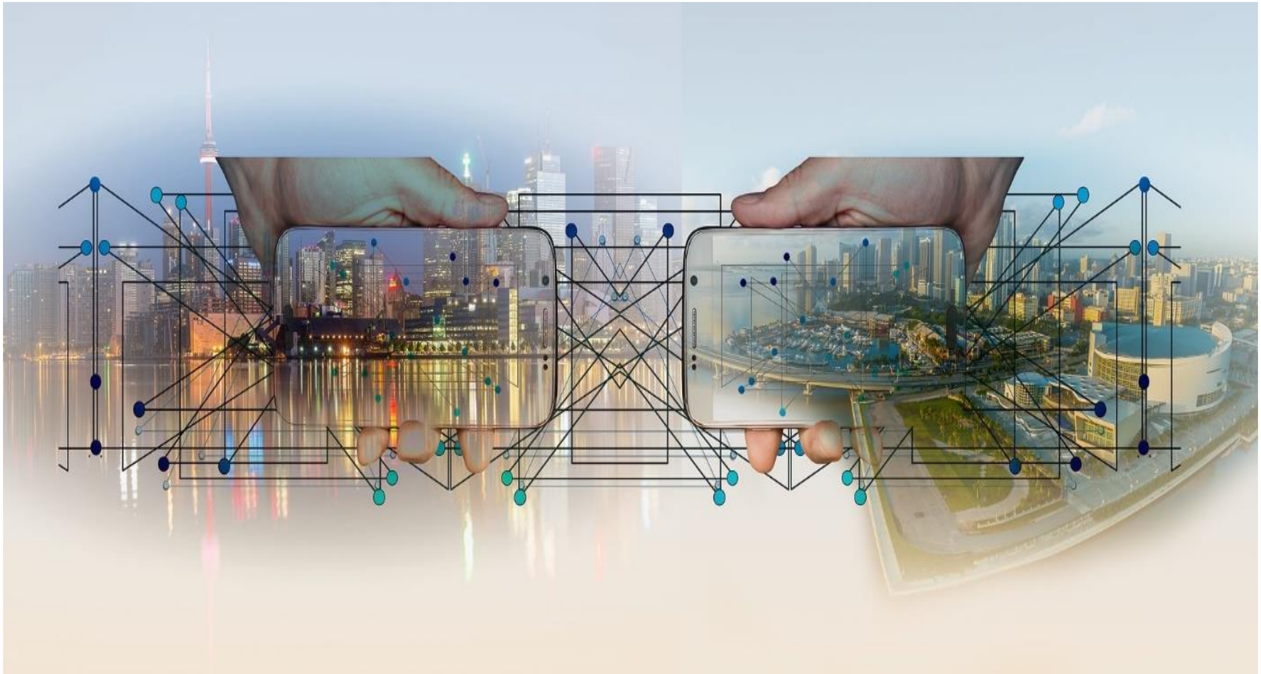
Data Science Meets the Agrifood Sector

Developing a Business Strategy for Info Support's new AgriFood Branch



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1. Abstract

IT is a versatile topic that is rapidly growing in various domains. In the agrifood sector that growth is becoming imperative due to the increase in Earth population and the demand for a better-quality food. Info Support as a mid-sized IT consultancy company opened a new business unit dedicated to agrifood, and is looking for the best strategy for entering the market and becoming a trusted advisor in it. This internship has focused on a research that outlines such strategy for Info Support.

During the research, 4 topics were identified. The first topic is poultry farming due to, on one hand, low level of IT adoption, and on the other, the vicinity of Barneveld to Info Support head office in Kruisboog, Veenendaal. The second topic is whole-loop supply chain optimization. It is satisfying the IT and data analytics needs of supply chain optimization using the Info Supports's expertise in data analytics for analyzing and optimizing regular, forward-facing supply chain and advising on creation of reverse supply chain. The third topic is the creation of IoT middleware that is needed in various sectors using IoT. The fourth topic is the creation of decision support systems (DSS) for various agrifood topics which requires combination of extensive domain and technical knowledge.

It is shown that the first three topics have realistic possibility for success and should be performed in cascading order as the results of one can be used when working on the next topic. It is also shown that the fourth topic (creation of DSS) did not satisfy commercial requirements, but could be a good source of internship and graduation assignments.

2. Introduction

Info Support B.V. is an IT company with a head office based in Veenendaal (The Netherlands) and another office based in Mechelen (Belgium). It was founded in 1986. and up to now it has grown to more than 450 employees and several subsidiaries in Belgium and The Netherlands.The company belongs to a software and data consultancy category, specializing in developing, managing and hosting custom software, BI and data science and integration solutions. In addition to the consultancy, Info Support has a well-renowned training center. The center provides trainings in several categories such as architecture, continuous delivery, data solutions, Java, Linux, SAP, Oracle, Web Development. Info Support training center is, in addition, an official Microsoft training and certification center.

Currently, Info Support bv. (IS) is present in several industries such as healthcare and insurance, energy, finance, government and transport. Their list of clients includes Vecozo, Fudura and Enpuls, ING bank, Timeos, FMO, Belastingdienst, Rijk Zwaan, NS and many others. The company is organized in business units that are focusing on each of the previously mentioned markets. Within each business unit, there are experts in different areas that work both in the company and at the client. At the highest level the experts are classified as software engineers, systems engineers and data engineers, and further classified within these three domains of expertise. Info Support B.V. is an Agile company, and that can be seen in the way the projects are organized and performed.

Due to Info Support's head office specific location in Veenendaal, the company is positioned in the center of the so-called Food Valley. Food Valley is the ecosystem inspired by Silicon Valley but revolving around food, agriculture, research and connection between industry, research and academia. This area houses a perfect mix of industry, entrepreneurs and knowledge providers whose collaboration leads the economic improvement for Netherlands and the world, and increases the knowledge about the sector. In addition to being in the heart of Food Valley, municipality of Veenendaal started the initiative of transforming Veenendaal into the ICT city (Veenendaal ICT centrum, 2018.). Veenendaal ICT city combines ICT companies, experts, students and research to work together towards creating a stronger and smarter eco system, thus boosting the local economy. Aside of being focused on ICT sector as a whole, Veenendaal is establishing the relationship between the Food Valley and ICT city and trying to provide further support to agritech solutions. This strengthens the community ties, and helps connect relevant expertise with the end users.

The agrifood sector is a new branch into which Info Support tries to enter and grow in, and it was established less than a year ago. As with any new initiative, time is needed to recognize the potential, threats, opportunities and common pitfalls in it. Also, each new initiative requires changing the mindset of the team in charge of implementing it. As Info Support is very experienced in various technological aspects, realizing the potential of implementing technology is not a problem. However, the problem lies in accumulating the internal knowledge about the sector. To identify relevant opportunities and threats that the field experiences a research was started with the quick market analysis. The market analysis focused on the information about the most successful technological start-ups and businesses that managed to enter and grow in the agrifood sector. Through various sources such as Forbes, Agfundernews, tech.com and agriculture.com the lists with annual most successful agritech companies was found. Afterwards, manual search of company webpages and profiles was performed for the companies mentioned. This method showed that the constant that differentiates the ones that succeeded from the ones that did not is in knowledge of the industry from the first-hand experience. The successful companies had former or current farmers and agrifood sector workers, working together with tech experts. One of the goals that is given the priority is to increase the knowledge of Business Unit Agriculture (BUA) employees in various aspects of agrifood sectors, which in turn lead to better solutions tailored for that sector.

