulting in more informed decisions (Arnott & Pervan, 2008). In unstructured problems, DSS were employed to handle a large number of parameters and relationships but also attempt to alleviate the effect of some unknown or shifting parameters and relationships on the decision.

Over the last 3 decades, DSS research has evolved to include additional concepts such as Group Decision Support Systems (GDSS), Executive Information Systems (EIS), Knowledge Management Decision Support Systems (KMDSS) and Decision Enhancement among others. Arnott and Pervan (2005, 2008) trace the evolution of DSS to GDSS, which led to negotiation-based systems. As technology evolved, co-location became unnecessary, and video conference-based GDSS were developed (Gray, 2008). Early work on GDSS revolved primarily around supporting co-located managers by providing computer support such as spreadsheets, brainstorming support, idea generation support, and voting capabilities during meetings. According to Arnott and Pervan (2005, 2008), EIS emerged from GDSS and further led to data warehousing and online analytical processing, data mining, and business intelligence tools. The concept of KMDSS stems from the 1990s and early 2000. KMDSS are

systems that facilitate decision making throughout and between organizations with the added component of knowledge management functions. Such functions include storage, manipulation, retrieval, transfer, and use of knowledge such that individuals and organizational memory benefit (Arnott & Pervan, 2008).

The concept of DSS and its related concepts have been successfully implemented in several forms over the last four decades. Nonetheless, they have also registered some failures (Hosack et al., 2012). Particularly in the field of agriculture, various DSS have been developed but are not fully exploited by farmers, which has been attributed to poor design, lack of shareholder involvement, or poor implementation (Arnott & Dodson, 2008) among other reasons. With a growing interest in service-oriented thinking in information systems research (Demirkan et al., 2009), there was need for of DSS to address this paradigm. Rai and Sambamurthy (2006) noted the importance of rethinking information systems from technical vintage points to a focus on services to create value.

Keen and Sol (2008) coined the term Decision Enhancement (DE) following a studio-based approach as the next development in the DSS research field specifically focusing on complex decisions called "Decisions That Matter" (DTM). They characterize DTMs as being urgent, consequential, non-avoidable, non-reversible, uncertain and wicked. Keen and Sol (2008) propose the development of Decision Enhancement Studios (DES) that are virtual environments in which people, processes and technology are brought together to improve collaboration and enhance decision making using suites and services. According to Keen and Sol (2008), decision making comes from the design of processes and not the search of solutions and focusses on decision makers and their stakeholders in the decision making arenas. DE provides services that target all levels of decision making in an organization; enhances the link between people and technology by enabling visual thinking through multi-media and through the combination of process enhancements, facilitation and appropriate analytical methods and computer tools or suites (Keen and So, 2008). DE services are geared to facilitating effective deployment of technology for achieving decision process agility; that is a decision that is characterized by speed, flexibility, coordination, collaboration and motivation (Keen and Sol, 2008). DE services may be delivered through suites to enable various knowledgeable stakeholders to collaborate in the decision making process.

Just like DSS, the concept of DE is evolving and has widened its focus to serve several reference disciplines and fields including mining (Ejiri, 2012), corporate organisations

(Amiyo, 2012; Mulira, 2007), public service (Knol, 2013), agriculture (Aregu, 2014)and asset management (Katumba, 2016; Bekker, 2016). This clearly shows an increasing interest in DE and its potential to handle complex decision making challenges in the respective fields. Accordingly, this study is grounded in the decision enhancement concept of Keen and Sol (2008) and aims at enhancing human decision making through the provision of studios and services to facilitate collaboration and informed and guided poultry farm management.

2.5 Application of DSS in Poultry Farm Management

The 21st century has been characterised by a wide range of opportunities provided by consequent technological advances in agriculture, poultry production in particular. World over, technology today is seen as the wheel of economic activities like poultry farming. In fact the growth of the poultry industry has been largely tied to the technology advancements in the industry. From genetic selection, advances in nutritional efficiency, automated real time monitoring of flock, image processing and analysis technologies, poultry farms have indeed undergone a lot of advances that have supported the growth of the sector world over.

Several scholars (e.g Hasan et al., 2015; Nyathi et al., 2013; Xiao et al., 2011, etc.) in the field of DSS have used technology to support decisions of poultry farmers. Various DSS addressing different aspects of poultry farm management have been designed and implemented by different researchers e.g poultry nutrition (Hasan et al., 2015), manure management (Corkery et al., 2013; Karmakar, 2007;), disease management (Stevenson et al., 2007; Sanson et al., 1993), farm performance (Xiao et al., 2011; Negash, 2012); planning (Papathanasiou, 2005) and flock replacement (Negash, 2010). Below we discuss a few examples of such DSS:

Hasan et al. (2015) developed a generic decision support system for poultry feeding which assists poultry farmers to get the optimum combination of available feed ingredients that can satisfy the nutritional requirements of a bird at the least cost possible for India. Following an exploration of various approaches of coming up with feed formulations, Hasan et al. (2015) applied Linear Programming to solve equations simultaneously and address the instability of nutrient levels of ingredients as well variations of pricing. In this system, a farmer provides the poultry type and growth stage and the system uses this information to create a query to search the database for the related nutrients, which represent the constraints for the given poultry type and growth stage. Nyathi et al. (2013) developed a DSS with an aim of solving

the problem of exploitative middlemen who linked small scale producers in Zimbabwe with large scale producers. This DSS was to facilitate the establishment of a symbiotic relationship between small scale poultry farmers and large scale producers. The system provides a web crawler where small scale producers can create individual blogs, a short message portal where large scale producers get notified when the small scale producers register and a point of direct connection between the different producers. Xiao (2009) developed a DSS for chicken breeding data to address pedigree matching, hatching management and determination of egg and report quality. This was later reinforced with Xiao et al. (2011) whose DSS focussed on production of commercial layers. This system records and analyses the data for growth, feeding, egg production, environment, immunisation and changes during brooding period, incubation and laying period. Both systems were developed for poultry farmers in China. Other DSS which have been developed specifically for poultry farms in Europe include a system for monitoring animal welfare by Gocsik et al. (2016); performance management systems by Negash (2010) and Ramsden and Gibbons (2009); and a system to support manure management by Karmakar et al. (2007). These are only some of several DSS which have been developed for poultry farms.

From this discussion so far, we note that different researchers from various disciplines focussing on specific aspects and customising them to their different contexts have developed DSS in poultry farm management. However, as Dornhofer et al. (2012) put it, there is lack of a simple all-encompassing approach to solve the challenges of poultry farm management. Poultry farm management is a continuous decision making process (Kay & Edwards, 1994), which points to the importance of an all-encompassing solution to the decision making challenges therein. We also note that the available DSS are often tightly focussed on a specific decision and lack flexibility which is important for farmers who operate in a highly dynamic and volatile business environment like the one in East Africa.

While various DSS have been developed and implemented for poultry farm management, their uptake in the East African region is still limited. Actually, studies indicate that adoption of agricultural technologies across Africa is rather low (Spielman et al., 2010), despite increased efforts of African governments towards encouraging use of technology to increase agriculture production (AU/NEPAD, 2003). In addition to this, few DSS are currently used to inform policy and to drive policy analysis (Van Delden et al., 2011; Oliver et al., 2011). Loevinsohn et al. (2013) emphasized the importance of putting into consideration the

dynamic interaction between characteristics of the technologies and the array of conditions and circumstances of farmers if adoption of technology is to improve. From the discussion of poultry farmers' decision making practices in section 2.3, we note that it is important that technologies address the issue of collaboration and heuristics as important requirements for addressing poultry farmers' decision making processes.

2.6 DE and Poultry Farm Management in East Africa

From the discussion so far, we note the following:

- Poultry farm management is a continuous decision making process and involves numerous decisions.
- Decisions of poultry farmers are highly consequential and are made with in the context of a complex and volatile business environment.
- Poultry farmers exhibit bounded rationality in decision making and their decisions are highly influenced by heuristics.
- Poultry farmers are highly social which makes collaboration with their stakeholders an important aspect of their decision making process.
- A lot of DSS research has already been done in poultry farm management; nonetheless, the decision making challenges of poultry farmers in East Africa are still apparent and have not been addressed.

Basing on the above, this study focusses on decision enhancement of Keen and Sol (2008) as appropriate in addressing the decision making challenges of poultry farmers. While DE has been successfully applied by researchers in East Africa (Katumba, 2016; Mirembe, 2015; Aregu, 2014; Ssemalulu, 2012; Amiyo, 2012; Ejiri, 2012), it has not been applied to the context of poultry farmers' decision making in the region. And yet its focus on decisions that matter which characterise poultry farm management and the aspects of flexibility, visualisation and collaboration that characterise the decision enhancement studio make it a viable option for addressing the decision making challenges of poultry farmers in the region.

- ***Flexibility*** is a key component of the Decision Enhancement Studio, which seeks to ensure that the studio easily adapts to the changing and volatile decision making environments (Knol, 2013), similar to those largely characterising poultry farm management.

- ***Visualisation*** in the decision enhancement studio involves use of appropriate images without losing focus on content (Keen & Sol, 2008). This focus on visualization is particularly relevant to farmers in East Africa whose skills in technology are still low compared to their counter parts in first world countries.
- The fusion of people, process and technology in decision enhancement not only enhances decision making but also improves ***collaboration*** of stakeholders. Decisions of poultry farmers require consultation among various stakeholders as the industry involves multidisciplinary approaches. For example a poultry farmer may require the assistance of a veterinary doctor, a nutritionist and a business expert to make a decision on which feeds to use on a recently adopted poultry strain. Inter-organizational information sharing and collaboration among stakeholders have been proven to improve performance and enhance competitive advantage (Li, et al, 2009), particularly among farmers (Jansen and Vellema, 2011; Bock and Van Huik, 2007). Decision enhancement starts from the lens that focuses on stakeholders in decision arenas and their decisions that matter (Keen & Sol, 2008).

Chapter 3- Exploration of Poultry Farm Environments

In order to gain a broader and practical understanding of poultry farm management, farmers' decision making practices and contexts, an exploratory study among selected poultry farmers and key stakeholders of the poultry industry was conducted. In this research, we used both case studies and focus group discussions to gain practical understanding of poultry farm management and the decision making practices, behaviours and processes of poultry farmers in East Africa. While case study based inquiry helped us to gain a detailed description of the context in which poultry farmers performed their tasks and made decisions, focus group discussions further advanced broader and deeper insights into respondents' views, attitudes, beliefs and motivations. This chapter presents the exploration exercise and its associated findings. Section 3.1 presents the case study based inquiry and how it was adopted in this study. Section 3.2 discusses the findings from the case studies. Section 3.3 gives a synopsis of the general insights from case studies. Section 3.4 presents the focus group discussions and how they were adopted in the study. Section 3.5 is a discussion of the findings from the focus groups. Section 3.6 presents a generic overview of decision making among poultry farmers in East Africa based on the researcher's findings.

3.1 Case Studies

Data Collection and Analysis

To collect data from the cases, we used a structured interview guide which was formulated based on information gathered from literature. A pilot test of this structured interview guide was conducted among a team of 6 people who included 3 staff from the School of Agricultural Sciences in the Agribusiness Department at Makerere University; one staff from the School of Computing and Engineering at Uganda Technology and Management University and 2 farmers from Kampala district. The purpose of the testing was to detect any flaws, limitations or other weaknesses within the guide (Kvale, 2007). This allowed the researcher to make necessary refinements to the interview guide before the actual interviews were conducted.

From literature and pilot studies, we obtained an empirical description of the research problem. The structured interview guide was designed to ascertain whether the description of

the problem area actually matched how poultry farmers experienced it. Furthermore, questions were structured to contribute towards answering of the overall research questions of the study. Using information from literature, the questions in the interview guide focussed on four key areas as presented in four sections:

The first section aimed at gathering the characteristics of all participating farms. This section required respondents to provide information like farm location, type, magnitude of production as well as farm management structure. Poppenborg and Koellner (2013) noted that farm characteristics have direct relationship with the farmers' decision making practices. The second section focussed on establishing what was involved in the poultry farm management operations and decisions therein. Farmers were asked about the different activities they engaged in as well as the decisions they make. In the same section, farmers also gave insight on why and how they make decisions, their sources of information during decision making and the challenges they face. The third section was to ascertain the current use of ICT at farms. The section particularly singled out the extent of the use of computers at the farms, farmers' computer literacy levels and the attitude of farmers towards computers. The fourth and last section was open to farmers to express themselves on their preferred requirements for decision enhancement. This section helped the researcher to understand the needs and expectations of the farmers from this study. The questions in the four sections were a blend of closed and open ended questions.

The researcher visited all case study farms between October and December 2014 and spent time at each of the farms observing the practices of farmers and/or farm managers as well as carrying out the interviews using the guide. Because of the researchers' presence at the farms during the interviews, clarity was sought whenever responses or questions were not clear.

Analysis of qualitative data followed the procedures of grounded theory (Strauss & Corbin, 1998). Having begun with information from literature and pilot studies, the use of grounded theory helped us to use emergent strategies and rely on comparative inquiry during analysis (Charmaz & McMullen, 2011). The three coding processes of grounded theory (open coding, axial coding and selective coding) were employed because of their ability to ground theory in data (Strauss & Corbin, 1998). As Holton (2007) puts it, it is through coding that the conceptual abstraction of data and its re-integration as theory takes place. Manual analysis also enabled the researcher to identify critical phenomenon and formulate themes and properties for the study.

Selection of Cases

Purposive sampling was used to select 13 poultry farms as cases for this research. Purposive sampling is the selection of respondents based on their unique qualities that make them likely to provide the desired opinions and experiences about a given phenomenon under investigation (Tongco, 2007). This enabled a deliberate choice of farms based on two qualities:

1) Farms had to conform to the descriptions of commercial poultry farms of this study which was guided by Sonaiya and Swan (2004) and FAO (2011) as discussed in chapter 1. We considered farms rearing at least 500 hybrid birds which are specially hatched for optimal meat or egg production.
2) Farm managers and/or farm owners had to have an interest to participate and share their views in the study.

Prior to the actual case study interviews, appointments were made with selected farms via phone calls. Farmers' phone contacts were obtained from a directory of poultry farmers at Biyinzika Poultry International Limited, a major supplier of day old chicks in Uganda. While over 20 farmers were contacted, only 13 could meet both of the above qualities.

Description of case studies

Multiple cases in exploration offer a robust framework for data collection (Remenyi et al., 1998) and give the researcher a *'helicopter view'* of the problem landscape (Rowley, 2002). The cases helped us to broaden our understanding of poultry farmers' decision making behaviours and contexts. The 13 selected cases were a diverse organizational mix in terms of size which is mainly represented by flock numbers. The combination of farms managed by farm owners and those managed by farm managers gave a wealth of practices and experiences as far as farm management is concerned. From the first section of the questionnaire characteristics of the farms such as location, types of birds reared, flock size and the person at the helm of managing the farm were gathered. Farm characteristics can be insightful in understanding individual farmers' decision making practices (Poppenborg & Koellner, 2013).

Table 3-1: A description of farms which participated in the case study interviews.

	Farm	**Location**	**Type of birds**	**No. of birds reared**	**Person in charge (Business owner/ Farm Manager**
1	Mazima Farm Ltd	Kampala, Uganda	Layers	550	Business Owner
2	FarmFair Ltd	Entebbe, Uganda	Layers & Broilers	1,000	Business Owner
3	Nami Farm	Mukono, Uganda	Layers	1,000	Business Owner
4	Impressed Company Ltd	Mukono, Uganda	Layers & Broilers	1,300	Farm Manager
5	Mugabane's farm	Mukono, Uganda	Layers & Broilers	2,000	Business Owner
6	Kwagarakwe farm Ltd	Mukono, Uganda	Broilers	2,400	Farm manager
7	Kirangira Poultry farm	Wakiso, Uganda	Layers & Broilers	3,370	Farm Manager
8	Kari Chicken (K) Ltd	Naivasha, Kenya	Layers & Broilers	5,800	Farm Manager
9	Delo farm Ltd	Mukono, Uganda	Layers & Broilers	8,000	Business Owner
10	Kigata Farm Ltd	Mukono, Uganda	Layers & Broilers	10,000	Farm Manager
11	Maito Farm	Mwanza, Tanzania	Broilers	10,000	Farm Manager
12	Dem Commercial	Mityana, Uganda	Layers & Broilers	15,000	Farm Manager

	Farm	Location	Type of birds	No. of birds reared	Person in charge (Business owner/ Farm Manager
	farmers Ltd				
13	Musiyani Farm Ltd	Nakuru, Kenya	Layers & Broilers	30,000	Farm Manager

Out of 13 farms, only 5 (38.5%) were managed by the business owners. The other 8 (61.5%) were managed by employed farm managers. It was observed that farms with small flock numbers were more likely to be managed by business owners compared to farms with bigger flock numbers. This finding rhymes well with McElwee (2008) who observed that small farms were more likely to be family businesses and run by the owners and the family. McElwee (2008) also described an emerging group of farmers who are highly opportunity-aware and often using a variety of business strategies to ensure business success. This group of farmers may obtain secondary income from alternative businesses or even formal employment to supplement farm income and possibly invest further in the farm (McElwee, 2008). From table 3-1, it is clear that more and bigger farms are indeed run by employed farm managers as the farm owners could probably be focusing on alternative businesses or formal employment.

It was also noted that only 4 out of 13 farms (30.8%) specialized in a particular type of bird reared (i.e. layers or broiler birds). The other 9 out of 13 farms (69.2%) were of a diversified nature and reared both layers and broilers. This is in line with Kaba (2016) who observed a growing trend of diversification in farms as a process accompanying economic growth and an indicator of increasing commercialization and structural transformation of agricultural economies. Effective diversification in farms promotes farm competitiveness (Kaba, 2016) and helps farmers to counter shocks arising from seasonal factors (Francesco, 1999). Diversification is also key in broadening income sources of farms.

3.2 Presentation and Discussion of Case Study Findings

Below we present and discuss the findings from case studies covering poultry farmers' activities and decision, triggers of decision making, performance indicators for decision making, information sources for decision making, challenges of poultry farm management, use of ICT in poultry farms and requirements for decision enhancement

Poultry Farmers' activities and decisions

From the discussion in chapters 1 and 2, we observed that poultry farm management involves complex operations in which numerous decisions are made. It was also apparent that farmer perceptions of particular activities will most likely impact the kind of decisions they made concerning those activities. Therefore we sought to understand activities farmers perceived as important to their farm businesses and in which they made critical decisions. Each respondent was asked to list at least six of such activities. The intent of this question was to understand poultry farmers in their own terms and make meaning of their operations and business processes in which they made decisions that matter. The responses have been summarized in the table below.

Table 3-2: Important poultry farm activities where decisions are made

Poultry Farm Activity	**Frequency**	**%age (of total respondents)**
Input purchasing	13	100
Vaccination	13	100
Brooding	11	84.6
Feed mixing	9	69.2
Flock replacement	9	69.2
Financial management activities	8	61.5
Marketing and sale	6	46.1
Biosecurity and disease control	4	30.8
Slaughter	2	15.4

Poultry Farm Activity	Frequency	%age (of total respondents)
Storage	1	7.7
Selective hiring of staff	1	7.7

These responses point to several issues:

1) Poultry farm management activities as per above responses and consequently decisions are not any different from those gathered from literature as discussed in section 2.1.
2) All respondents acknowledged input purchasing as an important activity in which they made decisions that matter. This is in agreement with FAO (2011) who noted that farmers in the East African region make their own decisions to purchase farm inputs and are highly involved in all aspects of purchasing from placing their orders till delivery of inputs to the farm (FAO, 2011).
3) All respondents noted vaccination as another important activity in which they make critical decisions. This may be due to the challenge of high rate of disease prevalence that has affected the poultry industry in East Africa as reported by Natukunda et al. (2011) and Adei and Asante (2012). From these responses, we note that farmers are highly aware of this challenge and consider decisions concerning vaccination and disease control as critical decisions.
4) With over 50% of the respondents agreeing to the same activities as per table 3-2, we note that activities of poultry farmers in East Africa and consequently their decisions are largely similar.

Triggers for decision making

To understand the farmers' decisions further, we asked respondents about what mainly triggered them to make decisions in their operations. Responses were recapped into five triggers: routine, information, observation, trends in the farm records and market forces. All 13 respondents (100%) were prompted to make decisions based on observation of their flocks, routines and information received. 9 respondents (69.2) further added trends in the

farm records while 6 respondents (46.2%) mentioned that market forces trigger their decisions as well.

From this, we note that poultry farmers' decisions can be prompted by multiple factors. However, focusing on observation as a trigger of decision making, we further note that decision making among poultry farmers is a continuous process because birds, like other living beings, are always growing and can change their behavior and physiology to adapt to changes in their environments (Crespi & Denver, 2005). Equally these environments are constantly changing both naturally and artificially (Cheng, 2010). Therefore, this requires that the decision maker in a poultry farm is always actively participating in the farm processes to be able to make informed decisions amidst the continuous changes. It is important that any initiatives to guide or enhance farmers' decisions make consideration of farmers' observations and salient knowledge which can mainly be attained if farmers are empowered to remain in the 'loop'. We also agree with the findings of Ohlmer et al (1998) who noted that farmers rarely make decisions in a sequential process because of the elements that trigger their decisions such as observation. This further points to the complex nature of poultry farmers' decision making processes.

Performance indicators used for decision making in poultry farms

To better understand the decision objects involved, farmers were asked about the performance indicators which they use as a guide to decision making during their operations. Multiple indicators were raised as shown in table 3-3:

Table 3-3: Responses on performance indicators used for decision making

Performance indicator	**Frequency (out of 13)**	**%age (of total respondents)**
Healthy chicken (free of disease)	13	100
Mortality rates	13	100
Growth rates	13	100
Production rate	13	100
Sales rates	11	84.6

Performance indicator	Frequency (out of 13)	%age (of total respondents)
Egg damage rates	11	84.6
Age of birds	11	84.6
Bird weight growth rates	10	76.9
Financial performance / Profit	10	76.9
Hygiene in the chicken house	8	61.5
Feeding rates and patterns	6	46.1
Morbidity rates	5	38.5
Rates of failures/abnormalities (e.g egg damages, cannibalism)	5	38.5

From these responses, we note that:

1) Farmers are largely in agreement on the kind of indicators that guide decision making in farm and flock management.
2) Poultry farmers rely on multiple farm/flock performance indicators to make decision which makes the decision making processes rather complex. A performance indicator is a concrete management decision that has to be practiced on a continuous basis to reach the main objective (Goodger, 1984).
3) The above findings underscore the importance of continuous flow of information on such indicators to ease farmers' decision making processes particularly because many poultry farm management factors are related to performance indicators at different stages. These indicators also give insight on the kind of information poultry farmers would require during decision making.

Information sources during decision making

In chapters 2, we identified that farmers get information from multiple sources during decision making. In the structured interview guide, respondents were asked about their

sources of information during decision making. This was mainly to understand what and who influences farmers at their points of decision making. Seven options were given and respondents were allowed make multiple selections. The options given were a) Veterinary doctors; b) Government extension workers; c) Fellow farmers; d) Experience; e)Main stream media; f) Others (specify). Their responses are reflected in the table below:

Table 3-4: Information sources during decision making

	Source of information during decision making	**Frequency (out of 13)**	**%age (of total respondents)**
a)	Veterinary doctor	13	100
b)	Government extension workers	9	69.2
c)	Fellow farmers	13	100
d)	My previous experience	13	100
e)	Internet	10	76.9
f)	Main stream media (newspapers, radios, TV)	13	100
g)	Others	10	76.9

In the option of 'others', the specifications given were suppliers, family, market sources, farmer association, farm workers and farm owners.

From the responses above, we observe the following:

1) Poultry farmers largely operate in multi-stakeholder settings and often seek opinions from others. In our case, all 13 respondents sought information from veterinary doctors. This shows the significant role poultry farmers attach to veterinary doctors. All 13 respondents also sought information from their fellow farmers. This confirms the strong social network of farming communities in Africa already observed in literature (Maertens and Barrett, 2013; Brock and Durlauf, 2000; Manski, 1993).
2) There is reduced influence of government extension workers who have previously been considered to occupy a strategic position of information dissemination to farmers as observed by Aina (2012).

3) Documentation of experience throughout rearing is important as farmers can then be able to use the records of previous experience as a support for decision making. This emphasizes the fact that good quality records should be kept, analysed and interpreted to enhance better poultry farm management decisions.
4) With 10 of the 13 respondents (76.9%) using the internet as a source of information for decision making, we acknowledge a growing interest in technology among poultry farmers in East Africa especially since previous studies (Spielman et al., 2010) observe low technology adoption among farmers in Africa.

Challenges in Poultry Farm Management

Respondents were specifically asked to write down the challenges they face during poultry farm management. The information about poultry farm management challenges helps us to further understand the decision making context of poultry farmers as decisions must be made to counter such challenges. Several challenges were listed and have been summarized below:

- Poor quality of farm supplies and inputs e.g. day old chicks and feeds
- Capital/financing challenges
- Unpredictable weather patterns which affects availability of feed inputs
- Fluctuations of costs of farm inputs and supplies
- Challenge of getting skilled workers
- Counterfeit drugs on the market
- High mortality rates
- Cannibalism
- Egg damages
- Market challenges
- Fluctuation of prices
- Thefts in farms by workers
- Short shelf life of poultry products
- Lack of information about the industry e.g. about disease outbreaks
- Lack of regulation
- Diseases.

From the responses, we observe that poultry farmers are faced with numerous challenges and are highly aware of them. Decisions made in the context of such challenges must aim at

addressing them. The long list of challenges given by respondents also confirms that poultry farms in East Africa are indeed faced with various challenges as already noted by Kurukulasuriya and Mendelsohn (2008). In the same study, they noted that these challenges have held back the growth of the poultry industry in the region. Innovations towards addressing these challenges therefore would enhance growth of the industry.

Use of ICT in poultry farms

Of the 13 case studies, only 3 (23.1%) had a computer on site. These three farms were all using Microsoft Excel and Microsoft Word to store farm records and make performance reports. Of the 10 who had no computers on site, 6 (60%) said they didn't find any value added by the presence of computers at their farms, 4 (40%) gave no reason for not having a computer on site. All the 10 respondents (90%) with no computer agreed that they would purchase a computer only if it added value to their businesses. While all respondents were computer literate, none of the respondents was using any ICT service/application for management and decision making. It was however observed that all the 13 farms had at least more than one mobile phone on site. After a further inquiry on the use of mobile phones at farms, respondents mentioned that they used mobile phones for making and receiving calls, sending messages, searching the internet for information and using social media

While these finding agree with the low technology usage widely reported among farmers in East Africa (Spielman et al., 2010), it also shows that farmers would utilise technologies if they perceived them to be of added business value to their farms. The finding that no farmer was currently using any decision support ICT service or application may be an indication that current decision support services have not been widely promoted among farmers in East Africa.

Type of information required by farmers to enhance decision making

Having taken note of the importance of information in decision making (Solano et al., 2003), respondents were requested to provide us with the type of information they required to enhance their decisions. Responses were summarized as below:

- Rearing requirements
- Information on different suppliers of poultry farm inputs and credibility
- Rearing guidelines for different poultry types and breeds
- Feed ratios and Formulations

- Poultry breeds and their unique requirements
- Information on vaccination of birds and use of drugs
- Market information like price changes, buyers
- Rearing guidelines
- Information on relevant policies for the poultry industry
- Information on business opportunities for farmers
- Inputs and prices
- Information on disease outbreaks.

