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# ERP in agriculture: Lessons learned from the Dutch horticulture

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ABSTRACT

Farming nowadays is a complex managerial task that imposes stringent requirements on farm management information systems. In other sectors, Enterprise Resource Planning (ERP) systems are widely implemented to meet such requirements. This paper assesses the applicability of ERP systems in the agri-food domain by investigating the experiences of agri-food companies that already have implemented an ERP system. More specifically, the research has analyzed the drivers and barriers for adoption of ERP in the Dutch horticultural sector. The results show that the alignment of ERP with the specific characteristics and requirements of a company is a crucial challenge in order to capitalize the benefits of ERP. The study also shows that it is possible to deal with this challenge. The majority of the respondents (62%) is positive about of the match of the specific ERP solution with the company's business processes during implementation. Most of these respondents have implemented a system that includes a sector-specific layer around a standard ERP solution. Moreover, it is concluded that a proper management of the orientation, selection and implementation processes is of crucial importance for a successful adoption.



## 1. Introduction

The industrialization of agriculture has expanded a lot in the previous decades. Farms are developing towards high-tech factories that are characterized by large scale production and intensive use of technology. Farms should not only be very efficient, but also have to meet high quality and environmental standards and should adapt flexibly to changing market conditions. In this complex and turbulent business environment, it is of great importance to keep business processes in control. This imposes high requirements on the managerial tasks in agri-food business and consequently on the supporting information systems, particularly regarding flexibility, integration and incorporation of intelligence for advanced decision making (Sørensen et al., 2010; Wolfert et al., 2010). It is widely argued that the current information systems in the agri-food sector do not sufficiently meet these requirements (Sørensen et al., 2010; Teye et al., 2012; Lehmann et al., 2012; Kruize et al., 2013; Verdouw et al., 2013). In other sectors, Enterprise Resource Planning (ERP) systems are widely implemented to mitigate for this. An ERP system is a standardized software package that combines functionality of multiple business functions into one integrated system (Davenport, 2000; Kumar and Hillegersberg, 2000). ERP helps to overcome fragmentation between organizational units (functional silos) and systems (island automation). As a result, ERP could potentially be an effective solution approach also for the agri-food sector.

Hence, this paper assesses the applicability of ERP systems in the agri-food sector by investigating the experiences of companies that already have implemented an ERP system in this sector. More specifically, the research aims to identify drivers and barriers for the adoption of ERP systems in the Dutch horticultural sector. This sector is chosen because of its expected front-running position concerning ERP adoption within the Dutch agri-food cluster. The trend towards complex managerial tasks and scale-enlargement is already in an advanced phase in Dutch horticulture (Berkhout et al., 2014). Production processes are highly industrialized and companies have developed into big international organizations. As a result, ERP systems are increasingly used in Dutch horticulture.

The paper is structured as follows. It first describes the research methodology and it provides some background of ERP and its application in agriculture. Next, it introduces the framework for analysis that is used to identify barriers and drivers in the adoption of ERP. The paper subsequently presents the results of the investigation of existing ERP implementations in the Dutch horticulture. Finally, it concludes with summarizing the main findings and discussing the main contributions to literature and practical implications.

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## 2. Methodology

### 2.1. Project context

The research has been carried out as part of the research and innovation programme of the Digital Greenport Holland. In this Public Private Partnership (PPP) businesses, knowledge institutes and the (national) government are working closely together towards a common vision and action plans on digital information management and standardization in the Dutch horticultural cluster (Verdouw et al., 2014a). The main business partners are three industry associations for chain information in the Dutch horticulture, i.e. Frug I Com (fruit and vegetables), Floricode (flowers and plants) and EDIbulb (flower bulbs). The members of these associations cover nearly all companies active in the Dutch horticulture, including producer organizations, auctions, traders, logistics service providers and information technology vendors. The activities of Greenport Digital Community focus on four key themes: e-Standards, e-Information Integration, e-Government and e-Competences. The research presented in this paper was part of the e-Information Integration theme.

### 2.2. Research design

The research is carried out in four phases: (i) Literature review; (ii) development of a theoretical framework for analysis; (iii) data gathering in in-depth structured interviews with industry experts; and (iv) data analysis and evaluation.

The research started with a literature review on farm management systems and ERP to define the problem context of the research. The second step was the development of a theoretical framework for analysis, i.e. a systematic classification of critical factors for the adoption of ERP systems. These factors can either be barriers that negatively influence adoption or drivers that positively influence it. The broadly accepted theory of Rogers (1995) about the adoption of innovations was selected as the basis of the framework. Next, the most important factors that influence ERP adoption were identified based on ERP literature.

The third research phase conducted interviews with experts of Dutch horticultural companies that implemented ERP. Based on the theoretical framework, a questionnaire for in-depth semi-structured interviews was developed. Next, a long list of ERP implementations in the Dutch horticulture was defined based on the input of the business experts of the Digital Greenport Holland. The long list identified 25 producers, 29 traders or auctions and 16 other companies like food processing companies, cooperatives and sector organizations. From the long list in total 13 companies were selected, aiming for a balance of the involved subsectors and the supply chain roles (see Table 1). The data were collected by conducting in-depth interviews with key experts of the selected companies, who have a good overview of the ERP selection and implementation process.

