XXIII. International RESER Conference: Franchising services in the agricultural domain: a case study

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In the agricultural domain, for a long time mainly hardware such as machinery was in the focus of innovation. Recent advancements in microtechnology paved the way for an increasing use of information technology leading to advanced concepts like precision farming. Parallel to this change the field of services becomes more important. Based on an exemplary precision farming service, this paper describes how service engineering can be used to achieve qualitative and quantitative advancements of agricultural services and to transfer them into a franchise-like concept.

1. Introduction

The increased economic relevance of the service sector and the resulting growing competition lead to an innovation-demanding market. Service providers continuously have to find innovative ways to improve efficiency and effectiveness of their services. Qualitatively, this can be achieved by increasing service productivity. On a quantitative dimension, economies of scale can be strived for, e.g. by implementing a franchise concept. The focus of this paper is to show an approach for implementing a franchise concept by structurally analysing and formally specifying services applying the concept of service engineering. This includes the improvement of these services in their quantitative as well as qualitative dimension. Service engineering is used to increase the efficiency of production processes, e.g. in the fields of resource planning or process optimisation. Due to recent innovations, especially in the agricultural domain, the potential regarding productivity improvements is enormous.

While farming has been a comprehensive activity with an immense need for longstanding experience, the mechanisation and informatisation of agriculture in the past century has raised farming processes to a complete new level, requiring not only experience but increasingly also technical and organisational skills. Precision Farming (PF) is a complex system consisting of various farm machinery equipped with a multitude of different sensors, satellite-based navigation, positioning systems and accompanied by detailed analysing and evaluation methods (Steinberger, et al., 2009; Patikova, 2002; Wolf, Buttel, 1996). By generating site specific information, precision farming becomes possible. Variable rate technology based on site specific nutrient mapping can lead to various economic benefits compared to conventional cultivation systems. For example, fertiliser can be applied corresponding to site specific needs resulting in savings of resources respectively maximising yields. In this way, precision farming contributes significantly to increase efficiency and effectiveness of the agricultural sector.

Conventional farming requires wide knowledge and long experience in cultivation of the fields. Farmers acquire their know-how about site-specific characteristics of their fields through knowledge passed down from one generation to the next. In contrast to conventional farming, the fast developing field of PF with its wide range of technical equipment and algorithms can hardly be followed by single farmers. Here, cultivation experience is not the only crucial factor but also the amount and quality of data. Therefore, complex machinery and analysing software plays a decisive role in decision making process. In that context, service providing companies act within a fast growing market including selling or leasing of expensive machinery as well as data storage and analysis. The complexity of the system requires certain skills for handling highly engineered equipment and knowledge for analysing the collected data.

Therefore, PF was chosen as an exemplary, service intense subdomain of agriculture. Adapting approaches of service engineering can help to analyse domain specific requirements and lead to innovative solutions not only for existing but also for newly developed services. In the context of this paper, the service of nutrient mapping was taken as an exemplary industrial use case for illustrating the findings and applying them in practical use.

Thus, the paper is structured as follows. First of all, the methodology for analysing domain specifics is presented. After identifying and gathering different requirements for precision farming processes and services (e.g., equipment, knowledge), domain specific challenges (e.g., weather, seasonality) are stated. Analysing abstract specifics for services in PF in general supports the efficient application of a service engineering approach. Subsequently, the industrial use case of nutrient mapping is introduced. Potentials for optimising the management of the service process can be deduced from regarding workflows within the complex service in a structural way. In this context, the cross-company cooperation within various service parts needs to be focused. Furthermore, modelling of the service processes allows for transforming it into a franchise-like concept and, thereby, raises service provision to a new level. Finally, this allows for abstracting general challenges in context of franchising in the domain of agriculture and PF in particular.

2. Services in PF

Precision farming uses a multitude of different data starting from information about soil texture and nutrient content up to plant growth and crop yield. Detailed analysis of the plants growing process and evaluation of recent seasons allow for deduction of harvest forecast. Additionally, by incorporating weather forecast into decision making processes along with site specific fertilization, crops yield can be increased.

