

**A technology diffusion perspective of  
Enterprise Resource Planning across  
European Small and Medium Enterprises:  
from determinants to Use to Value**

por,

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**A technology diffusion perspective of  
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European Small and Medium Enterprises:  
from determinants to Use, to Value**

Tese Orientada por,  
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**Lisboa, Fevereiro de 2013**



## Abstract

There is a great interest among researchers and practitioners in *information systems* (IS) value. This is particularly important in cases of systems such as *enterprise resource planning* (ERP), as the use of these systems involves significant investment. This dissertation focuses on ERP post-adoption stages that build the foundation for a firm gain a competitive advantage to improve firms' performance. It consists of four inter-related chapters to investigate the determinants of ERP use and value among European *small and medium enterprises* (SMEs). In Chapter 2, drawing upon theories on the process and contexts of *information technology* (IT) we aim to explain ERP post-adoption impact on firms' performance. Grounded on the *diffusion of innovation* (DOI) literature we hypothesize how compatibility, complexity, efficiency, best-practices, training, and competitive pressure explain ERP use. Based on the *resource-based view* (RBV) theory we hypothesize how ERP use, collaboration and analytics explain ERP value and its consequences on Portuguese SMEs performance. Through structural equation modelling, a data set of 134 web-surveyed firms is used to test the nine hypotheses. Our empirical analysis leads to three main findings: 1) System compatibility, best-practices, complexity, and efficiency are more important determinants for ERP use than training and competitive pressure, suggesting that technological product characteristics are the main drivers of ERP use among Portuguese SMEs. 2) Similarly, collaboration and analytics are more important for ERP value upon use, suggesting that integrative characteristics are the main drivers of ERP value. 3) For Portuguese SMEs the mostly valued metric attained through ERP is management control.

In Chapter 3, we investigate the above integrative model in a different context and compared two countries (Portugal and Spain). Testing was conducted through structural equation

modelling, utilizing data from 558 web-surveyed firms, leading to three main outcomes: 1) Full sample analysis finds that competitive pressure, training, best-practices, compatibility, and efficiency are important antecedents of ERP use. Together with usage, collaboration and analytics capabilities contribute to ERP value. Cross-country analysis reveals that complexity is an important inhibitor for ERP use in Portuguese firms whereas it is a facilitator for Spanish firms. 2) While for Portuguese firms, compatibility and efficiency are significant, they are not for Spanish. For ERP value, while use and collaboration are more important for Portuguese firms, analytics is more important for Spanish. 3) Whereas approximately 70% of Portuguese firms responded that they had been using ERP for less than five years, while Spanish firms expressed only 40%.

In Chapter 4, grounded on the previous studies we made an effort to understand and measure the differences and similarities between two cultural disparate regions (Iberian vs Scandinavian). We assess the ERP use and value by using 883 SMEs surveyed, leading to four main outcomes: 1) Whereas for both regions, competitive pressure, efficiency, and best-practices are important factors to use ERP, analytics and collaboration are important factors for ERP value. 2) Whereas complexity and training are not relevant for ERP use among Scandinavian SMEs, they are facilitators for Iberian firms. 3) Whereas 65.1% of Scandinavian SMEs have used ERP for more than 5 years, 55.0% of Iberian SMEs have use it for less than 5 years. 4) Whereas for Scandinavian SMEs user satisfaction is considered as the important indicator of ERP value, for Iberian SMEs management control has the highest importance.

In Chapter 5, we investigate the ERP system capabilities effect of ERP value among different commercial products. Using a data set of 883 firms from Portugal, Spain, Denmark and

Sweden, we assessed three determinants of ERP value based on the RBV and evidenced differences and similarities among top four commercial ERP packages (Microsoft NAV, SAP All-in-one, ORACLE JDE and SAGE X3). Our empirical analysis leads to three main outcomes: 1) Whereas for Dynamics and ORACLE the most important factor is analytics system capability, for SAP and SAGE it is the greater collaboration system capability. 2) Furthermore, for SAP and ORACLE greater ERP use is perceived as an important factor, but not for Dynamics and SAGE. 3) Furthermore both collaboration and analytics capabilities are the greater differentiators to ERP value.

The research was informed by contextualist theory to organize our proposed research model. In epistemological terms, we adopted a posture characteristic of positivism. With regard to research methodologies we used the deductive method.

With this dissertation we intend to contribute to a better understanding of the determinants of ERP use and value at firm level. Unlike the typical focus on ERP adoption found in the literature, these studies focuses on post-adoption stages, linking actual use with value. This is the first empirical theoretically grounded research studying ERP across European SMEs, thus adding an international dimension to the IS literature, as well moving beyond dichotomous “adoption versus non-adoption”, and how firms find value from the top four commercial-packaged ERPs adding a real-world dimension the IS literature.

**Keywords:** *ERP, SME, diffusion of innovation, resource-based view, post-adoption, use, value, Europe.*



## Resumo

Actualmente o valor dos *sistemas de informação* (IS) é um assunto de elevado interesse entre a comunidade científica e profissional. Particularmente importante nos sistemas *enterprise resource planning* (ERP) uma vez que a sua adopção envolve avultados investimentos. A presente dissertação centra-se nos estágios pós-adopção do ERP, em particular no uso e valor, uma vez que são estes estágios que permitem o desenvolvimento efectivo de uma vantagem competitiva de forma a melhorar a performance da empresa. Consiste em quatro capítulos interrelacionados onde é investigado os determinantes do uso e valor do ERP entre as pequenas e médias empresas (PMEs) Europeias.

Fundamentado em teorias sobre processo e contexto das *tecnologias de informação* (IT), o Capítulo 2 pretende explicar o impacto do ERP (nos estágios de pós-adopção) na performance das empresas. Baseado na literatura sobre *difusão de inovação* (DOI) postula-se que a compatibilidade, complexidade, eficiência, melhores-práticas, formação e pressão competitiva explicam o uso do ERP. Baseado na *teoria baseada nos recursos* (RBV), postula-se que o uso do ERP, colaboração e capacidade analítica explicam o valor do ERP e sua consequência na performance das PME Portuguesas. Recorrendo à modelação de equações estruturais são testadas nove hipóteses de uma amostra de 134 empresas que responderam ao questionário ministrado via internet. A análise empírica revela três principais conclusões: 1) A compatibilidade do sistema, melhores-práticas, complexidade e eficiência são os factores mais importantes para o uso do ERP do que a formação e a pressão competitiva, sugerindo que as características tecnológicas do sistema são os principais determinantes para o uso do ERP entre as PME Portuguesas. 2) A capacidade analítica e de colaboração são factores mais importantes para o valor do ERP que o seu uso, sugerindo que

as características integradoras do sistema são os principais determinantes para o valor do ERP. 3) Para as PME's Portuguesas o indicador mais valorado do ERP é o controlo de gestão. No Capítulo 3, investiga-se o modelo anteriormente desenvolvido num contexto diferente, comparando assim dois países (Portugal e Espanha). Recorrendo a uma amostra de 558 PME's (134 Portuguesas e 424 Espanholas) são testadas as hipóteses do modelo. A análise empírica revela três principais conclusões: 1) A amostra total (558) revela que a pressão competitiva, formação, melhores-praticas, compatibilidade e eficiência são ascendentes importantes para o uso do ERP, enquanto para o valor do ERP a capacidade analítica, colaboração e o uso do ERP são ambos ascendentes importantes. 2) A análise entre países revela que enquanto para as PME's Portuguesas a complexidade é um importante factor inibidor para o uso do ERP, para as Espanholas é um factor facilitador. Enquanto para as PME's Portuguesas, compatibilidade e eficiência são significantes, não o são para as Espanholas. Em relação ao valor do ERP, enquanto o seu uso e colaboração são importantes para as empresas Portuguesas, a capacidade analítica do sistema é mais importante para as Espanholas. 3) Enquanto cerca 40% das PME's Espanholas responderam que utilizam o ERP à menos que cinco anos, 70% das Portuguesas responderam utilizar o ERP à menos de cinco anos.

No Capítulo 4, apresenta-se um estudo que pretende entender e medir as diferenças e semelhanças entre duas regiões culturalmente díspares (Ibéria e Escandinávia). O uso e o valor do ERP foram avaliados por uma amostra de 883 PME's questionadas via internet. A análise empírica revela quatro principais conclusões: 1) Enquanto para ambas as regiões a pressão competitiva, eficiência e melhores-práticas são factores importantes para o uso do ERP, a capacidade analítica e colaboração são factores importantes para o valor do ERP. 2) Enquanto para as PME's Escandinavas a complexidade e formação não são relevantes para o

uso do ERP, são por seu turno facilitadores para as empresas Ibéricas. 3) Enquanto cerca de 65% das PMEs Escandinavas utilizam o ERP há mais de cinco anos, apenas 45% das Ibéricas utilizam á mais de cinco anos. 4) Enquanto para as PMEs Escandinavas a satisfação dos utilizadores é o indicador mais importante para o valor do ERP, para as empresas Ibéricas é o controlo de gestão.

No Capítulo 5, investigamos os efeitos das capacidades do sistema no valor do ERP no contexto de quatro ERP comerciais líderes de mercado (Microsoft NAV, SAP All-in-one, ORACLE JDE e SAGE X3). Utilizando dados de 883 PMEs de Portugal, Espanha, Dinamarca e Suécia, avaliou-se três determinantes do valor do ERP baseado na RBV. A análise empírica revela três principais conclusões: 1) Enquanto para o Dynamics e ORACLE o factor mais importante é a capacidade analítica do sistema, para o SAP e SAGE é a sua capacidade de alavancar a colaboração. 2) Enquanto para o SAP e ORACLE uma elevada utilização do ERP é percebida com um factor importante para o valor do sistema, não o é para os sistemas Dynamics e SAGE. 3) Este estudo releva que as capacidades analíticas e de colaboração são os grandes factores diferenciadoras para o valor do ERP.

A presente investigação, assente na teoria do contextualismo estruturou o modelo de investigação proposto. Em termos epistemológicos, foi adoptada uma postura própria do positivismo. No que diz respeito às metodologias de investigação usámos o método dedutivo. Com esta dissertação pretende-se contribuir para um melhor conhecimento dos determinantes do uso e valor do ERP ao nível da empresa. Ao invés do foco comumente encontrado na literatura (intensão de adopção e factores críticos de sucesso à sua implementação), os estudos apresentados nesta dissertação focam-se nos estágios pós-adopção, vinculando o uso do ERP ao seu valor. Testado em diferentes contextos, o modelo apresentado é o primeiro

teoricamente fundamentado a estudar o ERP entre as PME Europeias, adicionando uma dimensão internacional à literatura de IS, ao mesmo tempo afasta-se da dicotomia “adoção vs. não-adoção”. Além disso proporciona uma evidência empírica de como as PME Europeias percebem o valor dos ERP comerciais líderes no presente mercado.

**Palavras-chave:** *ERP, PME, difusão de inovação, teoria baseada nos recursos, pós-adoção, uso, valor, Europa.*

# Publications

## List of publication resulting from this dissertation

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Ruivo, Pedro; Oliveira, Tiago; Johansson, Björn; Neto, Miguel, (2013) “Differential effects on ERP post-adoption stages across Scandinavian and Iberian SMEs”, *Journal of Global Information Management (JGIM)*, Vol. 21 Issue: 3, pp.1-20.

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# Index

<b>Chapter 1 – Introduction</b> .....	<b>1</b>
1.1. Motivation.....	1
1.2. Theoretical frameworks.....	3
1.3. Research focus.....	4
1.4. Research methodology .....	5
1.5. Path of research.....	7
<b>Chapter 2 – ERP post-implementation enhancements and determinants: examine use and value impact on Portuguese SMEs performance</b> .....	<b>11</b>
2.1. Introduction.....	11
2.2. Literature review and development of hypotheses.....	13
2.2.1. ERP post-implementation and Portuguese Small and Medium Enterprises.....	14
2.2.2. Post-implementation enhancements in ERP use and diffusion of innovation.....	15
2.2.3. Post-implementation enhancements in ERP value and resource-based view.....	19
2.3. Research method and results .....	24
2.4. Discussion .....	29
2.5. Conclusions.....	38
<b>Chapter 3 – ERP use and value: Portuguese and Spanish SMEs</b> .....	<b>40</b>
3.1. Introduction.....	40
3.2. Theoretical perspectives.....	41
3.2.1. ERP use and diffusion of innovation.....	41
3.2.2. ERP value and resource-based view .....	42
3.3. Research model and hypotheses.....	43
3.3.1. Hypotheses to explain use.....	44
3.3.2. Hypotheses to explain value.....	47
3.3.3. Hypothesis to explain the differences between countries.....	50
3.4. Research methodology and data.....	50
3.5. Data analysis and results .....	52
3.6. Discussion .....	57
3.7. Conclusion.....	63
<b>Chapter 4 – Differential effects on ERP post-adoption stages across Scandinavian and Iberian SMEs</b> .....	<b>65</b>
4.1. Introduction.....	65

4.2.	Theoretical foundation .....	67
4.2.1.	Diffusion of Innovation theory and IT use.....	68
4.2.2.	Resource-Based View theory and IT use .....	68
4.3.	Conceptual model and hypothesis.....	69
4.4.	Research methodology .....	76
4.5.	Results .....	78
4.5.1.	Measurement model .....	78
4.5.2.	Structural model .....	80
4.6.	Discussion and contributions .....	82
4.7.	Conclusions .....	87
<b>Chapter 5 – Enterprise resource planning value variations across commercial packages.....</b>		<b>89</b>
5.1.	Introduction .....	89
5.2.	Theoretical background.....	91
5.2.1.	Business value of ERP .....	91
5.2.2.	Resource-based view theory and ERP.....	92
5.3.	Conceptual model to assess ERP value.....	93
5.4.	Research method and data.....	97
5.5.	Results .....	99
5.5.1.	Measurement model .....	100
5.5.2.	Structural model .....	101
5.6.	Discussion .....	104
5.7.	Conclusions .....	110
<b>Chapter 6 – Conclusions .....</b>		<b>111</b>
6.1.	Contributions .....	114
6.2.	Limitations and future work .....	115
References.....		119
Appendix A. Items measurements .....		133

## List of Tables

Table 2.1. The characteristics of the Portuguese sample.....	26
Table 2.2. PLS factor loading, composite reliability, and average variance extracted	27
Table 2.3. Descriptive statistics, correlations and square root of the AVEs.....	28
Table 3.1. Characteristics of the samples (Full, Portugal and Spain) .....	52
Table 3.2. PLS factor loading, composite reliability, and average variance extracted of full and country samples.....	54
Table 3.3. Results of pooled error term t-Tests by subgroup (compare Portugal with Spain).....	58
Table 4.1. Characteristics of the samples (Scandinavian and Iberian).....	79
Table 4.2. Loadings, Descriptive statistics, CR, AVE constructs values, correlations and square root of AVEs.....	81
Table 4.3. Results of pooled error term t-Tests by subsamples (compare Scandinavian with Iberian).....	84
Table 5.1. Characteristics of the sample (N=883).....	100
Table 5.2. Characteristics of the sample by product.....	101
Table 5.3. Survey questions.....	101
Table 5.4. Item question Loadings, CR, and AVE construct values (products).....	103
Table 5.5. Descriptive Statistics, Correlations, and square root of AVEs (products).	103
Table 5.6. Results of test statistic comparisons between products.....	106



## List of Figures

Figure 1.1. Research focus.....	4
Figure 1.2. Studies covered in this dissertation to address ERP post-adoption.....	5
Figure 2.1. Research model to explain ERP use.....	16
Figure 2.2. Research model to explain ERP value.....	21
Figure 2.3. Research model to explain ERP use and value.....	24
Figure 2.4. Path model.....	29
Figure 3.1. Research model.....	44
Figure 3.2. Path models of full sample and by country.....	55
Figure 4.1. ERP post-adoption theoretical foundation.....	69
Figure 4.2. Integrative conceptual model.....	72
Figure 4.3. Path models of Scandinavian and Iberian SMEs.....	83
Figure 5.1. RBV framework applied to ERP.....	95
Figure 5.2. Conceptual model for assessing the ERP value.....	97
Figure 5.3. Path models by product.....	104



## Abbreviations

ABC	Activity-Based Costing
AIS	Accounting Information Systems
AN	Analytics
AVE	Average Variance Extracted
BD	Base de Dados
BI	Business Intelligence
BP	Best-Practices
CO	Collaboration
COGS	Cost of Goods Sold
CB	Compatibility
CP	Competitive Pressure
CRM	Customer Relationship Management
CR	Composite Reliability
CX	Complexity
DOI	Diffusion of Innovation
EDI	Electronic Data Interchange
EF	Efficiency
ERP	Enterprise Resource Planning
ERPU	ERP use
ERPV	ERP value
EU	European Union

FIFO	First In First Out
IDC	International Data Corporation
IO	Industrial Organization
INVT	Inventory Costs
IS	Information Systems
IT	Information Technology
KPI	Key Performance Indicators
OLAP	On-line Analytical Processing
PME	Pequenas e Médias Empresas
PLS	Partial Least Squares
SCM	Supply Chain Management
SEM	Structural Equation Modelling
SME	Small and Medium Enterprises
TAM	Technology Acceptance Model
TN	Training
RBV	Resource-Based View
ROA	Return On Assets
ROI	Return On Investment
ROS	Return On Sales
SGAE	Selling, General, and Administrative Expenses
TOE	Technology Organizational Environment
TPB	Theory of Planned Behaviour
UTAUT	Unified Theory of Acceptance and Use of Technology

# Chapter 1 – Introduction

## 1.1. Motivation

*Enterprise Resource Planning* (ERP) systems have been applied by many firms around the world as a key part of the organizational infrastructure. ERP encompass a wide range of software products supporting day-to-day business operations and decision-making. These systems tend to have a long life cycle in organizational use, and their processes have been extended into external organizations across the industry value chain (Davenport and Harris, 2007). ERP systems are expected to provide, seamless integration of processes across functional areas with improved workflow, standardization of various business practices, improved order management, accurate accounting of inventory, and better supply chain management (Mabert et al., 2003). A major question among researchers and decision-makers in organizations regarding adoption of ERP systems is whether these kinds of systems increase firm performance or not. There are disparate results and thoughts about this, but despite that, organizations have heavily implemented ERPs. ERP systems were initially implemented mostly in large organizations, and this has probably been the main reason for why (albeit few) research has focused on large enterprises. Although *small and medium enterprises* (SMEs) have been adopting ERPs for many years, the literature argues that little attention has been given to research on ERPs in SMEs, and less on cross-national and cross-products studies. As SMEs' are fundamentally different from large enterprises, both strategic and operational management decisions on ERP should not be taken with the same lens (Marbet et al., 2003). Moreover, according to the European Commission (2011), 99% of all European firms have fewer than 250 employees. Because SMEs are the backbone of Europe's

economy, important for increasing productivity and gaining competitive advantage, as well important drivers of innovation and transformation, it can be stated that the organizational applications and managerial implications of ERP systems play an important role in providing deep understanding of the phenomenon to researchers and practitioners in the information management discipline, in particular studying the ERP at the SME level across-countries - products is of interest (Maguire et al., 2010).

Thus, it is fundamental to understand ERP post-adoption by Portuguese and European SMEs. In order to understand the determinants ERP use and value in the Portuguese and European context, this study will use a quantitative approach. In this dissertation, there are four main motivating research questions (RQ):

*RQ1: What framework can be used as a theoretical basis for examine the ERP use and value impact on Portuguese SMEs performance?*

*RQ2: What are the factors driving ERP use and value across Portuguese and Spanish SMEs?*

*RQ3: What are the differences in ERP use and value between Iberian and Scandinavian SMEs?*

*RQ4: What are the ERP variations in value across commercial-packaged amongst European SMEs?*

To answer these research questions we developed a conceptual model based on a synthesis of two theories: *diffusion of Innovation* (DOI) and *resource-based view* (RBV). We empirically evaluate the joint model through a large-scale survey (883 firms) in Portugal, Denmark, Sweden, and Spain.

## 1.2. Theoretical frameworks

There are several theories that aim to explain the adoption (use) of technology. The most used theories are the *technology acceptance model* (TAM) (Davis, 1985), *theory of planned behaviour* (TPB) (Ajzen, 1985), *unified theory of acceptance and use of technology* (UTAUT) (Venkatesh et al., 2003), *Diffusion of Innovation* (DOI) (Rogers, 1995) and *Technology–Organization–Environment* (TOE) framework (Tornatsky and Fleischer, 1990). Several studies refer to ERP system as an innovation that integrates IS with the core business where the whole business is potentially affected and the innovation has strategic relevance to the firm (Zhu and Kraemer, 2005, Bradford and Florin, 2003). Whereas the TAM, TPB, and UTAUT are used to explain adoption at the individual level, DOI and TOE operate at the firm level. Because TOE explain better the intention to adopt and DOI explain better the post-adoption stages (Oliveira and Martins, 2011), in this dissertation we will develop DOI to explain ERP use.

Literature shows that there are three major frameworks used to explain IT Value: *industrial organization* (IO) theory (Porter, 1980); theoretical framework of IS success (DeLone and McLean, 1992) and the *resource-based view* (RBV) of the firm (Barney, 1991). According to Caldeira and Ward (2003) resource-based view (RBV) theory has been developed to understand how organizations achieve sustainable competitive advantages. Barney (1991) specifies four conditions necessary for a resource to confer a sustainable competitive advantage: value, rareness, inimitability, and non-substitutability. One of the major motives of ERP implementation is to provide an organization with a sustained competitive advantage (Botta-Genoulaz and Millet, 2006), ERP systems and its embedded capabilities are

considered to be value creation strategic tools, whereby value is derived through operational performance improvements (McAfee, 2002, Hendricks et al., 2007), cost reduction and customer service improvements (Shang and Seddon, 2002, Yang and Bambacas, 2009). Several studies confirmed the relationship between ERP use and its capabilities are tied to competitive strategy (Hunton et al., 2003, Yen and Sheu, 2004). The RBV has been used frequently in IS literature to explain how IT creates competitive advantage (Melville et al., 2004), in this line we, in this dissertation we will develop RBV to explain ERP value.

### 1.3. Research focus

The focus of this dissertation is understanding the drivers for ERP post-adoption, particularly use and value (inside of the dashed rectangle of Figure 1.1). We are interested in developing these two stages of the ERP life-cycle framework proposed by Esteves and Pastor (1999).

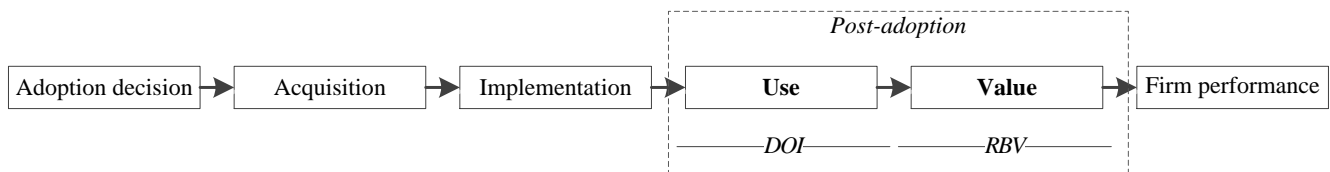


Figure 1.1. Research focus (adapted from Esteves and Pastor, 1999)

While ERP implementation refers to the stage of system planning, configuration, testing, and "going-live", ERP use means ERP utilization. It refers to the experience of managing the operation of the system software throughout the system's post-implementation stages (Nah et al., 2004).

While ERP use refers to the production stage of system usage among firms actually using ERP in their daily business activities, ERP value refers to firms' ability to utilize ERP to

create a competitive advantage. It refers to the ERP impact on a firm's performance, throughout the system life in the post-adoption stages (Rhodes et al., 2009).

From a technology diffusion perspective this research is based on two theoretical foundations: DOI and RBV theories (further detailed in next chapters).

To understand ERP post-adoption, particularly Use and Value, it is critical to study these stages in different contexts. We expect that this dissertation will contribute to a better understanding of ERP in SMEs. Figure 1.2 shows the different topics covered in our approach. We develop four studies: a single country study in Portuguese context, a second comparing two countries (Portugal with Spain), a third one comparing different cultural regions (Iberian with Scandinavian), and a fourth comparing the ERP value across four commercial-package ERP (these studies are detailed in next chapters).

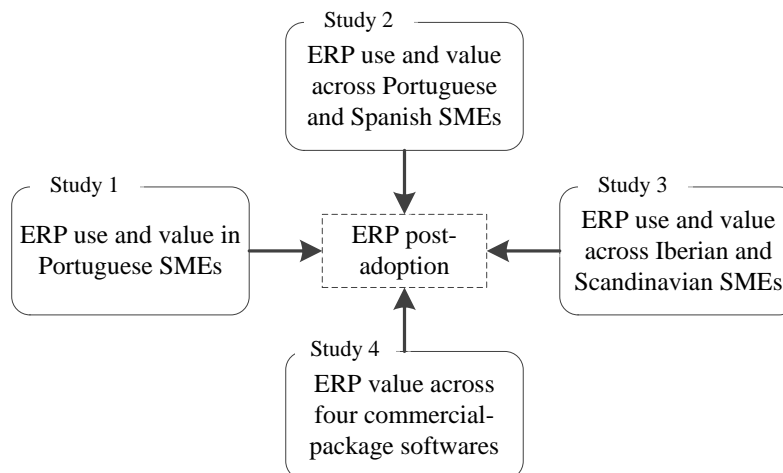


Figure 1.2. Studies covered in this dissertation to address ERP post-adoption European amongst SMEs

## 1.4. Research methodology

The current dissertation is included in the information systems research body, and is centred on the ERP systems and IT business value literature. This work follows an objective ontology

according to a positivist epistemology, considering that the knowledge can be codified without being influenced by the researcher. As the scientific rigor in this kind of research paradigm is of crucial importance in order to truthfully explain the social reality under investigation, the present work develops a research model and a set of hypotheses from the existing literature and theories, which serve as the building blocks and guidance for this research. These set of hypotheses will then be empirically tested. The research is based on a combination of DOI and RBV theories into an integrative research model. Where DOI aims to explain ERP use and RBV aims to explain ERP value. The ontological and epistemological positions of the researcher influence the research design decisions made throughout this work and also the steps taken towards the building and testing of the new theory. As the nature of the objective and conceptual framework of this dissertation demand the use of a methodology approach. In philosophical perspective and taking into account the main characteristics of positivism, realism and interpretivism, we can consider that this work presents characteristics very consistent with those of positivism. With regard to research methodology we used the deductive and quantitative approach (Saunders et al., 2009).