These responses show that farmers have a lot of information needs and any innovations towards making this information readily available would add value and improve the management and subsequently decision making processes of poultry farmers.

3.3 Findings from Case Studies

From the exploration, the following general findings emerged:

- Farms are mainly managed by farm managers. These managers however consult farm owners before making decisions. Likewise, decisions made by farm owners are largely influenced by information provided by the farm managers.
- The importance of continuous flow of information on critical aspects of poultry farm management is key. Farmers need to be facilitated with knowledge and information about the performance indicators of their flocks to guide the routines of farm and flock management and consequently decision making. Information (descriptive, diagnostic, predictive and prescriptive) is vital in decision making and achieving farm goals.
- Poultry farmers' decisions are triggered by what they observe, hear from others or perceive from their experiences. This points to the fact that that they may not necessarily follow a sequence of processes in decisions making.
- Farmers are faced with numerous challenges in their operations, which they are much aware of. These challenges impact poultry farm management and farmers' decision must be geared towards overcoming or countering these challenges. Functionalities aimed at solving such challenges would improve poultry farm management in general.
- Poultry farmers have multiple sources of information during decision making. Their decisions are largely tied to several stakeholders in the farmers' social network.

- From the case studies, we also noted the importance of comprehensive record keeping and management at poultry farms especially because farmers can make reference to previous records and experience before making decisions. It is important that all experiences at a poultry farms are well documented for future reference.
- While the mobile phone is a very popular gadget used at every poultry farm, it is mainly to support collaboration, communication and information search.
- The use of computers at farms can be encouraged especially if computer systems are perceived to be useful and of value to farmers' processes.

3.4 Focus Group Discussions

Focus group discussions (FGDs) are a research technique that collects data through group interactions on a topic determined by the researcher (Morgan, 1996). Litoselliti (2003) asserted that FGDs are a good way of exploring complex issues. In this study, focus groups were adopted to obtain different perspectives on findings from case studies; examining participants' shared understanding, gaining deeper insights on participants' views, attitudes, beliefs and motivation; and gaining insights into the ways in which individuals are influenced by others with in the discussions (Litoselliti, 2003).

Following the findings from the case studies, two FGDs were held in Kampala, Uganda on 3rd June 2015 and 9th June 2015. We followed the guidelines of Freitas et al. (1998) for using FGDs in research. The key objective of the FGDs was to get deeper insights in the general findings from the case study interviews and observations made. The FGDs provided a natural environment where participants could influence and be influenced by others – just as they are in real life (Krueger & Casey, 2000). The spontaneity that arose from the strong social context of poultry farm management was well brought into practice at these meetings because participants were able to articulate themselves even more. Other than taking the role of setting the pace for discussion, the researcher took a much less dominating role and instead focused on getting deeper and broader insights by maximizing interaction between the participants as recommended by Freitas et al. (1998).

Selection of Participants

Focus groups should be small enough so that everybody has an opportunity to share his/her perceptions and big enough to provide diversity of perceptions (Freitas et al., 1998; Krueger, 1994; Oppenhein, 1993; Morgan 1988). We decided to have a maximum number of 12

participants for each of the two focus groups as recommended by Freitas et al. (1998). The participants were selected basing on their availability, involvement and experience (Veser, 2004). A combination of homogeneous and snowball sampling methods were used to select the 24 participants. Goodman (1961) recommended that an initial sample be drawn using a known sampling method before snowball sampling can be employed. Therefore using the homogenous sampling, we zeroed on 10 participants. Homogeneous sampling is used when researchers want to select participants from a particular group who share same characteristics (Riazi, 2016). Ten participants of the case study interviews were contacted by phone and invited to participate. These already shared characteristics of commercial poultry farmers as defined in chapter 1 and they had all participated in the case study interviews whose findings set the agenda for the FGDs. The other three respondents of the case study interviews were unavailable because of the distance from Kampala to their respective farms.

To get a good blend of participation, the researcher sought to have other key stakeholders of the poultry industry in the focus group discussions. In particular, stakeholders who influenced farmers' decision making practices were of keen interest. The researcher zeroed on veterinary doctors, extension workers, representatives of key suppliers and representatives of farmers' associations because these had been mentioned in the case studies as sources of decision support for the farmers. Snowball sampling method was then employed by asking the 10 participants to endorse these key people as recommended by Patton (2002). The snowball method was useful in taking advantage of the social network of the poultry farmers and provided the researcher with a reasonable number of potential participants (Thomson, 1997). With over 30 names endorsed by the farmers, the researcher segmented the group into categories of the different disciplines that they represented to ensure that we had a multi-disciplinary mix of participants for variety of views for each meeting. They were then contacted on phone and only those who could be available on selected meeting days and were willing to participate and openly share their views were selected. For each of the two groups, we had 5 poultry farmers, 2 veterinary doctors, 2 hatchery representatives and 3 feed suppliers making 12 participants. Freitas et al (1998) recommended a maximum of 12 participants for an FGD to have effective deliberations.

Focus Group Discussion Settings

Each of the meetings lasted 1.5 hours. The meetings began with self-introduction of the participants. This was followed with a ten minute presentation by the researcher about the

purpose of the study, the general findings from the case studies and reason for the FGDs. The presentation was concluded with two questions to the participants.

1) What makes decision making in poultry farm management complex?
2) How can decisions of poultry farmers be enhanced?

According to Freitas et al. (1998), introductory questions can give participants an opportunity to contemplate previous experiences thereby creating a platform for discussion. The discussions were mainly driven by the participants' interaction with minimal intervention from the researcher, who on a few occasions interrupted with a transition question to move the conversations back to the key questions. During the meetings, it was observed that FGDs were instrumental not only in collecting a wide range of opinions from a cross section of stakeholders of the poultry industry but also to validate the information.

3.5 Presentation and Discussion of FGD Findings

From the meetings, it was noted that poultry farm management comprises of comprehensive processes characterized by multiple decisions. Participants observed that decisions made during poultry farm management were highly consequential. The decisions made in one stage of the process had impact on output in all other stages as well as other process e.g. decisions made at the brooding stage affect growth of birds which leads to effects on their production rates and body weight throughout rearing and would lead to birds attracting a low price in the market. This may explain why decision support systems which only support a small part of the rearing process are not highly adoptable among farmers in East Africa. Because of the inter-related nature of flock rearing activities and processes as well as the consequential nature of decisions, it is important that poultry flock management and entire operations involved in the life cycle of flock be considered as one whole if decisions of poultry farmers are to be enhanced.

One of the key challenges to decision making in poultry farm management was identified as inadequate regulation in the sector. As participants discussed, it was a general consensus that this made purchasing decisions complex. Participants noted that there were a lot of poultry inputs on the market which were substandard and it was difficult to identify the genuine ones. Equally, the sector has a lot of 'quack practitioners' who misguided farmers. We noted from the discussion that poultry farmers are engaged in repeated purchases of farm inputs such as day old chicks, feeds and vaccines. They also purchase services of veterinary practitioners

and consultants to guide them in management and decision making. The importance of activities of input purchasing, which had already been highlighted by respondents in the case study interviews was further emphasized. Because of the challenges with purchasing, it was also noted from the FGDs that farmers preferred to mix their own feeds because only then could they ascertain quality besides saving some costs. This gave further insight on why 69.2% of the case study respondents mentioned feed mixing as an important activity in poultry farm management. Farmers were also concerned about an increased number of hatcheries which were substandard and selling out poor quality chicks. This resonated with the findings of Msoffe and Ngulube (2015) who asserted that East African countries lack comprehensive veterinary laws and policies and where these are in existence, they are hardly implemented.

> *"I bought my Day Old Chicks from a hatchery in Mpigi. But they just couldn't grow however much I fed them. They were stunted. Until a doctor came in and told me the problem came from the hatchery. The supplier couldn't even compensate me. I have since purchased day old chicks from suppliers recommended by experienced farmers only"*
>
> Melvin Kabunga, Poultry farmer, Mpigi District

The fact that farmers operate without budgets came out clearly in the meetings. In the discussions, it was noted that often farmers started rearing flock without concrete plans which affected them during rearing. Rearing flocks involves dedication of resources such as finances, time, commitment and labour. It is therefore important that farmers are able to plan so they can only rear flocks that fit into their plans. In the meetings, participants agreed that planning should involve information seeking, budgeting and dedicating resources. It was the general consensus of the participants that decision making would be eased if farmers dedicated time to plan before rearing flock. This would help them dedicate the necessary resources to avoid hasty decisions particularly in moments when resources were scarce.

> *"I bought 2000 layer chicks and started rearing. But I didn't have a plan. At 13 weeks, I couldn't manage the expenditure anymore. I ended up selling my birds at a give-away price to someone who could afford to raise them further"*
>
> Annette Kiconco, Poultry farmer, Mukono

The importance of information sharing and dissemination among farmers and stakeholders of the industry was further emphasized in the FGDs as well. Participants shared the view that information was key in enhancing decision making in poultry farm management. Examples given of information that would support poultry farmers included information on how to rear different strains and types of flocks from start of rearing to the end, market information, disease outbreaks and key poultry farm management aspects like construction of chicken houses. This further grounded the conclusion made during the case studies about importance of farmers having information on key performance indicators of their farms.

> *"I lost 3000 birds in one week. We had forgotten to vaccinate and we didn't know there was an outbreak of new castle disease"*
>
> Jasper Mayeku, Poultry farmer, Namawojolo

Participants also expressed concern about there being no formal way of identifying markets and interacting with others in the industry. Participants acknowledged the importance of collaboration of stakeholders in the industry through which they could access mentorship, information and decision making support from one another. This further emphasized the importance of social networks in farm management as already noted by Osinga (2015), FAO (2011), Nosheen et al. (2010) and Edeoghon et al. (2008) as well as confirmed during the case study interviews

Participants in the focus group discussions had general consensus about the high disease prevalence affecting farms. Participants mentioned New Castle, Gumboro and Coccidiosis as the major diseases affecting their farms. Both New Castle Disease and Gumboro are preventable through vaccination while coccidiosis is preventable through bio-security management at the farms. During the case studies, respondents all noted that they treated vaccination activities as important. It was therefore surprising that participants still had an issue of disease outbreaks particularly for diseases that can be preventable by vaccination. On a further inquiry about this, it was noted that while some farmers may have previously skipped a vaccination activity hence attracting disease, there were possible cases of vaccine failure arising from the sources or suppliers of vaccines. The poultry doctors at the FGDs particularly mentioned the importance of purchasing vaccines from reliable and certified sources.

On a whole, the focus group discussions zeroed on the importance collaboration, information and transparency of players as important issues for eliminating decision making challenges of poultry farmers.

3.6 Generic Understanding of Decision Making Among Poultry Farmers

Generalising is 'central to the definition and creation of valid public knowledge (Metcalfe, 2005). In this research, the depth to which exploration was carried out involving multiple cases and multiple stakeholders was aimed at substantiating generalisation of findings to decision making in poultry farm management in East Africa. Consistent findings over multiple cases can be considered robust findings (Yin 2011; 1993) and provide a basis for generalisation of findings from a particular study sample to the entire population (Myers, 2000; Polit and Hungler, 1991). The discussion in this section therefore generalises findings of this chapter to poultry farm management in East Africa.

As a recap of our findings so far, we note that poultry farm management operations involve numerous activities. Basing on our findings from both case studies and focus groups on what the farmers largely get involved in, we note that poultry farm operations involve numerous activities and consequential decisions. Considering the findings from exploration, we group the different activities under four main processes of planning, purchasing, rearing and marketing. Planning entails information gathering market exploration and budgeting; purchasing involves sourcing for farm inputs, purchase and inventory management; rearing involves the day to day activities of flock handling such as health monitoring, nutrition management, flock welfare and record keeping; while marketing involves advertising and sale of farm inputs. These four processes are inter-related because of the consequential nature of the decisions involved in the processes. Henceforth, we note that poultry farm management involves a complex interaction of four inter-related processes of planning, purchasing, rearing and marketing, in which farmers continuously make decisions.

Nonetheless, these four processes remain ineffective as long as the poultry farmer is unable to collaborate with stakeholders of his/her value chain because of the influence of these stakeholders on the poultry farmers' decision making processes and general management. This makes collaboration another important aspect of poultry farm management which is inter-related with the initial four processes. Collaborating is an important aspect in poultry farm management as per findings from both literature and exploration. It is thus adopted as a

fifth process of poultry farm management as it is inter-related with planning, purchasing, rearing and marketing.

From the discussion so far, it is also apparent that decisions made across these inter-related processes are decisions that matter (DTM) as defined by Keen and Sol (2008). They are complex, consequential, uncertain, non-reversible, non-avoidable and multi-actor as elaborated in table 3-5.

Table 3-5: Poultry farmers' decisions in the context of DTM

Characteristic	**As seen from the poultry farmers' view**
Complex	Management of a poultry farm requires continuous analysis of information and animal variables (such as body weight of birds, feeding patterns, production rates, growth rates, temperature, etc.) to identify changes and possible areas of improvement.
Consequential	Decisions made in one stage of the business process can have diverse effects on other stages e.g. the purchase of poor quality inputs affects the entire rearing period and can lead to poor output off the flock.
Uncertain	The business environment in developing countries is highly unpredictable. Farmers operate in situations of high uncertainty due to problems such as inadequate regulation and impact of natural weather patterns among others.
Non-reversible	Most decisions made by farmers are hard to reverse. Once made, farmers are often faced with challenges of living with the repercussions and dealing with revenue losses that may arise from poor decisions.
Non-avoidable	No matter what, poultry farmers must make decisions in their processes.
Multi-actor	The cross cutting nature of poultry rearing processes necessitate the involvement of multiple stakeholders e.g. farm managers, veterinary and animal nutrition experts, suppliers of different inputs, customers, regulators.

From exploration, we also noted the importance poultry farmers and/or farm managers attach to their involvement in their processes. In fact, we learnt that farmers consider themselves as custodians of salient knowledge because of the experiences they accumulate in handling flocks. Just by observing flocks, they are able to make decisions. This denotes the importance of their involvement in farm and decision making processes because of the skills and experience they have in poultry farm management.

The challenge of an inadequately regulated business environment stood out in both literature and exploration and has adverse effects of poultry farmers' decision making processes. Poultry farmers are faced with a challenge of inadequate regulation, hence operating in volatile and unpredictable environments. They face problems such as dealing with quack practitioners and having challenges in distinguishing the genuine and counterfeit inputs/products on the market. This impacts the poultry farmers' decision making processes because they have incomplete understanding of the products and practitioners and how the options they make are linked to the final outcomes of their decisions. The importance of lobbying and supporting East African governments to actively regulate the poultry industry is apparent in this research.

From the above discussion, we construe that poultry farmers in East Africa may not always follow logical decision making processes like other decision makers, and yet they must make timely and effective decisions numerous times. Because of this, there is likely to be a discrepancy between the desired effect of a decision and its actual effect. We also note that poultry farmers will most likely apply heuristic rules since heuristics mainly stem from the decision maker's observations, perceptions and past experiences (March, 2002).

Basing on the above understanding of decision making among poultry farmers in East Africa, we apply the concept of decision enhancement of Keen and Sol (2008) to the problem domain. Particularly, a Decision Enhancement Studio is highlighted as an appropriate mechanism for enhancing decisions made by poultry farmers throughout their processes. The use of a decision enhancement studio, which starts from the lens that focuses on stakeholders in decision arenas and their decisions that matter (Keen & Sol, 2008), can enhance poultry farmers to appropriately collaborate with other actors in the poultry industry in a streamlined process where stakeholders can be identified and their skills, qualifications and experiences used as a basis for collaboration. Whereas much of the focus of the application of information technology aims at taking people out of the loop, the approach of decision enhancement is to

use technology not to replace or support decision making but to enhance and extend decision makers' capabilities (Keen & Sol, 2008), which in essence takes care of poultry farmers' local salient knowledge and experience. This research proposes a Poultry Decision Enhancement Studio (PDES) to enhance poultry farmers' decision making. In the next chapter, the author describes the design of the proposed PDES.

Chapter 4 - Designing the PDES

In the previous chapters, poultry farm management was studied from both literature and exploration to gain a generic understanding of the field of decision making among poultry farmers in East Africa. This chapter departs in orientation from problem formulation to problem solving using a decision enhancement studio. In section 4.1, we present the Poultry Decision Enhancement Studio as a prescriptive conceptual model for the decision making challenges of poultry farmers and introduce the "ways of" framework, as a way for describing the Poultry Decision Enhancement Studio design. Section 4.2 presents the way of thinking; section 4.3 describes the way of governance; section 4.4 illustrates the way of modelling while section 4.5 demonstrates the way of working.

4.1 A Decision Enhancement Studio for Poultry Farmers

The object of this chapter is to describe the design of the Poultry Decision Enhancement Studio (PDES), whose focus is to enhance poultry farmers' decisions throughout the poultry farm management processes. Venable and Baskerville (2012) assert that a purposeful artefact is any kind of artefact designed to achieve some human purpose, which is the PDES in the case of this study. Through literature and exploration, we gained new ideas and concepts relevant for building the proposed PDES as discussed in section 3.6, from which the following considerations for the design of the PDES have been adopted.

1) The design should facilitate collaboration and networking among stakeholders of the poultry industry because their views enhance poultry farmers' decision making processes.
2) The design should enable interdependence of decisions across the processes of poultry farm management i.e. planning, purchasing, rearing, marketing and collaboration. This is because of the inter-related nature of these processes and consequently their corresponding decisions.
3) The design should encompass the three major perspectives of a decision enhancement studio (people, process, technology).
4) The design should facilitate a transparent and regulated environment through which farmers can operate and make decisions.

5) The design should support documentation of farmers' experiences and farm information because these can be a good basis for decisions making.
6) The design should enable information interpretation and analysis. Poultry farmers' decisions are highly influenced by the information they have. Interpretation and analysis of this information further enhances timely decision making.
7) The design should provide guidelines to poultry farmers on flock handling and decision making on key performance indicators of flock and farm management.

Basing the above considerations, figure 4-1 presents an overview of the design of the PDES and its corresponding suites. PDES emphasizes the interaction of the five inter-related process of poultry farm management of planning, purchasing, rearing, marketing and collaboration. The design particularly emphasizes the importance of the continuous interaction of the processes and possible overlaps in the decisions made across the processes. These processes are highly integrated and do not exist in isolation. In the PDES design, the interaction of the poultry farm management processes encompasses the three major perspectives of a decision enhancement studio (i.e. people, processes and technology) as shown in Figure 4-1 and described in the next sections.

PDES consists of five suites of different technology enablers. The major decisions supported by the PDES suites include decisions on planning; decisions on input purchasing; decisions involved in day to day flock rearing including health and nutrition management and decisions on marketing. In the suites, factors affecting the above decisions have been put into consideration. These include: information, regulation, farmers' social networks, skills and experiences of stakeholders among others.

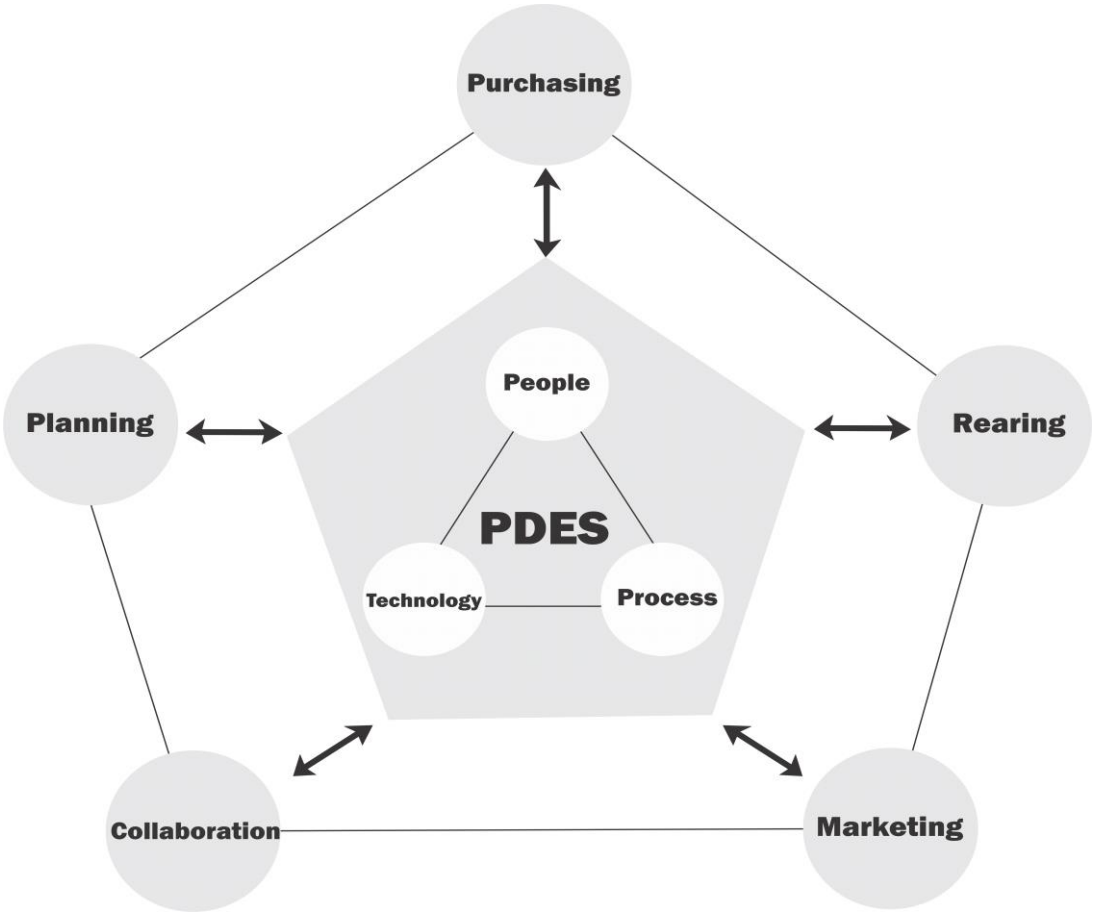

Figure 4 – 1: Overview of the PDES

The PDES suites, services and supporting guidelines subsequently enhance decision making during poultry farm management by facilitating collaboration, transparency, regulation, visualisation, information interpretation and analysis. As guided by Gregor and Hevner (2013), we note that the construction of the PDES and its description in terms of design principles and technological rules are steps in the process of developing a comprehensive body of knowledge. The PDES design is thus described in terms of the "ways of" framework consisting of the way of thinking, way of governance, way of working and way of modelling (Selingmann et al., 1989; Sol, 1988) as shown in figure 4-2. The choice of this framework is based on the experience of several researchers in information systems (Katumba, 2016; Mirembe, 2015; Aregu, 2014; Ejiri, 2012; Amiyo, 2012; De Vreede and Briggs, 2005), who were able to successfully employ the framework in the design, development and implementation of information systems, approaches, methods, frameworks and solutions to problems in various domains.

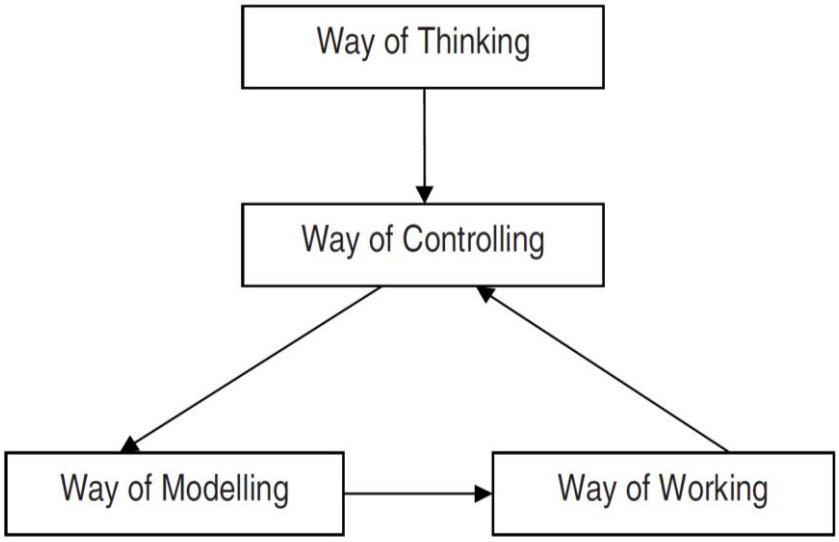

Figure 4 - 2: Framework to assess design approaches (Source: Sol, 1988)

4.2 Way of Thinking

The way of thinking depicts the concepts and theoretical foundations to enhance poultry farmers' decisions as well as expressing the underlying philosophy. From the previous chapter, it is clear that poultry farm management is dynamic, continuous and complex and it involves decisions that matter as defined by Keen and Sol (2008). In light of this, the line of thought in this research is that the decision enhancement concept (Keen & Sol, 2008) can enhance decision processes of poultry farmers. The PDES design integrates the perspectives of a decision enhancement studio into the five inter-related processes of poultry farm management with an aim of guiding and enhancing poultry farmers' decisions.

From the previous chapters, we identified a number of factors that limit poultry farmers' decision making processes i.e. inability to network and collaborate with relevant stakeholders, lack of relevant information, inability to analyse and interpret available information, inadequate regulation and; lack of relevant information and communication channels. To mitigate these limitations, the PDES was proposed following the Decision Enhancement framework, which was advanced by Keen and Sol (2008) for solving human decision challenges involving complex and uncertain problems. Based on insights from Keen and Sol (2008), we define the PDES as a prescriptive environment which enhances decision making in poultry farm management through providing guidelines and interpreted and analysed information for farmers and/or farm managers, promoting collaboration of the

poultry industry stakeholders and enabling transparency and regulation of the industry. The way of thinking of the PDES is based on the interaction of the three major perspectives of people, process and technology of a decision enhancement studio (Keen and Sol, 2008).

The "**people**" aspect refers to the poultry farmers and the different actors involved in the poultry farmers' decision processes. People make decisions, which are shaped by their institutional knowledge, skills, values, judgement and experiences (Keen & Sol, 2008). Poultry farmers are involved in making decisions very frequently, but face challenges in their decision making processes ranging from lack of information, inability to collaboratively share experiences and lack of skills among others. This has a direct impact on their decision outcomes. From exploration, we noted the importance of collaboration among stakeholders of the poultry industry whose input has a bearing on poultry farmers' decisions. The PDES enables collaboration among such stakeholders because these actors' presence and roles on the PDES enhance farmers' decision making processes. Other than poultry farmers, other people on the PDES include poultry farm input suppliers, regulators of the poultry industry, poultry health experts and consultants, farm employees and buyers of poultry farm outputs (Table 4-1). The PDES can also be a valuable source of information to other groups such as potential farmers, researchers, funders and farmer associations

The decision "**process**" influences the likelihood of actors to make effective decisions. Keen and Sol (2008) define a decision process as that process that has one and only one purpose: "making real impact for stakeholders in handling decisions that really matter in their sphere of responsibility". This study is concerned with the decision making processes of poultry farmers. From literature and exploration, we noted that poultry farmers will most likely apply heuristic rules during decision making. Heuristics mainly stem from the decision makers' observations, perceptions and past experiences (March, 2002). This points to the fact that poultry farmers' decision processes may follow the prescriptive perspectives which relate to the search for optimal solutions to a problem situation (Keen and Sol, 2008). The aim of the PDES is to increase decision process agility of the poultry farmers. Decision process agility is a combination of speed, flexibility, coordination, collaboration and innovation (Keen and Sol, 2008). As already noted, poultry farm management involves inter-related processes and decisions that matter. The need for decision process agility across these processes is paramount. The studio concept as described by Keen and Sol (2008) and successfully applied by various researchers (Katumba, 2016; Mirembe, 2015; Aregu, 2014; Knol, 2013; Ejiri,

2012; Ssemaluulu, 2012; Amiyo, 2012 etc) has already been effective in enabling decision process agility in different contexts and environments.

