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What determines the acceptance and use of electronic traceability systems in agri-food supply chains?

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ABSTRACT

The paper is investigating the electronic-based traceability systems (ETsystems) that are considered as a valuable tool for the assurance of food safety and quality, for guaranteeing value added to products and ultimately, for serving the transparency and sustainability of agri-food chains. The objective of this research is to investigate the factors influencing the acceptance and use of ETsystems in agri-food chains.

A model that identifies the most significant factors influencing farmers' and processors' behavior regarding the installation and operation of an ETsystem is proposed. The theoretical approach is based on a combination of the Technology Acceptance Model 2 (TAM2) and the Theory of Planned Behavior (TPB). The theoretical concept and related hypotheses are tested by means of PLS-SEM analysis of data from the dairy supply chain in Greece.

'Perceived Control' and most importantly, the 'perceived costs' over the installation and operation of the ETsystem, is the most important factor with the strongest direct effect influencing the intention to install and operate such a system. This effect is stronger in the case of dairy farmers than in the case of dairy processors. Stronger for dairy farmers is also the identification mechanism thus, their need to comply with their social/business group expectations.

Useful findings offered for policy makers and regulators interested in the way traceability systems could be successfully integrated within an agri-food sector to guarantee its added value. The limitation of voluntariness and the enforcement of certain mandatory requirements is one tool to exploit and, based on our study, would be more effective at the processors' level.

1. Introduction

A traceability system is an increasingly important tool within the agri-food sector. The development of traceability systems throughout the food supply chains reflects a dynamic balancing of associated costs and benefits. Although many firms operate traceability systems for different objectives, these have played varying roles in driving the development of traceability systems in the food supply system (Golan et al., 2004).

Electronic Traceability Systems - ETsystems are considered by scholars and policy makers a necessity or, at least, a valuable tool for the assurance of food safety and quality (Regattieri et al., 2007; Hobbs, 2006; Pouliot and Sumner, 2008a, 2013; Trienekens and Zuurbier, 2008; Valeeva et al., 2004; Menard and Valceschini, 2005). Traceability for food safety is a field extensively covered in the literature (Trautman et al., 2008; Barker et al., 2009) and incorporated in legislation like the EU General Food Law (Reg. (EC) 178/2002). According to this EU law, traceability is mandatory in the form of 'one step forward and one step back' reporting of the whereabouts of a food due to possible safety issues and recall needs.

Beyond the mandatory requirements of the EU General Food Law, ETsystems in the European and global dairy sector are adopted on a voluntary basis with different levels of integration (Henson et al., 2005; Golan et al., 2004; Augustin et al., 2013; Banterle and Stranieri, 2008). In this paper, the term 'ETsystem' refers to an electronic-based, as opposed to a document-based, system of tracking and tracing food, which enables supply chain participants to react effectively to possible food recall incidents that go beyond the obligatory one step forward and one step back concept and include detailed 'information gathering and transmitting' about quality and credence attributes.

Credence attributes are the extrinsic quality attributes in added value products that include "country of origin", "fair trade", "organic production", etc. that cannot be detected by consumers without some form of quality signal, such as a label (Hobbs, 2002). The non-observable credence attributes of traditional products, that compose their quality and authenticity, have to be certified along the entire supply

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chain in order to allow capitalizing on their reputation (Pascucci, 2010). If there is no effective traceability system along the entire supply chain of an agri-food the trust of the consumers in relation to the anticipated credence attributes will be lost and consequently the competitive advantage of the agri-food will be deprived (Young and Hobbs, 2002).

However, full traceability systems, that presuppose the compatibility of systems and close, strategic cooperation between the different actors along the supply chain, could only be voluntary (Bosona and Gebresenbet, 2013). This voluntariness provokes different reactions from these actors, regarding the installation and operation of traceability systems (Stranieri and Banterle, 2006). Such reactions depend on factors that are necessary to investigate in order to be able to understand and subsequently to elaborate at the various policy levels. The already widespread voluntary use of traceability complicates the application of a centralized system because actors have developed so many different approaches and systems of tracking and tracing (Golan et al., 2004).

Although, drivers such as, food safety and quality, regulatory, social, economic, and technological concerns (Hobbs, 2003; Roth and Doluschitz, 2007; Goldsmith, 2004; Theuvsen and Hollmann-Hespos, 2005), barriers such as, resource/capacity, information, standard and awareness limitations (Resende-Filho and Buhr, 2007; Gellynck et al., 2007; Holleran et al., 1999) and benefits such as, market and consumer satisfaction, regulatory fulfilment, improved recall and risk management, transparency of supply chain etc. (Sparling et al., 2006; Pouliot and Sumner, 2008b; Chryssochoidis et al., 2009), of the ETsystems have been identified in the literature, which factors influence the actual installation and operation of an ETsystem and their correlation, still remains an open question.

The value of investment in a traceability system constitutes a matter of considerable concern and debate for both practitioners and academics alike (Chryssochoidis et al., 2009). Fritz and Schiefer (2009) summarize the decision situation for enterprises and their sector in a cost–benefit decision table for a tracking and tracing system but based on safety issues and product recalls. Heyder et al. (2012) were the first to attempt an in-depth analysis of the determinants of investments based on a comprehensive model that allows the derivation of testable hypotheses as a basis for large-scale empirical research.

Yet, these studies do not incorporate and combine insights gained from technical and socio-economic analyses of ETsystems. This research fills this knowledge gap. More specifically, the objective of this study is to investigate the factors influencing the installation and operation of ETsystems by the actors of the dairy chain (milk farmers and processors) combining technology acceptance with behavioral analyses. The results of this research are expected to provide policy makers with insight into the psychological factors that influence the installation and operation of ETsystems. These insights can be used to develop policy initiatives to promote the adoption and use of ETsystems in agri-food chains. We analyze empirical data from the Greek dairy sector, using a Partial Least Squares - SEM (PLS-SEM) analysis approach. The theoretical model developed and tested can serve as a predictive model.

Data collection through a questionnaire was conducted in the main milk producing regions of Greece. This country represents an interesting case because although the importance of tracing and certifying the credence attributes, such as geographical indication of origin or organic production, has been widely recognized, it is unclear why the application of such systems is rather the exception than the rule.

Greece has a long tradition of high quality dairy products, some well-known worldwide, like Feta Cheese, a white cheese in brine from sheep and goat milk of Protected Designation of Origin (PDO) in the EU. The size of the dairy sector, as measured by both the number of producers and the quantity of milk produced, has declined during the last decade and the current financial crisis has worsened the conditions even further. Exports are considered a promising marketing option but in order to compete on the international market against similar, lower-cost products, being able to promote and guarantee the differentiating quality attributes of these products is vital. ETsystems function as a tool to support and implement the aforementioned strategy (Theuvsen and Plumeyer, 2007; Barjolle and Sylvander, 2002; Becket and Staus, 2008; Giacomini et al., 2010).

2. Theoretical framework

In order to achieve the objective of this study and investigate the factors influencing the installation and use of ETsystems by milk farmers and processors of the dairy chain we combine technology acceptance with behavioral analyses.