Sensors and satellite technology lead to an increasing automation but also growing complexity of farming processes (Sørensen, et al., 2010). Sowing machines, harvester and other agricultural machinery are equipped with automatic guidance systems and can (if desired) perform a large part of tillage autonomously. Furthermore, sensors can assist in identifying the individual needs of plants. Sprayers, for example, are equipped with sensors that can automatically detect nutrient deficiencies and apply fertilizer soil-specific. Sensors can even monitor plant growth and identify weeds.

Due to highly complex machinery maintenance, software implementation and cultivation of land, working procedures in PF can hardly be conducted by single farmers alone. Furthermore, data acquired by multiple machinery need to be compiled wherefore matching interfaces are required. Service providers can profit from this trend towards technologically supported decision making by promoting the adoption process through providing external services such as data analysis or storage. Additionally, service providing companies can equip farmers with the required knowledge for handling the machinery and further processing of data (Gnip & Charvát, 2003).

2.1. Methodological approach for analysing domain specifics

By using a twofold approach, domain specific challenges in the context of providing PF services have been analysed. On the one side, a literature review was conducted, which allows for generating a theoretical basis for PF services. On the other side, a survey was carried out focussing an exemplary industrial use-case.

By combining theoretical findings and practical experience, strategies for implementing a franchise-like concept for services in PF can finally be deduced. Thereby, the importance and usefulness of service engineering in the domain of PF could be illustrated.

Since the interdependencies of services and PF have hardly been explored, scientific literature is rare. Therefore, the literature research was carried out with a broad approach focussing not only the agricultural domain. In this context, specific challenges for processes in the agricultural domain such as weather and seasonality were revealed and requirements for precision farming methods were identified. Additionally, characteristics of service provision, especially with regard to cross-company cooperation have been analysed. By illustrating global requirements for service provision in general and challenges in the agricultural domain in particular, the findings from the literature research form the theoretical background for further proceeding.

To transfer the theoretical findings in practical use, an industrial case study was conducted. Due to its complex and cooperative structures, the chosen service of nutrient mapping was considered suitable as an exemplary case study. The service providing company has to interact with the farmers but also coordinates associated partners necessary for the provision of nutrient mapping services. In this context, the necessity of matching data structures and standardised interfaces could be illustrated.

Various actors representing different institutions involved in the service provision were interviewed using semi-standardised questionnaires. This includes laboratories, engineers, consultants and employees of the service providing company. The survey pursued various goals. On the one hand, different requirements of the participants could be identified. On the other hand, processes were modelled describing the current workflow of various service parts thereafter.

Ultimately, error-prone or inefficient process steps could be identified on basis of the interviews and, by taking the previously identified requirements and challenges into account, an optimised process could be modelled. On that basis, strategies for the development of a franchising service could be developed.

2.2. Relevant areas for service provision in the domain of PF

Service providing companies dealing with PF practices can profit from the existing hesitancy in adoption of PF techniques, since certain requirements have to be met by farmers to apply PF methods. The willingness to adopt PF methods, therefore, depends on multiple factors such as economic costs due to highly technologised machinery, personal skills of the farmer, awareness of and confidence in new technologies and not least a certain unpredictably of its benefits (Kitchen et. al, 2002; Reichardt, Jürgens, 2009).

Especially in association with small-scale farming structures, PF methods often lack efficiency, since machinery and services are aimed at a large-scale farming environment (Auernhammer, 2001). Therefore, the investment in highly technologised equipment makes the conventional PF adoption process unprofitable for small-scale farmers; leasing of machinery or purchasing of services can provide adequate solutions for them. Even in case of medium farm size, renting of equipment can facilitate adoption of PF methods by reducing financial risks since weather seems to have an enormous impact on the profitability of site specific farm management (Graeff et al., 2010), too. While effort for purchase, maintenance and software development is on side of the service providing company, farmers can concentrate on working with the results. Thus, leasing of machinery and adequate software or the provision of comprehensive services is beneficial for both service providers and farmers.