The "technology" aspect enables decisions by providing the tools necessary for farmers' decision making processes packed in suites, guidelines and a facilitative environment. Suites consist of services, which form building blocks and support recipes for repeated processes (Katumba, 2016). Technology provides multiple types and levels of support focused on enhancing the inter-related poultry farm management processes, so that decisions in these processes are skilfully handled and effective. Technology has the potential to support business strategies (De Haes et al., 2013), but can only be beneficial if it is used as a tool, which can be adjusted to combine additional knowledge and experience and adopted with in a local context (Aregu, 2014; Wade, 2002). Specifically, technology may lead poultry farmers to a number of benefits such as: transparency among actors of the industry, low overhead costs, provision of timely information, increased interaction among stakeholders, analysis and interpretation of animal variables and enabling an improved regulatory environment.

Table 4-1: The actors (people) on the PDES and corresponding roles

Actors	**Roles**
Administrator/Facilitator	• Responsible for setting up and running the PDES • To Provide support to farmers who want to use the studio • To make sure the studio works and delivers the relevant services to stakeholders • Invite and train participants to use the studio • Ensure active participation of all actors on the studio
Poultry Farmers	• Use PDES suites for guidance during poultry farm management • Participate in studio activities e.g virtual meetings and networking • Receive reports from farm employees • Update studio suites with relevant farm information • Study reports from the studio as a guide to decision making

Actors	Roles
Farm workers	• Update studio suites with relevant farm information • Use studio services and suites as instructed by farm owner
Suppliers	• Sell quality poultry farm inputs in a transparent environment • Participate in networking on the PDES
Poultry Health Experts	• Attend to farmers' queries concerning flock • Advise actors on poultry health management
Buyers	• Buy poultry outputs from poultry farmer
Regulators	• Authenticate and verify documents submitted by actors • Implement government policies on the studio among actors
Potential farmers, Scholars, funders	• Seek information on the poultry industry

4.3 Way of Governance

The way of governance expresses the managerial aspects of the PDES. Keen and Sol (2008) refer to this as the governance architecture, which may include guidelines, regulations and/or shared facilities. Governance in service systems includes coordination, service frameworks, trust and controls. Because of the multi-disciplinary nature of poultry farm management, the PDES actors (see table 4-1) are a diverse group representing different organisations. This denotes the importance of measures and methods for managing the decision processes. Below, the author examines issues that should be observed while using the PDES for decision enhancement.

1) All participants on the PDES have clear terms and conditions for which they must assent to prior to admission. These help the PDES actors to understand the intent of

their presence on the PDES as well as giving clear guidance of conduct particularly on what the different players are expected to deliver and the benefits they derive from the PDES (See table 4-1).

2) Mutually beneficial relationships for all actors on the PDES should be a benefit for all participants on the PDES. While all actors provide different input into the PDES, they equally derive various benefits from the studio. Poultry farmers can have their decisions enhanced; suppliers are able to access markets of the farm inputs as well as benefiting from farmer reviews to build their profiles; buyers get quick access to farm outputs from trusted sources; poultry health experts are able to build their profiles through knowledge sharing and can benefit by selling their consultancy services to other actors; while regulators can use the PDES to communicate and implement government policies.
3) All players on the PDES should be vetted by the administrators to ensure transparency and regulation of the industry. Actors will be admitted to the PDES because of their registration status (e.g suppliers, farmers, farmers) and qualifications (poultry health experts). This will lead to trust, commitment and involvement in the decision process and consequently regulation in the poultry industry.
4) All content on the PDES must be vetted and reviewed by experts and administrators to ensure quality information is accessed by all actors.

4.4 Way of Modelling

The way of modelling identifies the models that were used for decision making (Katumba, 2016; Van de Kar, 2004; Sol, 1982). In our way of modelling, operational business processes were modelled using data from the different poultry breeders on the chicken strains on the Ugandan market. Data was arranged in spreadsheet format, which was encoded into an array of JSON (JavaScript Object Notation) and converted into graphs. One mechanism for improving decision making has been noted to be associated with the use of information, information presentation and visualization (Keen and Sol, 2008; Speier and Morris, 2003; Tufte, 2001). In the way of modelling, we use graphical and visual representations of the poultry rearing processes particularly mirroring the key performance indicators of flock management because these were of interest to poultry farmers as per findings from exploration. We also utilise spreadsheets to work with stream data on the PDES such as getting the daily changes in supplier prices. The trial and error technique of Afoloyan and Afoloyan (2008) was utilised to model optimal feed formulations for chicken while Unified

Modelling Language (UML) was used because it consists of several graphical options for systems design (Wieringa, 2002; Eshuis, 2002; Eriksson and Penker, 2000) and it is agile in various modelling tasks, making artefacts understood by all actors.

4.5 Way of Working

The way of working denotes the steps that are followed in using the PDES for decision enhancement. Subsequent to the design considerations pointed out in section 4.1 and the way of thinking described in section 4.2, five suites were identified to provide the required functionality of the studio. These are planning, purchasing, rearing, marketing and collaboration suites. A suite of software services is the foundation for meshing technology and the process (Keen & Sol, 2008). A suite contains domain specific services, which form building blocks and support recipes for the inter-related processes in poultry farm management. Based on the generic understanding gained on poultry farm management and decision making practices of poultry farmers in the context of the East African region, the proposed studio suites and functional requirements are presented in table 4-2. The suites are further described using activity flow diagrams.

Table 4-2: PDES Suites and their functions

PDES Suites and services	**Suite functionalities and requirements**
Planning Suite • **Information** • **Market exploration** • **Budgeting**	• Provide general information on poultry farm management such as housing, site selection, environmental management • Heighten a regulated environment by supporting formal registration of the poultry sector players • Facilitate planning by engaging farmers on knowing their environments of operation • Facilitate the drawing up of working budgets for farmers before they make the decision to rear flock
Purchasing Suite	• Provide information on all suppliers of inputs of poultry farms, their corresponding regulation

PDES Suites and services	Suite functionalities and requirements
• **Supplier information** • **Quality Purchasing** • **Inventory management**	status and their perceived performance on the market • Provide an interface for collaboration among farmers and their suppliers • Provide farmers with a shopping interface with suppliers where they can make direct purchases and agree on corresponding service level agreements with their preferred suppliers • Support farmers to keep track of their inventories there by guiding decisions on when to purchase particular inputs • Support farmers to review their suppliers and offer feedback on product quality as well as after sales service
Rearing Suite • **Process monitoring** • **Record and reports** • **Feed mixing** • **Health management**	• Provide guidelines to farmers for daily flock monitoring particularly on the key performance indicators • Provide a repository for poultry breeds/strains and their unique requirements and characteristics • Support farmers' ability to keep and manage records • Provide different feed rations and formulations in relation to different bird stages and expectations • Provide a tool for tracking production and performance of flocks • Provide a repository for information on poultry disease diseases; both curative and preventive measures as well as poultry drugs • Support farmers to manage the health of flock

PDES Suites and services	Suite functionalities and requirements
	using preventative means by guiding vaccination activities, enabling farmers to carry out quick diagnoses of flock and providing a list of veterinary listings with corresponding locations by google maps for easy access • Provide an interface to directly engage an online poultry health expert in times of urgency
Marketing Suite • **Market access** • **Buyer links**	• Provide real time information on market and prices • Provide an interface for farmers and buyers of poultry farm outputs to continuously collaborate • Provide an interface for making sales and agreeing on corresponding SLAs
Collaboration Suite • **Networking** • **Interaction** • **Communication** • **News**	• Enable an interactive environment among poultry farmers and strategic stakeholders • Provide a portal for news on the poultry industry • Provide an interface for stakeholders of the industry to share their experiences • Provide an environment where actors can hold virtual meetings • Provide an interface for actors to engage in private chats and conversations

Activity flow modelling

Decision making in poultry farm management involves a series of activities. We used activity flow diagrams to describe the steps that lead to decision making with in each of the poultry farm management processes. Activity flow diagrams offer a way to present activities by enabling easy representation of the relationships between those activities (Dennis et al., 2012). Following the engaged scholarship philosophy of this research, the participants of the

focus group discussions described in section 3.4 were involved in the modelling of the different activity flow diagrams of the poultry farm management processes. The idea of engagement of users in activity flow modelling was based on 3 principles of inclusiveness, acceptability and effectiveness as pointed out by Oliver et al. (2011) and Fiorino, (1990).

1) Inclusiveness: Individuals or stakeholders have a legitimate right to influence processes that have a direct bearing on them. The PDES was developed for these stakeholders. Their input in ensuring that it meets needs of poultry farmers and their stakeholders across the East African region was considered significant.
2) Acceptability: Users will potentially be more accepting of systems if they have been involved in the processes and reasoning that underpinned these systems (Oliver et al., 2011). The engagement of farmers and the stakeholders in their decision making arenas in activity flow modelling was aimed at achieving legitimacy of the processes in question and to create a foundation for acceptance of the PDES by users.
3) Effectiveness: The engagement of the PDES stakeholders provided a source of practical know-how that informed the modelling of the poultry farmers' decision processes.

With insights from the participants, BiZaGi process modeller was employed to describe the different steps taken by farmers with in the farm management processes to make decisions. BiZaGi process modeller is a software environment focusing on development of diagrams or process chains (Nikolaev et al., 2015). The use of BiZaGi allowed us to describe poultry farmers' decision processes using diagrams and to depict how the different suites and sub-suites of the PDES interact for poultry farmers to be able to make their decisions. Each of the PDES suites is described in detail.

Planning suite

During exploration, it was noted that poultry farmers operate without budgets and concrete plans for their businesses, which impacts the kind of decisions they make throughout their operations. The principles of managing a farm are no different from the principles of managing any other complex business enterprise (Dent et al., 2013). Poultry farmers therefore should be able to formulate plans and continually monitor set plans to be able to make decisions aimed at ensuring that their farm businesses remain on target in terms of set plans. In the PDES design, the Planning suite focuses on aiding poultry farmers' planning capabilities using three key services: information, market exploration and budgeting. These

services emphasize the importance of farmers accessing relevant information concerning poultry farm management and poultry flocks, exploring market environments for costs on inputs and outputs and budgeting for flock cycles in the farm.

The process flow of the planning suite (see figure 4-4) begins when the farmer identifies an interest to purchase new flock. The farmer accesses relevant information concerning flock rearing and the associated variables like housing, flock strains, flock management, manure management etc. Basing on the insights gained from this information, the farmer then explores his/her market for costs and availability of relevant inputs for the flock cycle. With full understanding of the market, the farmer can choose to proceed with the interest to start a new flock cycle or focus on understanding the markets better or even exploring other markets as well. Once a farmer proceeds with the interest to start a new flock cycle, he/she can generate a working budget or review an already generated budget. If the budget is workable, the farmer can then proceed to the purchasing suite. If the budget is not workable, the farmer may choose to review the generated budget or even generate a new workable budget. The decisions enhanced in this process as shown in figure 4-4 are 1) the decision to proceed with a new flock cycle and 2) the decision to adopt a generated budget. These decisions are enhanced by information availability and interpretation and collaboration with market actors. The services of the planning suite also enhance farmers' decisions on other poultry farm aspects such as decisions on disposal of manure or construction of a new chicken house. Planning in poultry farm management can counter poultry farm management challenges such as a failure to maintain or manage flocks as noted from exploration (see section 3.5).

Purchasing suite

During exploration, we noted that farmers consider decisions concerning purchasing to be significant. We also noted that these decisions were largely affected by an inadequate regulatory environment and inadequate information. The purchasing suite was conceptualised to enhance poultry farmers' decisions concerning when to purchase inputs, where to purchase inputs, how to get purchased inputs to the farm premises and how to manage purchased inputs once at the farm. The purchasing suite is embedded with two services: Suppliers catalogue and Inventory management. The supplier catalogue service focuses on farmers' having the capacity to access all relevant information concerning suppliers of poultry farm inputs, which includes location, products/services, formality of operations and the

experiences of farmers who may have interfaced with these suppliers. The supplier catalogue service focuses on farmers being able to make decisions concerning input purchasing in a transparent, well informed and regulated environment. At the point of decision making, the service supports farmers to directly interface with suppliers regulated suppliers, collaboratively agree on service level agreements with chosen suppliers, place orders and track their orders till delivery. Experiences of farmers throughout this process are documented to assist the farmer in reviewing a particular supplier and sharing of farmer experiences in the farmers' social networks, which were noted as important during exploration and literature. The supplier catalogue service enables transparency among suppliers of poultry farm inputs, regulates the input market and gives farmers a platform to share their experiences in the input market. The inventory management service on the other hand supports farmers to track the stock in their inventories so as to make decisions on when to purchase. Inventory management is an important aspect of business management.

The process of the purchasing suite (see figure 4-5) begins when a farmer decides to purchase a farm input. The farmer creates evaluation criteria for the suppliers using the supplier catalogue service and is able to interface with suppliers who meet this criteria. The most appropriate supplier can be selected basing on attributes such as supplier ratings, price, location or service level agreement depending on the farmer's interest. A farmer can then interface with a supplier of interest to confirm workable business terms, and if this fails the farmer can return to selecting another appropriate supplier. The farmer can place an order for farm inputs with a supplier of choice after workable business terms have been established. The order is processed basing on these terms and once it is accepted, the farmer's inventory is updated. The updated inventory guides the farmer in following up with aspects such as delivery and usage at the farm.

Rearing suite

The rearing suite is concerned with the day to day process monitoring of flock and facilitates poultry farm management through services of flock registration, record management and monitoring of key performance indicators that impact flock growth. During exploration and literature, we noted that poultry farmers lack guidance on day to day rearing of flocks. We also noted that poultry flock management involves monitoring of multiple key performance indicators to ensure farm efficiency and productivity. Some of these indicators included bird growth, egg production rates, egg damage rates, egg weight, feeding patterns, water

consumption, temperature, mortality rates, vaccination scheduling among others. These indicators are also highly considered by poultry parent breeders as important in poultry flock management (Hyline, 2015). The object of the rearing suite is to enhance the poultry farmer to monitor and document information concerning these indicators. The suite analyses and interprets documented information concerning the indicators to further enhance farmer decisions concerning flock welfare such as undertaking interventions to improve flock growth, performance and production. The rearing suite is also embedded with the feed mixing and health management sub-suites. While feed mixing sub-suite supports farmers to generate workable feed formulations, the health management sub-suite is centred to enhancing the farmers to address poultry health challenges in a timely manner.

The process of the rearing suite (see figure 4-6) begins with the arrival of a new batch of day-old chicks (DOC) at the farm. The farmer registers the DOC to generate a day-to-day rearing guide for the flock. This guide is open sourced from parent breeders. On a daily or weekly basis depending on a farmer's preference, the farmer updates a report on the key performance indicators of the flock. The progress of flock as per the farmer's updates is interpreted against the standard rearing guidelines of the reared strain to gauge flock performance. If the progress meets the acceptable standards, the farmer proceeds with day-to-day rearing. If progress does not meet expected standard, the affected indicators are evaluated and the farmer further uses the health management or feed mixing sub-suite depending on the results of the evaluation. The aim of the health management and feed mixing sub-suites is to guide the farmer in addressing relevant key performance indicators. If identified indicators are addressed, the farmer proceeds with day-to-day rearing. In case the flock is due for sale as per the rearing guidelines, the farmer proceeds to the marketing suite. Where any issues with flock management that are not addressed in the feed mixing and rearing suite, the farmer can proceed to collaborate with relevant experts on poultry farm management.

Feed Mixing Sub-suite

During exploration, it was observed that farmers preferred to mix their own feed to cut cost and ascertain quality. While the purchasing suite provides farmers with the chance to ascertain quality of feeds, the feed mixing sub-suite enhances them to make decisions on which feed formulations to use in case they can get the nutrients at workable costs. The feed mixing sub-suite supports farmers to generate effective formulations basing on flock age and the requirements as per flock reports generated by the key performance indicator reports of

the rearing suite. The trial and error technique of generating feed formulations (Afoloyan & Afoloyan, 2008) was utilised in the feed mixing sub-suite so that farmers can be able to instantly formulate feed rations of flocks of different ages and different requirements when in need. This sub-suite enhances farmers' decisions on whether to mix their own feeds and which feed formulations they can apply to flocks.

The process of the feed mixing sub-suite (see figure 4-7) begins with evaluating relevant KPIs in relation to nutrition of flock. Depending on the affected KPI, nutrition needs of flock are evaluated and a new feed formulation generated for the flock. When the new feeds are administered, the farmer proceeds with da-to-day rearing to ascertain if the problem can be addressed with the new feeds. If the problem is not addressed, the farmer proceeds to collaborate with an poultry nutrition expert. Depending on the condition of flock, the farmer can also choose to contact the expert at the on-set of identifying a problem.

Health Management Sub-suite

The Health Management sub-suite enhances farmers to make timely decisions concerning the health of flocks. From both literature and exploration, we noted that poultry farmers are faced with challenges of high disease prevalence at farms. This sub-suite therefore facilitates farmers to carry out timely vaccinations, identify disease symptoms using information on the suite and observe flocks to enable culling of any infected birds thereby preventing further infection spread. The suite also facilitates collaboration by providing an interface where poultry farmers can interact with online poultry health experts in case of emergencies. Through the health management sub-suite, farmers are enhanced to make decisions on when to contact a poultry health expert, which experts to contact, when to vaccinate flock and when to cull birds to prevent further infection.

The process of the health management sub-suite (see figure 4-8) begins with evaluating the relevant KPIs in relation with flock health. The farmer studies the symptoms of the birds to identify possible health issues, evaluates the identified issues before deciding on an appropriate solution. If the issue is addressed, the farmer can proceed with day to day rearing. If not, the farmer collaborates with a poultry health expert for professional guidance.

Marketing suite

The marketing suite is concerned with enhancing famers' decisions relating to sale of the outputs of their farms. The suite provides services of advertising and buyer access. The object of the marketing suite is equipping farmers to interact with reputable and registered traders of poultry products in an open and transparent market. During exploration, farmers mentioned that they had challenges of identifying formal markets for their products. Interactions of farmers and buyers on the marketing suite enables poultry farmers to evaluate buyers before select preferred buyers, agree on prices and assent to workable service level agreements before finally making the decision to sell. This suite enhances farmers decisions on which buyer to sell to, which price to sell at and how to deliver produce to buyers.

The process of the marketing suite starts with the farmer having farm outputs for sale. These can be eggs, chicken meat, live birds or manure. The farmer creates a buyer selection criterion to access potential buyers. By collaborating with potential buyers, the farmer is able to identify an appropriate buyer depending on aspects like price, service level agreement and any other terms the farmer may deem fit. Once an appropriate buyer is selected, the buyer formally places an order and issues an invoice to the farmer. The farmer follows up to deliver goods to the buyer and issues a receipt after receiving payment for the goods.