Agrifood sector is undergoing a transformation from a traditional sector to a more efficient, feasible and sustainable one. The challenge that the sector faces is the mismatch between the pace with which the food production is growing and the world population growth. World population is expected to grow by about 2.3 billion people by 2050, and this growth is expected to occur mainly in the developing countries out of which most notably in sub-Saharan Africa (FAO, 2009.). Growing population will become economically stronger, which will also lead to the change in dietary habits. Currently, populations in developing countries bases their diet mainly on cereals, grains and other plant products while the demand for meat is lower. However, as the buying power increases so does the demand for animal products. In 2050., the overall food demand is expected to increase by 70% of the demand today. The demand for crops might be even higher, based on the demand and policies following bio-fuel adoption (FAO, 2009.). In order to achieve such high volumes of production that is being demanded, the standard farming methods need to be improved. Although the Netherlands is the target market, and it is not a part of the developing market, it is affected by the same circumstances which affect the supply and demand globally.

The improvement can be achieved through various methods, but implementing only one solution is likely not going to be sufficient so more initiatives are creating integrated approaches to tackle it (Schaefer, 2004.). Agri-food sector is affected by the increasing demand for a higher food yield while maintaining and increasing the higher level of food quality and safety. The food production is becoming more intensive, meaning that the food producers are required to provide the larger volume of food from the same or lower amount of resources than ever before. According to Schaefer (2004.) IT is increasingly recognized as a key enabler for this type of change, as they "build on changes in enterprises' internal activities and their interaction with each other". According to the same author, focus of IT can be divided into 3 general categories: market activities, process activities and management decision and extension activities. Market activities are considered to be the tasks and activities that "enable the business" on a higher level, focusing more on external processes, such as ensuring food safety and quality, transparency and traceability, ensuring consumer trust, supply chain optimization and cooperation. In simpler words, according to Schaefer (2004.), "The keyword for IT support is communication and the utilization of the emerging integrated communication technologies".

Process activities in contrast to market activities, are focused more on internal processes, and more specifically on internal processes with regards to food production. Some of the processes are usage of sensors, satellite imagery, geo-information systems and combining them for i.e. precision agriculture or precision farming. It tends to focus on automation of tasks and optimization. Thanks to major development in IoT (Internet of Things), an increasing amount of data is being generated in various industries, and agrifood is not the exception. Various sensors are measuring temperature conditions, feed and water levels and intake, humidity levels and many more. Increasingly, the sector is implementing novel ICT technologies such as wireless communication systems, sensors and RFIDs, GPS, GIS, knowledge management systems and many more. As a standalone, information generated in such manner are not sufficient for improving decision-making processes. Thanks to IoT technologies, a modern farm, food procession facility, storage etc. collect immense amount of data that can potentially provide many new possibilities.

The utilization of such data is a third IT process mentioned by Schaefer (2004.), and it focuses on management decision and extension activities. This process consists of management decision support, and contains various information systems such as Management Information Systems, Decision Support Systems and Executive Information Systems. According to the author these systems "…involve the collection, selection, processing and communication of information in one- or two-way communication activities". However, a lot of the available information is underutilized and rarely gets to this third process. It is estimated that the amount of data used to support decision-making ranges between 2% and 10%. Due to the Info Support's expertise, it has the potential to thrive in the agrifood domain and bridge the domain/IT gap that currently exists on the market.

The purpose of this internship is to devise a business strategy that will help Info Support gain insight into farm business processes, identify who its potential competitors and collaborators can be, and identify potential business opportunities. Particularly, the main obstacles for farmers in using data need to be identified. Farmers follow intensive routine in their day to day business and may be risk averse. They are not lenient to experiment with the solutions that might increase their risk without having any proof of a long-term benefit. One important competency of Info Support B.V. is data science, including big data and machine learning. The company has great potential to contribute towards what many stakeholders call the "fourth industrial revolution" (Schwab, 2017.) and more notably – to its effect on "digital revolution of agriculture" (Gustafson, 2016.). The digital agricultural revolution is seen as an integration of ICT and agricultural practices in order to create more sustainable, optimized food production. According to Gustafson (2016.) ICT can decrease the risk and uncertainty, provide better choice for planting and harvesting based i.e. on weather data and satellite imagery, or improve the production planning based on the data about market demand. For that purpose, a business strategy is needed that guides how tech experts can most efficiently collaborate with the actors of agri-food businesses and farmers.

In more concrete terms, the purpose of this internship project is to discover how to establish and maintain a relationship with the experts in agricultural sector, and to become their solution provider and trusted advisor for both software and data solutions.

Some of the questions that this project will seek to answer are:

- How can a software company become a solution provider and a trusted advisor within the agrifood sector?
- How to help farmers exploit the growing amount of data that is being made available thanks to the increasing deployment of IoT technologies at farm?

These questions will serve as a starting point of the research and will help with setting up the further questions and search direction with more specific and easily measurable metrics.

Although there are two main research questions, they are interrelated. In order to provide data solutions to the farmers and help them with creating meaning of the data, a company needs to become a trusted advisor. The obstacles in becoming a trusted advisor, as shown in the study done by Columbia Business School (2015.), shows that people have concerns with how their data is being used, the level of transparency, effect of the sharing on the company's competitive advantage and the degree of openness. Many initiatives that were using farm data created an additional lack of trust, as the agri data were gathered from the businesses and then used to create paid solutions or farm equipment upgrades, which were impossible for a farmer to refuse. Most notable example of this was John Deere, which created proprietary tractors that gathered immense amount of data from the farmers and used it to create an even better equipment later on. At the same time, John Deere created a system in which farmers have no control over the equipment, to such extent that even if the tractor gets broken the farmer cannot fix the problem themselves but have to wait for an official servicemen which can sometimes take days to arrive. Farmers in the USA started to complain about these practices, as they are deemed unfair, and there is a bigger pressure for open access solutions (Wanstreet, 2018.).

Technological companies, especially software and data oriented ones, face similar issues when trying to get a share of this market. Many actors in the agrifood sector are not aware of the potential solutions that technology can provide them, induction of food production quotas on the national level ensured that various actors are already operating with profit, and both situations lead to low willingness to change. IT seems as an increased liability, it can drive initial costs and it requires the change in the way the business is done, while the positive outcomes seem blurry for many farmers. On the other side, there is an increased pressure from the government for quality monitoring, better performance indicators, monitoring and optimizing environmental impact, transparency for growth, storage and transportation of the goods and many more (Sorensen et al. 2010.). At the same time, farmers are forced to reduce production cost while increasing output volume and the quality in order to stay competitive on the market (Sorensen et al. 2011.). These events are providing the opportunity for implementing technology, but at the same time it does not resolve the lack of knowledge about possible solutions that could improve their business, or the lack of trust towards the tech providers. An evidence of that can be seen when searching for the companies and startups which managed to enter the agrifood market, get funding and get a stable market share. The common aspect behind each successful companies was that they were either founded by the people working in agrifood domain, or working in close collaboration with people from the domain. Detailed case study was not done for further assessment of this, as it was outside of the scope of this project.

Under the supervision of business unit manager – Henk Brands and data architect Hans Geurtsen, the project was started by identifying which initiatives were already started within the company. Both supervisors have extensive knowledge of the data and BI solutions, and have experience with creating and implementing the solutions in various domains. They are also part of the core team for agrifood, and have spent significant time in understanding the sector and how the business strategy of Info Support fits into it. Thanks to bi-weekly meetings with Henk Brands, and regular discussions with Hans Geurtsen with whom I was sharing the office, the start of the internship project was fast and efficient.