The size of the interviewed companies ranges from less than 20 FTE to over 200 employees (see Fig. 1). Only one company employs less than 20 FTEs, which illustrates that ERP is mostly implemented by companies that are relatively large for the agri-food domain. In total eight of the interviewed companies use Microsoft Navision, which has a large share in horticulture. The other implemented ERP systems are SAP (1), Freshng Advanced Software (1), PlantITware based on Infor LN, formerly Baan (1) and custom ERP solutions (2).

**Table 1**
Distribution of the interviews.

| Horticultural subsector | Supply chain role | | | Total |
|---|---|---|---|---|
| | Growers/ farmers | Traders/ auctions | Both | |
| Fruit & vegetables | 1 | 2 | 1 | 4 |
| Plants | 2 | 2 | | 6 |
| Flowers and flower bulbs | 2 | 2 | 1 | 7 |
| Total | 5 | 6 | 2 | 13 |

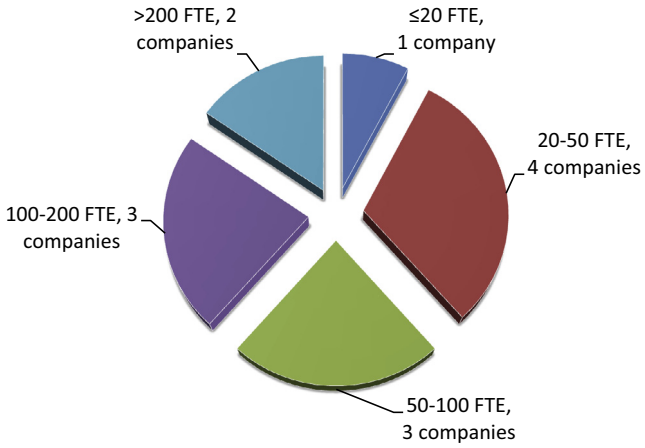


**Fig. 1.** Company size of the respondents in number of employees.

The fourth and final research phase was the analysis and evaluation of the interview results. The analysis has identified and prioritized the drivers and barriers by analyzing the frequency of the occurrence of each factor. The results were evaluated in a working group of six experts of the Digital Greenport Holland.

The remainder of the paper introduces the results following the research steps as described above.

## 3. Farm management information systems and ERP in agriculture

To ensure the effectiveness and efficiency of business processes, information must be continuously captured, edited and communicated. Enterprise Information Systems support the processing of information at different levels ranging from operational to strategic, i.e.: (i) mechanized cultivation and logistic systems, (ii) enterprise management systems and (iii) business intelligence applications. The present research focuses on the enterprise management layer, which provides basic capabilities to process transaction data and to support operational decision-making based on these data. This section introduces the current situation concerning these systems in the agricultural sector.

### 3.1. Farm management information systems

In agriculture, the adoption of ICT has generally been low, especially in comparison to other, more industrialized sectors (Teye et al., 2012). Applications have primarily come from technology developments in the field, greenhouse or animal house. Especially, the introduction of sophisticated sensing and monitoring technology has resulted in the trend of precision farming or -horticulture (Nikkilä et al., 2010). Other driving forces were the advancements in modelling biological processes which has led to a number of decision support systems (DSSs) e.g. for pests and diseases or nutrient management (Nikkilä et al., 2010).

Precision farming and related DSSs focus on specific aspects of farm management (Keating and McCown, 2001; Wolfert, 2002). Usually these systems require more general farm data e.g. on fields, implements, herd composition, etc. This has led to DSSs that also

act as kind of Farm Management Information Systems (FMISs). However, because that was never the primary objective, these FMISs are not satisfying from a whole farm management perspective.

On the other hand there has been a development of FMISs that were setup from a whole farm management perspective. This development started from the 1980s on, when PCs were introduced to the general public, also to farmers. Farmers or farm-related people started to make database programs (sometimes just out of curiosity or amateurism) to get an overview of their fields, herds or to make economic farm calculations. Gradually these database programs evolved from MS-DOS through MS-Windows operated systems to internet-based versions nowadays. External developments such as policy regulations, and certification have led to further specialization and wider adoption of these FMISs.

The current situation is that there are many FMISs, DSSs and many applications in between, all covering different aspects of farm management (Kruize et al., 2013). Since last decade the call for better interoperability between these different systems has become louder (Sorensen et al., 2010; Wolfert et al., 2010; Kruize et al., 2013). In other sectors, Enterprise Resource Planning (ERP) systems are widely implemented to achieve enterprise integration. The next sections elaborates to what extent this could be an effective solution approach also for the agri-food sector.

### 3.2. Enterprise resource planning systems

ERP has emerged in the early 1990s as a logical extension of the material requirements planning (MRP) systems of the 1970s and of the manufacturing resource planning (MRP II) systems of the 1980s (Akkermans et al., 2003; Jacobs and Weston, 2007). Nowadays, ERP has become a de facto standard in many industries. For example, Aberdeen reported in 2012 that 92% of the manufacturing companies have implemented ERP (Castellina and Prouty, 2012).