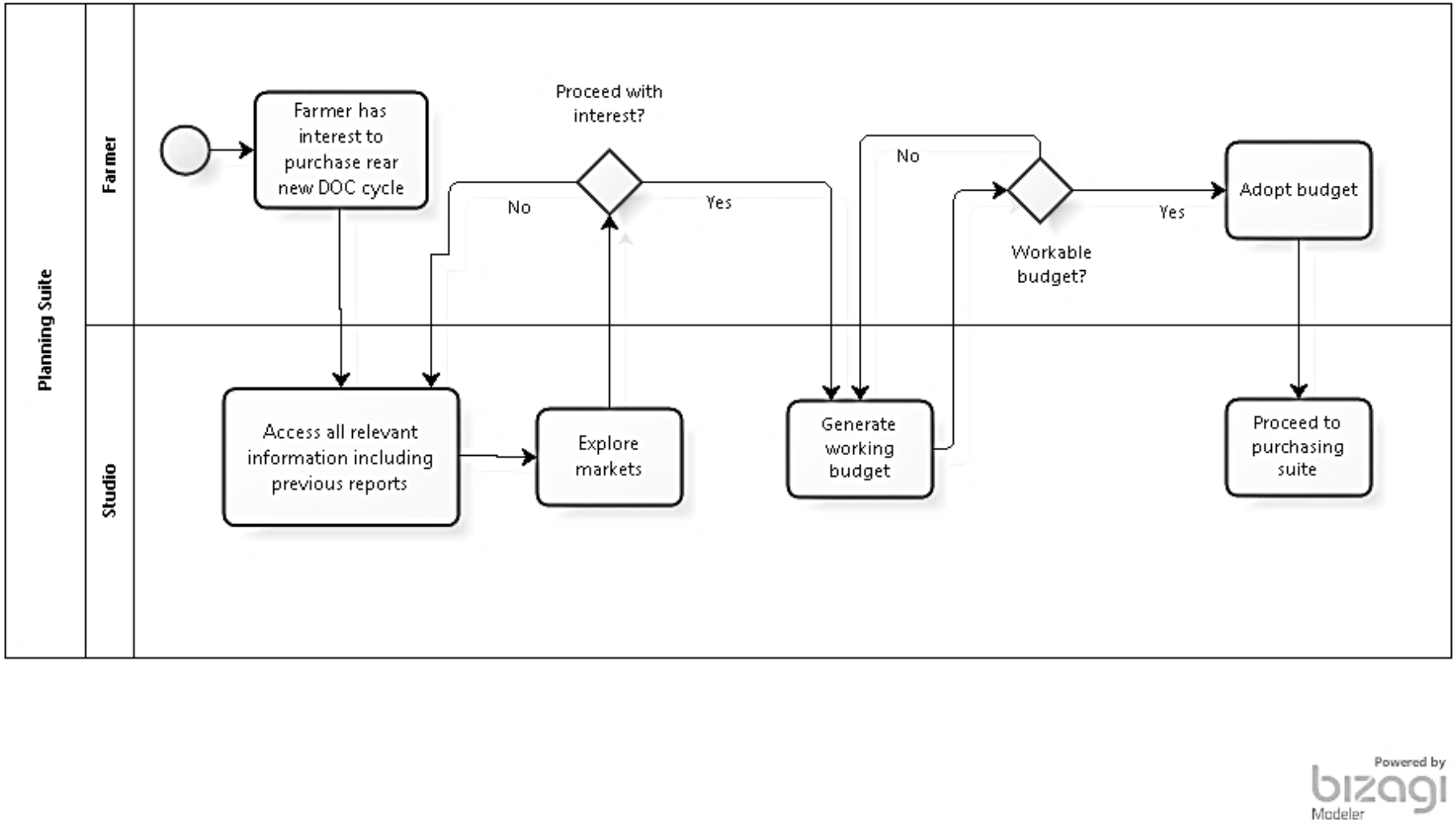

Figure 4 - 3: Activity flow diagram of the planning suite

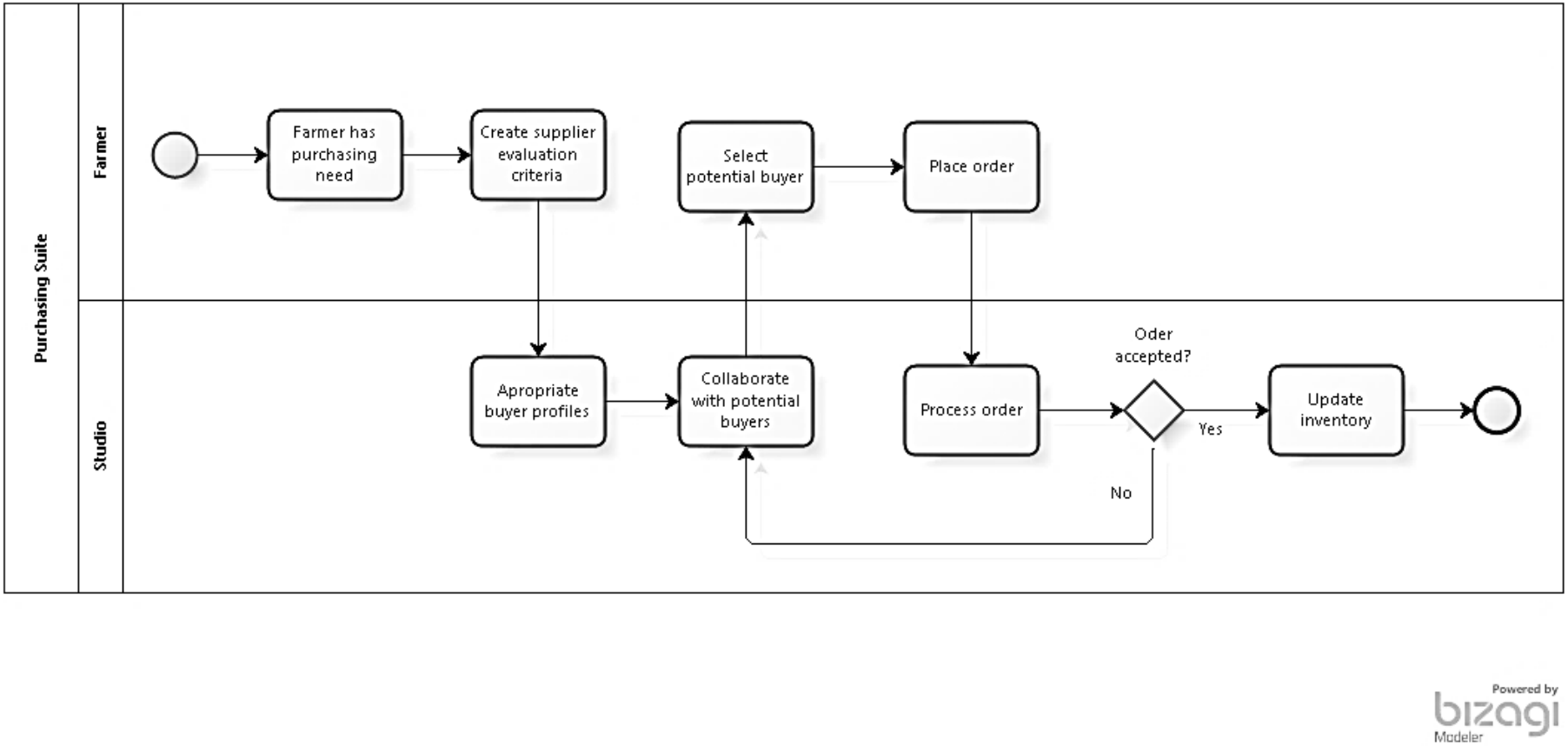

Figure 4 - 4: Activity flow diagram of the purchasing suite

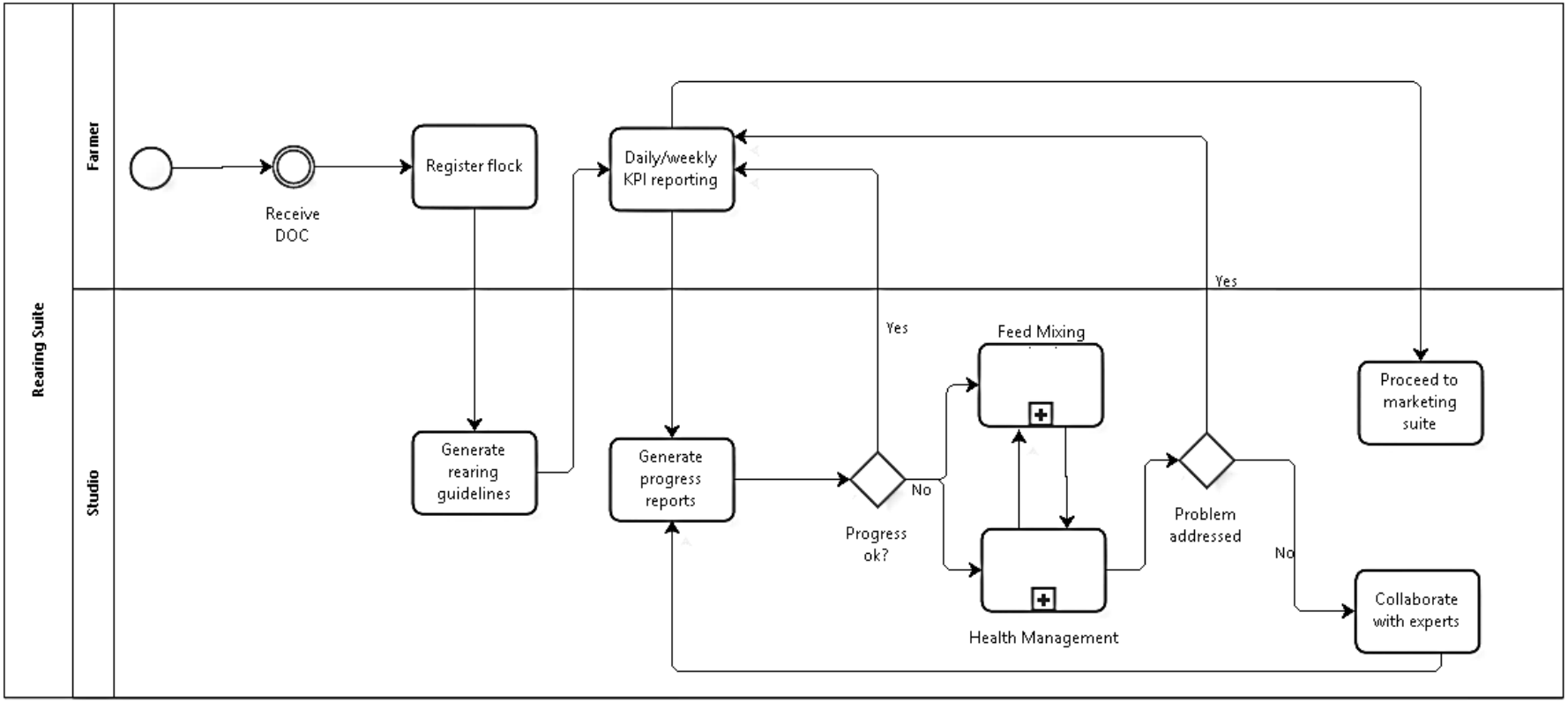

Figure 4 - 5: Activity flow diagram for the rearing suite

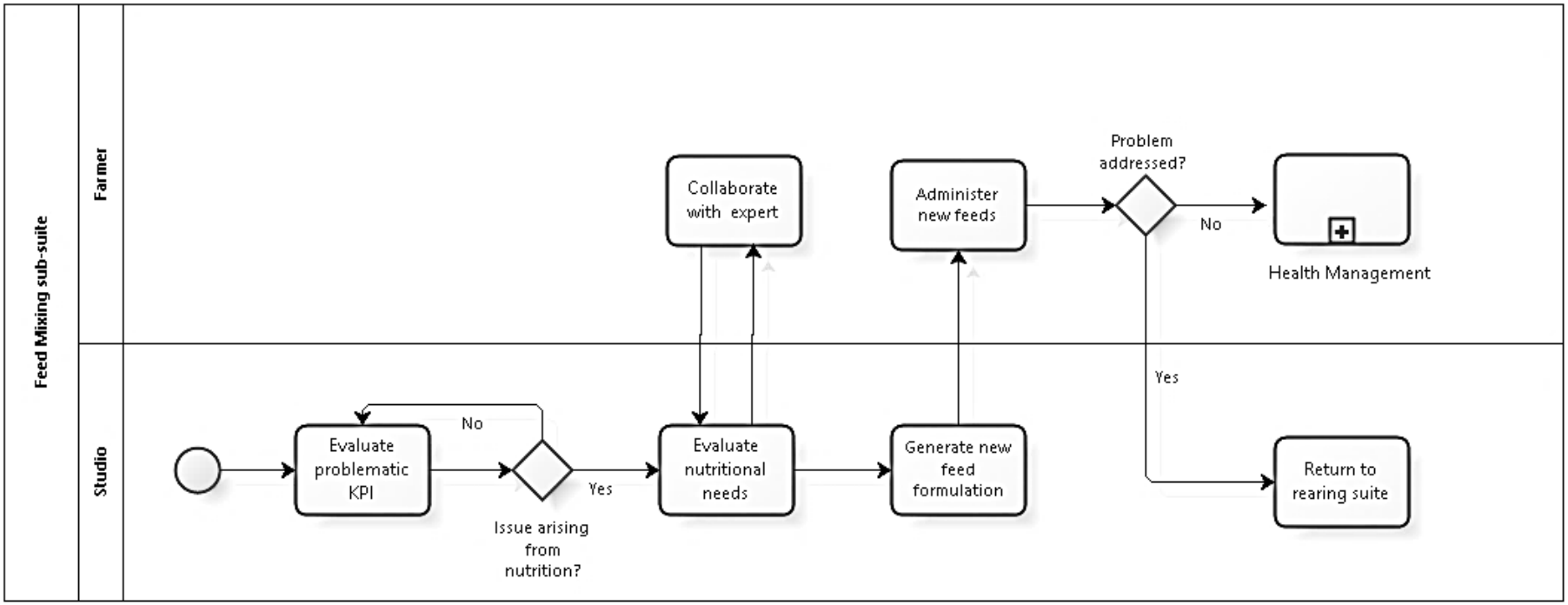

Figure 4 - 6: Activity flow diagram for the feed mixing sub-suite

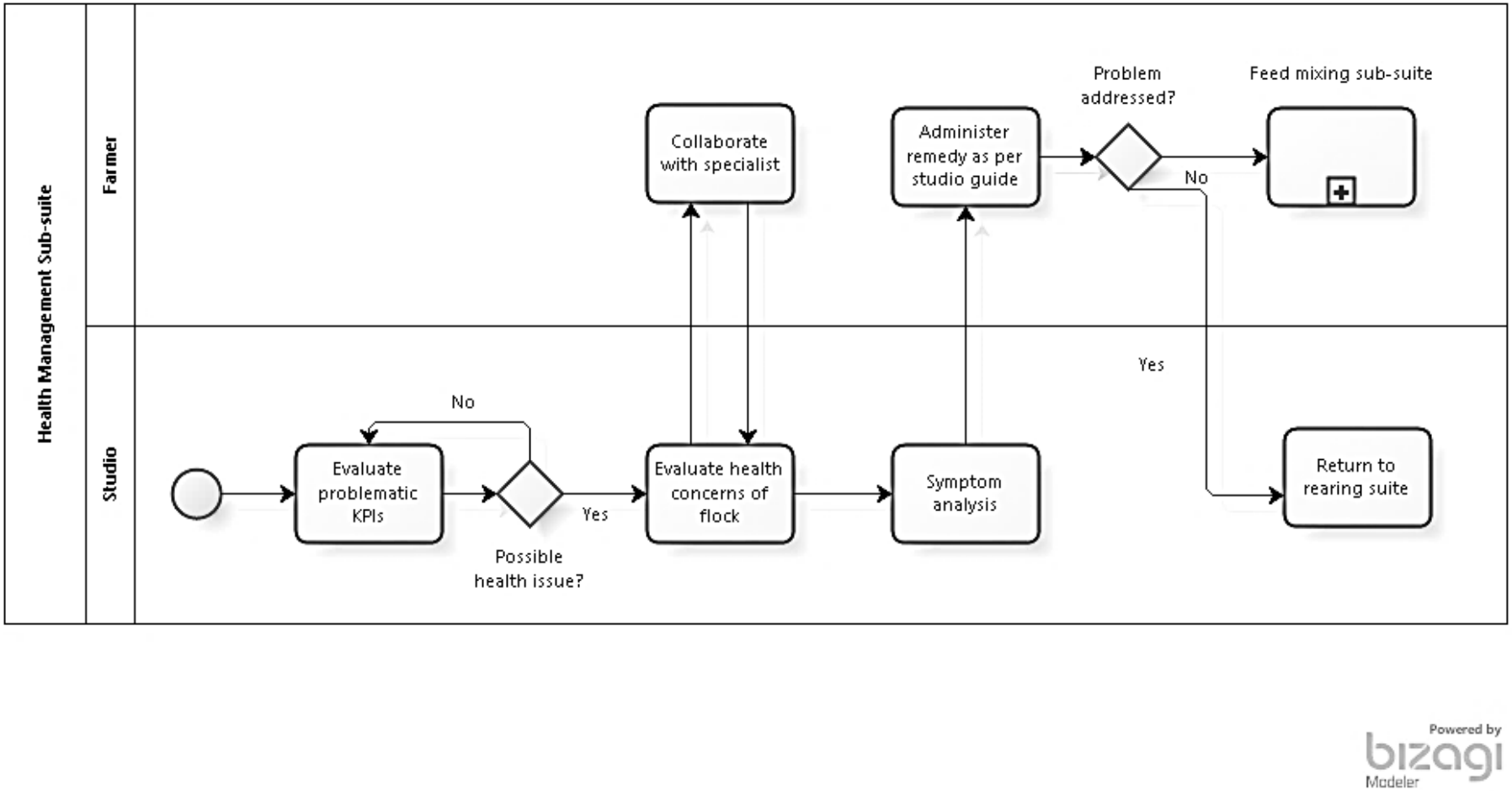

Figure 4 - 7: Activity flow diagram for the health management sub-suite

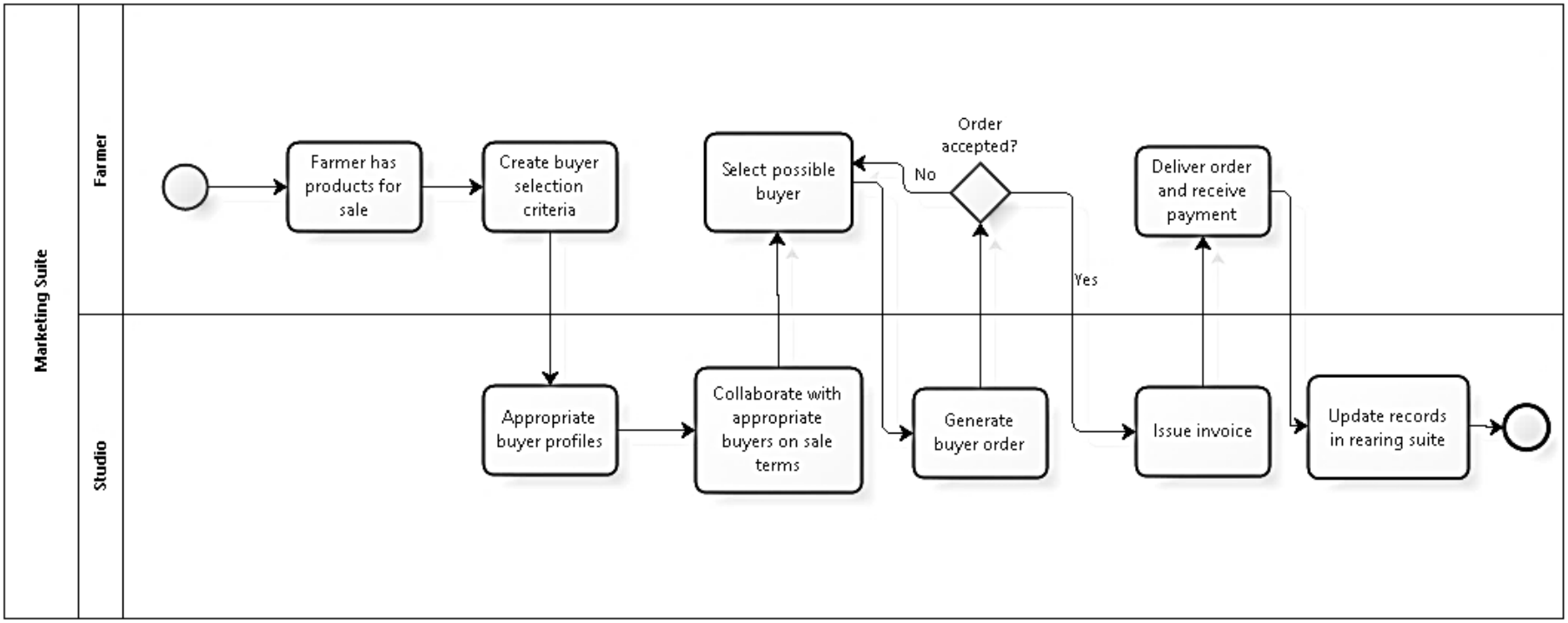

Figure 4 - 8: Activity flow diagram of the marketing suite

Collaboration suite

From literature and exploration, we observed that poultry farmers attach critical significance to collaboration with key stakeholders in their decision making processes. Inter-organizational information sharing and collaboration among stakeholders have been proven to improve performance and enhance competitive advantage (Li et al., 2006), particularly among farmers (Jansen and Vellema, 2011; Bock and Van Huik, 2007). As Keen and Sol (2008) rightly put it, "collaboration is a key to handling complexity; no one actor has all the information or skills to make effective choices". The collaboration suite enhances continuous collaboration among stakeholders of the poultry industry whose roles, skills and experience can be tapped during the farmers' decision making processes. The collaboration suite promotes interaction and networking of all actors and across all the other processes on the PDES and news and information sharing on poultry farm management. The collaboration suite enhances continuous and consistent social interaction of users, which allows actors to freely share insights which could support others in decision making. The suite also enhances virtual one-on-one meetings with actors as well as group meetings. This suite enhances farmers to engage their social networks in a formal way so as to enhance their decisions. The collaboration suite supports farmers to identify authorities in different disciplines who can impact their decisions in the multi-disciplinary setting of poultry farm management.

Use-case modelling

In order to visualize the interaction between actors using the PDES, a use-case diagram was used. The use case defines the interactions among actors to achieve the goals of the PDES. Users in our case include poultry farmers, suppliers of poultry farm inputs, buyers of poultry farm products, poultry health experts and regulators (figure 4-4).

The poultry farmers use all the five suites to enhance their decisions across the poultry farm management processes. They are able to plan accordingly and make viable planning decisions. They are able to make decisions concerning the purchase of farm inputs using the purchasing suite and its services. The farmers are able to monitor and rear flocks using the rearing suite and its services. They are also able to use the marketing suite to identify buyers for poultry farm products as well as manage their sales and income. Through all these processes, farmers are able to collaboratively engage stakeholders of the poultry industry who have an impact on the decisions they make. Buyers use the marketing suite to identify poultry

farm products on sale; suppliers use the purchasing suite to market their products to poultry farmers; while experts use the rearing suite to advise and guide farmers on aspects of poultry health and nutrition management where they hold specialty. All users of the PDES use the collaboration suite for purposes of engagement, networking, information sharing and communication on the PDES.

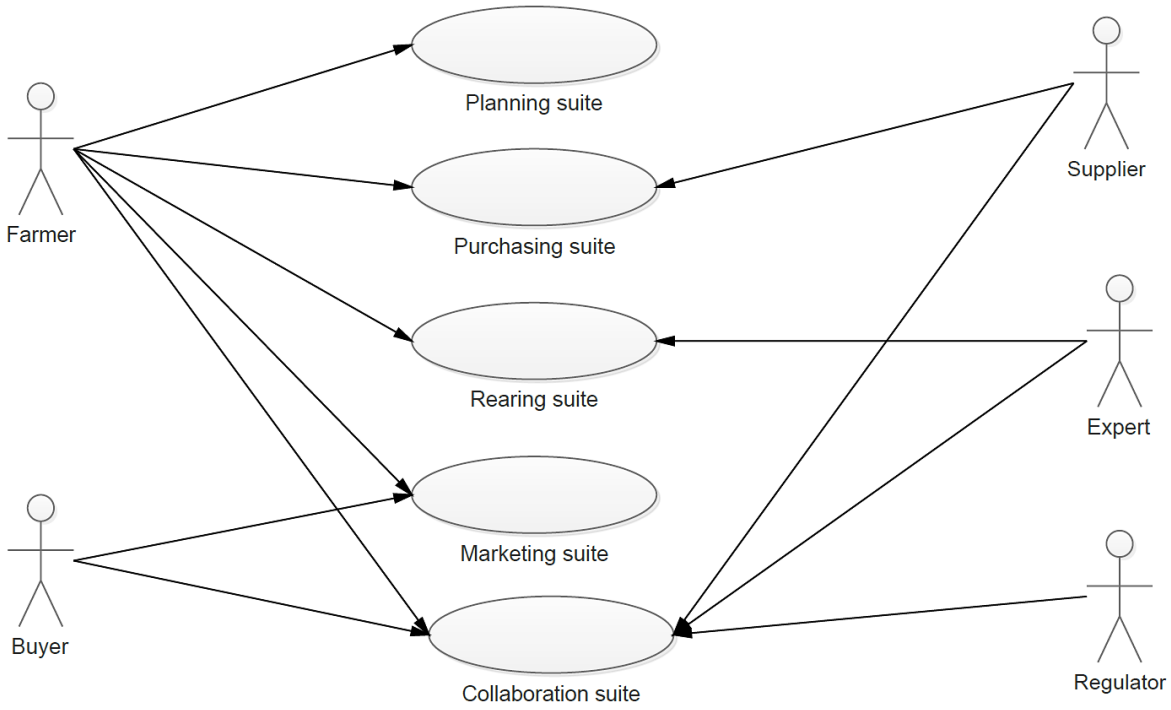

Figure 4 - 9: PDES Use-Case Diagram

Chapter 5 - Instantiation of the PDES

This chapter describes the instantiation of the PDES. During instantiation, attention was paid not only to addressing poultry farmers' requirements as discussed in chapter 4 but also to external factors that could influence service delivery such as user experience. Section 5.1 presents the instantiation considerations; Section 5.2 gives a detailed description of PDES suites and services; Section 5.3 discusses the verification procedure of the PDES.

5.1 Instantiation Considerations

Design science must produce a viable artefact in the form of a construct, model, method or instantiation (Hevner et al., 2004). Following the design described in chapter 4, the PDES was instantiated to practically provide a collaborative and facilitative environment for poultry farmers and their stakeholders. Eastwood et al. (2012) emphasized the importance of understanding potential implications for end-users to be able to construct effective and applicable tools for farmers. There has already been lower than expected uptake of farming technologies (Bewley, 2010), mainly due to a focus on technology development without an accompanying effort by researchers to understand the challenges of on-farm application (Kutter et al., 2011). To counter this, requirements and design considerations for the PDES were based on both literature and exploration. Owing to the low technology adoption widely reported among African farmers (World Bank, 2007), focus was particularly put on ensuring perceived benefit and credibility as well as user friendly designs throughout the instantiation of the PDES. Against this background, the studio architecture of the PDES was based on insights from Service Oriented Architecture (SOA) principles (Aregu, 2014; Amiyo, 2012; Kamoun, 2007). The integration of SOA principles enabled the building of applications with good levels of flexibility, agility and simplification (Aregu, 2014; Keen and Sol, 2008; Kamoun, 2007). Based on the SOA principles, instantiation involved cross-platform implementation, loose coupling and set up of well-defined interfaces.

Programming Languages

The prototype was implemented using several programming languages that included; Hyper Text Mark-up Language (HTML); JavaScript web development languages; Cascading Style Sheets (CSS); MySQL and PHP hypertext Preprocessor (PHP). These were used for the different purpose depending on the expected output and agility of the language.

HTML was used to mark up the content and define the basic structure of the studio; CSS was used to define the different styles and create the consistency in the look and feel within the studio; JavaScript was used to enhance users' experiences by converting the studio from a static page to one they can interact with; MySQL was used to generate scripts that create the databases, save data into the databases, retrieve the data and manipulate the data through different queries; while PHP was used to write scripts the make pages dynamic in nature as well as perform calculations, collect user information, interact with MySQL databases and create graphics.

5.2 Description of the PDES

For the PDES to achieve its goal of enhancing poultry farmers' decision making processes, instantiation focussed on ensuring availability of studio suites with minimal limiting factors as well as the farmers' requirements as identified in chapter 3 and the design considerations in chapter 4. The PDES is a web-based system that is hosted on a remote server and connected to a remote MySQL database. This is to enable the different users to access the studio on their devices at any location and anytime. The PDES runs in a web browser and is compatible with browsers such as Mozilla Firefox, Internet Explorer, Opera and Google Chrome. Therefore, any user with a web browser can be able to access the studio. The PDES is hosted under the domain name http://www.poultrydes.com (see figure 5-1) and allows different users to create accounts which undergo a verification process as part of the PDES' role in addressing the challenge of inadequate regulation which was noted in this study to affect farmer decision making processes. Users include poultry farmers, input suppliers, output buyers, poultry health experts and the different regulators of the industry.

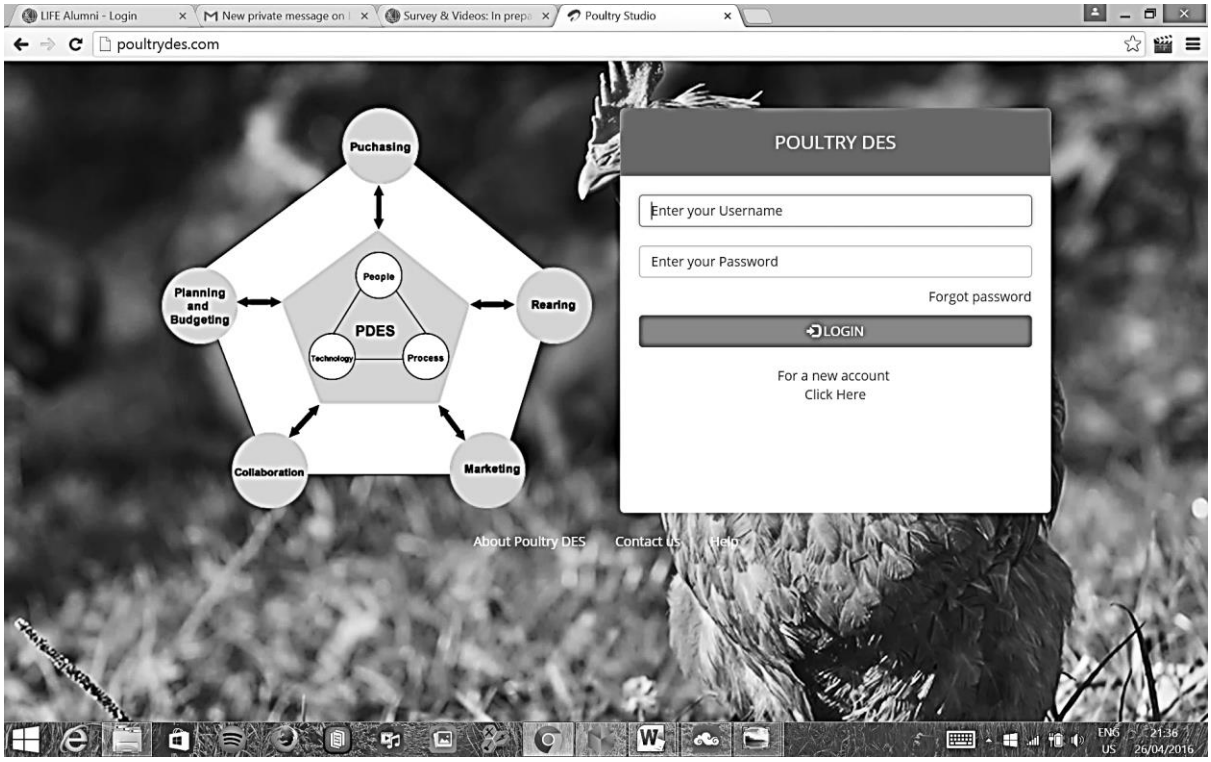

Figure 5 - 1: A screen shot of the PDES main page

The PDES comprises of five suites namely; Planning, Purchasing, Rearing, Marketing and Collaboration. Upon log in by a registered farmer, the five suites are presented on the left hand side vertical menu in the studio. Each menu item represents a suite and these are clickable (in form of links). Upon clicking a particular suite, an expandable dropdown menu with services and sub-suites of the suite is displayed. The clicked link becomes active by giving a grey background to the main link and dropdown links thus this enables the user to easily view and track their activities on the studio. When a user clicks on a particular service, the corresponding web page containing the content about the selected menu item is loaded and displayed. For each of the suites, the main instantiation issues were the technology tools used to provide the services and how to ensure that the services are easily accessible to users. In this section, we provide a detailed description of PDES suites and services as well as the corresponding instantiation issues considered.

Planning Suite

Planning is an important aspect of business management (Dent et al., 2013) In the PDES, the planning suite provides farmers with relevant information and tools to plan for their farm businesses. The suite provides three key services of rearing information, market reports and

budgeting. When the user clicks the Planning suite, the dropdown menu with Rearing information, Market Reports and budget services is displayed.

Under the "Rearing Information" service, relevant information concerning poultry farm management and flock management is presented in horizontal tabs which enable the user to switch between different sections on the same web page. During exploration, the importance of such relevant information was eminent in a poultry farmer's decision process. In the "Rearing Information" service, each tab represents a section of different rearing information which poultry farmers require not only at planning but throughout their processes of farm management. This information has been split into small units or learning objects and the text is accompanied by images to facilitate farmer understanding. Each section has various sub-sections shown by tabs on a dropdown menu which is displayed when the user clicks on the Arrow Down Caret (icon) next to the main section title. Tabs were used because the user is able to access sections or switch between sections without necessarily loading the pages afresh, hence avoiding high data costs.