The main personal study goal was to intertwine the knowledge of change and risk management by identifying possible obstacles that occur in other IT initiatives in various sectors. Second goal was to learn how to prepare a business unit strategic plan which is aligned with the strategic plan of the company. Strategic plan for BUA defines potential customer as the ones that satisfy following conditions:

Table 1: Client selection - general criteria

1.	Technological fit
2.	IT department located in the Netherlands
3.	IT is of critical value to the company
4.	Partnership
5.	Accessible location
6.	Recurring business (within BV services)
7.	Fits in the market sector
8.	Good credit standing
9.	Willingness to purchase various services from the portfolio (cross-selling)
10.	Impact on C-level
11.	Willing to invest in the level of quality that IS provides

Additionally, in order to fit the criteria, the needed size of the company can be read from the following table:

Table 2: Client selection - per size

Klantrubricering		
Omzetpotentie in € / jaar	Op basis van omzet	Omzet + criteria passende klant
< 200.000	S	M
200.000 - 500.000	M	L
500.000 - 1.000.000	L	XL
> 1.000.000	XL	**XXL**

For these reasons the initial plan of putting the partnership focus predominantly to the level of farmers in the area was abandoned, as it did not align well with the aforementioned business strategy of Info Support. As an IT consultancy with more than 450 employees, creating solutions from the ground up is not the targeted direction they would like to pursue as a first step in market penetration. A method of choice is to use the already existing solutions and tailor them to customers needs. That way, the company is not busy with creating foundations but only with tinkering with the client-specific parameters. In example, IS would not be busy to create a software in which to make dashboards for clients BI needs but would use an existing software such as PowerBI and focus only on creation of client-specific dashboards within it.

3. Theory and methodology

3.1. Agrifood domain

Research in agrifood domain consists of various subsectors and topics of interest. Due to the scope of this research being limited to the length of the internship (4 months) the scope had to be narrowed. The classification of subsectors was done based on the Internet of Food and Farm classification, as it was concluded that it covers the widest range of agrifood topics of interest and is flexible enough to add further, more detailed classification if needed. The IoF classification is as follows:

Table 3: Agrifood classification according to IoFF project

1.	Arable
2.	Fruit
3.	Vegetables
4.	Dairy
5.	Meat

In order to narrow the scope, the extensive literature review needed to be performed. Literature review was performed via manual search of Wageningen UR library resources that was further expanded via "suggested articles", provided through the search results. In order to cover novelty topics, a manual search of white papers and newspaper articles was done to identify the trends. Manual search of whitepapers and news articles was done to provide novelty information, as it can take several months for a paper to be published in a journal and the information might lose its market novelty by then.

In addition to literature review, exploration of current Info Support's projects was performed. The first assessment was done to identify existing projects that were happening in BUA, and the assessment was performed through set of interviews with various people within the business unit. Once the progress of BUA projects was assessed it was decided to assess other business units that might have experience with solutions that could be replicable in the agrifood sector. The goal of this action is to integrate identified market needs and combine them with tech expertise that the company possesses. Since Info Support does not have extensive experience in agrifood, the best option is to identify the projects done in other domains and find the common points which would make these solutions easily applicable and reusable.

3.2. Poultry sector

Through the interviews and assessment of Info Supports business strategy and development plans, a detailed assessment of possible fields of interest was done. For Info Support, in addition to getting the larger clients which fit into the size and scope of the company, it is also important to establish and maintain the good relationship with the community in which the business is active. Since Info Support BV is located in the heart of the Food Valley and in an ICT-oriented city of Veenendaal, the connection with the agritech sector is clear. In addition to that, a close neighbor of the company is the city of Barneveld which is the largest center of poultry production (both broiler and laying hens) in the Netherlands. Poultry sector is still a sector with low profit margin per individual animal, unlike cows or pigs, so the approach needs to be different but if successful it provides access to the large market. The strength of entering the poultry sector is the possibility to create easily replicable solutions. Many poultry farmers experience the same issues, and the market does not have a dominant product or a service that resolves it.

Poultry sector can be divided into two areas and three phases. Two areas are considered to be laying hens (egg producing) and broiler chickens (grown for meat), and 3 phases are hatchery, barn and slaughterhouse. The chickens are hatched and raised in initial phase of life in hatcheries. The hatcheries are trying to raise the chickens in optimal temperature conditions, as even the slight distress by exposing the young chickens to temperatures that are too warm or too cold leads to the lifetime of lower egg production capabilities. Such chickens were shown to provide smaller number of eggs as well as the lower egg quality (Brockotter, 2013.). Often, the distress of chickens that affects the egg quality can occur even before the animal starts showing the signs such as having cold feet and grouping of animals if they are too cold, or hyperventilating and trying to distance themselves if too hot. Moreover, egg producing capabilities can be affected due to various reasons, such as parents genetics, age, health of the animal, conditions and hygiene of the environment in which it is kept, as well as the temperature in which both the laying hen and the egg prior to hatching are kept.

Due to this sensitivity, the hatcheries were separated from the farms which are ultimately raising the chickens for the longest part of their life. Through this approach, hatcheries are focusing solely on assuring the most optimal environment for the gestation and first weeks after hatching. Barn prepared to serve as a hatchery requires more temperature sensors, higher precision, peaceful environment in which eggs can be hatched, special heaters, good food adapted to the chicks needs. All of the vaccinations and disease controls are done internally and on a large scale (barn level). Many hatcheries are still collecting the information about the chickens in the paper format, and then forwarding the papers to the farm in which the chickens will spend the longest part of their lives. Due to an average of 50 000 chickens per barn, paper based hatchery reports are difficult to use and it is difficult to assess how many chickens may produce lower egg quality due to its upbringing.

After hatcheries, the chickens go to regular barns. Animals at this stage are less sensitive for temperature change, but can become stressed and agitated if it is not suitable. The level of stress can be manifested through behavioral changes and high pitched voice. Changes in the environment of the chickens can be observed through movements and daily behavior of animals in the barn. Series of interviews with farmers and researchers, as well as literature review was used to answer which solutions are needed in order to improve this sector, and resolve some of the existing issues.

3.3. Whole loop supply chain optimization

The modern supply chain consists of unique nature of the products as in most cases they refer to “short life-cycle goods” or more specifically – fresh food. Modern supply chain is affected by the several parameters identified through CBS reports from 2013. to and including 2016. These parameters as summarized by Closs (2005.) are:

Table 4: Modern supply chain parameters

1.	high product differentiation,
2.	seasonality in harvesting and production operations,
3.	variability of quality and quantity on farm inputs and processing yields,
4.	specific requirements regarding transportation, storage conditions, quality, and material recycling,
5.	need to comply with national/international legislation, regulations and directives regarding food safety and public health, as well as environmental issues (e.g. carbon and water footprints),
6.	need for specialized attributes, such as traceability and visibility,
7.	need for high efficiency and productivity of the expensive technical equipment, despite the long production times,
8.	increased complexity of operations, and
9.	the existence of significant capacity constraints

With an increased pressure for retailers to minimize food waste and overall waste connected with their fresh food supply, there is a growing number of initiatives that are looking how to further optimize the chain (Gattorna, 2016.). The Netherlands are historic and current leader in supply chain optimization, and they are investing significant efforts to continue being the world leader in the field (O’Marah, 2018.). As the forward facing supply chain (traditional, goods flow from producer to customer) is already quite optimal and advanced, it was recognized that a whole loop (forward facing chain, plus the return path), in which waste of food is going to be accounted for, is also going to bring additional profits. The case study of Tesco (Evans, 2018.) is seen as the most optimal solution for whole loop supply chain in the fresh food sector, however multiple companies that tried similar initiatives have failed. In order to identify what was the greatest obstacle for successful transitioning and the most common cause for pitfalls, a detailed literature review was performed. The first focus of the literature study was to identify relevant case studies describing Tesco experience, and extract key elements from it.