Research in the information systems (IS) literature explaining user acceptance of new technology has resulted in several theoretical models, with roots in information systems, psychology, and sociology, that routinely explain over 40 percent of the variance in individual intention to use technology (Venkatesh et al., 2003). Among the most influential theories in the IS field is the Technology Acceptance Model – TAM. For the investigation of psychological factors influencing actors' decisions and behaviors the Theory of Planned Behavior - TPB has been widely used.

2.1. Technology acceptance models in agricultural studies

Regarding the acceptance and use of technology in a business environment, especially information and communication technology (ICT), there is substantial theoretical and empirical support toward the Technology Acceptance Model (TAM). The TAM, adapted from the Theory of Reasoned Action (Ajzen and Fishbein, 1980) and originally proposed by Davis (1986), is considered the most influential and commonly employed theory for describing an individual's acceptance of information systems (Lee et al., 2003). TAM theorizes that an individual's behavioral intention to use a system is determined by two beliefs: perceived usefulness, the extent to which a person believes that using the system will enhance his or her job performance, and perceived ease of use, the extent to which a person believes that using the system will be free of effort (Venkatesh and Davis, 2000).

According to TAM, perceived usefulness (PU) is also influenced by perceived ease of use (PEOU) because, other things being equal, the easier the system is to use, the more useful it can be. TAM 2 (Fig. 1), which is an extension of the technology acceptance model by Venkatesh and Davis (2000), explains perceived usefulness and usage intentions by introducing two additional theoretical constructs: social influence processes (subjective norm, experience, voluntariness, image) and cognitive instrumental processes (job relevance, output quality, result demonstrability).

Although TAM 2 has been broadly used in various disciplines it appears at a lesser extent in agricultural studies. Some examples, using mostly the earlier TAM, are: the examination of technology adoption in dairy farming (Flett et al., 2004), the investigations into the perception and attitudinal characteristics of farmers who plan to adopt precision agriculture (Adrian et al., 2005), the research about the applicability of TAM to agriculturist's acceptance of a knowledge management system in agricultural extension services (Folorunso and Ogunseye, 2008), the prediction of factors affecting intention to adopt precision agriculture technologies among agricultural specialists (Rezaei-Moghaddam and Salehi, 2010), the study of the major factors influencing the investment behavior of agribusiness firms concerning tracking and tracing schemes (Heyder et al., 2010), experimental evaluation of a decision-support system for monitoring crops using technologies such as wireless sensor networks with a group of potential users (Cardenas Tamayo et al., 2010), explaining the difficulties of precision agriculture technology adoption (Aubert et al., 2012) or measuring the volitional aspect of the ICT adoption behavior of young entrepreneurs in a rural community (Zaremohzzabieh et al., 2015).

As stated before, although TAM is a powerful and robust predictive

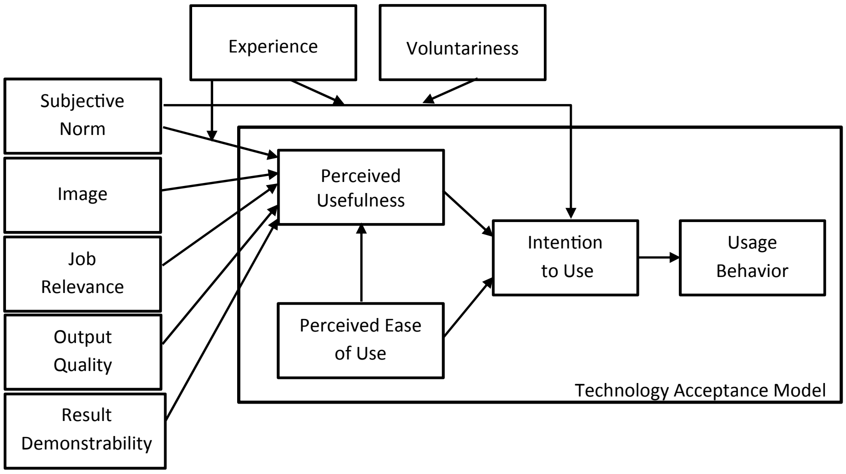

Fig. 1. TAM 2 – extension of the Technology Acceptance Model (Venkatesh and Davis, 2000).

model, and its simplicity is valued by many (King and He, 2006), at the same time, it has been questioned by others (Yang and Yoo, 2004; Schepers and Wetzels, 2007; Bagozzi, 2007b; Turner et al., 2010).

2.2. Behavioral approaches in agricultural studies

Behavioral approaches in agricultural studies are not new. They cover a broad range of studies that employ actor-oriented quantitative methodologies to the investigation of decision-making. Burton (2004) described three characteristics of these approaches: (a) they seek to understand the behavior of individual decision-makers, (b) focus on psychological constructs such as attitudes, values, and goals but also commonly gather additional relevant data on farm structure, economic situation, etc. and (c) employ largely quantitative methodologies, in particular psychometric scales such as Likert-type scaling procedures for investigating psychological constructs.

For the investigation of psychological factors influencing actors' decisions and behaviors in the agri-food chain, the theory of planned behavior (TPB), developed by Icek Ajzen, has been widely used (Fig. 2).

3. Model development

TAM and TPB theories and models have been considered as important theoretical background for research about individual user's reaction and behavior upon IT and other technology adoption (Lee et al., 2003; King and He, 2006). While their model constructs or theory concepts have been approached in different ways, some researches combine TAM and TPB to establish an adapted framework in different technology, organization or user population context (Taylor and Todd, 1995; Venkatesh et al., 2003; Riemenschneider et al., 2003; Gong and Yan, 2004) while others (e.g., Bagozzi, 2007b) have called for alternative theoretical mechanisms in predicting technology use.

Inspired by the work of Heyder et al. (2012), who investigated the investment behavior of traceability systems in German agribusiness companies, and based their theoretical model on the TAM 2, we delve into the theory and elaborate further, combining some core constructs from the TAM 2 and TPB models. While TAM has consistently outperformed the TPB in terms of explained variance across many studies, its parsimony has created limitations and essential determinants of decisions and action have been overlooked (Bagozzi, 2007b). TAM 2 is an improved version toward lifting these limitations but could arguably benefit from the behavioral approach of the TPB based on psychological constructs (Burton, 2004).