The "Market Reports" service was particularly designed to enhance farmers to explore their market environments during planning and overall management of farm and flocks. As noted by Keen and Sol (2008), the notion of decision enhancement focusses on keeping the decision maker in the loop and not taking them out of the decision making process. From exploration and literature, we noted a highly unstable business environment in which poultry farmers operate which is characterised by inflation, unstable prices among other issues. We also noted the need for full information in order for farmers to be able to make timely and effective decisions. The "Market Reports" service provides farmers with a market guide on costs of different poultry farm inputs and outputs. In this service, MySQL database tables were created on an online server for each of the items (both inputs and outputs) involved in poultry farm management (e.g day old chicks, feeds, feeders, eggs, chicken etc.). The first time the user logs into the system, they are presented with HTML tables of different items with columns showing the types/categories of items and columns of costs. The users are allowed to update these costs basing on their different locations and operating environments. Every table has a button to update its content whenever the user has finished entering/updating the table item(s). When a user clicks the 'update' button, the MySQL tables for the particular item is updated. This is done with the help of PHP scripts which post the user data into the online database. With this service, farmers are able to explore their market environments if the costs provided by the studio don't match their plans. Nonetheless, the

studio is continuously updated with average costs of the different inputs and outputs to guide farmer decision making during the planning process.

The "budget" service facilitates farmers to prepare working budgets for flock cycles because budgets inform decision making. When a farmer clicks on the budget service, the studio displays a web page that contains a budget generation engine with budgets Tabs. The budget generation engine allows the user to select a category/type of poultry which the farmer is interested in from a dropdown menu. The farmer then enters the number of birds he/she wishes to plan for and clicks the "compute" button. The service helps the farmer to generate a budget based on the information provided as well as the costs of inputs and outputs as derived from the "Market Reports" service. The farmer can save the generated budget to the database under a name of their choice by entering a name and clicking the "save budget" button. By saving a budget, farmers are able to adopt a preferred budget for a particular flock cycle when they choose to. This budget guides in monitoring of expenditure and income of a particular flock cycle. This budget can be referred to by farmers throughout rearing and the studio uses the budget information to provide farmers with updates on expenditure and income of flocks in comparison to initial budget plans. This budget is displayed in a simple and easy to understand format. It is divided in short phases of the rearing period with in which the farmer can work and plan accordingly. Working budgets often form the foundation upon which business owners like farmers base their various decisions.

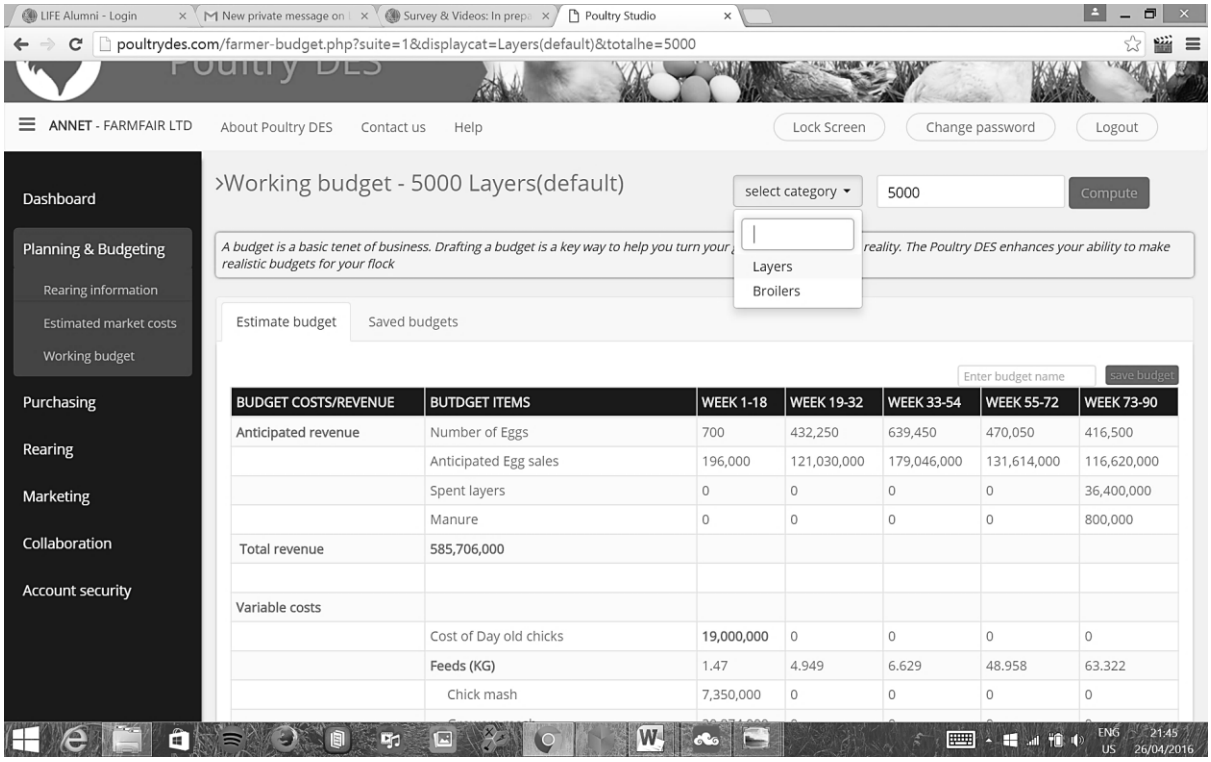

Figure 5 - 2: A Screen shot showing the budget service of the planning suite.

The Purchasing Suite

The purchasing suite enhances poultry farmers' decisions concerning purchase of farm inputs as well as inventory management. From literature and exploration, it was noted that common considerations in these decisions include quality, price, storage and handling costs, availability and views of others in the industry. These considerations have been catered for in the purchasing suite. This suite has two key services i.e. "Supplier Catalogue" and "Inventory Management" services. When a user clicks on the Purchasing suite, a dropdown menu containing 'Supplier catalogue', 'My orders' and 'My inventory' links is displayed and activated.

The 'Supplier Catalogue' service is a one-stop centre where poultry farmers can find and interact with all registered suppliers of their farm inputs. When a farmer clicks the supplier catalogue, the web page loads and the studio automatically fetches all the suppliers whose accounts have been approved from the remote database and displays them on this web page. Data is fetched by PHP scripts and displayed by HTML. After loading the content of the web page, a dynamic search engine is displayed at the top of the page. The engine uses the "sortable" JavaScript plugin to perform an automated search such that as the user types in the textbox, it automatically filters the supplier list and displays suppliers with characteristics that

match the provided input. Farmers can search suppliers by location or product. This enhances the farmer's decision in selecting a supplier as he/she only has to view a smaller number of suppliers who are relevant to the farmer's needs at the time. Suppliers and their details are displayed on "data cards" with each data card representing a single supplier. The data cards provide summarised information about suppliers, the goods and services they offer as well as their ratings on the studio. Ratings are generated from suppliers' ability to meet regulation requirements as well as their ability to meet the expectations of previous customers on the studio. After successful purchase, the studio provides farmers with a "Review your supplier" form where farmers can share their views about their interactions with a supplier. These include quality of service/product offered and ability to meet service level agreements. After using the suppliers products/services for three months, the studio again notifies farmers to do another review of their suppliers focussing on 'after sales service'. The ratings are captured in the studio to guide decisions about other transactions of other farmers who may want to make decisions based on these views. These ratings are shown on supplier data cards (see figure 5-3) in the form of stars.

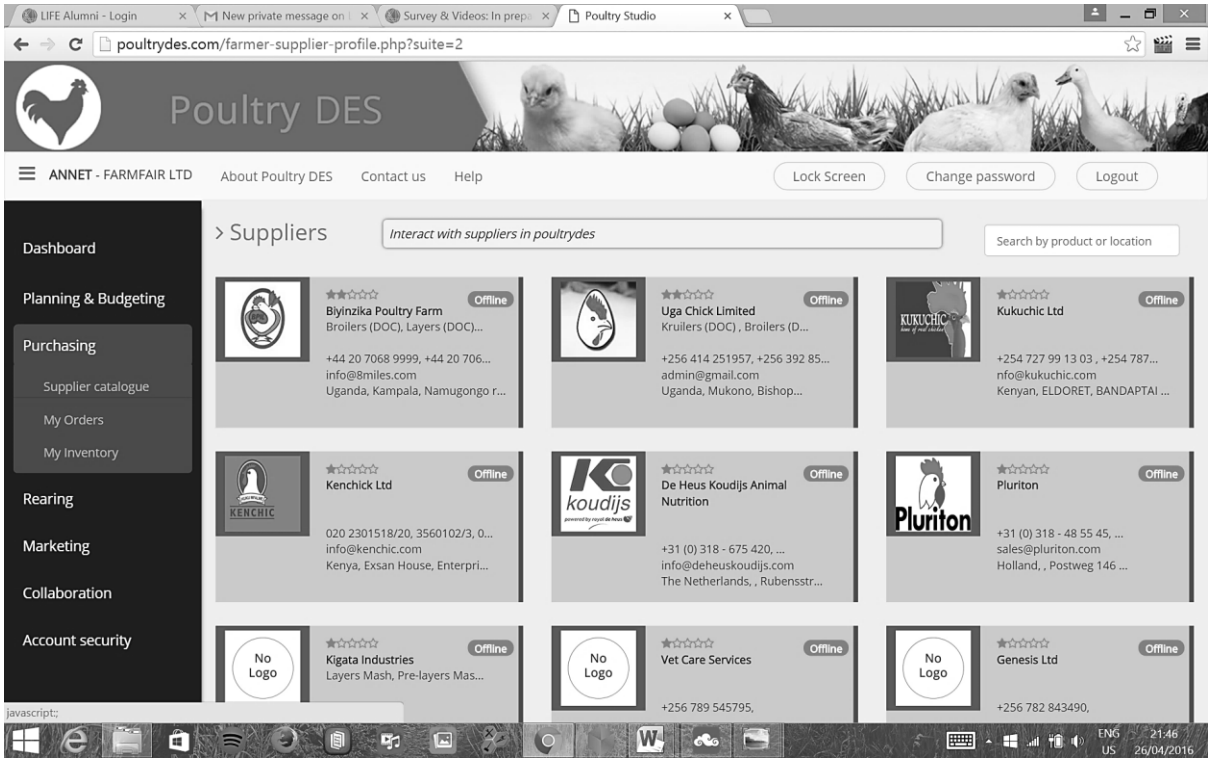

Figure 5 - 3: The supplier catalogue in the purchasing suite of the PDES

When a farmer clicks a particular data card, a web page containing supplier detailed information, such as products, order forms and shopping cart is displayed. Here each product

is also presented on its own data card. To order for an item, one enters quantity they want to purchase and clicks the "Add to cart" button. The studio then computes the amount payable depending on orders presented and the prices set by the supplier. The orders are reviewed by the supplier who may choose respond to the order as per terms agreed by both parties. The progress of orders as per response from the supplier is captured into a remote database with the help of PHP scripts. The 'My Orders' button, displays information about a farmers' orders e.g pending, rejected, accepted but pending payments, accepted and pending delivery or delivered. PHP is used here to fetch the information that was posted in the "Supplier Catalogue" and HTML displays the content in a user friendly and easy to understand table format. A "Loop" is done through the database table in order to fetch all the orders by the given user. Using the "My Orders" button, a farmer is able to know the status of his/her orders and undertake necessary actions such as payments, delivery or pick up plans and preparation of storage space. Once the orders are successfully delivered to the farm, they are registered into the farm inventory and the "Inventory Management" service tracks them from there on.

The Inventory Management service supports farmers to manage stock in their inventories. Using this service, poultry farmers are able register all purchases as they enter inventory, monitor how stocks are put to use and alert the farmer at the appropriate time for restocking before stocks run out to enhance the decisions concerning purchase or optimal utilisation. This service enables poultry farmers to maintain control over their inventories as well as make informed decisions concerning any purchases or utilization of farm inputs. When the 'My Inventory' link is clicked, Tabs of expected stock, delivered stock and stock status with their corresponding content are displayed. Under the expected stock tab, the system fetches information from the database n the status of orders placed by the farmer e.g accepted orders, orders pending verification, etc. When the items are delivered to the farm or picked, they are mandated to click the "Delivered" button against the delivered item. Here the item is now updated in the database as delivered and then deleted from this pending orders tab. Information about items that were declared as delivered in the "Expected stock" tab are automatically displayed in the "delivered" tab. With this tab, a farmer at any time of the year can check their purchase history, which can be valuable to a farmer's decision making process at a given time. In the 'stock status' tab, the studio computes and provides the availability status of a given item in stock according to what has been declared as used by the user in the rearing suite. All purchases in this suite are reconciled with the budget which was

adopted in the planning suite for the particular flock in question and the farmer gets a report on their expenditure versus the working budget limits. Such reports are useful in guiding farmer decisions concerning farm expenditure. The conditions of the different tabs in this service are defined by the PHP scripts to differentiate the status of various items.

Rearing Suite

The rearing suite provides day to day guidelines of flock handling for poultry farmers. This suite provides two services of process monitoring and record keeping and is also embedded with the feed mixing and health management sub-suites. When a user clicks the rearing link, a dropdown menu showing flock registration, my farm records, KPI reports, feed mixing and health management are displayed.

The flock registration link gives a web page with tabs for registering farm flock batches and viewing all registered flock batches. A flock batch is considered as a group of day old chicks that are brought into the farm on the same day and reared together till sell off. Farms can have one or various flock batches. On the studio, the registered flock batches are presented in a simple-to-read HTML table containing summarised information on the flocks as fetched from the database. The user can click the "view more" icon and get a modal pop up with details of the selected flock batch. To register new flock, a farmer clicks the flock registration link and updates the studio with information concerning the new flock batch received at the farm. This information includes date of arrival, date of hatching, poultry strain and type, number of birds among others. Depending on the information registered, the rearing suite generates standard guidelines for the particular flock for its entire flock lifecycle according to key performance indicators (KPI) of flock growth. The standard guidelines are provided by breeders of strains in open source content and further reviewed by poultry health experts to ensure quality of information. The studio simplifies this detailed content to ease farmer understanding by presenting it in an easy-to-read format of simple graphs. The key performance indicators were provided by farmers during exploration. They include body weight, feeding pattern, mortality rates, water consumption, production rates, lighting among others.

Despite this initial registration, farmers are able to use this suite to keep all relevant records concerning the farm. On a daily basis, farmers or their delegated assistants are encouraged to take a moment to observe flock and make key observations, which are recorded on this service. During exploration, we noted that farmers believe they have salient knowledge and

like to make decisions based on their personal observations of flock. This service equips farmers to observe flock and take note of important information concerning flock. Farmers are enhanced to use the "my farm records" tab to update daily flock records of the key performance indicators. This information is presented in table format so that farmers can easily refer to it. A farmer can click a particular entry to input or view more information on flock performance for a particular day. The information is further interpreted and analysed against the standard guidelines of flock under the 'KPI Reports' service. The 'KPI reports' link is a web page, which displays different graphs interpreting the flock records. The graphs are plotted using the data acquired from a database containing information about different flock strains. The graphs show the farmers how their flocks are progressing against their standard requirements and/or expectations. These graphs ease farmer understanding of flock requirements and enhance farmers' decisions in their day to day operations. Such decisions include how much feeds to administer in a chicken house, how much light to apply to flock, when to contact an expert, etc. The "HiChart" plugin was used to generate the graphs. The user can view KPI reports of a flock batch by selecting a flock from the dropdown menu on the top right hand side of the web page. The graphs are displayed on clickable cards that bring up a modal pop up with more content about a particular graph to guide decision making on the key performance indicator represented by the graph. The graphs provide analysed and interpreted information about flocks which enhances farmers to detect any problems or inefficiencies in their flocks and consequently make timely decisions.

Figure 5 - 4: The "KPI reports" service in the rearing suite

The Feed Mixing Sub-suite

The feed mixing sub-suite guides farmers to generate workable feed formulations for flock. While the purchasing suite encourages farmers to purchase quality and trustable whole feed, the feed-mixing suite was designed and instantiated to address farmers who may still prefer to mix their own feeds. When a user clicks on the feed mixing sub-suite, the studio automatically fetches and selects the latest or last registered flock for the user in order to carry out the computations. The user has the ability to alter the flock by clicking on the dropdown at the top right hand side of the web page. This presents the user with flocks that exist in the database to select the one for whom he wants to generate a feed formulation. When a flock is chosen, the system automatically computes the age of the flock by using the current date and the hatching date that was provided by the user during flock registration. Based on the details of the selected flock batch, a feed mixing generation engine and an HTML table for displaying the results are generated and displayed on the web page. The user can then provide the sub-suite with specific information such as how many kilograms of feed he/she intends to mix before clicking the "Generate" button. The system computes and displays an HTML table with the feed mixtures according to the selected flock's unique characteristics.

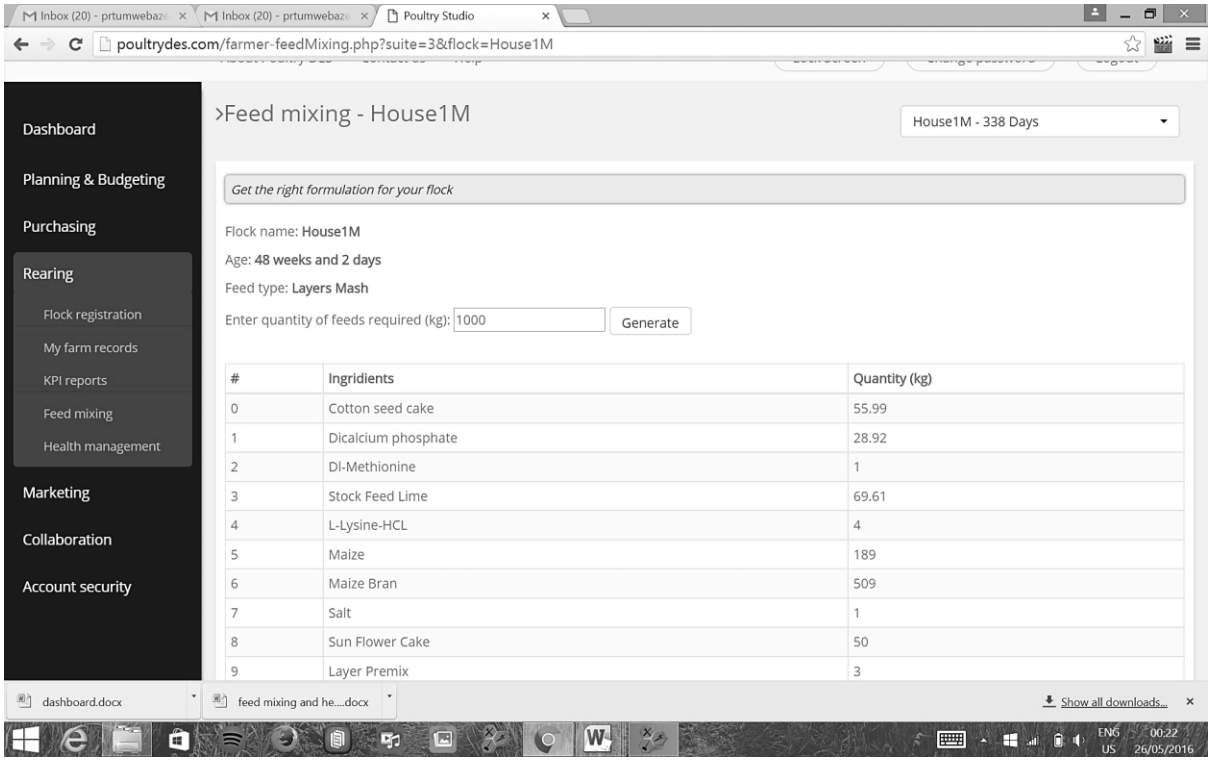

Figure 5 - 5: The feed mixing sub-suite helps the farmer to generate feed formulations

The Health Management Sub-suite

The health management sub-suite is a one-stop centre for all poultry health concerns. The sub-suite provides vaccination schedules for flocks and alerts farmers in time to perform vaccinations, deworming and other mandatory health procedures of flock. The sub-suite also provides a symptom checker, which guides farmers to make key observations of any symptoms of chicken and provides relevant attention points which a farmer can take about observed symptoms. On this sub-suite, farmers are also able to contact an online poultry health expert and upload pictures for relevant advice from the expert. When the Health Management link is clicked, a web page with Tabs is displayed. The Tabs include: Vaccination schedule, Local vet listing, Symptoms checker, Self-diagnosis, Poultry diseases, Drugs, and Consult expert. The system automatically fetches and selects the latest or last registered flock batch for the user in order to carry out any health investigations. The user has the ability to alter the batch by clicking on the dropdown at the top of the web page. This presents the user with flocks that exist in the database from which he/she can select the flock of interest. When a flock batch is selected, the system makes all computations based on the selected option.

On first load of the web page the vaccination schedule tab is active. Under this tab, the studio fetches the details about the flock and the corresponding vaccination schedule. The vaccination schedule is generated from a table in the database which contains the standards of when different vaccines and drug can be applied on different types and strains of poultry. Therefore, the sub-suite fetches the drugs and uses the current date to enhance farmer decisions concerning when they are supposed to administer a given drug/vaccine and how it is supposed to be administered. When a vaccination is carried out, the user is supposed to record or approve that this was done by clicking on the link under the "Administered" column. Towards the date for administration, the studio alerts the farmer about the pending vaccination to enhance their decisions concerning making preparations for the vaccination exercise. If they miss a given date, the studio will alert the farmer about the missed vaccination. In the "Local vet listing" tab, the system fetches all the veterinary experts that are registered and approved by PDES administrators and industry regulators. Each veterinary expert's information is presented on a data card which is clickable. On clicking an expert's data card, a new web page is loaded displaying all the information about the selected expert. Farmers can contact these experts directly on the PDES. In the Symptoms checker tab, a well labelled chicken is presented to the user. The labels are of the parts of a chicken and these are clickable. On clicking a certain label, a modal window pops up showing the possible signs and symptoms that can occur on the particular body part of a chicken. This facilitates the farmer to have all necessary information concerning health of birds and possible actions to take in case a particular body part of a bird exhibits certain symptoms. In the self-diagnosis tab, an HTML form with mainly dropdown elements is displayed. This is to enable the user have options when setting parameters for generating results. When the form is fully filled, the user clicks the "Diagnose" button and the studio uses the input information to generate the possible results. The system achieves this by making multiple combinations of the user data and data in the database about different chicken conditions. When the results are displayed, the user can choose to click the "consult expert" button to help them share the results with the PDES online veterinary expert. Under "consult expert" tab, there is an HTML form that helps a user to submit data about disease or any other issues on their farms. This information is saved and viewed by the expert who then provide feedback. Whenever data is submitted, the studio fetches it and displays it under the inquiries section besides the HTML form to enable the expert track the inquiries. Each inquiry is clickable and on clicking a certain inquiry, a new web page is loaded with all the details about the inquiry and the corresponding

comments. On this web page, there is a right sidebar that uses the "Sortable" plugin to arrange and filter the inquiries according to categories. When a button is clicked, a list of inquiries from that category shows up. The tab also allows farmers to upload picture of chicken to ease the doctor's capacity to virtually diagnose the condition at hand. Finally, in the Poultry diseases and drugs tabs, plain HTML text is presented using the "Sortable" JavaScript plugin to categorize the content and "Non-loading" JavaScript plugin to prevent loading of pages when switching between links on this same web page. When a user clicks on the button of a disease type, the studio filters and displays only links of diseases in that category. On clicking the links, plain information is displayed besides the links. This is supported by pictures that show how the different chicken diseases manifest. This sub-suite enhances farmers' decisions concerning health of flock through facilitating virtual collaboration with poultry health experts, providing relevant information on poultry health, enabling remote diagnosis and symptom studies as well as providing necessary alerts for mandatory vaccinations and treatments.

Marketing Suite

The marketing suite enhances farmers' market decisions. It has two main services: a buyers catalogue and advertising board. When a farmer clicks on the marketing suite, the buyers catalogue, advertisement board and farm sale records are displayed in a dropdown menu. The buyers catalogue displays a web page containing registered buyers of poultry farm outputs. The web page has clickable data cards that contain the buyer information. These are similar to the ones used in the supplier catalogue of the purchasing suite. When a data card is clicked, more detailed information about a given buyer is fetched and loaded on another web page. The buyers' catalogue is a one-stop market where farmers can sell their farm products or outputs. In this market, farmers are able to virtually interface with vetted buyers of farm produce, agree on service level agreements and complete their sales without the need for traditional forms of marketing and selling. The PDES market is an open and transparent market where farmers are availed with full market information and prices are set by market forces. It is a practical solution to problems of informal markets which impact farmer decision making processes as noted during exploration. The marketing suite also has an advertisement service (see figure 5-6) where farmers can advertise their products so that buyers are able to readily find them and contact them online to finalize sale agreements before proceeding to buy. When a farmer clicks on the advertisements service, an HTML form is displayed on the web page. This form allows the user to create an advert and save it

into the database by clicking the "post advert" button. The saved data will then be fetched and accessed by potential buyers. On this same page, the studio fetches the previously posted adverts and displays them together with the potential buyers to enable the user track their posted adverts.

The marketing suite is also embedded with a sales management option which fetches and displays an HTML table on a web page comprising of all the information about the sales recorded by the user. To save a record, the user clicks the "Record new farm sale" button. The web page expands and displays an HTML form that the user fills in and submits to the database by clicking the "save" button. The user is also able to print out the records by clicking the "Print record" button. The system uses the "mpdf" plugin to generate a printable version of the records displayed on webpages. Sales management allows farmers to keep all records of sales as these can be used for decision making at different stages of farm management. The sales on this suite are reconciled with the adopted working budget in the planning suite which helps the farmer to review progress of a particular flock batch as far as planned income versus actual income is concerned.

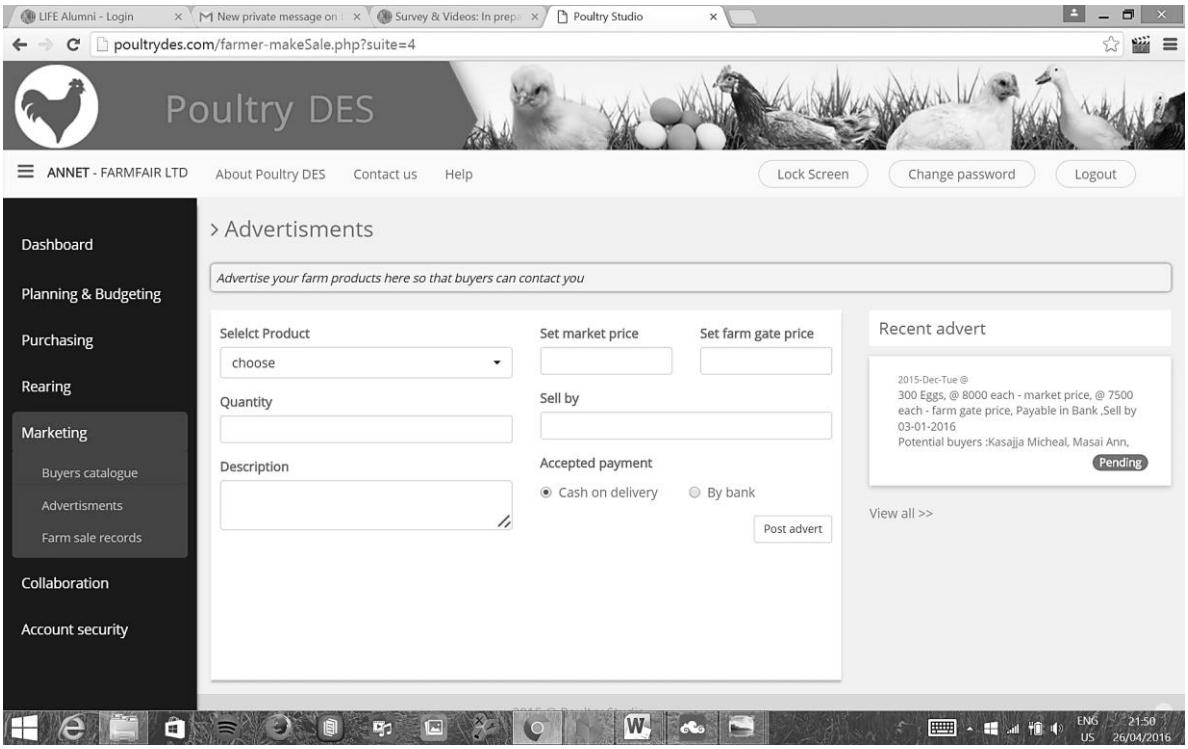

Figure 5 - 6: The advertisement service in the marketing suite

Collaboration Suite

The collaboration suite is a place where stakeholders of the poultry industry can engage one another and network. The suite has three services for all users of the PDES: The PDES timeline, the Chatroom and Poultry news as displayed on the drop down menu of the suite.