For data collection this research used a large scale web-survey over a two-month period (September-October 2011). In total, 2000 firms received the web-survey, and 883 completed responses were received, resulting in a response rate of 44% which comparable to others studies of similar scale is much higher. To ensure the generalization of the survey results, the sampling was stratified by country (Denmark, Portugal, Spain, and Sweden), by firm size (between 10 and 250 employees), by industry (finance, distribution, manufacturing, and professional services), and by commercial-package ERP (Microsoft NAV, SAP All-in-One, ORACLE JDE and SAGE X3).

To assess the two ERP post-adoption stages (use and value), in Chapter 2 we use Portuguese data (n=134), in chapter 3 we use a data set of n=588 (424 Spanish and 134 Portuguese), in chapter 4 use n=883 (558 Iberian and 325 Scandinavian), lastly in chapter 5 use the data set stratified by commercial-package ERP system (n=883, where Dynamics NAV = 266; ORACLE JDE = 208; SAGE X3 = 192; and SAP All-in-One = 217)

Considering the fact that ERP post-adoption is observed only for those firms that actually use ERP, we used structural equation modelling to empirically assess the research model.

Partial least squares (PLS) was chosen as the technique to analyse our data because: (i) the proposed model has not been tested in the literature; (ii) the research type is correlational; (iii) there is no distribution assumption regarding the data, (iv) the model is complex with many latent variables and (v) the constructs have mixed scales (Ringle et al., 2005). We then examined the measurement model by assessing the indicator reliability, construct reliability, convergent validity, and discriminant validity (further detailed in next chapters).

## **1.5. Path of research**

This dissertation gathers the findings of several research studies, reported in this dissertation separately by chapters, including international journals and conferences with double blind review process (indexed in ISI web of knowledge).

The path of present research started at the 4<sup>th</sup> European Conference on Information Management and Evaluation (ECIME) 2010 with an exploratory study based on 10 semi-structured interviews to SMEs CEOs identifying which are the most valuable KPIs extracted from their ERP systems (Ruivo and Neto, 2010). Then a conclusive study was carried throughout 85 web-surveyed Portuguese SMEs using ERPs assessing eight KPIs categories

which contributes for firm performance, and presented at the 6<sup>th</sup> Iberian Conference on Information Systems and Technologies (CISTI), 2011 (Ruivo and Neto, 2011). From the feedback gathered of above conferences we conduct a study on ERP value in post-adoption stage among Portuguese SMEs presented at 7<sup>th</sup> Iberian Conference on Information Systems and Technologies (CISTI), 2012 (Ruivo et al., 2012e) which operationalized the eight categories into three constructs.

As the findings of above studies as well literature pointed that ERP value might be greatly dependent from its greater use we developed a second phase of research which resulted in a paper presented at the 7<sup>th</sup> Mediterranean Conference on Information Systems (MCIS) 2012 entitle “ERP post-adoption: use and value - an empirical study on Portuguese SMEs”, which was selected to be part as a book chapter (Ruivo et al., 2012d). Furthermore, the International Journal of Accounting Information Systems (IJ AIS) editor invited us to extend the paper to his journal as “ERP post-implementation enhancements and determinants: examine use and value impact on Portuguese SMEs performance” (Ruivo et al., 2012f). In Chapter 2, we present IJ AIS paper which build on DOI model and RBV theory we developed an integrated model incorporating determinants which explains ERP use and value at firm level. Using a sample of 134 Portuguese SMEs we assess their perceived importance.

Then to test the model by comparing two similar cultural regions, the study entitle "ERP use and value: Portuguese and Spanish SMEs" was carried-out and published in the Industrial Management & Data Systems journal (IMDS), been shown in Chapter 3 (Ruivo et al., 2012g). Using the developed integrated model from prior study, we made an effort to understand the same determinants in a different context, more precise; we assess the model

by using another sample of 558 SMEs and then measure the differences and similarities between Portuguese and Spanish SMEs in regards to ERP use and value.

Later a similar study was carried out in Denmark and Sweden, which tested the model in a different context, and the outcome presented at the 6th European Conference on Information Management and Evaluation (ECIME), 2012 with the entitle “Evaluating determinants for ERP use and value in Scandinavia: exploring differences between Danish and Swedish SMEs” (Johansson et al., 2012).

Following to evaluate different cultural regions another paper prepared and was presented at 4th Conference on Enterprise Information Systems (CENTERIS) 2012 with the title “Determinants that influence ERP use and value: cross-country evidence on Scandinavian and Iberian SMEs” (Ruivo et al., 2012a) where it was selected as best paper and invited to further enhancement in Journal of Global Information Management (JGIM) as "Differential effects on ERP post-adoption stages across Scandinavian and Iberian SMEs" (detailed in Chapter 4) (Ruivo et al., 2013a). Grounded on the previous studies, we made an effort to understand and measure the differences and similarities between two cultural disparate regions (Iberian vs. Scandinavian), we assess the ERP use and value by using 883 SMEs surveyed.

Meanwhile we were invited to develop a book chapter to Springer about IS and SMEs, and therefore enhanced the above research to have the four countries analysed in a single paper entitled as “Empirical study on differences and similarities in ERP usage among European SMEs” (Ruivo et al., 2012c).

In order to access ERP value among European SMEs in another different context a fourth study (shown in Chapter 5) was made to compare four commercial-package ERPs

(DYNAMICS NAV, ORACLE JDE, SAP All-in-One and SAGE X3) and submitted to IJPE entitle “Enterprise resource planning value variations across commercial packages” (Ruivo et al., 2013b). We investigate the complementary effect of ERP value among different products. Using data from Portugal, Spain, Denmark and Sweden, we assessed three determinants of ERP value based on the RBV and evidenced differences among top four implemented ERP products (DYNAMICS, ORACLE, SAP and SAGE). Furthermore, a systematic literature review approach on the ERP value amongst SMEs was conducted and provided an updated bibliography of ERP publications published in the IS journal and conferences during the period of 2000 and 2012 submitted to CISTI 2013 (Ruivo et al., 2013). Along the way I had the opportunity to work with several remarkable international IS researchers, namely Dr. Niels Björn-Andersen, Dr. Andreas Nicolaou, and Dr. Björn Johansson. This resulted in partnering with them to accomplish publications.

In the last chapter are the conclusions, i.e. the summary of conclusions presented in Chapters 2 to 5.

## **Chapter 2 – ERP post-implementation enhancements and determinants: examine use and value impact on Portuguese SMEs performance**

### **2.1. Introduction**

Several authors have pointed out that the relationship between information technology (IT) and firm performance appears to be the most complex, penetrating and unpredictable in the field of *accounting information systems* (AIS). It can be argued that studying the interfaces between IT and AIS is important in its own right for several reasons, especially with regard to its impact on firm performance. Generally, firms adopt IT to improve their competitiveness and business performance. Davenport (1998) qualified enterprise resource planning (ERP) systems as the most important development in the enterprise use of IT. ERP's main purpose is to integrate in a collaborative platform as many enterprise functions as possible; it supports the execution of operational transactions and advanced planning, as well as enabling on-time and easy-to-use rolling forecasting and performance measurement systems. In addition, data warehouse technology and the rapidly increased supply of analytical package software have brought many enhancements in multidimensional analytical power and the efficiency of accounting processes (Klaus et al., 2000, Granlund, 2011).

Much of AIS research fails to measure the value of these systems and other effects such as the use of AIS. Perhaps the major problem with these works is their overly simplified assumption that the design and implementation of a management accounting system is about choosing certain solutions, thereby ignoring the post-implementation impact on firms' strategy and organization (Nicolaou, 2004a, Nicolaou, 2004b, Granlund, 2011). This is increasingly important, as accountants and managers must deal with a host of complex issues

that did not even exist in the past (Nicolaou and Bhattacharya, 2008, Hyvönen et al., 2008, Granlund, 2011).

Earlier studies such as Nicolaou (2004a) and Buonanno et al. (2005) reported that a lag of at least two years is necessary before adopters would begin to demonstrate positive differential performance. In this vein Nicolaou and Bhattacharya (2006, 2008) studies reinforced the question that studying the post-implementation phase is essential for measuring the impact of ERP on firms' performance.

Regardless of the country or the size, every firm has the need to manage both information and managerial resources to increase productivity and gain a competitive advantage (Hitt et al., 2002, Buonanno et al., 2005, Raymond and Uwizeyemungu, 2007, Chuang et al., 2009). Recently, small and medium-sized enterprises (SMEs) have also showed an increasing interest in ERPs, and AIS research is lacking with regard to SMEs. Moreover, an interesting question is how decision-makers in SMEs evaluate the use and value of the adopted system, and which metrics contribute most to firm performance. As the European economy is composed mainly of SMEs, as is Portugal and it is important to measure the post-implementation success of these systems.

This study is motivated by the mixed findings of recent studies examining the performance effects of ERP systems. In particular, our study explores an alternative way to understand and measure IT value by studying ERP in its post-implementation stages; use, and value. In this paper, based on the diffusion of innovation (DOI) model and resource-based view (RBV) determinants, we empirically study ERP use and value for a sample of 134 Portuguese SMEs. The theoretical perspectives and development of hypotheses are discussed in next section.

## **2.2. Literature review and development of hypotheses**

As suggested in the literature, both academics and practitioners have a growing interest in measuring the bottom-line benefits of AIS systems. Since the impact of IT systems on a firm's performance is mostly long-term and indirect, measures of the ERP system value to business are linked primarily to system use (Devaraj and Kohli, 2003, Nicolaou, 2004a, Zhu and Kraemer, 2005, Ruivo et al., 2012d).

Studies such as Nicolaou and Bhattacharya (2006, 2008) report a positive relationship between ERP implementation and firm efficiencies and pointed out that “firms which implement an ERP system must be conscious of and circumspect enough to realize that ERPs are different from other IT systems. They bring about strategic changes to firms' business processes and as such their deployment presents not a finale but the start of post-implementation activities critical when competitive advantage is a goal to pursue. Earlier evidence suggests that ERP benefits accrue over periods of time as opposed to one-time windfall gains, and that a time-lag of few years is necessary before ERP adopters begin to demonstrate long-term positive differential (Nicolaou, 2004a, Buonanno et al., 2005). Similarly, Ruivo and Neto (2011), and Ruivo et al. (2012d) argue that the benefits of ERPs reside in how firms use and exploit the integration capabilities (both data and process) of these systems after the post-implementation phase.

Earlier studies such as Hakkinen and Hilmola (2008), Markus et al. (2000b), and Davenport and Harris (2007) suggest that after the shakedown stage, firms continue adding functionalities to their baseline ERP implementation to support newer business processes and information needs. In accordance with Nicolaou and Bhattacharya (2006) any organizational

benefits that accrue to the adopting firms come as a result of the baseline ERP adoption event, based on the nature (enhancements and abandonments) and timing (early and late) of such post-implementation changes. As these events deal with strategic changes, the sustainability of AIS value such as ERPs depends on the horizontal business functionalities such as management accounting and control, adding new modules, upgrades, or add-ons and without linking them to the firms' business logic they may result in a negative impact on performance. ERP does not define firms' management accounting logic, but the configuration, use, and enhancements may define the value (enabling or constraint) of management control and eventually firms' performance (Kallunkiaa et al., 2011, Granlund, 2011).

### **2.2.1. ERP post-implementation and Portuguese Small and Medium Enterprises**

The globalisation of the economy is forcing many enterprises to change in order to survive. To compete in global markets many SMEs need to develop new business strategies and employ new technologies. However, SMEs usually have poor human and financial resources and are therefore likely to be less prepared and less able to change (Buonanno et al., 2005, Raymond and Uwizeyemungu, 2007). A better understanding of the ways in which SMEs use and extract value from new technologies, like information technology (IT), is necessary because earlier research in the area is limited and mostly out-of-date due to the rapidly changing costs of using IT, and the resulting increased adoption by SMEs (Chuang et al., 2009).

Portuguese industry is dominated by small and medium sized enterprises (98% of all firms). Because of their lack of bargaining power, scarce resources, and low management skills, Portuguese SMEs have been deeply affected by the increasing globalisation of the world

economy (Ruivo et al., 2012d). The current research provides an in-depth understanding and explanation of the relative levels of success in ERP use, as well as the causes of the relative levels of adoption and success, with reference to appropriate theory. IS research is often criticized for lacking theoretical foundations or for insufficient reference to theory in explanations of findings Oliveira and Martins (2011). Our paper describes how the findings from the study can be understood with reference to diffusion of innovation and resource-based theory on post-implementation phases and correspondent enhancements.

### **2.2.2. Post-implementation enhancements in ERP use and diffusion of innovation**

According to Nicolaou and Bhattacharya (2006) ERP enhancements (upgrades/add-ons) that occur early in the post-implementation period (during the year of completion or in the year following) may signify that the post-implementation review process is well managed and has either identified deficiencies in the initial implementation that need correction or has identified areas of improvement and the system is expanded to better fit needs. This improves system acceptance and system reach, promoting ERP use.

Literature on IT suggests that ERP use means ERP utilization, referring to the experience of managing the operation of the system software throughout the system's post-implementation stages (Nah et al., 2004, Nicolaou, 2004a). Through greater use and diffusion, ERP systems not only extend basic business and streamline integration with suppliers and customers, they also tailor system use to the firms' performance (Zhu and Kraemer, 2005, Nicolaou and Bhattacharya, 2006). According to Oliveira and Martins (2011), both Rogers' (1995) DOI model and Tornatsky and Fleischer's (1990) Technology-Organization-Environment (TOE) framework explains firm performance at firm level. While the TOE dependent construct is

based on likelihood to adopt IT, DOI is based on implementation success for IT use. Studies conducted by Bradford and Florin (2003) verify some DOI determinants regarding successful ERP use, more precisely, compatibility, complexity, training, and competitive pressure. Light and Papazafeiropoulou (2004) and Waarts et al. (2002) add best-practices and transactional efficiency constructs as important dimensions for ERP use. With this in mind, it our belief that DOI has the potential to provide a more favourable framework to explain the ERP use with regard to performance at the firm level. Therefore, in this study we postulate that all six factors embedded in the DOI context: Compatibility, Complexity, Efficiency, Best-practices, Training, and Competitive pressure explain the ERP use (Figure 2.1). Next, theorized constructs and hypotheses relationships for ERP use are explained.

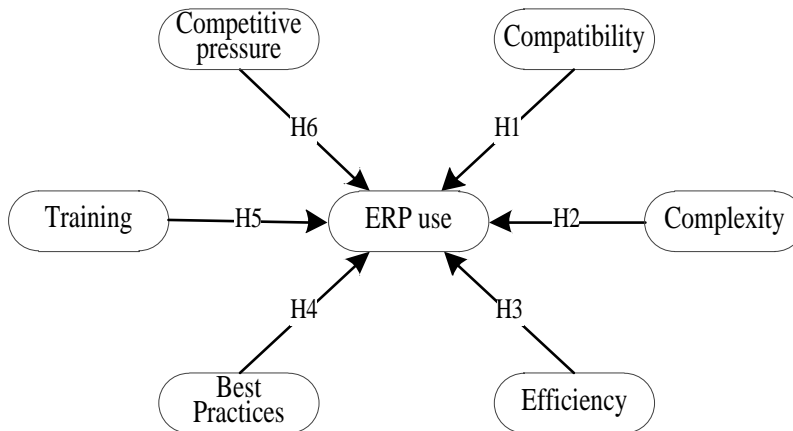


Figure 2.1. Research model to explain ERP use

The compatibility construct is measured by the degree to which the ERP system matches IT features, such as compatibility with hardware and other software. According to Bradford and Florin (2003) and Elbertsen et al. (2006) the degree of compatibility of ERP systems with existing software and hardware will positively impact system adoption and use. We thus formulate the first hypothesis:

**H1.** *Firms having ERP systems with greater compatibility are likely to use ERP more.*

The complexity construct is measured by reversing the item-questions scale of how intuitive the application is; how quickly users can become proficient with the application; and how comfortable they are using it. According to Cooper and Zmud (1990), Kositanurit et al. (2006) and Chang et al. (2011a), the ERP complexity is a major factor affecting user job performance. Additionally Bradford and Florin (2003) and (Chiang, 2009) concluded that ERP complexity has a strong relationship with success or failure of implementation and its use. Based upon this, the second hypothesis is:

**H2.** *Firms having ERP systems that are perceived to be complex are likely to use ERP less.*

The efficiency construct is measured by how easy it is for users to execute common and repetitive tasks, the effectiveness of the user interface, and the speed and reliability of the software. Gattiker and Goodhue (2005), Bendoly and Kaefer (2004), and Rajagopal (2002) assessed that transactional efficiency has a direct influence on ERP use, in particular, that data posting and its communication over the ERP improves the firm's overall performance. Taking this into account, we construct our third hypothesis:

**H3.** *Firms having ERP systems of greater transactional efficiency are more likely to use ERP.*

The best-practices construct is measured by how easy it is for users to set up the application and map workflows based on local requirements, and the system's adaptability to business needs. According to Velcu (2007), Chou and Chang (2008), and Wenrich and Ahmad (2009), firms that implement industry best-practices dramatically reduce risk and time consuming project tasks such as configuration, documentation, testing, and training, and the main reason for firms to adopt standard 'best practice' is the belief that ERP design does things in the

right way. Also, Quattrone and Hopper (2005) conclude that ERP diffuse best-practices embedded in the system (e.g., ABC and stock accounting methods: FIFO, LIFO, Average, etc.) and through built-in benchmarking drive homogeneity and standardization. It is also a fact that as the number of ERP systems sold is enormous, similar solutions are adopted globally with minor or no variation. Thus, we postulate that firms that opt to implement ERP based on standard best-practices will use the system more. Based on these considerations, we formulate the fourth hypothesis:

**H4.** *Firms with standard best-practices in their ERP systems are more likely to use ERP.*

The training programme construct is a measure of how easy it is for users to be trained on the system, to understand the content material, and to navigate through topics applied to daily tasks. O’Leary (2000) and Bradford and Florin (2003), state that the degree of preparedness of ERP users to meet situations and carry out a planned sequence of actions without upstream errors has an instantly positive impact on business. Teaching how to use the system will improve familiarity and boost its use. We therefore postulate that firms with a higher degree of training tend to enjoy greater readiness to use ERP. In line with research, we construct the fifth hypothesis:

**H5.** *Firms with greater user-training programmes are more likely to use ERP.*

The competitive pressure construct is a measure of the degree of pressure that firms feel from competitors in the industry to use ERP. Competitive pressure is recognized in the innovation diffusion literature as an important factor of technology diffusion (Bradford and Florin (2003), Zhu and Kraemer, (2005). These authors have shown that innovation diffusion is accelerated by the competitive pressure in the environment. Thus, we postulate that

competitive pressure is an important determinant for firm use of ERP systems. In line, we construct the sixth hypothesis:

**H6.** *Firms facing higher competitive pressure are more likely to use ERP.*

### **2.2.3. Post-implementation enhancements in ERP value and resource-based view**

According to Nicolaou and Bhattacharya (2006), ERP enhancements (upgrades/add-ons) that occur later in the post-implementation period (at least two years after system completion) may signify that the system has actually been well accepted in the organization and now serves as the basic infrastructure for launching other strategic initiatives, such as customer relationship management or supply chain management. This improves firm's organizational performance by system optimization and exploitation of superior analytical data, promoting ERP value.

Literature on IT suggests that ERP value refers to firms' ability to utilize ERP to create a competitive advantage, with regards to the ERP impact on a firm's performance, on the post-implementation stage (Nicolaou and Bhattacharya, 2008, Rhodes et al., 2009). Since ERP value relies on how firms strategically exploit the system, firms' performance in a competitive environment is a subject that draws much attention and attempts to build explanatory theories such as *Industrial Organization* (IO) theory and RBV theory of the firm. Although both IO and RBV theories are interested in the competitive advantage approach to strategic management, claiming that external pressures and the internal capability to respond to it are the major determinants of a firm's success, RBV states that firm specific resources determine a firm's performance and explain sustained advantages (Hedman and Kalling, 2003). In the IS literature, the RBV has been used to analyse IT capabilities as a resource and

to explain IT business value. The greater the use, the more likely the firm is to develop unique capabilities from its IT business applications (Bharadwaj, 2000, Zhu and Kraemer, 2005, Antero and Riis, 2011, Ruivo et al., 2012d). Studies by Hedman and Kalling (2003) and Fossier et al. (2008) used RBV and extended Mata et al.'s (1995) framework for organizational and business resources, concluding that ERP systems are IT resources that can lead to sustained competitive advantages. Specifically, Nicolaou and Bhattacharya (2008) studied the role of ERP post-implementation by examining firms that adopt Nicolaou's (2004b) PIR-Quality framework and show sustainable improvements in their financial performance (competitive positioning or process efficiency/effectiveness). Taking the above reflections, it is our belief that RBV has the potential to provide a more favourable framework to explain the ERP value with regards to impact on firm's performance. From the RBV perspective, some (although few) researchers have shown that greater system use is associated with firm performance (Mabert et al., 2001) and changes to firms' business processes such as collaboration (Gattiker and Goodhue, 2005) and analytics (Davenport and Harris, 2007) are additional important dimensions that will influence ERP value in the post-implementation phase. With this in mind, we believe that RBV has the potential to provide a more favourable framework to explain the ERP value with regard to performance at the firm level. Therefore, in this study we postulate that three factors embedded in the RBV theory of the firm (Use, Collaboration and Analytics) explain the ERP value (Figure 2.2). Next, theorized constructs and hypotheses relationships for ERP value are explained.

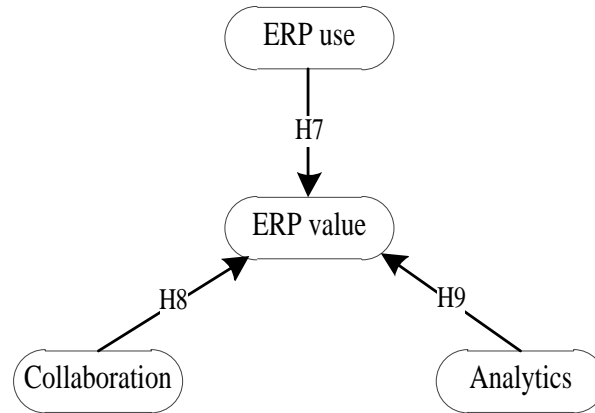


Figure 2.2. Research model to explain ERP value

The ERP use construct is measured by how many employees use the system daily, how much time is spent per day, and how many reports are generated per day. The ERP use and ERP value link is a measure of how users work with the system and of decision-making based on analytical indicators. Grounded on RBV, we explain the connection between use and value, that is - the greater the extent of ERP use, the greater the likelihood that firms will create capabilities that are rare, inimitable, and valuable. Shahin and Ainin (2011) found that user fit on ERP is critical in explaining the ERP use, and a successful adaptation of new functionalities with firms' processes and data flow makes ERP worthwhile. With ERP systems, through their integration capability, firms can form a specific resource that guides collaboration and provides the repository to perform business analyses. Zhu and Kraemer (2005) and Devaraj and Kohli (2003) demonstrate that there is a strong link between system use and system impact, that is, any impact on firm performance is possible only when firms actually use ERP systems to conduct business. In line with literature, we formulate the seventh hypothesis as:

**H7.** *Firms with greater ERP use are more likely to generate higher ERP value.*

The collaboration construct is measured by how easy it is to collaborate with colleagues, partner with ERP system, and communicate with suppliers, partners, and customers. ERP systems help users to collaborate, increasing their productivity and the health of their firms and business partners. In accordance with Calisir and Calisir (2004), Gattiker and Goodhue (2005), and Ruivo and Neto (2011), ERP systems are platforms that allow both humans and applications to collaborate, from meeting basic accounting to promoting enterprise performance. ERP systems provide users with a structured communication channel with the right information at the right time, resulting in increased productivity. We believe that partnering with ERP and cross-group collaboration extends the ERP value. Therefore, and in line with RVB theory, we postulate the eighth hypothesis:

**H8.** *Firms' greater collaboration with ERP systems is positively associated with higher ERP value.*

The analytics construct is measured by how well the software enables comprehensive reporting, access to real-time information, and visibility into cross-departmental information. Davenport and Harris (2007) state that although not many firms give analytics priority, those that use business analytics to leverage the investment they have made in ERP systems gain a competitive advantage. Consolidation and visibility of data across functional departments allows firms' metrics to be unified and consistent. Although ERP systems are essentially transaction-focused on internal data, those firms that have ERP-embedded analytics capabilities can easily and quickly use data for management accounting and control, as well as for managerial decisions (Chiang, 2009, Ruivo and Neto, 2011). In line with RVB theory and literature, we believe that analytics provides users with unique business insight information, and therefore postulate the ninth hypothesis:

**H9.** *Firms having greater analytics capacity embedded in their ERP systems are positively associated with higher ERP value.*

The ERP value construct is measured by assessing the degree of system impact on the firm's performance. The study conducted by Nicolaou (2004a) used a process-oriented model of the enterprise to measure the economic consequences of ERP investments. He used eight operational measures, so-called first-order effects, to measure gains/losses in firms' operational efficiency (see Nicolaou (2004a) for a concise review). Studies conducted by Zhang et al. (2005) and Bradford and Florin (2003) concluded that ERP value output can be measured by user satisfaction. Studies conducted by Park et al. (2007) and Chang et al. (2011a) defined ERP value proposition as: individual productivity, customer satisfaction, and management control. In the same line, Quattrone and Hopper (2005), Hyvönen et al. (2008), Kallunkia et al. (2011), and Granlund (2011) state that management control plays an important role in AIS - improving accounting and decision making - critical indicator for ERP value since they have horizontal business functionalities embedded. Due to data availability, in our study we assess the positive impact of an ERP system on firm performance through user satisfaction, individual productivity, customer satisfaction, and management control.