Considering their complementary advantages and disadvantages we argue that a combination strategy in applying these theories could enhance the understanding of ETsystems adoption in an agri-food sector in a way that, the proposed model is managerially relevant, pointing to specific factors that may influence adoption and use and

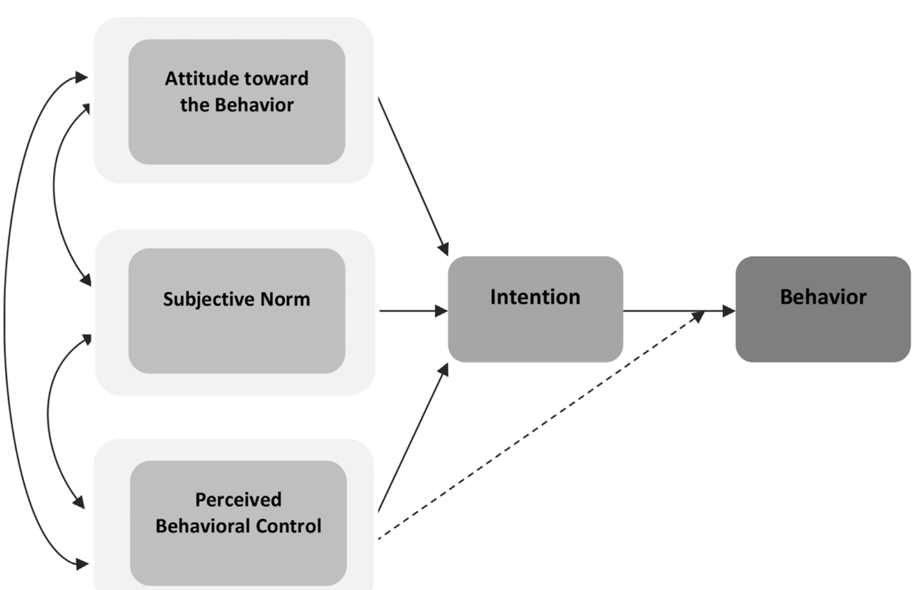

Fig. 2. Theory of planned behavior (TPB) (Ajzen, 1991).

may be manipulated through implementation strategy, that is of interest for policy makers and regulators.

3.1. Theoretical model

In this study, our theoretical model proposes a combination of TAM2 and TPB conceptualizing that the constructs of TAM2 should be incorporated in the TPB model. The basic assumption of the proposed model is that, the behavior of installing and operating an ETsystem is caused by the actors intention to do so, which is influenced by (1) the subjective norm that is expressed through perceived 'image', 'external pressure' and 'voluntariness' regarding installation and operation of ETsystems, (2) the attitude of decision makers, which are formed by the perceptions about 'output quality', 'job relevance' and 'result demonstrability' (cognitive instrumental processes) of the ETsystems and subjective perceptions concerning their usefulness, and (3) perceived behavioral control formed by 'perceived ease of use' and 'perceived control of costs/resources'.

The rationale for a direct effect of subjective norm (social influences) on 'Intention', is that people often choose to perform a behavior when one or more important referents say they should, and they are sufficiently motivated to comply with the referents, even though they do not like or believe in it (Schepers and Wetzels, 2007). The causal mechanism underlying the effect of subjective norm on 'Intention' in mandatory settings and some voluntary settings was referred to in Venkatesh and Davis (2000) as 'compliance'. They theorized the direct compliance effect of subjective norm on 'Intention' to operate whenever an individual perceives that a social actor wants him or her to perform a specific behavior, and the social actor has the ability to reward the behavior or punish non-behavior.

In our model the 'compliance' is reflected through the variable "External Pressure". It expresses the degree to which the ETsystem is perceived as necessary due to competitive pressure or expectations/demands of trading partners, and measures the social/business influences of our respondent's intention to install and operate an ETsystem in the dairy sector in a voluntary, versus a mandatory, context of the technology and correlates to the 'subjective norm' of TAM2.

We test the hypothesis that, the higher the perceived external pressure to operate an ETsystem, the higher is the intention to invest/install and operate one in a voluntary context (H1 and H2). This is due to the lack of regulatory or sectorial obligations in the dairy sector, other than the safety related provisions of Regulation (EC) 178/2002 that do not go beyond one step back and one step down.

We theorize that, the other social influence of "Image", the degree to which the installation and use of an ETsystem is perceived to enhance one's image or elevate one's status within the market (Moore and Benbasat, 1991), is not expected to have a direct effect on intention to install and operate an ETsystem but rather an indirect effect through the contribution to a positive "Attitude towards the installation" that has a direct positive effect on Intention (H3). This social influence is described as "identification" and occurs when an individual accepts influence because he wants to establish or maintain a satisfying image/status within a reference group (Kelman, 1958). This influence resulting from enhanced image or elevated status provides a more favorable attitude toward the intention to install and operate an ETsystem. An actor's perception in the dairy chain that, using an ETsystem will lead to image/status enhancement, over and above any performance benefits, directly attributable to the ETsystem use and indirectly to improvements in job performance, effects a more favorable attitude toward the intention to install and operate an ETsystem.

The theoretical mechanism of 'Internalization' is also included in TAM2 and incorporated in our model. The 'Internalization' refers to the process by which, when one perceives that an important referent thinks she or he should use a system, one incorporates the referent's belief into her or his own belief structure and value system (Venkatesh and Davis, 2000). We incorporate and test 'Internalization' in our model through the hypothesis that perceived "External Pressure" has a direct positive effect on "Attitude towards the Behavior" (H4).

In TAM2, in order to distinguish between mandatory and voluntary usage settings, the model posits voluntariness as a moderating variable. Our study is in line with those studies that incorporate voluntariness as a direct effect on "Intention", in order to account for perceived non-voluntary adoption (Venkatesh et al., 2003). Additionally, we tested the moderating effect on the predictor variable "Perceived External pressure" (H5).

Based on the above, the first set of hypotheses, reflecting the subjective norm of the proposed model, is:

H1 and H2. The perceptions about 'External Pressure' and 'voluntariness of use' have each of them a significant direct positive effect on 'Intention to install and operate' an ETsystem

H3 and H4. 'Image' and 'External Pressure' have a significant direct positive effect on 'Attitude' towards installation and operation of an ETsystem

H5. 'Voluntariness' has a moderating effect on 'External pressure'

After subjective norm, the second core construct influencing behavioral intention of the proposed model, in analogy to the TPB, is the "Attitude toward the behavior" of installing and operating an ETsystem. In TAM2 attitude is considered to have little value in predicting technology use, leaving the two users' beliefs — PU and PEOU — as powerful and parsimonious predictors (Yang and Yoo, 2004). We measure the attitude as a second order reflective-formative construct resulting after a repeated indicator approach on a four-item construct of "Perceived usefulness" and the single-item variables of "Output Quality", "Relevance", "Result Demonstrability" of an ETsystem. We argue that these variables, originating from TAM2, are dimensions and form the "Attitude towards the behavior" of installing and operating an ETsystem which has a significant direct positive effect on the 'Intention' to install and operate one (H6).

Increasing profitability is the main motivation that stimulates the use of a new technology (Pierpaoli et al., 2013). Perceived usefulness defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989) conveys this meaning together with other interrelated like, job effectiveness or productivity.

In pursuing to determine the behavior of installing and operating an ETsystem in an agri-food chain, we consider perceived usefulness, e.g. expected benefits, as one dimension of the "Attitude toward the behavior" exerting a direct positive effect (H7).

The next dimension of attitude in the proposed model is the "output quality" (Davis et al., 1992) that represents perceptions about how well and reliable the ETsystems are performing. Judgements about output quality could be considered as a kind of profitability test in which one would prefer to choose a system that delivers the highest output quality among multiple relevant systems and thus form a more favorable attitude toward the usage of this system (H8) (Venkatesh and Davis, 2000). Concerning ETsystems, output quality refers to the reliability and technical capabilities of the systems (Heyder et al., 2010). Of predominant importance is how reliable information management will take place and that, depends on technical aspects (e.g. unintentional mixture of batches and loss of tags or other product labels) as well as on human behavior (e.g. probability of opportunistic behavior) (Theuvsen and Hollmann-Hespos, 2005).