The PDES Timeline is an intersection of users on the PDES. This service taps into the advance of social networking, which has been proven to help people build flexible relationships with remote talent (Archak, 2010) as well as support crowd sourcing of new ideas (Di Gangi and Wasko, 2009). When a user goes to the PDES timeline, different information that has been shared by other users is displayed on this web page. The Timeline is open for all users to post their views, share experiences, blog and discuss issues of concern in an open and all-involving manner. The PDES timeline also allows users to upload pictures to make experience sharing even more rational. Users can comment on a particular post by clicking the "comment" button. This will load a new web page with the details of the initial post, other user's comments and a text area to enable one to type their comment and save it by clicking the "post" button. The studio will assign the comment specifically to the selected post. The PDES timeline enables all users of the PDES to openly share their views and facilitates networking as actors on the studio exchange knowledge and expertise concerning the poultry industry.

The chatroom service (see Figure 5-7) allows users to hold private chats with individuals and also facilitates group meetings. When one clicks the chatroom link, a web page containing the various users of the system is displayed. Each user is presented on a data card. Each data card has a "send message" button that enables the user to initiate a private conversation with a user of choice. To initiate a conversation, a user types in the textbox and clicks the "Enter" button. The studio uses the "auto-load" and "non-load" JavaScript plugin to fetch and display the sent message in the chat space between the two parties without repeatedly loading the web page throughout the conversation. The user also has the ability to create or initiate a group chat. This is achieved by clicking on the "Create new group" link under the "GROUPS" section on the right sidebar. When the link is clicked, an HTML form is loaded on a new web page where the user enters a group name and then adds members to the group by selecting them from the multi-select dropdown menu. After filling the form, the user submits the data by clicking on the "create" button. The created group is then displayed in the left sidebar of the web page. To initiate a group conversation, the user clicks on the group

name. The studio with the help of the "auto-load" JavaScript plugin keeps on updating and displaying the activity of the users on the system by providing the status in the right sidebar. This also uses the "Sortable" plugin that enable the user to perform a dynamic search in the user list as the user types in the characters in the textbox. All conversations are fetched and displayed on the main chatroom web page which is displayed on clicking the "chatroom" link. To create a virtual group meeting, one is required to enter details about the meeting (i.e. date, time and planned duration), meeting agenda and then proceed to invite selected invitees for the meeting. Invitations are then sent to the inboxes and dashboard alerts of all invited users. At the time of meeting, all attendees are able to type and submit their views for consideration by others. The facilitator of the meeting manages the entire meeting process by calling the meeting to order, guiding the discussion, activating the meeting agenda at different times to guide the discussion and finally calling the meeting to adjournment or close. Thereafter, the PDES automatically provides all attendees with a report detailing the entire meeting proceedings.

Finally, the Poultry News service is a repository for all current news concerning the poultry industry. This news can be handy in updating users about issues concerning the industry. The system fetches random poultry news across the internet. This is achieved through sending an "HTTP request" with keywords that are used to compare, match and filter content that is displayed on the web page.

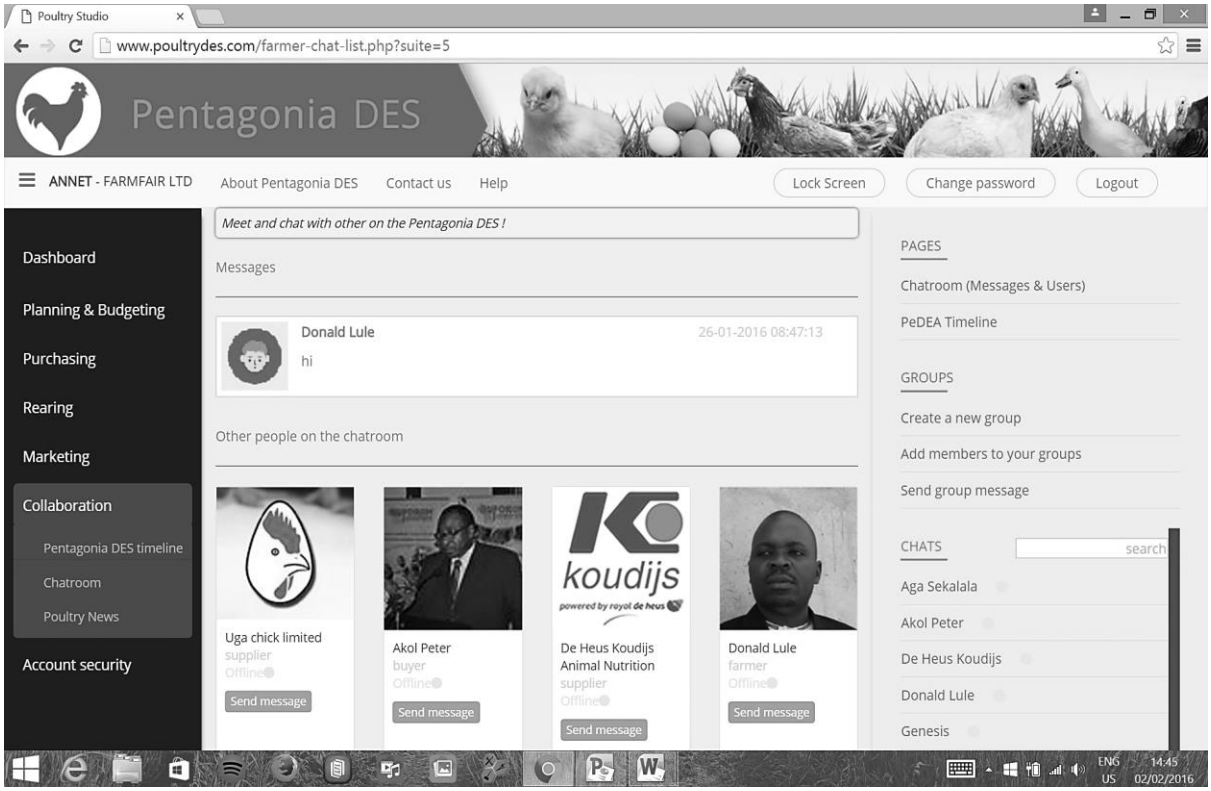

Figure 5 - 7: The chatroom service on the PDES

The PDES Dashboard

From the discussion so far, it can be noted that the PDES has various suites, sub-suites and services, which are elaborate and important for decision enhancement. To make information across the different suites easier to internalize by farmers, the PDES summarizes all information across its different services in an interactive and highly visual dashboard (see figure 5-8). The dashboard provides a simple over all presentation of information from all suites and services on the PDES. This dashboard is particularly important for farmers whose farms are managed by managers. The dashboard provides quick reports to the farmer and can be accessed anywhere at any time using a computer or mobile gadget. On logging into the studio, the first web page to be loaded is the Dashboard. The web page is divided into three sections: the navigation menu which displays all the links to all suites and sub-suites; the content section which displays the information of a chosen link; and the alerts sidebar which displays user notifications. In the content section, the system automatically fetches and selects the latest or last registered flock from the database for the user and provides key information concerning that flock. The user has the ability to alter the flock batch by clicking on the dropdown menu at the top of the web page. This presents the user with flocks that

exist in the database to select the flock of concern. When the flock is selected, the studio fetches data from the database with the help of PHP scripts and a summary about the flock is provided and each sub-section has a "view more" link to enable the user view the details about the displayed information. At the bottom of the web page are the data cards that also provide brief details about the selected flock with visual representations in form of graphs. The visuals are populated by data from the database and plotted by the help of the "HiCharts" plugin. In the alerts section, the notifications are generated from the studio suites. The notifications are clickable and these load new web pages to the corresponding suite when clicked. The alerts give farmers quick information of what should be happening at the farm e.g vaccination, supplier review.

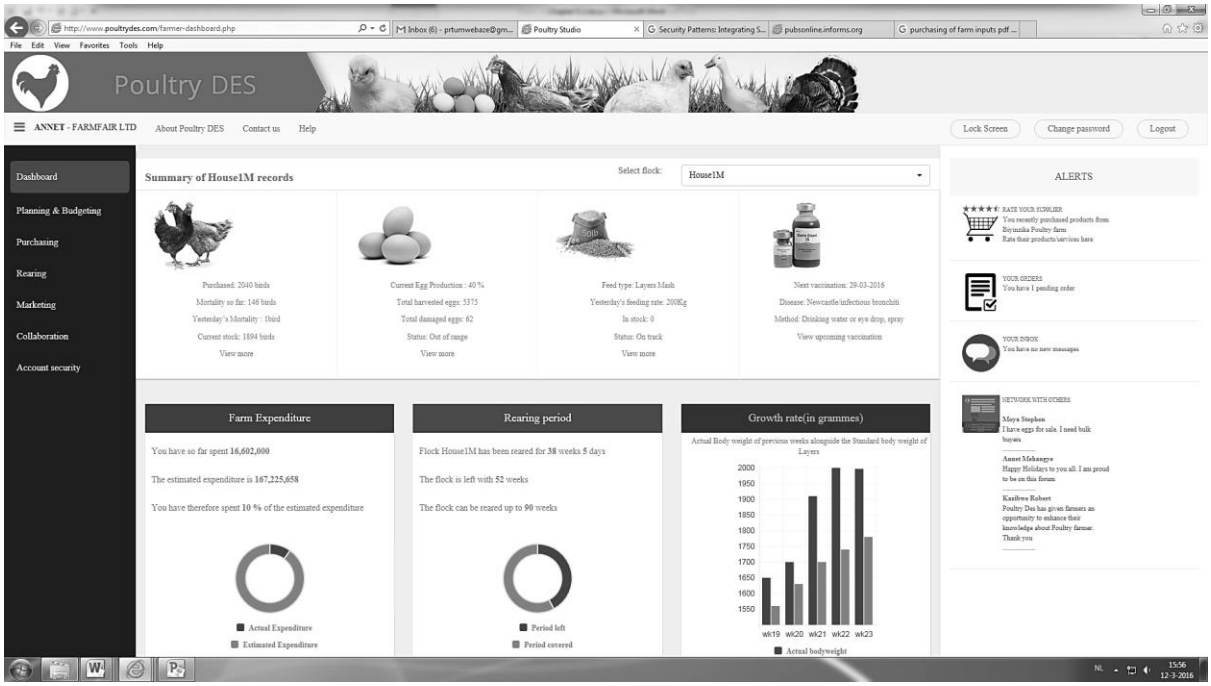

Figure 5 - 8: A screen shot of the PDES dashboard

5.3 Authenticity and Quality of Data

During the interaction with the PDES suites and services by the actors on the studio, planning and rearing suites have a lot of information that is input by the PDES administration. This information includes strain specific information, health information, feed information and budgeting values. Without the ability to assess the quality of such information, the PDES stakeholders cannot comfortably rely on it and monitor its improvement. Basing on insights from Weiskopf and Weng (2013), we adopted two dimensions of correctness and plausibility

to assess information quality on the PDES. Information is considered correct if it is true and it is considered plausible if in agreement with the general poultry industry knowledge.

To ensure correctness, the PDES administrators and appointed poultry health experts verify information sources as authentic and approved. Information sources on the rearing suite are mainly poultry breeders while sources of the planning suite are market players. To confirm information plausibility, the appointed health experts and PDES administrators bring on board their expertise to ensure that all information on the PDES is in agreement and acceptable with benchmarks from industry knowledge. These assessments will be done annually and at points of inputting new information.

The PDES contact functionality also enables all actors to report any anomalies that may be found within the data. This sort of validation empowers the PDES stakeholders to always check for and assess the quality of their information.

Chapter 6 - Evaluation of the PDES

This chapter presents the evaluation of the PDES, which was conducted to ascertain its perceived usefulness and perceived usability in enhancing poultry farmers' decisions. Section 6.1 defines the evaluation parameters. Section 6.2 discusses the evaluation approach and describes the methods applied in the evaluation exercise. Section 6.3 presents, interprets and discusses farmer evaluation results. Section 6.4 presents, interprets and discusses the expert evaluation results. Finally, section 6.5 is a discussion of insights gained from evaluation.

6.1 Evaluation Parameters

In design science, researchers conduct two key activities: "build and evaluate" (Pries-Heje et al., 2008; March and Smith, 2005). Artefacts must be evaluated rigorously before they are released into the environment (Hevner, 2007). As Venable et al. (2012) rightly put it, evaluation provides evidence that a new technology developed in design science research 'works' or achieves the purpose for which it was designed. In this chapter, we discuss the evaluation of the PDES. To attain objective feedback from evaluation, we defined suitable parameters upon which view points and consequently conclusions could be based (Mirembe, 2015; Hevner et al., 2004). Perceived usefulness and usability were considered as good parameters for evaluation as derived from the Technology Acceptance Model of Davis (1989) and Keen and Sol (2008).

The Technology Acceptance Model (Davis, 1989) suggests that when users are presented with a particular information technology, a number of factors, notably perceived usefulness and perceived usability influence their decisions of how and when they will use the technology. Keen and Sol (2008) also mention the constructs of usefulness and usability as important in studio evaluation. The PDES was evaluated for perceived usefulness and perceived usability to establish the possibility of it being put to use to address the decision making needs and challenges of poultry farmers in East Africa.

Perceived usefulness is "the degree to which a person believes that using a particular system would enhance his/her job performance" (Davis, 1989). There is a close correlation between usefulness and constructs such as valuable, effectiveness, beneficial, importance and relevance (Bekker, 2016; Davis, 1989). As applied to this research, perceived usefulness is defined as the extent to which the PDES is perceived as useful or beneficial, in enhancing the

decision making processes of poultry farmers in East Africa. Throughout evaluation, the emphasis of usefulness was on the value added the PDES offers to poultry farmers.

Perceived usability refers to "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989). There is a close correlation between usability and constructs such as simplicity, clarity, flexibility, compatibility and convenience (Bekker, 2016; Davis, 1989). Keen and Sol (2008) further clarified that usability largely depends on the interface between the user and the studio suites. As applied to this research, perceived usability is defined as the extent to which the PDES is perceived as easy to use. The emphasis of usability in evaluation was on attributes of user interaction such as terminology used, lay out and navigation.

6.2 Evaluation Approach

Several researchers (Vaishnavi and Kuechler, 2008; Peffers et al., 2008; Hevner et al., 2004; etc.) have proposed many different methods for evaluating artefacts such as case studies, field studies, experimentation, dynamic analysis, informed arguments, functional testing, expert evaluations, illustrative scenarios among others. This research employed a multi-method approach involving practical experimentation of the PDES by poultry farmers and expert evaluation by domain experts from the fields of information systems and poultry farming.

Practical experimentation is an ideal technique for testing newly developed artifacts and for systematically deriving design improvements (Hevner et al., 2004). Tichy (1998) recommended experiments as a good method for theory testing. Through practical experimentation, poultry farmers tested the PDES in the context of their farm processes during the evaluation exercise. Expert evaluation focused on both the PDES design and the studio. The experts were particularly selected because of their expert knowledge in the two domains of information systems and poultry farming. During evaluation, experts assessed both the PDES design and studio by applying it in envisaged contexts thereby making predictions about the effects of both the design and studio with in context to form their perceptions.

The evaluation of the PDES involved 20 poultry farmers and 79 domain experts. To ensure a successful evaluation exercise, the following criteria were defined for participants of the exercise. 1) Participants had to be interested in taking part in the evaluation exercise and sharing their tacit insights willingly; 2) Farmers had to be able to use a computer and internet

to put the PDES to test and experiment in their processes for the period of evaluation; 3) Farmers who did not participate in the exploration phase of this research were particularly targeted to get new input and objective feedback on the studio; 4) Domain experts had to be qualified with at least a bachelor' degree and over three years' experience in either information systems or poultry farm value chain. Snowball sampling (Patton, 2002) was used to select participants who met the criteria because it provided us with a reliable way of reaching both farmers and domain experts through their social networks. Using the already rich database of poultry farmers and poultry industry stakeholders engaged in the research, 20 poultry farmers who met the above criteria were drawn from around central Uganda. Domain experts were identified through a team of faculty members of Uganda Technology and Management University.

All participants who met the criteria for participating in the evaluation exercise were formally invited to participate by phone call and email. The evaluation participants included the researcher, research assistants, poultry farmers and domain experts. The roles of the participants are summarized in table 6-1.

Table 6-1: Participants of the Evaluation Exercise and their Roles

Evaluation Participants	**Number**	**Roles**
Researcher/Facilitator	1	• Organise resources/logistics for the evaluation exercise • Set agenda for the evaluation exercise • Facilitate the evaluation exercise • Continuously engage participants for the period of evaluation • Compile feedback and consider it for possible refinements after evaluation
Research Assistants	4	• Take minutes of the evaluation workshops • Offer technical support to farmers during the experimentation period • Offer technical support during the

Evaluation Participants	Number	Roles
		evaluation workshops
Poultry Farmers	20	• Attend evaluation workshops • Use PDES suites and services in their processes • Provide feedback on experiences from experimentation
Domain Experts	79	• Attend evaluation workshops • Critically study and evaluate the PDES design as well as studio • Apply different scenarios and use cases to the PDES design and studio • Provide feedback on PDES design and studio

Evaluation Instruments

The primary method for the evaluation was interviews. Two separate questionnaires were used to facilitate the interviews for the two groups. Both questionnaires included quantitative and qualitative sections. The quantitative sections consisted of both positively and negatively formulated statements regarding the PDES design and actual studio on parameters of usefulness and usability. The use of both positively and negatively formulated statements was to prevent response bias (van Sonderen et al., 2013). The statements were adopted from previous works (Aregu, 2014; Habinka, 2012; Yonazi, 2010; Tsakonas and Papatheodorou, 2006; Van de Kar, 2004), with changes made in expressions in order to adjust them to the context of this study. Each statement was measured according to a five point Likert scale (Jamieson, 2004) ranging from 1 (Strongly disagree), 2 (Disagree), 3 (Neutral), 4 (Agree) and 5 (Strongly agree). The Likert scale provided evaluators with different options for expressing their opinions. To determine the general and most common opinions of participants and whether there is a general consensus amongst participants, we present the results of the quantitative section according to mean, standard deviation and mode. The qualitative section consisted of an open ended question for capturing further qualitative opinions from evaluators in support of their quantitative feedback and enabled us to identify areas of improvement and

new concepts regarding the studio for further research. The qualitative data was analysed using content analysis.

Evaluation Setting

- **Farmer Evaluation**

Two orientation workshops were organized to introduce the selected 20 poultry farmers to the PDES. In the workshops held on 4/12/2015 and 5/12/2015, the researcher gave a recap of what the research was about, the problem focus of the research, the proposed solution of the PDES and the reason for evaluation. The researcher elaborately presented the studio suites and services. This was followed by an open session where participants were given chance to log onto and navigate their way around the studio. At the end of these workshops, participants were asked to apply the PDES in their farm processes by putting the different suites and services through practical experiments for three weeks in order to form opinions arising from their different contexts. Experimental tasks were defined for farmers to ensure that they put to use the different services of the studio (see table 6-2). Throughout the three weeks of experimentation, farmers received technical support from four research assistants to ensure smooth experimentation. After three weeks of practical experimentations, the farmers were hosted to the third workshop on 29/12/2015 where they shared their experiences with the PDES. They were then subjected to questionnaires aimed at getting their opinion of the PDES.

Table 6-2: List of experimental tasks for poultry farmers

Suite	**Decisions associated with suite**	**Experimental tasks**
Planning Suite	Decisions concerning planning for the farm	• Explore local market and update the market report service with costs of inputs and outputs in farmer's context • Use the budget service to generate working budgets for flocks at the farm
Purchasing suite	Decisions concerning purchase	• Contact available suppliers through the suppliers catalogue service • Place orders on the purchasing suite

Suite	Decisions associated with suite	Experimental tasks
	farm inputs	• Track the placed orders on the purchasing suite • Follow inventory updates on the suite
Rearing suite	Decisions concerning day to day rearing of flock	• Update the Record Management service daily • Review KPI reports to study flock progress • Generate flock reports from the suite • Collaborate with the online poultry health expert • Use the feed mixing suite to generate feed formulations from time to time • Use the symptom checker in the health management sub-suite
Marketing suite	Decisions concerning sale of farm outputs	• Advertise products on the suite dashboard • Collaborate with buyers on the buyers catalogue service • Make sales using the studio
Collaboration suite	General decisions	• Attend meetings on the suite • Chat privately with selected members of the studio • Update the PDES timeline and engage in discussions on the timeline with others • Follow the news on the PDES

- **Expert Evaluation**

In one orientation workshop on 8/1/2016, the experts were introduced to the PDES design and PDES studio. In the workshop, the researcher gave a recap of what the research was about, the findings from exploration and the proposed solution of a decision enhancement

studio. The researcher elaborately presented the PDES design as well as the actual PDES studio suites and services to the experts. This was followed by an open session where participants were given chance to unpack the design against the suites and services of the PDES. The experts were also given chance to log onto and navigate their way around the PDES. Using role playing, different scenarios and use cases, they put the PDES design and studio to test. At the end of the workshop, participants were given five more days to continue with their testing and assessment in order to form opinions required from the evaluation exercise.

The experts were hosted to another workshop on 13/1/2016 where an open session was held and the PDES design and studio openly and critically discussed. Thereafter, the experts were subjected to anonymous online questionnaires aimed at getting their opinions of the perceived usability and perceived usefulness of the PDES.

6.3 Farmer Evaluation Results

Through practical experimentation, the perceived usefulness and perceived usability was evaluated among 20 poultry farmers. Tables 6-3, 6-4, 6-5 and 6-6 provide the qualitative evaluation results of the PDES according to mean, standard deviation and mode. The negative and positive statements were analyzed separately for purposes of consistency and clarity.

Table 6-3: Farmer evaluation results of PDES usefulness (positively formulated statements)

S/N	Usefulness statement	Mean	Standard Deviation	Mode
1	Using the PDES can help me to manage my operations better	4.70	0.47	5.00
2	Using the PDES has helped me understand the activities involved in my poultry farm business better	4.50	0.51	5.00
3	Using the PDES supports my ability to make effective decisions at the different stages of my value chain	4.55	0.51	5.00

S/N	Usefulness statement	Mean	Standard Deviation	Mode
4	The PDES can help me to do my work more efficiently	4.50	0.51	4.50
5	The PDES facilitates my access to information concerning the poultry industry	4.25	0.55	4.00
6	The PDES makes it possible for me to get timely reports about my farm	4.35	0.59	4.00
7	The PDES supports regulation to access of my information	4.25	0.79	4.00
8	I can access the PDES anywhere and thus can make decisions concerning my operations in real time	4.10	0.85	4.00
9	The Planning suite can enhance my ability to make effective planning decisions concerning my poultry farm	4.55	0.51	5.00
10	The purchasing suite can enhance my ability to make effective decision concerning the purchase of inputs for my poultry farm	4.25	0.64	4.00
11	The rearing suite can enhance my ability to make effective decisions concerning activities involved in the day to day monitoring of my flock	4.50	0.51	5.00
12	The marketing suite is helpful in guiding me to make effective market decisions concerning price and buyer choice	4.25	0.64	4.00
	Grand Mean	**4.39**	**0.59**	**4.46**

Table 6-4: Farmer evaluation results for PDES usefulness (negatively formulated statements)

	Usefulness statement	Mean	Standard Deviation	Mode
1	The PDES is not practical in improving management of my farm	1.90	0.79	2.00
2	The suites in the PDES don't reflect the actual process involved in the management of a poultry farm	1.60	0.59	2.00
3	There is no added value in using PDES	1.45	0.69	1.00
4	I would prefer to carry out my operations without the PDES	1.50	0.69	1.00
5	The PDES cannot support me to make effective decisions concerning my poultry farm	1.70	0.98	2.00
6	The communication suite is of no value and does not support me to collaborate with other actors in the poultry farm value chain	1.60	0.82	1.00
	Grand Mean	**1.63**	**0.76**	**1.50**

Table 6-5: Farmer evaluation of the PDES usability (positively formulated statements)

	Usability statement	Mean	Standard Deviation	Mode
1.	The PDES uses simple language that is easily understandable	4.55	0.94	5.00
2.	The PDES is easy to learn to use	4.10	0.31	4.00
3.	Information on the PFDES is easy to access	4.30	0.57	4.00
4.	I did not always seek clarification when using the PDES	3.45	1.19	4.00
	Grand Mean	**4.10**	**0.75**	**4.25**

Table 6-6: Farmer evaluation of the PDES usability (negatively formulated statements)

	Usability statement	**Mean**	**Standard Deviation**	**Mode**
1	The 'Help' function of the PFDES does not ease usability	2.00	0.86	2.00
	Grand Mean	**2.00**	**0.86**	**2.00**

According to the results presented in the tables 6-3 and 6-4, the farmers' perceptions on the usefulness of the PDES were largely positive. Table 6-3 shows that farmers perceived the PDES as useful. The mean response for the positively formulated statements regarding PDES usefulness was 4.9, which implies that most users either strongly agreed or agreed to the usefulness of the PDES. The standard deviation from the mean for the positively formulated usefulness statements was 0.59, which shows that respondents largely held similar opinions about the PDES. Table 6-4 presents the results from the negatively formulated statements on usefulness of the PDES. The grand mean of 1.63 shows that users largely disagreed with the negatively formulated statements, which mainly intimated that the PDES was not useful. The standard deviation of 0.76 further reveals that most respondents held similar opinions against the negatively formulated statements on the usefulness of the studio.

Tables 6-5 and 6-6 present the results on perceptions of poultry farmers towards the usability of the studio. From the tables, the grand mean of 4.1 for the positively formulated usability statements and 2.0 for the negatively formulated usability statement shows that users generally agreed that the PDEs was usable and disagreed that it was not usable. The standard deviation figures of 0.75 and 0.86 are both within the range of -1 to 1 which means that most of the respondents had similar opinions about the usability of the PDES. Nonetheless, we note that the negatively formulated usability statement, "I did not always seek clarification when using the PDES" had indifferent scores of standard deviation compared to the rest of the statements. This points to the low usage of ICT among the poultry farmers as earlier identified in both literature and exploration, hence the struggle of some poultry farmers in experimenting with the PDES without support. It also highlights the importance of rigorous training for farmers to smoothly adopt and be able to use the PDES especially since they also noted that the studio is very easy to learn to use.