In sum, as illustrated in Figure 2.3, DOI will influence ERP use and its actual use contributes to ERP value, which in turn has an impact on the firm's performance (Devaraj and Kohli, 2003). The upper tier shows the extent of ERP use, influenced by six specific factors embedded in the DOI context: compatibility, complexity, efficiency, best practices, training, and, competitive pressure. Toward the bottom we postulate that ERP leverages unique characteristics of the IT to improve business performance. We define as unique: collaboration

and analytics. Together with use, we believe that these two IT-enhanced capabilities will contribute to ERP value. In addition to these theoretical variables, control variables need to be incorporated to better explain cross sectional variations in ERP use and value. Our data set includes a number of industries and different firm sizes. Hence, we need to control for industry and firm size effects. Following the literature (Zhu and Kraemer, 2005, Oliveira and Martins, 2010b) we incorporate industry dummies and firm size as control variables. Methodology, data analysis and results are presented in the next section.

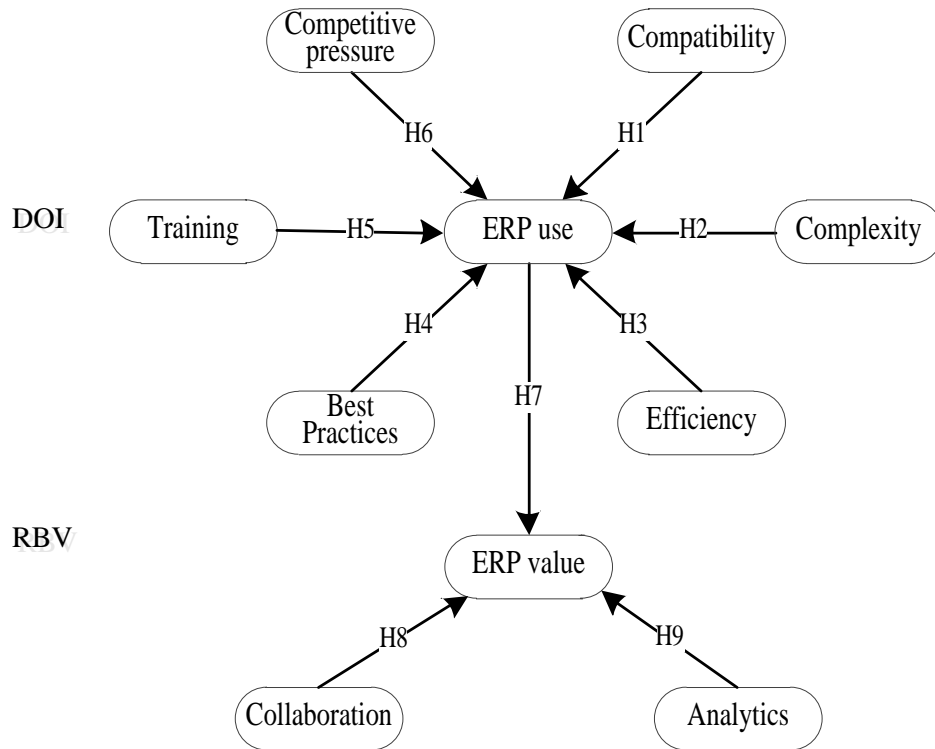


Figure 2.3. Research model to explain ERP use and value

### 2.3. Research method and results

A web-survey was used for data collection and each item-question was reviewed for content validity by ERP experts. The initial questionnaires were pilot tested on 10 firms and some

items were revised for clarity with assistance from the International Data Corporation. To ensure the generalization of the survey results, the sampling was stratified by firm size (fewer than 250 employees), and by industry (finance, distribution, manufacturing, and professional-services). Questionnaires were designed to be answered in 15 minutes and sent in September and October 2011 (Dillman, 2000). In total, 400 Portuguese firms received the email survey, and 134 valid responses were returned (33.5%). Table 2.1 shows characteristics of the sample, regarding number of years using ERP, industry type, position of respondent, and which modules firms had implemented, suggesting the excellent quality of the data. There is a high percentage (70%) of SMEs that have used ERPs for less than five years. Also, the sample shows that 37.1% of SMEs ranked ‘management control’ as the most important metric of ERP value.

<i>Number of years using ERP</i>	<i>Percentage</i>
<2	36.6
2-5	33.3
>5	30.5
total	100.0
<i>Industry type</i>	
Distribution	28.4
Manufacturing	23.9
Finance	24.6
Services	23.1
total	100.0
<i>Respondent type</i>	
CEO, owner	20.9
IT/IS manager	27.6
Finance manager	20.1
Sales manager	23.1
Manufacturing manager	8.2
total	100.0
<i>ERP importance</i>	
User satisfaction	11.9
Individual productivity	21.8
Customer satisfaction	29.2
Management control	37.1
total	100.0
<i>Implemented modules/add-ons*</i>	
<2 years	Core ERP and basic reporting
2-5 years	SCM/CRM functionalities
>5 years	Advanced analytical/BI

\*>80% of respondents answers were grouped in regards to the number of years

Table 2.1. The characteristics of the Portuguese sample

The constructs were operationalized and measurement items developed on the basis of a literature review (Appendix A). While the ‘ERP use’ construct was measured by items scaling for responses in percentages, all other constructs were measured by a five-point Likert scale. The control variables were country, size, and industry type.

To empirically assess the constructs theorized in Section 2, we conducted a structural equation model. Because our purpose is to exam the validity of the constructs and do not require normal distribution for the variables, we used the partial least squares (PLS) as implemented in the software SmartPLS. We performed the Kolmogorov-Smirnov test and confirmed that none of the items measured are distributed normally ( $p < 0.001$ ). CB3, CX1, TN1, CP2, and ERPU1 question-items of Appendix A were excluded from our research model after the PLS model estimation due low loadings.

Table 2.2 shows that except for BP1 (0.691) all other items have loadings above 0.7 and are significant at ( $p < 0.001$ ). In accordance with Chin (1998), factor loadings should be at least 0.6 and preferably greater than 0.7. We therefore retain all items shown in Table 2.2.

<b>Construct / Item</b>	<b>Loading</b>	<b>t-Stat*</b>	<b>CR</b>	<b>AVE</b>
<b>Compatibility</b>				
CB1	0.925	7.360	0.958	0.919
CB2	0.991	12.141		
<b>Complexity</b>				
CX2	0.936	97.797	0.925	0.860
CX3	0.919	93.032		
<b>Efficiency</b>				
EF1	0.764	32.003	0.847	0.649
EF2	0.768	26.920		
EF3	0.880	61.194		
<b>Best Practices</b>				
BP1	0.796	33.578	0.834	0.628
BP2	0.691	18.552		
BP3	0.880	60.196		
<b>Training</b>				
TN2	0.954	269.978	0.957	0.917
TN3	0.961	345.770		
<b>Competitive Pressure</b>				
CP1	0.983	161.226	0.882	0.791
CP3	0.784	23.648		

<b>ERP Use</b>				
ERPU2	0.894	137.936	0.878	0.782
ERPU3	0.875	84.041		
<b>Collaboration</b>				
CO1	0.898	188.766	0.902	0.754
CO2	0.887	156.042		
CO3	0.818	53.113		
<b>Analytics</b>				
AN1	0.875	111.851	0.915	0.782
AN2	0.903	103.026		
AN3	0.874	84.742		
<b>ERP Value</b>				
ERP V1	0.747	52.967		
ERP V2	0.927	225.381	0.886	0.664
ERP V3	0.862	87.722		
ERP V4	0.703	34.468		

Table 2.2. PLS factor loading, composite reliability, and average variance extracted

Furthermore, Table 2.2 shows that composite reliability (CR) and average variance extracted (AVE) for each construct are above the cut-off of 0.7 and 0.5, respectively. In accordance with Hair et al. (1998), the CR measures the internal consistency of the construct and the extent to which each item explains the corresponding construct, and the AVE signifies the amount of indicator variance that is accounted for by the corresponding construct.

In Table 2.3 the square root of the AVE in all cases are greater than the correlations, thus suggesting discriminant validity. In summary, our measurement model satisfies reliability, validity, and discriminant criteria. Consequently, the constructs developed can be used to test the postulated hypotheses.

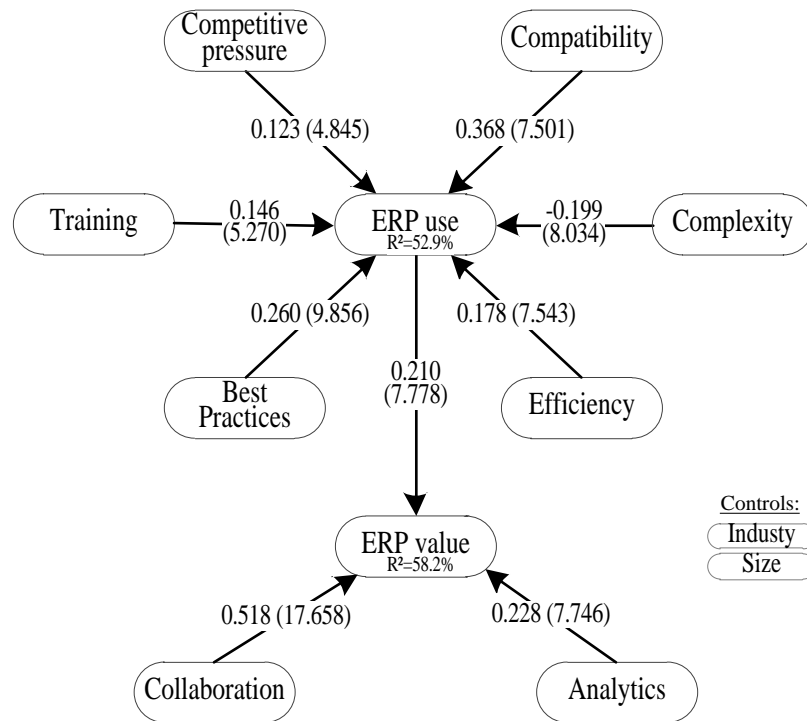
	Mean	SD	1	2	3	4	5	6	7	8	9	10
<b>Compatibility (1)</b>	3.922	0.738	<b>0.959</b>									
<b>Complexity (2)</b>	3.425	0.604	0.397	<b>0.927</b>								
<b>Efficiency (3)</b>	4.037	0.644	-0.242	-0.194	<b>0.806</b>							
<b>Best Practices (4)</b>	3.488	0.648	-0.340	-0.371	0.396	<b>0.792</b>						
<b>Training (5)</b>	2.847	0.785	-0.178	-0.403	0.194	0.503	<b>0.958</b>					
<b>Competitive Pressure (6)</b>	4.131	0.790	-0.061	-0.108	0.346	0.353	0.348	<b>0.889</b>				
<b>ERP Use (7)</b>	71.567	11.308	0.097	-0.238	0.432	0.473	0.358	0.364	<b>0.884</b>			
<b>Collaboration (8)</b>	3.888	0.670	-0.410	-0.455	0.477	0.637	0.484	0.332	0.344	<b>0.868</b>		
<b>Analytics (9)</b>	4.040	0.626	-0.353	-0.328	0.322	0.566	0.330	0.223	0.247	0.629	<b>0.884</b>	
<b>ERP Value (10)</b>	3.735	0.624	-0.164	-0.397	0.387	0.567	0.501	0.439	0.414	0.697	0.542	<b>0.815</b>

Note: Diagonal elements are root squares of the AVEs and off-diagonal elements are correlations.

Table 2.3. Descriptive statistics, correlations and square root of the AVEs

The results are shown in Figure 2.4, where path coefficients with significance levels (t-statistics) are presented in parentheses, as well the R<sup>2</sup> values for dependent constructs.

To empirically analyse the hypotheses postulated in Section 2, we examined the standardized paths. For ‘ERP use’, all six DOI determinants – compatibility, complexity, efficiency, best-practices, training, and competitive pressure – have positive and statistically significant paths leading to the dependent construct. The path associated with complexity is statistically significant and negative, as we expected, and therefore, all hypotheses (H1 to H6) dealing with ‘ERP use’ are supported. In addition, the model shows a significant positive link from use to value (0.210), thereby supporting H7. Although collaboration (H8) has a stronger relationship (0.518) with ‘ERP value’ than analytics (H9), both H8 and H9 are supported.



Note: t-statistics values are in parentheses and greater than 1.978 are significant at p < 0.05.

Figure 2.4. Path model

Furthermore, through  $R^2$  value examination, the ascendants (Compatibility, Complexity, Efficiency, Best-practices, Training and Competitive Pressure) can explain 'ERP use' in 52.9% and (ERP use, Collaboration and Analytics) explain 'ERP value' in 58.2%, implying a good fit of the model. Overall, the above results provide support for the determinants shaping ERP use in which firms adopt IT, and support our theoretical arguments presented in Section 2, where we postulated that, as more firms use ERP (together with collaboration and analytics IT-enhanced capabilities) more value is created by ERP. The results discussion and findings, as well as academic and managerial implications are discussed in the next section.

## **2.4. Discussion**

Our research hypotheses recognize nine determinants that explain ERP use and value among Portuguese SMEs. Among the DOI determinants, compatibility and best practices are found to have significant impact on the degree of 'ERP use', followed by complexity and transactional efficiency, while training and competitive pressure have less impact. That is, firms having systems that are more compatible with other hardware and software and also have low levels of customization in their ERP system tend to use ERP more, as do firms with less complex systems and greater transactional efficiency. In turn, our interpretation for organizational elements is that firms with better trained users tend to use ERP more, as do firms facing higher levels of competitive pressure. Then, technological characteristics such as compatibility and efficiency are dependent on the system stability, which requires time from IT and often support from suppliers, been in accordance with Bradford and Florin (2003), and Light and Papazafeiropoulou (2004) results. Also, ERP with fewer

customizations (using standard protocols and best-practices) is more fitted to users to become familiar with ERP and make low investment in terms of training and proficiency in manipulating the system in effective ways and obtaining value from it. The results show that technological product characteristics are the main drivers of ERP use amongst Portuguese SMEs.

Among the RBV determinants, use, collaboration, and analytics are found to have a significant impact on the degree of ‘ERP value’. The ‘ERP use’ and ‘ERP value’ relationship is found to be significant and positive. This means that higher degrees of ERP use are associated with firm performance, in accordance with Devaraj and Kohli (2003), Nicolaou (2004a) and Zhu and Kraemer (2005). Both collaboration and analytics IT-enhanced capabilities are also found to be significant and positive links to ‘ERP value’. Firms with good collaboration systems contribute to value creation, as do firms with greater embedded analytics capacity. As argued in Section 2, while collaborating with colleagues, system, suppliers, partners, and customers increases productivity, analytics provides greater business insight for a better decision-making process and management control. As a result, these two ERP capabilities help firms to improve performance because they are firm specific, difficult to imitate, and less mobile across firms, which is consistent with the RBV theory. Although both paths associated with collaboration and analytics are significantly positive, collaboration is much stronger. This is probably true because good compatible systems provide firms with a real-time collaboration framework that is fact oriented. The underlying reasoning would be that Portuguese firms perceive greater value and advantage in a collaboration system, because it provides a prolific field for internal organizational changes in order to improve firm performance. Furthermore, as SMEs face high levels of competitive

pressure and hold great ERP transactional efficiency, business analytics becomes critical for gaining competitive advantage. These results are in line with Nicolaou and Bhattacharya's (2008) study, in which they demonstrated that firms that have been using ERP systems to manage activities have a positive financial performance differential effect on firms' organizational performance. The underlying reasoning is that, if on the one hand ERP inherent integration capabilities (enhancing ERP through the form of either add-ons or upgrades) helps firms to collaborate, analytics capabilities helps firms to obtain the updated and reliable information to conduct their daily activities, and experience an incremental return on performance. The results show that organizational performance characteristics provided by ERP are the main drivers of ERP value among Portuguese SMEs.

Our results evidence the relationship between the number of years using ERP with the nature of changes, as defined by Nicolaou and Bhattacharya (2008), that enhancements to ERP systems that are typically taken in the form of modular additions to the original implementation and/or upgrades result in a positive increase of performance. More precisely, our results show that 36.6% of Portuguese firms have been using ERP for less than two years in conducting their business activities by using the ERP core modules (financial management, general ledger, accounts schedules, budgets, dimensions, payables, receivables, cash management, and basic accounting reporting functionalities, among others), whereas 33.3% using ERP between two and five years are using the system enhanced with Supply Chain Management (SCM) modules (inventory management, warehouse, manufacturing, inventory/manufacturing costing, material/resource planning, among others) and/or Customer Relationship Management (CRM) modules (campaigns, contact classifications, opportunities, mailing and interactions management, among others), and 30.5% of

Portuguese firms have used ERP for more than five years have implemented advanced analytical/BI modules (OLAP, KPIs, dashboards, balance-scorecards, among others), to their baseline ERP. In sum, our results are in line with Nicolaou and Bhattacharya's (2006) study in which they show that any organizational benefits that accrue to the adopting firms come as a result of the baseline ERP adoption event, based on the nature and timing of such post-implementation changes. Plus, our study also supports earlier conclusions of Hakkinen and Hilmola (2008) that after the shakedown stage, firms continue to add post-implementation functionalities to their baseline ERP implementation to support newer business processes and information needs.

Regarding early enhancements in the post-implementation phase (within the two years after the system rolled over), we find that greater use alongside enhancing ERP baseline with greater accounting functionalities grounded in methodologies such as PIR-Quality (see Nicolaou's (2004b) for a concise review) not only provide a differential financial performance, but also provide an excellent platform for new waves/activities of enhancements such as SCM, CRM, Analytics/BI capabilities, and later enhancements in the post-implementation phase (Nicolaou and Bhattacharya, 2008). More precisely, our study suggests that both two post-implementation phases characterizes the ERP value. That is, our results suggest that firms that undertake early enhancements to their ERP enjoy a positive impact on the firm's performance, as well as late enhancement to their ERP baseline.

Moreover, our study reveals that among Portuguese SMEs, management control is the most important indicator of ERP value which is linked to the ERP embedded accounting logic. This finding in is in accordance with Kallunkia et al. (2011) who confirmed that enterprise resource planning systems has a huge impact on management control systems and firm

performance. Our finding is that both early and late enhancements are important determinants for management accounting and control. Specifically, as ERP use and value have direct consequences on firms' cost management and performance measurement, Portuguese SMEs consider ERPs as the core control systems when new strategies are implemented. According to Granlund (2011), the most widely adopted ERP system, SAP, offers horizontal functionality embedded in the German concept of "Controlling" and much of the existing ERP software follows this logic. We expected that this would have different impact on different countries/cultures. That is, a cost or profit centre would have a different meaning in an ERP and in everyday language, and these changes in the nature and quality of such crucial concepts of responsibility accounting would affect management control due to cultural changes (Everdingen and Waarts, 2003). However, our study finds that the majority of Portuguese SMEs implement and value the logic of management control systems (37.1%) in comparison with other performance metrics such as user satisfaction, individual productivity, and customer satisfaction, in line with Quattrone and Hopper (2005), Hyvönen et al. (2008) Kallunkia et al. (2011), and Granlund (2011), in which management control is a critical metric.

Unlike larger enterprises, in SMEs the CEO and other managers are frequently owner, entrepreneurs, and their relationship with ERP vendors is a complex interplay of interpersonal associations. Therefore, the CEO has the authority to influence other members of the firm to use ERP and probably also the exploitation of standard best-practices and reporting embedded in their ERP, as well as the management accounting and control functionalities to positively impact the firm's performance, findings that are in accordance with Buonanno et al. (2005) and Chuang et al. (2009). Our study also supports the theoretical

assumption that SMEs are recognized as highly socio-economic and particular formations and, thus, ERP adoption theories that explain the social uniqueness relative to SMEs organizations are needed. Like large organizations, SMEs pursue pecuniary and non-pecuniary goals simultaneously but their future positioning is greatly shaped by owner-managers' influences and others (Raymond and Uwizeyemungu, 2007). The efficacy of ERP use lies in their ability to take into account these multiple goals and complex inter-personal relationships. Our analysis shows that the DOI and RBV theories provide an integrated framework that is comprehensive in explaining ERP post-implementation phases. More precisely RBV theory explains that SMEs also pursue pecuniary ends such as inimitable, rare, and less mobile, to attain a sustainable and competitive advantage, and DOI models assume ERP use behavior as a collection of mediating barriers and drivers, that is, recognizing ERP use determinants reflecting SMEs' heterogeneity and the decision-making processes (Ruivo et al., 2012d). In addition to the existing body of knowledge on AIS adoption by SMEs, our model captures the technological and organizational determinant of use and value as well the competitive environment. We hope that our study trigger further investigation.

### **Academic implications**

These results have several important implications for the scholarly community. Through an empirical work we have demonstrated the solid theoretical arguments that DOI and RBV can explain for ERP use and value among SMEs. We have shown the usefulness of a single framework for identifying factors that affect ERP use and value at odds with current literature studying use and value separately. Unlike the typical focus on ERP adoption reported in the

literature, this study moves AIS research beyond dichotomous “adoption versus non-adoption”, linking actual use to value creation. This framework could be used by other researchers for studying technology use and value. Also, the result could serve as a theoretical base for studying further sources of value creation from technology innovations. Although using a different methodology and data set, we also find strong affinity between our results and those of Nicolaou (2004a), Nicolaou and Bhattacharya (2006), Nicolaou and Bhattacharya (2008), Chou and Chang (2008), and Häkkinen and Hilmola (2008), that is, the surveyed SMEs understand that ERP systems are different from other IT systems, and their deployment represents not a finale but the start of a series of post-implementation activities. The present empirical results support theoretical arguments in Section 2, in favour of post-implementation ERP management (in particular changes made in the form of module upgrades/add-ons to the baseline ERP after the initial system roll-over) and its impact on firm’s performance. This is the first empirical study on Portuguese firms, and is unlike the earlier literature on SMEs. Moreover, adding this study to AIS literature, examining the determinants for ERP use and value among Portuguese SMEs, shows that management control is a critical performance metric for ERP value, in accordance with Kallunkia et al. (2011) and Granlund (2011). We also support the conclusions of earlier studies that emphasized the critical importance of managing firms’ post-implementation processes. That is, our results support Nicolaou and Bhattacharya’s (2008) conclusion that the inherent modularity of the post-implementation stage of ERPs and enhancements undertaken by firms may impact the performance differentials attained by these firms over their post-implementation life-cycles.

### **Management implications**

Our results have several important implications for management. They offer a useful framework for managers to assess both the organizational and technological conditions under which ERP adds value to business. As internet technologies become more widespread and necessary, IT-enhanced capabilities such as collaboration and business analytics will become even more critical. In particular, our results reveal collaboration to be a major source of ERP value. Our model shows that support for transactional efficiency has been an important determinant to ERP use and that both collaboration and business analytics are important of ERP value. Therefore, we contribute to the research of IT value by including them.

Finally, our study also offers implications for software makers. While compatibility, transactional efficiency, and embedded best practices are perceived as ERP necessities, complexity (as opposed to familiarity and user-friendliness) is found to be an important inhibitor for ERP use, and collaboration and business analytics functionalities have emerged as important facilitators for ERP value. The vendor and provider of ERPs will gain a better understanding of what organizations experience about value gained in the post-implementation phase of an ERP. Those organizations that have not yet decided to adopt ERP will gain knowledge on what they can expect as a result of adopting an ERP system. This study also explains the phenomenon of how it is that a few employees using the ERP system have a great impact on firm performance, and that Portuguese SMEs value ERP for its contribution to user satisfaction, individual productivity and customer satisfaction, but mostly its capability in management control.

### **Limitations and future work**

The work has been carried out in a rigorous and objective manner, in important areas of ERP research identified by other researchers. It is based on underlying theory and definitions established by several other researchers. The form used in the survey is to a large extent based on the same questions and scales used in earlier studies performed by respected research teams (see literature support in Appendix A).

Some of the limitations of this study may also be viewed as avenues for future research. As this study applies only to Portuguese SMEs, future work should address cross-country variation in use and value. Furthermore, we cannot speak empirically on the issue of whether value is sustained, because this requires a longitudinal study, our empirical results show only relationships existing among the ERP use and value determinants. Future work might seek to capture the change and flexibility of organizational control practices through an actor-network approach and shield management control domain (Hyvönen et al. (2008).

Although our data cover general Portuguese sites; some biases may have been introduced. This is a concern because different sites have different operating characteristics and environments, establish different strategic objectives, and perhaps accept that organizational effectiveness can be viewed and measured in various ways, and the factors related to the impact of ERP may be quite different. Unlike larger enterprises, SMEs usually have scarce financial resources and do not have the same ease of hiring qualified IS/IT experts. Moreover, it may be difficult to bring highly-qualified IS/IT experts to remote sites, far from major towns, (where many Portuguese SMEs in traditional industries are located). Therefore, the technical ERP skills can be a source of competitive advantage and a future study on this matter could be developed.

The impact measures were subjective in the sense that they were based on Likert-scale responses provided to SMEs managers. While we have been careful in assessing potential biases inherently associated with such data, it would have been desirable to have more objective measures of impact, that is, although there probably is a relationship between firm size and both the sites and skill levels of users, the current use measures are only a proxy for ERP use. Furthermore, our sample may represent advanced ERP firm users in each site rather than a representative sample of the overall population. Also, our measure of ERP value is general in the sense that it could include specific performance metrics such as financial performance indicators. Therefore, a more complete test of the process model would require more comprehensive, longitudinal data or in depth case studies over time. Moreover, possibly post-implementation stages show different performance ratios depending on the number of years of ERP use. A possible future work would be to use Nicolaou (2004b) eight operational measures (so-called first-order effects) and examine gains/losses in firms' operational efficiency.