After output quality, the next dimension of attitude is "relevance". It is defined, in accordance with Venkatesh and Davis (2000), as an individual's cognitive judgement regarding the degree to which the ETsystems are applicable to his or her establishment. Perceptions about relevance could be considered as a kind of compatibility test since systems that are judged not to be job-relevant are eliminated from further adoption consideration. This led to the hypothesis that 'relevance' has a direct positive effect on attitude (H9).

The fourth dimension, that forms the attitude toward the installation and operation of ETsystems, is "Result demonstrability" of their use, vis-à-vis external stakeholders or any interested party. The variable communicates the degree to which an individual believes that the results of using a system are tangible, observable, and communicable (Moore and Benbasat, 1991). If positive results are produced through the installation and operation of an ETsystem but a farmer or a processor cannot readily observe, communicate or promote them to other actors in the dairy chain or the consumers, they will unlikely have a favorable attitude toward using them (H10).

Based on the above, we derived the following hypotheses:

H6. The 'Attitude' towards the installation and operation of an ETsystem has a significant direct positive effect on the 'Intention' to install and operate one

H7 to H10. 'Received Usefulness', 'Output quality', 'Relevance' and 'Result Demonstrability' have an indirect effect on 'Intention' to install and operate an ETsystem

The conceptualization of the four variables, originating from the TAM2, as determinants of the overall "Attitude toward the Behavior", that is one of the three conceptually independent constructs of TPB, is proposed in order to capture a more abstract construct, present theoretical parsimony but also to test the variance explained. Justification for this is based on at least two grounds: (i) the fact that our investigation does not concern individual's acceptance of a technology (scope of TAM2) but rather a decision procedure of a higher management level about installing and operating a new technology that needs a behavioral approach (TPB) considering attitude and (ii) prior research that did not find, through testing of a refined TAM2, significant direct effects of "Output quality" or "Results Demonstrability" on perceived usefulness of tracking and tracing systems (Heyder et al., 2012) but, did not investigate the effects these have on attitude within the TPB.

'Perceived behavioral control' encompasses perceptions of resource and technology facilitation conditions, similar to self-efficacy (SE) in social cognitive theory (SCT) (Gong and Yan, 2004). In our model, the "Perceived Control of Behavior" was also formulated as a second order reflective-formative construct incorporating 'perceived ease of use' and 'perceived control of costs/resources', the latter being measured through indicators reflecting the "Perceived costs" and the "Perceived resources" (Fig. 3). We argue that the 'perceived control' over the conditions that facilitate an investment in an ETsystem is determined by the perceived ease or difficulty of performing the investment and the perceptions of the internal and external constraints. Hence:

H11 and H12. 'Perceived control of Behavior' has a significant direct positive effect on 'Intention' to install and on the 'Behavior of installation and operation' an ETsystem

H13 and H14. 'Perceived Ease of Use' and 'Perceived Control of Costs/Resources' have a direct positive effect on 'Intention' to install and operate an ETsystem

Our theoretical model belongs to the research stream that employs intention and/or usage (behavior) as the key dependent variable. Our goal is to understand the behavior of implementing and operating an ETsystem in an agri-food chain as the dependent variable. Therefore the last, but not least, hypothesis of this study is:

H15. 'Intention' to install and operate an ETsystem has a direct positive effect on the 'Behavior of installing and operating an ETsystem

An essential limitation of the existing technology acceptance models reviewed by Venkatesh et al. (2003), including TAM2, was the fact that the technologies were relatively simple, individual-oriented information technologies as opposed to more complex and sophisticated organizational technologies, that are the focus of managerial concern, as are the ETsystems. The latter affected the measurement scales that had to be adjusted due to our study's focus on the acceptance of ETsystems by a whole organization with respondents being the owners or senior management and not employees (individual end users) for which the said user acceptance models and related scales have been designed.

In Fig. 3 we present the path model of our proposed theoretical model that illustrates the research hypotheses and displays the variable relationships that will be examined. The measurement model, which consists of the relationship between the constructs and their respective indicators, is not particularly illustrated in order to project mainly the proposed theoretical model. The measurement model includes, except of reflective constructs, two formative constructs, namely that of 'attitude' and 'perceived control of behavior', thus our model is a formative model (Peter et al., 2007). Whereas with reflective indicators the direction of causality is from the construct to the indicators and changes in the underlying construct are hypothesized to cause changes in the indicators, with formative indicators the direction of causality flows from the indicators to the latent construct, and the indicators, as a group, jointly determine the conceptual and empirical meaning of the construct (Jarvis et al., 2003; Bagozzi, 2007a). In that context, based on studies that call for attention to avoid misspecification (Diamantopoulos et al., 2008), we argue that 'attitude' toward installing and operating an ETsystem and the 'perceived control' over this behavior are latent variables formed by their indicators/measures. We operationalize these core constructs of our model as a combination of the indicators that are not mutually interchangeable and that, if the assessment of the trait changes, all items, assuming they are equally coded, will not change in a similar manner (Chin, 1998). Description

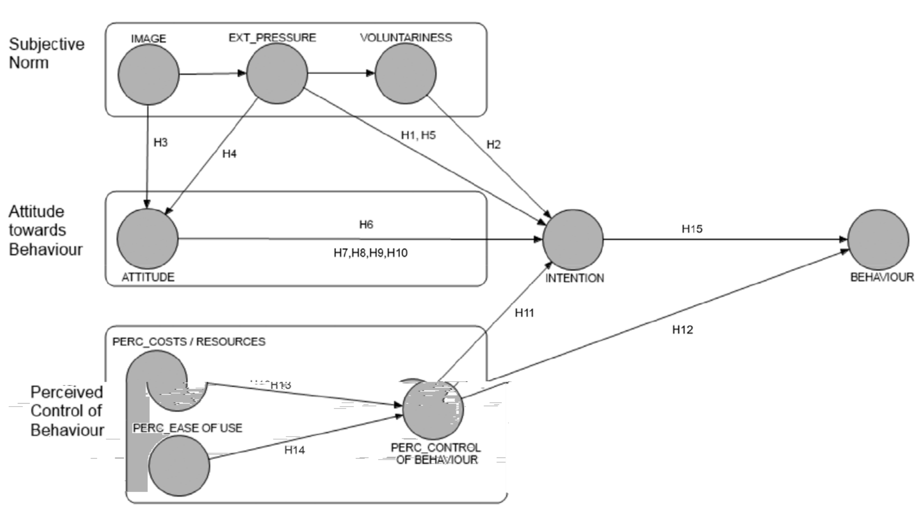

Fig. 3. Proposed theoretical model.

Table 1
Dimensions of model constructs, observed items and research hypotheses.