From the evaluation, we note that there is a general agreement among poultry farmers that the PDES facilitates the poultry farm management processes, guides farmer activities, supports farmers by evaluating and interpreting relevant information and enables farmers to collaborate with their stakeholders. We also note a general agreement among the farmers on issues concerning usability of the PDES. Farmers indicated that the PDES is easy to learn and navigate and uses familiar terminologies and navigation. Generally the farmer evaluation results show that poultry farmers largely perceived the PDES as useful and usable in enhancing their decisions.

From the qualitative section of the farmers' questionnaire, generalized statements were constructed from the most common responses used by evaluators. The most significant statements are recorded below:

- The PDES will improve performance of poultry farms if adopted.
- The PDES can help to regulate the poultry industry.
- The PDES will work best if all players involved accept to purchase and use computers and internet.
- There is need for committed facilitation for users to be able to learn to use the PDES.
- An offline version of the PDES would be even more convenient and cheaper for the rural farmers.
- The PDES should be up scaled to other agricultural sectors such as dairy farming.
- Governments should be engaged to ensure all actors use the PFDES..
- The PDES should give instant warnings to a farmer if information entered is not up to standard.

6.4 Expert Evaluation Results

The PDES design and studio was both presented to domain experts for evaluation. Perceived usefulness and perceived usability were evaluated by expert from two domains of information systems and poultry farm management. A total of 79 experts formally participated in the evaluation exercise. Of these, 78.5% were information systems experts while 21.5% were experts in agriculture with specialization in the poultry value chain. This gave us a diverse mix of evaluators in the two domains in which the PDES is grounded. While 46% of the experts held undergraduate degrees, 54% held postgraduate qualifications. Of the 79 respondents, 19% held three years' experience in their respective fields, 66% held 4-7 years

of experience, 9% held 8-11 years of experience while the remaining 6% held over 12 years of experience. This shows that the evaluation was carried out by experts who are highly qualified and experienced in the domains of information systems and agriculture. Tables 6-7, 6-8, 6-9 and 6-10 provide the qualitative results of the perceived usefulness and perceived usability of the PDES according to mean, standard deviation and mode. The negative and positive statements were analysed separately for purposes of consistency.

Table 6-7: Expert evaluation results of perceived usefulness of the PDES (positively formulated statements)

	Usefulness statement	**Mean**	**Standard deviation**	**Mode**
1	The PDES design addresses the decision making challenges in poultry farm management	4.19	0.62	4.00
2.	The PDES can be applied to poultry farms across the East African region	4.33	0.47	4.00
3.	The PDES design if applied can improve the efficiency of poultry farmers and farm managers	4.33	0.50	4.00
4.	The PDES studio has the potential to improve profitability in the poultry industry	4.15	0.53	4.00
5.	I can recommend the PDES studio to farmers	4.22	0.52	4.00
	Grand mean	**4.24**	**0.53**	**4.00**

Table 6-8: Expert evaluation results of perceived usefulness of the PDES (negatively formulated statements)

	Usefulness Statement	**Mean**	**Standard deviation**	**Mode**
1.	The PDES design does not support open communication and collaboration among stakeholders in the poultry farm chain	1.80	0.56	2.00
2.	The PDES design does not address the key	1.99	0.76	2.00

	Usefulness Statement	Mean	Standard deviation	Mode
	challenges faced by the poultry industry			
3.	The PDES studio does not support generation of reports for users	2.23	0.58	2.00
4.	The PDES studio cannot guide poultry farmers and/or farm managers to make real time decisions from anywhere at anytime	1.94	0.74	2.00
	Grand mean	**1.99**	**0.66**	**2.00**

Table 6-9: Expert evaluation results of perceived usability of the PDES (positively formulated statements)

	Usability statement	Mean	Standard deviation	Mode
1.	Process sequences of the PDES design are logical	4.33	0.50	4.00
2.	The PDES design is clear and simple to interpret	3.80	0.52	4.00
3.	The Guidelines to use PDES are easy to learn	4.20	0.52	4.00
	Grand mean	**4.11**	**0.51**	**4.00**

Table 6-10: Expert evaluation results of perceived usability of the PDES (negatively formulated statements)

	Usability statement	Mean	Standard deviation	Mode
1	Terminologies are not consistent with those in the industry	1.92	0.47	2.00
2.	Information on the PDES studio is not easy to access	1.84	0.49	2.00

	Usability statement	**Mean**	**Standard deviation**	**Mode**
3.	Farmers will not be able to learn to use the PDES	1.87	0.63	2.00
	Grand mean	**1.88**	**0.53**	**2.00**

According to the results presented in the tables 6-7 and 6-8, the experts' perceptions on the usefulness of the PDES were largely positive. Table 6-7 shows that experts agreed that the PDES was useful. The mean response for the positively formulated statements regarding PDES usefulness was 4.24, which implies that most experts agreed to the usefulness of the PDES. The standard deviation from the mean for the positively formulated usefulness statements was 0.53, which shows that respondents largely held similar opinions about the PDES. Table 6-8 presents the results from the negatively formulated statements on usefulness of the PDES. The grand mean of 1.99 shows that users largely disagreed that the PDES was not useful. The standard deviation of 0.66 further reveals that respondents held similar opinions against the negatively formulated statements on the perceived usefulness of the studio.

Table 6-9 and 6-10 present the results on perception of experts towards the usability of the PDES. From the tables, the grand mean of 4.11 for the positively formulated usability statements and 1.88 for the negatively formulated statement shows that users generally agreed that the PDES was usable and disagreed with the negatively formulated usability statements. The standard deviation figures of 0.51 and 0.53 both show that that most of the respondents had similar opinions about the usability of PDES.

These results build a strong case that domain experts perceived both the PDES design and studio as being useful and usable in enhancing poultry farmers' decisions during poultry farm management.

From the qualitative section of the experts' questionnaire, generalized statements were constructed from the most common responses used by evaluators. The most significant statements are recorded below:

- The government should be engaged further to support the adoption of PDES among users.

- The PDES will improve the poultry industry in Uganda.
- An offline version of the PDES can help users access it anytime even without internet.
- Preamble statements for all suites would guide users and improve usability further.
- Some information shouldn't be password locked to attract more users of the PFDES.
- A training manual should be developed for users before the PDES is rolled out for actual use.

6.5 Insights from Evaluation

The concept of usefulness in the PDES evaluation involved understanding whether the PDES constituted valuable tools to enhance poultry farmers' decision making processes while usability focused on the user-system axis. From the evaluation, we can conclude that poultry farmers agreed that the PDES has the potential to achieve its objective of enhancing poultry farmers' decisions and is easy to use. From the results, we also note that the farmers opined that usability can be better achieved with meticulous training. Domain experts also highly perceived the PDES design and the studio as useful and usable in addressing the poultry farmers' decision making challenges. Both usability and usefulness were further supported with positive statements in the qualitative sections of the questionnaires. Evaluators generally observed that the PDES was a good input for the poultry industry and had the potential to solve the decision making challenges of poultry farmers.

From the evaluation results, we observe that respondents generally agreed with the positively formulated statements and disagreed with the negatively formulated statements. This implies that evaluation participants were not acquiescent respondents (van Sonderen et al. 2013), but rather unbiased respondents who read and understood meanings of statements before responding. This points to an effective selection of participants for the evaluation exercise.

Nonetheless, we also note that participants raised concerns about the general low use of computers and internet at farms across East Africa and raised concerns about the option of an offline PDES. Despite the enormous spread of the internet, this shows that the benefits of the internet have not impacted poultry farmers in the region like other economic activities. The spread of internet usage is generally associated with positive economic outcomes such as trade and economic growth (Elgin, 2013). In Uganda alone, internet users grew tremendously from 5.7 million people in 2012 to 8.5 million people in 2014. The use of an online based PDES therefore will be part of the ICT revolution and therefore a technological development

that poultry farmers can embrace especially if its usefulness and usability have been confirmed.

The importance of lobbying governments to support the efficient running of PDES through implementation of the regulatory environment envisioned by the studio was another concern raised by evaluators. While there has been an apparent disconnect between scientific knowledge and implementation in many fields (Cockburn et al., 2016), it has mainly been attributed to mismatches between the knowledge that researchers generate and that which practitioners require in their decision making and practice (Van Kerkhoff and Lebel 2006, McNie 2007). The evaluation of the PDES confirms that poultry farmers' requirements in decision making and practice can be addressed by the PDES if it is put to use by farmers and their stakeholders. In recent years, the East African countries have promoted policy frameworks to support the agriculture sectors (FAO, 2009) and the PDES is one of several ways that governments can implement policies aimed at improving the poultry industry.

Chapter 7 – Epilogue

In this chapter, we reflect on the overall research journey. Section 7.1 discusses the thesis overview and a reflection on the research questions. Section 7.2 is a reflection on the research approach. Section 7.3 discusses the research contribution. Section 7.4 presents the possible generalisation of the PDES design. Section 7.5 presents recommendations for further research.

7.1 Thesis Overview

This research originated from a need to improve management competences of poultry farmers in East Africa by enhancing their decision making processes. With increasing attention to economic viability in poultry farms, there is an evident trend of commercialisation of the poultry industry. However, an initial literature survey revealed that poultry farmers in East Africa were faced with various challenges, which were triggered and further intensified by lack of guidance in decision making throughout their operations. The complex nature of a poultry farmer's business environment was apparent because of challenges such as inadequate regulation, lack of relevant information, inadequate management competences and limited use of technology. These challenges define the complexity of the context in which a poultry farmer makes decisions. The decision enhancement approach of Keen and Sol (2008) was abstracted as a suitable approach for enhancing poultry farmers' decisions amidst this complex and volatile business environment. Keen and Sol (2008) instituted decision enhancement following a studio-based approach as an improvement to the decision support systems field focusing on decisions that matter. The choice of decision enhancement as a suitable approach was inspired by its successful application by various researchers (Katumba, 2016; Mirembe, 2015; Aregu, 2014; Amiyo, 2012; Ssemaluulu, 2012; Habinka, 2012) to address decision making challenges in various domains in East Africa.

Accordingly, the key research question this design science research sought to address was ***"How can decision making among poultry farmers in East Africa be enhanced?"***. Decision making became a point of focus for this research basing on the premise that successful management of poultry farm operations can only be attained with effective and timely decision making by farmers. In order to provide definite direction to guide deep investigation of the key research question, four specific questions were derived:

Question 1: What are the key processes involved in the operations of poultry farms in East Africa?

Because the focus of this research was decision enhancement among poultry farmers in East Africa, we started off with this question to get a detailed understanding of poultry farm management. This set the scene for understanding the decision making environment of poultry farmers, the decisions involved in poultry farm management and the decision making practices of poultry farmers. We obtained an in-depth understanding of poultry farm operations from literature (chapter 2) and also engaged poultry farmers and their stakeholders through exploration (chapter 3) to get practical insights. The poultry farm operations described from literature were no different from those identified in exploration. Nonetheless, we used the insights gathered from both literature and exploration to cluster poultry farm operations into four key inter-related processes of planning, purchasing, rearing and marketing. The decisions made across these processes are equally inter-related and overlap. These processes were generalised to the East African region to define the context of a poultry farmers' decision making environment. It was noted that poultry farmers' decisions across these processes were in conformity with the description of decisions that matter as defined by Keen and Sol (2008) i.e. complex, uncertain, highly consequential, non-reversible, non-avoidable and multi-stakeholder. The decision enhancement approach of Keen and Sol (2008) is ideal for enhancing such decisions that matter as already demonstrated by various researchers (Bekker, 2016; Katumba, 2016; Mirembe, 2015; Aregu, 2014; Knol, 2013; Amiyo, 2012; Ejiri, 2012; etc).

Question 2: What factors influence poultry farmers' decisions throughout their operations?

Having gained a clear understanding of the operations of poultry farms, the researcher sought to ascertain the factors influencing farmers' decisions in these operations. This question was addressed from both literature and exploration. In literature we noted that farmers are not rational decision makers and will most likely apply heuristic rules during decision making. Heuristics mainly stem from the decision maker's observations, perceptions and past experiences (March, 2002; Antonides, 1996). It was also noted that farmers are social creatures, whose decisions are influenced by interactions with other farmers, farm advisors, farm suppliers, veterinarians, and others in their social networks (Osinga, 2015; Jansen and Vellema, 2011; Bock and Van Huik, 2007). From exploration, we noted that poultry farmers

made decisions in the context of views from the different stakeholders in the poultry industry such as fellow farmers, veterinary practitioners and input suppliers. The strong attachment of poultry farmers and their stakeholders was also observed from the spontaneity that arose in the strong social context in which they articulated their views during the focus group discussions. The importance of collaboration of farmers and their stakeholders was evident from case study interviews and focus group discussions as well. Collaboration is not only important in decision making but has an influence on the four processes of poultry farm management identified in question 1 above. We noted that the interrelated nature of the four processes was more efficient if supported with collaboration. Against this background, we co-opted collaboration as another key process of poultry farm management because of its influence in the decisions of farmers across the four processes.

Exploration also gave us insights into the significance which poultry farmers attached to their experiences and accumulated salient knowledge. We noted that farmers and/or farm managers make decisions based on what they observe or had previously observed in their poultry farms. Equally they valued mentorship from more experienced farmers because they were believed to have accumulated even more salient knowledge. Based on the influences of decision making among poultry farmers, we noted that poultry farmers may not always follow logical decision making processes as is common with other decision makers and because of this, there is likely to be a discrepancy between the desired effect of a decision and its actual effect. This further substantiated the need to enhance poultry farmers' decisions.

Question 3: How can we design a studio for decision enhancement for poultry farmers in East Africa?

After achieving a generic understanding of poultry farm management and decision making among poultry farmers, we further sought to enhance farmers' decision making processes by designing a decision enhancement studio, which starts from the lens that focuses on stakeholders in decision arenas and their decisions that matter (Keen and Sol, 2008). Using the insights gained from answering the first two questions, design considerations for the Poultry Decision Enhancement Studio (PDES) were formulated. The design considerations focus on the continuous interaction of the five inter-related processes of poultry farm management as abstracted from literature and exploration and generalised to the context of East Africa. These are planning, purchasing, rearing, marketing and collaboration. This design is also grounded in the interaction of the three major perspectives of a decision

enhancement studio i.e. people, processes and technology (Keen and Sol, 2008). This research question is answered in chapter 4, where we elaborately describe the PDES design in terms of the "ways of" framework consisting of the way of thinking, way of governance, way of working and way of modelling (Selingmann et al., 1989; Sol, 1988). To facilitate the application of the PDES design, it was instantiated into a studio in which poultry farmer's decisions can be enhanced practically.

Question 4: How can we evaluate the perceived usefulness and perceived usability of the PDES?

The purpose of the fourth question was to establish whether the PDES could indeed enhance poultry farmers' decisions. As Venable et al. (2012) rightly put it, evaluation provides evidence that a new technology developed in design science research 'works' or achieves the purpose for which it was designed. Evaluation was based on the parameters of usefulness and usability as derived from the Technology Acceptance Model of Davis (1989) and insights from Keen and Sol (2008). Perceived usability and perceived usefulness were evaluated by poultry farmers and domain experts.

20 poultry farmers evaluated the PDES positively as discussed in chapter 6. According to the farmers, using the PDES helps them manage their operations better, facilitates information access, addresses regulatory gaps in the industry, facilitates collaboration and on the whole enhances decision making. These 20 poultry farmers were a new group into the study at the evaluation stage. Prior to this, a team of poultry farmers and key poultry industry stakeholders had been involved throughout the research process as guided by the philosophy of engaged scholarship. This was instrumental in ensuring that the problem domain was well understood and defined, specifications for the PDES were well defined and a useful and usable PDES prototype was designed. The new 20 poultry farmers who participated at the evaluation stage were evaluating an artefact that had been designed and implemented in a rigorous research process. This may give an indication as to why the evaluation results as presented in chapter 6 were highly positive.

Besides the poultry farmers, 79 domain experts also perceived the PDES as useful and usable in enhancing poultry farmers' decisions as presented in chapter 6. In this study, the domain experts were considered because their expert knowledge in the fields of information systems and poultry farm management. As presented in chapter 6, the expert evaluators noted that the

process sequences in the PDES design are logical, the design is clear and simple to interpret and navigation is easy on the studio. In general, the expert evaluators were confident that both the PDES design and studio had the potential to enhance decision making among poultry farmers in East Africa.

Nonetheless, there was a notable discrepancy with the responses from farmers about using the PDES without seeking clarification. While some farmers used the studio easily without seeking technical support, others had to seek support and clarification throughout the evaluation exercise. This points to the limited use of technology in poultry farms which was already noted in literature and during exploration. Farmers lack experience in the use of technology, which explains the need for technical support for some of them during the evaluation period. We noted from both exploration and literature that farmers were ready to utilise technology if proved to be usable and useful. This however doesn't in anyway confirm sustainable use and adoption, which is important for this study.

Basing on insights from Seidel et al. (2013), adoption and sustainable use of the PDES can be triggered by four key pressures faced by poultry farms and the industry in general

1) Pressure from the value chain since the PDES brings together a community of farmers and their stakeholders such as suppliers, experts, regulators and customers among others. Farmers on the PDES do not work in isolation but in a community of stakeholders who add value to each other in the poultry value chain. The pressure to remain part of this community and ease the value chain is a good reason for farmers to sustainably adopt the PDES.
2) Market pressure: Commercial poultry farms target operational excellence, which is well enabled by the PDES. From exploration and literature, it was noted that poultry farmers seek opportunities for business growth and business efficiency, which can be tapped from the PDES suites and services. Easy access to markets and operation efficiency and highly enabled by the PDES and can be reliable factors for driving sustainable adoption of the PDES.
3) Customer pressure: The PDES offers a collaborative and network-focussed approach to managing customer relationships. The pressure to respond to customer demands for efficiency and collaboration is a factor that can drive adoption and sustainability of the PDES since it fosters relationships with the customers who have only been identified and engaged informally previously as observed during exploration.

4) Regulatory pressure: As discussed in chapters 1, 2 and 3, the issue of inadequate regulation has greatly hampered poultry farmers' decisions. The PDES community incorporates regulators of the poultry industry and addresses the regulation gaps in the industry as well which are highly required by farmers and regulatory bodies.

Basing on the above pressures, it is no wonder that during evaluation, farmers generally agreed that they would use the PDES in their processes and would recommend it to others for use as well. Nonetheless, training will be a relevant mechanism to assist farmers to adopt the PDES and sustainably benefit from its suites and services.

From this discussion, we note that the overall research question was addressed, thereby meeting the objectives of the study. Decision making among poultry farmers in East Africa was enhanced using the decision enhancement approach of Keen and Sol (2008) and the PDES was designed, implemented and evaluated to practically enhance poultry farmers' decision making processes. The decision making challenges resolved by the PDES are real problems affecting the East African region and many transition countries, hence the PDES could potentially add value to more economies seeking to increase productivity of the poultry industry. Reflecting on the design science research cycles the environment (the poultry industry and the problems and opportunities therein) and the knowledge base (i.e. existing theories, methods and experiences) were integrated into a design cycle where the PDES was conceptualised and evaluated to solve a relevant and identified problem.

7.2 Reflection on Research Approach

This study applied a rigorous research approach as presented in chapter 1. As a poultry farmer, the researcher was a reflective practitioner who applied a philosophy of engaged scholarship (Van de Ven, 2007) with key principles of design science research (Hevner & Chatterjee, 2010) and followed a research strategy of Singerian inquiry (Lester, 2005) in a pragmatist framework of abductive reasoning. Engaged scholarship in this study facilitated participation of stakeholders throughout the research process and helped to mitigate the biases of the researcher. Engaged scholarship informed the participation of farmers and other stakeholders at all stages of the research, making the study less of a solitary but rather a collective achievement. The design science philosophy was followed in order to create and apply an innovative artefact, the PDES, to an identified problem of poultry farmers' decision making (chapter 1 and 3) after understanding of the problem domain (chapter 2). Design

science enabled this research to advance both science and practice. Hevner et al. (2004) emphasized that researchers thoroughly research and reference the knowledge base in order to guarantee that designs produced are indeed research contributions. This thesis presents a thorough research process involving a review of the knowledge base and rigorous exploration of the problem domain which guided the design of the PDES, as the major contribution in the study.

An epistemological choice of pragmatism was integrated with ontological realism to ensure that the research was well grounded by appreciating underlying perceptions, theories and constructions in the problem domain (chapter 2) before finally designing and implementing a practical solution that would be useful in practice (chapters 4 and 5). Given the ill-structured nature of the research problem, the research followed five major steps of initiation, abstraction, theory formulation, implementation and evaluation (Sol, 1982) which guided a clear understanding and conceptualisation of the problem before changing focus to problem solving. This strategy ensured that the design of the PDES was shaped by both theoretical and practical concepts.

Poultry farm management and decision making among farmers were studied from literature. An exploratory study was also carried out involving 13 poultry farms in case study interviews and 24 poultry industry stakeholders in focus group discussions. The multiple cases and multiple stakeholders gave the desired depth of the exploration exercise and robust findings, which were generalised to the East African region. Subsequently, this generic understanding informed the design considerations for the PDES. The PDES design is described using the "ways of" framework (chapter 4) in terms of way of thinking, way of governance, way of modelling and way of working (Selingmann et al., 1989; Sol, 1988). The design involved engaging with farmers and poultry industry stakeholders to model activity flow diagrams for the processes of planning, purchasing, rearing ad marketing. These diagrams informed how farmers make enhanced decisions and were used to design the PDES.

To facilitate its application, the PDES was instantiated (chapter 5) following insights from the prototyping approach of farming systems (Sterk et al., 2007) and principles of Service Oriented Architecture (Kamoun, 2007). Instantiation focussed on the end user and ensuring that the PDES was easy to use and understand for the farmers.

An evaluation was conducted among 20 poultry farmers and 79 domain experts to ascertain the perceived usefulness and perceived usability of the PDES. The evaluation results were largely positive as elaborated in chapter 6, which gave the desired credibility to the PDES as a major contribution of this study.

Throughout the research, several appropriate research instruments including case studies, focus group discussions and literature were used (see figure 7-1). The study was highly participatory and engaged stakeholders at every stage of the research, providing a vicarious link with the researcher's experiences. The involvement of targeted users of the PDES throughout the study provided the researcher with adequate understanding of the users and their needs.

From this research, we note that design science is a relevant research paradigm for problems faced by developing countries, which require practical solutions for their economies. To address the widely perceived disconnect between scientific knowledge and practice (Cockburn et al., 2016), the design science philosophy can be put to use by academic researchers in developing countries to generate practical solutions to real world problems.

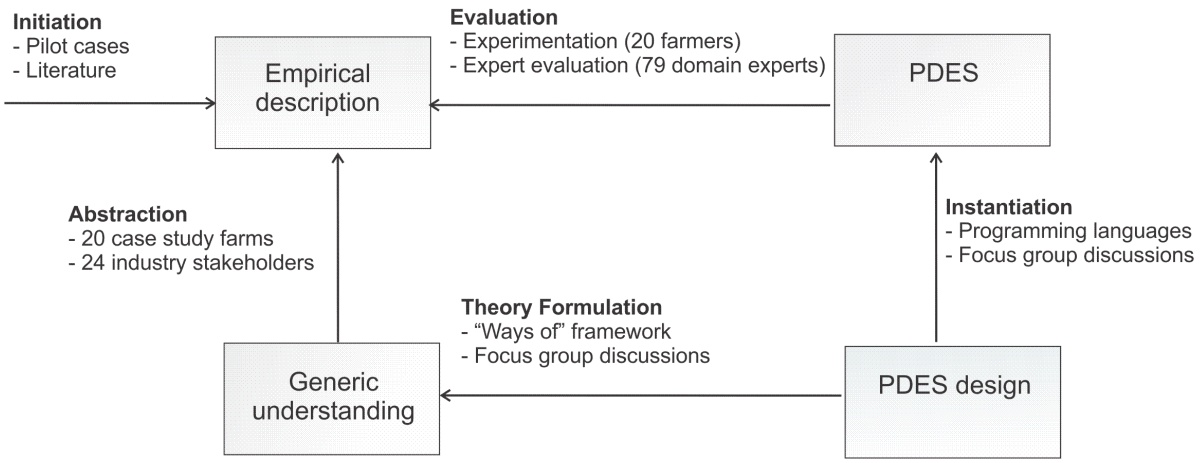

Figure 7 - 1: Research methods applied in the study

7.3 Research Contribution

Design science research should make clear contributions to the real world application environment from which the research problem or opportunity is drawn in addition to knowledge contribution (Hevner et al., 2004). Van de Ven and Johnson (2006) also

emphasized that engaged scholarship should not only facilitate the relevance of research for practice but also contribute significantly to advancing research knowledge in a given problem domain. From the perspectives of both engaged scholarship and design science, which are the guiding philosophies of this research, contribution to science and practice are important. It is against this background that this research recognized the importance of both science and practice contributions as recommended by Gregor and Hevner (2013), Baskerville et al. (2009) and Myers and Baskerville (2009).

This research started off by studying the decision making behaviours of poultry farmers, associated challenges and relevant concepts related to the problem domain such as decision support systems and decision enhancement (chapters 1 & 2). To further understand the problem domain, practical insights were gained through exploration. From exploration, some insights were abstracted and generalised to the problem domain in the context of East Africa. Some of the generalised insights included:

1) Poultry farmers operate in a highly complex and volatile business environment, which equally makes decision making complex.
2) Poultry farmers make decisions in five key inter-related processes of planning, purchasing, rearing, marketing and collaboration.
3) Decisions in these processes conformed to the description of decisions that matter as defined by Keen and Sol (2008).
4) Poultry farmers' decisions are often based on the views of their stakeholders.
5) Because of the influence of heuristics in poultry farmers' decisions, they may not always follow logical decision making processes.

Consequently, the decision enhancement approach of Keen and Sol (2008) was adopted as an appropriate mechanism for enhancing decisions made by poultry farmers. Hevner et al (2004) noted that additions to the knowledge base as a result of design science research can include any extensions made to original theories and methods during the research. This study extends the decision enhancement approach of Keen and Sol (2008), which is grounded in the theory of decision support systems, to poultry farm management. As far as we know, no researcher had applied the decision enhancement approach to the complex decision making problem of poultry farm management despite the approach having been successfully applied to various complex situations in research within the East African region (e.g. Katumba, 2016; Mirembe, 2015; Aregu, 2014; Habinka, 2012; Amiyo, 2012). The successful application of the decision

enhancement approach to the different contexts substantiated its effectiveness in addressing decision making challenges in the context of East Africa and the wider developing region.