## **2.5. Conclusions**

This study explores the concept that ERP post-implementation is a key determinant of firm performance. Anchored on the DOI model and RBV theory, we empirically assess ERP use and value at the firm level. While these are usually studied separately, our study proposes that use and value are closely associated with the post-implementation stages. Our study contributes to the literature by moving beyond dichotomous “adoption versus non-adoption”, and links actual use to value creation. Empirical data collected through a web-survey of 134

Portuguese SMEs is used to check the measurement validity and to test nine hypotheses. For ERP use, our study examines six DOI determinants (compatibility, complexity, efficiency, best practices, training, and, competitive pressure), in which some of these determinants play different roles for system use. Based on RBV, for ERP value, our study examines three determinants (use, collaboration, and analytics) and demonstrates that the degree of ERP use and IT-enhanced capabilities, such as collaboration and analytics, contribute to value creation from ERP and positively impact firm performance. In sum, the results show that whereas technological product characteristics are the main drivers of ERP use amongst Portuguese SMEs, the organizational performance characteristics are of ERP value. Our research hypotheses also recognize that the time beyond initial implementation of ERP describes a period that is required by a firm to adjust to the new system and train its users so that benefits may materialize. Such adjustments take on the form of positive changes as either upgrades or add-ons depending on the time period elapsed since the first implementation. Our survey shows evidence that firms' performance benefits accrue to ERP adoption after some years of use (Buonanno et al., 2005, Nicolaou and Bhattacharya, 2006, Häkkinen and Hilmola, 2008), and that system enhancements to firms' business processes, in order to pursue sustainable competitive advantage, is an on-going activity and post-implementation phases are critical to manage. Moreover, our results indicate that careful attention must be paid to the capabilities that firms use to achieve sustainable competitive advantages through ERP systems, paying special attention to how system upgrades/add-ons and overall post-implementation enhancements impact critical horizontal functionalities such as management control.

## Chapter 3 – ERP use and value: Portuguese and Spanish SMEs

### 3.1. Introduction

As suggested in the literature, innovation is more and more identified as the transformative force that creates and shapes new economies in today's digital world. Firms often adopt *information systems* (IS) to upgrade or improve their business performance and be more competitive (Ho and Tai, 2004). Davenport (1998) qualified *enterprise resource planning* (ERP) systems as the most important development in enterprises' use of *information technology* (IT). ERP's main purpose is to integrate functions of financial management, supply chain management, and customer relationship management to the greatest extent possible. Such systems manage both information and resources by supporting execution of operational transactions and advanced planning, alongside real-time data access (Klaus et al., 2000).

As with many other technological innovations, ERP systems were initially implemented mostly in large organizations, and this has probably been the main reason for research to focus on large enterprises. Although *small and medium enterprises* (SMEs) have been adopting ERP systems for many years, the literature reveals that little attention has been given to research on ERP in SMEs, and less on cross-national studies. Moreover, according to the European Commission (2011), 98% of all European firms have fewer than 250 employees, and both Portugal and Spain adhere to this profile, and with the same percentage. Because SMEs are the backbone of the economy, important for increasing productivity and gaining competitive advantage, as well as being important drivers of innovation and transformation,

it is valuable to study ERP at the SME level across countries (Hitt et al., 2002, Raymond and Uwizeyemungu, 2007, Chuang et al., 2009, Maguire et al., 2010).

As the impact of IT systems on a firm's performance is mostly long term and indirect, measures of the value to business are linked primarily to system usage (Devaraj and Kohli, 2003, Zhu and Kraemer, 2005). The current investigation explores an alternative way to understand and measure IT value by studying ERP in its post-adoption phases; use and value. We develop and test a model based on the *Diffusion of Innovation* (DOI) model and *resource-based view* (RBV) theory.

The theoretical perspectives and research model proposed to explain use and value are outlined in next two sections. The appropriateness of the model is then tested using a sample of 588 firms. Tests for differences based on Portugal and Spain are also conducted. Finally, we discuss our results and offer implications and conclusions.

## **3.2. Theoretical perspectives**

### **3.2.1. ERP use and diffusion of innovation**

Whereas ERP implementation refers to the stage of system planning, configuration, testing, and "going-live", ERP use means ERP utilization. It refers to the experience of managing the operation of the system software throughout the system's post-implementation stages (Nah et al., 2004, Liang et al., 2007). In line with literature we consider ERP to be a type of innovation that is implanted in a firm's core business processes in order to leverage performance (Rajagopal, 2002, Zhu and Kraemer, 2005). Not only does it extend basic business and streamline integration with suppliers and customers, it also directs system usage

to the firm's performance. Rogers' (1995) DOI model seeks to explain and predict if and how an innovation is used within a social system, with regard to performance at the firm level. Research conducted by Bradford and Florin (2003), Waarts et al. (2002) and Light and Papazafeiropoulou (2004) verifies DOI determinants regarding ERP use. Considering their findings, we believe that DOI has the potential to provide a favourable framework for explaining ERP use.

### **3.2.2. ERP value and resource-based view**

While ERP use refers to the production stage of system usage among firms actually using ERP in their daily business activities, ERP value refers to firms' ability to utilize ERP to create a competitive advantage. It refers to the ERP impact on a firm's performance, throughout the system life in the post-adoption stages (Rhodes et al., 2009). Since ERP's value relies on how firms strategically exploit the system, firm's performance in a competitive environment is a subject that draws much attention and some authors attempt to build explanatory theories. One of the most recognized is the RBV theory, which states that firm-specific resources determine the firm's performance. It is linked to the competitive advantage approach to strategic management and can explain sustained advantages (Hedman and Kalling, 2003). In the IS literature, the RBV has been used to analyse IT capabilities as a resource and to explain IT business value. That is, IT business value depends on the extent to which IT is used in the key activities of the firm. The greater the use, the more likely the firm is to develop unique capabilities from its IT business applications (Bharadwaj, 2000, Zhu and Kraemer, 2005, Antero and Riis, 2011). Hedman and Kalling (2003) and Fosser et al. (2008) used RBV to extend Mata et al.'s (1995) framework for organizational and

business resources and concluded that ERP systems are IT resources that can lead to sustained, competitive advantages. With this in mind, our theoretical model for ERP value will include variables that input value to ERP and positively impact the predisposition to extract value from the system.

### 3.3. Research model and hypotheses

The post-adoption model presented in Figure 3.1 outlines our proposal that the DOI model explains ‘ERP use’ and RBV theory explains ‘ERP value’. The left-hand side shows the extent of ‘ERP use’, influenced by six factors embedded in the DOI context: compatibility, complexity, efficiency, best-practices, training and competitive pressure. On the right-hand we postulate that ‘ERP value’ is explained by: ‘ERP use’, collaboration, and analytics.

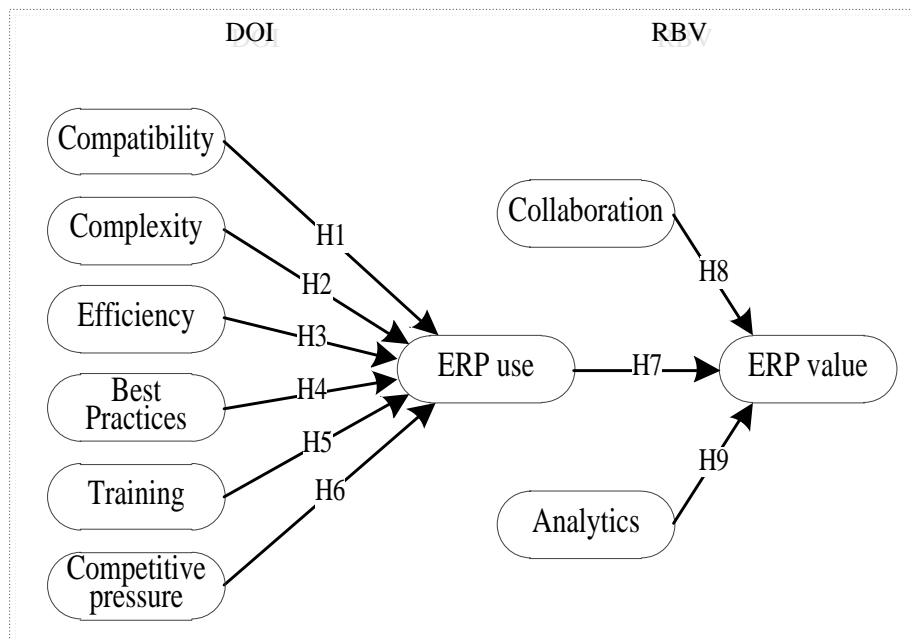


Figure 3.1. Research model

### **3.3.1. Hypotheses to explain use**

Based on DOI literature, compatibility and complexity have shown consistent associations with IS adoption. O’Leary (2000) and Bradford and Florin (2003) report that best-practices, training, and competitive pressure are also important dimensions for ERP usage. We contribute to this research by including the level of transactional efficiency as an important dimension that will influence ERP usage, and therefore postulate six hypotheses.

#### **Compatibility**

Compatibility is measured by the degree to which the ERP system matches IT features, such as compatibility with hardware and other software. Bradford and Florin (2003) and Elbertsen *et al.* (2006) concluded that the degree of compatibility of ERP systems with existing software and hardware will have a positive relationship with implementation success (system adoption and use). We thus formulate the first hypothesis:

*Hypothesis 1. Firms having ERP systems with greater compatibility are more likely to achieve more ERP use.*

#### **Complexity**

Cooper and Zmud's (1990) research indicates that system usage enhances job performance. Studies conducted by Kositanurit *et al.* (2006) and Chang *et al.* (2011a) conclude that ERP complexity is a major factor affecting user performance. Bradford and Florin (2003) concluded that ERP complexity is a critical factor for successful implementation. When users find it difficult to obtain the desired result from the ERP, frustration and unwillingness to use the system generally result. When users are comfortable using ERP, it scales up the users’

knowledge of the system and, so too, their skills in manipulating the system in effective ways. Moreover, it prepares users to comprehend the system trends sufficiently and comprehensively (Yu, 2005). Based upon this, we state our second hypothesis:

*Hypothesis 2. Firms having ERP systems that are perceived to be complex are less likely to use ERP.*

### **Efficiency**

Bendoly and Kaefer (2004) assessed transactional efficiency on data posting and found that its communication over the ERP improves the firm's overall performance. Rajagopal (2002) found that transactional efficiency has a direct influence on ERP use. Business process benefits of ERP investment include transactional efficiency, where reliability effectiveness on the application improves user confidence. Along the same lines, Gattiker and Goodhue (2005) found that coordination improvements and efficiency are significant benefits to ERP use. Taking this background into account, we construct our third hypothesis:

*Hypothesis 3. Firms having ERP systems with greater transactional efficiency are more likely to use ERP.*

### **Best Practices**

From the perspective of business process reengineering, there are two main options in implementing ERP systems: modify (customization) the ERP package to suit the firm's requirements (with high costs), or the implementation of an ERP package with minimum deviation from the standard settings (with lower costs) (Davenport, 1998). According to Light and Papazafeiropoulou (2004), Velcu (2007) and Chou and Chang (2008) the reason for adopting 'best practice' is the belief that ERP design does things in the right way, that is,

using the standard business process embedded in the software package without or with low minimum deviation from the standard. In line with Wenrich and Ahmad (2009) and Maguire et al. (2010), firms that implement industry best-practices dramatically reduce risk and time-consuming project tasks such as configuration, documentation, testing, and training. Thus, we postulate that firms that opt to implement ERP based on standard best-practices will use the system more. Based on these considerations, we formulate the fourth hypothesis:

*Hypothesis 4. Firms with a greater degree of business process fit to standard ERP 'best-practices' are more likely to use ERP.*

### **Training**

Several researchers, including O'Leary (2000), Bradford and Florin (2003), and Maguire et al. (2010) state that one of the main determinants for successfully adopting, using, and benefiting from ERP systems is the training of the users. The state of preparedness of users to meet situations and carry out a planned sequence of actions without upstream errors has an instantly positive impact on business. These researchers state that the level of the training programme that employees undergo with respect to ERP systems should focus on content, format and applicability, providing knowledge and skills to employees on how to use the system that improves familiarity and boost its use. We therefore postulate that firms with a higher level of training programme raise employees' readiness to use ERP. In line with research, we construct the fifth hypothesis:

*Hypothesis 5. The level of firms training programme will have a positive relationship with ERP use.*

### **Competitive pressure**

Competitive pressure has long been recognized in the innovation diffusion literature as an important driver of technology diffusion (Bradford and Florin, 2003, Zhu and Kraemer, 2005, Oliveira and Martins, 2010b). These studies have shown that innovation diffusion is accelerated by the competitive pressure in the environment. Thus, we postulate that competitive pressure plays an important role in pushing firms toward using ERP systems. In line with research, we construct the sixth hypothesis:

*Hypothesis 6. Firms facing higher competitive pressure are more likely to use ERP.*

### **3.3.2. Hypotheses to explain value**

From the RBV perspective, some (albeit few) researchers have shown that amount of use is associated with firm performance (Mabert et al., 2001). We contribute to this research by considering collaboration and analytics to be additional important dimensions that will influence ERP value, and therefore postulate three hypotheses.

#### **ERP use**

The link between ERP use and ERP value is a measure of the breadth and depth of how users work with the system and of decision-making based on analytical indicators. To explain the connection between usage and value, we support our proposition on RBV; the greater the extent of ERP use, the greater the likelihood that firms will create capabilities that are rare, inimitable, valuable, and sustainable, thereby contributing to value creation. A study conducted by Shahin and Ainin (2011) found that user fit on ERP is critical in explaining the ERP usage, and a successful adaptation with firms' processes and data flow from other IS

makes ERP worthwhile. With ERP systems (and their integration capability with other systems) firms can form a specific resource that guides both internal and external collaboration and provides the repository to perform business analyses. As a result, it is only when firms are actually using ERP systems to conduct business that ERP can have an impact on firm performance. Obviously, without system usage it is impossible for ERP to generate any impact on firm performance (Devaraj and Kohli, 2003, Zhu and Kraemer, 2005). These researchers demonstrate that there is a strong link between system use and system impact. In line with literature, we formulate the seventh hypothesis as:

*Hypothesis 7. Firms with greater ERP use are more likely to generate higher ERP value.*

### **Collaboration**

Calisir and Calisir (2004), Gattiker and Goodhue (2005), and Ruivo and Neto (2011) support the conclusion that ERP systems help users to collaborate; up, down, and across their department, company, and industry ecosystem, increasing their productivity and the health of their firms and business partners. ERP is a kind of gateway to unique functions. That is, ERP is the *sine qua non* factor for others (both humans and applications) to collaborate with ERP – from meeting service-level agreements to promoting enterprise performance. ERP systems provide users with a structured communication channel with the right information at the right time, resulting in increased efficiency and effectiveness. We believe that partnering with ERP and cross-group collaboration amplifies the ERP value. Therefore, and in line with RVB theory, we postulate the eighth hypothesis:

*Hypothesis 8. Firms' greater collaboration ERP systems are positively associated with higher ERP value.*

## **Analytics**

Davenport and Harris (2007) stated that “*analytics is not new*” but that not many firms give it priority. Firms generally use business analytics to leverage the investment they have made in ERP systems. In seeking to gain competitiveness, firms use integrated data and set analytics as a strategic initiative. The common data model and visibility across functional departments allows firms’ metrics to be unified and consistent. Although ERP systems are essentially transaction-focused on internal data, those firms that use ERP-embedded analytics capabilities can easily and quickly use data for managerial decision making and realize an advantage in their pursuit of sustainable performance (Chiang, 2009, Ruivo and Neto, 2011). In line with RVB theory and literature, we believe that analytics provides users with unique business insight information, and therefore we construct the ninth hypothesis:

*Hypothesis 9. Firms with greater levels of analytical information extracted from ERP are positively associated with higher ERP value.*

## **ERP value measurement**

Studies conducted by Park et al. (2007) and Chang et al. (2011a) concluded that ERP value output can be measured by three dimensions: individual productivity, customer satisfaction, and management control. Furthermore, both Zhang et al. (2005) and Bradford and Florin (2003) established user satisfaction as an important dimension of ERP value. In our study, we assess the positive impact of an ERP system on firm performance by user satisfaction, individual productivity, customer satisfaction, and management control.

### **3.3.3. Hypothesis to explain the differences between countries**

According to the European Commission (2011), although Spain is five times larger than Portugal, it had a negative growth rate of *Gross-Value Added* (GVA) produced by private businesses in 2010, while Portugal had a positive growth rate. Rogers (1995) and Zhu and Kraemer (2005) found that diffusion occurs differently across countries due to different environments. Looking specifically at the use of ERP, as country home market dimension and consumer product demand define industry type, firm's strategies, and country overall GVA, it therefore shapes ERP value across countries. In this line, we wish to understand the differences of ERP use and value across countries and therefore we construct the tenth hypothesis, as a result:

*Hypothesis 10. The antecedents of ERP use and value will differ for Portuguese and Spanish SMEs.*

## **3.4. Research methodology and data**

A survey methodology is proposed for data collection to validate the research model and test its nine hypotheses. Each survey item-question was reviewed for content validity by ERP experts; three academics and two consultants. The initial questionnaires were pilot tested on 10 firms, and some items were revised for clarity. The finalized questionnaire was designed to be answered in 15 minutes (Malhotra and Birks, 2007). With the assistance of International Data Corporation (IDC) we conducted a web-survey during September and October 2011. To ensure the generalization of the survey results, the sampling was stratified by country (Portugal and Spain), by firm size (fewer than 250 employees), and by industry (finance,

distribution, manufacturing, and professional services). Questionnaires were translated into the two languages and sent only to firms that use ERP in conducting their business. In total, 1400 (1000 Spanish and 400 Portuguese) firms received the email survey, and 588 valid responses were returned (424 Spanish and 134 Portuguese).

Table 3.1 shows the sample characteristics; approximately 70% of Portuguese firms responded that they had been using ERP for less than five years, while Spanish firms expressed 40%. The wide range of the respondent and industry types, suggests the good quality of the data source.

Characteristics	<b>Full sample (N=558)</b>		<b>Portugal (N=134)</b>		<b>Spain (N=424)</b>	
	Frequency (%)	Cumulative (%)	Frequency (%)	Cumulative (%)	Frequency (%)	Cumulative (%)
<b><i>Number of years using ERP</i></b>						
<2	28.0	28.0	36.6	36.6	19.7	19.7
2-5	26.8	54.7	33.3	69.5	20.3	39.9
5-10	31.4	86.1	27.5	97.0	35.3	75.2
>10	13.9	100.0	3.0	100.0	24.8	100.0
<b><i>Industry type</i></b>						
Distribution	29.6	29.6	28.4	28.4	30.0	30.0
Manufacturing	30.8	60.4	23.9	52.2	33.0	63.0
Finance	19.2	79.6	24.6	76.9	17.5	80.4
Services	20.4	100.0	23.1	100.0	19.6	100.0
<b><i>Respondent type</i></b>						
CEO, owner	18.5	18.5	20.9	20.9	17.7	17.7
IT/IS manager	27.4	45.9	27.6	48.5	27.4	45.0
Finance manager	19.9	65.8	20.1	68.7	19.8	64.9
Sales manager	22.9	88.7	23.1	91.8	22.9	87.7
Manufacturing manager	11.3	100.0	8.2	100.0	12.3	100.0

Table 3.1. Characteristics of the samples (Full, Portugal and Spain)

The constructs were operationalized on the basis of a literature review (shown in Appendix A). Constructs were measured using a survey instrument and multiple indicator items to strengthen validity. Whereas the ‘ERP use’ construct was measured by items calling for responses in percentages, all other constructs were measured by item responses on a five-

point Likert scale ranging from 1=low to 5=high. The control variables used were country, size, and industry type.

### **3.5. Data analysis and results**

A structural equation model was conducted to empirically assess the constructs theorized above. Because our purpose is to exam the validity of the constructs and does not require normal distribution for the variables, we used the *partial least squares* (PLS) as implemented in the software SmartPLS. We performed the Kolmogorov-Smirnov test and confirmed that none of the items measured are distributed normally ( $p < 0.001$ ). In accordance with Chin (1998), factor loadings should be at least 0.6 and preferably greater than 0.7. For this reason CB3, CX1, TN1, CP2, and ERPU1 question-items of Appendix A were excluded from our research model following the PLS model estimation due to low loadings. We retain the items presented in Table 3.2, except for BP2 (0.691), all other items have loadings above 0.7 and are significant at ( $p < 0.001$ ).

Item	Full sample (N=558)		Portugal (N=134)		Spain (N=424)	
	Loading	t-Stat*	Loading	t-Stat*	Loading	t-Stat*
CB1	0.978	480.195	0.925	7.360	0.953	178.696
CB2	0.981	637.229	0.991	12.141	0.963	231.001
CX2	0.771	3.734	0.936	97.797	0.813	10.621
CX3	0.965	7.020	0.919	93.032	0.923	24.525
EF1	0.790	29.259	0.764	32.003	0.823	36.359
EF2	0.796	26.170	0.768	26.920	0.810	34.927
EF3	0.842	30.017	0.880	61.194	0.806	26.461
BP1	0.820	44.817	0.796	33.578	0.820	39.199
BP2	0.716	19.890	0.691	18.552	0.719	18.002
BP3	0.825	38.751	0.880	60.196	0.811	33.816
TN2	0.939	173.910	0.954	269.978	0.931	148.220
TN3	0.936	156.885	0.961	345.770	0.936	148.252
CP1	0.957	168.484	0.983	161.226	0.948	193.680
CP3	0.859	48.499	0.784	23.648	0.878	61.211
ERPU2	0.894	117.847	0.894	137.936	0.900	114.363
ERPU3	0.871	84.732	0.875	84.041	0.851	62.882
CO1	0.893	151.719	0.898	188.766	0.892	150.663
CO2	0.828	72.089	0.887	156.042	0.803	59.303
CO3	0.808	44.080	0.818	53.113	0.805	44.901
AN1	0.829	72.541	0.875	111.851	0.816	62.040
AN2	0.883	91.012	0.903	103.026	0.878	89.616
AN3	0.777	49.521	0.874	84.742	0.746	41.004
ERP V1	0.725	46.535	0.747	52.967	0.721	45.912
ERP V2	0.900	156.543	0.927	225.381	0.893	133.216
ERP V3	0.846	92.060	0.862	87.722	0.841	93.742
ERP V4	0.745	48.323	0.703	34.468	0.754	48.440
<b>Construct</b>	<b>CR</b>	<b>AVE</b>	<b>CR</b>	<b>AVE</b>	<b>CR</b>	<b>AVE</b>
Compatibility (CB)	0.980	0.960	0.958	0.919	0.957	0.917
Complexity (CX)	0.864	0.763	0.925	0.860	0.861	0.757
Efficiency (EF)	0.851	0.656	0.847	0.649	0.854	0.661
Best Practices (BP)	0.831	0.622	0.834	0.628	0.827	0.616
Training (TN)	0.936	0.879	0.957	0.917	0.931	0.871
Competitive Pressure (CP)	0.905	0.827	0.882	0.791	0.910	0.835
ERP Use (ERPU)	0.876	0.779	0.878	0.782	0.868	0.767
Collaboration (CO)	0.881	0.712	0.902	0.754	0.873	0.696
Analytics (AN)	0.870	0.690	0.915	0.782	0.856	0.665
ERP Value (ERP V)	0.881	0.652	0.886	0.664	0.880	0.648

Table 3.2. PLS factor loading, composite reliability, and average variance extracted of full and country samples

Furthermore, Table II shows that *composite reliability* (CR) and *average variance extracted* (AVE) for each construct are above the cut-off of 0.7 and 0.5, respectively (Hair et al., 1998). In short, our measurement model satisfies convergent validity criteria. Consequently, the constructs developed can be used to test the conceptual model and its hypotheses.

We tested the conceptual model by using both the full sample and the sample split between Portugal and Spain. Figure 3.2 shows the path coefficients and t-statistics (in parentheses) derived from bootstrapping (500 resamples), as well as the  $R^2$  values for dependent constructs.