Variable/Construct	Description/Explanation	Indicator/Measurement Item/Statement	Hypotheses
Subjective Norm	**"The person's perception that most people who are important to him think he should or should not perform the behavior in question" (Fishbein and Ajzen, 1975)**		
Image	"The degree to which use of a technology/innovation is perceived to enhance one's image or status in one's social system" (Moore and Benbasat, 1991)	1. ETsystems are necessary for the certification of authenticity of dairy products 2. Establishments/Organizations that operate ETsystems have a better image in the market	**H1 and H2**: The perceptions about 'External pressure' and 'voluntariness of use' have each of them a significant direct positive effect on 'Intention to install and operate' an ETsystem **H3 and H4**: 'Image' and 'External Pressure' have a significant direct positive effect on 'Attitude' towards installation and operation of an ETsystem **H5**: 'Voluntariness' has a moderating effect on 'External pressure'
External Pressure	The degree to which the ETsystem is perceived as necessary due to competitive pressure or expectations/demands of trading partners	1. In our sector, ETsystems are not considered necessary [r] 2. Traceability will be asked more and more by both the market and the society [r]	
Voluntariness of use	"The degree to which use of the innovation is perceived as being voluntary, or of free will" (Moore and Benbasat, 1991)	There is no need to implement an ETsystem if there is no legal obligation[r]	
Attitude towards the Behavior ***(2nd order reflective-formative construct)***	**An individual's positive or negative feelings (evaluative affect) about performing the target behavior (Fishbein and Ajzen, 1975)**		
Perceived usefulness	Perceived usefulness of the ETsystem regarding the certification of dairy product's attributes, reducing problems related to their dairy products, improvement of input and output management, improvement of communication and cooperation with trading partners of the organization	1. The implementation and operation of an ETsystem will have a decisive contribution in the quality certification of our product/s 2. The implementation of an ETsystem will help reducing product/s problem occurring 3. With the implementation of an ETsystem we will improve input/output management 4. The implementation of an ETsystem will improve communication and cooperation with all our suppliers and customers	**H6:** The 'Attitude' towards the installation and operation of an ETsystem has a significant direct positive effect on the 'Intention' to install and operate one **H7 to H10:** 'Perceived usefulness', 'Output quality', 'Relevance' and 'Result Demonstrability' have a direct positive effect on 'Attitude' towards the installation and operation of an ETsystem
Output Quality	Perception that the installation of an ETsystem will guarantee that data management will always be reliable	The installation of an ETsystem guarantees that data recording and transmitting will always be reliable	
Relevance	Perception that the installation of an ETsystem is not relevant to their establishment *(recoded)*	The installation of an ETsystem is not relevant to our business activity [r]	
Result Demonstrability	Perception that it is important to be able to demonstrate the results of an ETsystem's use to any interested party (Moore and Benbasat, 1991)	It is important that the results of implementation of an ETsystem will be able to be demonstrated outside our establishment	
Perceived Control of Behavior ***(2nd order reflective-formative construct)***	**Refers to the perceived ease or difficulty of performing the behavior and reflects past experience as well as anticipated impediments and obstacles (Ajzen, 1991) and the perceptions of internal and external constraints on behavior**		
Perceived Ease of Use	The perception about the degree of effort the installation and operation of an ETsystem would require (Moore and Benbasat, 1991)	1. The installation and operation of an ETsystem will not be easy 2. For the installation and operation of an ETsystem training is needed that requires valuable time [r]	**H11 and H12:** 'Perceived control of Behavior' has a significant direct positive effect on 'Intention' to install and the 'Behavior of installation and operation' an ETsystem **H13 and H14:** 'Perceived Ease of Use' and 'Perceived Control of Costs/Resources' have s positive direct effect on 'Intention' to install and operate

Table 1 (*continued*)

Variable/Construct	Description/Explanation	Indicator/Measurement Item/Statement	Hypotheses
Intention to install and operate an Electronic Traceability System (ETsystem)			
Intention		1. The installation and operation of an ETsystem in our establishment would not have to offer much at this point [r] 2. We are not interested for an installation of an ETsystem in our establishment [r]	**H15:** 'Intention' to install and operate an ETsystem has a direct positive effect on the 'Behavior of installing and operating an ETsystem
Behavior of installing and operating an ETsystem	**The self-reported behavior/act of installing and operating an ETsystem as measured by asking about the actual 'state of the art' of the installation and operation in each establishment**		
Behavior	Self-reported usage behavior of ETsystems	1. We will not install and operate an ETsystem 2. The installation of a customized ETsystem is in the planning stage 3. We are in the installation phase of an ETsystem 4. We have already installed and operate an ETsystem	

* Recoded items.

and explanation of all variables and the respective indicators have been included in Table 1.

Regarding construct specification, we operationalize both "Attitude toward installing and operating an ETsystem" and the related "perceived behavioral control" as multidimensional constructs of Type II (reflective first-order, formative second order) (Jarvis et al., 2003) or otherwise reflective-formative hierarchical latent variables (Becker et al., 2012; Hair et al., 2013). Justification for the use of higher-order constructs is the more theoretical parsimony and the less model complexity (Becker et al., 2012).

The actual measurement items (indicators) of the latent variables, that were included in a questionnaire for collecting the necessary data, are an outcome of a procedure that involved a literature review and in-depth interviews with experts, rural extension agents and dairy union representatives who pretested the questionnaire. The statements were formulated to capture the respondents perceptions and the wording was based on previous related research about the investigation of investment behavior regarding traceability systems in the food industry (Heyder et al., 2012), although adapted to allow clear understanding for all respondents (dairy farmers and processors) acting in our study area. This procedure led to the change of the pilot 5point Likert scale as to allow all respondents to distinguish between the response options in a meaningful and harmonized way. Respondents were asked to indicate on a 3point Likert scale, for all variables (except behavior), the extent to which they agreed with the proposed statements. The end point 1 had the heading "Disagree", the middle point 2 had the heading "Neither Agree nor Disagree" and the end-point 3 had the heading "Agree". Three point Likert scales have been used in previous research literature and are arguably good enough (Jacoby and Matell, 1971). Both reliability and validity are independent of the number of scale points used for Likert-type items (Matell and Jacoby, 1971). Furthermore, we evaluated our measurement model for reliability and validity and made necessary adjustments to it concerning the indicators used as suggested by the relevant literature and presented in more detail in section 4.1.

Regarding 'Behavior' we employed self-reported, as opposed to objectively measured, usage by asking about the possible phase of the installation and operation of a farm- or firm-specific ETsystem, knowing the controversial point of the self-report measures of the behavioral construct (Straub et al., 1995; Lee et al., 2003). However, we believe that the research of technology acceptance (including ours) is ultimately concerned with explaining and predicting the users' behavioral intention, that determines people's behavior, so that the emerging factors influencing behavioral intentions can provide useful insight to strategically plan interventions and policies toward increasing intentions and subsequently actual use of the technology. We argue that self-reported behavior in our study does serve this goal.

3.2. Sampling

The respondent's geographical distribution covered the main milk production areas of Greece. Farmers and processors producing or processing milk from any dairy animal (cow, sheep or goat) were included. The basic demographics concerning age were similar between the farmers and the processors. Approximately half of them were up to the age of 45 and the rest above 45 up to 69. That was not the case, as expected, with the level of education. Whereas 53.1% of the processors had a college or university degree, the respective percentage for the farmers was only 8% (39.9% of farmers had obtained only primary education that accounted mostly for the elder respondents). The percentage of income from milk production at the farm level was between 15% and 100% with a mean value of about 68%. At the processing level, milk is processed mainly to cheese (by 74,5% of the processors of which 61.7% are producing products with protected denominations of origin-PDO). Exporting does the 36.2% of the respondents.