An ERP system is a standardized software package that combines functionality of multiple business functions into one integrated system (Davenport, 2000; Kumar and Hillegersberg, 2000). Four important characteristics can be identified:

1. An ERP system is *multi-functional*, i.e. it supports multiple business processes, such as order management, financial administration, warehouse management, production planning, sales, purchasing and distribution.
2. An ERP system is an *integrated* system in which the integrations of different functionalities are embedded in the system. Data are automatically shared in the complete system directly after data entry.
3. An ERP system is *business critical* because it is leading in the execution of business processes. This results in up-to-date management information, which enables immediate corrective and preventive actions.
4. An ERP systems is a *standard software package* that supports different types of companies in various industries. The system's functionality is fit to the specific companies by setting specific parameters.

The major advantage of ERP is that it provides a stable backbone for the registration and communication of information among business functions, and consequently it ensures the availability of timely and accurate information for integrated business process management. There is a lot of literature showing that the performance of companies using ERP is better than companies that have not implemented ERP, for example: Poston and Grabski (2001), Hunton et al. (2003) and Nicolaou (2004). However, two important remarks should be made. First, the implementation of an ERP system requires a considerable investment. Companies that implement ERP often face a lot of start-up problems, which result in a performance dip immediately after implementation in the short term (McAfee, 2002). Second, an ERP implementation has a big impact on the business processes. The benefits can only be realized if implementation is combined with properly managed business processes. These notions emphasize that the adoption and implementation process needs to be carefully managed to capitalize the benefits of an ERP system.

### 3.3. ERP in agriculture

The applicability of ERP in the agri-food sector has often been considered to be limited. ERP systems perfectly cover the demands of efficient supply chains that are characterized by stable business processes and low demand uncertainty. However, in sectors with a highly uncertain demand and supply in production and logistics processes, traditional ERP is experienced as an obstacle in achieving the required flexibility (Akkermans et al., 2003; Koch, 2007; Rettig, 2007). Agri-food is a typical example of such an industry, due to its dependence on biological processes (e.g. plant growth, soil processes, etc.) that are accompanied by a high uncertainty (Verdouw, 2010; Verdouw et al., 2010a; Trienekens et al., 2012). An additional complication is that many ERP-systems lack sector-specific functionality, because for a long time agri-food business was a too small market for ERP vendors to develop specific functionalities.

However, this situation is changing. The ERP industry has acknowledged the lack of flexibility and in the previous decade it has worked hard to transform ERP into ERP II systems, which are web-based, open and componentized based on Service-Oriented Architecture (Bond et al., 2000; Møller, 2005), as illustrated in Fig. 2. Furthermore, many sector-specific ERP solutions has emerged, also in agriculture. These solutions consist of sector-specific layers around standard ERP systems. In the horticultural sector, several growers and traders already have implemented such ERP systems in the previous decade.

The remainder of this paper investigates the experiences of a selection of those companies in order to identify the lessons learned for agriculture in general. Before reporting the results of

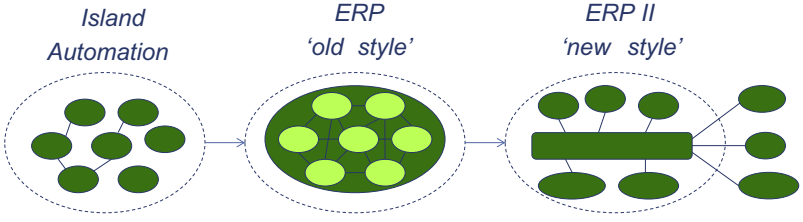


**Fig. 2.** Towards ERP II.

this investigation, the next section first introduces the framework for analysis.

## 4. Framework for analysis

This section presents the theoretical framework for analysis, which classifies the factors that are important for the adoption of ERP systems. These factors can either be barriers or drivers. The framework for analysis is based on a combination of: (i) innovation literature on adoption factors and (ii) ERP literature on factors that determine the success and/or failure of ERP implementations.

Fig. 3 provides an overview of the framework. The main elements are the adoption unit (who is adopting?), the adoption object (what should be adopted?) and the adoption process (how?). The factors that influence adoption are twofold. The first type of adoption factors are concerned with the perception of the adoption unit (i.e. the company that is considering to implement ERP) about the adoption object (i.e. the ERP solution and the implementation partner). The second type of adoption factors are inherent characteristics of the adoption process (i.e. the orientation, selection and implementation phases) and the adoption unit (i.e. the implementing horticultural company). Below, these categories are further introduced, including a definition of the ERP adoption factors of each category.