To benefit from the wide range of analysing possibilities and variable rate technology, recorded data needs to be stored and processed. For this purpose, PF requires efficient information systems for data capturing and analysis (Fountas, et al., 2006; Murakami, et al., 2007).

In this context, the issue of software system complexity becomes obvious. Since a growing number of engineering innovations for cultivating land (different sensors, GPS technology, site specific mappings, e.g.) deliver huge amounts of data, systems and algorithms for storage and analysis need to be developed. For that matter, adequate interfaces are required to enable data transfer from the multiple tools to the data storage system of the service provider or the farmer itself.

Thus, the structure of PF methods requires multiple equipment, data and knowledge in order to develop its full potential. Service providing companies can support farmers to overcome barriers of adoption of new technology by providing the relevant infrastructure. An overview of the corresponding fields is given in Table 1.

Equipment	data storage	data analysis	knowledge transfer
•selling & disposal of sensors, vehicle guidance system •software for steering & GPS-implemenation •maintenance	•GIS-information •soil analysis data •data interchange •weather data •farm data	•yield monitoring •nutrient mapping •mapping for application of fertilizer	•education •training •consulting

Table 1: Relevant areas for service provision in the domain of Precision Farming

Since PF is a fast developing field based on complex technical innovations and increasing possibilities for yield increase through innovative land use, the complexity can hardly be managed by single farmers. While large agricultural companies can afford multiple specialists and new technical innovations for their own account, small- and medium-sized farm benefit from external supply of equipment, knowledge and services.

2.3. Domain specific challenges for services

Besides various barriers of adoption in context of profitability and efficiency service providing companies face several domain specific challenges. The spectrum of challenges ranges from structural circumstances and legislative regulation (e.g., in context of food chain management and monitoring of processes) to natural influencing factors, such as weather and seasonality. How much impact single challenges have depends on the specific characteristics of the service.

For example, for nutrient mapping fields must not be organically fertilised the previous days and need a low soil water content. In this case, the farmers' processes have to be adopted according to the current weather situation for a successful provision of the nutrient mapping service.

An overview of difficulties and challenges for working with PF methods is given below, based on the findings presented by Klingner, et al.(2013). To illustrate the abstract concepts, various examples are added to the challenges.

2.3.1. Structural circumstances

Farm structures have great influence on the efficiency of PF procedures. From a global point of view, agricultural structures are highly diverse. While, for instance, Asia is dominated by small-scale farming structures, large farms are predominant in North and South America. Especially for small and medium-sized farms, purchase of services is more beneficial. For those companies with smaller farm sizes or discontiguous fields, leasing of PF machinery can be an option but still the inefficiency in processing might be an issue. Service providing companies can profit from this fact and increase the adoption rate of PF by providing services to small-scale farmers. Through techniques of transborder farming (Auerhammer, 2001), the machinery can be used efficiently. With the consent of the small-scale farm holders, adjoined fields are cultivated together. The application rate for fertilizer and nitrogen but also the efficiency of cultivation processes can be increased in that way. Besides, farmers can avoid high acquisition costs and additional work for analysis of soil or data for farmers. From the perspective of the service providers, transborder farming allows for working on adjacent fields and multiple costumer orders can be executed parallel what makes the service more efficient (Rothmund, et al., 2003).

In the context of transborder farming, service providers have to consider distinctions in cultivation (e.g., organic fertilization, cultivation condition) and land use respectively between-field variability (Shibusawa, 2002). By using the service providers' own machinery and software, the compatibility of different farm equipment and data sources is ensured. Nevertheless, matching formats and interfaces that transfer the gathered data to the information systems of the farms are required (Steinberger, et al., 2009).

2.3.2. Legislative regulations

Often, food production is state-controlled to ensure a certain level of quality and transparency. This is especially important in times of global trading. Accordingly, governments nowadays have strict regulations for monitoring food production processes (Ruiz-Garcia, et al., 2010; Schmidhalter, et al., 2008). Not only the maintaining of the cold chain and finishing processes are monitored but also the application of pesticides or fertilizer. How much fertilizer has been sprayed, who sold it, when has it been applied? These questions are important with regard to transparency of the production process. Likewise, soil cultivation is subject to legal regulations.