The state of play, regarding IT systems usage by the respondents in general, was low. At the farm level, the only IT system that reached about 29% of usage by farmers was the animal identification system. Only about 9% of the farmers responded to operate a total herd management system. At the processor level one can observe a relatively

Table 2
Economic characteristics of the sample.

	farmers	processors
Number or employees[a]	5,50%	62%
Members of a cooperative	45%	6%
Implementing funded development program	58,50%	51%

[a] Percentage of respondents with 0–5 employees including family members where applicable.

higher diffusion of IT systems. The IT systems for storage management were the most accepted, with about 33% of the respondents stating to use them, followed by IT systems for monitoring/managing production with about 22%. Only 15.6% of the processors stated to operate an integrated electronic traceability system and even less, only 8.9%, stated RFID usage for their products.

Further comparable economic characteristics of both farmers and processors in the sample are presented in Table 2.

3.3. Data collection and handling

Based on data of the milk sector's structure, obtained from the competent public authorities in Greece, 32 out of the 51 perfectures, being the main milk production areas, were selected as the study area of the research. As the population of interest, which consisted of the dairy farmers and processors, was very large for the execution of the survey a convenience sample was used. A questionnaire that was first pre-tested, as previously stated in section 3.1 for comprehensibility, clarity of language, ease of use and common terminology understanding (familiarity of terms), was prepared. Extra care to minimize possible response bias and consistency artifacts was given through counterbalancing questions order (Podsakoff et al., 2003). Additionally, a cover letter accompanied the questionnaire, explaining the scope and the intentions of it, together with the reassurance of the respondents that there is no right or wrong answer. The questionnaires were completed anonymously (Podsakoff et al., 2003).

For delivering the questionnaires we proceeded with a mix of methods in order to increase response rate. Due to the very large target population, we sent the questionnaires by post or electronically (e.g. e-mail) to selected milk farmers' union representatives and milk buyers/processors throughout the main milk production areas of Greece (complete list was available from the competent authorities) with the help of rural extension agents. In certain cases, these governmental agents did a handout of questionnaires or conducted face-to-face interviews of individual farmers. All in all, our sample was a convenience sample with a purpose. A justifiable use for a convenience sample is for exploratory purposes, that is, to get different dimensions of a problem, to probe for possible explanations or hypotheses, and to explore constructs for dealing with particular problems or issues (Ferber, 1977), exactly the scope of this study. Moreover, our sample, (1) is entirely relevant to the population of interest, (2) has an adequate sample size for analysis with PLS-SEM and (3) serves the analytical purpose.

The mail survey process resulted in the collection of 188 questionnaires that enabled us to proceed with the PLS analysis. The response rate of our questionnaire administration procedure is estimated at about 30%.

Independently of the statistical analysis chosen the sample size adequacy has been calculated with an online tool for a 95% confidence level (http://www.surveysystem.com). Based on the percentage of the respondents that picked the same statement, that is mostly over 50%, the confidence interval is 7.14%, meaning that we can be 95% sure that the real percentage of the whole population lies between 43% and 57%.

The data was screened for missing values (outliers were not an issue due to the usage of an ordinal 3point Likert scale). Cases with more than 10% non-response were deleted resulting in 152 usable cases that did not diminish statistical power. This number is in compliance with the "10-times rule of thumb" for the PLS-SEM analysis. That means that the minimum sample size should be equal to 10-times the largest number of structural paths directed at a particular construct in the structural model or equivalently 10-times the maximum number of arrowheads pointing at a latent variable anywhere in the PLS path model (Hair et al., 2014). There was no issue of high proportion missing data on just a single variable. After the deletion of the above-specified cases, the rest of missing data on certain items was handled using median replacement due to the Likert scale applied because means are less meaningful with these scales (Gaskin, 2016).

3.4. Estimation strategy

We estimate our model and its prediction power using PLS analysis, a component-based structure equation modeling technique-SEM. In contrast to covariance-based SEM, PLS-SEM is a prediction-oriented variance-based approach that focuses on endogenous target constructs in the model and aims at maximizing their explained variance (i.e., their R-square value) and thus, is the preferred method when the research objective is theory development and prediction (Haenlein and Kaplan, 2004; Hair et al., 2011a; Hair et al., 2012a; Hair et al., 2012b; Ringle et al., 2012; Hair et al., 2014). PLS–SEM is better at identifying population relationships and more suitable for exploratory research purposes – a feature that is further supported by the less restrictive requirements of PLS-SEM, in terms of model complexity and data characteristics (Chin, 1998; Hair et al., 2012a).

The hypotheses of the study that have been summarized in Table 1 serve only as a starting point to theory development through estimating numerous configurations of the model in the course of learning about the data and the phenomena underlying them. We adopt an exploratory approach, although the distinction, between confirmatory and exploratory techniques, is not always clear-cut (Chin, 2010). We use an exploratory technique (PLS-SEM) but there is an existing conceptual framework (hypotheses of existing theories and concepts) that influences our decisions and the alternative routes that we seek to confirm.

PLS-SEM is particularly appealing when the research objective is to predict and explain the variance of key target constructs (e.g., 'Intention' to install and operate an ETsystem and the 'Behavior' of installing and operating one) by different explanatory constructs (e.g., perceived external pressure, attitude towards the behavior, perceived control of behavior). PLS-SEM is also attractive when the sample size is relatively small and/or the available data is non-normal (Chin, 1998; Hair et al., 2011b; Ringle et al., 2012). Moreover, formatively measured constructs are particularly useful for explanatory constructs of key target constructs (e.g., second order hierarchical component constructs of "Attitude" and "Perceived Control of behavior" in our study) and easily handled with PLS-SEM (Chin, 1998, 2010; Peter et al., 2007; Wetzels et al., 2009; Becker et al., 2012) In contradiction, attempts to explicitly model formative indicators in covariance-based SEM analysis have been shown to lead to identification problems with efforts to work around them generally unsuccessful (Chin, 2010). PLS-SEM is the preferred alternative over CB-SEM in these situations, since it enables the creation and estimation of such models without imposing additional limiting constraints (Chin, 2010; Hair et al., 2011b, 2012b; Peng and Lai, 2012; Lowry and Gaskin, 2014).

PLS-SEM works efficiently with small sample sizes and complex models and makes practically no assumptions about the underlying data (Marcoulides et al., 2009; Urbach and Ahlemann, 2010; Hair et al., 2014). As mentioned, PLS-SEM can easily handle reflective and formative measurement models, as well as single-item constructs and different scale types (e.g. ordinal, as Likert scales), with no identification problems (Hair et al., 2014).

Considering all the above, we chose for our analysis the statistical program SmartPLS version 2.0.M3, developed by the Institute of Operations Management and Organization of the University of Hamburg (Ringle et al., 2005).

After modeling the hypotheses we evaluated the measurement model for reliability and validity and made necessary adjustments to it concerning the indicators used. In a second stage we applied a mixture of the repeated indicator approach and the use of latent variable scores in a two-stage approach to form our two, second order reflective-formative constructs of 'Attitude Towards Behavior' and 'Perceived Control of Behavior' (Hair et al., 2014; Lowry and Gaskin, 2014). We tested the structural model relationships and performed a Power Analysis in order to evaluate the statistical power of our calculations (the ability to detect and reject a poor model). Multigroup Group Analysis was applied for the two main groups of our study, because we claim

Table 3
Results summary for the reflective measurement model assessment.