The adoption process (how?) is the core of the framework. The process of adopting an ERP system involves different actors, processes and elements and can be divided into distinct phases. The model of Rogers (1995) identifies five stages of an adoption process: (i) knowledge: learning about the innovation's existence and becoming familiar with its functioning; (ii) persuasion: forming of a favorable or unfavorable attitude towards the innovation; (iii) decision: choosing to adopt or reject the innovation; (iv) implementation: putting the innovation into use; and (v) confirmation: reinforcing or reversing previous adoption. The majority of related ERP literature focusses on implementation and to a lesser degree it also includes selection (i.e. the decision phase in Roger's model). However, the initial phases of ERP adoption are relatively under-researched. The knowledge and persuasion phases of Rogers (1995) were therefore combined into the phase Orientation. Furthermore, the confirmation phase is left out from the scope of this research. As a result, the following phases of an ERP adoption processes are defined:

1. *Orientation*: gaining knowledge and forming a favorable or unfavorable attitude towards different ERP systems and implementation partners.
2. *Selection*: deciding to adopt or reject a specific ERP system and implementation partner.
3. *Implementation*: putting the ERP system into use.

The framework includes the following ERP adoption factors related to the ***characteristics of the orientation and selection phases*** (among others based on Bernroider and Koch, 2001; Reuther and Chattopadhyay, 2004; King and Burgess, 2006; Deep et al., 2008):

- *Requirements' level of detail*: the accurateness of the functional and non-functional requirements analysis.
- *System type selection*: the degree to which a company consciously selects a specific type of system (e.g. customized, best-of-breed or standard ERP) that fits their requirements.
- *Solution evaluation*: the broadness and thoroughness of the evaluation of possible ERP solutions.
- *Resource allocation*: the available budget and resources for orientation and selection.
- *Decision-making approach*: the involvement of top-management in the decision-making process and the way decisions are made e.g. authority versus cooperative choices.

The framework includes the following ***characteristics of the implementation phase*** that are important for the adoption of ERP (among others based on Holland and Light, 1999; Scott and

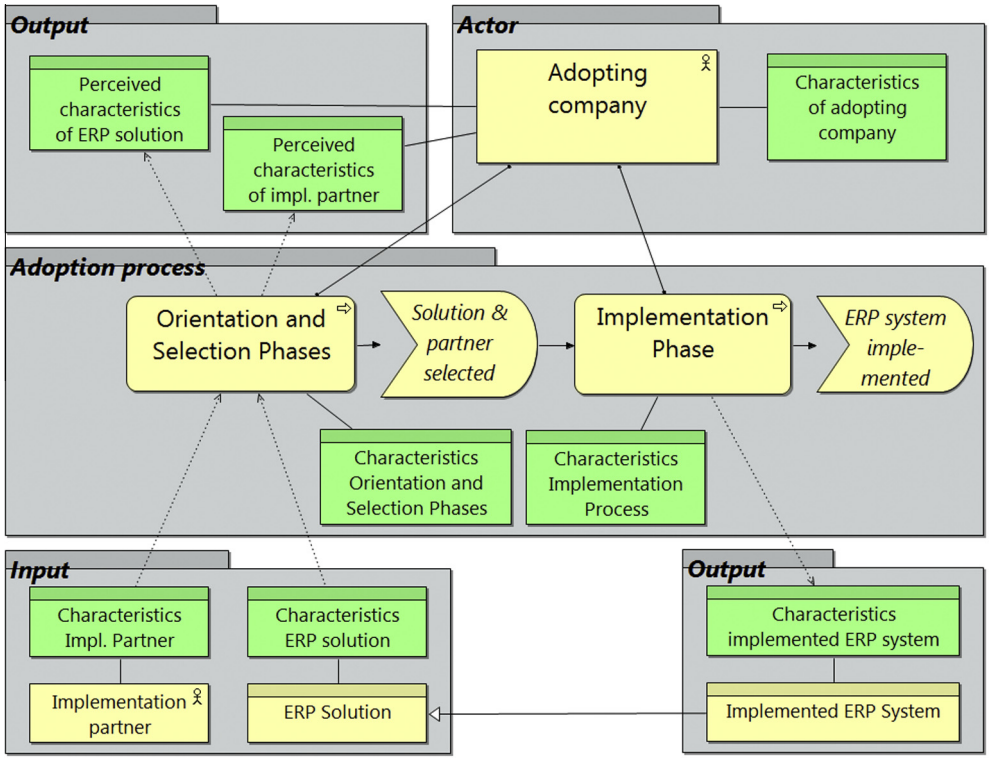


**Fig. 3.** Theoretical framework for analysis.

Vessey, 2002; Gargeya and Brady, 2005; King and Burgess, 2006; Ngai et al., 2008):

- *Supplier cooperation*: the quality of the cooperation with the ERP implementation partner.
- *User acceptance*: the extent to what the end users of the system have a positive attitude towards the ERP system.
- *Match business processes*: the match of the configured system with the business processes.
- *Sufficient resources*: the amount of resources allocated to the implementation phase.
- *Customization*: the extent to what the system is tailored to specific requirements of the adopting company.
- *Tests*: the amount of functional and non-functional tests that are carried out to ensure a stable system that complies with the requirements of the organization.
- *Planning and structure*: the quality of the planning, schedules and structures that are used to guide the implementation processes and to ensure project focus.