Afterwards, a literature review about current and proposed future trends was performed to identify key opportunities and obstacles in the sector, and to find the alignment with the activities that Tesco performed and build from there. This was done through a search of Wageningen library and in main logistics and supply chain optimization journals. After the extensive literature review, it was decided to deepen the knowledge with interviews with the experts in the field. The experts were selected based on the projects they were active on within Wageningen Economic Research (LEI) and Wageningen University chair for operations research and logistics. Once all of the theoretical knowledge was answered, a link between smarter algorithms (machine learning, deep learning) and supply chain data was identified. In order to deepen the domain knowledge and identify whether the discussed algorithms were feasible in Info Support's expertise, an interview was conducted with the company's AI research unit. The technical knowledge and ML expertise that the company is already experienced with was deemed as sufficient for domain needs. It is also concluded that the technical knowledge combined with the AI canvas (Appendix A) which was developed by Info Support as a guideline for Proof of Concept and project preparation is sufficient for this type of project.

3.4. IoT middleware

Internet of Things in its essence is internetworking of physical objects or so called “things” (various objects, devices that serve various purposes) to the internet (Scully, Lueth, 2016.). However, IoT is still a concept without a single, unified definition (Anzelmo et. al., 2011). Interconnecting the devices among themselves affects “...sensors, aggregators, actuators and diverse domain of context aware applications, while preserving the security and privacy” (Bandyopadhyay et al., 2011.). As the technology such as sensors, actuators, embedded and cloud computing systems becomes more advanced, it is easier to make everyday objects “smart” by connecting them with each other and internet (Fleisch et a. 2015.; Razzaque et al., 2016.). In more simple terms, devices are made “smarter” by equipping them with sensors and actuators which are combined with internet technology through sets of passive and active sensors. Sensors are mainly electronic devices which gather the information about their environment or internal state, based on their role (Rayes, Salam. 2016). Sensors are usually said to “imitate the human senses”, and on the highest level they can be classified as passive sensors which do not have their own source of power to transmit information, and active ones that do.

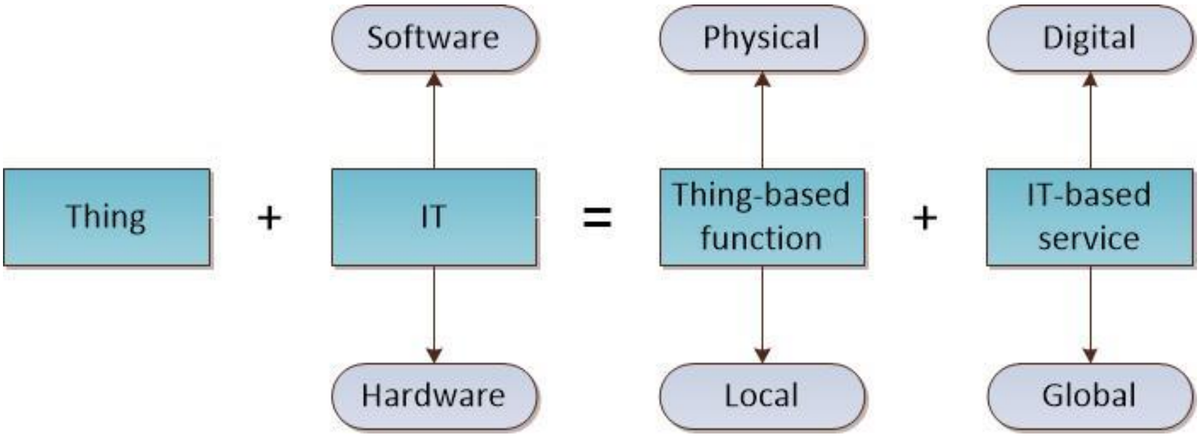

Figure 1: Fleisch et al. 2015 – IoT elements

As the devices and network itself need to comply to industry standards, the interoperability problem exists. As the devices are so versatile, so are the standards that they need to comply with. Even with the enforcement of a common standard, it will take years before the market changes existing devices for the new – standardized ones. The IoT devices need to be interoperable, context-aware, account for privacy and security as well as data volume and data prioritization (which data needs to be delivered in real time, which can wait) (Razzaque et al., 2016.). In agrifood domain, this problem is no different. Growing number of devices are accumulating vast amount of data, from categories such as poultry farming (egg production volume, water and feed consumption, amount of excrements, air quality and temperature), cattle farming both for meat and for dairy (how much time an animal spent on milking robots, how much time spent outdoors, quality of milk, health conditions of animal), crops (use of fertilizers and crop protection agents), farming machinery (surface area covered, efficiency of the machinery in performing a certain task or sets of tasks) to logistics and supply chain (traceability, weather conditions during transport and storage, ethanol outputs and other uses) and many other applications across the domain.

The issue with aforementioned data sources lies in low capabilities for combining the generated information. This topic was identified through farm visits, interviews with farmers and literature review. Many farmers still rely on their “gut feeling” that comes with years of experience, but according to the interviews done with farmers at the beginning of internship research – with the increasing scope of business it is harder and harder to rely solely on it. Many farmers started to rely on the device outputs to improve their job, as increasing amount of devices are put on premises. However, the low to almost no interaction among the devices means that the farmer looks at multiple individual devices, reads the output provided, and then – again – relies on intuition and experience to draw a conclusion. This approach leads to the similar risk as relying solely on intuition.

Beyond the farms, many wholesalers, transporting service, storages and food processors are facing the same problem. As mentioned in 3.1, various subsectors of agrifood have different level of technological readiness. This occurrence can be observed in the level of data utilization, which can be resolved through combining IoT sources through a proper middleware in many fields (Razzaque et al., 2016.). Searches of Google and of WUR library show that the countries which are discussing and publishing the most research on the topic of IoT middleware are USA and India. European Union has limited initiatives through startups whose scope is not significant enough to affect the entire market, and through several Horizon 2020 projects (AIOTI, UNIFY IoT,EIP-AGRI and FiWare) but currently none has a widespread solution readily available. The research was done in depth to identify what are the main obstacles that are preventing middleware creation and adoption.

3.5. Decision Support Systems (DSS)

Decision Support Systems (DSS) was selected as an additional and final topic for the scope of the internship project. Through the literature reviews done for the prior topics, it was recognized that the topic of creation, implementation and adoption of DSS is seen as both important and beneficial for various stakeholders (Tuzun et. al. 2017.). Many IT companies were focusing on creation of complex analytical tools and farm management systems (FMS) (Alvarez, Nuthall, 2006.). According to the studies mentioned by Alvarez and Nuthall (2006.) information combined with other business drivers such as “land, labour, capital and management” are a constant that distinguishes successful from unsuccessful agribusinesses. Same authors also point out that various information systems can simplify and speed up value creation from gathered data. Various surveys and researches show that for many farmers these solutions are perceived as disproportionately complex, expensive and difficult to use without directly observable benefit (Rose et. al. 2016.). Level of technical knowledge, experience, general education and desired outcome of the business differentiates farmers that are more likely to adopt new systems from the ones that are not.

DSS are mainly software-based systems which can be classified based on a number of factors. The most general and widely accepted classification according to Turban (2011.) is differentiating three types of DSS - passive, semi-active and active. In passive DSS the support doesn’t occur automatically but the users need to explicitly request it and various inputs are manually fed to the system. Semi-active DSS is acquiring information automatically, but the information needs to be explicitly requested by the user and often the relevant parameters need to be input manually. Active DSS is acquiring information automatically, parameters are either predefined when setting up the system or defined automatically with the system identifying patterns and the output is provided even when not explicitly requested by the user.