Where quantities of data are gathered and transferred, as in case of PF, data protection is highly relevant for farmers (Bahlmann, et al., 2009; Korduan, 2001). Data that allows for drawing conclusions on the economic situation of the farm must be administrated with care. Therefore, farmers ascribe great importance on data security in case of outsourcing data storage to external service provider.

2.3.3. Natural influence factors

The economic potential of the soil is to be exploited by detailed analysis of nutrient loading and its natural condition. Additionally, water (e.g., in regard to soil water content or nutrient leaching) is an omnipresent factor in context of farming processes. Weather forecast and long-term prognoses for climatic changes can support farmers in their cultivation decisions and, therefore, have a great impact on processes in PF.

Satellite and imagery technique is, e.g., affected by overcast weather (Batte & Arnholt, 2003; Pedersen, et al., 2004). Rainy weather can lead to problems in working with sensors. Even the general practicability of the fields depends on the soil water content. If the soil water content is too high, heavy machinery cannot drive on the fields since the risk of soil compaction is too high or the machines could get stuck. Additionally, specific farming procedures, such as haying or pesticides application, require certain weather conditions. Therefore, weather marks a certain risk for services in the domain of PF, requiring flexibility on a micro level.

Since agriculture is a business characterized by growth and harvest cycles, service providing companies have to deal with peak times during season, where high customer demand has to be satisfied. In contrast, there are also times with very low demand, especially during winter time. Thus, to provide the necessary flexibility on a macro level the service providers have to conduct a comprehensive planning of resources. The capacity of resources (both human and material) needs to be adjusted in accordance with demand. Keeping business economy in mind, strategies for an efficient employment of the available resources in summer as well as innovative approaches in times with low demand necessarily need to be developed.

3. Nutrient mapping – an industrial use case

To illustrate the findings presented above, the service of nutrient mapping is used as an exemplary industrial use case. In association with an industrial partner, the detailed capturing and modelling of processes was conducted. The data was gathered by means of qualitative interviews with associated partners.

Nutrient mapping is used to show the variability of the soil's nutrient content within a field. By taking soil samples and analysing them for Phosphorus (P), Magnesium (Mg), Potassium (K) and pH-value, nutrient maps can be generated. Ultimately, recommendation for the use of fertilizer can be derived from this which in turn allows for reducing the application rate of fertilizer significantly through site specific application.

The entire process of nutrient mapping includes different groups of actors for soil sampling, analysing as well as data for further processing of the results for generating nutrient maps.

3.1. Process modelling

Corresponding to the concept of service modelling (Böttcher & Klingner, 2011), the aim of modelling processes is transparency to determine obstacles within complex monolithic processes. This is done by illustrating the process steps of every participating actor in detail. To identify potentials for optimisation, interfaces between associated service partners can be focused for example. By synchronising these interfaces, errors resulting from problems with data transfer can be avoided. Additionally, improvements in the process structure and sequences can be achieved on basis of a detailed process modelling which ultimately leads to an increase of efficiency in processing. If franchising is taken into consideration, a detailed description of the complex service necessarily needs to be done.

The exemplary process of nutrient mapping involves various actors; laboratories, field engineers and consultants participate in the process next to the service providing company and the farmer itself. The customer's order of the service is the trigger of the process. A detailed representation of the process is shown in Fig. 1 using the modelling notation BPMN (OMG, 2011).

Shortly after receiving an order confirmation from the service providing company, the field engineer has to get in touch with the customer to fix a date for soil sampling and additional services (such as land surveying). After soil samples were taken, supported by GPS technology, they are transferred to the appropriate laboratory which analyses for basic nutrients P, K, Mg and pH. Afterwards, the laboratory submits the results to the service providing company which places digital and print versions of the nutrient maps at the customer's disposal. Finally, the invoice has to be transmitted to the farmer along with a fertilizer planning map if requested by the customer.