Latent Variables	No of Indicators	Loadings[a]	Indicator Reliability[b]	Composite Reliability[c]	AVE[d]	Discriminant Validity[e]
Image	1	0,72	0,518	0,724	0,567	YES
	2	0,78	0,608			
ExtPressure	1	0,87	0,757	0,767	0,624	YES
	2	0,70A	0,493B			
PercUsefullness	1	0,83	0,689	0,902	0,696	YES
	2	0,85	0,723			
	3	0,84	0,706			
	4	0,82	0,672			
PercEaseOfUse	1	0,87	0,757	0,856	0,748	YES
	2	0,86	0,740			
PercCosts/Resources	1	0,76	0,578	0,842	0,571	YES
	2	0,78	0,608			
	3	0.71	0,504			
	4	0.77	0,593			
Intention	1	0,79	0,624	0,836	0,719	YES
	2	0,90	0,810			

A and B After analyzing the impact of indicator deletion on AVE, composite reliability and content validity, indicator was retained.
[a] Loadings > 0,708.
[b] Indicator Reliability (Item Communality) > 0,50.
[c] Composite Reliability > 0,708.
[d] AVE > 0,50.
[e] Discriminant validity: a) The square root of the AVE of each construct should be higher than its highest correlation with any other construct (Fornell-Lacker criterion), b) An indicator's outer loadings on a construct should be higher than all its cross loadings with other constructs.

that the most important heterogeneity factor of our data is the difference between dairy farmers and dairy processors. Significant differences were calculated using the PLS-MGA approach described in Hair et al. (2014). Interaction terms were generated and the related paths tested for significance using the bootstrapping method available in SmartPLS.

4. Data analysis and results

4.1. Evaluation of the measurement model

Assessment of the model's latent variables with reflective measurements included (1) individual indicator reliability, (2) composite reliability to evaluate internal consistency, and (3) average variance explained (AVE) to evaluate convergent validity. In addition, the (4) Fornell-Lacker criterion and cross loadings were used to assess discriminant validity (Chin, 2010; Hair et al., 2014; Lowry and Gaskin, 2014). The results are summarized in Table 3 and document the fulfillment of each criterion.

For the two second order reflective-formative constructs the internal consistency concept is inappropriate and assessing convergent and discriminant validity using criteria similar to those associated with reflective measurement models is not meaningful. Establishing content validity and ensuring that the formative indicators capture all (or at least major) facets of the construct is advised (Jarvis et al., 2003; Peter et al., 2007; Diamantopoulos et al., 2008; Wetzels et al., 2009; Hair et al., 2014).

As already stated, we assessed, positively, first the appropriateness of the lower first-order reflective constructs that form the second order higher constructs. Next, for the assessment of the higher-order constructs, different from that of the first-order constructs, the role of the weights and loadings in the analysis are not obtained from the relations between higher-order construct and manifest variables, but from the relations between higher-order construct and lower-order constructs. This distinction is especially important if the repeated indicator approach is used, as the weights and loadings are now represented by the path coefficients between higher-order and lower-order constructs, and not by the manifest indicators that are repeated at the construct level (Becker et al., 2012). Following the above, we performed the bootstrapping procedure in Smart PLS to test the significance of the path coefficients in our two second order formative constructs and found them all significant. Additionally, we tested for collinearity issues among the lower order first constructs for both the second order constructs and found the variance inflation factor - VIF < 3 which is acceptable and indicates no collinearity issues (Hair et al., 2014). The R^2 values for ‘Attitude towards Behavior’ and ‘Perceived Control of behavior’ are 0.526 and 0.999, respectively.

4.2. Evaluation of the structural model

The assessment of the structural model involved examination of the model's predictive capabilities and the relationships between the constructs. Before these evaluations, we examined the structural model for collinearity because the path coefficients may be biased if the estimation involves significant levels of collinearity among predictor constructs (Peter et al., 2007; Hair et al., 2012b, 2014).

All VIF values are clearly below the threshold of 5 and therefore collinearity among the predictor constructs is not an issue in our structural model (Table 4).

After running the PLS-SEM algorithm we obtained the path coefficients that estimate our structural model relationships. The path coefficients were tested for significance, which depends on their standard error that is obtained by means of bootstrapping in SmartPLS. The bootstrap standard error allows computing the empirical t value. When the empirical t value is larger than the critical value we can say that the path coefficient is significant at a certain significance level. Commonly used critical values for two-tailed tests are 1.65 (significance level 10%), 1.96 (significance level 5%) and 2.57 (significance level 1%). The path coefficients and their respective significance are shown in our final predictive model of the intention and the behavior of installing and

Table 4
Collinearity assessment.

Construct “Intention”		Construct “Behavior”	
Predictor constructs	VIF	Predictor constructs	VIF
External Pressure	1,640	Intention	1,535
Attitude Towards Behavior	1,749	Perceived Control of Behavior	1,535
Perceived Control of Behavior	1,250		
Voluntariness of Use	1,341		

operating an ETsystem in the dairy sector (Fig. 4).

All direct path coefficients are significant at 1% probability of error except the ones representing the relationship of the variables "External Pressure" and "Voluntariness" towards the "Intention" construct that are found not significant confirming prior research about the effect of the subjective norm in non-mandatory setting, as in our case (see Section 3.1). Not significant was also the tested interaction term with 'Voluntariness' as the moderator variable and 'External Pressure' as the predictor variable on the target variable of 'Intention' and therefore not included in the final model. We confirmed these findings about the non-significant relationships with a post hoc statistical power analysis. Total effects (the sum of direct and indirect effects) were also evaluated.

The R^2 values for our endogenous key latent variables 'Intention to install and operate an ETsytem' and 'Behavior of installing and operate one' are 0.469 and 0.355 respectively, and are satisfactory given the number of latent variables but also results of prior research (Heyder et al., 2012).

Next, in addition to evaluating the magnitude of the R^2 values, as a criterion of predictive accuracy, we examined the Stone-Geisser's Q^2 value as an indicator of the model's predictive relevance by using the blindfolding procedure with the cross-validated redundancy approach in SmartPLS. Q^2 represents a synthesis of cross-validation and function fitting and is a recommended assessment criterion for PLS- SEM applications (Chin, 1998, 2010; Peng and Lai, 2012; Hair et al., 2012b, 2014). The Q^2 value of our key target reflective constructs, the 'Intention' and the 'Behavior', is 0.4642 and 0.3548 respectively, which imply that our model has predictive relevance for these constructs.

Finally, we proceeded with the multigroup analysis PLS-MGA for Group 1 (the dairy farmers - 108 cases of the sample) and Group 2 (the dairy processors - 44 cases of the sample) to find out whether there is a significant difference between the path coefficients in the model for each group using the parametric approach after testing for equality of standard errors in the population. The results are presented in Table 5.