Implementing an ERP system is a complex and intensive process that is strongly influenced by the cooperation between the implementing organization and the implementation partner. Consequently, a good relation between these parties is essential. The framework includes the following ***characteristics of the implementation partner*** that are important for ERP adoption (among others based on Robey et al., 2002; King and Burgess, 2006; Ngai et al., 2008):

- *Consultant 'click'*: the degree to which the adopting organization describes the relation with the implementation consultants as positive and mutually productive.
- *Sector knowledge*: the degree to which the adopting organization describes the sector knowledge of the implementation partner as sufficient.

The adopting unit (who is adopting?) is the horticultural company that considers to implement an ERP system. The characteristics of this adopting organization have an important role in the entire adoption process. The following ***characteristics of adopting company*** (i.e. the adoption unit) are taken into account (among others based on Hsu et al., 2008; Ngai et al., 2008):

- *Entrepreneurial spirit*: the degree to which the organization has a progressive and entrepreneurial way of approaching business challenges.
- *Communication style*: type (formal or informal), the intensity and scope of the communication within the organization during the adoption process.
- *Flexibility*: the degree to which the organization is able to cope with unforeseen circumstances.
- *Perceived uniqueness*: the degree to which the organization perceives their business processes as unique and distinct from other industries.
- *Focus on issues of the day*: the degree to which the organization lets issues of the day rule the agenda and thereby losing sight of a longer term strategy.

The last category is concerned with the ERP solution itself (what is being adopted?). Following Rogers (1995), the framework includes the following ***perceived characteristics of the ERP solution*** that influence the adoption process:

- *Relative advantage*: the degree to which the ERP system is perceived as beneficial to the user organization, taking into account the financial and non-financial costs and benefits.
- *Complexity*: the degree to which the ERP system is perceived to be difficult to implement, understand and use to the adopting organization.
- *Compatibility with existing values and beliefs*: the degree to which the ERP system is perceived to be compatible with existing values, practices and beliefs that are specific to the adopting organization.
- *Observability*: the degree to which the ERP solution is visible to the adopting company, among others due to marketing activities, publicity, and reputation.
- *Triability*: the degree to which it is considered easy to, prior to implementation, get an idea about the look, feel and use of the ERP system within the organization, for example by using demonstration versions or taking guided tours to evaluate implementations at similar organizations.

This section has introduced the theoretical framework for analysis. The next section will apply this framework to the Dutch horticulture in order to identify and prioritize the drivers and barriers.

## 5. Drivers and barriers for adoption of ERP in horticulture

This section presents the results of the analysis of ERP implementations in the Dutch horticulture. First, it provides an overview of the main barriers and drivers for the adoption of ERP. Subsequently, the results of the different parts of the framework for analysis are discussed, i.e. the (perceived) characteristics of (i) the orientation and selection phases, (ii) the implementation phase, (iii) the implementation partner; (iv) the adopting company, and (v) the ERP solution.

### 5.1. Most important barriers for adoption of ERP

Table 2 lists the barriers that were mentioned most by the respondents. It shows that a lot of the barriers are related to the alignment of ERP with the specific characteristics and requirements of the adopting company. The barrier that is mentioned most is the perception of a low compatibility of ERP with the specific values, practices and beliefs of the adopting organization (barrier 1). In order to deal with the high dynamics in horticultural supply chains, many companies heavily rely on improvisation and consequently lack a well-structured administrative organization. The lack of a detailed requirements analysis, mentioned only by growers, indicates that the fit of ERP solutions with the specific

**Table 2**
Main barriers for ERP adoption in Dutch horticulture per category. The percentage indicates the frequency an indicator was mentioned as a barrier.

| Indicators | Category | Barrier (%) |
|---|---|---|
| 1. Compatibility with existing values and beliefs | Perceived ERP solution | 69 |
| 2. Complexity | Perceived ERP solution | 54 |
| 3. Triability | Perceived ERP solution | 46 |
| 4. Requirements' level of detail | Orientation and selection | 38 |
| 5. Match business processes | Implementation | 31 |
| 6. Perceived uniqueness | Adopting company | 31 |
| 7. Focus on issues of the day | Adopting company | 31 |
| 8. Sector knowledge | Implementation partner | 31 |
| 9. Planning and structure | Implementation | 31 |
| 10. Relative advantage (perceived costs of the system) | Perceived ERP solution | 31 |
| 11. Decision-making approach | Selection | 31 |

needs of horticultural companies is often not evaluated sufficiently (barrier 4). In the implementation phase, an important barrier is that the match of the evaluated ERP solutions with the business processes of horticultural companies is considered to be insufficient (barrier 5). Concerning the inherent characteristics of the adopting company, the perceived uniqueness and a focus on issues of the day are important barriers (barriers 6 and 7). The last barrier, highlighting the importance of an organizational fit, is the lack of sector knowledge of implementation partners (barrier 8).

Other important barriers include the perceived complexity of the ERP solution, which means that the ERP system is considered to be difficult to implement, understand and use to the adopting company (barrier 2). A related barrier is the low triability of ERP, which implies that it is difficult for companies to evaluate the usability of the ERP system prior to implementation (barrier 3). An important barrier during the implementation is an insufficient quality of the planning, schedules and structures that are used to guide implementation processes (barrier 9). This factor is related to a focus on issues of the day (barrier 7), which also results in a lack of proper management of the implementation project. Furthermore, the perceived costs of the ERP system negatively influences the adoption (barrier 10). Last, for several larger companies (only traders) it was difficult to come to shared decision on the ERP solution, in particular due to the number of people that were involved in the decision making process (barrier 11).