As DSS need to combine data sources from which the relevant information can be extracted, as well as to provide a sufficient domain knowledge for proper defining of decisions, the attempt to create a DSS with purely tech approach is insufficient. As Info Support is an IT company, there is a need for collaboration and conjoining their tech expertise with the expertise from agrifood sector. The first question that will be answered is whether creation of DSS would fit into the tasks and topics of Info Support BV based on their business goals. Additionally, if the previous question is answered successfully, the further research will focus on identifying relevant domain partnerships that IS needs to establish in order to create useful and usable DSS.

4. Results, Conclusions and Discussion

A literature review about agrifood sector as a whole helped to identify following topics as the key drivers for changes within the Dutch sector (CBS reports 2013., 2014., 2015., 2016., 2017.):

Table 5: Key drivers to change in Dutch agrifood sector

1.	rapid urbanization,
2.	growth and liberalization of domestic and global markets,
3.	decrease of public sector funding,
4.	emergence of globalized Supply Chains (across the countries and continents)
5.	customers concern for food quality and safety (requiring tracking and tracing),
6.	changes and growth in technology and in farming (e.g. precision agriculture),
7.	weakening of regional rural populations and small farmers, and their inability to comply with the requirements posed by dominant enterprises,
8.	climate change effects on farming,
9.	establishment and strengthening of Corporate Social Responsibility (CSR) practices.

For the farmers operating in various subsectors of agrifood, some additional issues were identified through the reports by Wolfert et. al (2014. And 2017.) and Gilpin (n.d.) and interviews with poultry farmers in the Netherlands:

- Farmers not willing to share their data without clear and measurable benefit for their business,
- Famers afraid of disproportionate advantage between competition, other stakeholders and them if others improve their business offer thanks to their data,
- Farm management information system (FMIS) most successful if they integrate DSS that could either increase profit or decrease risk for the farmer, stand-alone FMIS not well accepted,
- FMIS need to be interoperable within various systems on a farm, “one system for all”,
- Large availability of open data even for commercial purposes exists, but farmers without IT/data knowledge unable to gain value from it,

- Intuitive GUI for analyzing the data is lacking. Existing ones are too complex for average farmer that is not tech savvy or good analyst,
- Pricing strategy is often unclear and gets changed often – how will fmis/dss/data storage/analytics be charged to the farmer? (More successful commission based, which charge the percentage of farmers gains),
- Missing link – **middleware** to connect different vendor data sources – which would create interoperability and proper software/hardware eco system
    - the systematic analysis of Kruize et al. (2013) showed that “ICT components used within the same farm enterprise (i) have partly overlapping and partly unique services, functions and interfaces, (ii) are missing required application services, functions and interfaces, (iii) have separated data repositories and (iv) have inadequate and incomplete data exchange”.
- Importance of partnerships (between domain experts and various tech-intensive companies)

From these key points, the topics presented in chapter 3 were formulated in a greater detail. Key issue is whether sufficient systems and technologies exist on the market, and if they do – is it a better option to create a solution that integrates within the existing system, or to create an information system that puts needed, customized apps, connections with various data sources and systems within it?

Table 6: Selected topics for further research

1.	System for poultry farming (make sense out of the data acquired through poultry farm equipment)
2.	Whole loop supply chain (forward and backwards)
3.	IoT middleware which connects with the IS that contains farm data and other sources (i.e. open sources) of data for decision making. Simple GUI and intuitive analytics tool that require no knowledge of coding
4.	Importance and receptiveness of DSS, more demanding to create (requires specific domain knowledge on top of technical knowledge) but a domain partnership could help.

4.1. Poultry Sector

Due to low profit margin per individual animal, the technological investments are very low in the poultry sector. Sensor solutions that are tried and used for larger animals such as cows, pigs, sheep and goats do not work for smaller animals such as chickens. Due to the large volume of the animals, it is very difficult to fit them with an individual sensor and to observe parameters on an individual animal. According to the experts from The Big Dutchman, technical constraint that exists in poultry sector is a very high rate of hardware damage as opposed to other sectors. Hardware damage happens due to the fine dust that spreads through air when the chickens are walking on the floors, as well as intense pecking of the equipment. Because of that, there is a large market demand for sturdier sensors and equipment. As new hardware is being developed, this leads to a higher demand for software as well as analytics tools that can be combined with the equipment. Many hardware providers are providing basic software systems "out of the box" with their equipment, but a strong software partner such as Info Support could be a beneficial partner that adds value to the hardware company.

The initial idea of partnering at the farmer level and providing a solution on their end is conflicting with the requirements that Info Support has when choosing customers presented in Introduction. The only way in which a farm-level solution would be profitable is through a repeatable solution that will be applied to many clients. As this would require significant upfront investment with moderate to high risk of not finding enough clients willing to adopt it, the focus was shifted on a higher level in the chain. The farmers are still kept as persons of interest for building community ties and recognizing market interests and needs which can improve applicability of solutions provided to hardware producers. Farmers will also be used for proof of concept and pilots. The farmers with strong ties in the community, local politics and innovators will be the best persons of interest for this.

A research of various startups and small businesses manually performed through various statistical reports, business reports, whitepapers and surveys show the distinction between the companies that managed to use data efficiently to improve their business versus the ones that failed. The successful companies had an expert with domain knowledge of the relevant agrifood category and a tech expert. The case study was not performed to assess whether this was the only factor, and this can be seen as a future direction. Once this was identified, an interview with four poultry farmers in Barneveld was done to identify their individual and common problems in a farm.

The common aspects were identified as:

Table 7: Common problems in a farm – farmers input

1.	No integration of information sources (lacking middleware solutions), all of them use MOBA, Stienen and Vencomatic devices on their farms as a common part, with additional devices that could be from different vendors.
2.	No integration of hatchery information that could be combined with adult chicken Info – essential to predict laying eggs and egg quality in the future. Information is still mainly in paper form.
3.	It would be of interest to have individual measures for a chicken body temperature, food intake, water intake, amount of walking and time spent outdoors, body weight and number of individual eggs laid. This could also provide foundation for poultry precision farming (already increasingly done with cows and pigs).
4.	Level of distress is very important, both on the individual level and barn level (may direct to possible barn-level problem before becoming obvious to the farmer).
5.	Different equipment and metrics that could indicate whether the barn equipment is functioning properly. It can open up a possibility for predictive maintenance due to chickens being so sensitive of the changes in the environment and showing, and reacting quickly to them. In example, in case of water or feed system, animals would automatically switch to the working equipment, so the farmer can get alerted about unusual behavior of the animals and react quickly..

These topics of interest should be discussed with hardware providers and included in the software system which will be developed.