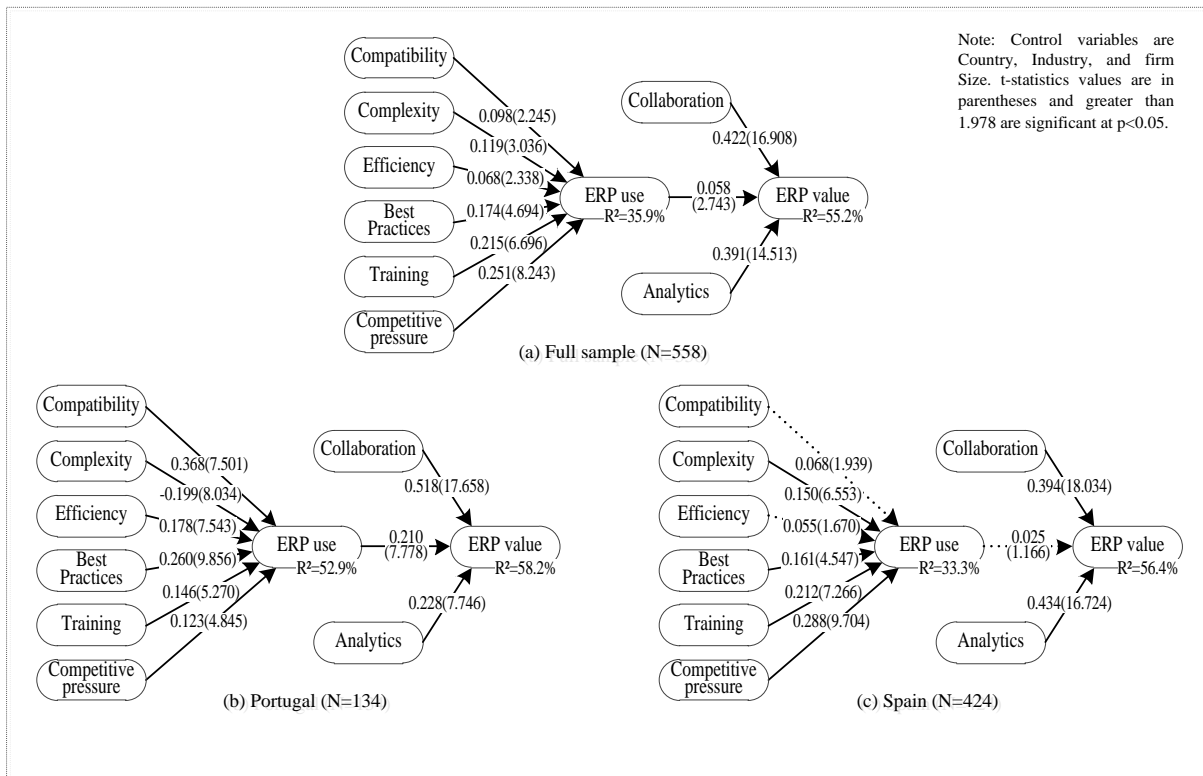


Figure 3.2. Path models of full sample and by country

The analysis of hypotheses for the full sample was based on the examination of the standardized paths shown in Figure 3.2(a). For ‘ERP use’, all six DOI determinants; compatibility, complexity, efficiency, best-practices, training and competitive pressure, have positive and statistically significant paths leading to the dependent construct. Although the path associated with complexity is statistically significant, it does not have the negative sign

that we expected. Therefore, all hypotheses (except H2) dealing with ‘ERP use’ are supported. In addition, the model shows a significantly positive link from use to value (0.058), thus supporting H7. Collaboration and analytics are also shown to have significantly positive associations with ‘ERP value’; hence, H8 and H9 are supported. To assess model fit, we present  $R^2$  values in Figure 3.2(a), which indicates how well the antecedents explain the dependent construct. An examination of the  $R^2$  values shows that all six DOI determinants explains the variability of ‘ERP use’ in 35.9%, and ‘ERP use’, collaboration and Analytics determinants explain the variability of ‘ERP value’ in 55.2%, suggesting a good fit for the model.

The analysis of hypotheses on the Portuguese and Spanish subsamples was also based on the examination of the standardized paths shown in Figures 3.2(b) and 3.2(c), respectively. In the Portuguese subsample, for ‘ERP use’, although complexity has a negative path while the other five factors have positive paths, all six DOI determinants are statistically significant. Thus, H1 to H6 regarding ‘ERP use’ are supported. In addition, the model indicates a strong link from ‘ERP use’ to ‘ERP value’ (H7). Although collaboration (H8) has a stronger relationship (0.518) with ‘ERP value’ than analytics (H9), both H8 and H9 are supported. Regarding the Portuguese subsample, based on this model 52.9% of the ‘ERP use’ variability was explained by six determinants, and 58.2% of the ‘ERP value’ variability was explained by three determinants.

In the Spanish subsample, for ‘ERP use’, although all six DOI determinants are positive, only four are found to be significant; compatibility and efficiency are insignificant. Complexity was expected to be negative and therefore, H4, H5, and H6 for ‘ERP use’ are supported. The

model shows a not significant link between ‘ERP use’ and ‘ERP value’, hence H7 is not confirmed. As in the Portuguese subsample, the Spanish shows a significantly positive association of collaboration and analytics with ‘ERP value’. Hence, H8 and H9 are supported. For Spain, best-practices, training, and competitive pressure explain the variability of ‘ERP use’ in 33.3% and, ‘ERP use’, collaboration, and analytics explain the variability of ‘ERP value’ in 56.4%.

In a deeper analysis, we tested the differences between the path coefficients across the Portugal and Spain subsamples. Table 3.3 shows that regarding ‘ERP use’; training has no statistically significant differences ( $p > 0.10$ ) between countries, being equally important for both Portuguese and Spanish firms. Whereas best-practices, compatibility, and efficiency are more important factors to Portuguese firms, competitive pressure is more important to Spanish firms. Moreover, complexity is found to be an important inhibitor for Portuguese firms and a facilitator for Spanish. Regarding ‘ERP value’; whereas ‘ERP use’ and collaboration are more important for Portuguese firms, analytics is more important to Spanish firms.

	<u>Portugal</u>		<u>Spain</u>		t-Stat.	p (2-tailed)
	Path coeff.	SE from bootstrap	Path coeff.	SE from bootstrap		
Compatibility -> ERP Use	0.368	0.049	0.068	0.035	4.989	0.000
Complexity -> ERP Use	-0.199	0.025	0.150	0.023	-10.359	0.000
Efficiency -> ERP Use	0.178	0.024	0.055	0.033	3.021	0.003
Best Practices -> ERP Use	0.260	0.026	0.161	0.035	2.260	0.024
Training -> ERP Use	0.146	0.028	0.212	0.029	-1.625	0.104
Competitive -> ERP Use	0.123	0.025	0.288	0.030	-4.214	0.000
ERP Use -> ERP Value	0.210	0.027	0.025	0.021	5.383	0.000
Collaboration -> ERP Value	0.518	0.029	0.394	0.022	3.409	0001
Analytics -> ERP Value	0.228	0.029	0.434	0.026	-5.269	0.000

Table 3.3. Results of pooled error term t-Tests by subgroup (compare Portugal with Spain)

Overall, the above results provide support for the cross-country differences in the determinants shaping ERP use and value in which firms adopt IT, thereby supporting Hypothesis 10.

### 3.6. Discussion

The purpose of this paper is to identify the determinants that explain ERP post-adoption with regard to usage and value and to determine the magnitude of variations across Portugal and Spain. Empirical results support our theoretical model, and all hypotheses have been tested on full sample and subsamples. Both academic and managerial implications are discussed below.

#### Full sample

As indicated by their significant and positive paths in Figure 3.2(a), amongst the DOI determinants, competitive pressure is found to have the most significant impact on the degree of ‘ERP use’, followed by training and best-practices. That is, firms facing greater

competitive pressure tend to achieve a greater extent of ‘ERP use’, as do firms with better trained users, as well as using ERP systems with standard best-practices. Our study provides evidence that system compatibility and transactional efficiency are important drivers for system usage. That is, as daily operations are more and more managed through ERP use, and compatibility issues are resolved, ERP becomes more stable, increasing the reliability and effectiveness for its usage, thus becoming a necessity.

Contrary to the conclusions of Bradford and Florin (2003), Kositanurit et al. (2006), and Chang et al. (2011a), and our predictions, our results reveal a positive effect of system complexity on ‘ERP use’. It has been widely believed that complexity of business applications is an inhibitor to use, but our results provide evidence that for Spanish firms system complexity is not an inhibitor, such as it is for Portuguese firms.

As shown in Figure 3.2(a), the ‘ERP use’ and ‘ERP value’ relationship is found to be a significant and positive link from use to value, supporting our research design, in which use explains the value, in accordance with Devaraj and Kohli (2003) and Zhu and Kraemer (2005).

Both collaboration and analytics capabilities are found to be a significant and positive links to ‘ERP value’. As discussed in the “hypothesis to explain value” subsection, while collaborating with colleagues, system, suppliers, partners, and customers increase productivity, analytics provides greater business insight for better decision making processes. As a result, these two ERP enhanced capabilities help firms to improve performance because they are firm specific, difficult to imitate, and less mobile across firms, which is consistent with the RBV theory.

**Differences between Portugal and Spain.**

Our study finds that for Portuguese SMEs the ERP value relies greatly on the capacity of users to collaborate to meet service levels, mainly because transactional data become visible to the supply chain, decreasing the bullwhip effect. Since quality of the data (and thus also the quality of its ramifications) is largely dependent on using the system correctly, the ‘ERP use’ is also perceived as an important determinant for ERP value. Subsequently, as data become available and transformed into business information, allowing reporting, analytics capabilities are considered alongside as an important factor of ERP value. For Spanish SMEs the ERP value is composed largely of system analytics capabilities to make full use of operational data, and generate more detailed reports to support decision-making and resource planning in an improved manner - followed by collaboration, to serve new possibilities for using information to improve transparency and business processes.

Contrarily to Portuguese SMEs, the greater ERP use amongst Spanish firms is not perceived as an important factor to generate value from ERP. This difference might be explained by the fewer number of years in which Portuguese firms have been using ERP; whereas the Portuguese subsample shows that 70% of firms have been using ERP systems for less than 5 years, the Spanish subsample shows 40%. (Table 3.1). That is, utilizing the ERP logic for more years, the perception of ‘ERP use’ upon ‘ERP value’ drops in importance next to collaboration and analytics capabilities. In line with Hakkinen and Hilmola (2008) the perception on ERP success usage drops from the ‘shakedown’ phase (when the system was just adopted) to post go-live phase (a few years after the system start been utilized). Moreover, Buonanno et al. (2005) state that ERP starters confer more value to collaboration because it is often connected to the organizational enhancements, whereas firms using ERP

for more years confer to fully exploit data analytically. Thus, whereas for Portuguese firms organizational factors such as ‘ERP use’ have a great impact on value, for Spanish firms it loses importance to factors such as business analytical information.

With regards to ‘ERP use’, although competitive pressure, training, and best-practices are significant factors for countries, compatibility, complexity, and efficiency importance differ (Figures 3.2(b) and 3.2(c)). The underlying rationale would be that the number of years using the system shapes ‘ERP use’. This conclusion might be explained through cross-country analysis.

First, although ERP best-practices (using standard protocols and few customizations) is more fitted to IS starters (Buonanno et al., 2005, Nicolaou and Bhattacharya, 2006), in connection with users trained through key-users and/or help-on-line tools, both are important drivers for ERP use in both shakedown and post go-live phases. In line with Hakkinen and Hilmola (2008), poor helpdesk support and training (to reduce system complexity and create users skills), and customizations were the main barriers to best possible use of the ERP.

Second, although competitive pressure is statistically significant for both Portuguese and Spanish firms, it is stronger for Spanish firms. A possible explanation is that Spanish firms have been using ERP for more years, revealing that competitive pressure is a subject where analytics plays a critical role in gaining business advantages.

Third, although compatibility and efficiency have positive paths for both countries, they are not statistically significant for Spanish firms. This can be explained by the importance that Portuguese firms confer to technological characteristics such as compatibility with other hardware and software, and transactional efficiency (for fast and real-time data quality, avoiding errors, higher inventories, lower profits, and non-value-added work), which are

dependent on the system stabilization throughout the shakedown phase (Häkkinen and Hilmola, 2008, Gattiker and Goodhue, 2005).

Finally, while complexity is significant for both countries, it has a negative impact for the Portuguese firms. That is, since characteristics such as familiarity with ERP could depend on use over time, ERP starters generally have more complexity worries in manipulating the system in effective ways and obtaining worth from it. In contrast, as Spanish firms could be more familiar with ERP logic, they do not perceive system complexity as an inhibitor for ERP use.

### **Managerial implications**

These results offer a useful framework for managers to assess post-adoption cross-country variations in usage and value of ERP. Both countries' managers should maintain priority on training programmes as well as using the ERP standard best-practices; these factors will contribute to increase skills and familiarity with the system. With the same priority, Portuguese managers should closely manage the compatibility with legacy systems and plan activities concerned with system efficiency in order to achieve greater usage and quality data. In order to create competitive advantages, both countries' managers should define strategies based on the fact that as ERP diffuses through usage and becomes a necessity to business process and organizational coverage, the competitive pressure infuses the strategic exploitation of the ERP transaction data into high value processes that are supported by new IT analytical functionalities and capabilities in areas such as collaboration throughout the supply chain. Our study also offers implications for IT industry/services. System complexity and business analytics functionalities have emerged as important factors for ERP use and

value in such a way that for Portuguese SMEs familiarity is an important factor, while analytics capabilities are more important for Spanish SMEs, which implies different implementation methodologies and support contracts, alongside developing friendly front-end functionalities that extend both collaboration and analytics, yet based on standard best-practices.

### **Research implications**

We believe this study offers implications for other researchers as well. First, we have shown that the proposed research model in Figure 3.1 is a useful theoretical framework for explaining determinants that affect the ERP use and value across countries and may be extended to other countries. Second, we have developed several constructs, including efficiency, which have passed convergent validity testing, and could be used in future studies. Third, supported with theory and empirical data, we have categorized two IT-enhanced capabilities (collaborations and analytics) and analysed their relative significance for ERP value. The result could serve as a theoretical base for studying additional sources of value creation derived from technology innovations.

### **Limitations and future work**

This paper has some limitations that may form the starting point for further research. First, although our empirical results show that relationships exist among the determinants, we cannot speak empirically to the issue of whether value is sustained, because this requires a longitudinal study, so longitudinal studies could be developed. Second, although our study

shows evidence that the determinants of use and value vary across-countries in association with the number of years using ERP, we cannot speak empirically to the issue of whether the maturity stages play a role, because this would require an adoption process life-cycle study (Holland and Light, 2001). An interesting different direction could be to study the maturity stages of ERP. Third, although data cover industry types, some biases may have been introduced. Perhaps different industries have different operating characteristics and environments, and the factors related to ERP use and value may differ accordingly (Oliveira and Martins, 2010a). Consequently, we encourage further studies that compare industries.

### **3.7. Conclusion**

Consistent with DOI and RBV, we developed and empirically evaluated a research model for assessing ERP use and value at the firm level. While these are usually studied separately, our study proposes that use and value are closely associated for the post-adoption stages. Besides being the first model applied to Iberian SMEs, our study contributes to the literature by moving beyond dichotomous “adoption versus non-adoption” linking actual usage to value creation, and adds transactional efficiency and collaboration as important determinants for Portuguese firms, as well as business analytics, but more important for Spanish firms. For ‘ERP’ use, our study has examined six DOI determinants; whereas competitive pressure, training and best-practices are important to both Portuguese and Spanish firms, cross-country analysis also shows complexity to be an important inhibitor for ‘ERP use’ among Portuguese firms, but a facilitator for Spanish. In addition, while for Portuguese, compatibility and efficiency are significant, they are not for Spanish. For ‘ERP value’ (and consistent with

RBV), our study demonstrates that the degree of ‘ERP use’ and IT-enhanced capabilities such as collaboration and analytics, contribute to value creation from ERP. Moreover, our study reveals that for Portuguese firms ‘ERP value’ is mainly explained by ‘ERP use’, collaboration, and analytics, whereas for Spanish firms ‘ERP value’ is mainly explained by collaboration and analytics capabilities. Finally, our study exposes that both countries’ SMEs are not using ERPs as a transaction processing system alone, but also as a front-end application.

## **Chapter 4 – Differential effects on ERP post-adoption stages across Scandinavian and Iberian SMEs**

### **4.1. Introduction**

*Enterprise resource planning* (ERP) is an IT resource that supports business activities along the value chain (Bharadwaj, 2000). The ERP is considered as one of the most significant and complex technological innovations for a firm (Davenport and Harris, 2007). The value of ERP systems is an active research area in the *information systems* (IS) discipline. Although important, much of the existing literature has focused on the adoption decision, more precisely on “adoption versus non-adoption” (Huy et al., 2012). However innovation diffusion represents a complex process that starts at adoption and extends to use and value creation (post-adoption) (Zhu and Kraemer, 2005, Devaraj and Kohli, 2003, Gattiker and Goodhue, 2005).

ERP systems were initially implemented mostly in large organizations, and this has probably been the main reason for why research has focused on large enterprises. Although *small and medium enterprises* (SME) have been adopting ERPs for many years, the literature argues that little attention has been given to research on ERPs in SMEs (Chang et al., 2010, Sharma et al., 2012) and even less on cross-national studies (Buonanno et al., 2005, Lee et al., 2012).

European firms are more and more adopting information systems to transform firm’s value-chain activities. According to the European Commission (2011), 98% of all European firms are SMEs with less than 250 employees. Although culturally disparate, both Scandinavian (Sweden and Denmark) and Iberian (Portugal and Spain) regions (Everdingen and Waarts,

2003), both regions adhere to this profile, and with the same percentage. Because SMEs are the support of Europe's economy, and are important for increasing productivity and gaining competitive advantage in the global economy. They are also important drivers of innovation and transformation.

The organizational applications and managerial implications of ERP systems play an important role in providing a deep understanding of the phenomenon to researchers and practitioners in the information resource management domain, and studying ERP use and value among SMEs across two distinct European regions is of special interest (Ramdani et al., 2009).

Motivated by these issues, this study seeks to improve the understanding of ERP on SMEs by inquiring:

RQ1 – What are the factors driving ERP use and value in both Scandinavia and Iberia?

RQ2 – What are the differences and similarities in ERP use and value across Scandinavia and Iberia?

To answer these research questions we developed a conceptual model based on a synthesis of two theories: *diffusion of Innovation* (DOI) and *resource-based view* (RBV). We empirically evaluate the joint model through a large-scale survey (883 firms) in Scandinavia and Iberia.

The paper is organized as follows: we next present the theoretical foundation. We then propose the conceptual model and hypotheses development, followed by the methodology and results. This paper closes with a discussion of major findings, contributions and limitations, and concluding remarks.

## 4.2. Theoretical foundation

Unlike the typical focus on adoption (or intent to adopt), we focus on post-adoption stages, that is, actual use of ERP and value creation from ERP. Both are critical stages that impact a firm's performance (Tornatsky and Fleischer, 1990, DeLone and Mclean, 2003, Zhu and Kraemer, 2005, Cooper and Zmud, 1990, Devaraj and Kohli, 2003) (Figure 4.1).

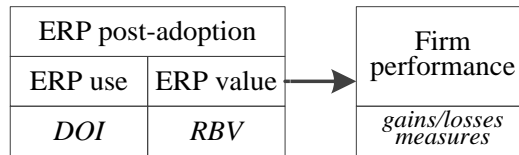


Figure 4.1. ERP post-adoption theoretical foundation

Whereas ERP use refers to the production stage of system usage in firm's daily business activities, ERP value refers to a firm's ability to utilize ERP to create a competitive advantage to positively impact firm performance (Mata et al., 1995, Rhodes et al., 2009, Shahin and Ainin, 2011).

In accordance with Rai et al. (2006) and Porter (1998) firm performance may be measured through cost efficiency. As ERP systems greatly enhance cost efficiency, Nicolaou and Bhattacharya (2008) and Hitt et al. (2002) used accounting-based firm performance data to assess the impact of ERP on firm performance, more precisely on Return On Investment (ROI), Return On Assets (ROA), Return On Sales ratio (ROS), Inventory Costs (INVT), Cost of Goods sold (COGS), and Selling, General, and Administrative Expenses (SGAE). These so-called first-order effects measure gains/losses and are expected to contribute to the overall firm's performance.

The goal of this paper is to understand the ERP post-adoption stages through the lens of the *diffusion of Innovation* (DOI) and *resource-based view* (RBV) theories. A brief description of each are presented next.

#### **4.2.1. Diffusion of Innovation theory and IT use**

Earlier research (Tornatsky and Fleischer, 1990, Iacovou et al., 1995, Rogers, 1995) suggests that factors such as technological backwardness, organizational obstacles and environmental constraints explain the variation in IT use. The Roger's (1995) DOI theory aims to explain how an innovation moves from conception to use. These innovation characteristics are: 1) *relative advantage* (the degree to which an innovation is perceived as being better than the previous ones, 2) *compatibility* (the degree to which an innovation is perceived to compare with previously introduced ones, 3) *complexity* (the degree to which an innovation is perceived as difficult to understand and use), 4) *triability* (the degree to which an innovation may be experimented with), and 5) *observability* (the degree to which the results of an innovation are visible to others). Literature shows that the DOI theory has a solid theoretical foundation and consistent empirical supports to explain IT use (Azadegan and Teich, 2010, Ifinedo, 2011, Leinbach, 2008, Zhu et al., 2006). Studies conducted by Bradford and Florin (2003), and Light and Papazafeiropoulou (2004) verified DOI determinants in regards to ERP use. We therefore believe that DOI has the potential to provide a favourable framework for explaining ERP use.

#### **4.2.2. Resource-Based View theory and IT use**

Earlier research suggests that the business value of IT resides in how firms create competitive advantage from their resources (Hedman and Kalling, 2003, Mata et al., 1995, Caldeira and

Ward, 2003, Barney, 1991, Bharadwaj, 2000). IT value is a subject that draws much attention seeking to build explanatory theories such as the RBV theory of the firm. RBV posits that firms create value through resources that are valuable, rare, imperfectly imitable, and non-substitutable. With its roots on strategic management, in this theory the firm-specific resources determine a firm's performance (Mata et al., 1995, Barney, 1991). In IS literature the RBV has been used to analyse IT capabilities and to explain IT business value. That is, IT business value depends on the extent to which IT is used in the key activities of the firm. The greater the use, the more likely the firm is to develop valuable unique capabilities from its IT (Zhu and Kraemer, 2005, Devaraj and Kohli, 2003).

From the RBV perspective, some researchers have shown that enhancements to firms' business processes through collaboration (Gattiker and Goodhue, 2005, Rai et al., 2006, Chiang, 2009) and analytics (Davenport and Harris, 2007, Chiang, 2009, Carte et al., 2005) are important dimensions that influence IT value. Hedman and Kalling (2003) used RBV and extended Mata et al.'s (1995) framework for organizational and business resources, concluding that ERP systems build capabilities that positively impact on firm's performance. The literature shows that the RBV theory has a solid theoretical foundation and consistent empirical support to explain IT value and therefore, we believe that RBV has the potential to provide a favourable framework for explaining ERP value.

### **4.3. Conceptual model and hypothesis**

We develop an integrative framework theoretically grounded on DOI and RBV theories, shown in Figure 4.2. It outlines that the DOI explains ERP use and RBV explains ERP value. Where ERP use is influenced by six factors embedded on the DOI context: compatibility,

complexity, efficiency, best-practices, training and competitive pressure. As the ERPs possess less observability and triability (Rogers, 1995), we will not include these in our research framework. ERP value is explained by ERP use, collaboration and analytics. The model research hypotheses are presented next.

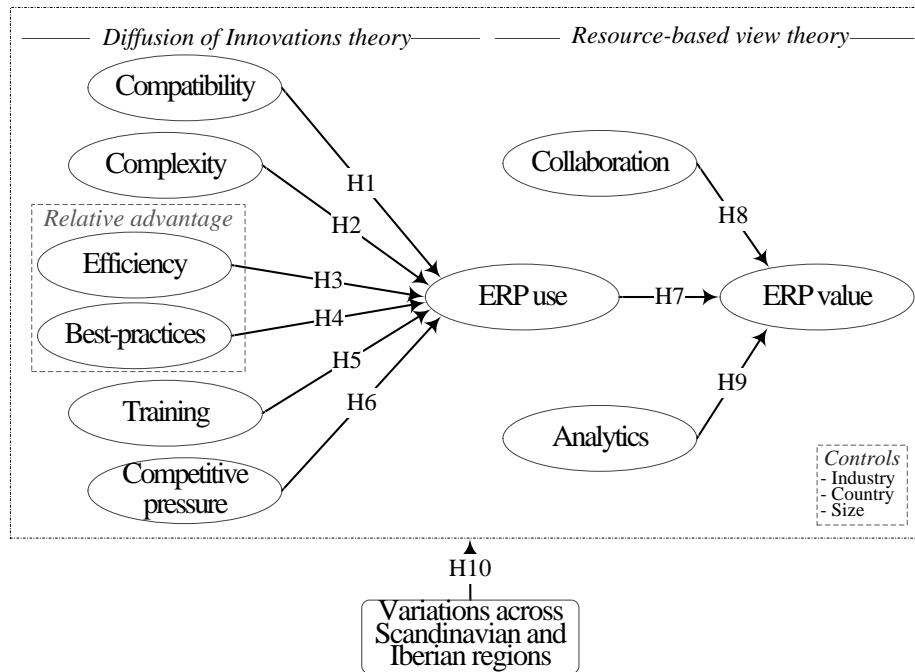


Figure 4.2. Integrative conceptual model

#### 4.3.1. Hypotheses development to explain ERP use

##### Compatibility

*H1: SMEs having ERP with greater compatibility are more likely to use ERP.*

In the innovation literature compatibility has been shown to be an important determinant to system adoption and use (Chang et al., 2010, Light and Papazafeiropoulou, 2004). The degree on which IT resource integrates with retained systems the greater the use and chances of

realizing organizational benefits and more satisfied users will be (DeLone and Mclean, 2003, Bradford and Florin, 2003, Light and Papazafeiropoulou, 2004, Cooper and Zmud, 1990).

### **Complexity**

*H2: SMEs having ERP that is perceived as complex are less likely to use ERP.*

Studies conducted by Chang et al. (2011a) , Kositanurit et al. (2006) and Light and Papazafeiropoulou (2004) conclude that ERP complexity is a major factor affecting user performance. When users find it difficult to obtain the desire result from the ERP, frustration and unwillingness to use the system arises (Bradford and Florin, 2003). When users are comfortable using ERP, it scales up the users' knowledge of the system and, so too, their skills in manipulating the system in effective ways.

Relative advantage has been widely identified in the innovation diffusion context as a significant factor for driving the usage of IT innovations. System transactional efficiency and embedded best-practices enables firms to reduce transaction and coordination costs (Zhu et al., 2006, Light and Papazafeiropoulou, 2004). Therefore in this study the relative advantage construct is composed by two variables: efficient and best-practices.

### **Efficiency**

*H3: SMEs having ERP of greater transactional efficiency are more likely to use ERP.*

Bendoly and Kaefer (2004) assessed transactional efficiency and found that improves the firm's overall performance. Rajagopal (2002) found that transactional efficiency has a direct influence on ERP use. Business process benefits of ERP investment include transactional

efficiency, where reliability effectiveness on the application improves user confidence (Gattiker and Goodhue, 2005).