### 5.2. Most important drivers for adoption of ERP

Table 3 lists the drivers that were mentioned most by the respondents. The perception of benefits is by far the most important driver to adopt an ERP system (driver 1). The most mentioned benefits of ERP are a better transparency, control and planning of the business processes; a better integration and efficiency improvements. Furthermore, many respondents have made a well-considered strategic choice for the type of ERP solution, i.e. standard, customized or best-of-breed software (driver 2). Next, over 60% of the respondents indicates that the match with the company's business processes is the most important driver during implementation (driver 3). Most of the respondents that are positive about this match have implemented a system that includes a sector-specific layer around a standard ERP solution. The adoption process was also influenced positively by the decision making approach of many of the respondents (driver 4). The (top) management is highly involved and there is a high speed of the decision making process because the companies are relatively small and have a strong entrepreneurial culture. A related driver is the communication style of the adopting companies, which was characterized by a lot of informal communication both with management and employees during the entire adoption process (driver 5). The relation with implementation consultants was also positively influencing the adoption process of many respondents (driver 6). Most of these companies have cooperated with ERP service providers that are specialized in horticulture. Their consultants have a lot of sector knowledge and are able to empathize with the situation of the implementing company. Related to this driver, also the quality of the cooperation with ERP suppliers during implementation was mentioned as a positive factor (driver 9). The next adoption factor is the acceptance of users, which was positively influenced by the involvement of users already from the beginning of the adoption process (driver 7). The broadness and thoroughness of the evaluation process was considered to be a driver, mainly for the interviewed traders (driver 8). A related driver, only mentioned by traders, was the requirements' level of detail (driver 10). Finally, several respondents, mainly traders, perceived the costs of the implemented ERP system to be reasonable in relation to the benefits (driver 11).

So far, the main barriers and drivers are introduced. The remainder of this section will discuss the coherence of these factors per category of the framework.

**Table 3**
Main drivers for ERP adoption in Dutch horticulture per category. The percentage indicates the frequency an indicator was mentioned as a driver.

| Indicators | Category | Driver (%) |
|---|---|---|
| 1. Relative advantage (perceived benefits of the system) | Perceived ERP solution | 92 |
| 2. System type selection | Orientation and selection | 69 |
| 3. Match business processes | Implementation | 62 |
| 4. Decision-making approach | Selection | 54 |
| 5. Communication style | Adopting company | 54 |
| 6. Consultant 'click' | Implementation partner | 54 |
| 7. User acceptance | Implementation | 46 |
| 8. Solution evaluation | Orientation and selection | 46 |
| 9. Supplier cooperation | Implementation | 38 |
| 10. Requirements' level of detail | Orientation and selection | 38 |
| 11. Relative advantage (perceived costs of the system) | Perceived ERP solution | 38 |

### 5.3. Characteristics of the selection and orientation phases

The main adoption factors, related to the selection and orientation, are the decision-making approach, system type selection, requirements' level of detail, solution evaluation and resource allocation (see Table 4). These factors show that a major challenge is to balance progress and thoroughness. The emphasis of many respondents is on making progress at the expense of thoroughness. For them, the efficiency of the decision-making process is an important driver and they make a conscious choice about what type of system to select. However, the requirements are not evaluated into detail and insufficient resources are allocated for orientation and selection. For a second group of respondents, the requirements' level of detail and the thoroughness of evaluation are important drivers. Conversely, for many companies in this group the decision making process is an important barrier.

### 5.4. Characteristics of the implementation phase

The main adoption factors, related to the implementation, are threefold (see Table 5).

The first category is about how to deal with organization-specific functionalities in the implementation. The match of the configured system with the business processes of the organization, is the most important driver in this phase and at the same time it is also one of the most important barriers. Flexibility is a critical capability in order to cope with dynamic product characteristics and high supply chain uncertainties. A related factor is the amount of customization needed to align the system with the organization's business processes. The customization mentioned include specific features concerning dynamic production planning, lot

**Table 4**
Adoption factors related to the characteristics of the selection and orientation phases.

| Indicators | Barrier (%) | Driver (%) | Sum (%) |
|---|---|---|---|
| Decision-making approach | 31 | 54 | 85 |
| System type selection | 8 | 69 | 77 |
| Requirements' level of detail | 38 | 38 | 76 |
| Solution evaluation | 15 | 46 | 61 |
| Resource allocation | 23 | 15 | 38 |

**Table 5**
Adoption factors related to the characteristics of the implementation phase.

| Indicators | Barrier (%) | Driver (%) | Sum (%) |
|---|---|---|---|
| Match business processes | 31 | 62 | 93 |
| User acceptance | 23 | 46 | 69 |
| Planning and structure | 31 | 31 | 62 |
| Customization | 23 | 31 | 54 |
| Supplier cooperation | 15 | 38 | 53 |
| Sufficient resources | 23 | 23 | 46 |
| Tests | 23 | 23 | 46 |

management, container composition, export documentation and plant royalty management.