In summary, the clients of interest that fit into Info Supports criteria would be at the level of hardware providers for various farming equipment. By selecting a client large enough and with its own extensive client base, it is possible to use existing technology to create value for companies' end users (in this case – farmers at various levels). This approach provides the groundwork for resolution of this topic and establishing IS as a software and data company active in agrifood. Hardware providers that may be of interest are the companies such as The Big Dutchman, Vencomatic, Stienen, MOBA and similar which are already used at an average Dutch poultry farm. These companies may have sufficient leverage to help with integrating information down the value chain, which might solve the problems as the one mentioned in table 7, problem 2. A lot of information already exists in the digital form, but due to the lack of technical knowledge it is not properly utilized, combined and shared, which is the expertise of IS. Once the groundwork is completed, it is possible to provide more specific solutions. These solutions could be used to measure animal welfare and distress by i.e. monitoring the pitch of their voice to identify outliers that are known to indicate an issue (farmers learn to listen for these high pitches but on the modern farm they cannot monitor every farm at all times). The solutions could also be used for predictive maintenance, for example by providing crowd monitoring sensors (i.e. based on heat signature) or cameras that identify chicken movements within the barn, it is possible to identify whether the chickens are avoiding a certain feeder system – which could indicate poor performance of it. Once IS has a large hardware client, it is easier to get in contact with farmers. In addition, by providing internship projects on the farm level – it is possible to gain knowledge of what the farmer needs. By gaining this relevant insight, it is easier to approach the larger hardware company with a very specific project proposal that their clients need. The project proposal can then be proven through the insights acquired during the internship. To overcome the lack of domain knowledge IS can partner with academic agents such as WUR and Leeuven universities, connect more with farmers and other end users, as well as bring versatile profile of IT students and potential trainees that come from mixed technical and domain backgrounds.

4.2. Whole loop supply chain

In addition to establishing the relationship with the local community, Info Support wants to expand the scope from the farm level and to widen the focus from the classic farming to other food-related businesses such as wholesellers, retailers, food processors, transportation etc. All of these businesses have specific tasks that could be optimized with the use of technology. For the first business of interest it was decided to focus on the supermarkets. The supermarkets were selected as an easier point of entry since Info Support BV. owns a company called R&R which produces workforce management software, and with it have several supermarkets as their clients. Once the business of interest was selected, it was important to identify which problem should Info Support seek to answer. The job portals of AH, Jumbo and Superunie were searched for current and past job ads to identify which business areas are experiencing the largest growth. By combining job portal data and Github repositories with Dutch supermarket data, it was possible to extract the information. This process showed the growth for data analysts, data scientists, machine learning experts (most notably in AH) and in operations and logistics. A tailored search was made to identify which topics of interest could be identified that would require specialists from the areas in which most employees are hired. The search has identified supply chain optimization, or more specifically the whole loop supply chain optimization. All of this is either done to resolve demand uncertainty and complex interactions in supply chain as key obstacles to proper optimization or to improve routing and lead time minimization problems (Zhao et. al. 2002., Mastrocinque et. a. 2013.)

Experts from R&R which are currently working at the supermarkets implementing workforce management system mentioned the topic of whole loop supply chain at the client meetings and it peaked the interest of management, which should enable the willingness to do a short experiment/demonstration. As AI department of Info Support has developed an AI experiment canvas that enables identification of key issues that the company wants to achieve, along with information such as acceptable timeline and length of project, metrics for assessing the experiment success, data privacy, hard limit after which the experiment ends etc. It enables the companies to see which business need can be solved through on a very small scale (one to two weeks). It also provides the opportunity for Info Support to tailor the experiment to the specific needs of each client. Although Info Support does not have current experience with supply chain optimization in fresh food domain, with access to data and close collaboration with the client it is possible to choose correct algorithm and optimize it on the go. According to Mr. Joop Snijders, similar lack of domain knowledge occurred on projects of several other business units, but it was always easily resolved.

The key problem that may occur is a lack of relevant datasets, in case the companies did not collect information that are needed for reverse supply chain as it was not perceived as important. To identify how likely this could happen, an interview with Rene Haijema from Wageningen University – department for Operations Research and Logistics was scheduled. Many companies are focusing on forward facing supply chain exclusively, and aside of Albert Heijn many are likely to face this issue. Also, according to Mr. Haijema, many companies see reverse supply chain as a bigger source of complexity rather than a benefit. However, due to increasing pressures from the EU at least the larger retailers such as Jumbo and AH are trying to find a solution. Many retailers have simple supply chain systems, and only gathered the information that were needed to answer current needs. It may be possible to combine the existing information from forward facing SC in such a manner that it answers the reverse chain questions and provides good metrics. Answers to these issues will be easily answered during the AI experiment.

During the discussion with Mr. Haijema, it became clear that instead of focusing on highly volatile and uncertain whole loop supply chain as a first project, a better approach is to focus on regular – forward facing – supply chain further improved with more advanced analytics. This would ensure Info Support to get a better grasp of which data is being collected in average supermarket chain, which metrics are the most important for predicting customer demand and churn etc. On the side of the supermarket, it would help to strengthen the position of Info Support as a trusted advisor as the results for forward facing supply chain are easier to identify monetary. The change is visible faster and it affects the bottom line almost directly. After an extensive literature review, it became clear that many Dutch supermarkets (with the exception of AH and to the smaller scale Jumbo) rely on pure optimization without implementing “smart algorithms”. Many have very simple in-house data analysts, usually focusing on customer trends via weather data, historic data, seasonality and very limited number of other metrics.

Machine Learning and Big Data are growing topics of interest as the growht of computing power helps to analyze much larger sources of data and find patterns in multidimensional space in which it would be impossible for human actor to identify it. The study by Carbonneau et. Al. (2008.) has shown that implementing ML techniques paired with regular logistics principles could improve the demand forecasting and lower the uncertainty. Out of all algorithms, the Support Vector Machine (SVM) and Recurrent Neural Network (RNN) provided the largest improvement out of all tested algorithms. Due to significant fuzzy part of demand and any type of human behavior predictions, the accuracy can never reach

100%, but it can increase the existing bottom line. For the routing and lead time minimization, a study done by Mastrocinque et. al. (2013.) showed ABC algorithm (Artifical Bee Colony) as currently most optimal. As it requires complex mathematics, it is still not widespread in the industry regardless of the good results it shows in researches.

Very important element of supply chain optimization lies in providing the foundation for proper tracking and tracing in the food sector. An increasing customer awareness towards food safety and quality, movements that are promoting local food purchases, customer investments towards sustainable and bio production of food are increasing in the Netherlands (CBS, 2017., CBS 2016.). As the customer demands for better quality is happening, issues such as horse meat scandal, Fipronil scandal and similarly are deepening the lack of trust towards all of the links in the supply chain. Because of this lack of trust, customer demands and consequently government regulations are becoming stricter. Regardless of the transparency being increased for some products in the supply chain, the real tracking and tracing is still a “distant dream more than a reality”. Initiatives such as using sensors, both active and passive or a mix of both, as well as blockchain technology, is becoming larger but there is still no widespread solution. It is known that many projects regarding this topic fail, according to TE-FOOD (2017.) there are various reasons for that. The crucial reason lies in unbalanced advantage that traceability provides to wholesellers and retailers as opposed to producers and transporters. The reality is that producers have a large choice of producers and transporters they can collaborate with, so if the existing partners make any mistake they are going to get kicked out of business. At the same time, transporters and producers very rarely have the option to do the same to the retailer or wholeseller that makes a mistake.

Trienekens et al (2012.) and Verdouw et al. (2015.) did a very systematic research of each stakeholder that is involved within traceability within food supply chain. The transparency of a supply chain can best be explained as “...…the extent to which all its stakeholders have a shared understanding of, and access to, the product-related information that they request, without loss, noise, delay and distortion” (Hofstede et. al. 2005.). The same paper provides key demands and key enablers for each participant of the supply chain and other parties of interest outside of it. Due to the high level of fear and uncertainty of increased risk for minimum benefit, a trusted expert company such as Info Support that establishes its position within agrifood technology sphere through supply chain optimization from different perspective, has a better leverage point to join the traceability projects too.