4.3. Results

As can be seen in Fig. 4, all hypotheses could be confirmed through the significance test of the calculated path coefficients except hypotheses H1 and H2. The perception about the 'External Pressure' and 'Voluntariness of use' an ET system in the dairy sector found to not have a significant direct positive effect on 'Intention' (hypotheses H1 and H2 respectively rejected). No significant interaction term was identified either (hypothesis H5 rejected). That means that, when the ETsystems are not obligatory, as in the dairy sector studied, the 'Intention' to install and operate an ETsystem and subsequently the eventual 'Behavior' of the key deciding persons are not influenced significantly by any competitive pressure and are not considered as necessary, irrespective of what might the expectations of their trading partners be. In contrast to the lack of a significant direct effect there is a significant total e

The most important factor influencing the 'Intention' of installing and operating an ETsystem is the 'Perceived Control' of the act of installing and operating an ETsystem, being also the most important direct effect of the model. In terms of total effects the perceptions about the ability to control the costs of installing and operating an ETsystem have double the effect the perceptions about the 'ease of use' have. The same is valid also for the total effects on the actual 'Behavior' on which the 'Perceived control of Behavior', i.e. the perception about the control of the needed resources or costs and the controllable degree of effort the installation and operation of an ETsystem would require, has a direct positive effect in only a slightly lower level than the 'Intention'. But, if we sum the indirect effect through the 'Intention', the total effect of the 'Perceived Control of Behavior' is of higher importance. Altogether, hypotheses H11 to H14 are confirmed.

The multigroup analysis resulted in valuable knowledge about the differentiation between the factors influencing the dairy farmers' and the dairy processor's behavior regarding the installation and operation of an ETsystem. The most important, statistically significant, difference is the direct effect of 'perceived control of Behavior' on 'Intention'. For dairy farmers, the perception that they are able to control the costs, the resources or the overall effort needed for the installation and operation of an ETsystem is the most important contributor/predictor of the 'Intention' and has a much higher value than in the case of the dairy processors. For the dairy processors, the most important direct effect between the key constructs in the model is the effect of 'External Pressure' on 'Attitude' although overall the subjective norm ('External Pressure' and 'Image') has a stronger effect on the dairy farmers' 'Attitude' towards the installation and operation of an ETsystem. Especially, the direct effect of 'Image' on 'Attitude' is stronger for dairy farmers compared to dairy processors meaning that the identification mechanism (if important members of a person's social/business group believe that he or she should perform a behavior will tend to elevate his or her standing within the group) is more observable. Overall, the model predicted only 0.272 and 0.112 (R^2 values) of the variance for 'Intention' and the 'Behavior' for the dairy processors in comparison with the respective 0.538 and 0.341 R^2 values for the dairy farmers.

5. Discussion and conclusions

The model developed in this research, that is a mixed model combining TAM2 and TPB, illustrates the factors influencing the adoption of ETsystems in the dairy sector by highlighting the way the respective behavior of farmers and processors is formed. More specifically, we identified how their attitude toward the ETsystems, their normative beliefs and their perception about the ease or difficulty to adopt this technology influence their intention to eventually install and operate an ETsystem at the farm and processing level, respectively. Additionally, using PLS-SEM we were able to assess the relative importance of attitude, subjective norm and perceived control of behavior, as was the case in studies not applying structure equation modeling.

The most important factor influencing the 'Intention' of installing and operating an ETsystem in the dairy chain is 'Perceived Control' over the installation and operation of such a system. When dairy farmers and processors perceive the costs, the resources, or the overall effort required as being under their control, they are more willing to invest in an ETsystem. This effect is stronger in the case of dairy farmers than in the case of dairy processors. Burton (2004), in there reconceptualization of the behavioral approach in agricultural studies, affirm that, within agriculture, where farmers are subject to fluctuations in the physical, economic and political environments, perceived behavioral control can play an important role. In other studies, like that of Wauters et al. (2010) and Yazdanpanah et al. (2014), perceived behavioral control seemed not to be the major influence on farmers' intention and actual adoption of soil conservation practices and water conservation behavior, respectively. In contrast, Lynne et al. (1995) in a prior study about water saving technology adoption and technology investment behavior found perceived behavioral control to be important in explaining the decision and the actual behavior. Similarly, Borges et al. (2014) found that perceived behavioral control had a positive and significant effect on intention of farmers to improve natural grassland. In a comparable study about tracking and tracing systems in the food industry, Heyder et al. (2012), who studied investment behavior based only on TAM2, the hypothesized negative effect of perceived costs on the intention to invest could not be verified, although costs are considered a central determinant of investment decisions in agribusiness firm. Our conceptualization of perceived costs as a component of perceived behavioral control based on TPB and multigroup analysis featured a positive effect on intention to install and operate an ETsystem but at a lesser extent at the processors' firm level compared to the farm level.

Stronger for dairy farmers, than for the processors, is also the identification mechanism thus, their need to comply with their social/business group expectations. User acceptance research examining the direct effect of subjective norm on 'Intention' has yielded mixed results ranging from no significant effect of subjective norm on 'Intention' to a significant effect (Venkatesh and Davis, 2000). This is in line with other behavioral approaches in agricultural studies that found mixed results for the role of external pressure in that, not all important referents are perceived by actors to influence their decisions (Borges et al., 2014).

While previous investigations of actors' decision-making has focused on structural and demographic characteristics of farm and farmer or agribusiness firm the relevance of considering actors' psychological constructs has been demonstrated in many studies (Burton, 2004; Hansson et al., 2012). Siebert et al. (2006) developed a basic categorization of four factors that contribute to farmers' behavior: (1) farmers' willingness to participate; (2) farmers' ability to participate; (3) general social influences and (4) the effect of policy. In this study our proposed model has enabled inclusion of the attitudinal, social and practical constructs in the decision making process by incorporating TAM constructs into the TPB model, to provide useful and credible framework for predicting technology acceptance behavior.

One limitation of this research is the high dependence on sector characteristics. Yet, this limitation might be counterweighted by two important contributions relative to previous research. First, our approach uses knowledge and insights gained by both technological and behavioral sciences. Second, we extend the empirical basis of analysis with respect to supply chains and geographic regions, something that has been underlined as necessary to be researched (Frentrup and Theuvsen, 2009).

6. Policy implications and further research

Our research was able to shed light on the complicated procedure of strategic decision making for business operators regarding the implementation of a new technology and specifically an ETsystem along the dairy chain. This adoption of ETsystems has to be viewed as an innovation adoption that not only has to do with technology acceptance but a procedure that has to be accompanied by very important operational changes following a whole new approach in functioning. Data recording and information exchange along a large number of actors in a timely and precise manner are functions that require important intra-organizational changes. Yet, in order to add value to the whole agri-food chain, a collaborative environment or 'co-construction', as stated by Siebert et al. (2006), is necessary. Barriers to achieving chain-wide traceability are not merely technological, but also organizational. It is known that "harmonizing information standards and implementation of inter-operable technology is difficult, especially without strong legislative enforcement" (Wognum et al., 2011). Thus, organizational changes might have to be preceded by changes in the institutional environment and regulatory rules.

Our findings are useful to policy makers and regulators interested in the way traceability systems might be successfully integrated at the farm and processing level of an agri-food sector. The diverse acceptance factors have to be known and taken to account. First of all, the

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