The second category is concerned with the management of the organizational change process, which is especially reflected by user acceptance. This factor is considered as a barrier by almost a quarter of the respondents. However, it is a driver for almost half of the respondents, mainly because of the high involvement of users already from the beginning of the adoption process.

The third category factor is related to project management issues. The planning and structure of the implementation is one of the most important barriers in this phase, while it is a driver for just as much respondents. Also the cooperation with the supplier of the ERP system, the allocation of sufficient resources and the amount of functional and non-functional tests are important factors during implementation.

### 5.5. Characteristics of the implementation partner

The main adoption factors, related to the perceived characteristics of the implementation partner, are the 'click' with its consultant and its sector knowledge (see Table 6). The relation with the implementation consultants is a driver for many of the interviewed companies. Most of these companies have cooperated with, often relatively small, ERP service providers that are specialized in horticulture. Their consultants are familiar with the sector's culture and are able to empathize with the situation of the implementing company. A drawback that was mentioned by some respondents was the continuity of their effort for the company. It is therefore important to evaluate also the reliability and financial viability of the partner.

The sector knowledge of the implementation partner is an important barrier for other respondents. They experienced a lack of the ability to think along with the company's specific characteristics, which resulted in troubles during implementation to align the system with the company's business processes.

### 5.6. Characteristics of the adopting company

The main adoption factors, related to the characteristics of the adopting company are communication style, perceived uniqueness, focus on issues of the day, entrepreneurial spirit and flexibility (see Table 7). Many companies in the Dutch horticultural sector can be characterized as agile companies. They heavily rely on improvisation and interpersonal and ad hoc communication in order to deal with the high dynamics of horticultural supply chains, especially due to the involvement of fresh products and biological processes. The informal communication style and flexibility positively influence the adoption process. A related positive factor is the entrepreneurial spirit of many horticultural companies, which results in a positive attitude towards innovations once a new product or practice is considered beneficial. However, there are also drawbacks on this agility. In particular, the short-term focus on issues of the day and the ad hoc style of management also hampers the adoption of ERP systems. Many horticultural companies lack a well-structured administrative organization. As a consequence, the implementation of an ERP system is a major change, because it requires to work strictly according to plans and guided by the system. Another important barrier is that many horticultural companies consider what they do as very unique. As a consequence, they don not expect that a standard ERP system will be a sufficient solution.

**Table 6**
Adoption factors related to the perceived characteristics of the implementation partner.

| Indicators | Barrier (%) | Driver (%) | Sum (%) |
|---|---|---|---|
| Consultant 'click' | 0 | 54 | 54 |
| Sector knowledge | 31 | 8 | 39 |

**Table 7**
Adoption factors related to the characteristics of the adopting company.

| Indicators | Barrier (%) | Driver (%) | Sum (%) |
|---|---|---|---|
| Communication style | 8 | 54 | 62 |
| Focus on issues of the day | 31 | 8 | 39 |
| Perceived uniqueness | 31 | 8 | 39 |
| Entrepreneurial spirit | 0 | 23 | 23 |
| Flexibility | 0 | 15 | 15 |

### 5.7. Characteristics of the ERP solution

The main adoption factors, related to the perceived characteristics of the ERP solution, are concerned with its compatibility, relative advantage and complexity (see Table 8).

The most important barrier is the perceived degree to which the ERP system is considered to be compatible with existing values, practices and beliefs that are specific to the adopting organization. As described at the characteristics of the adopting company, horticultural growers and traders very much adhere to improvisation and interpersonal and ad hoc communication in order to deal with the high dynamics of horticultural supply chains. This contrasts with the reputation that ERP systems are rigid systems, requiring drastic standardization of business processes. Therefore, many respondents perceive the compatibility of ERP systems as a threat to this.

Concerning the relative advantage, the perception of the benefits is by far the most important driver to adopt an ERP system. Virtually all respondents expect (or expected before implementation) to realize a better organizational management by implementing an ERP system, i.e. a better insight, control and planning of the business processes. Other expected benefits are efficiency improvements, better integration between business functions, improvements in the ease of use and a higher quality of output and services to customers. The perceived costs are considered both as a driver and as a barrier. The implementation costs are perceived to be high and

**Table 8**
Adoption factors related to the perceived characteristics of the ERP solution.

| Indicators | Barrier (%) | Driver (%) | Sum (%) |
|---|---|---|---|
| Compatibility with existing values and beliefs | 69 | 31 | 100 |
| Relative advantage (perceived benefits of the system) | 0 | 92 | 92 |
| Relative advantage (perceived costs of the system) | 31 | 38 | 69 |
| Complexity | 54 | 8 | 62 |
| Triability | 46 | 15 | 61 |
| Observability | 8 | 31 | 39 |

also the licensing costs and the hiring costs of implementation consultants can be considerable. Several companies indicated that it is hard for them to assess the business case, because of high costs and because expected benefits are hard to quantify.