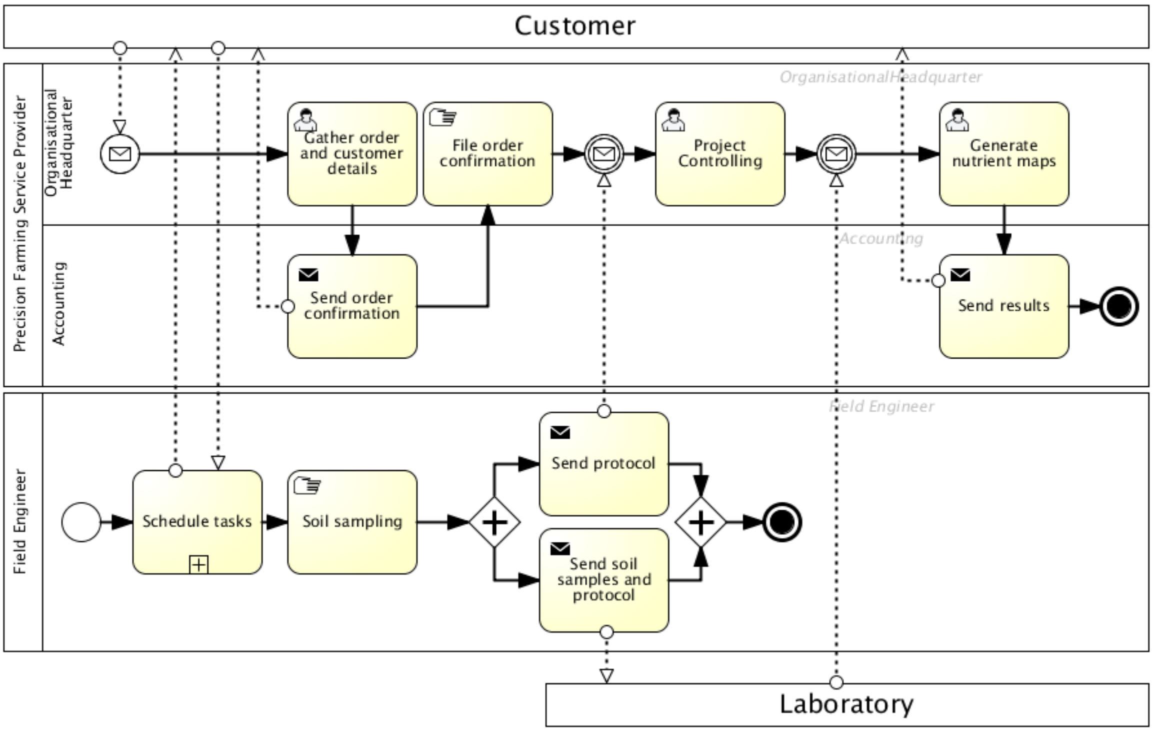

Fig. 1: BPMN Nutrient Mapping

The conducted interviews revealed that especially media disruptions, e.g. misunderstandings through illegibility of handwritings in the order form for the laboratory, but also delays caused by incomplete delivery of soil samples lead to an increased expenditure of time. But also date arrangements between the service provider, field engineers and farmers can be complicated since farming cycles, organic fertilizer application and weather (especially in context of soil water content) have to be considered. Furthermore, the previous process mixed dependent and independent activities, which lead to long waiting times for further proceedings (e.g., in generating geographical maps und nutrient mapping). For an optimal processing of the service, structural improvements by transparent structures and digital communication of orders, protocols and results are required and processes have to be parallelised as far as possible.