In summary, as various links in the value chain implement different techniques, IS should secure a short proof of concept with the desired client. In order to get a better understanding of which solution would be best suited for the client, IS needs to get a deep insight into the type of data being gathered. IS also needs to identify the current parameters upon which a potential client bases its forecasts. There is plethora of possible algorithms used in supply chain optimization and although none of them are wrong in general, without proper information about the client's specific information it is impossible to select the proper one. AI research of IS has relevant information and significant expertise which is separable from any domain knowledge, with providing an intriguing one-pager it is possible to establish the communication with the potential clients. The creation of one-pager requires some research and domain knowledge, and possible solutions for that exist. IS can provide established supply chain companies which have low to midi knowledge and expertise the technical knowledge they need, while acquiring the domain knowledge in process. Other possibility is to get in contact with WUR Operations Research and Logistics chairgroup and try to get involved with their projects as technical partners for both software side as well as data side. The third possibility is to get internship projects as a collaboration of IT and logistics students, applied mathematics students, from various relevant programs. A research structured in this manner leaves IS with new insights and information that can be developed further in-house.

4.3. IoT Middleware

Info Support is providing IoT solutions in various sectors through various business units, which simplifies the application in agrisector. According to IoT agenda (n.d.) middleware for IoT provides a "bridge" between various IoT components and devices, enabling them to communicate properly. IoT devices, due to the lack of standardization, still don't enable proper seamless integration and connectivity. The middleware solutions exist in the form of an API and are currently provided by Mulesoft, Oracle, RedHat and WSO2 among others. Very often, according to the same article, middleware is applied to both sensor and application level, so it ensures seamless integration of both levels. Middleware can have multiple features such as device management, interoperation, platform portability, context awarenes, security and privacy, and can use various protocols such as Zigbee, WIFI, 6LowPAN, Bluetooth, NFC, LoRaWAN etc.There are three main IoT middleware architectures according to Ngu et al (2016.), service based, cloud based and actor based.

Table 8: IoT middleware architectures(Ngu et al 2016.)

1.	**service based** – "generally adopts Service Oriented Architecture, and allows developers and users to add or deploy a diverse range of IoT devices as services."
2.	**cloud based**, according to the same paper, "limits the users on the type and the number of IoT devices that they can deploy, but enables users to connect, collect and interpret the collected data with ease since possible use cases can be determined and programmed a-priori."
3.	**actor based** – "emphasizes on the open, plug and play IoT architecture. A variety of IoT devices can be exposed as reusable actors and distributed in the network."

According to Verdouw et al (2016.) there are multiple important challenges that may affect IoT implementation and adoption. These challenges range from ensuring interoperability of diverse IoT devices, standards, IoT architectures (also not unified), multiple platforms across which they span, to issues with vertical and horizontal scalability. The ease of use for people with low technical skills and affordability also pose problems for general acceptance. Other issues that the topic also faces are sensitivity of equipment which can pose the problem if they need to be adapted into harsher environments (an example would be sensor for poultry sector mentioned in 4.1), lack of reliability and stability in wireless communications that is still not fully resolved. Energy efficiency and standard among the sensors for their power source (to help with predictive maintenance) is still not solved, which means that various sensors have different battery life and need to be changed at various times making it more complicated to change.

In summary, remote areas (agri sector specifically affected by it) are more prone to lack of stable connection, which affects the acceptance rate among this category of potential customers. Security, privacy and trust are the last but not the least source of problems and reluctance for adoption. There is a fear of unfair advantage that large companies can have over smaller ones due to information coming from equipment. The biggest concern is geared towards the producers and sellers of the smart equipment. As there is a growing concern about competitive advantage, this topic is also the one in which experience with agrisector and different topics that use similar solutions can build trust between potential customers and Info Support BV. As an independent party not responsible for the hardware part, it can build trust towards the motives Info Support has within this domain.

4.4. Decision Support Systems (DSS)

DSS are an interesting and very useful systems for various business dilemmas, however at this stage they do not fit into the Info Support's selection of projects and clients. The main obstacle of starting with DSS as a first initiative lies in very high need for domain knowledge. As IS is just entering the market, the employee knowledge is still not advanced in agrifood domain and there are no established relationships that the company could rely on to fill that gap. DSS can provide answers based on real-time data on weather, soil and air quality, crop maturity and even equipment and labor costs and availability, predictive analytics can be used to make smarter decisions.

DSS can be applied to various topics, such as choosing a proper crop, assigning a proper irrigation methods and frequency, choosing the most optimal fertilizer and pesticide, selection of proper ploughing time, seeding and combining the supply and demand requirements just to name a few. DSS can also be used for disease prevention and management, and in various sectors – most notably horticulture – they are being used increasingly.

Creation of DSS often requires extensive domain knowledge, significant customization and tailoring based on customer needs, and for use in agrifood sector it is usually done for smaller clients than defined in the table in chapter 2. The potential for Info Support to provide these solutions is by establishing relevant partnerships with experts in various domains. A potential interesting party would be a partnership with Wageningen Research, as various businesses reach out to the university with projects that can be resolved through this. Many projects are done on the proof of concept phase and don't get into full development afterwards.. Although the profits would still not be significant and fitted to the size of Info Support, it could help strengthen the position within the industry.

In summary, an approach to feasibly provide such solutions while gaining the domain knowledge is by providing internships for various WUR students and other students with a mixed background between agrifood and IT domain which are capable of creating a system themselves. During the internship assignment, the students have time, resources and supervision sufficient to develop a usable DSS with the expenses kept significantly lower than by assigning full-time developers and consultants to do it. The experts can later test the system and if needed add minor modification before it is deployed if the DSS has realistic market value. This topic can be further explored later, but at this stage it was not developed in more detail due to low commercial value for IS.

5. Conclusion and advise

During the 4 months of internship, I was exposed to various experts in the fields ranging from software development, security, AI, business intelligence and many more, as well as various industries and business units. It quickly became clear why this is a company that, for several years, won the award for the best employer in the Dutch IT sector. The exchange of knowledge promoted even further through various in-house trainings and Wednesday's ISKA (Info Support Kennis Avond) distincts Info Support from many competitors that are "knowledge oriented" only on paper. From the first weeks when the scope of the research project had to be narrowed down, I was supported by more experienced colleagues and supervisors to find the topic that has the best commercial and applicable value. As agrifood is such a versatile topic, the bigger part of the first month was spent on selection of proper subsectors that would fit into the length and scope of the project. Multiple meetings and interviews with people from within the company and from the university and research center helped me improve my domain knowledge to the sufficient level to be able to extract value from it.

However, as with any novelty idea, the first weeks were spent trying to understand how the topics that seemed interesting from the academic point of view fitted into the commercial role that a company of Info Support's size needs. As business unit dealing with agriculture is relatively new, there was no direct research line that needed to be followed which ensured complete freedom but also more uncertainty. The topics that were initially selected were focusing on small businesses, farmers and startups which were too risky and potentially unfeasible to properly charge for an IT consultancy company. Once it became clear what the cut-off point was, it was easier to filter through the topics and select the most interesting ones. Strategic and change management are filled with uncertainty, and it was almost impossible to create a detailed timeline of activities as very often it was not known where will the newly acquired insights take the research topic. That made scheduling more abstract and complex.

As the internship progress started to show relevant results after the first month to month and a half, it was easier to start preparing tangible project and POC ideas and take them from theoretical ideas into something measurable that could be shown to potential clients. The idea of creating a business model canvas for the business unit was proposed, but it was rejected as a different method was applied. Because of multiple studies that show importance of business model canvas in front of other methods for creating a clear outcome and helping to put the entire team on the same page with what is expected of them, it is still advised to invest time and create one. BMC can be adjusted with time if needed, but applying changes to the existing canvas can directly be shared with all of the team members thus quickly putting everyone back on the same perspective.