### **Best-practices**

*H4: SMEs with standard best practice in their ERP are more likely to use ERP.*

According to Light and Papazafeiropoulou (2004), Zach and Munkvold (2012) and Chou and Chang (2008) the reason for adopting ‘best-practice’ is the belief that ERP design does things in the right way, that is, using the standard business process embedded in the software package without or with low minimum deviation from the standard. In line with Wenrich and Ahmad (2009) and Maguire et al. (2010), firms that implement industry best-practices dramatically reduce risk and raise usage.

As training users and firm’s competitive pressure represent constrains and opportunities for greater IT use (Zhu and Kraemer, 2005, Bradford and Florin, 2003), we consequently include them as important determinants that influence the degree of ERP use.

### **Training**

*H5: SMEs with greater user training programmes are more likely to use ERP.*

Researchers, including Bradford and Florin (2003), Stratman and Roth (2002) and Maguire et al. (2010) state that one of the main determinants for successfully adopting, using, and benefiting from ERP systems is the training of the users. These researchers state that the level of the training programme that employees undergo with respect to ERP systems improves readiness, familiarity and boost its use.

### **Competitive pressure**

*H6: SMEs facing higher competitive pressure are more likely to use ERP.*

Competitive pressure has long been recognized in the innovation diffusion literature as an important driver of technology diffusion (Bradford and Florin, 2003, Chang et al., 2010, Oliveira and Martins, 2010b, Zhu and Kraemer, 2005). These studies have shown that innovation diffusion is accelerated by the competitive pressure in the environment.

### **4.3.2. Hypotheses development to explain ERP value**

#### **ERP use**

*H7: SMEs with greater ERP use are more likely to generate higher ERP value.*

Several researchers concluded that it is only when firms are actually using IT systems to conduct business that make IT worthwhile (DeLone and Mclean, 2003, Devaraj and Kohli, 2003, Zhu and Kraemer, 2005, Nicolaou and Bhattacharya, 2008, Venkatesh et al., 2012). These researchers demonstrate that there is a strong link between system use and system value. The greater the extent of ERP use, the greater the likelihood that firms will create capabilities that are rare, inimitable, valuable, and sustainable, thereby contributing to value creation (Devaraj and Kohli, 2003, Zhu and Kraemer, 2005, Shahin and Ainin, 2011).

#### **Collaboration**

*H8: SMEs greater collaboration ERP is positively associated with higher ERP value.*

Several researchers support the conclusion that ERP systems help users to collaborate; up, down, and across their department, company, and industry ecosystem, increasing their

productivity and the health of their firms and business partners. ERP is the sine qua non factor both humans and applications to collaborate – from meeting business agreements to promoting enterprise performance. ERP provide users with a structured communication channel with the right information at the right time, resulting in increased efficiency and effectiveness (Gattiker and Goodhue, 2005, Rai et al., 2006, Chiang, 2009, Sherer et al., 2011).

### **Analytics**

*H9: SMEs with greater levels of analytical information extracted from ERP are positively associated with higher ERP value*

Davenport and Harris (2007) and Chiang (2009) stated that firms generally use business analytics to gain competitiveness. By using integrated data allows firms' metrics to be unified and consistent. Although ERP systems are essentially transaction-focused, those firms that use ERP-embedded analytics capabilities can easily and quickly use data for managerial decision making and gain competitive advantage Carte et al (2005).

### **ERP value**

Several researchers found that when firms recognize their system as valuable IT resource they use it further more to increase performance (Zhu and Kraemer, 2005, Devaraj and Kohli, 2003, Gattiker and Goodhue, 2005). These researchers demonstrate that there is a strong link between system use and system value. Previous studies reported that the business value of ERP is in intangible areas such as management control and customer satisfaction (Mabert et al., 2001, Ranganathan and Brown, 2006). Studies conducted by Park et al. (2007), Chang et

al. (2011a) Hitt et al. (2002) and Cotteleer and Bendoly (2006) found that individual productivity is the main business value of ERP. Gattiker and Goodhue (2005), Zhang et al. (2005), Zhang et al. (2005) and Bradford and Florin (2003) found that ERP value lay on better information and efficiency and coordination which contributes to user satisfaction. It is only when firms use the ERP that can have a positive impact on firm performance.

#### **4.3.3. Hypothesis development to explain differences between regions**

The rate which IT resources are adopted and incorporated into the productive process is considered to be a major factor in driving performance (Rogers, 1995). However, this diffusion does not follow a common pattern in terms of rates or timing across-countries. While some countries are receptive to changes, others are not. Hence, some countries lag while others lead. This divergence is due to both economic (European Commission, (2011) and non-economic such as cultural factors (Hofstede, 2001, Lee et al., 2012, Sherer et al., 2011). Accordingly to the European Commission (2011), the *Gross-Value Added* (GVA) produced by SMEs in 2010 in Scandinavian (Denmark and Sweden) had an higher GVA than in Iberian region (Portugal and Spain). Looking specifically at the ERP, as culture, markets dimension, consumer product demand of firms define industry type, firm's strategies, and region overall GVA, it therefore shapes the business value of ERP across-regions. In this line, we wish to understand the differences in ERP use and value across these two regions and therefore we construct the tenth hypothesis as:

*H10. The antecedents of ERP use and value will differ for Scandinavian and Iberian SMEs*

#### **4.3.4. Control variables**

We used industry type, country and firm size as control variables (dummies) to control data variation not explained by the other variables (Oliveira and Martins, 2010b, Soares-Aguiar and Palma-dos-Reis, 2008, Zhu and Kraemer, 2005).

## **4.4. Research methodology**

### **4.4.1. Measurement**

To validate the research model and test the hypotheses presented in Figure 4.2 we conducted a survey on firms across Scandinavian (Denmark and Sweden) and Iberian (Portugal and Spain) regions. A survey instrument was developed on the basis of literature as well experts' opinion (Appendix). As suggested by Venkatesh et al. (2012) the questionnaire was reviewed for content validity by five IS experts. The measurement instrument was then tested among a small sample (pilot study with 10 firms) in order to determine if the respondents had difficulty answering the questionnaire, as well as test the reliability and validity of the scales. The ERP value variable was measured by four item-questions and all other variables were measured by three. The ERP use variable was measured by items calling for responses in percentages and all other variables were measured by a five-point Likert scale, where 1 means "low" and 5 "high".

### **4.4.2. Data**

For data collection this study used a survey methodology to validate the research model and test the hypotheses. With the assistance of IDC, data were collected using a web-survey over a two-month period (September-October 2011). In total, 2000 (1400 Iberian and 600

Scandinavian) firms received the web-survey, and 883 (558 Iberian and 325 Scandinavian) completed responses were received. The profile of the sample is shown in Table 4.1.

<b>Characteristics</b>		<b>Scandinavian (%)</b>	<b>Iberian (%)</b>
<b>Industry type</b>	Distribution	27.4	29.6
	Manufacturing	19.4	30.8
	Finance	29.8	19.2
	Professional Services	23.4	20.4
<b>Respondent's position</b>	CEO/owner	27.7	18.5
	IS/IT manager	11.7	27.4
	Finance manager	20.6	19.9
	Sales manager	28.9	22.9
	Manufacturing	11.1	11.3
<b>Number of years using ERP</b>	Less than 5 years	34.9	55.0
	More than 5 years	65.1	45.0
<b>Relative importance of ERP value<sup>1</sup></b>	User satisfaction	28.4	17.4
	Individual productivity	25.6	21.7
	Customer satisfaction	24.4	19.1
	Management control	21.6	41.8
<b>Gains/losses measure indicators<sup>2</sup></b>	ROI	94.7	82.2
	ROA	93.1	81.0
	ROS	94.8	80.8
	INVT	95.0	91.3
	COGS	96.2	91.8
	SGAE	98.5	92.7

<sup>1</sup>respondents were asked to rank their importance between them

<sup>2</sup>respondents were asked to assess how much did these ratios improved after adopt ERP

Table 4.1. Characteristics of the samples (Scandinavian and Iberian)

The respondents were qualified executives (CEO/owner, IT/IS manager, and operational managers). The sample covered varying types of industry (distribution, manufacturing, finance, and professional services) and represented SMEs (between 10-250 employees). The diversity amongst respondent's position as well as industry types ensures the generalization of the survey results, and suggests a good quality of the data.

Data show a great similarity in regard to tangible indicators (gains/losses), both regions score above 80%. Major differences in the samples are; whereas 65.1% of Scandinavian SMEs

have used ERP for more than 5 years and user satisfaction is considered as the important intangible factor of ERP value, 55.0% of Iberian SMEs have use it for less than 5 years, and management control has the highest importance.

## **4.5. Results**

Structural equation modelling (SEM) was used to empirically assess the research model. Kolmogorov-Smirnov test confirmed that none of the measurement items are distributed normally ( $p < 0.001$ ). This allows for the safe use of partial least squares (PLS) for the analysis (Ringle et al., 2005), as this does not require a normal distribution (Chin, 1998). Before testing the structural model, we examined the measurement model to assess reliability and validity.

### **4.5.1. Measurement model**

To measure the model we assessed: indicator reliability, construct reliability, convergent validity, and discriminant validity. First, the indicator reliability was evaluated based on the criteria that the loadings should be greater than 0.70 (Henseler et al., 2009). For this reason five items (CB3, CX1, TN1, CP2 and ERPU1) were eliminated, retained all other items in the Appendix, which are statistically significant at  $p < 0.001$ , fulfilling this criterion. Second, the construct reliability was tested using the composite reliability (CR) coefficient. All constructs have a CR above 0.7 (Table 4.2), which suggests that constructs are reliable (Henseler et al., 2009), fulfilling this criterion. Third, the convergent validity was tested using the average variance extracted (AVE). If coefficient is above 0.5 the latent variable explains more than half of the variance of its indicators (Hair et al., 2012, Fornell and Larcker, 1981,

Henseler et al., 2009). Based on Table 4.2, we can conclude that all constructs have an AVE above 0.5, fulfilling this criterion.

<b>Scandinavian (N=325)</b>															
Constructs	Loads range <sup>3</sup>	Mean	SD	CR	AVE	CB	CX	EF	BP	TN	CP	ERP <sub>u</sub>	CO	AN	ERP <sub>v</sub>
Compatibility (CB)	0.78 - 0.87	3.84	0.72	0.88	0.70	<b>0.84</b>									
Complexity (CX)	0.83 - 0.95	3.53	0.52	0.89	0.80	-0.16	<b>0.89</b>								
Efficiency (EF)	0.76 - 0.87	3.95	0.54	0.88	0.71	0.28	-0.09	<b>0.84</b>							
Best-practices (BP)	0.80 - 0.87	3.55	0.50	0.86	0.68	0.41	-0.29	0.51	<b>0.82</b>						
Training (TN)	0.72 - 0.99	3.38	0.55	0.85	0.75	0.12	-0.14	0.33	0.44	<b>0.87</b>					
Competitive Pressure (CP)	0.74 - 0.96	4.09	0.65	0.85	0.74	0.20	0.01	0.24	0.25	0.01	<b>0.86</b>				
ERP use (ERP <sub>u</sub> )	0.87 - 0.91	75.83	10.55	0.88	0.78	0.19	-0.09	0.37	0.40	0.12	0.42	<b>0.88</b>			
Collaboration (CO)	0.81 - 0.89	3.77	0.55	0.89	0.74	0.23	-0.26	0.47	0.54	0.32	0.19	0.16	<b>0.86</b>		
Analytics (AN)	0.79 - 0.89	4.02	0.51	0.87	0.70	0.37	-0.16	0.35	0.51	0.18	0.27	0.34	0.45	<b>0.84</b>	
ERP value (ERP <sub>v</sub> )	0.83 - 0.87	3.93	0.47	0.87	0.72	0.10	-0.11	0.35	0.48	0.24	0.38	0.26	0.53	0.52	<b>0.85</b>

<b>Iberian (N=558)</b>															
Constructs	Loads range <sup>3</sup>	Mean	SD	CR	AVE	CB	CX	EF	BP	TN	CP	ERP <sub>u</sub>	CO	AN	ERP <sub>v</sub>
Compatibility (CB)	0.79 - 0.95	3.83	0.71	0.93	0.81	<b>0.90</b>									
Complexity (CX)	0.79 - 0.96	3.28	0.55	0.87	0.77	0.16	<b>0.88</b>								
Efficiency (EF)	0.79 - 0.84	3.99	0.52	0.85	0.65	0.13	-0.13	<b>0.81</b>							
Best-practices (BP)	0.72 - 0.83	3.53	0.49	0.83	0.62	0.24	-0.27	0.43	<b>0.79</b>						
Training (TN)	0.69 - 0.93	2.92	0.71	0.77	0.64	0.23	-0.23	0.41	0.69	<b>0.80</b>					
Competitive Pressure (CP)	0.86 - 0.96	4.09	0.72	0.91	0.83	0.08	-0.01	0.29	0.22	0.21	<b>0.91</b>				
ERP use (ERP <sub>u</sub> )	0.86 - 0.90	76.26	11.68	0.87	0.78	0.31	0.08	0.27	0.35	0.31	0.37	<b>0.88</b>			
Collaboration (CO)	0.82 - 0.80	3.78	0.55	0.88	0.71	0.02	-0.48	0.46	0.52	0.47	0.20	0.08	<b>0.84</b>		
Analytics (AN)	0.78 - 0.88	4.07	0.54	0.87	0.69	0.22	-0.16	0.37	0.55	0.45	0.21	0.27	0.46	<b>0.83</b>	
ERP value (ERP <sub>v</sub> )	0.84 - 0.88	3.95	0.50	0.90	0.74	0.11	-0.25	0.42	0.51	0.44	0.32	0.22	0.57	0.59	<b>0.86</b>

Note: <sup>3</sup> All loadings are statistically significant (p<0.001)  
SD - Standard deviation  
N - Number of firms

Table 4.2. Loadings, Descriptive statistics, CR, AVE constructs values, correlations and square root of AVEs

Finally, discriminant validity of the constructs was assessed using two measures, i.e., Fornell-Larcker (1981) criteria and cross-loadings. For the first criteria we compute that the square root of AVE (Table 4.2 in bold) for constructs, that are greater than the correlation between each pair of constructs (off-diagonal elements). The second criterion resulted in that the loading of each indicator are greater than all cross-loadings (Chin, 1998), the Table with loadings and cross-loadings is available from the authors on request. Both criterions were fulfilled.

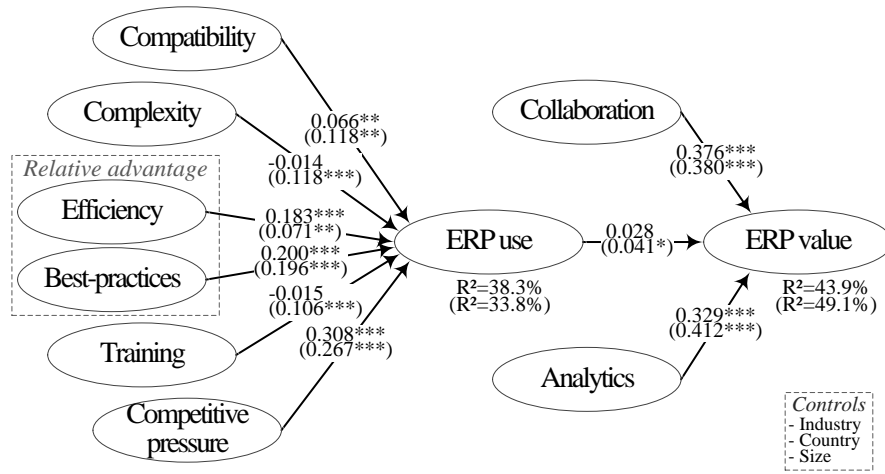
In short, the construct reliability, indicator reliability, convergent validity and discriminant validity of the constructs are satisfactory. Consequently, the constructs can be used to test the conceptual model.

#### **4.5.2. Structural model**

The structural model was assessed using R<sup>2</sup> measures and the level of significance of the path coefficients. Figure 4.3 shows the model results, the path coefficients ( $\hat{\beta}$ ) and statistically significant at 5% and 1%. For Scandinavian sample the R<sup>2</sup> of dependent variables are respectively 38.3% and 43.9% for ERP use and ERP value. From Iberian sample the R<sup>2</sup> of dependent variables are respectively 33.8% and 49.1% for ERP use, ERP value. These R<sup>2</sup> results suggest a good fit for the model (Fornell and Larcker, 1981).

The significance of the path coefficients was assessed by means of a bootstrapping procedure with 500 times resampling (Hair et al., 2012, Henseler et al., 2009). In the Scandinavian subsample, for ERP use; complexity and training shows negative paths ( $\hat{\beta}=-0.014$ ;  $p>0.05$ ) and ( $\hat{\beta}=-0.015$ ;  $p>0.05$ ) respectively, while the other four constructs have positive paths. The results also show that the negative paths are not statistically significant, while the other four constructs are statistically significant. Thus, H1, H3, H4 and H6 regarding ERP use are supported. In addition, even if the Scandinavian model indicates a positive link ( $\hat{\beta}=0.028$ ;  $p>0.05$ ), from ERP use to ERP value (H7) it is not statistically significant. Collaboration (H8) in the Scandinavian sample has a stronger relationship ( $\hat{\beta}=0.376$ ;  $p<0.01$ ) with ERP value than analytics (H9) ( $\hat{\beta}=0.329$ ;  $p<0.01$ ), although both H8 and H9 are supported.

Regarding the Iberian subsample, for ERP use; none of the factors show a negative path, so all six factors have positive paths, and are statistically significant. Except H2 ( $\hat{\beta}=0.118$ ;  $p<0.01$ ) (expected negative) hypotheses H1 to H6 regarding ERP use are supported. In addition, also among the Iberian SMEs there is a positive and statistically significant link between ERP use and ERP value ( $\hat{\beta}=0.041$ ;  $p<0.05$ ), hence supporting H7. Although Collaboration (H8) in the Iberian sample has a lesser relationship ( $\hat{\beta}=0.380$ ;  $p<0.01$ ) with ERP value than analytics (H9) ( $\hat{\beta}=0.412$ ;  $p<0.01$ ), both H8 and H9 are supported.



Notes: Estimates on the Iberian subsample are shown in parentheses. \*P<0.10; \*\* P<0.05; \*\*\*P<0.01.

Figure 4.3. Path models of Scandinavian and Iberian SMEs

To deepen the analysis, we tested differences between path coefficients across Scandinavian and Iberian subsamples, based on Kiel’s et al. (2000) formula:

$$t = \frac{\beta_{(1)} - \beta_{(2)}}{\sqrt{\frac{(n_{(1)} - 1)^2}{n_{(1)} + n_{(2)} - 2} \cdot se_{\beta_{(1)}}^2 + \frac{(n_{(2)} - 1)^2}{n_{(1)} + n_{(2)} - 2} \cdot se_{\beta_{(2)}}^2} \cdot \sqrt{\frac{1}{n_{(1)}} + \frac{1}{n_{(2)}}}}$$

Table 4.3 shows that regarding ERP use; compatibility, best-practices, and competitive pressure factors are not statistically significant different ( $p>0.10$ ), being equally important

for SMEs on both regions. Whereas efficiency is a more important factor ( $p < 0.05$ ) for Scandinavian SMEs, complexity and training are more important for Iberian SMEs ( $p < 0.01$  and  $p < 0.05$ , respectively).

Path		<u>Scandinavian</u>		<u>Iberian</u>		<u>Scandinavian -Iberia</u>
		Path coeff.	SE from bootstrap	Path coeff.	SE from bootstrap	t-Statistic
Compatibility	→ ERP use	0.066	0.031	0.118	0.045	-0.819
Complexity	→ ERP use	-0.014	0.028	0.118	0.034	-2.674 ***
Efficiency	→ ERP use	0.183	0.027	0.071	0.031	2.461 **
Best-practices	→ ERP use	0.200	0.032	0.196	0.038	0.072
Training	→ ERP use	-0.015	0.030	0.106	0.036	-2.310 **
Competitive Pressure	→ ERP use	0.308	0.023	0.267	0.030	0.953
ERP use	→ ERP value	0.028	0.023	0.041	0.022	-0.386
Collaboration	→ ERP value	0.376	0.025	0.380	0.026	-0.103
Analytics	→ ERP value	0.329	0.032	0.412	0.030	-1.795 *

**Note:** \* $P < 0.10$ ; \*\*  $P < 0.05$ ; \*\*\* $P < 0.01$ .

Table 4.3. Results of pooled error term t-Tests by subsamples (compare Scandinavian with Iberian)

Regarding ERP value; both ERP use and collaboration does not show a statistically significant difference ( $p > 0.10$ ) between Scandinavian and Iberian SMEs, which means that both ERP use and collaboration are understood as being equally important for both regions. The only statistical significant difference is analytics, which is perceived as a more important factor for Iberian SMEs when it comes to perceived ERP value ( $p < 0.10$ ).

Overall, the above results also provide support for the cross-regions differences among SMEs in the ERP use and value, hence supporting H10.

#### 4.6. Discussion and contributions

The empirical analysis demonstrated several major findings. Interpretations based on these findings and contributions for practitioners and researchers are discussed below.

*Finding 1: Although the impact of ERP on firm's performance through tangible ratios (gains/losses measures), does not show significant variability, few differences exist across-regions. That is, all accounting-based data show ratios above 80% (Table 4.1). Iberian SMEs show less differential on ROI, ROA, and ROS, and Scandinavian SMEs show high differential on INVT, COGS and SGAE. In line with Nicolaou and Bhattacharya (2008) and Hitt et al. (2002), longer-adopters improved all these metrics, and shorter-adopters start showing after the shakedown phase.*

*Finding 2: Compatibility, efficiency, best-practices and competitive pressure are important factors in both regions, while efficiency has little importance among Iberian SMEs. This seems to suggest that, as firms move into deeper stages of ERP use, the key determinant for maintaining a pace faster than competitor's shifts from business fit and integration to efficiency. This might be explained by the dependency on system stability, which requires use over time. Moreover, the result that best-practices is statistically significant, it can be concluded that SMEs feel a need to implement ERP systems in order not to have a competitive disadvantage. They do see implementation of best-practices as potentially improving their business. This is an interesting finding that sheds some new light into the debate about whether commercial ERP can create a competitive advantage, or if ERP systems are necessary in order to avoid competitive disadvantage by using ERP systems "as is", with embedded standard best-practices (Light and Papazafeiropoulou, 2004, Zach and Munkvold, 2012).*

*Finding 3: Training is an important determinant for ERP use among Iberian SMEs, but is not important for Scandinavian SMEs. Drawing upon our earlier argument, one explanation*

could reside in the fact that first-adopters depend greatly on training, and as time passes and SMEs become proficient in using the system, training is perceived as being less important than other determinants for ERP use.

*Finding 4: The importance of complexity differs across-regions.* It has been widely believed that complexity of business applications is an inhibitor to use, but contrary to our prediction and to the conclusions of Bradford and Florin (2003), Kositanurit et al. (2006) and Chang et al. (2010), our results reveal a positive effect of system complexity on ERP use among Iberian SMEs, but irrelevant for Scandinavian. Drawing upon our earlier argument despite the fact that Iberian SMEs have used ERPs for a shorter time, they do not see complexity as an inhibitor for ERP use (Figure 4.3), probably because they use only the out-of-the-box functionalities and with proper training the willingness to overcome a complex system is a new experience (Chang et al., 2010).

*Finding 5: The relationship between ERP use and ERP value is significant for Iberian SMEs, but not for Scandinavian.* As shown in Figure 4.3, Iberian SMEs associate higher degrees of ERP use with higher ERP value. Although this finding is in line with the conclusion of Devaraj and Kohli (2003) and Zhu and Kraemer (2005), that use is a missing link to IT value, it is not to Scandinavian SMEs, probably because longer-adopters perceived determinants such collaboration and analytics as more important for ERP value.

*Finding 6: Whereas collaboration is more important amongst Scandinavian SMEs, analytics is more amongst Iberian SMEs.* Although both paths associated with collaboration and analytics are significantly positive in both regions, collaboration is stronger among Scandinavian SMEs, while analytics is stronger among Iberian SMEs (Figure 4.3). However,

as show in Table 3, only analytics is statistically significant when comparing regions. This difference might be explained by the fewer number of years in which Iberian SMEs have been using ERP. Analysing this from the fact that Scandinavian SMEs show a stronger link between collaboration and ERP value at the same time as they have used ERPs for a longer time, it may be due to the greater competitive pressure exposure of Scandinavian firms which compel collaborative planning, forecasting, and replenishment with partners within and with different countries (Sherer et al., 2011). From the concept of absorptive capacity, and in line with Park et al. (2007) and Sharma et al. (2012), the fact that collaboration and analytics are recognized as important determinants for ERP value in both regions, allows us to consider that SMEs assimilate and use ERPs not only as a transaction-processing system, but as front-end applications in order to develop and sustain competitive advantage. Large firms use several IT resources to meet the same goal, but perhaps because of acquisition and maintenance costs (Buonanno et al., 2005, Chang et al., 2010).

*Finding 7: The importance of ERP business value varies across both regions.* Whereas for Iberian SMEs the intangible importance of ERP business value has to do with management control, for Scandinavian SMEs it is more about user satisfaction, individual productivity, customer satisfaction, and lastly, management control (Table 1). With above findings, the study highlights that cultural differences might have different implications on ERP use and value across-regions, especially the significance of efficiency, complexity, training and analytics (Table 3). As efficiency is significant for Scandinavian firms, let us say that it is due to its cultural aspects, which emphasize the importance of getting things done on-time. In line with Everdingen and Waarts (2003), Scandinavia is more receptive to breakthrough innovations mostly due its low-context culture and low power-distance factor characterized

by learning on the job and user satisfaction (Table 4.1). Iberian region is less likely to use such innovations spontaneously mostly due to its high-context culture and high power-distance factors. Where analytics is a significant determinant for Iberian managers' control, system complexity is perceived as comprehensive and broad which for Iberian culture is a challenge. Furthermore our results are in line with Miller et al. (2006), who found that for Scandinavian SMEs the importance of ERP is mostly to gain efficient, while for Iberian it is mostly to gain control.