3.2. Implementation of results

Since different actors are necessarily integrated in the provision of the nutrient mapping service, it is important to precisely define the how and when of the interaction between the involved participants. In the introduced use case, this was achieved by developing an information system hosted and administrated by the service providing company as collective interface for all the data communication. In this way, the process can be monitored in detail. In this context, the requirements for compatible interfaces between the provided information system, software of the laboratories and eventual information storage systems of the farmers have to be considered. By using an internet based platform, the whole complex of the service especially in regard to status tracking becomes transparent to a certain extent. Former errors in process resulting from difficulties in communication but also delays caused by long waiting periods in shipping can be avoided this way.

Additionally, a web-based information system with access for every involved actor allows for coping with the above mentioned challenges (Murakami, et al., 2007) and offers the opportunity to include digital maps. By using those maps to record confirmed orders, structural challenges especially in regard to transborder farming can be managed more easily. Also schedule and resource planning is simplified by such maps since long distances easily can be avoided in seasonal peak times.

Considering the findings of the literature research described in sect. 2.2 and 2.3, the service of nutrient mapping is explicitly beneficial for small and medium sized farms. Here, the service providing company has to give the farmers an understanding of the profitability of nutrient mapping. By providing the complex machinery and software, the farmer can concentrate on working with the results and minimise the financial risk linked to machinery purchase.

Since nutrient mapping is highly seasonal specific, service providing companies need to develop innovative strategies for handling high peak times as well as times with low demand. By introducing a franchise concept, problems in resource planning will be reduced and regional specifics (e.g. for analysing methods) can be handled more flexible by the franchisee.

4. Franchising services

Defining processes is important not only for analysing structural problems of the process but is also mandatory for franchising the service. By illustrating the complexity of the process, the required infrastructure becomes transparent and internal procedures are shown. The service engineering approach assists in improving the quality of the basic service and, thereby, creates the necessary conditions for further commercialisation of the provided service through franchising. As shown in Fig. 2, franchising services in the agricultural domain is beneficial for the franchising company as well as for the franchisee.

4.1. Franchise-like concept in agricultural domain

The definition of process models allows for analysing current workflows regarding potentials for optimisation in regards to the process efficiency. Accordingly, the capturing of the current process step is a prerequisite for adequate improvements regarding service productivity or the definition of new reference processes. This in turn is a precondition for implementing franchise structures or a more extensive inclusion of external service providers. In summary, the adoption of a service engineering approach contributes to the optimisation of services by identifying existing deficits within the process but also by determining global and actor-specific requirements for the provided service.

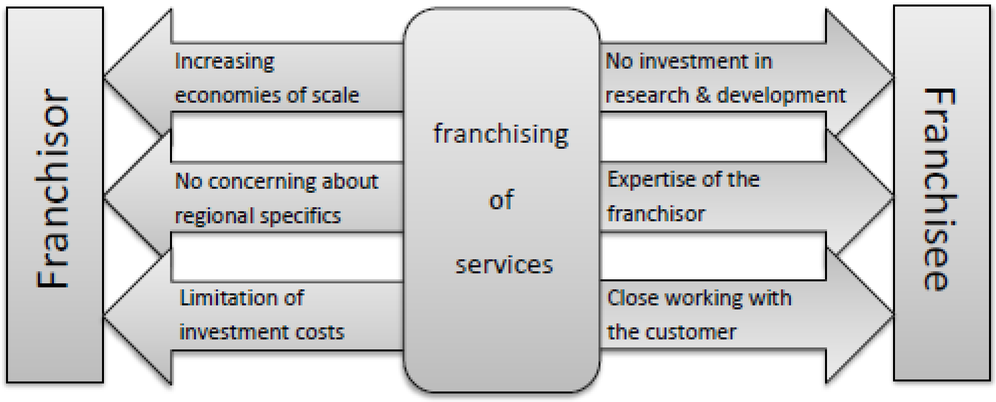

Fig. 2: Benefits of franchising services in the agricultural domain

On the basis of a precisely described service process, specific hardware and adequate software with matching interfaces can be provided. By making specific firm expertise and particular technology available, a certain quality of the service is ensured. Furthermore, franchisees can profit from this and directly start providing their service. Besides, the franchisee can profit from the franchisor's long-term expertise and does not have to deal with research and development.