The three out of four topics selected in (exception of DSS) can provide a good starting point for BUA. The poultry sector will open the contact with the first half of the supply chain (mainly food producers and processors) which are mainly smaller businesses tightly knit within the community. By entering them, regardless of the lower profit margin per farm, it establishes the name of Info Support as the company that is active within agrifood sector in addition to the existing sectors it is already renowned for. Also, thanks to quite unexplored market, the solutions required by poultry sector are easily replicable on many farms. Because of this the upfront investments, if the good initial clients get selected, could easily reach many farms and being fully paid off relatively quickly. As it is outside of the current customer scope, it is up to BUA management to decide if the potential benefit is worth the additional risk.

Whole loop supply chain management (WLSC), as opposed to the poultry sector, is predominantly focusing on wholesale and retail part of the supply chain. Both groups are presented by larger companies, and can easily fit into the ideal client as decided by Info Support. As whole loop supply chain adds additional risks, potential clients are less willing to start such project. By starting the project on forward facing supply chain optimized further by more intensive data analytics and smart algorithms, IS can show immediate results. By optimizing the forward facing supply chain IS gets better understanding of existing data and ideas for additional data that should be collected for reverse supply chain. As the client company gains trust and sees IS's expertise, they are more likely to trust them for additional, riskier projects. Also, as IS gained trust of the smaller stakeholder in the farm-level projects in the poultry sector with the possibility of entering other farming sectors, it has a better leverage to prevent obstacles to WLSC adoption discussed in 4.2. That would be a good entrance to the larger, retail market that has large profit margins and capability of financing larger projects.

IoT middleware is a good project that could be added to both poultry sector on the farm level, in all links of the supply chain, and various other projects both within BUA as well as other business units within IS. It helps create expertise, opens new sources of data and provides foundation for later projects for tracking and tracing. As IS is already very experienced witb IoT solutions, there is already a competitive advantage that many other tech companies that are trying to provide this solution don't have. So far, most IoT middleware solutions are either being developed by small startups that have difficulty with providing solution for all types of devices and protocols but need to focus, or very large companies which are less appealing and less flexible for many customers. IS with its mid-size seems to contain the best of both worlds for providing these solutions while keeping the flexibility. As in prior projects IS established partnerships and gained relevant information, it is much easier to become a trusted advisor and expert that can cover the tracking and tracing needs of the entire supply chain.

DSS solutions can be implemented in any of the previously mentioned topics of interest, and can be used as a testing field for new young talents during their graduation assignments and internships. The usable solutions can be further developed and added to one of the existing clients, or if particularly interested they could be developed as a standalone solution. Due to difficult and low margin, it should not be a focus of the company, but it should be seen as a “bonus” offer. Aforementioned internship assignments could help IS with establishing relevant partnerships with academia and research institutes that could benefit from the student topics. The initial step is the contact with Wageningen University and Research that could satisfy both aspects by providing highly trained students in both IT and agrifood domain knowledge.

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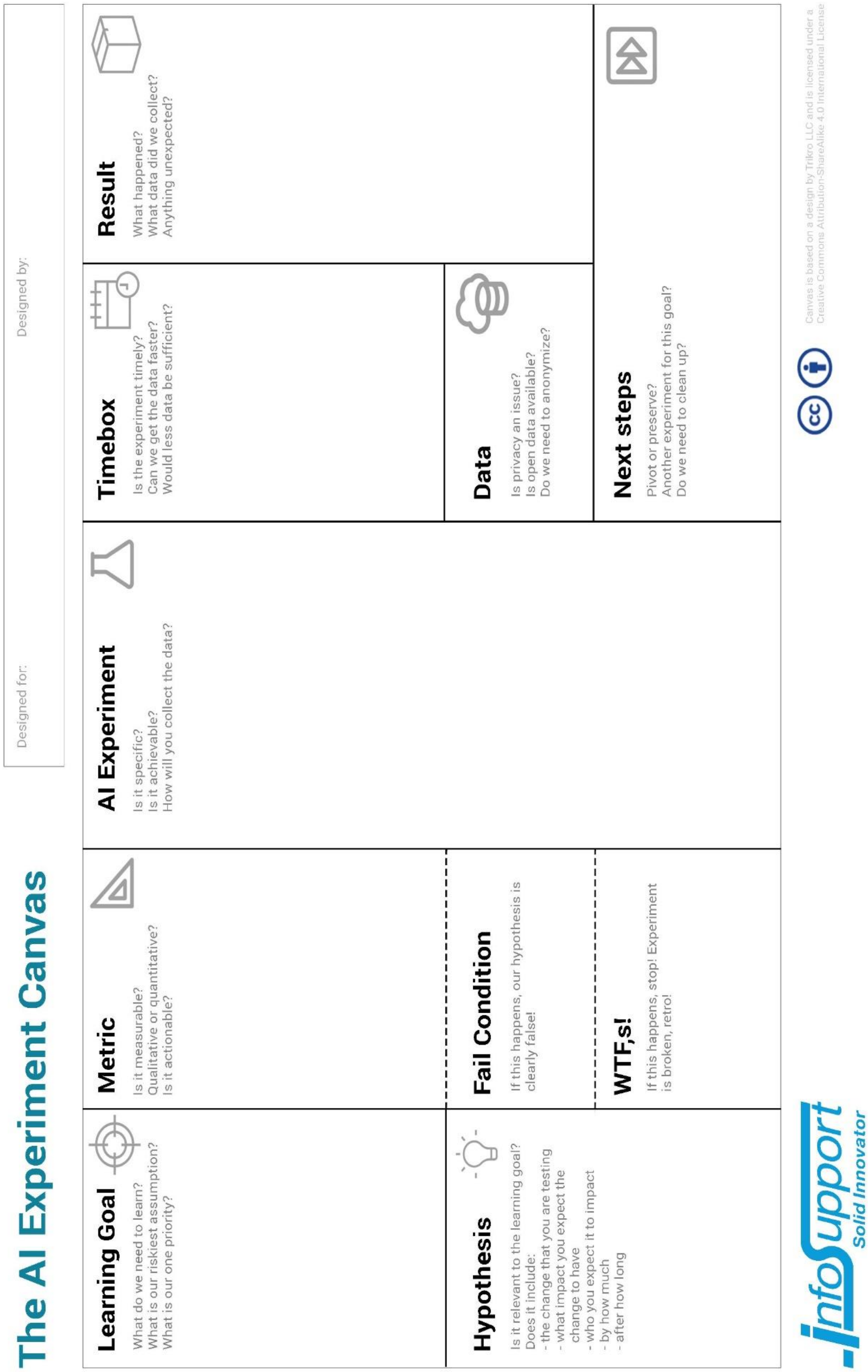
Appendix A


The AI Experiment Canvas
Designed for:
Designed by:
Learning Goal
What do we need to learn?
What is our riskiest assumption?
What is our one priority?
Metric
Is it measurable?
Qualitative or quantitative?
Is it actionable?
AI Experiment
Is it specific?
Is it achievable?
How will you collect the data?
Timebox
Is the experiment timely?
Can we get the data faster?
Would less data be sufficient?
Result
What happened?
What data did we collect?
Anything unexpected?
Hypothesis
Is it relevant to the learning goal?
Does it include:
- the change that you are testing
- what impact you expect the change to have
- who you expect it to impact
- by how much
- after how long
Fail Condition
If this happens, our hypothesis is clearly false!
WTF,s!
If this happens, stop! Experiment is broken, retro!
Data
Is privacy an issue?
Is open data available?
Do we need to anonymize?
Next steps
Pivot or preserve?
Another experiment for this goal?
Do we need to clean up?
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