### **Contributions to practitioners**

This study can assist managers to adjust their strategies according to each region's cultural traits. For instance, in high-context cultures (Iberia), ERP post-adoption may be managed effectively through transformational communications (information obtained mainly from personal networks) such as classroom training, good practices examples, and industry group meetings, while in low-context countries (Scandinavia) informational communications (mainly contained explicitly in words/numbers) such as Online/On-demand training, e-communications, and procedures could be the best way of getting worth from ERP. Our study also offers implications for ERP vendors, both business analytics and collaboration functionalities have emerged as important factors for ERP use and value as well as front-end applications based on standard best-practices.

### **Contributions to literature**

This study makes four specific contributions to IS literature. First, it is the first research studying ERP across two distinct European regions (Scandinavian and Iberian). Second, through an integrative framework theoretically grounded, we empirically tested the ERP use

and value. Third, unlike most of the studies found in the literature on innovation diffusion that use an “adoption versus non-adoption” approach, we assessed ERP in the post-adoption stages, more precisely linking determinants to use, to value. Finally, this study contributes to a better understanding of ERP in SMEs.

### **Limitations and future research**

This study has three limitations which may point the way to further research. First, although our study shows evidence that ERP post-adoption importance varies across-regions in association with the number of years using ERP and that cultural factors are associated, we cannot speak empirically about the issue of whether the maturity stages play a role, nor on the effect of regions’ culture on ERP. An interesting different direction could be to study the maturity stages of ERP (Holland and Light, 2001), as well as culture influences on ERP post-adoption (Lee et al., 2012, Sherer et al., 2011). Second, although data cover several commercial ERP products, we cannot speak empirically on the issue of different products having different operating characteristics and environments, and the factors related to ERP post-adoption may differ. An interesting study would be to compare ERP products (IDC, 2009). Third, the results show that ERP has an expressive impact on accounting-based firm performance ratios, and it is therefore not possible to assess in a single model its variability. Future work might be to measure other tangible benefits such as the impact on upstream coordination, internal operations and downstream sales (Zhu and Kraemer, 2005).

### **4.7. Conclusions**

This study contributes to a better understanding of *Enterprise resource planning* (ERP) in *small and medium enterprises* (SMEs). Unlike the literature that has mainly focused on single

countries this paper extends the international dimension by studying ERP across Scandinavia and Iberia. Drawing on *diffusion of Innovation* and *resource-based view* theories, we empirically test a research model to assess ERP in post-adoption stages. To do so, our study is based on primary data collected in Denmark, Portugal, Spain, and Sweden at the same time, and then tested through structural equation modelling. The current paper demonstrates the differential effect on ERP use and value across Scandinavian and Iberian SMEs. Whereas tangible benefits such as accounting-based firm performance ratios are consistently high across-regions, intangible ones (namely management control and user satisfaction) differ across-regions, most likely due to cultural differences. The overall conclusion is that ERPs are IT resources that are being used not only as transactional-processing systems, but also as front-end applications in SMEs. Theoretically grounded, this research shows usefulness and thus suggests that it can be applied to study other technological innovations.

## Chapter 5 – Enterprise resource planning value variations across commercial packages

### 5.1. Introduction

Today's economy is forcing many enterprises to change in order to survive. To compete in the global markets, firms often adopt *enterprise resource planning* (ERP) systems, which provide a better way to execute business operations in an effective, organized, and sophisticated way. The adoption of ERP has been described as one of the most innovative developments associated with the use amongst enterprises of *information technology* (IT) (Davenport and Harris, 2007). An ERP system integrates as many enterprise functions as possible into commercially-packaged software. An intriguing question among decision-makers in organizations regarding the adoption of ERP systems is whether or not these kinds of systems actually provide value to an organization. There are disparate findings and thoughts about this, but even so, firms have implemented ERPs to a considerable degree (May et al., 2013). Although *small and medium enterprises* (SMEs) have been adopting ERPs for many years, there is little research on ERP implementation in SMEs, and even less on cross-product studies. The literature reports many studies on ERP comparisons in terms of selection process, implementation duration, and total cost of ownership, for example, (Dezdar and Sulaiman, 2009, Forslund, 2010), but few that examine how these ERP products contribute to ERP value in the post-adoption stage, when firms are actually using the system (Gattiker and Goodhue, 2005, Shahin and Ainin, 2011, Hitt et al., 2002). Theories from both *supply chain management* and *information systems* (IS) argue that ERP systems allow information to flow transparently in a firm's ecosystem, benefiting its supply chain efficiency

(Ranganathan and Brown, 2006, Cotteler and Bendoly, 2006, Rai et al., 2006, Forslund, 2010, Dezdar and Sulaiman, 2009, Sarker et al., 2012). ERP vendors claim that ERP systems can bring firms operational excellence and competitive advantages. With these attractive benefits, large firms have already implemented ERP systems intensively, being followed by SMEs (Buonanno et al., 2005). As a consequence, ERP vendors are proposing commercial-packaged software to the SME market as the correct ERP solution to adopt.

Studies such as Sarker et al. (2012) and Strong and Volkoff (2010) pointed out that an important avenue for IS literature is to understand how a commercial-packaged software value can be assessed through academic lens. In this way help to reduce the many identified mismatches in packaged software implementation. Furthermore they claim that studies focusing on SMEs would fill an important void in the packaged software literature, which has tended to focus primarily on large firms. In this line, the present study fills this gap.

According to the International Data Corporation report (2009), SAP, ORACLE, SAGE, and Microsoft DYNAMICS are the world's top four ERP vendors regarding licenses, maintenance, and subscription revenue. Many firms run their daily business with one of these ERPs, which amongst them account for nearly half of the market share. Moreover, according to the European Commission (2011) annual report on SMEs, 99% of all European firms have fewer than 250 employees, and Denmark, Portugal, Spain, and Sweden adhere to this profile with the same percentages. Motivated by these issues, this study seeks answers to the following research questions:

RQ1 – How do European SMEs find value in commercial-packaged ERP?

RQ2 – What are the differences and similarities in ERP value across four commercial-packaged software products?

To answer these questions, we developed a conceptual model and empirically test it using a

large sample of 833 SMEs in four European countries. The theoretical background and the research model proposed to explain ERP value are outlined in the next two sections. The appropriateness of the model is then tested followed by testing the differences amongst the four products. Finally, we discuss our results and offer conclusions.

## **5.2. Theoretical background**

In this section we first review the existing studies in business value of ERP and then, grounded on the *resource-based view* (RBV) theory, we develop the conceptual framework to assess ERP value.

### **5.2.1. Business value of ERP**

Researchers such as Mabert et al. (2003) and Cotteleer and Bendoly (2006) pointed out that most improvements in ERP post-adoption are in intangible areas such as increased interactions across the enterprise, quick response time for information, integration of business process, and availability and quality of information. In the same line Gattiker and Goodhue (2005), Park et al. (2007), and Rhodes et al. (2009) reported that there are also improvements in communications, individual productivity, customer satisfaction, and management control. Studies conducted by Hitt et al. (2002) and Nicolau and Bhattacharya (2006) found that ERP improves coordination between different units, efficiency of business process, and individual productivity. Furthermore, both Zhang et al. (2005) and Bradford and Florin (2003) established user satisfaction as an important business value of ERP.

While the existing studies have expanded the business value of ERP understanding, the results look only at the IT within the firm. The present study looks at the firm's IT capabilities

to create unique characteristics, which when used together can leverage the value of ERP and create a competitive advantage to attain sustainable performance improvements. Melville et al. (2004) pointed out that most of the existing research on IT value focuses on the IT as a resource itself, but not on the much richer area of IT capabilities. Jacobs and Bendoly (2003) and Santhanam and Hartono (2003) suggest that ERP should be viewed as a capability because performance improvements such those mentioned above can be achieved all at once.

### **5.2.2. Resource-based view theory and ERP**

IT value is a subject that draws much attention seeking to build explanatory theories and has led to the resource-based view (RBV) theory of the firm. The RBV argues that when firm resources are economically valuable (exploiting opportunities and neutralizing threats), relatively rare, difficult to imitate, and imperfectly mobile across firms (remaining bound and available), they can create competitive advantages, which in turn can explain the differences in firm performance (Barney, 1991, Bharadwaj, 2000). The RBV has been used in the IS literature to explain IT business value, in which firm-specific sets of resources determine the firm's performance and explain sustained advantages (Hedman and Kalling, 2003, Mata et al., 1995, Caldeira and Ward, 2003).

Resources and capabilities are two terms that have been frequently used without distinction. Based on the definition of RBV by Wade and Hulland (2004), resources are inputs into a firm's production process, such as IT equipment, whereas capabilities refers to a firm's capacity to exploit the IT equipment (resources), usually through organizational processes, where through continued use, capabilities become more difficult for competitors to understand and imitate. According to Barney (1991), many studies investigating the

relationship between IT resources and firm performance have found that IT tangible resources (IT infrastructure) represent the fragile source of sustainable competitive advantage for a firm because the resources are easy for competitors to copy. From the RBV perspective this advantage can result in great part from development of intangible capabilities when embedded in a firm's daily business, that is, only in ERP post-adoption stages. Therefore, we suggest that while ERP as a resource may positively influence firm performance in the short term, intangible ERP capabilities are more valuable for providing firm competitive advantages (Ravichandran and Lertwongstien, 2005). Figure 1 shows the core concepts of the RBV applied to ERP systems.

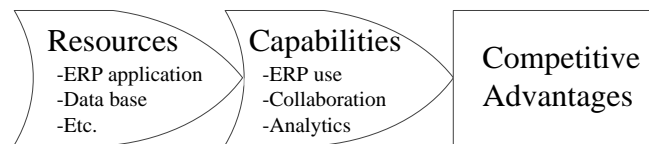


Figure 5.1. RBV framework applied to ERP

### 5.3. Conceptual model to assess ERP value

Based on the RBV framework above, we developed the conceptual model shown in Figure 5.2. We propose that the ERP capabilities; Use, Collaboration, and Analytics explain ERP value. These capabilities refer to the level of ERP use amongst firm's employees, to the firm's collaboration with its suppliers, customers, and within its firm, and to the firm's analytical information for better decision making.

The greater the use, the more likely the firm is to develop unique capabilities from its IT business applications (Zhu and Kraemer, 2005, Santhanam and Hartono, 2003, Venkatesh et al., 2012). Hedman and Kalling (2003) used RBV and extended Mata et al.'s (1995) framework for organizational and business resources, concluding that ERP systems are IT

resources' which have intangible capabilities that can lead to sustained, competitive advantages.

From the RBV perspective, some researchers have shown that enhancements to firms' business processes through collaboration (Gattiker and Goodhue, 2005, Lucas et al., 2008, Chiang, 2009, Rai et al., 2006, Phusavat et al., 2009, Hwang and Grant, 2011) and analytics (Davenport and Harris, 2007, Chiang, 2009, Carte et al., 2005, Lee et al., 2000, Ravichandran and Lertwongstien, 2005, Helo et al., 2008, Chang et al., 2011b) are additional important dimensions that will influence IT resources' value. Swaminathan and Tayur (2003), Rai et al. (2006) and Ruivo et al. (2012g) concluded that the full potential of an IT system cannot be realized if its collaboration and analytics capabilities are not exploited. Both extend the original value proposition of ERP, offering the opportunity to firms to build interactive relationships with their business partners and bring empowerment to every user. With ERP systems firms can form a set of specific capabilities that guide both internal and external collaboration and comprise the means to perform business analyses (Mabert et al., 2001, Markus et al., 2000a, HassabElnaby et al., 2012). As a result, it is only when firms are actually using ERP systems to conduct business that the system can have an impact on firm performance and be worthwhile (Kremer and van-Dissel, 2000, Zhu et al., 2004, Devaraj and Kohli, 2003).

Several researchers support the conclusion that ERP systems help users to collaborate up, down, and across their department, company, and industry ecosystem, increasing their productivity and the health of their firms and business partners, and amplifying the ERP value. And although ERP systems are essentially transaction-focused, those firms that use ERP analytics capabilities can easily and quickly use data for managerial decision making

and realize an advantage in their pursuit of sustainable performance through unique business insight information (Davenport and Harris, 2007, Jacobs and Bendoly, 2003, Ranganathan and Brown, 2006, Gattiker and Goodhue, 2005, Bendoly and Kaefer, 2004, Mabert et al., 2001, Lee et al., 2000, Forslund, 2010).

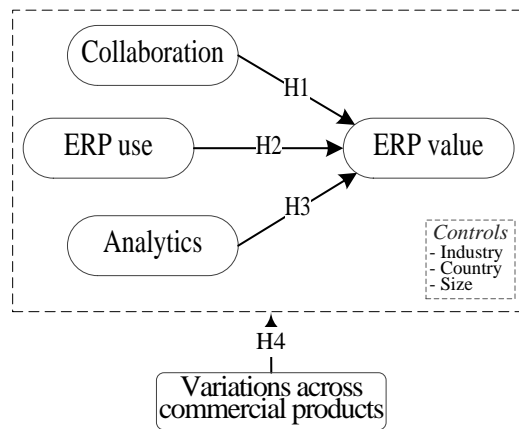


Figure 5.2. Conceptual model for assessing the ERP value

In line with the above literature we postulate that Use, Collaboration, and Analytics are positively associated with higher ERP value, and consequently we construct the following hypotheses.

**Collaboration construct** is defined as the extent to which ERP supports firms' collaboration through the value chain activities. It is measured by the degree of ease in collaborating with colleagues and the system, and communicating with suppliers, partners, and customers. Consistent with RBV, ERP firms create unique capabilities which allow trading among employees as well as with partners and customers, all of which increase firm performance (Gattiker and Goodhue, 2005, Lucas et al., 2008, Chiang, 2009, Rai et al., 2006, Lee et al., 2000, Ruivo et al., 2012, Phusavat et al., 2009). Thus, we construct the first hypothesis as:

*H1: SMEs with greater ERP collaboration capability are positively associated with higher*

*ERP value.*

**ERP use construct** is defined as the extent to which ERP is being used to conduct the firm's value chain activities. It is measured by how many employees use the system daily, how much time per day employees work with the system, and how many reports are generated per day. As RBV suggests, the greater the extent of IT use, the greater the likelihood that firms create IT capabilities that are rare, inimitable, valuable, and sustainable, contributing in that way to value creation. Without the use of ERP along the value chain, it would be impossible for ERP to generate any impact on firm performance. Many researchers have suggested that there is a strong link between use and value (DeLone and Mclean, 2003, Devaraj and Kohli, 2003, Zhu and Kraemer, 2005, Häkkinen and Hilmola, 2008, Nicolaou and Bhattacharya, 2006, Venkatesh et al., 2012). Based on the above, we postulate our second hypothesis. *H2: SMEs with greater ERP use capability are positively associated with higher ERP value.*

The **Analytics construct** is defined as the extent to which ERP provides analytical information for on-time fact based decision making. It is measured by the degree of comprehensive reporting, real-time access to information, and data visibility across departments. As RBV suggests, firms that explore ERP analytical capabilities to conduct their value chain activities increases firm performance, making it more difficult for competitors to understand and imitate (Davenport and Harris, 2007, Chiang, 2009, Carte et al., 2005, Ravichandran and Lertwongstien, 2005, Sen and Sinha, 2005, Ruivo et al., 2012, Helo et al., 2008). Hence, we postulate the third hypothesis. *H3: SMEs with greater ERP analytical capability are positively associated with higher ERP value.*

Because the ultimate goal of using ERP is to improve business performance, the **ERP value construct** is measured by the degree of ERP impact on user satisfaction, individual productivity, customer satisfaction, and management control (Park et al., 2007, Bradford and Florin, 2003, Mabert et al., 2001, Cotteler and Bendoly, 2006, Ranganathan and Brown, 2006, Hitt et al., 2002, Gattiker and Goodhue, 2005, Zhang et al., 2005).

Some researchers including Hedman and Kalling (2003), Wade and Hulland (2004), and Zhu and Kraemer (2005) and have found that IT value differs across environments. The value of an ERP to transform a short-term competitive advantage into a sustained competitive advantage requires that ERPs must be heterogeneous in nature and not perfectly mobile. Effectively, this translates into a valuable resource that is neither perfectly imitable nor substitutable without great effort. As a result, ERP capabilities (Use, Collaboration, and Analytics) may have differing importance across products in explaining the ERP value. In line with this reasoning, we postulate the fourth hypothesis. *H4: The antecedents of ERP value will differ across products.*

We used industry type, country, and firm size as **control variables** (dummies) to control data variation not explained by the other variables (Oliveira and Martins, 2010b, Soares-Aguiar and Palma-dos-Reis, 2008, Zhu and Kraemer, 2005).

#### **5.4. Research method and data**

A survey instrument was designed to investigate the ascendants of ERP value. A web-based survey was developed from existing literature by choosing appropriate items and creating items as necessary. A group of five established researchers reviewed the instrument for

content validity (Venkatesh et al., 2012). The initial questionnaire was pilot tested on 10 firms to assess any item's difficulty or ambiguity, as well as test the reliability and validity of the scales. Some items were revised for clarity. This phase provided preliminary evidence of the reliability and validity of the scales. With assistance from the IDC, questionnaires were sent in September - October 2011. In total, 2000 SMEs received the web-survey, and 883 valid responses were returned, resulting in a response rate of 44%, which is compared to others studies of similar scale is much higher. To ensure the generalization of the survey results, the sampling was stratified by country (Denmark, Portugal, Spain, and Sweden), by firm size (fewer than 250 employees), by vendor's product proposal for SME market (Microsoft NAV, SAP All-in-One, ORACLE JDE, and SAGE X3) and by industry type (finance, distribution, manufacturing, and professional-services). Tables I and II show the characteristics of the sample.

Characteristics		(N)	(%)
<b>Industry type</b>	Distribution	252	28.5
	Manufacturing	222	25.1
	Finance	216	24.5
	Professional services	193	21.9
<b>Respondent's position</b>	CEO/owner	204	23.1
	IT/IS manager	173	19.6
	Finance manager	178	20.2
	Sales manager	229	25.9
	Manufacturing manager	99	11.2

Note: N - represents the number of responses,

% - represents the percentage of the 883 respondents

Table 5.1. Characteristics of the sample (N=883)

Additionally, Table 5.1 shows that the respondents were individuals qualified to speak about the firm's ERP value, which suggests the good quality of the data.

Characteristics		(N)	(%)	Data-Base <sup>1</sup>	User-friendly <sup>2</sup>
<b>Product</b>	DYNAMICS	266	30.1	SOL	57.6
	ORACLE (JDE)	208	23.6	Oracle	38.3
	SAGE (X3)	192	21.7	Mix	52.5
	SAP (All-in-one)	217	24.6	Mix	41.9

Note: N - represents the number of responses

% - represents the percentage of the 883 respondents

<sup>1</sup>Data-Base used to run ERP application

<sup>2</sup>User-friendly, represents responses in percentage

Table 5.2. Characteristics of the sample by product

The constructs and measurement items were developed on the basis of the theoretical foundation discussed in the previous section, as shown in Table 5.3. Respondents were asked to rate their perception. While the ERP use construct was measured by items scaling for responses in percentages, other constructs were measured by a five-point Likert scale, in which 1 means “low” and 5 “high”

<b>Construct / Item-question</b>	
With regard to firm ERP user’s experience, please tell us how much you agree or disagree with the following enquiries about your ERP system.	
<b>Collaboration</b>	
Please rate the degree of effectiveness for users to...	
CO1	...collaborate with colleagues.
CO2	...collaborate with the system.
CO3	...communicate with suppliers, partners, and customers.
<b>ERP use</b>	
According to ERP use, please assess how...	
ERPu1	...many employees use the system daily?*
ERPu2	...much time per day employees work with the system.
ERPu3	...many reports are generated per day.
<b>Analytics</b>	
According to ERP system, please rate the degree of...	
AN1	...comprehensive reporting.
AN2	...real-time access to information.
AN3	...data visibility across departments.
<b>ERP value</b>	
Please rate the degree of ERP impact on...	
ERPv1*	...user satisfaction.
ERPv2	...individual productivity.
ERPv3	...customer satisfaction.
ERPv4	...management control.
<b>Note:</b> *ERPu1 question-item was excluded due to low loading.	

Table 5.3. Survey questions

## 5.5. Results

In the next two sub-sections we analyse the measurement model, and test the structural model. As none of the items in our data are normally distributed ( $p < 0.01$  based on the Kolmogorov-Smirnov test), the partial least squares (PLS) is the appropriate method to use to estimate the research model (Chin, 1998).

### 5.5.1. Measurement model

Measurement of the model is shown in Tables IV and V. We assessed indicator reliability, construct reliability, convergent validity, and discriminant validity.

1) Indicator reliability was evaluated based on Chin's (1998) criterion, that the correlations between the constructs and their indicators should be greater than 0.7. For this reason, with the exception of ERPu1 question-item (low loading), we retain all items in Table 5.3 that are significant at ( $p < 0.001$ ). 2) Construct reliability was tested using the composite reliability (CR) coefficient. Table 5.4 shows that the CR for each construct is above the cut-off of 0.7 (Chin, 1998). 3) Average variance extracted (AVE) was used as the criterion to test convergent validity; Table 5.4 shows that AVE for each construct is above the cut-off of 0.5 (Chin, 1998). 4) Discriminant validity of the constructs was assessed using two criteria; the Fornell-Larcker (1981) criterion and cross-loadings. For the first criterion we compute the square root of AVE (Table 5.5 in bold) for constructs, which are greater than the correlation between each pair of constructs (off-diagonal elements). The second criterion ensures that the loadings of each indicator are greater than all cross-loadings (Chin, 1998). The Table with loadings and cross-loadings is available from the authors on request.

<b>Items (loadings<sup>3</sup> range)</b>	<b><u>DYNAMICS NAV</u></b> (N=266)		<b><u>ORACLE JDE</u></b> (N=208)		<b><u>SAP All-in-One</u></b> (N=217)		<b><u>SAGE X3</u></b> (N=192)	
ERP use	0.89-0.90		0.90-0.75		0.78-0.92		0.91-0.82	
Collaboration	0.77-0.93		0.83-0.92		0.87-0.95		0.63-0.86	
Analytics	0.82-0.97		0.69-0.91		0.94-0.96		0.65-0.81	
ERP value	0.85-0.92		0.81-0.92		0.84-0.86		0.74-0.88	
<b>Construct</b>	<b><u>CR</u></b>	<b><u>AVE</u></b>	<b><u>CR</u></b>	<b><u>AVE</u></b>	<b><u>CR</u></b>	<b><u>AVE</u></b>	<b><u>CR</u></b>	<b><u>AVE</u></b>
ERP use (ERPu)	0.896	0.812	0.814	0.688	0.841	0.726	0.860	0.755
Collaboration (CO)	0.875	0.702	0.905	0.761	0.941	0.842	0.799	0.580
Analytics (AN)	0.890	0.729	0.857	0.670	0.861	0.687	0.790	0.558
ERP value (ERPv)	0.926	0.806	0.884	0.718	0.886	0.721	0.855	0.665

Note: <sup>3</sup>  $p < 0.001$

Table 5.4. Item question Loadings, CR, and AVE construct values (products)

Construct	<u>DYNAMICS NAV</u>						<u>ORACLE JDE</u>					
	Mean	SD	ERP <sub>u</sub>	CO	AN	ERP <sub>v</sub>	Mean	SD	ERP <sub>u</sub>	CO	AN	ERP <sub>v</sub>
ERP use (ERP <sub>u</sub> )	82.26	10.47	<b>0.90</b>				75.47	9.47	<b>0.83</b>			
Collaboration (CO)	3.7	0.55	-0.01	<b>0.84</b>			3.64	0.54	0.29	<b>0.87</b>		
Analytics (NA)	4.28	0.56	0.16	0.57	<b>0.85</b>		3.93	0.47	0.21	0.37	<b>0.82</b>	
ERP value (ERP <sub>v</sub> )	4.02	0.58	0.11	0.59	0.77	<b>0.90</b>	3.87	0.39	0.38	0.42	0.47	<b>0.85</b>
Construct	<u>SAP All-in-One</u>						<u>SAGE X3</u>					
	Mean	SD	ERP <sub>u</sub>	CO	AN	ERP <sub>v</sub>	Mean	SD	ERP <sub>u</sub>	CO	AN	ERP <sub>v</sub>
ERP use (ERP <sub>u</sub> )	76.26	9.79	<b>0.85</b>				68.67	10.87	<b>0.87</b>			
Collaboration (CO)	4.00	0.56	0.32	<b>0.92</b>			3.79	0.46	0.14	<b>0.76</b>		
Analytics (NA)	4.04	0.53	0.11	0.67	<b>0.83</b>		3.88	0.42	0.35	0.30	<b>0.75</b>	
ERP value (ERP <sub>v</sub> )	3.93	0.47	0.37	0.69	0.49	<b>0.85</b>	3.90	0.46	0.20	0.62	0.42	<b>0.82</b>

**Note:** Diagonal elements are square root of AVEs and off-diagonal elements are correlations.

Table 5.5. Descriptive Statistics, Correlations, and the square root of AVEs (products)

Consequently, our model has good internal consistency, convergent validity, and discriminant validity for all products. Thus, constructs developed using this measurement model can be used to assess the structural model.

### 5.5.2. Structural model

The structural model was assessed by examining the  $R^2$  and the level of significance of the path coefficients. The significance of the path coefficients was derived from bootstrapping (500 resamples) (Chin, 1998). Figure 5.3 shows the model results and path coefficients.