The application of the decision enhancement approach guided the design of the the PDES. while generic understanding of the decision making context of poultry farmers in East Africa as extracted from exploration formed the basis for design considerations for the PDES. New meta-artefacts arising out of design science research are additions to the knowledge base (Hevner et al., 2004). The PDES design is a new artefact, which was designed out of this design science research. It focuses on the five inter-related processes of poultry farm management (planning, purchasing, rearing, marketing and collaboration) and their interaction with the three aspects of a decision enhancement studio (people, processes and technology). The PDES design emphasizes the importance of managing all the poultry farm management processes interactively to enhance timely and effective decision making among farmers.

From literature, it was noted that previous researchers from various disciplines have developed poultry farming systems and approaches focusing on specific aspects of poultry farms and customizing them to their different contexts, giving farmers a diversity of approaches and systems. Examples of these include disease management (Stevenson et al., 2007; Sanson et al., 1993), flock replacement (Negash, 2012), performance management (Ramsden and Gibbons, 2009), environmental management (Karmakar, 2007) and farm performance (Xiao et al., 2011). While these systems and approaches have been valuable additions to the body of knowledge and practice, this research identified a lack of a more encompassing approach which addresses the poultry farm management processes together considering their inter-relatedness and the consequential nature of poultry farmers' decisions across these processes. This research fills this gap because the PDES design addresses the five processes of poultry farm management together thereby supporting their inter-relatedness and consequential nature of the decisions involved. The PDES design therefore is a contribution to the body of knowledge in poultry farm management and decision making.

To facilitate its application, the PDES design was instantiated into the PDES studio. The PDES studio is a facilitative, interactive environment in which poultry farmers' decisions are enhanced. PDES facilitates collaboration of farmers and other poultry industry stakeholders, provides guidance for farmer decisions, addresses challenges of complexity in the business

environment such as inadequate regulation and interprets and analyses relevant information for farmers. Accordingly, the PDES is a practical contribution to society.

The PDES design and studio were put to test and were perceived to be useful and usable by both poultry farmers and experts in a rigorous evaluation exercise described in chapter 6. Based on insights from Venable et al. (2012), the evaluation of the PDES provides us with evidence that it can address the purpose for which it was designed; as is core in design science research.

Contribution in design science research requires identifying a relevant problem, demonstrating that no solution exists, developing an artefact that addresses this problem, rigorously evaluating the artefact and articulating the contribution to the knowledge base and to practice (Gonzalez and Sol, 2012; March and Storey, 2008). In chapters 1, 2 and 3, the problem of decision making among poultry farmers was identified and described both theoretically and practically. In chapter 2, literature was reviewed from which the researcher demonstrated a lack of a solution for decision enhancement in the field of poultry farming for the East African region. In chapter 4, an artefact (the PDES) is designed to address the problem by enhancing decision making among the poultry farmers. In chapter 5, the PDES is instantiated for practical use of providing a facilitative and interactive environment in which the farmers' decisions are enhanced. In chapter 6, the PDES is positively evaluated by both poultry farmers and domain experts, who perceived it as useful and usable. This research process substantiates the contribution of this design science research as pointed out by Gonzalez and Sol (2012) and March and Storey (2008).

7.4 Generalizability of the PDES Design

Lincoln and Guba (1985) defined generalisability as "the assertions of enduring value that are context free". Generalisation is the fit between cases studied and other situations to an extent that make it possible to generalise research findings (Schofield, 1993). The potential capabilities of the PDES design can go beyond the poultry sector and address the decision making challenges of other livestock sectors (e.g. dairy, piggery, rabbit farming, sheep, etc). Possible generalisability of the PDES design in this research is based on the following conditions:

1) The primary focus of the notion of decision enhancement which grounds the design of the PDES is to enhance decision making processes of decision makers in a complex/volatile business environment. Livestock farmers in East Africa operate and make decisions amidst challenges such as inadequate regulation (Msoffe and Ngulubbe, 2015; FAO, 2009), inadequate management competences (Corkery et al., 2013) and high disease prevalence (Onono at al., 2013), which makes their business environment quite complex and volatile. The notion of decision enhancement in which the PDES design is firmly grounded has been successfully applied to complex and volatile environments in the East African region by researchers (Katumba, 2016; Mirembe, 2015; Aregu, 2014; Habinka, 2012; Amiyo, 2012; Ssemaluulu, 2012). Decision enhancement may thus not be limited to poultry farmers only but could provide practical solutions for enhancing decision making of livestock farmers in the complex and volatile business environment of East Africa.
2) The design considerations of the PDES as discussed in section 4.1 were conceptualised based on decision making challenges and practices of poultry farmers as identified from exploration and literature, which according to Nabukenya et al. (2014) cut across all livestock sectors as well. Several studies (Nabukenya et al., 2014; Scott et al., 2013; Benson and Mugarura, 2013; Katongole et al., 2012, etc.) already focus on general livestock agriculture rather than specialised sectors because of the similarities in the livestock sectors. Some common similarities in decision making behaviours of farmers include their bounded nature in decision making as noted by Osinga (2015); the influence of heuristics in farmer decision making processes (Nair, 2006; FAO, 2006); and the influence of farmer social networks in decision making (Van der Ploeg, 2010). Because of such similarities in decision making practices of farmers, the potential of the PDES design whose main goal is to enhance farmer decision making processes can be generalised beyond the poultry farms to serve other livestock farms as well.
3) The five inter-related processes of poultry farm management (i.e. planning, purchasing, rearing, marketing and collaboration) on which the development and design of the PDES was based, are typical processes for any livestock farm. The role of the PDES design is to enhance farmer decision making across these inter-related processes while taking into account the consequential nature of the decisions involved in the processes. Livestock farm businesses undertake these processes and the decisions involved are highly consequential. This makes the PDES design easily

applicable in addressing the decision making challenges of livestock farmers across these processes.

4) The stakeholders considered in the PDES design (i.e. farmers, suppliers, customers, regulators, experts) are relevant to all livestock sectors and are of importance in facilitating and enhancing the decision making processes of livestock farmers. As noted by Van der Ploeg (2010), farmers in general depend on views of such stakeholders during their decision making processes. The PDES design enables continuous interaction of farmers and the stakeholders in their decision making arenas which enhances farmer decision making processes.

However, generalisation of the PDES design can be confirmed by testing it in settings of different livestock sectors.

7.5 Directions for Further Research

Like any other scientific inquiry, the research creates an avenue for further investigation related to farm management and decision making. The following are suggestions of possible further research related to this study:

1) The PDES was perceived to be useful and usable. However it lacks a financial model through which it can be sustained once it is rolled out for use. Use of the PDES involves continuous maintenance, facilitation and administration, which can have a financial implication. Equally, a financial model should be a motivation tool for all actors on the PDES. Financial sustainability is key for immediate and long term success of the PDES or any other service systems. There is an avenue for research to be carried out to develop an appropriate and sustainable financial model not only for the PDES but other agricultural service systems as well.
2) Throughout this research, the concern of an inadequately regulated sector was apparent. 100% of the respondents of this study classified input purchasing as a process, which involves decisions that matter. During focus group discussions, the poultry industry stakeholders raised concerns about the inadequately regulated sector in which they purchased farm inputs and services, which largely affected the farmers' operations and subsequent decisions. The inadequate regulation affects quality of inputs and outputs of poultry farms. While the PDES facilitates regulation of the poultry industry, this research opens an avenue to carry out further research on a

quality assurance model for the industry, which can be implemented using the PDES. Quality assurance and certification is an important attribute not only for the growing poultry industry but other livestock sectors across East Africa.

3) To support a growing use of technology, further research can be carried out on how other technologies like sensor networks and GIS can be applied by poultry farmers in East Africa to capture flock information on the PDES. Such information may include rate of laying, body weight, growth patterns, rate of feeds and water consumption.

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Appendix A - Interview Survey and Letter to Respondents

Dear respondent,

My name is Rebecca Pearl Tumwebaze. I am working on a research study at the University of Groningen, in the Netherlands, for a study leading to the award of the degree of Doctor of Philosophy. This is the initial stage of an exploratory study of the research titled "Decision Enhancement for Poultry Farmers in East Africa". The study seeks to understand the decision making behaviours and context of poultry farmers and how these decisions can be enhanced. Within this PhD project, research and facilitation is done by prof. dr. Henk G. Sol, University of Groningen, Faculty of Economics and Business, Netherlands and prof. dr. Jude T. Lubega of Uganda Technology and Management University.

I would be grateful if you would accord me some of your time to fill in this structured interview guide. I will be happy to send you a copy of my final report upon your request. Your help will be very much appreciated.

Date of Participation	
Participant's Name & Signature	
Farm/Company Name	
Researcher's signature	

Section 1: Farm characteristics

1. Location of farm: ……
2. Type of birds reared (tick where appropriate)

Layers	
Broilers	

Both	

3. What is the number of birds currently reared at your farm?

   …….

4. Who is the person currently managing the farm? (Tick where appropriate)

Employed farm manager	
Farm Owner	

Other (Specify): ……

Section 2: Poultry Farm Management Processes and decisions

1. List at least six activities you engage in during your operations as a farmer where you make critical decisions?

1) ……
2) ……
3) ……
4) ……
5) ……

2. What normally triggers you to make decisions in the above activities?

……

……

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……

……

3. Which performance indicators normally guide the kind of decisions you make during farm operations?

1) ……
2) ……
3) ……
4) ……
5) ……
6) ……
7) ……
8) ……

4. Which of these below are your sources of information during decision making?

Tick where appropriate; multiple choices are acceptable

	Source of information	**Tick where appropriate**
a)	My farm veterinary doctor	
b)	Government extension workers	
c)	Fellow farmers	

d)	My previous experience	
e)	Internet	
f)	Main stream media (newspapers, radios, TV)	
g)	Others	

Others (Specify)

……

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……

List down the challenges you face during your operations as a poultry farmer and

1) ……
2) ……
3) ……
4) ……
5) ……

Section 3: Use of ICT at the farm

1. Do you have a computer at the farm? (Tick where appropriate)

Ye	

No	

a) If yes, answer the following

i) What are you currently using the computer for at your farm?

……

……

……

……

b) If no, answer the following

i) Why?

……

……

ii) Can you use a computer?

Ye	
No	

iii) Do you use any ICT application or system to support management and decision making at your farm?

Ye	
No	

If yes, specify names of applications and use

Name of ICT application/system	Use

iv) Would you purchase a computer for your farm if you confirmed that it can add value to your business?

Ye	
No	

Section 4: Information for decision enhancement

List down the types of information you would require to improve the kind of decisions you make

a) ……

b) ……

c) ……

d) ……

e) ……

f) ……

g) ……

Appendix B - PDES Evaluation Questionnaire for Farmers

My name is Rebecca Pearl Tumwebaze. I am working on a PhD research study under the topic "Decision Enhancement for Poultry Farmers in East Africa". From this research, it was observed that poultry farmers face challenges in making decisions throughout their operations. Therefore a Poultry Decision Enhancement Studio (PDES) was designed and implemented to address the aforementioned. Following an orientation workshop which you participated in and your acceptance to put the PDES suites and services to practical experimentation, this questionnaire aims at evaluating your perceived usefulness and perceived usability of the PDES in enhancing your ability to make effective decisions throughout your operations as a poultry farmer. As one of key stakeholders of the PDES, please share your perception on the usefulness and usability of the studio at enhancing your decisions.

Within this PhD project, facilitation and supervision is done by prof. dr. Henk G. Sol of the University of Groningen, the Netherlands and prof. dr. Jude T. Lubega of Uganda Technology and Management University.

I will be happy to send you a copy of my final report upon your request. Your help will be very much appreciated.

Section one: Background Information

1. Details of the farm

Location of farm	
Type of chicken reared (Broilers/Layers)	
No. of birds reared at the farm	

2. Poultry farming experience

Years of experience	
1-3	

4-7	
8-11	
11-15	
15+	

Section two: PFDES usability and usefulness evaluation

	Usability Statement	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1.	The PDES uses simple language that is easily understandable					
2.	The PDES is easy to learn to use					
3.	Information on the PFDES is easy to access					
4.	I did not always seek clarification when using the PDES					
5	The 'Help' function of the PFDES does not ease usability					

	Usefulness Statement	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**

1.	Using the PDES can help me to manage my operations better					
2.	Using the PDES has helped me understand the activities involved in my poultry farm business better					
3.	Using the PDES supports my ability to make effective decisions at the different stages of my value chain					
4.	The PDES can help me to do my work more efficiently					
5.	The PDES facilitates my access to information concerning the poultry industry					
6.	The PDES makes it possible for me to get timely reports about my farm					
7.	The PDES supports regulation to access of my information					
8.	I can access the PDES anywhere and thus can make decisions concerning my operations in real time					
9.	The Planning suite can enhance my ability to make effective planning decisions concerning my poultry farm					
10.	The purchasing suite can enhance my ability to make effective decision concerning the purchase of inputs for my poultry farm					
11.	The rearing suite can enhance my ability to make effective decisions concerning activities involved in the day to day monitoring of my					

	flock					
12.	The marketing suite is helpful in guiding me to make effective market decisions concerning price and buyer choice					
13.	The PDES is not practical in improving management of my farm					
14.	The suites in the PDES don't reflect the actual process involved in the management of a poultry farm					
15.	There is no added value in using PDES					
16.	I would prefer to carry out my operations without the PDES					
17.	The PDES cannot support me to make effective decisions concerning my poultry farm					
18.	The communication suite is of no value and does not support me to collaborate with other actors in the poultry farm value chain					
19.	The PDES is not practical in improving management of my farm					

Section three: Additional information

Give comments that you feel we can use to improve the usefulness and usability of the PDES

……

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Thank you very much for your contributions

Appendix C - PDES Evaluation Questionnaire for Experts

My name is Rebecca Pearl Tumwebaze. I am working on a PhD research study under the topic "Decision Enhancement for Poultry Farmers in East Africa". From this research, it was observed that poultry farmers face challenges in making effective decisions throughout their operations. Therefore a Poultry Decision Enhancement Studio (PDES) was designed and implemented to address the aforementioned. Due to your expertise, you were selected to participate in evaluating the perceived usefulness and perceived usability of the PDES design and studio in enhancing poultry farmers' ability to make effective decisions throughout their operations. As a stakeholder of the PDES, please share your perception on the usefulness and usability of the studio at enhancing poultry farmers' decisions.

Within this PhD project, facilitation and supervision is done by prof. dr. Henk G. Sol of the University of Groningen, the Netherlands and prof. dr. Jude T. Lubega of Uganda Technology and Management University. I will be happy to send you a copy of my final report upon your request. Your help will be very much appreciated.

Section one: Background Information

1. Field of specialisation

Information Systems	
Poultry Industry	

2. Highest level of education (tick one)

Undergraduate	
Postgraduate	

3. Field experience

Years of experience	
1-3	

4-7	
8-11	
11-15	
15+	

Section two: PFDES usability and usefulness evaluation

	Usability Statement	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1.	Process sequences of the PDES design are logical					
2.	The PDES design is clear and simple to interpret					
3.	The Guidelines to use PDES are easy to learn					
4.	Terminologies are not consistent with those in the industry					
5.	Information on the PDES studio is not easy to access					
6.	Farmers will not be able to learn to use the PDES					

	Usefulness Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	The PDES design addresses the decision making challenges in poultry farm management					
2.	The PDES can be applied to poultry farms across the East African region					
3.	The PDES design if applied can improve the efficiency of poultry farmers and farm managers					
4.	The PDES studio has the potential to improve profitability in the poultry industry					
5.	I can recommend the PDES studio to farmers					
6.	The PDES design does not support open communication and collaboration among stakeholders in the poultry farm chain					
7.	The PDES design does not address the key challenges faced by the poultry industry					
8.	The PDES studio does not support generation of reports for users					
9.	The PDES studio cannot guide poultry farmers and/or farm managers to make real time decisions from anywhere at anytime					

Section three: Additional information

Give comments that you feel we can use to improve the usefulness and usability of the PDES

……

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Thank you very much for your contributions

Summary

In the 21st century, management tasks in agriculture have gradually shifted to a new paradigm requiring increased attention to economic viability and the interaction with the surroundings (Dalgaard et al., 2006). This shift has particularly influenced the poultry industry in East Africa shown by an increasing number of commercial poultry farms in the region. This study was sparked by practical decision making challenges faced by poultry farmers in East Africa amidst this shift. The initial trigger was in fact the researcher's practical experiences as a poultry farmer, which further led to an initial study of poultry farm environments and the decision making practices of poultry farmers from both literature and exploration. The aim was to get an in-depth understanding of the context of poultry farm operations, the decisions involved in these operations, the factors influencing farmers' decisions throughout these operations and the theoretical perspectives in the field of decision making among poultry farmers. This would later guide the design of an appropriate solution for enhancing poultry farmers' decision making processes.

Initial studies revealed that poultry farmers in East Africa operate in complex business environments characterized by challenges such as high disease prevalence, insufficient regulation, unstable economies and lack of relevant information. Because of such challenges, poultry farmers are highly bound in decision making and are influenced by heuristics in their decision processes. These findings demonstrated the complex nature of the context in which poultry farmers make decisions. It was also noted that poultry farmers' decisions fitted the description of decisions that matter as defined by Keen and Sol (2008) i.e. consequential, uncertain, non-avoidable, non-reversible and multi-actor. From both literature and exploration, it was noted that a poultry farmer makes decisions in the context of other stakeholders of the poultry industry such as input suppliers, poultry health experts, other poultry farmers, customers and regulators. Against this background, it became evident that poultry farmers may not always follow logical decision making processes like other decision makers.

Consequently, this study set out to enhance poultry farmers' decisions using the notion of decision enhancement, (Keen and Sol, 2008) which is grounded in the decision support systems theory. The Poultry Decision Enhancement Studio (PDES) was envisaged to provide suites and services necessary for decision enhancement among poultry farmers. The PDES is

based on the continuous interaction of the five inter-related processes of poultry farmers in East Africa in relation to the three major perspectives of a decision enhancement studio (i.e. people, processes and technology) as pointed out by Keen and Sol (2008). The five processes are Planning, Purchasing, Rearing, Marketing and Collaboration.

PDES consists of five suites of different technology enablers. The Planning suite enhances poultry farmers' planning decisions using three key services: information, market exploration and budgeting. These services facilitate poultry farmers to access relevant information concerning poultry farm management and poultry flocks, explore market environments and budget for flock cycles in the farm. The purchasing suite enhances poultry farmers' decisions concerning when to purchase inputs, where to purchase inputs, how to get purchased inputs to the farm premises and how to manage purchased inputs once at the farm. It is embedded with two services i.e. Supplier catalogue and Inventory management. The rearing suite is concerned with the day to day process monitoring of flock and facilitates poultry farm management through services of flock registration, record management and monitoring of key performance indicators that impact flock growth. The marketing suite is concerned with enhancing famers' decisions relating to the sale of the outputs of poultry farms. It provides services of advertising and buyer access. Lastly, the collaboration suite enhances continuous collaboration among stakeholders of the poultry industry whose roles, skills and experience can be tapped during a farmers' decision making processes. The suite promotes interaction and networking of all actors and across all the processes on the PDES.

The PDES suites, services and supporting guidelines subsequently enhance decision making during poultry farm management by facilitating collaboration, transparency, regulation, visualisation, information interpretation and analysis.

On a practical note, PDES was instantiated into a virtual facilitative environment for poultry farmers and the stakeholders in the poultry industry. The PDES was also evaluated based on the parameters of usefulness and usability. Evaluation was carried out among poultry farmers through practical experimentation as well as experts from the domains of poultry farm management and Information systems. On the overall, participants perceived PDES as usable and useful for decision enhancement in poultry farm management.

The PDES is the major contribution of this research. It is a contribution to both theory and practice.

Following its successful instantiation and evaluation, it was noted that the potential capabilities of the PDES design can go beyond the poultry sector and address the decision making challenges of other livestock sectors (e.g. dairy, piggery, rabbit farming, sheep, etc). The five inter-related processes of poultry farm management (i.e. planning, purchasing, rearing, marketing and collaboration) on which the development and design of the PDES was based, are typical processes for any livestock farm. The stakeholders considered in the PDES design (i.e. farmers, suppliers, customers, regulators, experts) are relevant to all livestock sectors and are of importance in facilitating and enhancing the decision making processes of livestock farmers. It was also noted that the primary focus of the notion of decision enhancement which grounds the design of the PDES is to enhance decision making processes of decision makers in a complex/volatile business environment, which is typical of all livestock sectors in East Africa as discussed in chapter 7. However, the PDES' generalisability can be confirmed by testing it in the different livestock sector settings.

Samenvatting

In de 21ste eeuw zijn de beheerstaken in de landbouw geleidelijk verschoven naar een nieuw model, waarbij meer aandacht uitgaat naar de economische levensvatbaarheid en de interactie met de omgeving (Dalgaard et al., 2006). Deze verschuiving is in het bijzonder van invloed geweest op de pluimvee-industrie in Oost-Afrika, zoals blijkt uit het groeiende aantal commerciële pluimveebedrijven in de regio. De praktische uitdagingen bij de besluitvorming waarmee pluimveehouders in Oost-Afrika gedurende deze verschuiving te maken krijgen, vormden de aanleiding voor dit onderzoek. Het aanvankelijke idee voor dit onderzoek ontstond vanuit de praktijkervaring van de onderzoeker in de pluimveehouderij. Dit leidde tot een eerste onderzoek naar de omgeving van pluimveebedrijven en de besluitvormingspraktijk van pluimveehouders op basis van zowel de literatuur als verkennend onderzoek. Het doel was om een diepgaand begrip te verkrijgen van de context van de bedrijfsvoering van pluimveebedrijven, de beslissingen die hiermee gepaard gaan, de factoren die hierbij van invloed zijn op de beslissingen van de pluimveehouders, en de theoretische perspectieven op het gebied van besluitvorming onder pluimveehouders. Op een later moment zou dit ten grondslag liggen aan het ontwerp van een geschikte oplossing voor het verbeteren van de besluitvormingsprocessen van pluimveehouders.

Uit eerste studies bleek dat pluimveehouders in Oost-Afrika werken in complexe zakelijke omgevingen die worden gekenmerkt door uitdagingen zoals hoge ziekteprevalentie, ontoereikende regelgeving, onstabiele economieën en een gebrek aan relevantie informatie. Als gevolg van zulke uitdagingen zijn pluimveehouders sterk gebonden in hun beslissingen en worden zij in hun besluitvormingsproces beïnvloed door heuristiek. Deze bevindingen lieten zien hoe complex de context is waarbinnen pluimveehouders beslissingen nemen. Ook werd waargenomen dat de beslissingen van de pluimveehouders voldoen aan de beschrijving van beslissingen die er toe doen ("decisions that matter") volgens de definitie van Keen en Sol (2008), t.w. met verstrekkende gevolgen, onzeker, onvermijdelijk, onomkeerbaar en met meerdere actoren. Zowel uit de literatuur als uit verkennend onderzoek bleek dat een pluimveehouder beslissingen neemt binnen de context van andere stakeholders in de pluimvee-industrie, zoals leveranciers, pluimveegezondheidsexperts, andere pluimveehouders, klanten en toezichthouders. Tegen deze achtergrond werd duidelijk dat

pluimveehouders mogelijk niet altijd een logisch besluitvormingsproces vormen zoals andere besluitvormers.

Derhalve heeft dit onderzoek zich ten doel gesteld beslissingen van pluimveehouders te verbeteren met behulp van het begrip besluitverbetering ("decision enhancement") (Keen en Sol, 2008), dat zijn basis heeft in de systeemtheorie voor besluitondersteuning. De Poultry Decision Enhancement Studio (PDES) is ingericht om programma's en diensten te bieden die nodig zijn voor het verbeteren van beslissingen onder pluimveehouders. De PDES is gebaseerd op de doorlopende interactie van de vijf onderling samenhangende processen van pluimveehouders in Oost-Afrika, in verhouding tot de drie belangrijkste perspectieven van een studio voor besluitverbetering (t.w. mensen, processen en technologie) zoals aangegeven door Keen en Sol (2008). De vijf processen zijn Planning, Inkoop, Opfokken, Marketing en Samenwerking.

De PDES bestaat uit vijf programma's die verschillende technologieën behelzen waarmee zaken mogelijk gemaakt worden. Het programma Planning verbetert de planningsbeslissingen van de pluimveehouders door drie verschillende cruciale diensten: informatie, marktverkenning en budgettering. Dankzij deze diensten krijgen pluimveehouders toegang tot relevante informatie over het beheer van pluimveebedrijven en pluimveekoppels, kunnen zij marktomgevingen verkennen, en budgetteren voor fokcycli in het bedrijf. Het programma Inkoop verbetert de beslissingen van pluimveehouders met betrekking tot waar en wanneer er nieuwe input moet worden aangekocht, hoe deze nieuwe koppels naar het bedrijf kunnen worden vervoerd, en hoe er na aankomst mee moet worden omgegaan. Er zijn twee diensten vervat in dit programma, t.w. catalogus van de leverancier en inventarisbeheer. Het programma Opfokken betreft de dagelijkse procesmonitoring van het pluimvee en faciliteert het beheer van de pluimveehouderij door middel van diensten zoals koppelregistratie, archiefbeheer en monitoren van belangrijke prestatie-indicatoren die van invloed zijn op de groei van het koppel. Bij het programma Marketing gaat het om het verbeteren van de beslissingen van de pluimveehouders met betrekking tot de output van het pluimveebedrijf, door middel van advertentiediensten en diensten m.b.t. toegang tot kopers. Ten slotte zorgt het programma Samenwerking voor een verbetering in de voortdurende samenwerking tussen stakeholders in de pluimvee-industrie. Tijdens het besluitvormingsproces kunnen pluimveehouders gebruikmaken van de rollen, vaardigheden en ervaring van deze stakeholders. Het programma stimuleert netwerken en onderlinge interactie tussen alle actoren verspreid over alle processen in de PDES.

Op deze manier zorgen de PDES-programma's, diensten en ondersteunende richtlijnen voor een betere besluitvorming bij het beheer van pluimveebedrijven door het faciliteren van samenwerking, transparantie, regelgeving, visualisatie en de interpretatie en analyse van informatie.

De PDES is geconcretiseerd tot een virtuele faciliterende omgeving voor pluimveehouders en de stakeholders in de pluimvee-industrie. De PDES is ook geëvalueerd aan de hand van de parameters voor bruikbaarheid en toepasbaarheid. Er is geëvalueerd door pluimveehouders - door middel van praktisch experimenteren - alsmede door experts uit het veld van pluimveehouderij-beheer en informatiesystemen. Over het algemeen werd de PDES door de deelnemers ervaren als bruikbaar en nuttig voor het verbeteren van beslissingen bij het beheer van pluimveebedrijven. De PDES is de grootste bijdrage die uit dit onderzoek is voortgekomen en overbrugt de kloof tussen theorie en praktijk.

Curriculum Vitae

Rebecca Pearl Tumwebaze was born on 28th November 1981 in Western Uganda. She obtained her Bachelors' degree in Mass Communication with honours from Uganda Christian University in 2005. In 2012, she obtained a Master of Business Administration from Eastern and Southern Management Institute in Arusha Tanzania. Tumwebaze is a farmer in Uganda and is currently the Director of Family Orchard Uganda Ltd, a commercial farm dealing in poultry, piggery and dairy farming. Prior to following her passion to start her farm, she worked with Barclays Bank in the credit and loan processing sections. In academia, she teaches at Uganda Technology and Management University (UTAMU).