The franchisor can benefit from increasing economies of scale because franchising allows for multiplication of service activities. Since the franchisor is not responsible for providing current state of the art technique, his investment costs are significantly limited. While financial risk is on side of the franchisee, the franchise providing company can grow faster.

Additionally, by providing a franchise concept, the franchisor does not have to have concerns about the above mentioned regional specifics. Regional infrastructure (e.g. with regard to available laboratories) or even the stability of the internet access in rural areas have great impact on the functionality of the provided service. However, difficulties in handling these regional specifics are on side of the franchisee. This is beneficial for the franchisor especially in context of international expansion.

In context of agricultural services, service provision states an adequate solution for increasing the adoption rate of PF and thereby, in particular, enables small and medium sized enterprises to profit from site specific farm management. In this context, the requirements for standardised data exchange become obvious. Without consideration of interfaces for data exchange, a franchise concept will be non-functional in the agricultural domain. Due to the fact that the farmer has to communicate with various actors (service provider, supplier, administrators, customers or processors) obtained data urgently need to be utilizable within the farmer's own system. As a standard for data exchange in agriculture, agroXML (http://www.agroxml.de) was developed for this purpose (Schmitz, et al., 2009; Sørensen, et al., 2011). The usage of such a standard for data exchange is a necessary requirement for fast expansion of the franchised service.

4.2. Franchising of nutrient mapping service

The exemplary service of nutrient mapping is particularly suitable for franchising since service providers need only a limited amount of equipment. Under the prerequisite of the availability of laboratories and with only little hardware, the franchisee can start with soil sampling. The most important requirement is a suitable information system, which allows for an efficient information and data exchange between the associated actors. This system is provided by the franchisor and forms the base of the franchising service. After laboratories analysed the soil samples, the results are transmitted to the information system and nutrient maps are generated automatically. A system built on standards for data exchange support the implementation of the franchising concept considerably.

Franchisees can respond to regional farm structures and peculiarities in cultivation much more flexible than a single service providing company, acting international, could do. Besides, by adopting only logistical infrastructure and few specialised equipment, the franchisee can plan resources (human and machinery) autonomously. This, in turn, gives the service providing franchisee a high level of flexibility and short reaction times in planning according to local circumstances.

5. Conclusion

On a generic level, the paper showed an approach to improve a common service in a quantitative as well as a qualitative dimension. Qualitatively, the productivity of the service is increased by reducing media discontinuities and increasing ICT-support. Quantitatively, a formal definition of the workflow including processes, hardware and software is a prerequisite to implement a franchise-like concept to achieve significant economies of scale.

By taking nutrient mapping as an exemplary industrial use case, the adoption of a service engineering approach and its benefits for improvements of the service was illustrated. With the help of qualitative interviews, errors in process execution were analysed and the optimisation of the process was forced by parallelisation and structuring. Additionally, a comprehensive literature research revealed particular points of attention for service provision. Especially in context of franchising, the analysis of challenges and requirements brought important insights, e.g. in regard to the internationalisation of the service. On basis of the optimised process, an approach for implementing a franchise concept could be developed.

The application of a service engineering approach is new in the agricultural domain. However, especially in context of PF with its increasing demand for services, service engineering is beneficial. Franchising the service of nutrient mapping is highly promising in many respects. First, farmers with small and medium sized farms, who could not effort PF technology before, can benefit from methods of site-specific farm management this way. In this manner, farmers can become aware of the benefits of PF and barriers for the adoption of new developments and PF services are gradually reduced. Especially in regard to internationalisation of the provided service, having the global structures of farming in mind, the focus on small-scale farmers is worthwhile. Second, franchisees can profit from the basic infrastructure provided by the franchising company. On the basis of an information system which links all associated partners and generates nutrient maps automatically, the franchisee can start working right away. On the other side, the franchisor can concentrate on technological improvements and research and, therefore, guarantee that the provided franchising concept represents the state of the art. Even in barren times, franchising of services allows for expansion and offers an alternative approach for economic growth.

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