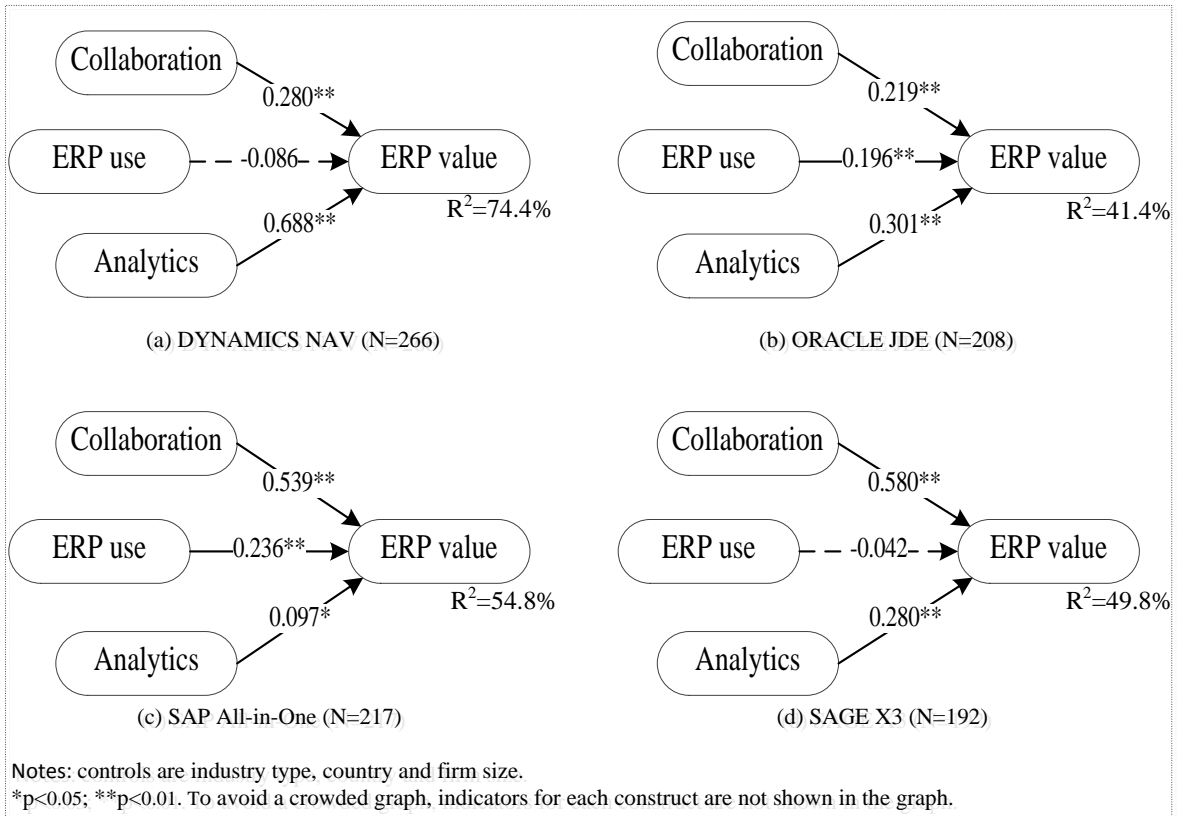


Figure 5.3. Path models by product

An examination of the  $R^2$  values reveals that ERP use, collaboration, and analytics factors explain the variability of ERP value. The result shows values above 40%, which suggests a good fit for the model. In both DYNAMICS and SAGE samples, ERP use shows a negative path, while the other two factors have positive paths. This result shows that the negative paths are not statistically significant, and therefore that even if both DYNAMICS and SAGE models indicate a link from ERP use to ERP value, it is not supported. Thus, only collaboration and analytics are supported by the model. In both ORACLE and SAP samples, all three factors show positive paths and are statistically significant. Thus, ERP use, collaboration, and analytics are supported. While collaboration in the SAP and SAGE samples has a stronger relationship (0.539 and 0.580 respectively) with ERP value, analytics

has a stronger relationship in the DYNAMICS and ORACLE samples (0.688 and 0.301 respectively).

In short, H1 (Collaboration) and H3 (Analytics) are supported for all four products, and H2 (ERP use) is supported only for ORACLE and SAP.

To deepen the analysis, the differences between paths coefficients across products were tested (Table VI). For that we used Kiel's et al. (2000) test statistic:

$$t = \frac{\beta_{(1)} - \beta_{(2)}}{\sqrt{\frac{(n_{(1)} - 1)^2}{n_{(1)} + n_{(2)} - 2} \cdot se_{\beta_{(1)}}^2 + \frac{(n_{(2)} - 1)^2}{n_{(1)} + n_{(2)} - 2} \cdot se_{\beta_{(2)}}^2} \cdot \sqrt{\frac{1}{n_{(1)}} + \frac{1}{n_{(2)}}}}$$

Table 5.6 shows that collaboration has no statistically significant differences ( $p > 0.05$ ) between DYNAMICS-ORACLE and SAP-SAGE, being equally important for both products. For ERP use, results between DYNAMICS-SAGE and ORACLE-SAP show that there are no statistically significant differences ( $p > 0.05$ ), being equally important for both products. Moreover, analytics has statistically significant differences between DYNAMICS-ORACLE ( $p < 0.01$ ), DYNAMICS-SAP ( $p < 0.01$ ), and DYNAMICS-SAGE ( $p < 0.05$ ). Additionally, the major difference amongst products is between DYNAMICS-SAP, which shows statistically significant differences for the ERP use ( $p < 0.01$ ), collaboration ( $p < 0.05$ ), and analytics ( $p < 0.01$ ).

Products comparison	ERP use ->	Collaboration ->	Analytics ->
	ERP value Test statistic	ERP value Test statistic	ERP value Test statistic
DYNAMICS-ORACLE	-4.279**	1.224	4.995**
DYNAMICS-SAP	-4.035**	-2.516*	6.381**
DYNAMICS-SAGE	-0.581	-4.127**	5.81*
ORACLE-SAP	-0.183	-3.171**	1.811
ORACLE-SAGE	3.023**	-5.651**	0.238
SAP-SAGE	2.895**	-0.359	-1.678

Note: \*p<0.05; \*\*p<0.01.

Table 5.6. Results of test statistic comparisons between products

Overall, the above results provide support for the cross-product differences in the determinants shaping ERP value in which firms adopt IT, thereby supporting hypothesis 4.

## 5.6. Discussion

Regardless of which ERP package SMEs use to run their business, when their IT capabilities are properly exploited (greater use, collaboration and analytics), they will support the firm's business integration to streamline the flow of the materials and information in supply chains. This effect has been proposed by several researchers as being the mechanism to fully exploit the value of information technology (Markus et al., 2000a, Mabert et al., 2001, Cotteler and Bendoly, 2006, Gattiker and Goodhue, 2005, Ranganathan and Brown, 2006), but to our knowledge it has never been empirically tested. The present study provides empirical evidence of the ERP capabilities effect.

We found that whereas ERP use, collaboration, and analytics have a direct and positive impact on firm performance, these IT capabilities do complement each other. In accordance with Forslund (2010), we further argue that the integration of these capabilities is the key mechanism in creating greater value and competitive advantage, because even though the technology is imitable, the knowledge about how to effectively integrate and use the

technology and business process is firm specific, which is consistent with RBV.

Our results show that SMEs have the same business needs as large enterprises in the pursuit of a sustainable competitive advantage. Through the greater use, collaboration, and better analytical information, SMEs assess these determinants as ERP value. However, probably due to a lack of financial and human resources, SMEs are using ERP as the primary resource to exploit these capabilities, whereas large firms extend ERP capabilities through the integration of other IT resources: EDI or e-commerce for collaboration, and business intelligence or data-mining for analytics, and new user interfaces for greater use (Swaminathan and Tayur, 2003, Davenport and Harris, 2007, Lucas et al., 2008).

Referring back to our research question about how firms find value in their ERP, contrary to the conclusions of Zhu and Kraemer (2005), Devaraj and Kohl (2003), and Kremers and Dissel (2000), as well as our predictions that system use is a missing link to IT value, the question of interest now becomes, “why is there a difference between DYNAMICS-SAGE and ORACLE-SAP?”. Although our results reveal a positive effect of ERP use on ERP value, it is not perceived as being relevant amongst DYNAMICS and SAGE users. As it is a widely-held belief that firms with greater ERP use are more likely to generate higher ERP value, this difference might be explained by user friendliness of DYNAMICS and SAGE products, as per Table II; that is, having few steps to perform and simple processes, and being easy to move around in, these packages enjoy greater daily-systems usage, communication, and reporting, which implies a drop in the importance (Häkkinen and Hilmola, 2008, Lucas et al., 2008). Therefore, ERP use is not perceived as significant in comparison to collaboration and analytics. Contrarily, ORACLE and SAP users attach considerable importance to ERP usage, probably because they use only the out-of-the-box functions. For ERP use the product

perceived as being a greater facilitator for ERP value is SAP, followed by ORACLE. Still, within SMEs another (complementary) explanation could be related to customer's firm size (Buonanno et al., 2005), because DYNAMICS and SAGE customers are typically smaller and less complex than the average SAP or ORACLE customer.

The results also show that, although collaboration is perceived as important for all products, it is more important to SAP and SAGE. The underlying rationale could be that both applications are supported on non-proprietary data bases (DB), as shown in Table II. Perhaps because they are not built on proprietary infrastructure, SAP and SAGE installations may face issues about compatibility that affect customer relationships, supply chain processes, communication, and so forth (Forslund, 2010, Sen and Sinha, 2005, Rai et al., 2006, Lee et al., 2000, Phusavat et al., 2009).

As shown in Figure 5.3, the analytics system capability is also perceived as important for all products, but has the highest path coefficient for DYNAMICS and ORACLE. The underlying rationale could again be the dependence on the DB used, that is, a proprietary DB facilitates the development and implementation of solutions for business analytics made on the same logic, and sees the standard ERP as a system that is used for supporting other systems with data running on the same type of DBs (Sen and Sinha, 2005). In this way the greater availability of information challenges firms to undertake analytics calculations that are more complex. Moreover, comparing products, Table VI reveals that analytics is more important amongst DYNAMICS users than amongst ORACLE users.

While collaborating with colleagues, systems, suppliers, partners, and customers increases productivity, analytics provides greater business insight for better decision making processes. These two ERP-enhanced capabilities help firms to improve performance because they are

firm specific, difficult to imitate, and less mobile across firms – all of which is consistent with the RBV theory. The fact that collaboration and analytics are important factors for ERP value in all products shows that ERPs are being used not only as a transaction processing system, but also as a front-end application to raise SMEs' performance, which is in line with Buonanno et al.'s (2005) study about differences with large firms.

From a different angle, for DYNAMICS, analytics capability is perceived as the most important factor of ERP value, followed by collaboration, but greater ERP use is not important in comparison to other factors. For ORACLE, analytics capability shows the strongest link to ERP value, followed by collaboration and ERP use. For SAP, greater collaboration is perceived as the most important factor of ERP value, followed by ERP use and analytics. Finally, for SAGE, greater collaboration shows a stronger link to ERP value, followed by analytics, and greater ERP use is not important.

### **Implications**

Three important managerial implications follow from this research:

1) Since the collaboration chain demands significant investment, in money as well as in time, it is considered as a risky investment. The challenge is to convince every employee, department in the firm, business partner, supplier, and particularly customer that each entity along the supply chain will benefit from information sharing (Lee et al., 2000, Forslund, 2010). Our research shows that through collaboration firms increase individual productivity and customer satisfaction (Park et al., 2007, Mabert et al., 2001, Hitt et al., 2002). Whether the cost and effort invested in collaborative systems would be justified for the organization is uncertain, but our study shows that firms invest in ERPs with the belief that such cost and effort will pay off. That is, the higher the level of collaboration, the better the resulting

performance.

2) Our study highlights use as an important linking stage in ERP post-adoption leading to value. This link suggests a dependence on how user-friendly the ERP system is (Lucas et al., 2008) and how successful the implementation process was (Dezdar and Sulaiman, 2009). When ERP is easy to use it will be used to a greater extent across a wider scope of value chain activities, which increases the degree of process automation and reduces coordination costs along the chain. In addition, due to the user-friendly interface (which probably encourages system use) ERP leads to user satisfaction and improves skills for managing ERP (Calisir and Calisir, 2004, Häkkinen and Hilmola, 2008, Bradford and Florin, 2003). Our results provide evidence that the role of system usage calls for further investigation, contradicting Delone and McLean (2003), Zhu & Kraemer (2005) and Devaraj and Kohli (2003), who assert that system use is the missing link to IT payoff.

3) At the analytics level, firms should utilize the ERP to build the firm's specific business capability, such as sharing information on inventory, lead-times, production planning, and forecasting. Our research shows that through analytics firms expect that the business process can reduce the bullwhip-effect, decrease inventory level, accelerate time to market, and increase profitability and management control (Mabert et al., 2001, Cotteler and Bendoly, 2006, Hitt et al., 2002, Gattiker and Goodhue, 2005, Helo et al., 2008). Our results demonstrate that firms, and more precisely SMEs, are now using IT differently than in the early 1990s. As indicated by Barney (1991) relatively few firms were able to deeply embed their information processing system into their daily business process and management decision-making process. Creating close business-IT alignment is now recognized by SMEs as holding out the potential of sustained competitive advantage for those that can achieve it.

### **Contribution to theory**

This study makes three specific contributions to IS literature.

1) Grounded on the RBV theory, we propose a research model for studying ERP value. 2) We conceptually and empirically distinguish between two concepts; resources and capabilities. We claim that a firm's ERP systems serve to build the firm's specific capabilities that RBV claims to affect the realization of business value. 3) As stated by Melville et al. (2004), IT value literature indicates that merely adopting IT does not by itself guarantee the achievement of performance improvements. It is only when firms develop effective capabilities that IT investments produce operational improvements. The fact that adopters of the same ERP product often show vastly differing results suggests that there are firm-specific capabilities at play. The present study has shown that ERP use, collaboration, and analytics are important capabilities that affect ERP value. In summary, the findings contribute to the debate on IT value, more precisely, on ERP ecosystems. Furthermore, this framework could be applied by researchers to study other complex IS in different contexts.

### **Limitations and future work**

While we believe that we have developed a sound and rich theoretical model for analysing ERP value, there are some limitations.

1) Perhaps the number of years using the system influence ERP value and further work should study maturity stages (Holland and Light, 2001). 2) Different environments may influence ERP value and we encourage further studies that compare industries (Oliveira and Martins, 2010). 3) In accordance with theoretical arguments, ERP value was measured by intangible factors. Future work should also assess objective factors such as the impact on upstream

coordination, internal operations, and downstream sales (Zhu and Kraemer, 2005).

## **5.7. Conclusions**

IT value is a subject that draws much attention from both academics and practitioners. This study seeks to better understand the factors that contribute to value creation of *enterprise resource planning* (ERP) and in *small and medium enterprises* (SME). Grounded in the *resource-based view* theory of the firm, this is the first empirical study to assess ERP value across four commercial ERPs amongst European SMEs. To realize ERP value, SMEs are looking beyond and exploiting through greater use the embedded capabilities. We show that the antecedents of ERP value differ across products. Whereas for DYNAMICS NAV and ORACLE JDE the most important factor is analytics system capability, for SAP All-in-One and SAGE X3 it is greater collaboration system capability. The overall conclusion is that analytics and collaboration are important factors for ERP value, providing evidence that SMEs are not only using ERPs as transaction processing systems, but also as front-end applications. Because of globalization, partnerships, value chains, and the enormous information flow across and within SMEs today, more and more SMEs are adopting ERP systems. The study adds new knowledge to IS research and provides valuable managerial implications.

## Chapter 6 – Conclusions

This dissertation investigates the determinants of *enterprise resource planning* (ERP) systems in post-adoption stages amongst *small and medium enterprises* (SMEs).

ERPs enable firms tighter links up and down the supply chain, from raw material suppliers to customers, and is aimed at achieving the supply chain management goal: Just-in-Time (delivering the right product, in the right place, at the right time, and at the right quantity), for a firm's competitive advantage. SMEs have been recognized as fundamentally different environments compared to large enterprises and organizational size plays an important role in ERP business value. The literature argues that little attention has been given to research on ERP in SMEs, as the majority of the ERP studies are based on findings from large enterprises (Mabert et al., 2003, Buonanno et al., 2005, Muscatello et al., 2003, Loh and Koh, 2004).

As European SMEs increasingly seek to improve their performance in value chain activities by using ERP systems, it is important to understand what factors influence ERP use and value. Drawing upon the *diffusion of innovation* (DOI) literature and the *resource-based view* (RBV) theory, this dissertation has theoretically developed and empirically evaluated an integrative research model to assess ERP use and value using primarily data, at the firm level in different contexts. This unified perspective provides a more holistic picture of the post-adoption diffusion and consequence of ERP on firm's performance, and moves beyond dichotomous "adoption versus non-adoption" found in literature.

Albeit few, previous studies have already addressed the importance and benefits of using ERP, but are limited in consideration of link use with value as an important factor for firm to

fully exploit benefits of information technology. There is also lack of empirical studies justifying whether ERP embedded capabilities can better exploit value of IT.

Drawing on a long stream of research on innovation diffusion theory, in this dissertation we integrate determinants based on DOI models in order to explain the ERP use, and grounded on the competitive advantage literature we integrate determinants based on RBV theory in order to explain ERP value. For ERP use, our research has examined six factors (complexity, compatibility, efficiency, best-practice, training and competitive pressure) as drivers of ERP use. Some of these factors play different roles across different economic environments. For ERP value, our study has demonstrated that the extent of ERP use and ERP capabilities (collaboration and analytics), contribute to value creation of ERP, which is consistent with the resource-based theory, in the sense that these capabilities possesses the value-creating characteristics of resources (that is, firm specific and difficult to imitate). These factors have different importance across countries and products. This finding shows that, although ERP is an international phenomenon amongst SMEs, its use and value is influenced by the context, more precisely, local environments and adopted commercial-package.

In chapter 2 we explore the concept that ERP post-adoption is a key determinant of firm performance amongst Portuguese context. This study shows that compatibility, complexity, efficiency, best-practices, training, and competitive pressure are significantly associated with ERP use, and together with collaboration and analytics contribute to value creation from ERP.

Next in Chapter 3 we study ERP post-adoption amongst Portuguese and Spanish context. This study shows that whereas competitive pressure, training and best-practices are important

to both Portuguese and Spanish SMEs, cross-country analysis also shows complexity to be an important inhibitor for ERP use among Portuguese firms, but a facilitator for Spanish. In addition, while for Portuguese SMEs, compatibility and efficiency are significant, they are not for Spanish. Furthermore as transactional efficiency, collaboration and business analytics are important determinants for both Portuguese and Spanish firms, analytics is more important for Spanish firms. For ERP value this study demonstrates that the degree of ERP use and IT-enhanced capabilities such as collaboration and analytics, contribute to value creation from ERP. Moreover, this study reveals that for Portuguese firms ERP value is mainly explained by ERP use, collaboration, and analytics, whereas for Spanish firms ERP value is mainly explained by collaboration and analytics capabilities.

We then further investigate cross-regions differences between Scandinavian and Iberian SMEs. In Chapter 4 we find that whereas for both regions, competitive pressure, efficiency and best-practices are important factors to use ERP, analytics and collaboration are important for ERP value. Furthermore, whereas complexity and training are not relevant for ERP use among Scandinavian, they are facilitators for Iberian.

To further assess the ERP business value in SMEs we also investigate the differences and similarities between four commercial-package ERP systems, presented in Chapter 5. This study shows that whereas for DYNAMICS NAV and ORACLE JDE the most important factor is analytics system capability, for SAP All-in-One and SAGE X3 it is greater collaboration system capability. Furthermore, whereas for SAP All-in-One and ORACLE JDE the greater ERP use is perceived as an important factor, it is not for DYNAMICS NAV and SAGE X3.

Because analytics and collaboration are important factors for ERP value in all contexts, provides evidence that European SMEs are not only using ERPs as transaction processing systems, but also as front-end applications. These studies also evidence that both cultural differences, adopted commercial-packaged ERP and the number of years using the systems play a role in shaping ERP use and value.

## **6.1. Contributions**

This dissertation has several important contributions. First, contributes to the debate on IT value; more precisely to better understanding ERP in the post-adoption stages amongst SMEs, thus moving beyond large enterprises as well from the dichotomous ‘adoption versus non-adoption’ usually found in IS literature. Second, to the best of our knowledge, this is the first empirical theoretically grounded research studying ERP use and value amongst European SME, thus adding an international dimension to the information management discipline. Third, we have developed several constructs such as transactional efficiency, best-practices, collaboration and analytics, which have passed convergent validity testing. These have been important determinants to explain ERP post-adoption. Therefore, we contribute to the research of IT value by including them. Fourth, our results reveals that while compatibility, transactional efficiency, and embedded best-practices are perceived as ERP core necessities, collaboration and analytics functionalities are perceived as core functions to gain competitive advantage. Sixth, this dissertation also explains the phenomenon of how it is that a few employees using the ERP system have a great impact on firm performance, and that European SMEs value ERP for its greater contribution on individual productivity, customer satisfaction, and management control. Seventh, we have shown that the proposed research model is a useful theoretical framework for explaining determinants that affect the

ERP use and value in different contexts. Finally, theoretically grounded on DOI and RBV, this research shows usefulness and we hope that these initial results will motivate others to engage in future research to refine the theory and measurement.

## **6.2. Limitations and future work**

While we believe that we have developed a sound and rich theoretical model for analysing ERP use and value, there are some limitations that might form the starting point for further research. First, although our empirical results show that relationships exist among the determinants, we cannot speak empirically to the issue of whether value is sustained, because this requires a longitudinal study, so longitudinal studies could be developed. Second, although our study shows evidence that ERP post-adoption importance varies across-countries in association with the number of years using ERP and that cultural factors are associated, we cannot speak empirically about the issue of whether the maturity stages play a role, nor on the effect of regions' culture on ERP. An interesting different direction could be to study the maturity stages of ERP (Holland and Light, 2001), as well as culture influences on ERP post-adoption (Lee et al., 2012, Sherer et al., 2011). Third, although data cover industry types, some biases may have been introduced. Perhaps different industries have different operating characteristics and environments, and the factors related to ERP use and value may differ accordingly (Oliveira and Martins, 2010a). Consequently, we encourage further studies that compare industries. Finally, in accordance with theoretical arguments, ERP value was measured by intangible factors. Probably future work should also assess objective factors such as the impact on upstream coordination, internal operations, and downstream sales (Zhu and Kraemer, 2005).



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## Appendix A. Items measurements

Variables	Indicators	Literature support
Using a five-point scale, where 1 means 'low' and 5 means 'high', the variables were measured by asking respondents* to rate their perception with regards to firm's ERP.		
<u>Independent variables:</u>		
<b>Compatibility</b>	was measured by the degree to which ERP is compatible with other...	
CB1	...software.	(Bradford and Florin, 2003,
CB2	...hardware.	Elbertsen et al., 2006)
CB3	...networks.**	
<b>Complexity</b>	was measured ( <i>reverse code</i> ) by how...	
CX1	...easy it is for users to learn the system.**	(Cooper and Zmud, 1990,
CX2	...how intuitive is to users use the system.	Kositaurit et al., 2006,
CX3	...comfortable users feel in using it.	Chang et al., 2011a)
<b>Efficiency</b>	was measured by...	
EF1	...the efficiency in executing repetitive tasks.	(Rajagopal, 2002, Bendoly
EF2	...efficiency of user-interface.	and Kaefer, 2004, Gattiker
EF3	...speed and reliability of system.	and Goodhue, 2005)
<b>Best-practice</b>	was measured by how ERP standardised-package (best-practices) fits firm's processes.	
Respondents were asked to rate the degree...		(Chou and Chang, 2008,
BP1	...of ease is for users to setup the application	Wenrich and Ahmad, 2009,
BP2	...to which one can map workflows based on local requirements (such as VAT, SEPA)	Maguire et al., 2010)
BP3	...of system adaptability to business needs.	
<b>Training</b>	was measured by the degree to which training programmes make sure users...	
TN1	...were trained on the system.**	(O'Leary, 2000, Bradford and
TN2	...understood the content training material.	Florin, 2003, Maguire et al.,
TN3	...navigate through the topic formats applied to daily tasks	2010)
<b>Competitive pressure</b>	was measured by the degree to which...	
CP1	...firm has experienced competitive pressure to use ERP	(Bradford and Florin, 2003,
CP2	...firm would have experienced competitive disadvantage if ERP had not been adopted**	Zhu and Kraemer, 2005,
CP3	...the ERP usage in firm's competitors affects their landscape market	Oliveira and Martins, 2010b)
<b>Collaboration</b>	was measured by the extent to which is for users...	
CO1	...collaborate among colleagues.	(Calisir and Calisir, 2004,
CO2	...collaborate with the system.	Gattiker and Goodhue, 2005,
CO3	...collaborate with suppliers, partners, and customers.	Ruivo and Neto, 2011)
<b>Analytics</b>	was measured by the extent to which the ERP provides...	
AN1	...comprehensive reporting (KPIs, Dashboards).	(Davenport and Harris, 2007,
AN2	...real-time access to information.	Chiang, 2009, Ruivo and
AN3	...data visibility across departments.	Neto, 2011)
<u>Dependent variables:</u>		
<b>ERP use</b>	was measured by how...	
ERPUI	...many employees use the system daily.**	(Bradford and Florin, 2003,
ERPU2	...much time per day employees work with the system.	Devaraj and Kohli, 2003, Zhu
ERPu3	...many reports are generated per day.	and Kraemer, 2005)
<b>ERP value</b>	was measured by how much ERP increased...	
ERPVI	...user satisfaction.	(Bradford and Florin, 2003,
ERPVI2	...individual productivity.	Devaraj and Kohli, 2003, Zhu
ERPVI3	...customer satisfaction.	and Kraemer, 2005, Shahin
ERPVI4	...management control.	and Ainin, 2011)

\* Respondents types were: CEO, owner, IT/IS manager, Finance manager, Sales manager and Manufacturing manager

\*\* CB3, CX1, TN1, CP2, and ERPU1 question-items were excluded after PLS model estimation due to low loadings.