Other important adoption factors are related to the complexity of implementing ERP systems. Unanimously, the respondents indicate that implementing ERP is very challenging because it is an extensive system, which automates and integrates a company's core business processes. It has a big organizational impact and consequently the perceived complexity of ERP is a major barrier for adoption. Concerning the perceived triability of ERP, there are limited possibilities for trying out the system prior to the selection. Although the basic system can be demonstrated and companies with a running system can be visited, it is not possible to try-out a system that is configured and customized to the specific requirements of the adopting company. A final related factor is the perceived observability of an implemented system, which is mainly a driver for ERP adoption. An important factor for respondents to adopt a specific ERP solution is the publicity and reputation of solutions that are already implemented at similar companies in the sector.

### 5.8. Wrap-up of the results

The results of this research indicate that it is worthwhile to invest in an ERP system and in the management of its adoption process. The perceived benefits have positively influenced the ERP adoption process of virtually all respondents. In order to capitalize these benefits, the alignment of ERP with the specific characteristics and requirements of the adopting company is a crucial challenge. The most important barrier is the degree to which the ERP system is considered to be compatible with existing values, practices and beliefs that are specific to the adopting organization. The importance of an organizational fit can be explained by the specific characteristics of horticulture. Like other agricultural sectors, the horticultural industry is characterized by highly dynamic business processes, especially due to the involvement of fresh products and biological processes. Many companies heavily rely on improvisation and ad hoc communication in order to deal with these dynamics and consequently they lack a well-structured administrative organization. As a consequence, the implementation of an ERP system is a major change, because it requires to work strictly according to plans and guided by the system.

However, this study also shows that it is possible to deal with these challenges. The majority of the respondents (over 60%) is positive about of the match of the specific ERP solution with the company's business processes during the implementation. Most of these respondents have implemented a system that includes a sector-specific layer around a standard ERP solution. This links up with shift to the new style ERP II systems that are web based, open and componentized (see Fig. 2), which is currently on-going. As a consequence, most of the available ERP solutions in horticulture can be positioned between the 'old style' and the optimal 'new style' of ERP, meaning that architectural improvements can still be made.

It can be concluded that a proper management of the orientation, selection and implementation processes is of vital importance to a successful adoption. ERP systems are considered to be difficult to implement, understand and use to the adopting organization. It is also difficult for companies to evaluate the usability of the ERP system prior to implementation. Another important barrier is the lack of proper management of the implementation project. However, this research identified several factors that positively influenced the management of the adoption process. For example, many respondents have made a well-considered strategic choice for the type of ERP solution, i.e. standard, customized or best-of-breed software. Furthermore, the (top) management is often highly involved and the speed of the decision making process is often high, because the companies are relatively small and have a strong entrepreneurial culture. A related driver is the communication style of the adopting companies, which was characterized as a lot of informal communication both with management and employees during the entire adoption process.

## 6. Discussion and conclusions

The main contribution of this paper is that it has introduced the perspective of ERP to farm management literature. To the best of our knowledge, it is a first attempt to combine ERP and farm management information systems (FMIS) research, which currently are two different worlds that hardly cooperate. Furthermore, a specific contribution to the ERP literature is that the paper provides an integrated analysis of the success and failure factors from an innovation perspective, including also orientation and selection. A majority of existing ERP literature focusses on the implementation phase.

The integration of ERP and FMIS research can result in many promising research opportunities. On the one hand, FMIS research can gain a lot from the impressive amount of available ERP research. For example: there is much literature available about the success and failure factors of ERP implementations that could be applied to FMISs. On the other hand, ERP research can also gain from the agri-food domain since this sector imposes challenging requirements on ERP systems. An example of agri-food research, which might be inspiring for ERP research in general, is the study of Kaloxylos et al. (2012) on future internet based FMISs. It addresses the development of web-based, open and componentized farm management systems, based on major trends such as the Internet of Services and the Internet of Things. These 'farm ERP systems' represent sector-specific functionalities by loosely coupled services and applications ('Apps') that collaborate through an Internet platform with basic functionalities such as authorization and middleware. Users do not need to buy and install a massive ERP system, but the required functionality is delivered as a set of distributed web services and that can be configured and executed when needed (Verdouw et al., 2014b). These developments are expected to result in sector-specific and flexible ERP solutions that are affordable also for small farmers and that overcome several barriers that were identified in this paper. This should be further investigated however.

This paper studied cases in the Dutch horticulture. We expect that the results are applicable to other agricultural sectors, including arable- and livestock farming. Also these sectors are already highly industrialized and the company size is growing fast. However, further research is needed to provide evidence for this assumption.

Finally, the present research has focused on the perceived characteristics of ERP. A study of the match between the (i) real characteristics of the ERP solution and (ii) organizational characteristics and business processes, including the type of production, was beyond the scope of this research. It is expected that it is crucial to get insight into the actual compatibility as soon as possible in the adoption process. A promising approach to achieve this, is to compare ERP functionalities into detail with the needs and characteristics of the adopting company with the help of reference information models (Rosemann, 2000; Verdouw et al., 2010b). Such an approach would help farmers to select ERP systems with the best organizational fit. It would also encourage ERP vendors to develop sector-specific solutions with a high compatibility.

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